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RENEWABLE ENERGY

Market & Policy Trends in IEA Countries

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The International Energy Agency (IEA) is an autonomous body which was established in November 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme.

It carries out a comprehensive programme of energy co-operation among twenty-six* of the OECD's thirty member countries. The basic aims of the IEA are:

- to maintain and improve systems for coping with oil supply disruptions;
- to promote rational energy policies in a global context through co-operative relations with non-member countries, industry and international organisations;
- to operate a permanent information system on the international oil market;
- to improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use;
- to assist in the integration of environmental and energy policies.

** IEA member countries: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, the Republic of Korea, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States. The European Commission also takes part in the work of the IEA.*

ORGANISATION FOR
ECONOMIC CO-OPERATION
AND DEVELOPMENT

Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The original member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996), the Republic of Korea (12th December 1996) and Slovakia (28th September 2000). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

Foreword

Renewable energy receives a great deal of attention as a possible contributor to solving some of today's energy challenges. Much of the debate has taken place without sufficient overview information about renewable energy policies and markets. To help fill that gap, *Renewable Energy Market and Policy Trends in IEA Countries* provides the best compilation yet of information on renewable energy over the last thirty years. It includes statistical data on more than 100 specific markets and a collection of almost 400 policies and measures that the IEA Member country governments have undertaken in research and development and to support the market deployment of renewable energy technologies.

The history presented here underscores that each renewable energy technology is unique, demonstrating quite different characteristics, levels of maturity and needs for market success. Hydropower, burning wood for heat and geothermal energy are the most mature renewable technologies, and mostly compete in today's markets without special policy support. They can be cost-competitive where the resource base is strong and where there is ready access to market the energy produced. Hydropower and geothermal energy achieved their current market share through a development path that included a substantial governmental role, while wood burning has been a traditional energy resource for millennia. Less mature, "new" renewables, including wind power, solar technologies and newer forms of bioenergy, are only now entering markets, and like other emerging energy technologies, have received governmental support for both technological development and for market deployment.

RD&D funding has been a longstanding tool of governments to develop technologies with perceived future benefits, including renewables. Government-funded RD&D usually is based on the fact that the private sector, particularly in competitive markets, typically will only invest in technology with foreseeable revenues. This report clarifies the level of RD&D support provided to renewables by each of the IEA governments, in the context of RD&D support to all energy technologies.

To support the market entry of new renewables, many policies have been established in IEA countries to offset their higher costs and to facilitate the market experience that will result in lower costs in the future. These approaches lead to "market learning", which is not unique to renewables, but is particularly relevant as these technologies are still quite immature. This study finds that the number of countries that pursued aggressive policies to encourage deployment of each renewable technology prior to 2000 was quite limited and the momentum of wind, solar photovoltaics and solar thermal power technologies rests on significant investments in just a handful of countries. Nevertheless, these new renewables have shown strong growth up to 2001 and have achieved substantial cost reductions as a result of their market experience, indicating the success of government intervention. The policy context is changing, however, as many new policies have been instituted between 2000 and 2003, increasing the number of countries with supportive policy conditions. These developments are too recent for the impacts to be seen in our statistics.

If these policies should prove to be successful in stimulating markets, new renewables present several challenges to integration into conventional markets and technical infrastructures. For example, the intertwined problems of intermittency and impacts on grid reliability present two of the strongest challenges to wind energy's future prospects. Because utilities must supply power in close balance to demand and within a narrow range of power quality, intermittency will limit the amount of wind that can be integrated into the grid, although it is not yet clear at what level. Photovoltaic provides another example, where highly dispersed generation poses new questions about distributed generation modalities in utilities. Finally, the incorporation of biofuels into the product stream of the fossil fuel industry and into the systems that utilise fossil fuels also present challenges, due to the different chemistries of the fuels, as well as the different industrial structure of fuel production. These challenges, and the national experience of dealing with them, are reported in the country profiles contained in this study.

In some regards, renewable energy market deployment incentives are a substitute for the costs of externalities. IEA governments often cite future energy security and environmental benefits in the establishment of renewable energy policies. This highlights the challenge for energy policy-makers who are balancing today's costs with tomorrow's needs in more liberalised markets – how much support for renewables is justified and for how long should it be provided? New renewables are not the only set of technologies on the pathway to the market; policy support afforded to them may be an indication of appropriate support levels for other innovative technologies such as fuel cells, hydrogen, clean coal technologies, and many others that will need governmental support to gain entry and experience in energy markets.

This study also underscores a major challenge to IEA governments: adequate data on early market development, technology cost information and details of policy budgets are extremely difficult to obtain. Our ability to conduct analysis of the cost-effectiveness of market deployment policies rests on the availability of accurate and detailed information. Such information is not yet available for renewables, and although we are well on the way to compiling it, this is why cost and budget details are not given in this study. This same issue is pertinent to other emerging technologies, and we call on the Member governments to increase their efforts at recording and making this detailed information available. Greater transparency will allow rational assessment of the cost-effectiveness of policies.

Renewable energy technologies are not the only options to be considered for solving today and tomorrow's energy challenges. In the end, renewables must achieve cost-competitiveness with fossil fuel and nuclear technologies and markets should work with minimal extraneous influence, yet taking into account external costs. Like RD&D, market deployment incentives have been provided in the past for almost all major energy technologies and are likely to be employed in the future. The challenge is to determine what level and length of support is appropriate to ensure strategic options that are important to build a secure and sustainable energy system. This includes options for a host of energy challenges, including energy access for the world's poor in developing countries, as well as providing secure, clean energy supply for more industrialised regions.

Renewable Energy Market and Policy Trends in IEA Countries details the policy and market histories of renewables over the past thirty years to record our efforts to develop alternative energy resources to improve the world's energy supply and demand structure. It is intended to inform the discussion about energy options and the further improvement of policies to enhance the performance of the energy sector toward the three pillars of energy policy – energy security, economic growth, and environmental quality.

This work is published under my authority as Executive Director of the IEA and does not necessarily reflect the views of the IEA Member countries.

Claude Mandil
Executive Director

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Part 1

Overview

Introduction

Energy policy-makers in IEA Member countries are facing the daunting challenge of achieving energy security, environmental protection and economic efficiency (the three Es). Renewables are considered by many policy-makers to contribute to improving energy security and protecting the environment. On an average cost basis, some renewables in the best locations are competitive with conventional energy sources, however, in many cases renewables are still not competitive. Supportive policies are still needed to encourage the further development and deployment especially of "new" renewables in energy markets.

The development range of renewable energy technologies varies from relatively mature technologies, such as hydropower, solar hot water, geothermal and some forms of biomass, to emerging technologies such as wind power, new biomass technologies, solar photovoltaic and concentrating solar power. There are also other forms of renewables, such as ocean energy and production of hydrogen from renewables that are not yet past the demonstration stage of development and which are not covered in this study. The renewables industry includes decentralised manufacturers and systems companies, electric utilities, independent power producers and retail equipment suppliers. Policy-makers need to account for the full spectrum of highly diverse technology development, as well as the characteristics of the industry and the rules by which the market operates.

In 2001, the most recent year for which complete official data are available, the share of renewable energy in total primary energy supply of IEA countries was 5.5%. The share of oil was 40.9%, gas 21.4%, coal 20.5% and nuclear 11.6%.

An assessment of renewable energy policies needs to be based on their costs and effectiveness. It should also examine how renewables mix with other energy alternatives, including energy efficiency, advanced nuclear power, carbon sequestration and hydrogen. Therefore, efforts to deploy new energy technologies into the marketplace need to identify and address three groups of policies that affect technology development and market uptake:

- **Research and Innovation Policies** that support the development of new and improved technologies;
- **Market Deployment Policies** that underwrite the cost of introducing technologies into the market to improve technical performance and to encourage development of an industry;
- **Market-Based Energy Policies** that provide a competitive market framework, and may internalise externalities in terms of energy security, environmental protection and economic efficiency.

Taken together, these policies constitute the energy policy context that governments need to establish with respect to renewables.

Research and Innovation Policies support technology innovation through basic and applied research up to the demonstration phase. Governments have traditionally played a decisive role in both framing and funding RD&D policies at the national level and in international collaborations. Governments have also been a catalyst in using research and innovation policy to motivate adequate private sector involvement in research, development and demonstration. In the context of the various types of renewables, two questions arise. Has public renewable RD&D in IEA countries been effective? Is the increasing importance attached to renewables adequately reflected in the allocation of public RD&D budgets?

Market Deployment Policies are typically supported by governments to facilitate the market introduction of new technologies with perceived societal value. Such public policy support is generally for a limited time, taking into account the progress needed to make new technologies competitive. Market deployment policies seek to:

- increase technical performance and differentiation of a product or service;
- improve technology cost-competitiveness;
- achieve a sustainable level of production and market share;
- enhance public awareness and social acceptance;
- move towards a sustainable energy system.

Governments have to choose policies with a view to which renewable technologies merit market deployment policy support and the extent and duration of such support. Have market deployment policies for renewables in IEA Member countries been effective based on the criteria above? Most governments have introduced incentives for market deployment of renewable energy technologies because general energy policies do not fully value energy security, economic development and environmental benefits. To some extent, direct funding of renewables is seen as by-passing the process of internalising the external costs of energy supply. Should this be the case in the future?

It is important that governments evaluate the direct and indirect costs of these policies. This will require more concerted efforts to record information on policy costs, market data and technology cost improvements. How long and to what extent should these market deployment policies be maintained for a given renewable type to avoid market distortions or the infant industry trap? How does the costs/benefit ratio of these policies compare with that of other options? These are issues that the IEA intends to pursue through further analysis.

Market-Based Energy Policies ideally should give participants a policy framework that provides a basis to select the best energy choice at the optimal price while internalising externalities related to energy security, environmental protection and economic development. How effective is the present energy policy framework from a three-Es policy perspective? Should governments consider the same policy instruments for all renewable technologies and/or for all carbon reducing energy technologies? What are the economic criteria to take into account, when analysing different local and national impacts? How can renewables policies be harmonised with environmental or energy security policies? How will grids deal with increasingly distributed and intermittent electricity supply? The answers to these and other questions are beyond the scope of this assessment, but their importance for the competitiveness of renewables is undeniable.

This study provides a comprehensive review of renewable energy markets in IEA countries, and renewable energy policies related to research and innovation and to market deployment strategies. The information is intended to provide a valuable resource for IEA Member governments to assess their renewables options in particular, and to pursue their energy strategies more generally.

Part 1 of this book provides overview information and statistics on renewable energy since 1970 and trends in research and innovation policies in IEA countries. It also categorises and explains the large number of market deployment policies and measures in IEA countries.

Part 2 contains profiles for each IEA country with data on renewable energy supply and an examination of market trends. The profiles take a historic look at RD&D and market deployment policies and measures.

Parts 1 and 2 draw on statistical data provided by official government sources and compiled in *Renewables Information 2003*.[1] More recent data were provided by official and other national sources. Information is as current and complete as possible at the time of publication. It represents the IEA's assessment of renewable energy markets, building on official submissions by national administrations.

An economic analysis of direct and indirect costs and benefits of renewable energy policies is not included in this study. Such an analysis would provide policy-makers with additional information for considering the role of renewables in the broad policy portfolio and the choice of measures in promoting renewables. This issue will be addressed by the IEA in co-operation with the governments and industries of Member countries in the future.

1. *Renewables Information, IEA/OECD, Paris, 2003.*

Chapter 1
Renewables in IEA Energy Supply

Highlights

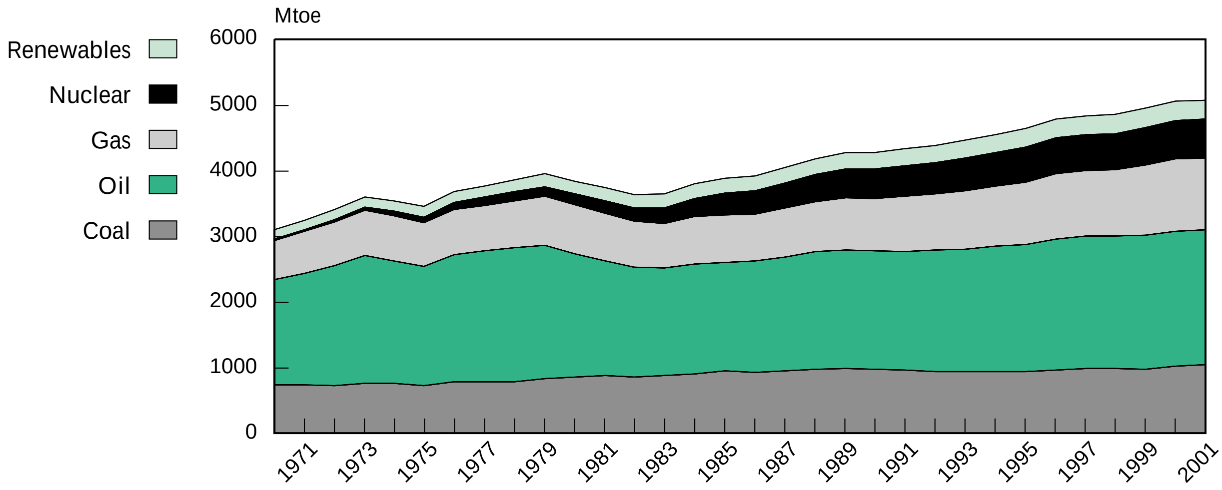
- The share of renewables in total primary energy supply in IEA countries increased from 141.5 Mtoe (4.6%) in 1970 to 280.9 Mtoe (5.5%) in 2001. Over the three decades, renewable energy supply increased at an annual average rate of 2.2% compared with 1.6% for TPES. Most of the increase in the share of renewables occurred from 1970 to 1990, when renewables supply grew by 2.8% a year. The annual growth rate of renewables supply slowed to 1.2% from 1990 to 2001.
- More mature renewables such as hydro and geothermal power did not increase and even declined, in the 1990s in many IEA countries. Energy supply from "new" renewables, *e.g.*, wind and solar, however, grew by 23% per year from 1980 to 2001. Thus some countries experienced growth rates of between 4% and 16% in total renewable energy supply from 1990 to 2001, including the Czech Republic, Denmark, Germany, Ireland, Korea, Netherlands and the United Kingdom.
- Combustible renewables and waste (CRW) supply grew by 3% per year on average from 1970. In 2001 CRW accounted for the largest share at 55% (161 Mtoe) of renewables supply in IEA countries, although this figure also includes energy from some non-renewable waste. Hydropower accounted for 35% (102.1 Mtoe), geothermal for 8% (22.5 Mtoe) and wind, solar and tide/ocean/wave for 2% (6.4 Mtoe) of the IEA renewable energy supply.
- Renewable energy sources fuelled 24% of total electricity production in 1970, but this share fell to 15% by 2001.
- Not surprisingly, hydropower was the major source of renewable-based electricity generation at 86% in 2001. Combustible renewables and waste accounted for 9% of electricity production from renewables, solar, wind and ocean energy for about 3% and 2% from geothermal. Because new renewables represent such a small share of total electricity generation, their rapid growth over the past decade was unable to compensate for limited growth of more mature technologies.
- Denmark dramatically increased its share of renewables in electricity generation from 0.1% in 1970 to 16% in 2001, mostly due to growth in wind power. Belgium, the United Kingdom, the Netherlands, Hungary and the Czech Republic also significantly increased their share of renewables in electricity generation.
- Solar and wind markets expanded by an average of almost 18% per year from 1970 to 2001. Growth rates have further accelerated in 2002-2003 according to preliminary data. However, statistics for these "new renewables" are still not completely reliable, particularly for solar PV and solar heating and cooling in the 1970s and 1980s due to the small, modular nature of these technologies.
- Solar and wind for electricity generation have increased significantly, but these new renewables are concentrated in just a few IEA countries. In 2001, 86% of the IEA total installed wind power capacity was in four countries: Denmark, Germany, Spain and the United States. About 84% of the installed solar photovoltaic capacity was in three countries: Germany, Japan and the United States. Solar thermal electricity production in 2001 was 556 GWh, almost entirely generated in the United States.

Renewables in Total Primary Energy Supply

The share of renewable energy supply in total primary energy supply (TPES) is strongly linked to a country's resource endowment. But it is also determined by technology development, policy choices and private sector investment, such that even in some countries with limited renewable resource availability, policy support for industrial development of renewable energy technologies has resulted in their rapid growth.

This chapter examines trends from 1970 to 2001 in the energy supply of combustible renewables and waste, hydropower, geothermal power, solar electricity and heat and wind power. It also looks at the relative importance of these renewables in the overall energy mix of IEA countries.[1]

Figure 1-1. **IEA Total Primary Energy Supply, 1970-2001**

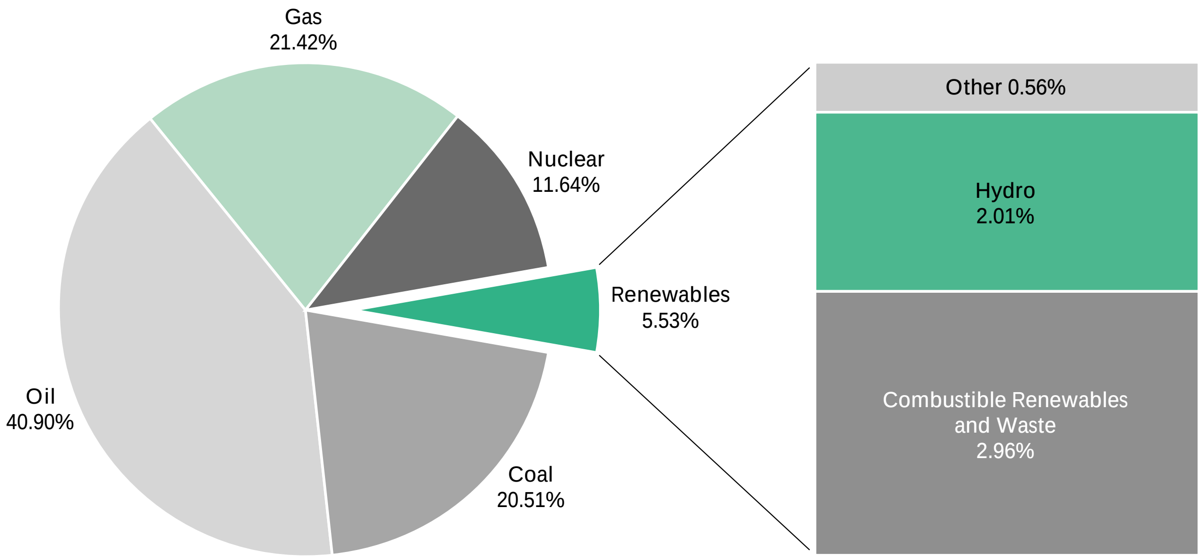


From 1970 to 2001, total primary energy supply in IEA countries grew by an average 1.6% per year. In the same period, renewable energy supply increased on average by 2.2% per year. Thus the renewable energy share in TPES increased from 4.6% in 1970 to 5.5% in 2001. Most of the increase in the share of renewables occurred in the 1970s and 1980s. From 1990 to 2001, renewables supply increased by only 1.2% a year, compared with growth in TPES of 1.6%.[2]

In 2001 renewable energy contributed 280.9 Mtoe, equal to 5.5%, of total primary energy supply in IEA countries. Combustible renewables and waste represented 3% of TPES, hydropower 2% and "other" renewables 0.4% (Figure 1-2). The "other" renewables category includes geothermal (0.443%), solar (0.06%), wind (0.058%), and tide (0.001%).

1. *2001 is the most recent year for which IEA renewable energy statistics are available. Policy information is given to 2003 where available, although the market impact of these recent policies generally cannot yet be seen in the statistics.*
2. *Statistics for TPES, renewables TPES and the share of renewables in TPES for IEA countries are in Annex 1.*

Figure 1-2. **Fuel Shares of IEA Total Primary Energy Supply, 2001**



Renewables growth in the 1970s and early 1980s was in large measure the result of RD&D and policy support in the aftermath of the oil price crises. Hydropower production increased from 71 Mtoe in 1970 to 91 Mtoe in 1980. Growth in hydropower production, however, slowed considerably in the 1980s and 1990s (Table 1-1). Production actually declined from 1995 to 2001, primarily due to a decrease of 9.7 Mtoe in hydropower production in the United States. Biomass supply nearly doubled from 1970 to 1990, but growth also slowed in the 1990s. Growth in geothermal supply slowed considerably in the 1990s. These more mature renewable technologies were not the focus of the policy support that benefited new renewables in the 1990s.

Table 1-1. **Average Annual Growth Rates of Renewable Energy Sources**

	1970-1980	1980-1990	1990-2001
Renewables	3.2%	2.4%	1.2%
*Biomass**	*3.5%*	*3.0%*	*1.6%*
Hydro	*2.6%*	*0.7%*	*0.4%*
Geothermal	*8.3%*	*9.4%*	*0.4%*
Wind/Solar	*6.4%*	*23.5%*	*23.1%*

** See Annex 2 for definition of biomass.*

Albeit from a low base, new renewables – solar electric, wind power, and some biomass technologies - have grown at impressive rates over the past three decades. Energy production from solar and wind grew by about 23% per year from 1980 to 2001, and this pace is estimated to have accelerated considerably in the last few years. Despite rapid growth, total production from new renewables was only 6.4 Mtoe in 2001.

The recent slowdown in growth rates of hydropower, biomass and geothermal has driven changes in the share of renewables in the TPES of IEA countries. The renewables share increased from 4.6% in 1970 to 5.8% in 1990, then declined to 5.5% in 2001 (Table 1-2).

Table 1-2. **Share of Renewables in Total Primary Energy Supply by Country**

Country	1970	1990	1995	2001
Australia	8.4%	5.8%	5.9%	5.7%
Austria	13.2%	19.9%	21.3%	21.5%
Belgium	0.1%	1.3%	1.3%	1.0%
Canada	15.1%	16.1%	16.5%	15.6%
Czech Republic	0.2%*	0.3%	1.4%	1.5%
Denmark	1.6%	6.6%	7.1%	10.4%
Finland	27.6%	19.5%	21.2%	23.0%
France	4.5%	6.8%	7.2%	6.8%
Germany	1.3%	1.6%	1.9%	2.6%
Greece	8.4%	5.0%	5.5%	4.6%
Hungary	2.8%	1.4%	2.1%	1.6%
Ireland	1.1%	1.6%	2.0%	1.7%
Italy	5.6%	4.3%	4.9%	5.7%
Japan	2.5%	3.1%	2.9%	3.1%
Korea	0.7%*	0.6%	0.6%	1.1%
Luxembourg	0.2%	1.0%	1.6%	1.8%
Netherlands	0.0%	1.0%	1.0%	1.4%
New Zealand	28.7%	34.7%	32.6%	25.8%
Norway	36.5%	50.1%	47.4%	45.0%
Portugal	20.8%	15.7%	13.1%	13.7%
Spain	6.2%	6.8%	5.4%	6.5%
Sweden	17.2%	25.1%	26.2%	29.1%
Switzerland	17.1%	13.1%	15.6%	16.2%
Turkey	34.3%	18.2%	17.4%	13.0%
United Kingdom	0.2%	0.5%	0.8%	1.1%
United States	3.7%	5.2%	5.2%	4.4%
IEA Total	4.6%	5.8%	5.9%	5.5%

** Data from 1971.*

Table 1-3. **Average Annual Growth of Renewable Total Primary Energy Supply by Country**

Country	Average Growth per year 1990 - 2001
Australia	2.35%
Austria	2.57%
Belgium	-0.62%
Canada	1.38%
Czech Republic	15.86%
Denmark	5.99%
Finland	2.96%
France	1.57%
Germany	4.20%
Greece	1.62%
Hungary	0.40%
Ireland	4.08%
Italy	3.71%
Japan	1.47%
Korea	13.30%
Luxembourg	6.25%
Netherlands	4.84%
New Zealand	-0.20%
Norway	0.30%
Portugal	2.14%
Spain	2.58%
Sweden	2.26%
Switzerland	3.23%
Turkey	-0.29%
United Kingdom	8.55%
United States	-0.09%
IEA Total	1.17%

Renewable Energy Supply - Overall Trends

Data aggregated across the IEA masks different patterns among the countries. Average annual growth between 1970 and 2001 was about 3% or higher, *e.g.*, in Austria (3.3%), Denmark (6.3%), Norway (2.8%) and Sweden (2.8%).

The share of renewables in total energy supply in 2001 was significant in Austria at 21.5%, Norway at 45% and Sweden at 29.1%. Denmark experienced a notable increase in the renewable energy share of TPES from 1.6% in 1970 to 10.4% in 2001. In some countries the share of renewables in energy supply was low in 2001 even though renewables had exhibited rapid growth: Belgium (1%), the Czech Republic (1.5%), Germany (2.6%), Ireland (1.7%), Korea (1.1%), the Netherlands (1.4%) and the United Kingdom (1.1%). In Canada, Italy, Spain, Japan and the United States, the share of renewables in TPES remained relatively unchanged from 1970 to 2001.

Seven IEA countries had a decline in the share of renewables in TPES between 1970 and 2001. The renewables share declined from 8.4% in 1970 to 5.7% in 2001 in Australia. The share in Finland decreased from 27.6% in 1970 to 23% to 2001; in Greece from 8.4% to 4.6%, in Hungary from 2.8% to 1.6%; in New Zealand from 28.7% to 25.8%; in Portugal from 20.8% to 13.7%; and in Turkey from 34.3% to 13%. Of these countries, only Finland reversed this trend in the 1990s.

Renewable Energy Supply - Trends: 1990 to 2001

Growth rates of renewable energy supply differed among IEA countries even more in the 1990 to 2001 period. In Korea, average annual growth in renewable energy supply was 13.3% and in the United Kingdom it was 8.55%. Whereas in the United States the renewable energy supply declined by 0.12% per year from 1990 to 2001 due to more stringent environmental regulations, uncertainties about policy continuity and regulatory issues. The renewable energy supply in Turkey declined by 0.29% per year over the period partly as a result of an overall economic decline.

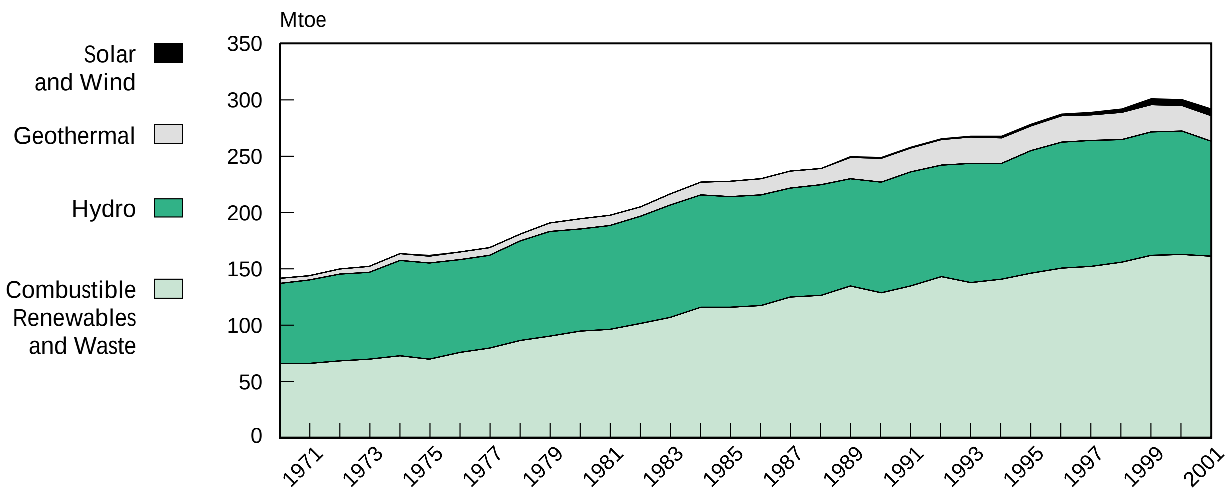
From 1990 to 2001, growth in TPES outpaced growth in renewable energy supply in Belgium, Norway, Spain, Portugal, Japan, Canada, Greece and New Zealand. The share of renewables in TPES declined in these countries due to policies favouring nuclear and natural gas, declines in biomass use and high economic growth rates.[3]

Average annual growth in renewable energy supply was more than 2% in sixteen IEA countries: Australia (2.4%), Austria (2.6%), the Czech Republic (15.9%), Denmark (5.6 %), Finland (3.0%), Germany (4.2%), Ireland (4.1%), Italy (3.7%), Korea (13.3%), Luxembourg (6.3%), Netherlands (4.8%), Portugal (2.1%), Spain (2.6%), Sweden (2.3%), Switzerland (3.2%) and the United Kingdom (8.6%). Most of these countries have well-established and consistent support policies for renewables.

The Mix of Renewables in Primary Energy Supply

In 1970, hydropower accounted for 50.1% (70.9 Mtoe) of renewable energy supply, followed by combustible renewables and waste (CRW) with 47.1% (66.7 Mtoe) and geothermal with 2.8% (3.9 Mtoe). Over the next three decades the composition changed due to more rapid growth in CRW supply (2.9%) compared with hydropower (1.2%). In 2001, CRW accounted for 55.2% (161.1 Mtoe) of total renewables supply, hydropower for 35% (102.1 Mtoe), geothermal for 7.7% (22.5 Mtoe) and solar and wind for 2.2 % (6.4 Mtoe).

Figure 1-3. **Renewables in Primary Energy Supply, 1970-2001**



3. *See country profiles for a more detailed discussion.*

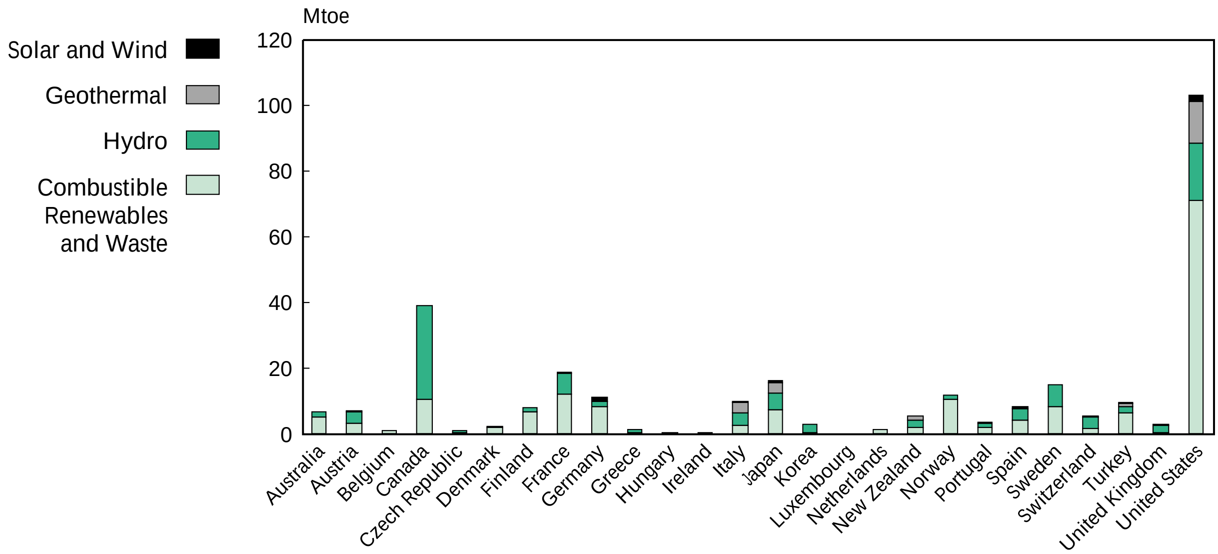
Growth in combustible renewables and waste supply between 1970 and 2001 in IEA countries reflects the development of advanced waste and biomass generation technologies and more stringent waste disposal and pollution regulations. Another factor was the economic and environmental benefits for industry and citizens that derived from producing energy from industrial and municipal waste and solid biomass (from wood chips to straw) whenever available.

Geothermal supply increased by 8.3% per year, from 3.9 Mtoe in 1970 to 21.5 Mtoe in 1990. Growth slowed dramatically to 0.4% per year from 1990 to 2001. RD&D and policy support for geothermal was substantial following the oil price crises of the 1970s, but most incentives had been phased out or diminished by the 1990s.

Combined energy production from solar, wind, and ocean sources grew by 17.5% per year from 1970 to 2001. Annual growth was even faster (23.1%) from 1990 to 2001, but still by 2001 these new renewables accounted for only 2.2% of IEA renewable energy supply.

Figure 1-4 shows the mix of renewable energy supply in IEA countries in 2001. The largest quantities are in the United States with 103.3 Mtoe and Canada with 39.1 Mtoe. Renewables contributed significantly in France, Japan and Sweden with more than 15 Mtoe, while supply in Norway was 11.8 Mtoe and in Germany 11 Mtoe.

Figure 1-4. **Mix of Renewables in Primary Energy Supply, 2001**



Note: Renewable energy supply in Figure 1-4 includes the non-renewable portion of MSW. See Annex 2 for details.

Combustible renewables and waste accounted for the highest share of renewable energy supply in fifteen IEA countries in 2001. Those with a CRW share greater than 75% of renewables supply include: Australia, Belgium, Denmark, Finland, Germany, Hungary, Netherlands and Norway.

Figure 1-4 shows that hydropower was the largest share of renewables supply in eleven IEA countries: Austria (52%), Canada (73 %), Greece (72%), Czech Republic (77%), Ireland (60 %), Italy (417%), Korea (84%), Luxembourg (77%), New Zealand (43%), Switzerland (66%) and the United Kingdom (85%).

Geothermal resources were a major contributor to renewable energy supply in Italy (32%), New Zealand (22%), Japan (18%), the United States (13%), and Turkey (7%).

Figures 1-5 and 1-6 show growth in new renewables, *i.e.*, solar, wind and ocean, from 1990 to 2001. Growth trends of these new renewable sources for selected countries with major shares are shown in Table 1-4. Wind power in particular experienced rapid growth in Germany, Denmark, Turkey, Spain and Greece. The market deployment policies that have spurred this growth are outlined in Chapter 4.

Figure 1-5. **Total Primary Energy Supply from Wind, Solar and Ocean, 1990-2001[4]**

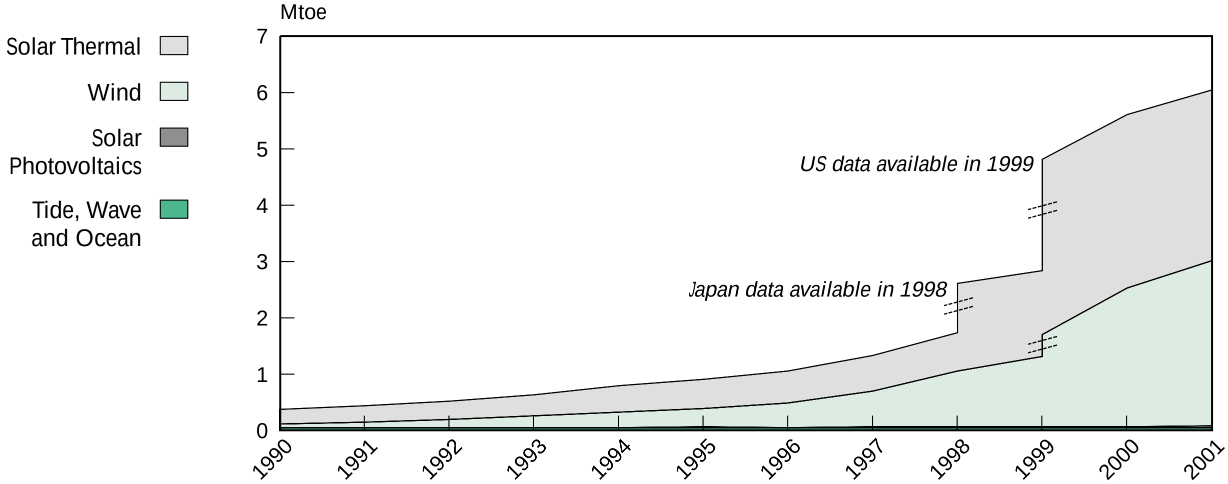
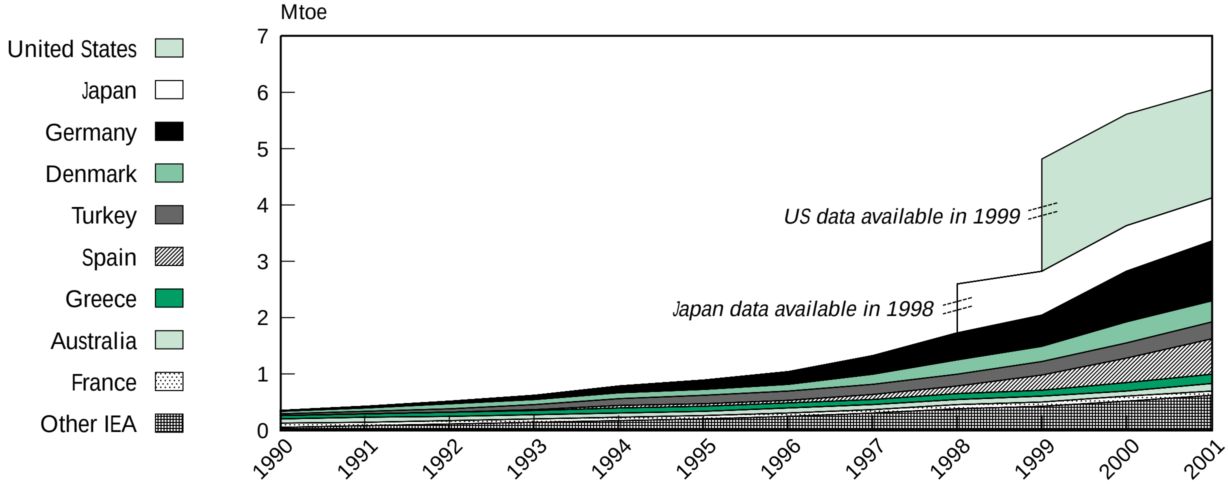


Figure 1-6. **Wind, Solar and Ocean Energy Supply in Key Producing Countries, 1990-2001**



4. Statistics for wind, solar and ocean energy provided by IEA Member countries are incomplete. The data for European countries are relatively reliable and consistent from 1990. Japanese data are considered to be reliable from 1998 and US data from 1999. Both Japan and the United States are reviewing and revising renewables data. All IEA countries are starting to compile separate statistics for solar, wind and ocean technologies. Current data do not provide a consistent time-series for off-grid solar photovoltaics or for roof-top solar hot water systems. This makes an analysis of market trends in solar, wind and ocean energy based on IEA data very difficult. Chapter 3 gives a more complete overview of these technologies based on other sources.

Table 1-4. **Wind, Solar and Ocean Energy in Renewable Energy Supply by Country**

Mtoe	1990	1998	1999	2000	2001	Growth rates per year 1990-2001	Growth rates per year 1998-2001	Growth rates per year 1999-2001
Australia	0.08	0.09	0.10	0.10	0.13	4.03%	11.24%	13.48%
Denmark	0.05	0.25	0.27	0.37	0.38	19.18%	14.81%	18.72%
France	0.06	0.07	0.07	0.08	0.08	2.81%	5.42%	8.34%
Germany	0.01	0.48	0.55	0.90	1.06	47.61%	30.46%	38.53%
Greece	0.06	0.10	0.11	0.14	0.17	10.24%	18.55%	22.31%
Japan	n.a	0.87	0.79	0.82	0.77	n.a	-4.13%	-1.47%
Spain	0.00	0.14	0.27	0.44	0.64	71.19%	64.57%	54.86%
Turkey	0.03	0.21	0.24	0.26	0.29	23.77%	11.58%	10.87%
United States	n.a.	n.a.	1.98	1.97	1.91	n.a.	n.a.	-1.75%
Other	0.07	0.39	0.44	0.53	0.62	22.58%	16.87%	19.28%

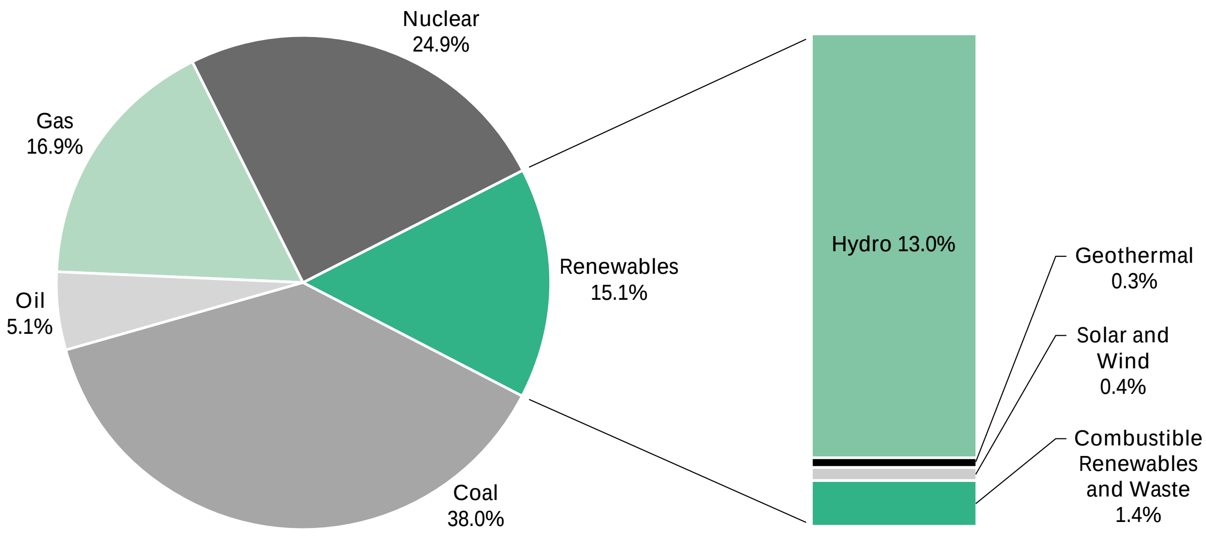
n.a. = not available

Renewables in IEA Electricity Supply

Renewables accounted for 15.1% of electricity production in IEA countries in 2001, compared with coal (38%), nuclear (24.9%), natural gas (16.9%), and oil (5.1%).

Composition of the renewable share of electricity production in 2001 was hydropower at 86.3%, combustible renewables and waste at 9.1%, solar, wind and ocean energy at 2.7% and geothermal at 1.9%.

Figure 1-7. **IEA Electricity Production, 2001**



As depicted in Figure 1-8, electricity generation from renewables increased steadily from 864 TWh in 1970 to 1 375 TWh in 2001, an average annual growth of 1.6%. Nuclear power production increased swiftly from 1970-2001 with an annual average growth rate of 11%, though the rate tapered off to 2.6% in the 1990 to 2001 period. Strong government support for nuclear power increased its contribution to IEA electricity production. An increase in nuclear and natural gas power production combined with slower growth of hydropower and biomass in the 1990s resulted in a decline in the share of renewables in IEA electricity production from 24.1% in 1970 to 15.1% in 2001.

Figure 1-8. **IEA Electricity Production, 1971-2001**

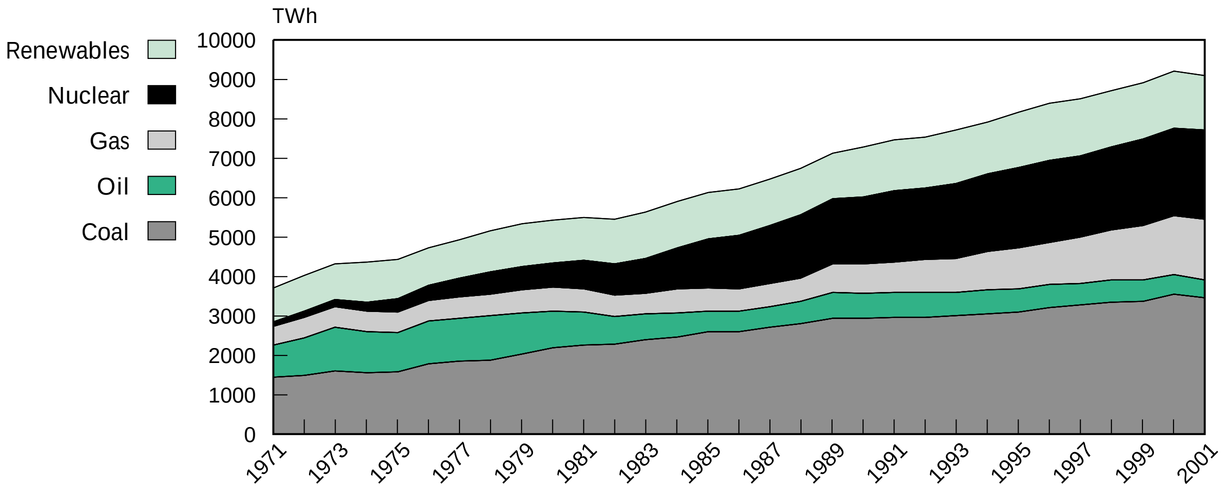


Figure 1-9. **Fuel Shares in IEA Electricity Production, 1971-2001**

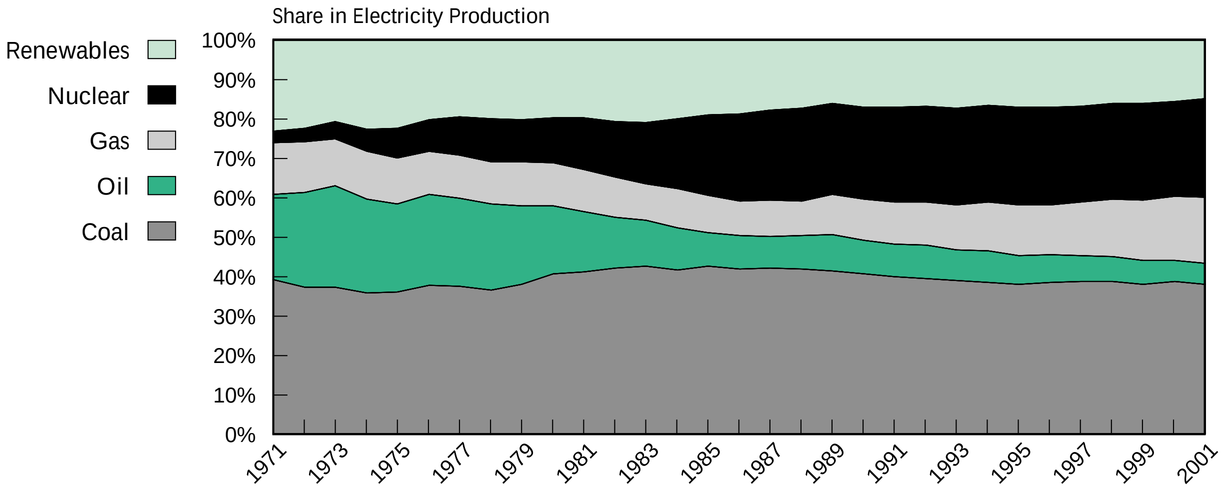


Figure 1-9 illustrates the shares of various energy sources used for electricity production across IEA countries over three decades. It clearly shows the lessening role of oil in electricity production, a decline in renewable sources and an increase in the shares of nuclear and natural gas.

The overall share of renewables in IEA electricity generation masks substantial differences among countries as shown in Table 1-5. Renewables provided almost 100% of electricity production in Norway from hydro and on the order of 70% in Austria, largely hydro and biomass, over three decades. In Denmark strong growth in wind and biomass-fired power led to an increase from 0.1% of renewable sources in the electricity production mix in 1970 to 16.4% by 2001. Belgium, the United Kingdom, the Netherlands, Hungary and the Czech Republic also increased the share of renewables in electricity production from 1970 to 2001.

Table 1-5. **Share of Renewables in IEA Electricity Production by Country**

	1970	1990	1995	2001
Australia	18.5%	9.6%	9.6%	8.3%
Austria	70.8%	66.2%	70.5%	70.1%
Belgium	0.8%	1.1%	1.3%	1.4%
Canada	75.5%	62.4%	61.0%	57.9%
Czech Republic	0.0%	2.3%	4.0%	3.5%
Denmark	0.1%	3.2%	5.5%	16.4%
Finland	42.1%	28.6%	30.9%	29.1%
France	39.4%	13.4%	15.5%	14.4%
Germany	6.5%	3.7%	5.1%	6.2%
Greece	26.8%	5.1%	8.6%	5.5%
Hungary	0.6%	0.7%	0.8%	0.9%
Ireland	13.8%	4.9%	4.1%	4.2%
Italy	38.3%	16.4%	17.5%	20.1%
Japan	21.3%	12.0%	10.1%	9.7%
Korea	0.0%	6.0%	1.7%	1.6%
Luxembourg	7.1%	16.7%	29.0%	44.0%
Netherlands	0.0%	1.1%	1.6%	3.5%
New Zealand	90.5%	80.5%	84.4%	63.4%
Norway	99.4%	99.8%	99.7%	99.6%
Portugal	80.5%	34.7%	28.3%	34.6%
Spain	49.4%	17.2%	14.9%	21.9%
Sweden	68.7%	51.0%	47.6%	51.3%
Switzerland	88.9%	55.2%	57.4%	59.8%
Turkey	37.1%	40.4%	41.6%	19.8%
United Kingdom	1.8%	1.8%	2.1%	2.5%
United States	15.5%	11.4%	11.0%	7.4%
IEA Total	**24.1%**	**17.4%**	**17.2%**	**15.1%**

In 2001, the fifteen European Union member countries set a target to increase electricity generation from renewable energy sources to 22% by 2010 (EU Directive 2001/77/EC). The box below lists the country specific targets.

European Union Member Country	Target for 2010 % Electricity Generation from Renewables
Austria	78.1
Belgium	6
Denmark	29
Germany	12.5
Finland	31.5
France	21
Greece	20.1
Ireland	13.2
Italy	22
Luxembourg	5.7
Netherlands	9
Portugal	39
Spain	29.4
Sweden	60
United Kingdom	10

Chapter 2
Research, Development and Demonstration Trends

Highlights

- Total government energy research, development and demonstration (RD&D) budgets increased sharply after the oil price shocks in the 1970s. Budgets declined to about half of their peak levels by 1987 and remained relatively stable to 2002. As a percentage of total RD&D funding, funding for renewables was higher from 1974 through 1986 than in the period since 1987.
- Renewable energy technologies accounted for just 7.7% of total government energy RD&D funding from 1987 to 2002. Over this period, the shares of renewable energy technologies out of total energy RD&D funding were:

Solar photovoltaic	2.7%
Biomass	1.6%
Wind energy	1.1%
Geothermal	0.9%
Solar heating and cooling	0.7%
Solar thermal electric	0.5%
Ocean energy	0.1%
Large hydro	0.1%
Small hydro	0.04%

- The United States, Japan and Germany accounted for 70.4% of IEA government renewable energy RD&D funding in the 1974 – 2002 period.
- The decreasing share of public funding for energy RD&D allocated to renewable energy appears to be inconsistent with presumed political intentions in many IEA countries to increase the share of renewables in TPES.
- Information on RD&D spending in the private sector generally is not in the public domain. Therefore, it is difficult to determine the impact of private sector spending on renewable energy markets, but general patterns can be discerned. RD&D support for mature technologies such as large hydropower has been provided by utilities, turbine and generator manufacturers and other industries related to the electricity system infrastructure. Municipal authorities are increasingly interested in extracting the energy component of waste “resources” such as refuse and landfills, and they often benefit from both public and private sector RD&D.
- Renewable technologies such as solar photovoltaic, solar heating and cooling and ocean energy are heavily dependant on public RD&D budgets.

Government RD&D Expenditures in IEA Member Countries[1]

IEA governments allocated about US$ 291 billion (2002 prices and exchange rates) for energy RD&D from 1974 to 2002. Figure 2-1 shows government budget outlays for energy RD&D in this period. In response to the oil price crisis, total IEA government investment for energy RD&D was about US$ 7 billion in 1974. Budget outlays peaked in 1981 at US$ 16 billion, but then declined to about US$ 9 billion in 1987. From 1987 to 2002, funding was relatively stable, averaging about US$ 9 billion from 1987 to 1991 and US$ 7.5 to 8 billion in the 1990s. Total energy RD&D expenditures in 2002 were just under US$ 8 billion (49% of the 1980 value). Renewable energy RD&D expenditures in 2001, at US$ 696 million, were about 35% of the 1980 value.

Aggregate IEA energy RD&D budget outlays for nuclear fission, fossil fuels and renewables decreased in the late 1980s and 1990s, while funding for nuclear fusion, conservation and power and storage technologies increased. RD&D investments in hydrogen and fuel cells (included in the “other technology” category) rose considerably in the 1990s and early 2000.

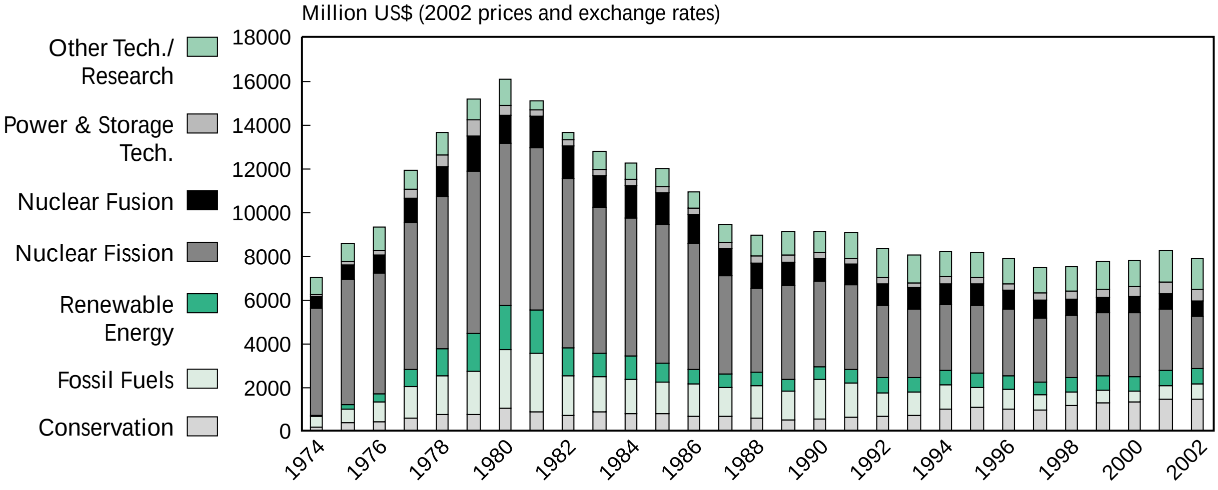
Table 2-1. **RD&D Budgets in IEA Countries by Technology[2]**

	Budget by Technology 1974-2002 (million US$)	**Shares in Energy RD&D 1974-2002**	**Budget by Technology 1974-1986 (million US$)**	**Shares in Energy RD&D 1974-1986**	**Budget by Technology 1987-2002 (million US$)**	**Shares in Energy RD&D 1987-2002**
Nuclear Fission	137 529	47.3%	84 866	53.6%	52 663	39.7%
Fossil Fuels	36 842	12.7%	20 559	13.0%	16 284	12.3%
Nuclear Fusion	30 562	10.5%	15 948	10.1%	14 615	11.0%
“Other” Technologies	29 212	10.0%	10 599	6.7%	18 613	14.0%
Renewable Energy	23 550	8.1%	13 317	8.4%	10 234	7.7%
Solar Heating & Cooling	*3 024*	*1.0%*	*2 140*	*1.4%*	*885*	*0.7%*
Solar Photo-Electric	*6 354*	*2.2%*	*2 717*	*1.7%*	*3 636*	*2.7%*
Solar Thermal-Electric	*2 555*	*0.9%*	*1 889*	*1.2%*	*666*	*0.5%*
Wind	*2 910*	*1.0%*	*1 445*	*0.9%*	*1 465*	*1.1%*
Ocean	*754*	*0.3%*	*626*	*0.4%*	*128*	*0.1%*
Biomass	*3 578*	*1.2%*	*1 495*	*0.9%*	*2 083*	*1.6%*
Geothermal	*4 088*	*1.4%*	*2 867*	*1.8%*	*1 221*	*0.9%*
Large Hydro (>10 MW)	*93*	*0.0%*	*0.00*	*0.0%*	*93*	*0.1%*
Small Hydro (<10 MW)	*49*	*0.0%*	*0.18*	*0.0%*	*49*	*0.0%*
Conservation	23 479	8.1%	8 607	5.4%	14 872	11.2%
Power & Storage Technology	9 844	3.4%	4 344	2.7%	5 500	4.1%
Total All Energy	**291 020**	**100.0%**	**158 240**	**100.0%**	**132 781**	**100.0%**

1. IEA countries have not reported RD&D budgets for every year, so the IEA Secretariat has estimated the missing data in order to construct a complete time series for this analysis. The estimations are based on the overall IEA trend for each individual technology. The RD&D data in this section may differ from the country profiles, since the profiles are based only on reported data.

2. Data may not add up in some cases due to the estimations of the IEA Secretariat.

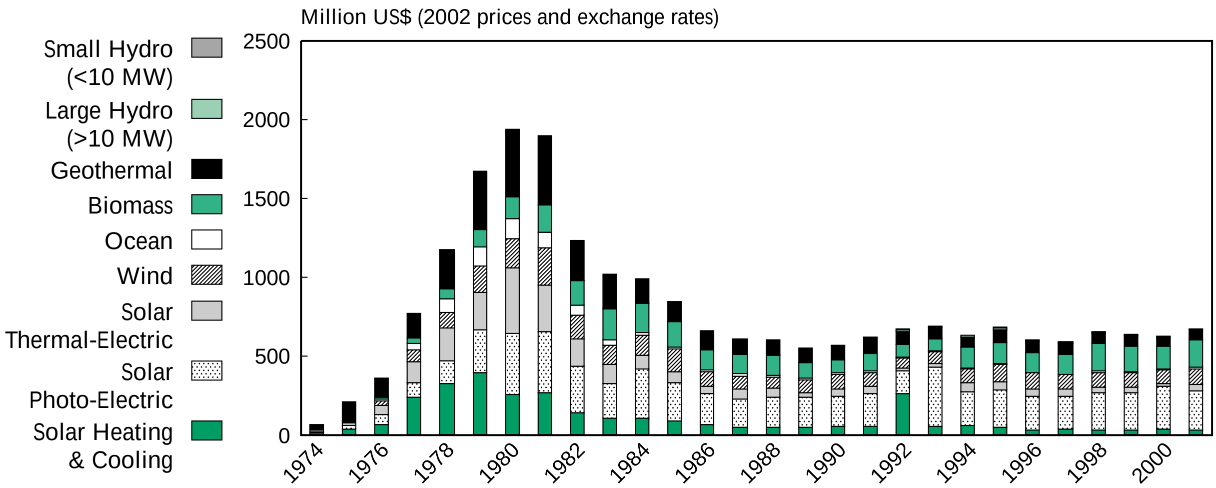
Figure 2-1. **Government Energy RD&D Budgets**[3]



Government Renewable Energy RD&D Budgets

IEA countries' renewable energy RD&D budgets totalled about US$ 23.55 billion, some 8% of total energy RD&D funding from 1974 to 2002. In 1974, renewable energy RD&D was US$ 65 million. Expenditures for renewables RD&D grew rapidly in the late 1970s and peaked in 1980 at just under US$ 2 billion. Expenditures declined by about two-thirds in the early 1980s but have been relatively stable since the late 1980s, in the range of US$ 550 million to US$ 700 million. Annual expenditures on renewables RD&D for all IEA countries averaged about US$ 650 million from 1990 to 2002, 7.7% of total government energy RD&D budgets.

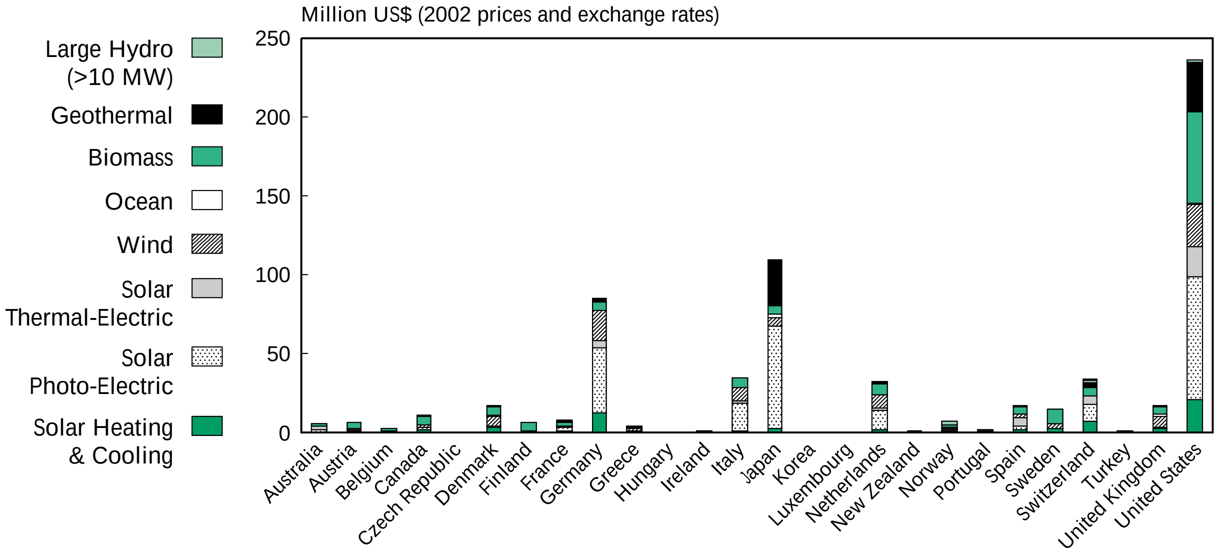
Figure 2-2. **Government Renewable Energy RD&D Budgets**[3]



3. *Data are not available for the Czech Republic or Korea.*

Germany, Japan and the United States accounted for about 66% of total renewables RD&D funding in the period 1990 to 2002. Italy, the Netherlands and Switzerland accounted for an additional 15%. These six countries combined invested US$ 531 million per year on average for renewable energy RD&D. The United States had the highest average renewables RD&D budget of US$ 236.9 million per year. The average annual budget in Japan was US$ 110.9 million and in Germany US$ 82.8 million between 1990 and 2002.

Figure 2-3. **Average Annual Renewable RD&D Budgets in IEA Countries, 1990-2002**



Renewable energy RD&D funding priorities usually reflect resource endowments. For example, New Zealand and Turkey have major geothermal resources, and 70% of RD&D funding in New Zealand and 45% in Turkey was for geothermal in the 1990-2002 period. Norway allocated 35% of its renewables RD&D to large hydropower. On average, biomass accounts for more than 40% of the renewables RD&D budgets in Austria, Canada, Finland, Hungary and Sweden. About 43% of renewables RD&D in Denmark and 37% in the United Kingdom went to wind energy. Both countries have significant wind energy potential. Natural resource endowments, however, do not always dictate renewable energy RD&D priorities. Germany has limited solar resources, but its budget for PV represented 48% of its renewable energy RD&D budget from 1990 to 2002.

RD&D budget priorities in the six IEA countries with the largest outlays for renewable energy from 1990 to 2002 are outlined below.

Germany

Technology	**Share of National Energy R&D Budgets 1990-2002**	**Share of National Renewables RD&D Budgets 1990-2002**	**Average Renewables Budget 1990-2002 (Millions US $)**
Photovoltaic	12.5%	48.4%	40.1
Wind	5.9%	22.7%	18.8

Italy

Technology	Share of National Energy R&D Budgets 1990-2002	Share of National Renewables RD&D Budgets 1990-2002	Average Renewables Budget 1990-2002 (Millions US $)
Photovoltaic	5.0%	46.8%	15.9
Wind	2.4%	23.0%	7.8

Japan

Technology	Share of National Energy R&D Budgets 1990-2002	Share of National Renewables RD&D Budgets 1990-2002	Average Renewables Budget 1990-2002 (Millions US $)
Photovoltaic	2.1%	59.6%	66.1
Geothermal	0.9%	26.0%	28.8

Netherlands

Technology	Share of National Energy R&D Budgets 1990-2002	Share of National Renewables RD&D Budgets 1990-2002	Average Renewables Budget 1990-2002 (Millions US $)
Photovoltaic	7.7%	37.7%	12.3
Wind	5.3%	26.0%	8.5
Biomass	4.8%	23.4%	7.7

Switzerland

Technology	Share of National Energy R&D Budgets 1990-2002	Share of National Renewables RD&D Budgets 1990-2002	Average Renewables Budget 1990-2002 (Millions US $)
Photovoltaic	8.0%	32.5%	10.8
Solar Heating & Cooling	4.9%	20.1%	6.7

United States

Technology	Share of National Energy R&D Budgets 1990-2002	Share of National Renewables RD&D Budgets 1990-2002	Average Renewables Budget 1990-2002 (Millions US $)
Photovoltaic	2.9%	32.6%	77.3
Biomass	2.3%	25.5%	60.3
Geothermal	1.2%	12.9%	30.6

Renewables RD&D and the Private Sector

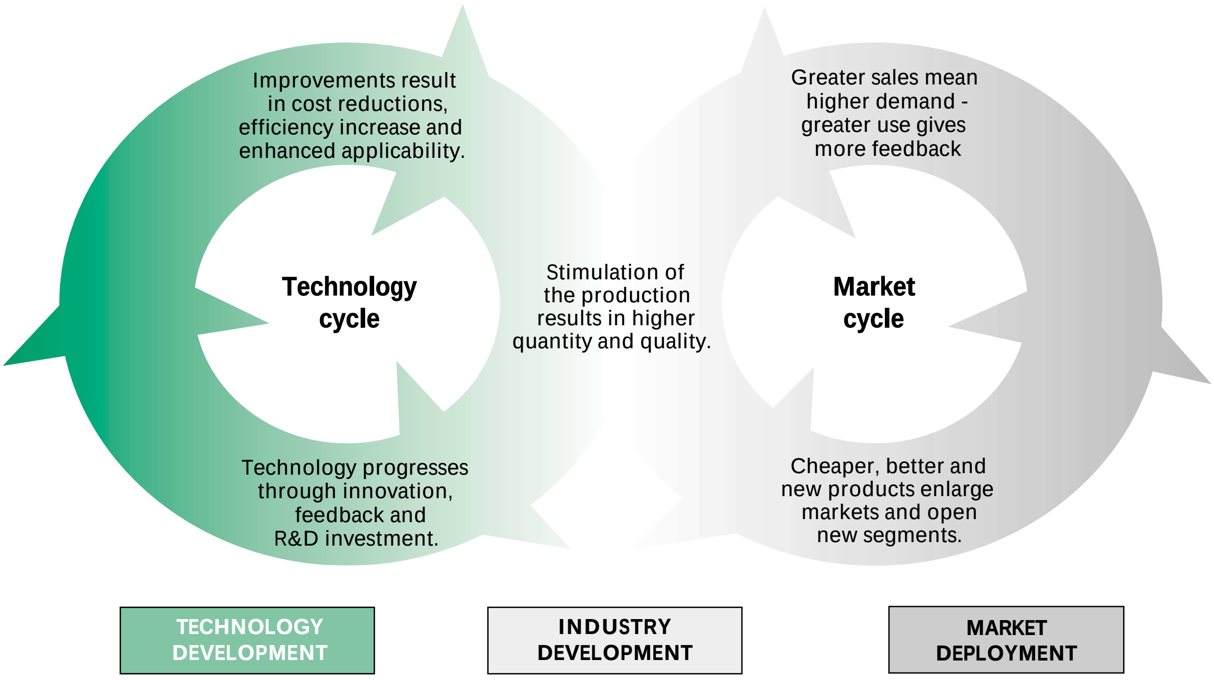
Private sector involvement in renewable energy RD&D is limited, with a few country and technology exceptions, despite the fact that RD&D is the driving force for innovation, cost reduction and market deployment opportunities for renewable energy technologies. Private sector companies are well-suited to carry out applied research, but they are often hesitant to invest in research projects from which competitors could gain. On the other hand, if research is publicly funded, then technological advancements become part of the public domain.

Unlike traditional energy companies and utilities, private sector management of renewable technologies is not well-established. With the exception of large hydropower, private sector RD&D for renewables is not broad-based. For example, an industry which is developing biomass-fired combined heat and power at the municipal level would not constitute a uniform group that could streamline private sector RD&D.

Private sector RD&D is mostly focused on solar photovoltaic and wind technology. The industries involved with the deployment of these technologies engage in mostly competitive, rather than collaborative, RD&D. For example, private sector companies specialising in the development of wind turbine systems focus on competition for turbine size. Limited resources are allocated to address barriers to wind power such as intermittency, storage and reliability. Similarly, the PV industry is developing several technological approaches to gain competitive advantage, and it has little capability to develop balance of system components.

Technology development and market experience are strongly linked and can function as a "virtuous cycle" as illustrated in Figure 2-4.[4] The virtuous cycle takes into account the relationship between technology RD&D, improvements in manufacturing and learning from market experience that is enhanced by a supportive policy framework. Complementary efforts by the public and private sectors in both technology development and deployment can enhance market growth.

Figure 2-4. **Virtuous Cycle in a Supportive Policy Environment**



Source: NET Ltd. Switzerland based IEA/OECD 2000.

Data on private sector research and development spending are generally not in the public domain and are often closely guarded for competitive reasons. The data and estimates below are based on a 2001 World Energy Council report.[5]

4. *Renewables for Power Generation, Status and Prospects, IEA/OECD, Paris, 2003.*
5. *Energy Technologies for the Twenty-First Century, World Energy Council, 2001.*

For the United States, private sector spending on renewable energy RD&D is aggregated with data for conservation and end-use efficiency. The total for the three categories was US$ 429 million in 1985, but declined 48% by 1996 when spending was US$ 221 million.

In Japan, total spending on renewable energy RD&D has fluctuated within a fairly narrow band, except for a period of low expenditures between 1988 and 1990 by both the government and private sector. Private sector spending on solar energy technologies nearly doubled between 1990 and 1997. Wind energy RD&D expenditures also experienced an increase in the 1990s. Government and private sector RD&D spending patterns have been broadly similar over the period.

In Austria, private sector spending on renewable energy RD&D was about 31% to 37% of the government level between 1993 and 1998. Industry spending increased nearly 70% over the period and more than 80% was allocated to biomass technologies.

In Denmark, private sector RD&D spending on renewable energy data is available for 1995, 1997 and 1998. There was an 89% increase in spending by wind turbine manufacturers between 1995 and 1998. Total private sector renewable energy RD&D spending was US$100 million in 1998, nearly five times higher than public spending.

In Spain, the private sector has spent only modest amounts on renewable energy RD&D in recent years. Since 1995 the government has accounted for more than 90% of RD&D spending on renewable energy.

In Korea, private sector RD&D expenditure for renewable energy was about US$ 13.4 million in 1998. In 1993, some companies directed their RD&D budgets to renewable waste technologies. Some private companies have undertaken RD&D for hydropower and electricity generation technologies.

In the Netherlands, private sector energy RD&D investments are on par with government energy RD&D budgets. However, renewable energy RD&D is predominantly financed by the public sector.

In Germany, public and private funding for RD&D was US$ 42 billion in 1997. The private sector accounted for nearly 62% (US$ 24 billion) of the total. In the late 1970s, the public and private sectors each funded roughly half of Germany's energy RD&D. More recently, the private sector has assumed a larger role.

In Canada, private sector investments in renewable energy RD&D were flat in real terms at C$ 22 million between 1983 and 1995. With the restructuring of the electric utility industry, RD&D for renewable energy may decline as the private sector generally views renewable technologies as unlikely to achieve wide market penetration in the near-term.

Chapter 3
Market and Policy Trends in Renewable Energy Technologies

This chapter provides an overview of market and policy trends for the following renewable energy technologies:[1]

- Hydropower
- Bioenergy
- Geothermal
- Solar photovoltaic
- Solar thermal
- Wind power.

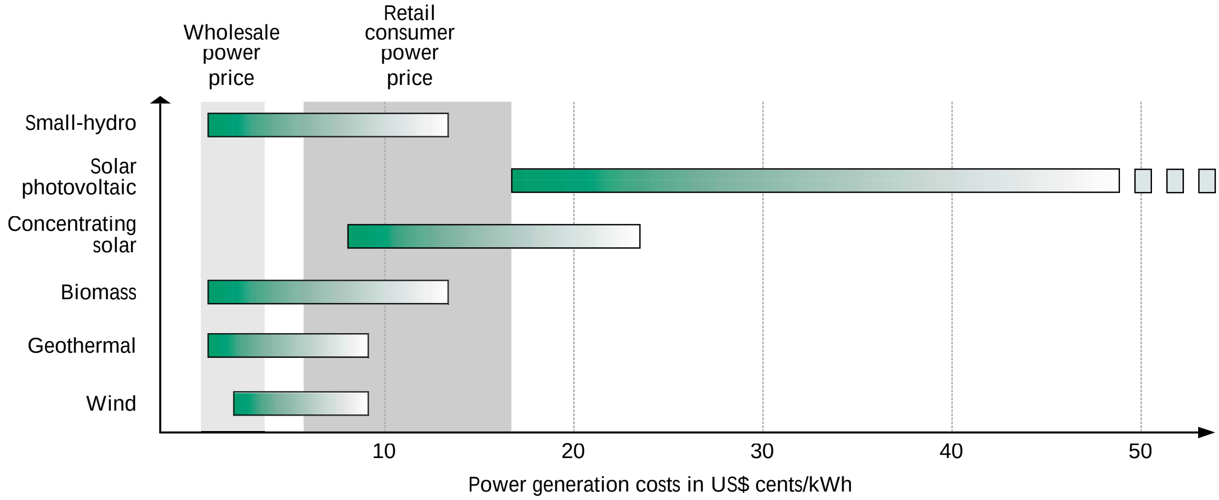
In this chapter solar thermal electric and solar thermal heating and cooling are both included in the solar thermal energy section. Biomass electricity generation, biomass heat production, biogas electricity generation and biofuels are covered in the section on bioenergy. Reference is made to commercial geothermal heat, but most of the section on geothermal energy focuses on electricity generation. Installed capacity, electricity and/or heat production, technology development and costs, and policy trends are presented for each technology.

Except for large hydropower and combustible renewables and waste plants, the average costs of renewable electricity are not widely competitive with wholesale electricity prices. However, depending on the technology, application and site, costs are competitive with grid electricity or commercial heat production. Figure 3-1 shows the cost range of electricity from renewable resources. To identify and exploit market opportunities, it is necessary to assess the competitiveness of specific applications and services in distinct local circumstances, be it large-scale on-grid applications, niche markets on and off-grid, or other specific market situations.

Under best conditions – optimised system design, siting and resource availability – electricity from biomass, small hydropower, wind and geothermal power plants can produce electricity at costs ranging from US$ 0.02 to 0.05/kWh. Some biomass applications are competitive as well as geothermal heat production in specific sites. Solar thermal heat and hot water applications are competitive in some countries. Other solar technologies are not as competitive. Yet in some countries where supportive policy frameworks have been established, solar technologies can compete with retail electricity. For example, California and south-western states in the United States have viable markets for solar technologies.

1. Other renewable energy technologies, such as ocean energy and the production of hydrogen from renewable resources, have not yet reached market entry, or are just entering markets. They are not covered in this study. Ocean energy, including tidal power, wave energy, ocean current power and ocean thermal power, is in various stages of RD&D or deployed in niche markets. Similarly, production of hydrogen from renewable resources is not yet a commercially viable technology.

Figure 3-1. **Cost Competitiveness of Selected Renewable Power Technologies**



Note: Cost calculation is based on system investment needed (capital cost is based on discount rate of 6% and amortisation period of 15 - 25 years) and power output. Lowest cost range refers to optimum conditions (i.e., proven technology, optimised plant size and design, and high availability of system and resources). Source: NET Ltd. Switzerland.

Market and Policy Trends: Hydropower

The exploitation of water for energy production began more than 2 000 years ago when water was used to turn water wheels to grind wheat and other grains into flour. The evolution of the waterwheel led to the development of watermills for milling grain and to the simple Norse wheel. The first modern hydropower plant was built after the invention of the water turbine in France in 1827. Large-scale hydropower turbines were first used for electricity generation in the 1880s. Access to transmission networks meant that large hydropower units benefited from economies of scale between the 1930s and 1970s. Most of this development was due to government sponsorship of large, multi-purpose dams that provided water supply, flood control and energy. As most of these sites in IEA countries were developed by the 1970s, and development of the few remaining sites was complicated by land use and water access concerns, the principle focus more recently has been on small hydropower development.

Liberalisation of the electricity industry in some countries has contributed to the development of small hydropower generating capacity by independent power producers (IPP). At the same time, new requirements for the maintenance of minimum water flow volumes have reduced the opportunities for hydropower production, for example in the United States and France.

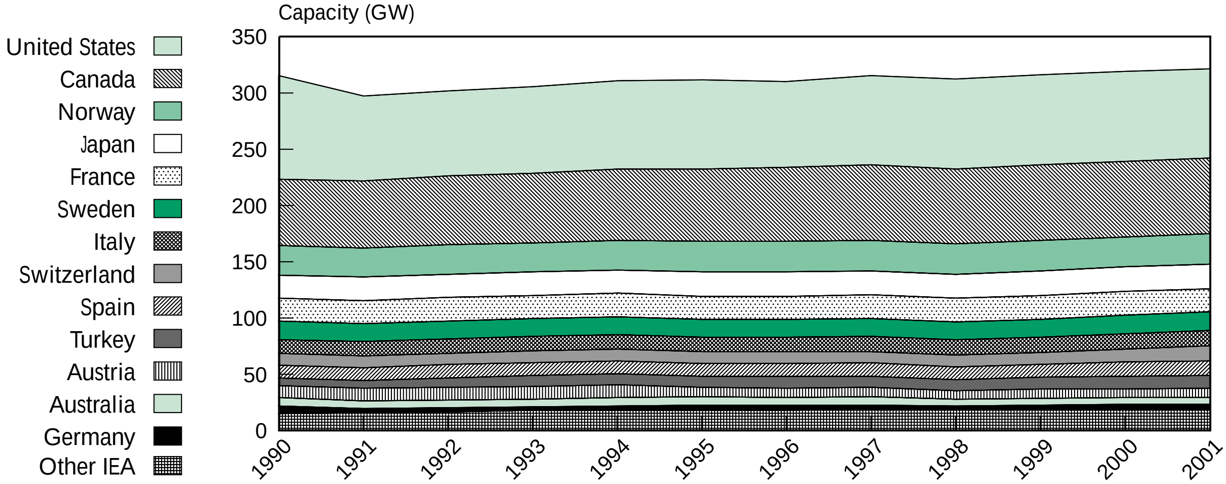
No international consensus exists on the threshold that separates small hydropower facilities from large ones. The upper limit for small hydropower varies from 2.5 MW to 30 MW, but 10 MW is becoming more generally accepted. Small hydropower facilities are commonly defined as:

- Small hydropower: capacity of less than 10 MW.
- Mini hydropower: capacity between 100 kW and 1 MW.
- Micro hydropower: capacity below 100 kW.

Installed Capacity

Hydroelectric development in IEA countries is fairly mature. Suitable and environmentally-acceptable hydropower sites are increasingly difficult to locate and develop, and thus hydroelectric capacity has been more or less stagnant for the past decade. Many of the civil works associated with existing capacity (waterways, tunnels, conduits) have been developed, maintained or replaced over the last century.

Figure 3-2. **Hydropower Installed Capacity in IEA Countries**



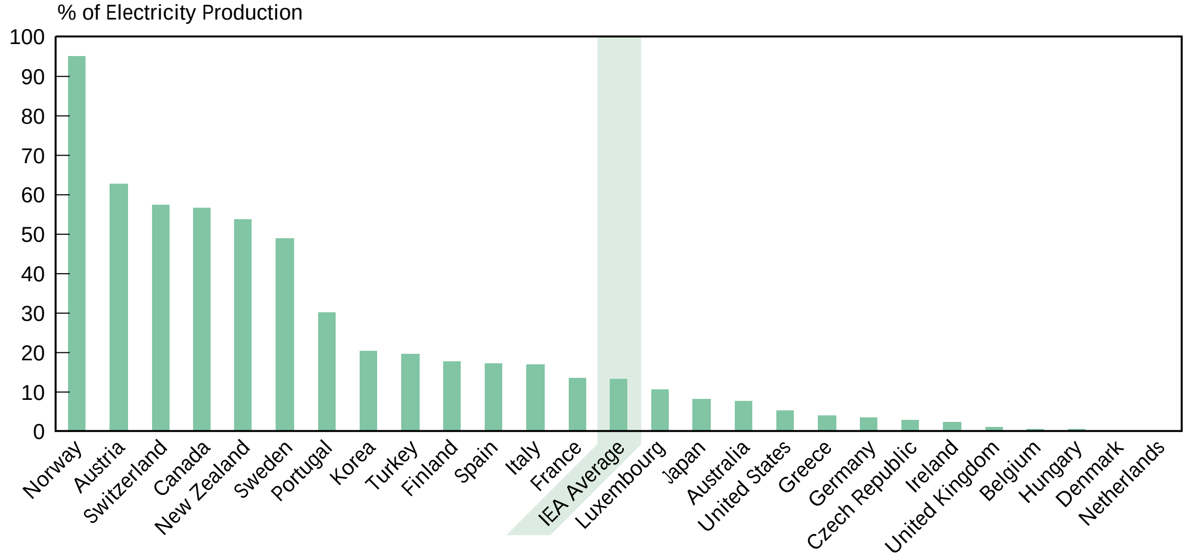
In 2001, IEA countries had a total installed capacity of 321 GW of hydropower. The United States, Canada, Norway and Japan together made up about 60% of total installed capacity in IEA countries with installed capacities of 79 GW, 67 GW, 27 GW and 22 GW respectively. The bulk of this installed capacity is derived from large hydropower stations that were developed before 1970. The other fourteen IEA countries in Figure 3-2 accounted for about 6% of total hydropower installed capacity in 2001.

Hydropower Electricity Production

Hydropower plants produced 1 186 TWh, or 13% of total electricity production in the IEA in 2001. Norway has the highest share, 99% in 2001, of hydropower in total electricity production among IEA countries (Figure 3-3).[2] Norway's heavy reliance on hydropower has caused supply problems, for example, during the winter of 2002/2003 when below average precipitation lowered reservoir levels and unusually cold temperatures increased electricity demand. Power prices rose to record highs with household bills two to three times higher than in 2001. To deal with seasonal and annual variability of hydropower production, Norway has increased international electricity interconnections. These interconnections export power in wet seasons and import power in dry ones. This system has reduced prices and increased the energy security of Norway and other countries participating in the exchange.

2. *Data excludes pumped storage.*

Figure 3-3. **Hydro Share in IEA Electricity Production, 2001**



In 1990, hydropower represented 91.4% of electricity produced from renewable sources. This share decreased to 86.3% in 2001. Seasonality and precipitation levels are important parameters for small hydro. To some extent, the low growth rate of overall renewable electricity was a result of the plunge of hydropower output in 2001 due to abnormally low global precipitation. Increases in hydro capacity in recent years are mostly from the addition of small hydropower plants at dams built for flood control, irrigation and/or drinking water supplies and from the restoration or refurbishment of large hydropower stations to improve efficiency.

Public Acceptance

Large hydropower projects have been increasingly associated with negative ecological and socio-economic impacts. Various techniques exist to minimise the ecological impacts: *e.g.*, fish ladders, careful operation of reservoirs, and integration of powerhouses into the landscape and noise reduction. Since most impacts are site-specific, each plant design requires individually appropriate environmental safeguards. Generally small hydropower projects have a higher level of public acceptance, as these sites can frequently be adapted to meet local environmental concerns.

Policy Trends

As a relatively mature technology, most hydropower policies in IEA countries focus on upgrading existing facilities to improve efficiency and supporting development of small hydropower systems. These policies rarely target hydropower exclusively, but usually promote renewables as a group including small hydro. Policies in IEA countries that promote hydropower offer tax incentives, investment support and/or feed-in tariffs. Australia offers investment support for the improvement and upgrading of existing hydropower stations through their Mandatory Renewable Energy Target. A number of European countries, including Belgium, Germany, Ireland, Spain and Switzerland, offer feed-in tariffs in the form of fixed buy-back rates. Japan has been providing capital grants to facilitate hydropower development for plants less than 30 MW since 1980.

A recent development is the increasing competition for watershed rights. In France and the United States, hydropower generation has fallen in recent years due to new regulations for the maintenance of increased minimum flow levels.

Technology and Cost Developments

Large hydropower provides one of the lowest cost options in today's energy market, primarily because most plants were built many years ago and their facility costs have been fully amortised. Sites for new large plants are scarce in IEA countries, but in the few cases where new sites could be developed, capital costs would be expected to be about US$ 2 400/MW and generating costs would be expected to be in the US$ 0.03 to 0.04/kWh range.

Under favourable circumstances small hydropower costs can be as low as US$ 0.02/kWh, although costs are generally in the range of US$ 0.04 to 0.06/kWh. Small hydropower can produce power at competitive costs in the range of wholesale electricity prices in good resource areas such as mountainous regions for high-head plants, rivers for low-head plants and various combinations. Small hydropower plants have a particularly long lifetime and relatively low operation and maintenance costs. Once the high up-front capital costs are written off (usually over fifteen to twenty years), the plant can provide power at even lower cost levels as such systems commonly operate without major replacement costs for fifty years or more.

Market and Policy Trends: Bioenergy

Bioenergy includes solid biomass (*i.e.*, forest product wastes, agricultural residues and wastes, and energy crops), biogas, liquid biofuels, and the organic component of industrial waste and municipal solid waste. Biomass-derived fuels are by-products of industrial or agricultural processes or fuels made from biomass feedstocks. In some instances, however, due to the existing system of data collection in some countries, bioenergy is combined with inorganic wastes in a reporting category termed combustible renewables and waste (CRW). Typically, the inorganic component of CRW is relatively small, but in a few cases it can be substantial.

In 2001, total bioenergy supply was 150.3 Mtoe, accounting for 3% of total primary energy supply in IEA countries. The share of bioenergy in renewable energy supply was 55%, up from 48.5% in 1980. Bioenergy is the largest contributor to renewable energy supply in IEA countries.

Potential

Estimates of the economic potential of bioenergy resources in IEA countries vary between 70 exajoules (EJ) to more than 200 EJ per year. In 2001, the use of combustible renewables and waste was only about 7 EJ.

Estimating biomass potential is complex because of the interface between biomass-derived fuels and the agricultural and forestry sectors. In the United States, the forest products industry uses 85% of its wood waste for energy. Most of this generated power is consumed on-site, but some manufacturers sell excess power to the grid. In the agricultural sector, the use of crop residues and livestock manure to produce energy can reduce waste management problems, as well as improve the economics of farming.

Production

Production of solid biomass in IEA countries was 5.2 EJ in 2001, representing about 80% of total combustible renewables and waste (CRW) production. The renewable portion of municipal solid waste accounted for 11%, industrial waste for 5% and gas from biomass for about 4%.

The fastest growing CRW market is gas from biomass, which grew by 16% per year from 1995 to 2001. Production of solid biomass is well-established in many IEA countries and average annual growth from 1990 to 2001 was nearly 2%.

Figure 3-4 provides a graphic presentation of CRW production. CRW can be used to produce electricity and heat (transformation sector) or for various end uses (final energy consumption sector). In 2001, 48 Mtoe, or 30% of CRW production, was used in the production of electricity and heat in IEA countries. More than 110 Mtoe was consumed directly in the industry, residential and transport sectors. Net imports were only about 0.5 Mtoe.

In IEA countries, the industry sector is the largest end-use consumer of combustible renewables and waste, accounting for 57% of total final sector CRW consumption in 2001. The pulp and paper industry alone consumed 42 Mtoe. CRW use in the residential sector is also substantial, representing 37% of final sector demand in 2001. Of the 48 Mtoe used in the transformation sector, 22 Mtoe went into the production of combined heat and power, 20 Mtoe in electricity-only plants and the remainder in heat-only plants and other transformation.

Figure 3-4. **Breakdown of Combustible Renewables and Waste Production and Targeted Technologies** (green boxes)

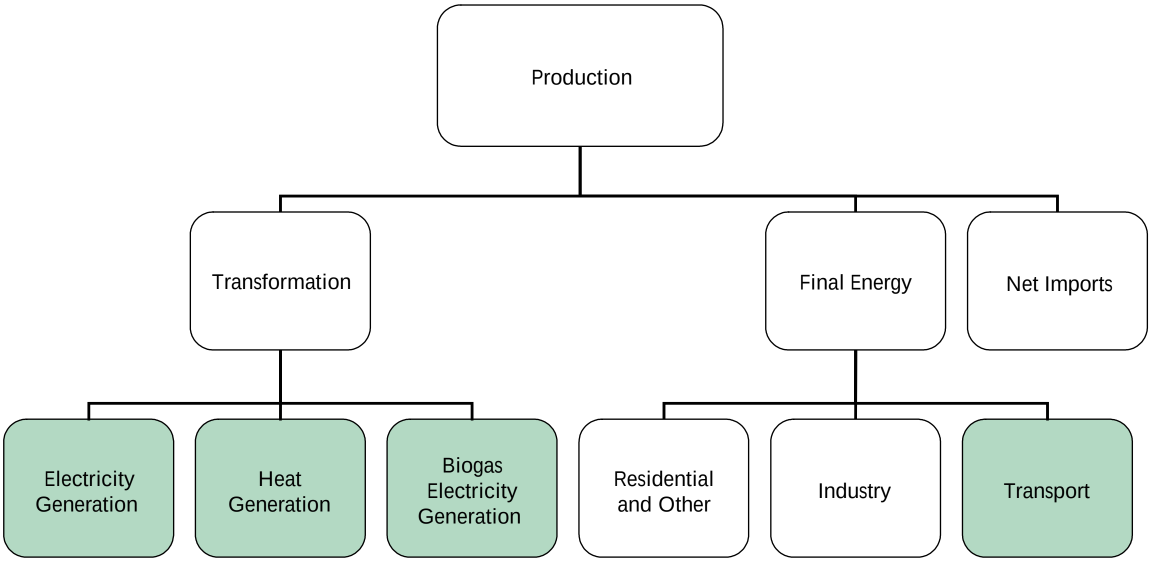


Table 3-1. **Breakdown of Combustible Renewables and Waste Ranked by Production, 2001**

	Production (TJ)	Transformation Sector Share (%)	Final Energy Consumption Share (%)
United States	2 216 811	22	78
Canada	438 020	6	94
France	401 646	2	98
Sweden	319 429	35	65
Finland	265 364	24	76
Turkey	263 634	1	99
Australia	200 729	12	88
Germany	190 882	4	96

The largest producers of combustible renewables and waste in the IEA are the United States, Canada and France. In Canada and France, only a small portion of CRW is used to produce electricity and heat. In contrast, electricity and heat production from CRW represent a large share of total production in Sweden and Finland. In Turkey, nearly all combustible renewables and waste are consumed in the residential sector for heating and cooking.

Until the 1970s, CRW use in the United States was dominated by wood burning for heat. Over the next two decades, however, wood burning declined, and by 2001, nearly two-thirds of the biomass contribution to TPES was waste residue used in the pulp and paper industry to produce steam and electricity. Other important uses of biomass in the United States include electricity generation from wood, waste fuels and biogas and ethanol derived from corn.

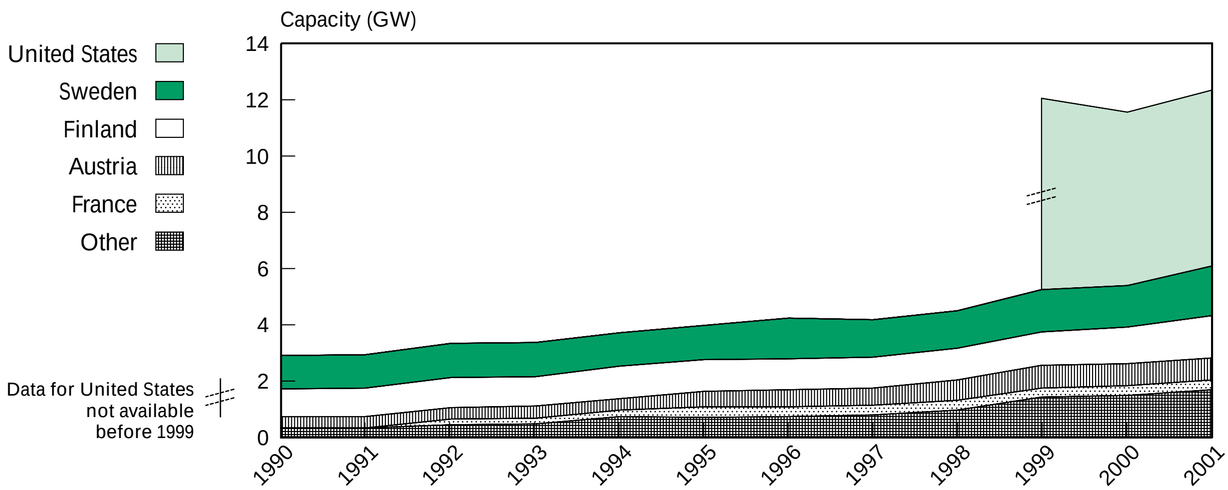
The pulp and paper sector accounts for more than three quarters of total combustible renewables and waste supply in Canada. In France, combustible renewables and waste contributes 64% to total renewable energy supply, most of which is in the form of wood heating in rural regions.

The technology sections of the country profiles focus on those technologies where renewable energy policies and measures have had the greatest impact on market development. The technologies that are highlighted in the profiles are electricity generation from solid biomass, heat generation from solid biomass, biogas electricity generation and biofuels, although this is only for countries with relevant markets.[3] The remainder of this section focuses on these four technologies.

Solid Biomass Electricity Production

Electricity generation in IEA countries from solid biomass was 84 TWh in 2001, 6.1% of renewable energy generation and 1% of total electricity generation. Generation from solid biomass was 60.5 TWh in 1990, and grew by 3% per year from 1990 to 2001. Installed capacity in 2001 was 12 GW.[4]

Figure 3-5. **Solid Biomass Installed Capacity in IEA Countries**



3. *Municipal solid waste is not included because countries have only recently begun to report separate categories for renewable and non-renewable waste. Renewable municipal solid waste, however, is estimated to have represented some 2.3% of renewable electricity generation in 2001. The portion of CRW used for co-generation is included.*
4. *Official data for the United States begins in 1999 and for Japan in 1998. Japan's total is included in Figure 3-5 under "Other".*

The countries with the largest share of biomass electricity generation among IEA countries, however, do not necessarily have a significant portion of total electricity generation based on biomass (see Figure 3-6). Finland uses solid biomass to meet 11% of its total electricity generation demand, while in the United States, the largest producer of biomass, solid biomass accounts only for about 1.1% of total electricity generation.

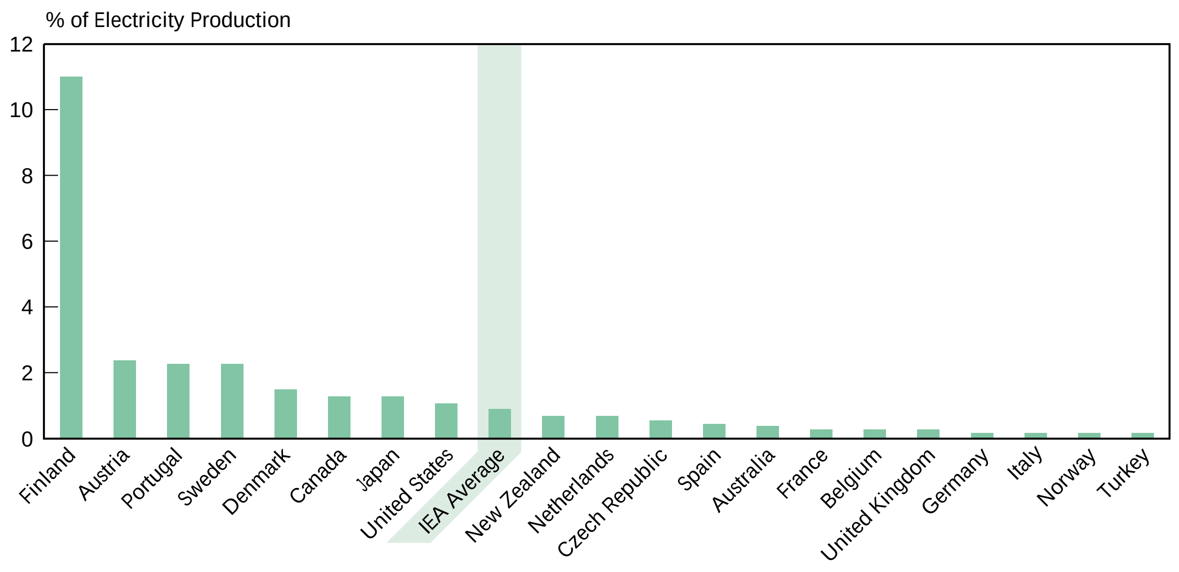
In Sweden, Austria and Portugal, electricity generation based on solid biomass accounted for more than 2% of total electricity generation in 2001. In Finland, the relatively high share is a result of government support to biomass technologies. From 1990 to 1997, solid biomass was exempt from a carbon tax on fossil fuels. In 1997, the carbon tax was replaced by taxation on electricity at the distribution level, with a refund granted to solid biomass of € 0.042/kWh.

In Sweden, electricity generation from solid biomass increased steadily from 1 200 MW in 1990 to about 1 800 MW by 2001, the result of a concerted government effort in the early 1990s to support biomass through taxation and other means. Taxes as a tool to increase biomass use are expected to continue to play an important role in the future.

In Austria, biomass contribution to electricity generation was 2.4% in 2001. The share has increased gradually since the early 1990s. Most of the growth can be attributed to the introduction of a guaranteed market through a voluntary agreement between the Ministry for Economic Affairs and the Association of Electric Utilities where 20% of the delivery price for biomass was provided by the government for three years. Further impetus was given by the tax on gas and electricity in 1996 and the implementation of the Promotion Instrument for Electricity from Renewables in 1997, which provided both a capital incentive and a guaranteed tariff for renewable electricity fed into the grid.

In Portugal, the primary impetus to electricity generation based on solid biomass was the ENERGIA Programme, established in 1994, which provided investment incentives for renewable energy projects.

Figure 3-6. **Solid Biomass Share in Electricity Production, 2001**

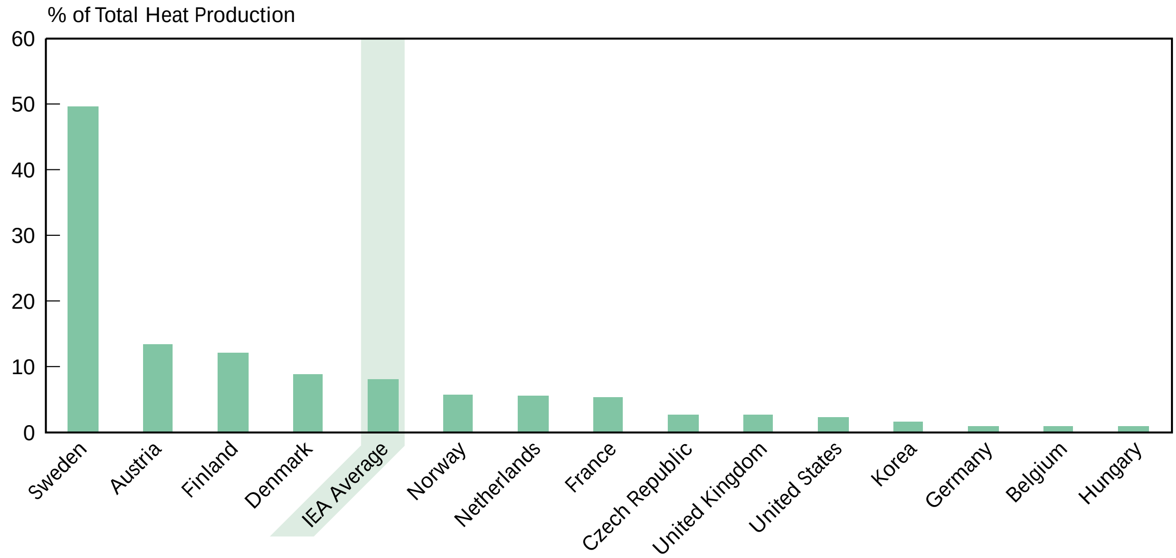


Biomass Heat Production

Gross heat production in IEA countries from solid biomass was 148 332 TJ in 2001, 38% of renewable heat production.[5] Data on heat in the IEA database are available in different years for different countries and thus aggregated country data should be used with caution.

In 2001, the largest producer of heat from solid biomass in the IEA was Sweden with production of 82 640 TJ, or more than 50% of total IEA heat production from biomass. Other major producers were Finland with 16 642 TJ, the United States with 11 662 TJ and Denmark with 11 337 TJ.

Figure 3-7. **Solid Biomass Share in Heat Production, 2001**



In Sweden, biomass now meets more than 50% of the supply for district heating systems. This proportion represents a five-fold increase of supply since 1990. In Finland, gross heat production from solid biomass increased from 6 118 TJ in 1995 to 16 642 in 2001, an average annual growth of more than 18% per year. Heat generation is not taxed in Finland and plants are eligible for investment credits.

In 2001, heat production in Austria was 8 874 TJ, up from 1 404 TJ in 1990. Federal and state policies have been instrumental in stimulating the market for biomass district heating plants for villages since the mid-1980s. These policies have primarily taken the form of implementation management and investment grants, a type of financial incentive. Installation of biomass district heating plants has increased steadily since the mid-1980s.

The share of heat in total final energy consumption is unusually high in Denmark at 16%. This is due to Denmark's extensive use of district heating, which was promoted after 1979 through the National Heat Supply Act. It included a national heat plan and the possibility for local governments to mandate connection to the district heat network for new and existing buildings. Regional subsidies for biomass-

5. Heat production from municipal solid waste is not included, because countries have only recently begun to report separate categories for renewable and non-renewable waste. Heat production from MSW was about 40% of total renewable heat production in 2001. The portion of CRW used for co-generation is included.

fired heating plants were offered (until 2001) for up to 21% of costs of installations in households and 26% for installations in companies. As a result, in 2001 Denmark had 50 heating plants operating on wood chips, 25 on wood pellets and 75 straw-fired plants.

Biogas Electricity Production

Electricity generation from biogas grew from an estimated 5 TWh in 1990 to 13.6 TWh in 2001. In the early 1990s, nearly all of the biogas electricity in IEA countries was produced in the United States. Over the past few years, most of the growth in IEA production of electricity from biogas has taken place in European countries. The United Kingdom is the largest producer in Europe, with 2.9 TWh in 2001. Germany produced nearly 2 TWh in 2001. The United States is still the largest IEA producer with 4.9 TWh in 2001.

Electricity generation from biogas sources in the United States, particularly landfill methane, was stimulated by a combination of the Public Utilities Regulatory Policies Act (PURPA), a federal tax credit for gas produced from non-conventional sources, known as the “Section 29” tax credit, as well as more recent environmental regulations requiring landfill operators to control methane emissions. Landfill methane generation also benefits from the evolving voluntary market for green power. The Section 29 credit, which was set at US$ 0.52 per mmBtu in 1980, but adjusted for inflation, had reached a value of more than US$ 1.00 per mmBtu of gas produced by the time it was allowed to expire in 1998. Since the expiration of the credit, the growth in new landfill methane facilities has slowed.

Biofuels

Production of liquid biofuels in IEA countries increased from 4.3 million tonnes in 1995 to 5.8 million tonnes in 2001. The United States accounts for more than 80% of total IEA production of biofuels, mostly ethanol. Other major ethanol producers are Sweden and Spain. The largest biodiesel producers are France and Germany.

There have been many recent efforts to expand the use of biofuels in IEA countries. In early 2003, the European Commission (EC) issued a Directive promoting the use of biofuels and other renewable fuels for transport. This directive created two indicative targets for EU member states: 2% biofuels penetration by December 2005 and 5.75% by December 2010. The targets are not mandatory, but governments are required to develop plans to try to meet them.

In the United States and Canada, legislation is under consideration that could lead to large increases in ethanol production over the next few years. Australia has recently implemented blending targets and Japan has made clear its interest in biofuels blending, even though its biofuels must be imported.

Technology and Cost Developments

Solid Biomass Electricity Production

Generation costs can be given for a range of biomass applications based on the system investment needed and annual electrical output. Very low generation costs (slightly above US$ 0.02/kWh) occur with co-firing, where relatively little additional investment is needed. Higher generation costs in the range of (US$ 0.10 to US$ 0.15/kWh) apply to innovative gasification plants.

The cost of producing electricity from solid biomass depends on the technology, fuel cost and quality of the fuel. Power plants tend to be small, typically 20 MWe or less, although there are quite a few CHP plants, for example in Sweden, that are much larger.

Biofuels

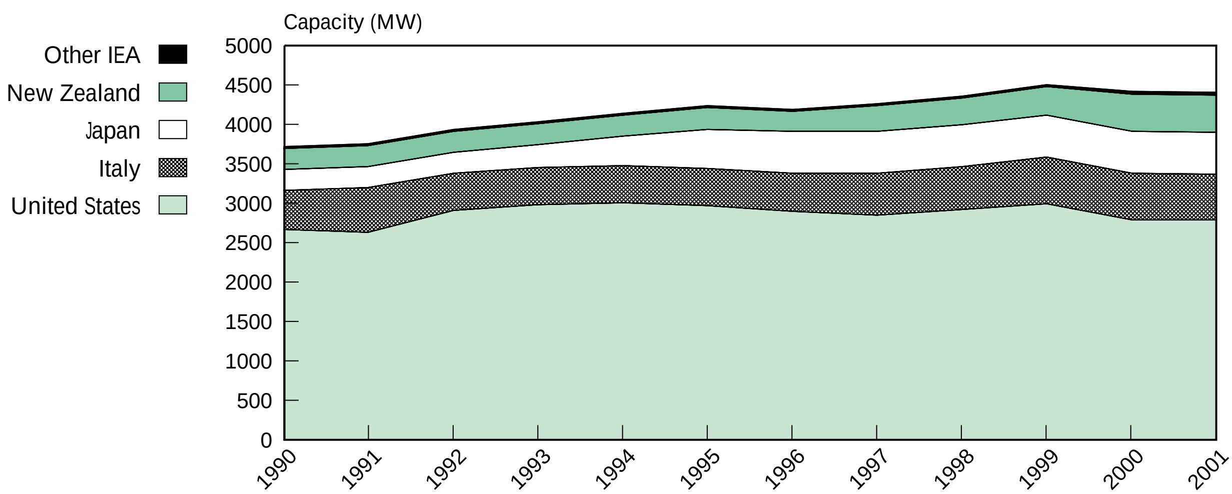
Biofuels are transportation fuels derived from agriculture, forestry or other organic sources. Cereals, grains, sugar crops and other starches are fermented to produce alcohol (usually ethanol) which can be used either as a blending component in gasoline, as motor fuel in pure form, or as a gasoline additive after being converted to ethyl-tertiary-butyl-ether (ETBE). Oil-seed crops (*e.g.*, rapeseed, soybean and sunflower) can be converted into methyl esters, a liquid fuel which can either be blended with conventional diesel fuel or burned as pure biodiesel. Cellulosic materials, including grasses, trees, and various waste products from crops, wood processing facilities and municipal solid waste, can also be converted to alcohol. The processing of these cellulosic materials is more complex than processing sugars and grains.

In IEA countries, the production cost of ethanol and biodiesel declined substantially over the past ten years, but is still up to three times that of gasoline and diesel. However, in some developing countries it is equal to, or lower than, fossil fuel costs. It does not seem likely that biofuels produced in IEA countries from grain and oil-seed feedstock using conventional conversion processes will compete with gasoline and diesel, unless world oil prices rise considerably. Technologies are relatively mature and cost reductions are ultimately limited by the fairly high feedstock costs. However, the use of low cost cellulosic feedstock with advanced conversion technologies, including those using the whole plant, could eventually lead to the production of lower cost ethanol in IEA countries. Large-scale importing of biofuels from developing countries could also expand IEA markets.

Market and Policy Trends: Geothermal Energy

Geothermal is energy available as heat emitted from within the earth, usually in the form of hot water or steam. Geothermal as a recoverable energy resource is very site specific. High temperature geothermal resources can be used to generate electricity, though the identified high enthalpy resources are not widely distributed in IEA countries. Low temperature geothermal resources are more wide spread and are employed in various direct uses such as district heating, industrial and agricultural processing, balneology and in conjunction with ground water heat pumps. Electricity generation from geothermal resources is the focus of this section.

Figure 3-8. **Geothermal Installed Capacity in IEA Countries**



Installed Capacity

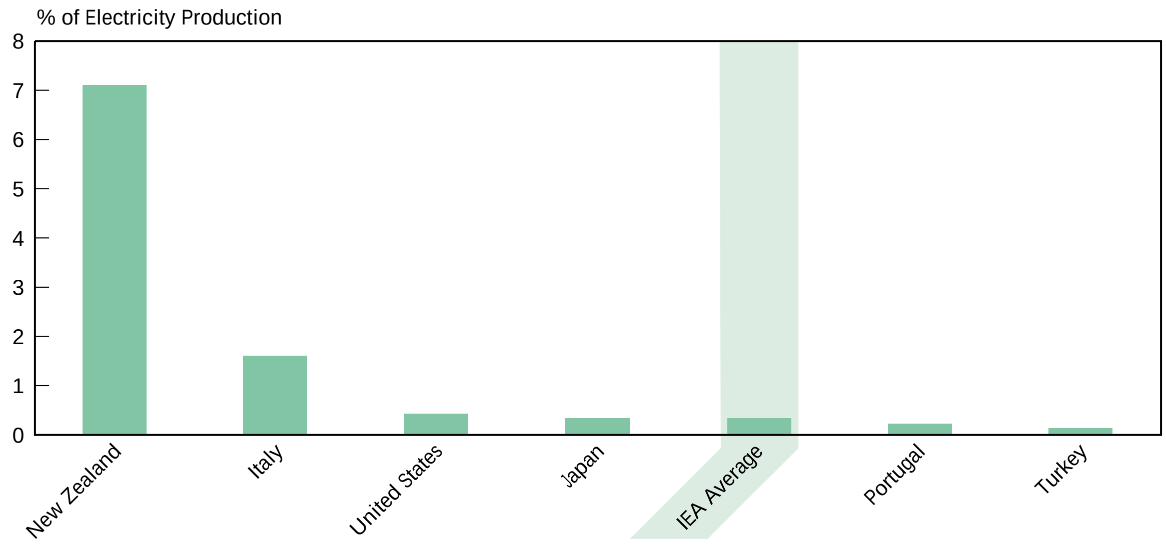
The first successful commercial project for generating electricity from geothermal steam was in Larderello, Italy in 1904. Between 1970 and 2001, geothermal markets exhibited two very different growth patterns. The 1970 to 1990 average annual growth was about 8.4%. In recent years, though, growth in installed capacity has been marginal from 3 717 MW in 1990 to 4 348 MW in 2001, at 1.4% annually. Practically all of the IEA installed geothermal capacity is in the United States, Italy, Japan and New Zealand, as illustrated in Figure 3-8. By far, the United States has the highest absolute amount of installed capacity at 2 793 MW.

Geothermal Electricity Production

Geothermal electricity is an important contributor to renewable electricity production. In the United States, however, production declined from 16 TWh in 1990 to 14.3 TWh in 2000. The highest growth rate of geothermal electricity generation was achieved in Iceland, an OECD but not an IEA Member country, where production increased by 15.4% annually from 0.3 TWh to 1.5 TWh between 1990 and 2001.

Overall, geothermal accounted for 0.3% of electricity supply in IEA countries in 2001. Only in New Zealand does geothermal provide a notable share of electricity supply at 8.2%. Lacklustre growth for geothermal electricity is projected in the next few years because few development schemes exist in IEA countries.

Figure 3-9. **Geothermal Share in Electricity Production, 2001**



Policy Trends

The US programme for geothermal energy began in the late 1970s and early 1980s when research and development related to geothermal received about US$ 100 million (1995 dollars) per year. In addition, the Public Utility Regulatory Policies Act (PURPA) mandated the purchase of electricity from qualifying facilities. In California, the Standard Offer Contract system for PURPA-qualifying facilities provided renewable electric energy systems with a relatively firm and stable market, thereby facilitating the financing of capital-intensive geothermal energy facilities. When R&D funding decreased and programmes were changed or halted, geothermal progress slowed in the United States.

Italy, with the second highest amount of geothermal electricity capacity, has provided government support through research and development and feed-in tariffs. The high level of the tariff (€ 0.17/kWh for the first eight operational years) under CIP6/92 led to significant capacity installation in the last decade, although older, less cost-effective plants were retired in the same period, limiting the resulting capacity increase.

In Japan, a 1980 law to promote alternative energy provided incentives to geothermal producers. From 1993 to 2000, the New Sunshine Programme provided a major impetus to geothermal development by supporting technology innovation, particularly for exploration and development, and funding resource assessments to help lower development risks. Social acceptance is important to the maintenance and further development of geothermal power in Japan. The government has invested considerable efforts to increase awareness of the benefits of geothermal power plants to local communities.

In New Zealand, where geothermal provides 8.2% of electricity production, government supported research and development and resource assessment have helped to improve cost effectiveness, but geothermal development has been more the result of private investment by utilities and their partners.

Technology and Cost Developments

The costs of geothermal energy have dropped substantially from the systems built in the 1970s. Costs are heavily weighted towards up-front investments. The resource type (steam or hot water) and temperature, as well as reservoir productivity, influence the number of wells that must be drilled for a given plant capacity. Typical costs for a single well range from US$ 100 to US$ 400/kW. Power plant size (rated capacity) and type (single-flash, binary, etc.), as well as environmental regulations, determine the capital cost of the energy conversion system. Because costs are closely related to the characteristics of the local resource system and reservoir, costs cannot be easily assessed on a general level.

Generation costs depend on a number of factors, but particularly on the temperature of the geothermal fluid, which influences the size of the turbine, heat exchangers and cooling system. US sources report current costs of producing power from as low as US$ 0.015 to 0.025/kWh at The Geysers, to US$ 0.02 to 0.04/kWh for single-flash and US$ 0.03 to 0.05/kWh for binary systems. New construction can deliver power at US$ 0.05 to 0.065 or 0.08/kWh, depending on the source. The latter figures are similar to those reported in Europe. Generation costs per kWh are € 0.05 to 0.09 for traditional power plants (liquid-steam water resources) and € 0.20 to 0.30/kWh for hot dry rock systems.

Geothermal power technology has been steadily improving. Although no clear trend toward lower energy costs can be shown for the plants producing electricity in the low-cost range, new approaches are helping utilise resources that would have been uneconomic in the past. This is the case for both power generation plant and field development. Drawing an experience curve for the geothermal power sector is difficult, not only because of the many site-specific features having an impact on the technology system, but also because of poor data availability.

Geothermal Direct Use

In addition to power generation, geothermal energy is sometimes used as heat. For example, in the United States, more than 600 MWt of geothermal heat capacity is used for industrial and agricultural purposes, such as district heating, food processing, greenhouses and aquaculture. Most of these direct use applications occur as a by-product of electricity generation and can be found in many of the countries producing geothermal electricity. However, lower temperature resources are found in many regions and countries where electricity production is not practical. In these places, geothermal heat can be commercially competitive, although policy supports are not generally in place specifically for geothermal heat.

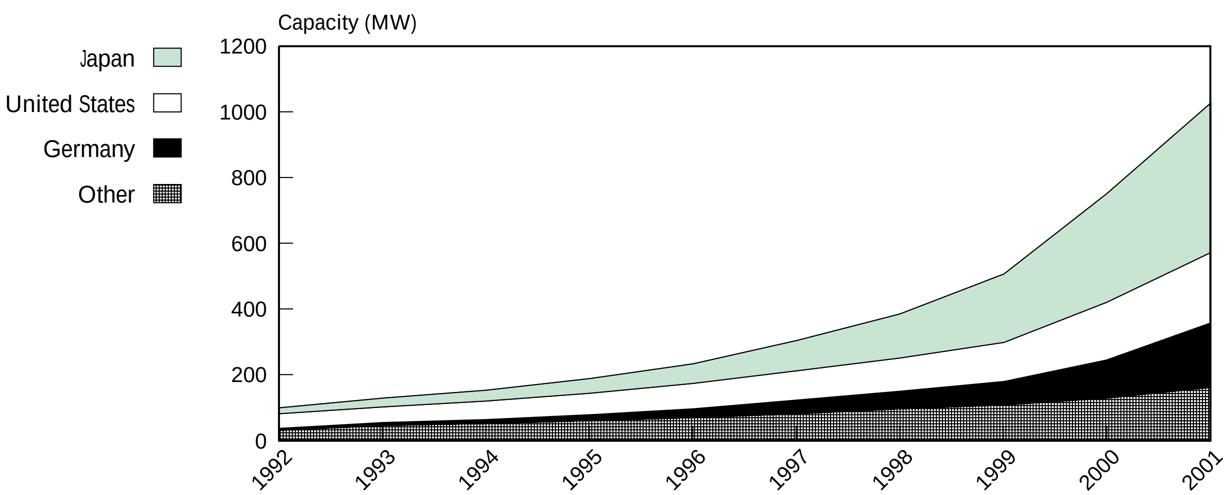
Market and Policy Trends: Solar Photovoltaic[6]

Solar PV technology was used primarily for satellites through the 1950s and into the 1960s. The price of PV systems dropped in the 1970s and 1980s allowing the technology to be increasingly used in remote areas where refueling a generator, recharging a battery or running a connection to the utility grid was prohibitively expensive. Grid-connected PV generated electricity has seen rapid growth since the late 1990s.

Installed Capacity

Solar PV experienced an annual average growth rate of 29% between 1992 and 2001. In 1992 installed capacity was 101 MW in 1992, with the United States containing the majority of it at 44 MW. Japan had 19 MW, Italy 8 MW, Australia 7 MW and Germany 6 MW. Japan, Germany and the United States accounted for 85% of total installed capacity of about 1 000 MW in 2001.

Figure 3-10. **Solar PV- Installed Capacity in IEA Countries**



In 2002, Japan, Germany and the United States accounted for 92% of new installations.

- Japan reached 637 MW, *i.e.*, 48% of total installed capacity in 2002 up from 17% in 1992. Average annual growth over the period 1998-2002 was 48%.
- Germany reached 277 MW, *i.e.*, 21% of total installed capacity in 2002 up from 5% in 1992. Average annual growth over the period 1998-2002 was 52%.
- The United States reached 212 MW, *i.e.*, 16% of total installed capacity in 2002 compared with 40% in 1992. Average annual growth over the period 1998-2002 was 21%.

In 1990, PV was used mainly in stand-alone systems for rural electrification and small-scale applications. Since then, the number of grid-connected systems has increased significantly. Europe and Japan have the largest number of distributed grid-connected PV systems, mostly building-integrated (BiPV). The market

6. It is difficult to assess early PV market trends as data reported by the Member governments for the late 1980s and early 1990s are often incomplete. These deficiencies are due to the very small scale of PV modules and remote installations. Most IEA countries do not collect data for off-grid systems, and techniques for on-grid data collection are only now being developed. The following discussion is based primarily on the limited set of official IEA statistics as reported by the Member governments. See Annex 2 for more detail.

share of distributed grid-connected PV installations has been growing steadily and reached 63% of cumulative capacity installed in countries collaborating in the IEA's Photovoltaic Power Systems Implementing Agreement by the end of 2001.

PV Electricity Production

Although solar PV markets are growing rapidly, the share of PV generated electricity is extremely small. Germany reports the largest proportion of electricity generated in 2001, accounting for approximately a quarter of a percent of domestic electricity generation. Despite its small overall proportion, electricity production from solar PV has been growing by nearly 60% per year.

Electricity production numbers for the United States and Japan would be expected to be higher than Germany's, as their installed capacity exceeds that of Germany's and their solar regimes are superior. Due to their net metering system, Japan does not gather electricity production data on a large part of their PV market, most notably the on-grid distributed portion, which is dominated by residential use and accounted for 86% of the market in 2002.

In the United States, almost two-thirds of PV electricity production is off-grid. More than 80% of PV capacity in Australia, Canada, Finland, France, Korea, Norway and Sweden is for off-grid applications. In Norway, Finland and Sweden, most PV installations are related to applications in holiday homes and boats. In Australia and France, PV is used for rural electrification. In Korea, most systems are for industrial and commercial applications including telecommunications and remote monitoring.

Policy Trends

PV is unlikely to be a significant contributor to the overall energy balance in the short term, although it may achieve significant penetration in remote areas. PV's current market growth of 30% per year is largely driven by government incentives. The resulting cost reductions are impressive, as every doubling of the volume produced has brought about a cost decrease of about 20%.

The commitment of the United States, Japan and Germany to PV technology is reflected in RD&D budgets over the period 1990-2002:

- The US average annual budget from 1990 through 2002 was US$ 77.3 million, representing 32.6% of its renewable energy RD&D budget, or roughly 2.9% of total energy RD&D expenditures.
- In Japan, the average annual budget from 1990 through 2002 was US$ 66.1, representing 59.6% of its renewable energy RD&D budget, or about 2.1% of total energy RD&D expenditures.
- In Germany, the average annual budget from 1990 through 2002 was US$ 40.1 million, representing 48.6% of its renewable energy RD&D budget, or about 12.5% of total energy RD&D expenditures.

Other countries with significant annual budgets for PV RD&D were Italy (US$ 15.9 million), the Netherlands (US$ 12.3 million) and Switzerland (US$ 10.8 million).

RD&D contributes to reducing production costs of PV modules, which represent an average of about 60% of the total costs of grid-connected systems (50-80% depending on actual working conditions). RD&D is capable of reducing module production costs by means of:

- Higher cell and module efficiency.
- More efficient use of semiconductor materials.
- Development of low-cost feedstock materials.
- Use of new materials (mostly thin films).

RD&D efforts, together with market deployment policies, have been efficient in helping reduce PV module production costs. It is clear, though, that further investments by the private sector in PV are dependent on public financial support in order to proceed down the learning curve. The weighted average price of modules in 2002 in the reporting countries with the seven largest markets was US$ 3.5 per Watt.

Japan, the largest producer of PV cells in the world, has strongly supported the domestic PV industry. With an annual manufacturing capacity for PV systems of more than 250 MW, the cost of solar cells, PV modules and PV systems have been steadily decreasing, largely due to financial support policies for RD&D and market deployment. Research and development in PV cell technology in Japan commenced under the Moonlight and Sunshine Programmes in the 1970s and 1980s. The New Sunshine Programme vastly increased funding for RD&D and promoted technology development of PV systems. In addition to RD&D funding, the PV market has been supported through net metering and capital grants. Solar PV capacity increased from 19 MW in 1992 to 453 MW in 2001, an average annual growth rate of more than 42%.

Germany has employed a combination of feed-in tariffs and production subsidies that resulted in growth of installed capacity of more than 47% per year between 1992 and 2001. Germany began with a demonstration project, the 1000 Roofs Programme in 1991, which succeeded in increasing installed capacity by 5.3 MW. This programme was succeeded by the 100 000 Roofs Programme in 1999. Under the Renewable Energy Sources Act of 2000, electricity suppliers pay at least € 0.51/kWh of solar generated electricity fed into the grid. Total installed capacity increased to 195 MW in 2001, an annual average growth of more than 47% since 1992.

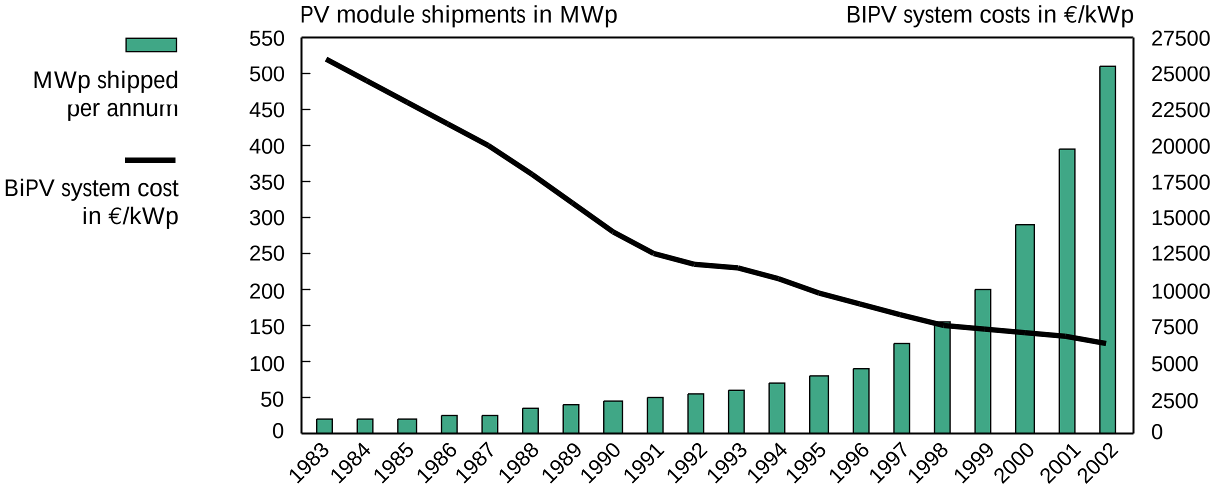
Significant programmes to encourage PV in the United Sates include the voluntary One Million Solar Roofs Initiative. One of the most successful policy supports has been the establishment of net metering rules, where PV systems can feed into, or draw out of, the utility distribution network for the same cost. In combination with net metering initiatives, state programmes through cash rebates and renewable portfolio standards have had a positive effect on the PV market. With 60% of the state of Arizona's renewable portfolio standard to be met from solar resources, 6 MW of PV projects have been installed to date. For the United States overall, these market deployment activities have on average increased the installed capacity of PV by nearly 20% per year between 1990 and 2001.

Technology and Cost Developments

Costs for PV systems vary widely and depend on system size, location, customer type, grid connection and technical specifications. Average installation costs are about US$ 5-9 per Watt for building-integrated, grid-connected PV systems. Costs vary according to the maturity of the local market and specific conditions. Furthermore, system costs vary significantly depending upon whether the system is part of a retrofit or is integrated into a new building. In many cases, the added cost to the building of the PV system is less than the figures shown here, as in modern systems the PV often replaces other building materials, and thus those costs are saved. Stand-alone systems cost more, but can be competitive with other autonomous small-scale electricity supply systems, particularly when traditional fuels are costly or not easily accessible.

Cost reduction has been a key issue for PV, as costs are still relatively high compared to other electricity production technologies. But cost reductions of building integrated PV (BIPV) systems have been considerable and average costs have been reduced by a factor of two in each of the last two decades, as depicted in Figure 3-11.

Figure 3-11. **Annual World PV Module Production and Building-integrated System Costs, 1983-2002**



Source: NET Ltd. Switzerland; PV News, February 2002.

Cost-reduction opportunities for solar cells and modules remain important because these items are expensive key components of PV systems. Both grid-connected and stand-alone applications need better balance of system (BOS) components. A variety of reliable components are available; nevertheless, the efficiency, lifetime and operation of some components can be further improved, especially inverters and batteries. Standardisation and quality assurance are crucial for components as well as for the entire system.

RD&D focused on the long-term is of high importance for PV, in particular for the solar cell. Furthermore, to bring new concept cells and modules to production, new manufacturing techniques and large investments are needed. Such developments typically require five to ten years to move from laboratory research to industrial production. Over the next decade, thin film technologies are expected to display their potential for cost reduction and improved performance.

Market and Policy Trends: Solar Thermal Energy

Solar Thermal Electricity

Potential

Solar thermal electric technologies have significant potential in countries with high direct insulation. In order to fulfil this potential, cost competitiveness must be achieved. The potential could be increased by electricity exports from neighbouring countries, such as North Africa/Turkey to Europe.

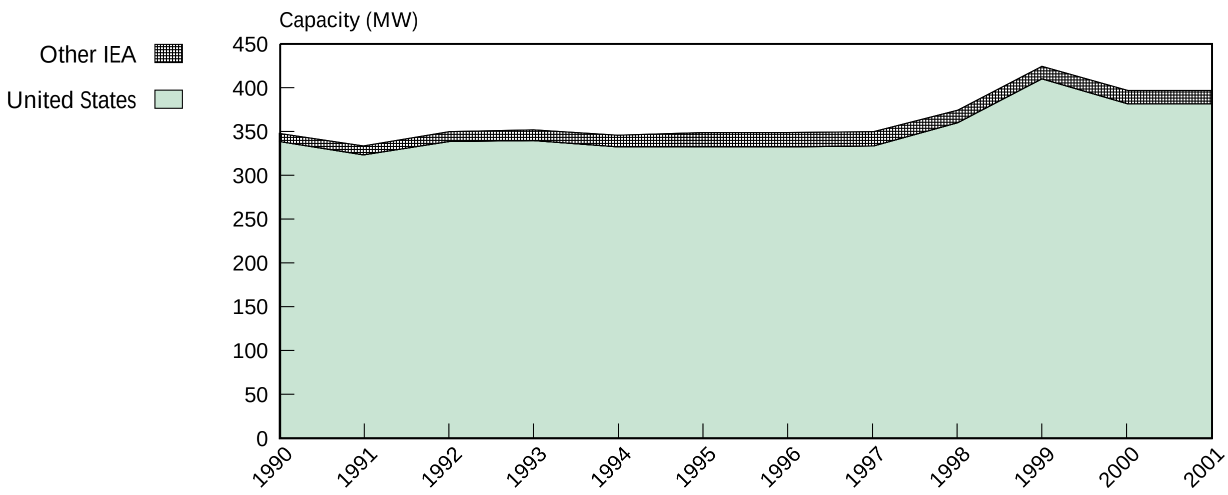
Solar Thermal Electricity Production

Solar thermal electricity production was reported to be 663 GWh in 1990, but this figure included electricity produced from burning natural gas as a back up in solar plants. In 2001, reported production was 556 GWh due to a reclassification of US data. Revised time series are expected for 2002. Production takes place almost exclusively in the United States, where 526 GWh were generated in

2001. The only commercial-scale solar thermal electric projects were installed in California from 1984 to 1990, employing parabolic trough technology. In total, 354 MW of solar trough plants were constructed by a single company taking advantage of the favourable PURPA implementation regulations in California as well as federal and state tax incentives. Ultimately, both the company and the technology became casualties of the unpredictability and decline of these incentives during the late 1980s and early 1990s as a result of falling prices for conventional generation fuels.

Australia also has small output of solar thermal electricity. In 2001, there was an estimated 397 MW of installed solar thermal electricity capacity in IEA countries, less than 0.001% of total renewable electricity capacity.

Figure 3-12. **Solar Thermal Electricity – Installed Capacity in IEA Countries**



Technology and Cost Developments

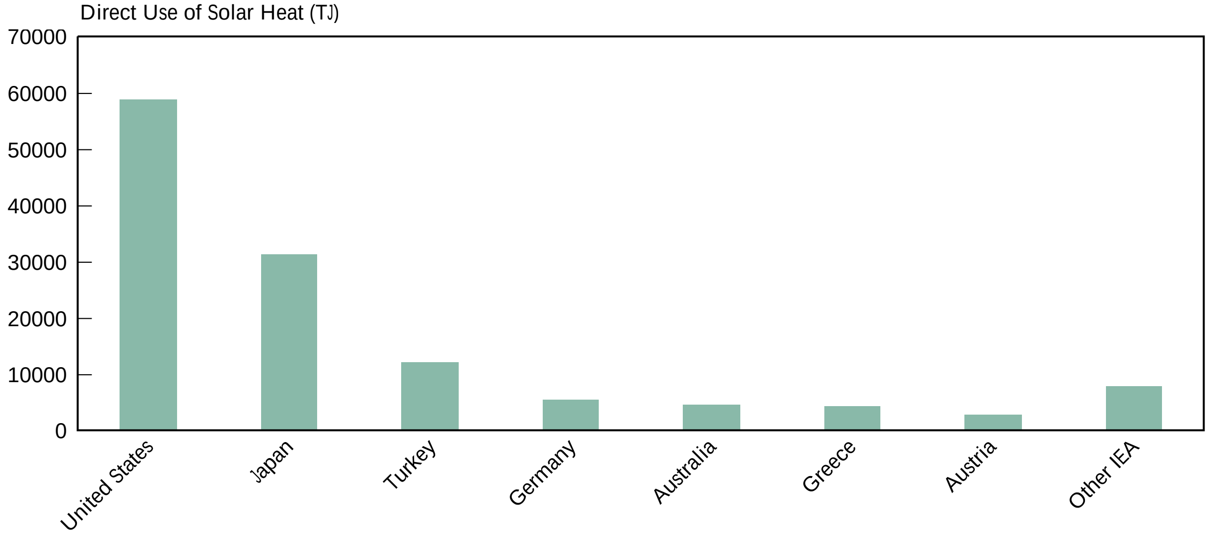
There are three basic solar thermal electric technologies: towers, dishes and troughs. The systems operate with a thermal phase, allowing either thermal storage or back-up fuels to offset intermittency and thus increase the commercial value of the energy produced. Recent trends include direct steam generation, integration in larger combined cycle power plants, compact fresnel reflectors, heat storage (Italy, Spain) and reduction of operation and maintenance costs.

Forthcoming trough solar – only projects include a 50 MW plant in Nevada and two 50 MW plants in Spain. Both projects have benefited from favourable feed-in tariffs. Costs are in the range of US$ 0.12 to 0.14/kWh for the Nevada plant and €0.15/kWh for the plant in Spain. Costs could be reduced by using a few arrays of small troughs to combine electricity production with heating and cooling in buildings.

Solar Thermal Heating and Cooling

The largest producers of solar hot water technologies in the IEA are the United States, Japan and Turkey. Together they account for more than 80% of direct use of solar heat in IEA countries. The United States produces 58 872 TJ of heat from solar sources, Japan 31 287 TJ and Turkey 12 014 TJ. Other significant producers are Germany, Australia, Greece and Austria.

Figure 3-13. **Direct Use of Solar Heat, 2001**



In 1999-2000, an average of two million square metres of solar collectors were installed in IEA countries. The collectors installed in Austria, Germany, Japan and the United States represented some 87% of the total. Data collected by the IEA's Solar Heating and Cooling Programme indicate an 8% growth in the market for flat plate and evacuated tube collectors in 2000 from the previous year. The calculated annual collector yield of the recoded systems, excluding air collector, is about 21.3 GWh.[7]

There are two basic types of solar thermal collectors in use in IEA countries: flat-plate and evacuated-tube. By the end of 2000, there were 31 million m^2 of flat-plate and evacuated tube collectors for hot water and space heating and 24 million m^2 of unglazed collectors for swimming pool heating. Greece experienced rapid growth in the number of solar heating systems from 1.8 million in 1990 to more than 3 million in 2001.

Technology and Cost Developments

Solar water heating systems can be active or passive. Active systems are typically more expensive, but at the same time more efficient. In general, passive systems are more reliable, easier to maintain and longer lasting than active systems. They are also less expensive, but less efficient because of slower water flow rates through the system.

Some IEA countries are engaged in significant efforts to reduce the cost of solar hot water systems. In Austria, the cost of large-scale solar heating systems for district heating and other large commercial projects is being reduced through the development of larger collector modules. Collector modules up to 15 m^2 in area increase efficiency, reduce connection costs and heat losses, and lower installation costs for an overall cost reduction of 30%. In Norway, a new plastic collector using a novel packed bed absorber design in a drain back configuration is expected to reduce costs and spur the growth of a new company.

The testing, certification and standardisation of solar equipment is becoming more common, with the aim of making the systems more reliable and cost-effective. One barrier to solar thermal energy is the high

7. For more information see www.iea-shc.org.

labour cost of installation. Companies are being formed in Portugal and the United States that sell solar heated water to commercial and residential consumers from systems that are owned and maintained by the energy service company.

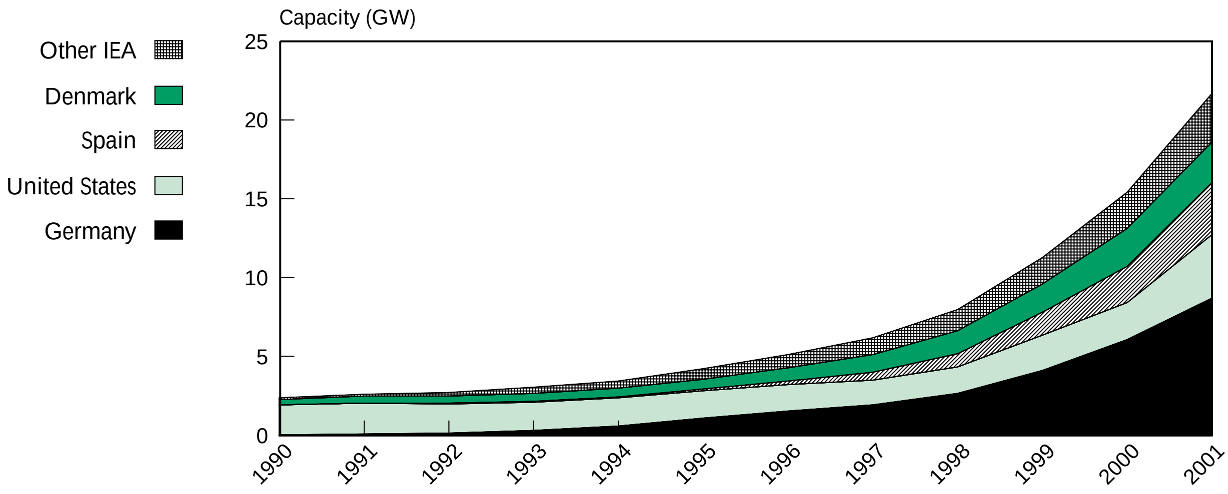
Market and Policy Trends: Wind

The commercial development of grid-connected wind generators started after the oil price crises in the 1970s, building from mechanical wind machines used mostly for water pumping. In the early 1980s, most commercial wind turbines were assembled using a number of standard components. Only blades and control systems were specially tailored for the wind turbine industry. With increased market volume, more specialised suppliers, including larger companies, are providing tailored components.

Installed Capacity

As the costs of wind turbines have steadily declined, technical reliability has increased and the last decade has seen an explosive growth in the development of wind power. In 1990, IEA countries had 2 395 MW of installed wind power capacity and by 2001 it had expanded to 21 707 MW, a 22.2% annual average growth rate. While a number of IEA countries have significant potential based on wind resource assessments, in 2001 about 86% of the installed capacity was in only four countries as depicted in Figure 3-14.

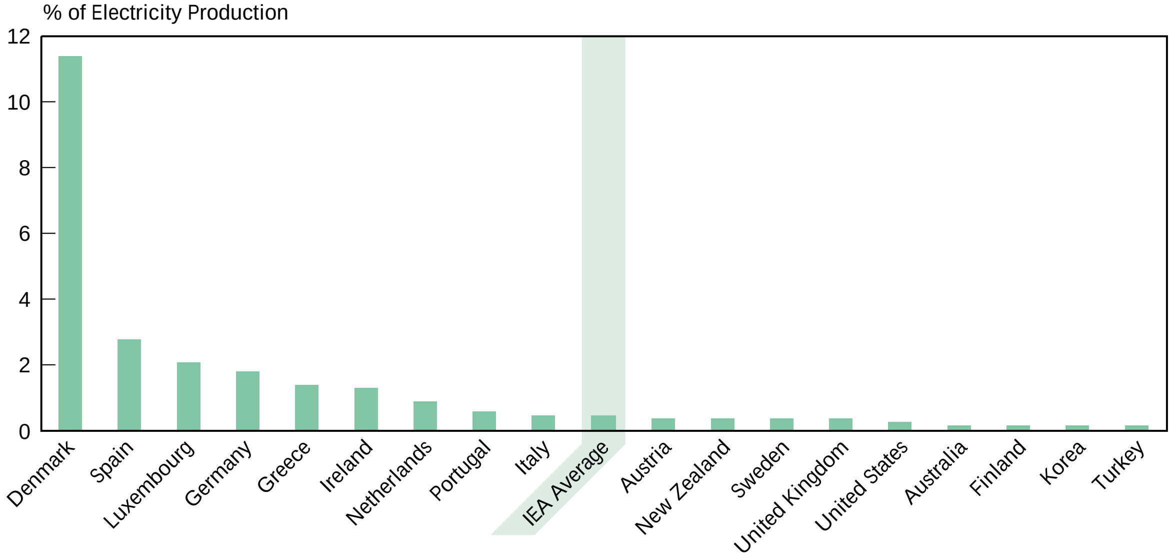
Figure 3-14. **Installed Wind Power Capacity in IEA Countries, 1990-2001**



Growth in installed capacity has been particularly notable since the mid-1990s. This is reflective of technical improvements and turbine size up-scaling as a result of research and development, market deployment policies and measures and the growth of the infrastructure necessary to support development, *e.g.*, manufacturers, installers and operators.

On average, wind power supplied less than one-half of one percent of electricity supply in IEA countries in 2001, as shown in Figure 3-15. Only in Denmark does wind power provide a notable share of electricity supply at 11.4%, though the contribution has been increasing in recent years in Germany and Spain.

Figure 3-15. **Wind Share in Electricity Production in IEA Countries, 2001**



Sources: NET Ltd., Switzerland. Raw data is from Durstewitz (1999) and Systèmes Solaires/EurObserv'ER (2003).

Policy Trends

There appears to be a strong link between RD&D in wind power technology and the development of markets and a supporting industry. In Denmark, Germany and the United States, for example, significant funds for RD&D were invested in the years preceding rapid market growth. RD&D investments in 1987-2001 by the seven countries with the most significant markets were 85% of the total invested in wind by all IEA countries. These seven countries represent 94% of the installed capacity in IEA countries.

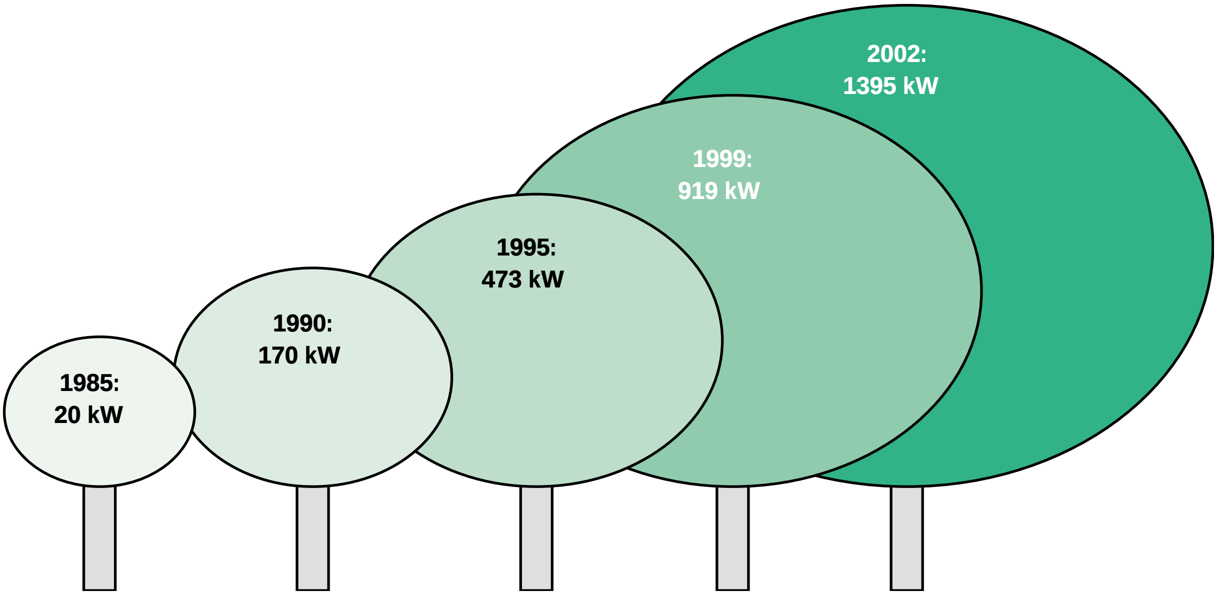
The global installed capacity of wind energy technology at the end of 2002 was more than 30 GW. Yet it is distributed very unevenly around the world – about 83% of total installed capacity is in only five countries: Denmark, Germany, Italy, Spain and the United States. Although European countries represent the bulk of this capacity, other countries, including China, Brazil and India, have considerable wind energy potential and are taking steps to foster industries to exploit it.

Wind diffusion is strongly supported by attractive incentives of feed-in tariffs in Germany, Spain and Denmark, where annual capacity increases between 1990-2001 were respectively 60%, 75% and 20%. Also in Italy, about 700 MW, or 90% of total capacity installed by 2002 was built under the CIP6/92 financing scheme. In the United States, the principal policy instrument has been the production tax credit, coupled with supportive policies in the states.

Technology and Cost Developments

Commercial and technological development has been closely related to turbine size (see Figure 3-16). From ten metres in diameter (typically with 22 kW to 35 kW of installed capacity) in the mid-1970s, wind turbines have grown to diameters of 80 metres and more (with multi-MW installed power). Technology development has resulted, furthermore, in variable pitch (as opposed to fixed blades), direct drives, variable-speed conversion systems, power electronics, better materials and better ratio of weight of materials to capacity installed. An important trend is toward increasing rotor diameter in order to develop turbines for offshore applications.

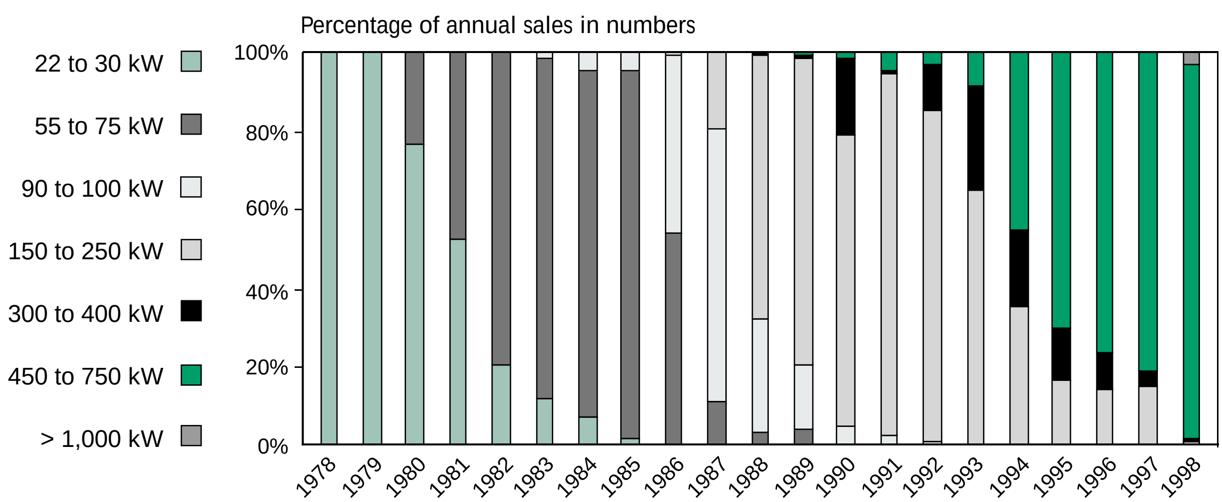
Figure 3-16. **Average Turbine Size at Market Introduction**



Sources: NET Ltd., Switzerland. Raw data is from Durstewitz (1999) and Systèmes Solaires/EurObserv'ER (2003).

Until the mid-1980s, wind turbine size was typically less than 100 kW, then in the range of a few hundred kilowatts up until the mid-1990s, when turbine sizes began to range from 0.5-1.5 MW (Figure 3-16). Such large-scale turbines are often used by onshore wind farm operators and owners of individual, mostly grid-connected wind turbines. In countries with less developed transport and power transmission and distribution infrastructure, this size class remains dominant. In Germany, average wind turbine size reached 1.4 MW in 2002 and this large-scale turbine size class is becoming very competitive. Virtually all of the capacity is grid-connected. In Denmark, the history of technology development and the growth in wind machine classes demonstrates the impact of technology progress on market up-take (Figure 3-17).

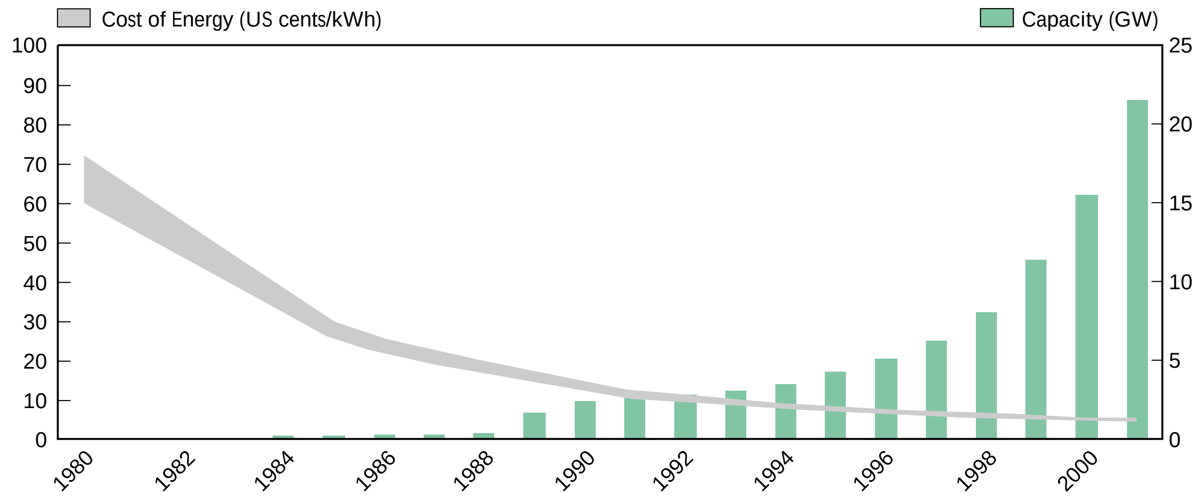
Figure 3-17. **Market Share of Seven Generations of Wind Turbines in Denmark**



Source: Danish Energy Agency.

As the best onshore locations are becoming more difficult to develop, coastal countries are beginning to investigate and exploit near-shore and offshore wind power resources. This process is starting in Europe, where Denmark, the Netherlands, Sweden and the United Kingdom have already amassed experience with near-shore wind farms. All new offshore wind farms are expected to have turbines exceeding 1.5 MW. New capacities totalling several GW may be installed in Germany, the United Kingdom, Ireland, Denmark, Canada, Belgium and other countries in coming years.

Figure 3-18. **Cost and Capacity Trends in Wind Power, 1980-2001**



Source: USDOE and IEA Statistics

Figure 3-18 shows the growth of wind capacity in IEA countries and the progression of cost reductions of delivered energy. From a pre-market level of about US$ 0.70/kWh in 1980, wind power costs have declined steadily. Wind power crossed the US$ 0.10/kWh threshold in about 1991, and dropped to about US$ 0.05/kWh in 1998. Since then, costs at the very best sites have dropped to about US$ 0.035 – 0.04/kWh. This progress has moved forward with the evolution of national policies from RD&D through market deployment.

Costs of wind turbines and plants depend on the system components and size, as well as the site. Generating capacity is primarily determined by the rotor-swept area and the local wind regime. Typical turnkey installation costs are about US$ 400 per m^2 of swept area or US$ 850 to 950/kW for onshore wind turbines.[8] Investment costs differ considerably between onshore and offshore applications in both relative and absolute terms. For offshore installations, the foundation amounts to one-third (or more) of turbine costs. Typical turnkey installation costs are now in the range of US$ 1 100 to 2 000/kW for offshore wind turbines, *i.e.*, 35% to 100% higher than for onshore installations.

Countries with significant installed wind capacity, *e.g.*, Denmark, Germany and Spain, which account for two-thirds of installed global wind capacity, also have most of the world's turbine manufacturers. The seven biggest manufacturers had a market share of 86% in 2001 with revenue of €4.8 billion. Danish and

8. There is some difference of opinion about the correct way to benchmark energy technologies. For wind turbines, for instance, both price per square metre of rotor area and price per kWh produced are used.

German wind turbine manufacturers export relatively high shares of their total output. In order to minimise transport costs, more and more turbines are being manufactured by subsidiaries of European companies in other countries. Most of the leading manufacturers of large wind turbines are developing systems for offshore applications.

Challenges to Future Growth

The intertwined problems of intermittency and grid reliability present two of the strongest challenges to wind energy's future prospects. When wind is providing too much or too little power, the reliability of the grid is affected. Because wind is based on natural forces, it cannot dispatch power on demand. Because utilities must supply power in close balance to demand, intermittency can limit the amount of capacity of highly intermittent technologies that can be integrated into the grid. Thus, as the share of wind energy increases, integration of wind turbines into the electrical network will need both more attention and investment. To an extent, technical solutions, energy management and regulatory practices can extend the penetration of wind, though these will require not only significant research and development, but also incur costs for consumers.

Yet another barrier is transmission availability. The best locations for new wind plants are often in distant areas without close access to a transmission line. This can be seen both in offshore areas of Europe and in rural areas in North America. Providing new transmission lines is often difficult due to planning barriers and land use rights.

Internationally accepted standards for power performance, safety, noise and other environment-related conditions should be developed in order to reduce trade barriers, as well as administrative and installation costs. New locations, especially offshore and non-surveyed terrain, should be mapped and assessed to reduce the visual impact on populations.

Chapter 4
Market Deployment Policies

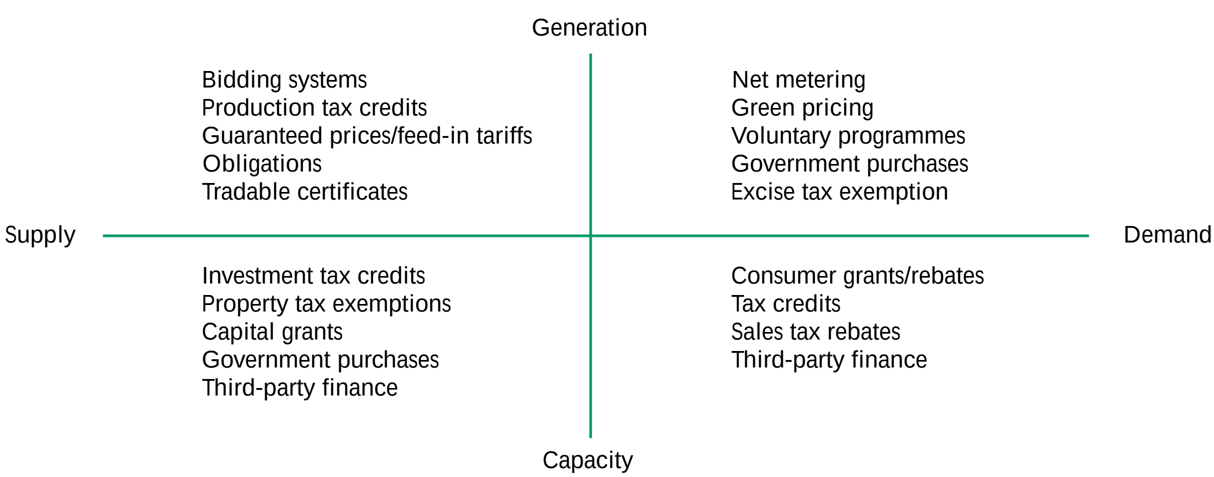
Policy Types

IEA countries have introduced a variety of policies to support the market deployment of energy technologies. Large-scale hydropower expanded as a result of government investment in multi-purpose dams, mostly prior to 1970. Nuclear power was funded from military RD&D budgets and was supported by government subsidies and tax reductions. More recently IEA countries have introduced policies to support the market deployment of renewable energy technologies, although in a challenging environment as many countries are liberalising their energy markets.

The IEA's *World Energy Investment Outlook* presents an Alternative Policy Scenario, in which renewable energy sources account for 25% of electricity generation in OECD countries in 2030, assuming that current and planned policies are effectively implemented.[1] This scenario and the targets that many IEA countries have established for increasing the share of renewables in TPES underscore the fact that market deployment policies are critical to the increased performance and market penetration of renewable energy technologies.

Policy instruments can be categorised into four quadrants, based on the direction of their support (Figure 4-1). Policies can be directed towards consumers (demand-side) or producers (supply-side). They can also be directed towards capacity (*i.e.*, the facility and/or its capital costs) or generation (*i.e.*, the product and/or the associated price to the customer). In some cases, the same policy can appear in more than one quadrant.

Figure 4-1. **Market Deployment Policy Instruments**



In addition to the policy instruments in Figure 4-1, there are administrative or regulatory procedures that are not financial in nature, but nevertheless contribute to the market deployment of renewables. Additionally, there are public awareness programmes that support market deployment. The following sections describe the major types of policies that have been employed in IEA countries.

1. *World Energy Investment Outlook, IEA/OECD, Paris, 2003.*

Policies Addressing Supply and Capacity

Investment Incentives

Investment incentives are used to reduce the capital cost of deploying renewable energy technologies. They can also reduce investor risk. For example, to stimulate photovoltaic (PV) power system development, Japan instituted a ***capital grants*** programme in 1994, which has been the driving force behind the country's rapid PV development. The grants programme also supported hydropower, geothermal and other new energy technologies.

Other types of incentives include ***third-party finance*** arrangements where the government assumes risk or provides low interest loans. Favourable lending schemes, in which banks guarantee the cash flow of a project thus reducing investor risk, have been very effective, as exemplified by the rapid growth of wind capacity in Spain.

Investment incentives are generally funded out of national and/or state budgets and thus compete with other public funding needs. As such, incentives are often subject to legislative review and changes, including recision. Incentives must be of adequate size and must be predictable and consistent over time to be effective. Governments must balance the budgetary burden against other public policy priorities.

The success of financial incentives to impact investment decisions also depends on whether the level of the incentive is adequate to bridge the gap between the market price of energy and the cost of renewable energy. Incentives should be gradually lowered and even phased out over time to ensure that manufacturers and developers continue to improve the technology and reduce costs. Governments need to monitor capital costs and incentive structures over time. This is challenging because capital cost reductions tend to be driven by global market growth, as markets within a specific country generally are not large enough to drive market learning.

Tax Measures

Tax policy is used to encourage production or to discourage consumption. On the production side, ***investment tax credits*** and ***property tax exemptions*** reduce tax payments for project owners.

Government Purchases

Government purchases of systems at above-market rates are a type of investment incentive to industry. In a number of cases, governments have purchased large, on-site renewable systems such as solar thermal hot water systems or photovoltaic systems for schools or other public buildings.

Policies Addressing Supply and Generation

Incentive Tariffs

Guaranteed price systems, feed-in tariffs and preferential rates are all terms for tariffs at above-market rates. Generally the government sets a premium price to be paid for power generated from renewable energy sources. The price is usually differentiated by technology, and is paid by either consumers or taxpayers through the utility.

Guaranteed price systems have been adopted in a number of IEA countries. The United States initiated the first system with passage of the Public Utility Regulatory Policies Act (PURPA) in 1978. PURPA required utilities to purchase power from renewable energy developers and to pay the utility's avoided cost, *i.e.*, the cost that the utility would have incurred by generating or otherwise supplying the power itself. These prices were not established by the federal government but rather by utilities or state regulatory commissions. At the time, avoided costs were high, due to high fossil fuel prices. As a result of PURPA legislation, more than 12 000 MW of renewable energy projects were developed during the 1980s and 1990s, including geothermal, wind and concentrating solar power plants. Although the law remains in effect, the prices offered by utilities now are generally too low to support new project development.

Germany, Italy and Spain have introduced feed-in tariff schemes based on avoided costs. A guaranteed price system is often supported by complementary rules. For example, electric utilities may be required to provide interconnection and non-discriminatory backup power to qualifying facilities. Feed-in tariffs, combined with other policy support, are considered to be the main impetus behind the development of 12 000 MW of wind energy capacity in Germany and of 4 830 MW in Spain.

Feed-in tariff schemes have several potential shortcomings. First, the tariffs are administratively determined. While the rate is sometimes set as a function of avoided cost, it is the government, rather than the market, that determines the tariff level. Second, guaranteed prices may be a disincentive for technology innovation or cost reductions unless the tariffs decrease over time. The time period over which a producer receives a guaranteed price should be sufficient to recover costs. Anticipating and scheduling reductions in guaranteed prices is challenging, as costs are determined by factors external to national markets. For example, market experience within a country can lead to reductions in installation costs, but equipment cost reductions are largely driven by the global market.

Furthermore, there is some controversy over whether feed-in tariffs can or should promote competition between renewables. Most feed-in tariff schemes differentiate tariffs to reflect different levels of maturity of renewable energy technologies. But some administrations employ a single tariff for all renewables, a "one size fits all" policy framework, in order to stimulate competition. This can lock the relatively less mature technologies out of the market at the RD&D stage.

Bidding systems such as the UK's Non Fossil Fuel Obligation (NFFO) and Ireland's Alternative Energy Requirement (AER) scheme are based on competition for contracts to build projects with the lowest generation costs. The principal mechanism is a guaranteed price, with the rate set by competition for the lowest bid. This is based on a function of the power pool wholesale price plus a technology-specific premium that is paid by electricity consumers. Renewable technologies are separated into different technology categories and competitive bidding rounds are organised for each category separately.

Tax Measures

The US ***production tax credit*** for wind energy established in 1992 has, in combination with other policies, spurred substantial new installations of wind power, but its piecemeal extension since 1999 has led to a "boom-and-bust" cycle of development in the US wind power industry. The success of tax policy in impacting investment decisions depends on whether the level of incentive covers the additional costs of the renewable energy system compared to market alternatives. As an example, the US federal production tax credit has aided the domestic wind industry, but has not been sufficient to spur the development of "closed-loop" biomass systems, which also qualify for the credit.

Obligations

Most obligations are based on the final product (kWh of electricity or litres of liquid fuel) although some are based on capacity. Renewable energy ***portfolio standards***, also known as ***quota systems***, place an obligation on suppliers to provide a set quantity or percentage of their supply from renewable energy sources. Generally, quota systems do not distinguish between different renewable energy sources, *i.e.*, a quota level is established and the market determines which resources are chosen. These systems encourage the development of renewables at lowest cost. Renewable energy certificates (discussed below) may be used to facilitate compliance with quota systems and can also reduce the cost of compliance.

Targets are a form of obligation being used in the EU countries and Australia. Target systems determine different levels of obligation for each renewable technology, sometimes with a penalty for non-compliance.

A penalty for non-compliance that is set at least as high as the estimated cost of meeting the obligation is crucial for the success of obligation systems because utilities and producers will be more inclined to comply. For example, in the United Kingdom, suppliers unable to meet their requirements must buy renewable obligation certificates at £30 per megawatt-hour (MWh). The revenue is distributed back to electricity suppliers according to their success in meeting the targets. This provides an additional incentive for companies to meet their requirements. In the US state of Texas, where suppliers must pay a non-compliance penalty of up to $50/MWh, far more capacity has been built than required to meet the state's renewable portfolio standard. The policy is considered a success, as the cost of wind power declined to the point that wind is the least-cost option in certain areas of the state.

An effective obligation system takes into account renewable resource availability, the ability of the renewable energy industries to respond with technology and systems and the lead times required to bring new projects into operation. Obligations should also be in place long enough to ensure that investors recover their investments.

Tradable Certificates

Renewable energy certificates (RECs) provide a mechanism to track and register renewable electricity production. Certificates can be used to document compliance with quota systems or can be sold to end-use customers in a voluntary green power market. The creation of a certificate allows the renewable energy attribute to be sold or traded separately from the physical electricity product. The establishment of a RECs system does not by itself constitute a supply requirement, but rather certificates provide greater market flexibility in achieving the goals of other policy instruments.

RECs systems can be consistent with energy labelling. This type of system may be advanced by the European Commission's Directive on guarantee of origin of electricity produced by renewable energy sources, which requires member states to establish appropriate mechanisms "to enable producers of electricity from renewable energy sources to demonstrate that the electricity they sell is produced from renewable energy sources".

RECs systems are also not without potential drawbacks. In some instances, for example, the administrative procedures can be substantial and may prove to be costly. Furthermore, there is considerable confusion about the distinction between "renewable energy attributes" and environmental benefits. For some, renewable energy attributes are greater than carbon value or environmental performance, but relate also to energy security and economic benefits. For others, the REC is a substitute for, and perhaps equal to, a carbon certificate, although such determinations have not yet been set by law. Clarifying these issues will be important to the future use of RECs on a larger scale.

Policies Addressing Generation and Demand

Voluntary Programmes

Several IEA countries have employed **voluntary programmes**. One of the first voluntary programmes for renewables was in Denmark in 1984 when utilities agreed to purchase 100 MW of wind power. In 1992, Japan established a similar programme when power companies developed agreements with renewable energy generators. The primary method of implementation was through government "request" to energy suppliers to buy electricity generated by renewables. Suppliers had to pay the retail price of electricity to the facility that generated the power. These voluntary purchase agreements in Japan made a large contribution to the penetration of solar and wind technologies.

Green pricing is an optional utility service that gives customers an opportunity to support an increased level of utility company investment in renewable energy technologies. Participating customers generally pay an additional amount on their electric bill to cover the incremental cost of the renewable energy. Many utilities are offering green pricing to build customer loyalty and expand business lines and expertise in advance of electric market competition. Green pricing programs are prominent in the United States and Europe.

Net metering arrangements, for example in Denmark, Italy, the United States and Japan, also provide a form of guaranteed pricing as customer-generators are credited for their electricity generation at the prevailing retail rate. For consumer-owned systems, net metering is a practice that allows customers to "bank" at the utility any excess electricity generated from qualifying systems for later use. The customer pays only for the electricity used "net" of the electricity generated over the entire billing cycle. Net metering allows customer-generators to maximise the value of their production because the generation is valued at retail prices. Usually the size of the system is capped to keep the policy focused on small-scale systems.

Tax Measures

Tax policy can be used to capture the externalities associated with energy production and consumption such as environmental degradation and energy import dependence. For example, the Netherlands and Germany introduced a regulatory energy tax or "ecotax" on final energy consumption in the 1990s. Renewable electricity consumption is exempt from the tax in the Netherlands. Moreover, in the Netherlands, producers of renewable electricity also receive a production incentive from the ecotax funds collected from consumers of non-renewable electricity.

A gasoline **excise tax exemption** allows liquid fuel refiners to offset the higher cost of including biofuels in gasoline blends. The biodiesel tax exemption has been the driving force behind the evolution of the biofuels market in Italy. Carbon taxes and taxes on other pollutants such as SO_x and NO_x are not, per se, renewables support mechanisms, but are part of the overall competitive energy policy framework. To the extent that they cause conventional energy prices to rise, and renewables are exempt from the tax, they do have the effect of increasing renewables' competitiveness.

Policies Addressing Demand and Capacity

Investment Incentives

In addition to supporting energy producers, investment incentives can also be used to reduce the capital cost of renewable energy technologies to end-users. For distributed, modular technologies such as solar hot water and PV, incentives can be directed toward customer, not the supplier. With ***consumer grants***, and ***third-party finance*** the government assumes risk by, for example, providing low interest loans, or bringing down the capital cost of renewable systems.

Tax Measures

For customer-owned systems, a **tax credit** or **system rebate** allows the owner to recover a portion of the up-front capital costs more quickly after the investment is made. Provisions are sometimes made for **sales tax rebates**.

Regulatory and Administrative Rules

In many IEA countries, market regulations have been introduced at the same time as market deployment policies. When this is not the case, there are often problems with successful deployment. Examples of market regulations include the Portuguese Independent Power Production Law of 1988, which requires electric utilities to interconnect and sign power purchase contracts with qualifying renewable energy facilities. Some market liberalisation schemes allow generators and independent marketers to wheel power to retail customers although the costs for this access can sometimes be high. Similarly, purveyors of small-scale systems must have access to consumer retail outlets and end-users must be able to install and interconnect systems to the distribution grid.

Planning and co-ordination is another area where government support can provide indirect assistance to renewables market deployment. For example, the Irish National Development Plan allocated € 67 million for renewable energy development from 2000 to 2006, including: reinforcement and upgrading of the grid to support increased use of renewables; support to the delivery of additional renewable energy supplies; and encouragement to new market participants through support for small-scale projects. In a similar vein, Australia, the United States, and a number of other countries support agencies that assist in renewables-related planning, resource assessment and industry development.

Public Awareness Programmes

IEA countries have promoted a number of **public awareness programmes** to encourage broad-based support for renewable energy. In 1996, Portugal established an Action Plan for Municipalities that promoted renewables use and energy management. It included training, technical assistance, financial advice activities targeted to local authorities and the creation of local energy teams or agencies. Energy labelling was established in Austria in 2000, which gave the public a clear understanding of the source of their electricity. Also in 2000, the Renewable Energy Action Agenda in Australia brought the government together with the renewable energy industry to implement actions that aim to increase community commitment to renewable energy, encourage exports, improve the reliability and quality of renewable energy products and services, develop a renewable transport fuels industry, ensure that skilled people are available to support industry growth and encourage a culture of market-driven innovation.

Trends in IEA Renewable Energy Policies

In 1970, hydropower accounted for the largest share at 50.1% of renewables in TPES, followed by CRW (47.1%) and geothermal (2.8%). These shares reflect market developments and technology competitiveness in the years prior to the oil price crisis of 1973. For hydropower, growth during the first half of the 20th century was largely driven by government investment in infrastructure projects, including water supply, flood control and economic development, along with public ownership or control of generation facilities. Combustible renewables and waste supply was generally wood burning for heat in the 1970s. For geothermal, the share reflected small installations in several resource-rich locations, principally The Geysers in the United States and Lardarello in Italy.

The market development of hydropower, bioenergy and geothermal technologies from 1970 to 2001 was driven largely by resource endowments and market conditions, including the generally high cost of fossil fuels up to the mid-1980s and lower costs thereafter. Another factor affecting all three technologies during the latter part of the period was increasing competition, particularly in electricity markets.

Sites for large hydro plants in Japan, the United States and Europe were mostly developed by 1970, and further development of small sites was affected by competing uses and by growing environmental regulations. Geothermal for electricity generation grew substantially in the period of high fossil fuel costs, but growth slowed thereafter.

In the 1970s, biomass use shifted away from wood burning in the residential sector towards use in industry. By 2001, nearly two-thirds of biomass supply was waste residues used in the pulp and paper industry to produce steam and electricity, a move that started during the oil crisis years and continued as companies sought to remain competitive. Additional important uses of biomass now include electricity generation from wood, waste fuels, biogas and biofuels.

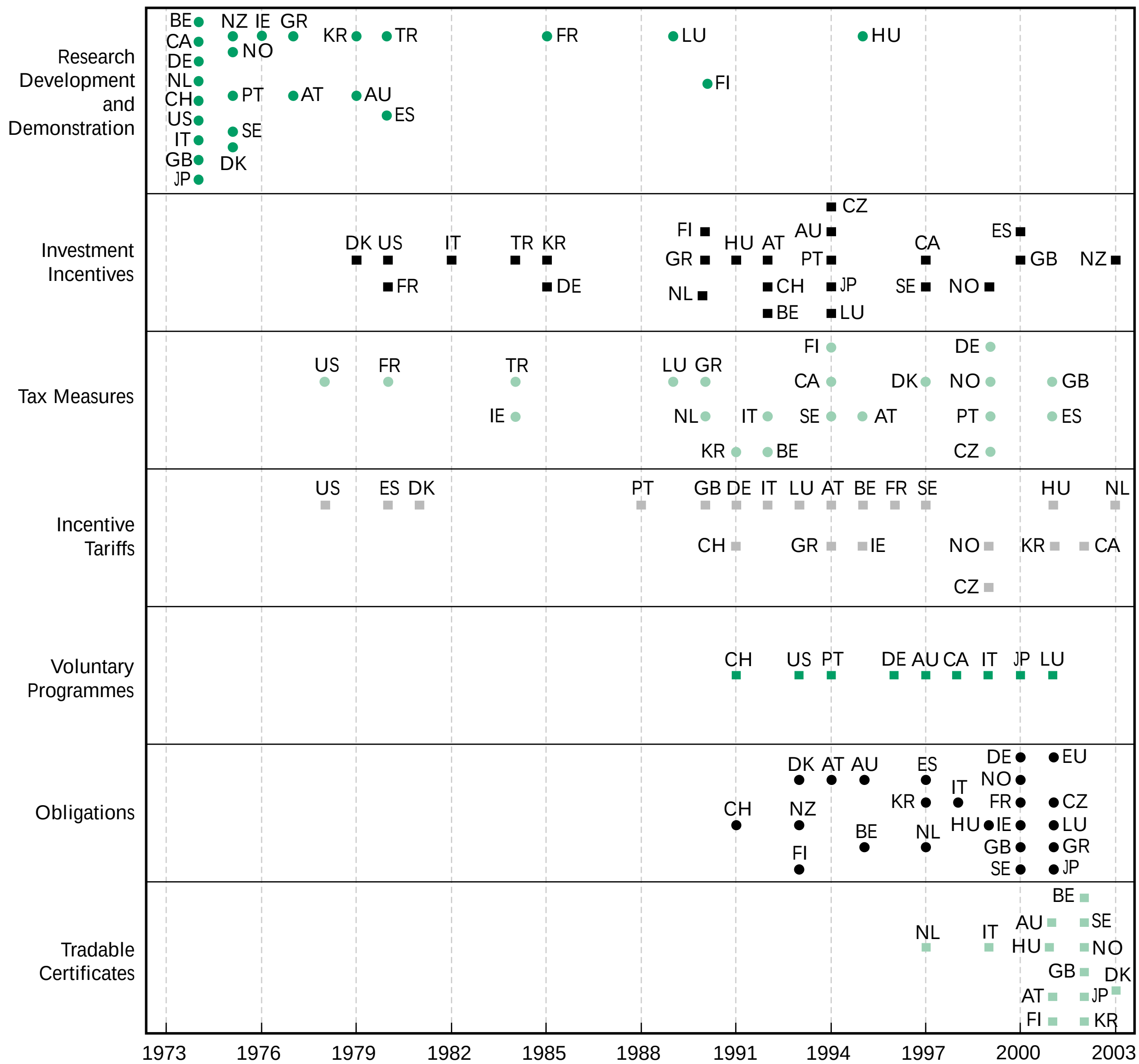
In 2001, the share of renewable energy supply in TPES was 5.5%. Combustible renewables and waste (CRW) accounted for 55% of total renewable energy supply, followed by hydropower with 35%, geothermal with 8%, and solar and wind 2.2%.

Figure 4-2 provides an indication of the evolution of policies and measures in IEA countries over the past three decades. On the vertical axis, renewable energy policies and measures include RD&D policies and various market deployment policies that are categorised as investment incentives, tax measures, incentive tariffs, voluntary programmes, obligations and tradable certificates. The year that each country first introduced a specific renewable energy policy is indicated by country initials. For example, in 1978, the United States introduced a programme of tax credits for households and businesses purchasing renewable energy equipment. This is shown in the Tax Measures row in Figure 4-2.

“New” renewables, including solar and wind technologies as well as new forms of bioenergy, were introduced into the market in the late 1970s. This development came after a period of research, development and demonstration that started in 1970 or before, and intensified as the impacts of the oil price crises mounted. Denmark, Finland and Germany were the first countries to allocate RD&D funding for renewable technologies. The United States, the United Kingdom and Japan also funded renewable energy RD&D programs in the early 1970s. Except for a few countries, RD&D spending on renewable energy represented the first tier of support to the development of renewable energy markets.

In the late 1970s and early 1980s, the United States, Denmark, Spain, France and Italy instituted the first market deployment policies in IEA countries. These began with the US PURPA guaranteed price programme, coupled with an investment tax credit, both of which were established in 1978. In the following year, Denmark instituted a capital grants programme for wind turbines. In 1980, Spain established its Energy Conservation Law, which guaranteed network interconnection, power purchase contracts and prices set by an administrative body. In 1980, France established a risk guarantee fund for low temperature geothermal energy, and the United States established a loan guarantee program for bioenergy and alcohol fuels. In 1981, Denmark announced the Act for the Support for Utilisation of Renewable Energy Resources which provided for RD&D, capital grants, and guaranteed prices. In 1982, Italy, established a capital grants programme. During the remainder of the 1980s, the pace at which policies were established remained relatively modest, at first due to a perception that the technologies were not yet ready for deployment, and later by the decline in fossil fuel prices. The policies during this period were predominately investment incentives, such as capital grants and low-interest loans for the uptake of renewable technologies, or tax measures, such as exemptions or credits to businesses and consumers.

Figure 4-2. **The Introduction of Renewable Energy Policies by Country**



AT=Austria - AU=Australia - BE=Belgium - CA=Canada - CH=Switzerland - CZ=Czech Republic - DE=Germany DK=Denmark - ES=Spain - FI=Finland - FR=France - GB=United Kingdom - GR=Greece - HU=Hungary - IE=Ireland IT=Italy - JP=Japan - KR=Korea, Republic of - LU=Luxembourg - NL=Netherlands - NO=Norway - NZ=New Zealand PT=Portugal - SE=Sweden - TR=Turkey - US=United States.

From 1988 to 1994, eight IEA countries introduced feed-in tariffs, starting a new wave of intervention. Portugal established an independent power law that allowed private generators of renewable systems to sell to the grid with interconnection and price guarantees. In 1990, the United Kingdom launched its Non Fossil Fuel Obligation (NFFO), a guaranteed price scheme with the added dimension of competitive bidding for the rate. Germany and Switzerland introduced their feed-in tariffs in 1991. Altogether, twenty IEA countries have had feed-in tariffs at one time or another, though not for every renewable energy technology.

The first voluntary programmes started in the early 1990s. Switzerland launched its Energy2000 programme in 1991. The US Climate Change Action Plan started in 1993 with the goal of co-operative programmes between utilities and the US Department of Energy. Portugal initiated its Energia Programme in 1994, which reinforced voluntary actions with capital grants.

The 1980s to the mid-1990s represented a period of experimentation with market deployment strategies among IEA countries. Some countries employed a wide range of policies, including new variations of guaranteed prices such as feed-in tariffs combined with investment incentives and tax measures. Renewable energy policy in Korea is based on a combination of corporate loans, tax incentives and feed-in tariffs. The United Kingdom, Portugal, the United States and Austria combined voluntary purchase agreements between public and private companies with other market deployment incentives. This period was followed by a period of rapid expansion in new renewable energy markets in IEA countries, particularly wind, bioenergy, solar energy and small hydropower. While a wave of IEA countries introduced investment incentives in the mid-1990s, tax measures have been employed more sparingly. Except for the United States, IEA countries did not generally introduce incentive tariffs until the early to mid-1990s.

Switzerland established a target for hydroelectric and heat from renewable sources in 1991. Denmark followed in 1993 with a Biomass Agreement to increase biomass use from about 50 PJ to 75 PJ by 2000. Finland established a 100 MW wind target in the same year. The Netherlands introduced renewable energy obligations in 1997 with a target of 3.2% renewables in electricity supply by 2000. The late 1990s saw a number of additional countries institute obligations and quota-based renewable energy policies as they strived to open and widen renewable energy markets. In 2001, the EU Directive for Electricity Produced from Renewable Energy Sources set indicative targets requiring member countries to implement relevant national policies. The targets are for the percentage of renewable energy in electricity consumption of each EU Member State by 2011. Thirteen states in the United States have similar strategies to expand the share of renewables through obligations, with a binding portfolio standard in many states and a non-binding quota in others.

The latest development of renewable energy deployment policies is the introduction of tradable certificates. The Netherlands was the first to employ these certificates in 1997 as a mechanism to efficiently achieve a target that was also set in 1997. Italy established its certificate system in 1999. Australia launched its Mandatory Renewable Energy Target (MRET) in 2000, which uses tradable certificates as a compliance instrument. MRET is the first target/certificate system with substantial penalties to enforce the obligation. By early 2004, ten other IEA countries had also introduced them.

The evolution of energy policies for new renewables shows a discernible pattern over the past three decades. Starting with RD&D in the early 1970s, government investments moved toward market deployment support with a variety of approaches. Beginning in 1978, but before 1985, countries were employing guaranteed prices, investment incentives, voluntary programmes, and tax measures. By the mid 1980s, virtually all IEA countries had RD&D policies as a foundation for market aspirations. By the early 1990s, many more countries had adopted the various market deployment policies and the first obligations were introduced. Almost all countries have established guaranteed prices at one time or another, with varying degrees of success. A few countries have moved to quotas and a number of countries have, or are in the process of establishing certificate systems. At the same time, several recent commitments have been made for guaranteed price systems.

While a clear evolution of overall policies and measures in IEA countries is evident from Figure 4-2, it does not necessarily denote a single trend. Each country has chosen policies and measures that best match their resource endowments, economic structure and objectives for market development.

Renewable Energy Market Deployment in IEA Countries Observations

- Large hydropower has had the largest share of renewable energy supply in IEA countries until recently. This is a mature technology and has received continuous support through its development and deployment. Combustible renewables and waste has experienced steady growth over the last three decades. In addition to energy, this reflects policies related to environmental concerns, as well as technology development and deployment policies. Geothermal also has a long history and has been developed in specific locations. Considerable additional geothermal potential exists that can be developed as more advanced technologies become available and technology deployment policies are put into place.
- Starting in the 1970s and sometimes even before, governments have set up RD&D programmes to develop renewable energy sources as an 'alternative' to fossil fuels. This was followed by a series of technology deployment schemes including investment incentives, tax measures and incentive tariffs, particularly for new renewables. In the late 1990s, countries started to experiment with tradable certificate systems.
- Significant market growth has always resulted from combinations of policies, rather than single policies. As an early example, in Japan, PV technology was supported by extensive RD&D investments to increase the competitiveness of the technology, by demonstration projects, which increase public awareness and acceptance, through financial incentives to reduce the purchase price of PV systems and by requiring utilities through net metering to accept excess power generated by PV systems at the retail price of electricity. In Spain, wind technology is supported by feed-in tariffs, low-interest loans, capital grants, and local support for manufacturing of turbines. In no case is there evidence of strong market growth with only one policy in place. Those countries that have experienced strong growth in "new" renewables, such as wind and solar, including Germany, Spain, the United States and Denmark, have done so through a combination of financial incentives and guaranteed prices, underpinned by strong RD&D.
- Longevity and predictability of policy support is important to overall market success. In most cases, feed-in tariffs for renewable energy sources typically have an eight- to twenty-year time frame, *e.g.*, Italy and Germany. The challenge is how to incorporate strong incentives for cost-reduction and competition while ensuring longevity and predictability of policy support. The long-term support offered to biomass district heating plants in Austria provides another example. Conversely, a "stop and go" nature of incentives, such as the production tax credits in the United States, has undermined private sector investment.
- National policies are also strengthened when local, state, or provincial governments have the authority to act independently of the national government. For example, in Spain, the bulk of wind power growth is occurring in those areas where regional governments have actively supported development through administrative changes and financial support, and in some cases, becoming a development partner. In the United States, although the federal government has established a renewable energy deployment programme, thirteen states have established their own renewable portfolio standards, and many more states offer their own set of financial incentives. These have met with varying degrees of success.

- Market liberalisation offers new challenges for renewable technologies still in the technology deployment stage. On the one hand, if energy prices fall, the price targets that renewables must meet become more challenging. On the other hand, policies and systems such as quotas and renewable energy certificates can be compatible with more competitive market structures. In fact, many current policies are being implemented within the backdrop of a transition to market liberalisation, *e.g.*, Ireland, Sweden and the United Kingdom.

- Individual policy mechanisms are evolving as countries gain more experience. In Germany, for example, early feed-in tariffs were set as a function of the avoided cost of electricity, and then modified to a level deemed necessary by the government to encourage industrial development. Later iterations included better measures for incorporating and driving cost reductions. At the same time, policies in some cases have been evolving from one type to another. In Denmark, for example, the feed-in tariff scheme is in transition as it was superceded by a certificate trading system that has not yet come into effect. When Japan established their portfolio standard in 2002, however, they retained the funding for RD&D and other incentives for market deployment. When a renewable portfolio standard does not specify a preferred renewable energy technology, competition is expected to be enhanced among technologies.

- It is too soon to fully assess the impacts of many renewable policies, as most have been established since 2000. This is particularly true for most obligation systems, as well as the tradable certificate systems. Nevertheless, experience with investment incentives, tax measures and incentive tariffs suggests that all these policies can be made effective. It is the design of the support mechanism rather than the type that determines the success of policies. Over time, the array of policy choices has become broader and the market learning experience richer. Strong market growth of new renewables in the late 1990s indicates that the support schemes in place may have been effective. On the other hand, it also can be stated that without government support new renewables would show low or no increase in market growth rates.

Annex 1
Total Primary Energy Supply and Share of Renewables

		1970	1990	2000	2001
Australia	TPES (Mtoe)	51.3	87.5	109.8	115.6
	Renewables TPES (Mtoe)	4.3	5.1	6.4	6.6
	% Renewables	8.4%	5.8%	5.8%	5.7%
Austria	TPES (Mtoe)	18.2	25.0	28.8	30.7
	Renewables TPES (Mtoe)	2.5	5.0	6.4	6.6
	% Renewables	13.2%	19.9%	22.0%	21.5%
Belgium	TPES (Mtoe)	40.2	48.7	59.3	59.0
	Renewables TPES (Mtoe)	0.0	0.6	0.6	0.6
	% Renewables	0.1%	1.3%	1.0%	1.0%
Canada	TPES (Mtoe)	139.5	209.1	250.9	248.2
	Renewables TPES (Mtoe)	21.1	33.7	42.0	39.1
	% Renewables	15.1%	16.1%	16.5%	15.6%
Czech Republic	TPES (Mtoe)	45.7*	47.4	40.4	41.4
	Renewables TPES (Mtoe)	0.1*	0.1	0.6	0.6
	% Renewables	0.2%*	0.3%	1.3%	1.5%
Denmark	TPES (Mtoe)	20.3	17.6	19.4	19.8
	Renewables TPES (Mtoe)	0.3	1.1	1.9	2.1
	% Renewables	1.6%	6.6%	9.9%	10.4%
Finland	TPES (Mtoe)	18.1	29.2	33.0	33.8
	Renewables TPES (Mtoe)	5.0	5.5	7.8	7.6
	% Renewables	27.6%	19.5%	24.4%	23.0%
France	TPES (Mtoe)	147.0	227.1	257.4	266.0
	Renewables TPES (Mtoe)	6.6	15.7	17.5	18.6
	% Renewables	4.5%	6.8%	6.6%	6.8%
Germany	TPES (Mtoe)	304.4	356.2	343.4	351.1
	Renewables TPES (Mtoe)	4.0	5.8	9.0	9.2
	% Renewables	1.3%	1.6%	2.6%	2.6%
Greece	TPES (Mtoe)	8.1	22.2	27.8	28.7
	Renewables TPES (Mtoe)	0.7	1.1	1.4	1.3
	% Renewables	8.4%	5.0%	5.0%	4.6%
Hungary	TPES (Mtoe)	17.9	28.5	24.9	25.3
	Renewables TPES (Mtoe)	0.5	0.4	0.4	0.4
	% Renewables	2.8%	1.4%	1.8%	1.6%
Ireland	TPES (Mtoe)	6.3	10.6	14.3	15.0
	Renewables TPES (Mtoe)	0.1	0.2	0.3	0.3
	% Renewables	1.1%	1.6%	1.8%	1.7%
Italy	TPES (Mtoe)	109.6	152.6	171.7	172.0
	Renewables TPES (Mtoe)	6.1	6.5	9.1	9.6
	% Renewables	5.6%	4.3%	5.4%	5.7%
Japan	TPES (Mtoe)	257.2	436.5	524.2	520.7
	Renewables TPES (Mtoe)	6.5	13.6	16.7	15.9
	% Renewables	2.5%	3.1%	3.2%	3.1%

		1970	1990	2000	2001
Korea	TPES (Mtoe)	17.0*	92.6	191.2	194.8
	Renewables TPES (Mtoe)	0.1*	0.5	2.1	2.2
	% Renewables	0.7%*	0.6%	1.1%	1.1%
Luxembourg	TPES (Mtoe)	4.1	3.6	3.7	3.8
	Renewables TPES (Mtoe)	0.0	0.0	0.1	0.1
	% Renewables	0.2%	1.0%	1.8%	1.8%
Netherlands	TPES (Mtoe)	49.3	66.5	75.5	77.2
	Renewables TPES (Mtoe)	0.0	0.6	1.0	1.1
	% Renewables	0.0%	1.0%	1.4%	1.4%
New Zealand	TPES (Mtoe)	7.2	13.9	17.9	18.1
	Renewables TPES (Mtoe)	2.1	4.8	5.1	4.7
	% Renewables	28.7%	34.7%	28.0%	25.8%
Norway	TPES (Mtoe)	13.6	21.5	25.8	26.6
	Renewables TPES (Mtoe)	5.0	11.4	13.3	11.8
	% Renewables	36.5%	50.1%	48.5%	45.0%
Portugal	TPES (Mtoe)	6.0	17.2	24.6	24.7
	Renewables TPES (Mtoe)	1.2	2.7	3.1	3.4
	% Renewables	20.8%	15.7%	12.8%	13.7%
Spain	TPES (Mtoe)	38.4	91.2	124.3	127.4
	Renewables TPES (Mtoe)	2.4	6.2	7.0	8.2
	% Renewables	6.2%	6.8%	5.7%	6.5%
Sweden	TPES (Mtoe)	37.9	46.7	47.5	51.1
	Renewables TPES (Mtoe)	6.5	11.7	15.3	15.0
	% Renewables	17.2%	25.1%	32.4%	29.1%
Switzerland	TPES (Mtoe)	16.5	25.1	26.5	28.0
	Renewables TPES (Mtoe)	2.9	3.3	4.2	4.7
	% Renewables	17.1%	13.1%	15.6%	16.2%
Turkey	TPES (Mtoe)	18.2	53.0	77.5	72.5
	Renewables TPES (Mtoe)	6.3	9.7	10.1	9.4
	% Renewables	34.3%	18.2%	13.2%	13.0%
United Kingdom	TPES (Mtoe)	207.3	212.2	231.2	235.2
	Renewables TPES (Mtoe)	0.4	1.0	2.4	2.5
	% Renewables	0.2%	0.5%	1.0%	1.1%
United States	TPES (Mtoe)	1 557.4	1 927.6	2 303.8	2 281.4
	Renewables TPES (Mtoe)	57.1	100.5	105.9	99.1
	% Renewables	3.7%	5.2%	4.6%	4.4%
IEA Total	TPES (Mtoe)	3 094.0	4 269.2	5 055.0	5 068.3
	Renewables TPES (Mtoe)	141.5	247.0	289.6	280.9
	% Renewables	4.6%	5.8%	5.7%	5.5%

* Data from 1971.

Annex 2
Renewable Energy Statistics – Definitions and Issues

Background on Statistics Collection for the IEA's *Renewables Information*[1]

Prior to 2000, statistics for renewable energy were reported to the IEA on three separate annual questionnaires:

1. Statistics on biomass and waste products (municipal solid waste, industrial waste, etc.) were reported on the coal questionnaire.
2. Statistics on hydropower (all size units), wind and solar PV electricity and on geothermal and solar thermal heat and electricity were reported on the electricity and heat questionnaire.
3. Statistics on liquid biofuels were reported on the oil questionnaire.

The Energy Statistics Working Group (ESWG) advises the IEA Energy Statistics Division (ESD), Eurostat and the United Nations Commission for Economic Cooperation in Europe (UNECE) on the format and content of the Joint Annual Questionnaires. The ESWG met in November 1999 and recommended adoption of a separate Annual Renewables and Wastes Questionnaire. The initiative was stimulated by actions of the European Union to double the proportion of renewable energy from 6% to 12% of primary energy supply by increasing the share of electricity generated from renewables from 14% to 22% of the total by 2010. In order to measure actual achievement versus targets, it became necessary to collect more detailed statistics from national governments. Other non-EU member countries supported the initiative to create the questionnaire.

Renewable statistics were collected for 1998 and 1999 in the Joint Annual Questionnaire cycle of 2000-2001. This questionnaire improved renewable statistics in two important ways. First, it incorporated a more extensive and thorough set of renewable and waste energy product definitions (see below). Second, responsibility for providing renewable and waste statistics was assigned to a specific contact – often in an office or division specialising in renewable energy – rather than spread among several contacts who often specialise in non-renewable forms of energy.

However, despite major improvements in some aspects of renewable and waste statistics, some difficulties have been experienced. Many national statistics agencies, which are the sole source for 'official' statistics collected by the IEA, did not have formal data collection systems for many renewable products and technologies. While there was generally good data collection for mature renewables like hydropower and geothermal, little if any historical data existed on "new" renewables like solar and wind. Further, monthly, quarterly and annual energy production, trade and consumption surveys (usually the basis of national energy statistics) did not request information on renewables products and technologies. Finally, due to the diverse nature of renewable energy technologies, even if surveys are modified to accommodate renewables, it is often difficult to find the right agents to survey. Thus, although all IEA countries now report some renewable and waste statistics, the creation of consistent time series is a work in progress, and thorough coverage of all renewables and technologies is an evolving effort at the national level.

The production of this study has stimulated considerable attention by national administrations on their reported data and has led to new submissions by a number of countries. In some cases, this data has been

1. Renewables Information, *IEA/OECD, Paris, 2003.*

integrated into official IEA data, and thus is reported in IEA figures in this book. However, in a number of cases, the data have been received too recently to be integrated. In a few such cases, the reported national statistics are provided in a separate table or figure. This information will be integrated in future reporting of renewables statistics.

Definitions of Renewable Energy and Waste Sources and Associated Technologies

While there are a limited number of renewable energy and waste sources, there are a large number of technologies allowing their exploitation, many of which are still at the research and development stage or have not yet reached commercial maturity. The renewable energy and waste sources and associated technologies listed below are those that are considered to be economically viable or approaching economic viability.

1. **Hydropower:** Kinetic energy of water converted into electricity in hydroelectric plants. Pumped storage information is included in the data collection, but in a separate category as it is mostly derived from non-renewable sources. Detailed plant sizes are reported net of pumped storage. The sum of < 1 MW, 1-10 MW, 10+ MW and production from pumped storage is included in 'Hydro, all plants'. However, only hydro generation net of pumped storage is included in "Total Renewable Energy Supply". In the technology sections in the country profiles, hydropower is net of pumped storage.

2. **Geothermal energy:** Energy available as heat emitted from the earth's crust, usually in the form of hot water or steam. It is exploited at suitable sites:
   - for electricity generation using dry steam or high enthalpy brine after flashing;
   - directly as heat for district heating, agriculture, etc.

3. **Solar energy:** Solar radiation exploited for hot water production and electricity generation, separately defined as:
   - flat plate heat collectors, mainly of the thermosyphon type, for domestic hot water or for the seasonal heating of swimming pools;
   - photovoltaic cells;
   - solar thermal-electric plants.

   Note: Passive solar energy for the direct heating, cooling and lighting of dwellings or other buildings is not included.

4. **Ocean energy:** Mechanical energy derived from ocean currents, tidal movement or wave motion and exploited for electricity generation. This data is collected as "Ocean/Tidal/Wave".

5. **Wind energy:** Kinetic energy of wind exploited for electricity generation in wind turbines.
   Note: The kinetic wind energy that is harvested as mechanical force for such applications as water pumps is not included.

6. **Biomass:** Due to its varied forms and uses, biomass is a highly challenging resource on which to compile statistics. In this study, "Biomass" comprises solid, liquid and gaseous organic feedstocks as defined below. "Biomass" also includes the organic component of industrial and municipal waste, but not inorganic waste. In some instances, however, due to the existing system of data collection in some countries, biomass is combined with these inorganic wastes in a reporting category termed "Combustible Renewables and Waste (CRW)." Typically, the inorganic component of CRW is relatively small, but in a few cases it is substantial. In the country profiles in this study, CRW is used in Figures 1 (TPES) and 3 (Total Renewable Energy Supply), but biomass is used in Figure 2 and Table 1.

Solid Biomass: Organic, non-fossil material of biological origin that may be used as fuel for heat production or electricity generation. It comprises:

- ***Charcoal:*** the solid residue of the distillation and pyrolysis of wood and other vegetal material.
- ***Wood, wood wastes, other solid wastes:*** purpose-grown energy crops (poplar, willow etc.), a multitude of woody materials generated by an industrial process (wood/paper industry in particular) or provided directly by forestry and agriculture (firewood, wood chips, bark, sawdust, shavings, chips, black liquor, etc.) as well as wastes such as straw, rice husks, nut shells, poultry litter, crushed grape dregs, etc. Combustion is the preferred technology for these solid wastes. The quantity of fuel used is reported on a **net** calorific value basis.

Biogas: A gas composed principally of methane and carbon dioxide produced by anaerobic digestion of biomass, comprising:

- Landfill gas, formed by the digestion of organic landfilled wastes;
- Sewage sludge gas, produced from the anaerobic fermentation of sewage sludge;
- Other biogas, such as biogas produced from the anaerobic fermentation of animal slurries and of wastes in abattoirs, breweries and other agro-food industries.

Liquid biofuels: cover the fuels listed below:

- *Bioethanol:* ethanol produced from biomass and/or biodegradable fraction of organic waste;
- *Biodiesel:* a diesel quality liquid fuel produced from biomass or used frying oils;
- *Biomethanol:* methanol produced from biomass and/or the biodegradable fraction of organic waste;
- *Biodimethylether:* a diesel quality fuel produced from biomass and/or the biodegradable fraction of organic waste;
- *Bio-oil:* a pyrolysis oil fuel produced from biomass.

Wastes:

- **Industrial Wastes:** Wastes of industrial, non-renewable origin (solids or liquids) combusted directly for the production of electricity and/or heat. Renewable industrial waste is reported in the solid biomass, biogas and/or liquid biofuels categories.
- **Municipal solid waste (renewables):** Waste produced by households, industry, hospitals and the tertiary sector that contains **biodegradable** materials that are incinerated at specific installations.
- **Municipal solid waste (non-renewables):** Waste produced by households, industry, hospitals and the tertiary sector that contains **non-biodegradable** materials which are incinerated at specific installations.

Issues Regarding Data Reliability

As with many types of energy statistics, the reliability and consistency of the data are dependent upon the experience that the collecting staff and the reporting agents have with the energy technologies and energy products. Often, surveys used to collect national statistics are variations of forms and collection systems that have been in place for decades, and both the collection staff and reporting agents have extensive experience with the data. For renewable energy, this is true especially where electricity generation is involved, and where the generating units are connected to the transmission grid. The transmission system operator is able to measure and maintain statistics on capacity, production, outages and other important factors. This is generally the case in IEA countries for hydropower, geothermal, large wind farms and large biomass facilities.

Statistics will also be more reliable for energy products and technologies in commercial markets where exchanges are likely to be recorded for taxation, subsidisation, market research and/or other market-related activities. Wood cut, dried and sold through a commercial outlet may be recorded in national statistics, while wood wastes collected by rural residents from nearby forests, wind breaks or removed from streams is not. Scrap wood collected by local residents from a construction site, or agricultural residues delivered by farmers to local biomass facilities may or may not be recorded.

To some extent, these problems can be overcome by periodic surveys, where experts, for example in wind and solar energy, forestry or agriculture, assist statisticians. In an effort to establish a reliable base period for the EU renewables initiative mentioned above, Eurostat commissioned detailed surveys of renewables energy production, trade and consumption in the fifteen EU member countries from 1990 to 2000. Thus, historical statistics in that time period for the fifteen EU member countries tend to be more consistent and more complete than for many non-EU IEA countries. Several of the non-EU countries are in the process of surveying and revising historical renewables statistics, but so far the efforts are not as systematic as the surveys commissioned by Eurostat proved to be.

Issues Related to Renewables Statistics

There are some specific issues that lead to inconsistencies and misreporting in renewables statistics. Recognition and discussion of these issues is essential to improve the collection and provision of accurate statistics – especially as energy markets evolve.

One issue results from the rapid expansion of distributed generation from solar PV and small wind, hydropower and biomass installations, as well as the provision of hot water from on-site solar thermal installations. This issue has both an off-grid and on-grid dimension. Although it is sometimes possible to track capital expenditures and capacity of such facilities, there is often no systematic means of collecting energy production statistics. Rather, these must be estimated by means accepted by the providers and users of the technology and the government agencies that collect and process statistics. Currently, the statistics collection approach used by many national governments does not account for off-grid facilities, thus energy production from new renewables like wind, solar PV and solar thermal often goes unreported. In some cases, capacity statistics are collected through commercial sales data, but without accepted means of estimating production. This obscures the picture further, as capacity increases but production remains flat. There is a strong incentive to solve this issue as distributed/dispersed generation is expected to expand rapidly, and new non-renewable, modular energy technologies such as fuel cells are expected to enter the market.

Combustion of municipal solid wastes for electricity and heat generation is a significant portion of energy provided by renewables and waste in some countries. There is controversy involved in the definition of municipal solid waste (MSW). Waste collected from households, commercial establishments, hospitals and other institutions contains components that are both organic and inorganic. Both the IEA and the European Union exclude inorganic municipal solid waste from their definition of renewables; however, some IEA Member countries count all MSW as renewable. In other Member countries, surveys are underway to determine what fraction of MSW is renewable. The implementation of recycling programmes, the separation of waste at the point of combustion and other techniques are expected to reduce the fraction of inorganic MSW. At this time, the IEA advises Member countries to divide the total quantity of municipal solid waste equally between the renewable and non-renewable categories if they cannot distinguish between the actual components. Thus, the renewable component of this resource may not fully reflect the volume that is actually produced and used. This inconsistency can lead to discrepancies among some of the tables and figures in the study, where totals and percentages may not add up to the same amount. For example, in the country profiles the shares derived from Table 1 may not reflect those in Figure 2 because non-renewable waste is allocated to the major fossil fuel category in Figure 2. Moreover, the “Total” given in Table 1 includes non-renewable waste as well as electricity trade, so that the individual numbers do not necessarily add up to the “Total”.

Part 2

Country Profiles

Australia

Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

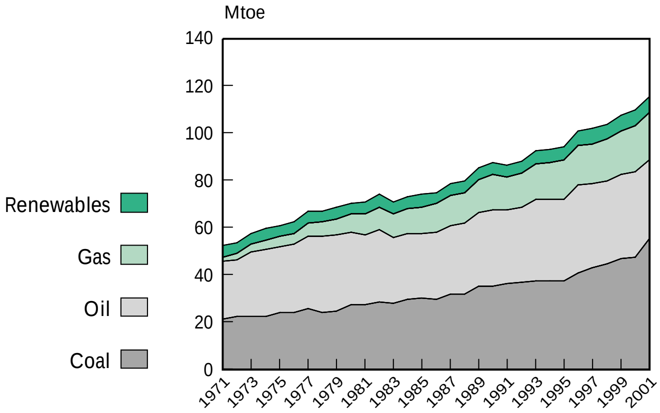
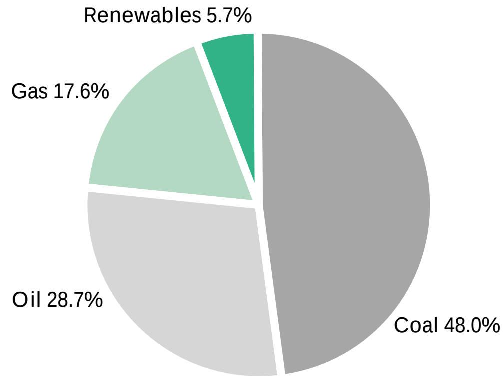


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1.
See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1970	1980	1990	1995	2000	2001	Imports
Coal	21.4	27.3	35.0	37.5	47.4	55.4	•
Oil	24.4	30.8	32.5	34.4	36.5	33.2	-
Gas	1.2	7.5	14.8	16.7	19.3	20.3	•
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	-
Renewables	4.3	4.7	5.1	5.5	6.4	6.6	-
Biomass	*3.5*	*3.6*	*3.8*	*4.1*	*4.9*	*5.0*	
Hydro	*0.8*	*1.1*	*1.2*	*1.4*	*1.4*	*1.4*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.1*	*0.1*	*0.1*	*0.1*	
Total	**51.3**	**70.4**	**87.5**	**94.4**	**109.8**	**115.6**	•
% Renewables	*8.4%*	*6.7%*	*5.8%*	*5.9%*	*5.8%*	*5.7%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*
• *Net Exporter*

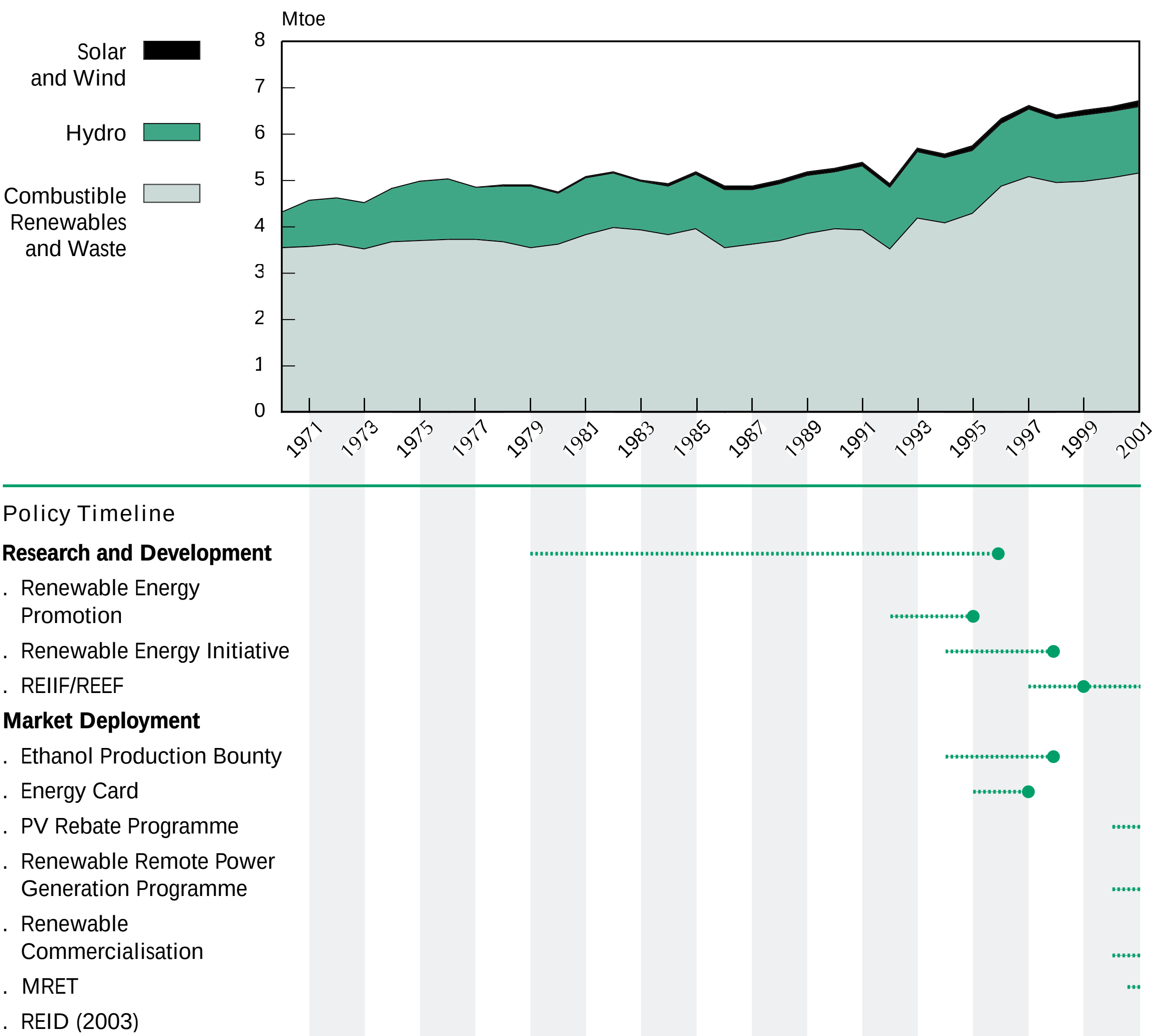
Total primary energy supply (TPES) increased on average by 2.6% per year from 1990 to 2001, from 88 Mtoe to 116 Mtoe. Australia has vast reserves of low-cost energy resources and is a major energy exporter. It is the world's largest hard coal exporter and holds nearly 30% of the world's resources of uranium. There is no nuclear production in Australia, and all of its uranium production is for export. Australia is also the world's third largest exporter of LNG. Energy supply is dominated by fossil fuels. In 2001, coal accounted for 48% of TPES, oil for 28.7% and gas for 17.6%.

Renewable energy sources accounted for less than 6% of TPES in 2001, consisting mostly of biomass and hydropower. This is substantially lower than the share in 1970 of more than 8%, and in 1980 of just below 7%. Nevertheless, renewables supply in TPES has increased from 5.1 Mtoe in 1990 to 6.6 Mtoe in 2001. This increase was due largely to an increase in biomass of 1.2 Mtoe over the period and to a smaller increase in hydropower of approximately 0.2 Mtoe.

Electricity generation increased by 3.1% per year from 1990 to 2001. Generation in Australia is predominately coal-fired, which accounted for 78% of total generation in 2001, reflecting the abundant supply and low price of coal. Gas (12%) and hydropower (7.7%) also contributed. The share of renewable energy sources in total electricity generation experienced a slight decline over the past decade from 9.6% in 1990 to 8.3% in 2001.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**

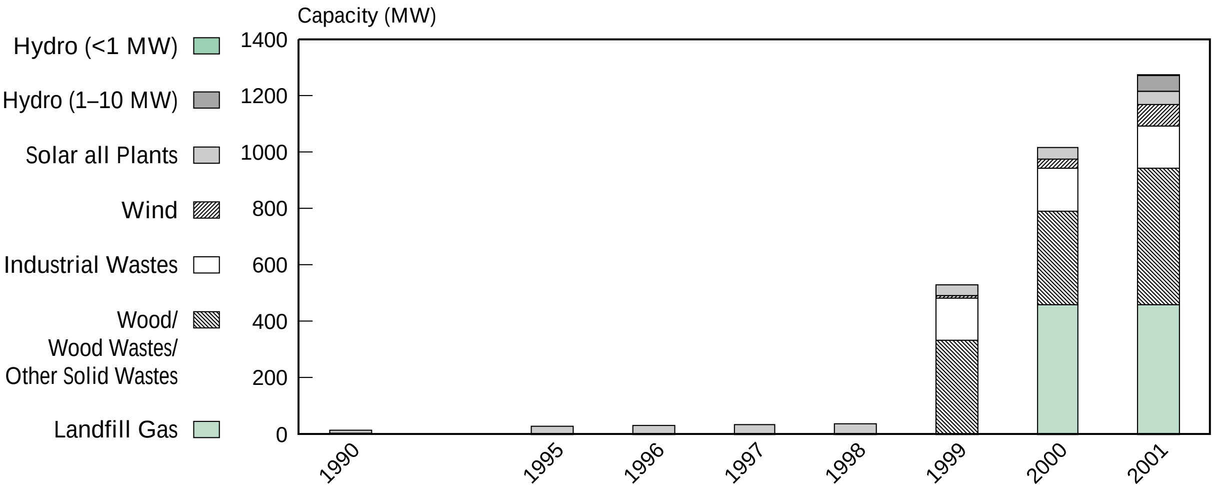


● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

The share of renewable energy sources in TPES in 2001 was 5.7%. Renewable energy supply is mainly comprised of biomass and hydropower. Biomass is the most significant contributor at 76.6% of total renewable energy sources while hydropower makes up 21.5%. Wind and solar combined contribute 1.9%.

The share of renewables in electricity generation decreased from 9.6% in 1990 to 8.3% in 2001. In 2001, hydropower was the main renewables contributor to total electricity generation at 7.7%. Figure 4 shows net generating capacity of renewables and waste products, excluding large hydropower in 2001. Net generating capacity from solar thermal sources increased on average by 5.8% per year from 1990 to 2001. Solar PV installed capacity grew at an average annual rate of 19.2% over the period. The first 2 MW of wind capacity came on-line in 1994. By 2001 installed wind capacity was 76 MW.

Figure 4. **Net Generating Capacity of Renewable and Waste Products**



Note: A change in data collection methods at the IEA occurred in 1999 with the separation of net generating capacity between small and large hydro. Capacity data for small hydro are not available prior to 1999.

Research and Development Trends[1]

The government total budget for energy RD&D was US$ 687 (in 2002 prices and exchange rates) between 1979 and 1997. In this period, 12% of the total RD&D budget was allocated to renewable energy RD&D.

Government RD&D expenditures for renewables peaked in the early 1980s and declined notably after 1985 except for a slight boost in 1993. The government RD&D budget for renewables in 1997 was approximately US$ 5 million.

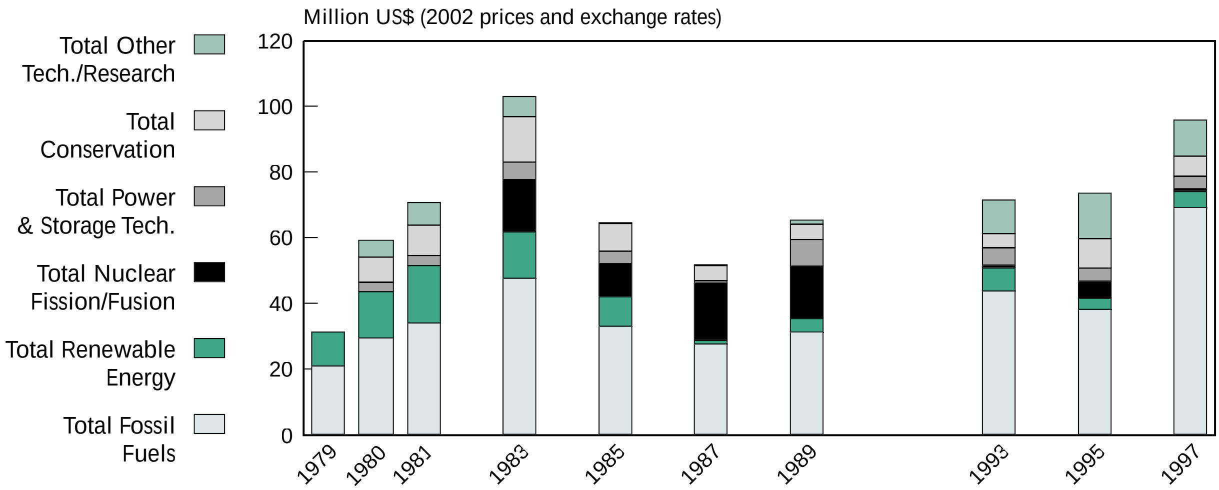
Among the renewable technologies, solar heating and cooling received the highest level of funding at US$ 28.43 million, or 33%, in the 1979 to 1997 period. Biomass was funded at US$ 20.23 million, representing 24% of renewable energy RD&D. Solar PV was the third largest area with 22% of the renewable RD&D expenditures from 1979 to 1997.

Prior to 1978, the main form of government support for renewable energy in Australia was direct investment by government-owned utilities, notably in hydropower. In 1978, the National Energy Research, Development and Demonstration Council (NERDDC) was established, beginning an era in which support for RD&D was the primary form of policy support for renewables in Australia. This phase lasted until 1997. Of the AUS$ 234 million committed under the NERDDC to 1990, 11% was devoted

1. *RD&D data for Australia are not available for certain years.*

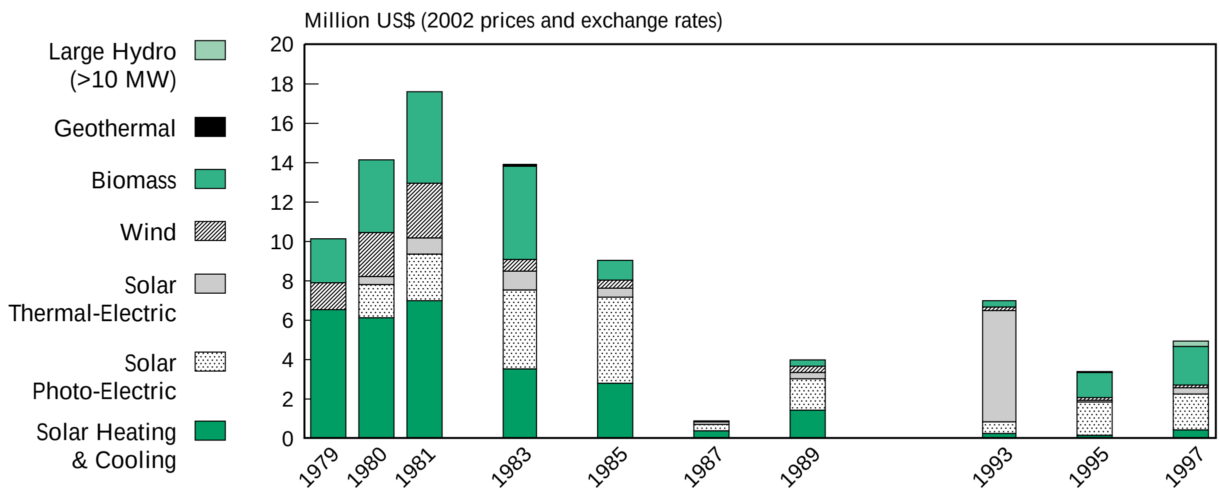
to renewable energy, while the bulk of the funds supported various forms of coal research. This programme, renamed the Energy Research & Development Corporation (ERDC), continued until 1997, and partially funded RD&D and commercialisation efforts in the renewable energy field, including small equity investments.

Figure 5. **Australia - Government Energy RD&D Budgets***



** Data are not available for certain years.*

Figure 6. **Australia - Government Renewable Energy RD&D Budgets***



** Data are not available for certain years.*

Market Deployment Trends

Competitive grants under the Renewable Energy Promotion Programme in 1992 were the first market deployment policies to promote renewable energy sources. Funding for the Programme was about AUS$ 10 million over the period to 1995. These were followed by low interest rate loans for individual customers in 1995 and a co-operative research centre in 1996. These policies were relatively short-lived.

In 1995, the Energy Card programme made available low interest loans for customers to purchase solar water heaters, heat pumps and other renewable energy technologies. Total funding for the programme was AUS$ 6 million. In 1996, a new co-operative research centre for renewable energy, known as ACRE, was established, and it successfully promoted small-scale renewable energy demonstration programmes until 2002. Many sub-national measures, such as the promotion of solar hot water heaters, are maintained by Australian states, and this effort has expanded noticeably in recent years.

National renewable energy policy in Australia took a major step in 1997 when the policy announcement, *Safeguarding the Future: Australia's Response to Climate Change*, was released. Most importantly, this policy included a Mandatory Renewable Energy Target (MRET), which requires additional electricity to be sourced from renewable energy. MRET is a non-technology specific broad market-based mechanism designed to stimulate competition between renewable energy suppliers and technologies, and hence to drive down costs over the medium term. (Although there is preferential treatment for solar hot water heaters.) The renewable energy sources and technologies eligible under the MRET are hydropower, wind, solar and various biomass products. This policy was expanded in 1998 to include investment incentives and grants targeting PV and off-grid power. The measure was implemented by fixing annual targets, ramping up from April 2001 to reach 9 500 GWh per year by 2010 and maintaining this requirement until 2020. Compliance is demonstrated via tradable certificates – the first mandatory national tradable certificate scheme for renewables in the world.

The renewable energy certificates (RECs) are created by generators accredited by the Office of Renewable Energy Regulator (ORER) with each certificate being equivalent to one MWh of generation from renewable sources. RECs can be traded in financial markets that are separate from physical electricity markets. They may also be banked by eligible generators, liable parties and REC market participants. RECs expire upon surrender by liable parties. All electricity from accredited renewable energy generators is considered eligible if generators commenced operation on or after 1 January 1997. Pre-existing generators only earn RECs for an increase in output above agreed baselines. Should liable parties fail to meet their share of the measure, they are responsible for a shortfall charge of AUS$ 40 per MWh. Shortfall charges are redeemable if shortfalls are made up within three years. Latitude of up to 10% is allowed in meeting targets.

The ORER reported that, as of September 2003, approximately AUS$ 900 million had been invested in new renewable energy projects with more than AUS$ 1 billion of investment money already committed or planned. Although the renewable energy industry seems to have been fairly responsive to the measures put in place by the MRET, a recent stalling in investment has been observed. This is considered to be in part attributable to regulatory uncertainty arising from the Parer Report, which recommended the dismantling of the MRET based on deficiencies within the Australian energy reform system. To date, growth in renewable energy generation has come primarily from hydro and solar hot water applications. Generation from biomass, including bagasse, has not been as significant as expected prior to the introduction of the MRET and it has had only a marginal influence on generation from solar PV.

In addition, the *Safeguarding the Future* statement announced the introduction of a suite of renewable energy commercialisation programmes including:

- Renewable Energy Innovation Investment Fund (AUS$ 21 million) operational since 2000 as the Renewable Energy Equity Fund, REEF;
- Renewable Energy Commercialisation Programme (RECP) (AUS$ 30 million) a competitive bidding programme, now fully committed, despite additional funding in 1999;
- Renewable Energy Showcase programme (AUS$ 10 million) a large-scale demonstration programme, also now fully committed.

In 1998, support for renewable energy was again expanded through the *Measures for a Better Environment* package. It established incentives for alternative and renewable transport fuels, a Photovoltaic Rebate Programme (under which up to 50% of system capital costs could be recovered), and a major grant scheme (up to AUS$ 264 million) for conversion of off-grid power schemes from diesel to renewables.

Recently, the government instituted the Renewable Energy Industry Development (REID) Programme, which provides grants to Australian companies who can demonstrate that their projects will assist the development of the Australian renewable energy industry. Industry development grants are typically on the order of AUS$ 100,000 and are intended to help address renewable energy market barriers, renewable energy resource assessment, best practice guidelines, training and standard setting.

Renewable Energy Markets

Hydropower

Figure 7. **Hydropower Capacity and Electricity Production**

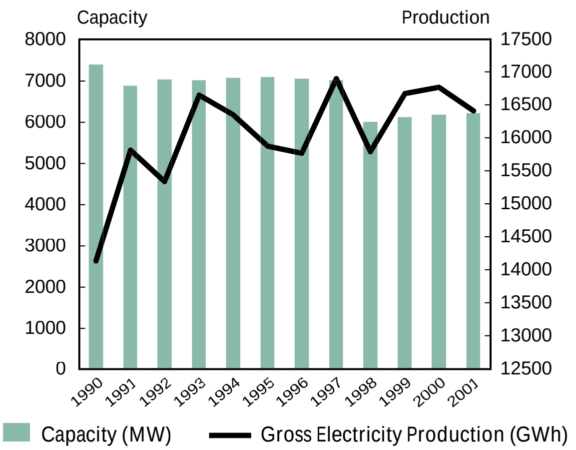
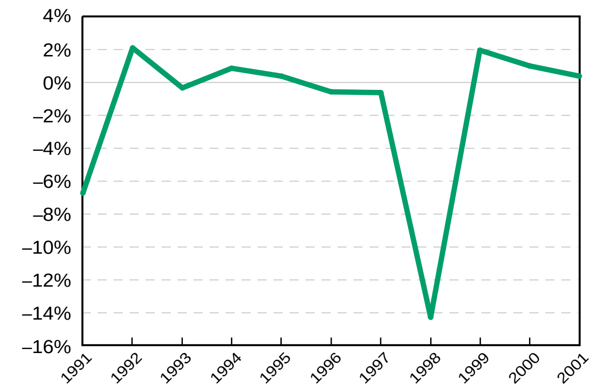
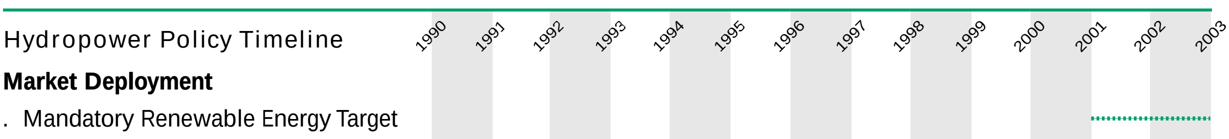


Figure 8. **Hydropower Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Hydropower was the main contributor (7.7%) from renewable sources to total electricity generation in 2001. Installed capacity from hydropower decreased from 7 381 MW in 1990 to 6 203 MW in 2001.

Hydropower has been developed in Australia throughout the twentieth century, but large-scale resources are concentrated in just two regions: the Snowy Mountains (Victoria/New South Wales (NSW) border) and Tasmania. Hydropower is eligible for support under MRET, provided the power is "new and additional". In fact, MRET has provided significant incentive for the hydropower market to improve and upgrade existing hydropower stations. The majority of these projects are in relation to existing generators allowing them to generate above their 1997 baselines. It is estimated that as a result of MRET, more than AUS$ 240 million will be invested in upgrading existing hydropower systems. MRET is also triggering investment in small-scale run-of-river and retrofit hydro systems.

Biomass Production

Biomass production experienced a slight growth of 2.2% per year between 1990 and 2001, an increase of 42 621 TJ. Biomass is the largest renewables contributor to TPES. In 2001, solid biomass contributed 76.6% of total renewables, which represents 4.3% of TPES.

Biomass resources – primarily bagasse, a by-product of sugar production – have been used for commercial power generation for at least fifty years, primarily in Queensland and Northern NSW, the sugar-growing districts. The economics are favourable economics and the plants have not received policy support.

More recently, new and innovative biomass-to-energy projects are being supported by the MRET and, at the sub-national level, policies such as greenhouse gas targets for power generators in NSW. These projects range widely, from co-firing of wood waste with coal (at very low cost) to gasification projects, waste-to-energy and bio-gas digesters. Some projects have also received financial support from sub-national governments, and research inputs from different institutions.

Growth in generation from biomass, including bagasse, has not been as significant as expected prior to the introduction of MRET. Approximately one-fourth of RECs created during the first two years of operation were created from biomass wastes, although none of them from dedicated biomass sources. There have not been any RECs sourced from native forests, due largely to public opposition to their harvesting. As well, within the MRET system, participants are unable to distinguish between wood waste RECs generated from native forests and from eligible wood waste sources. This may have been a factor in the unexpectedly low numbers of wood waste RECs created.

Figure 9. **Solid Biomass Production**

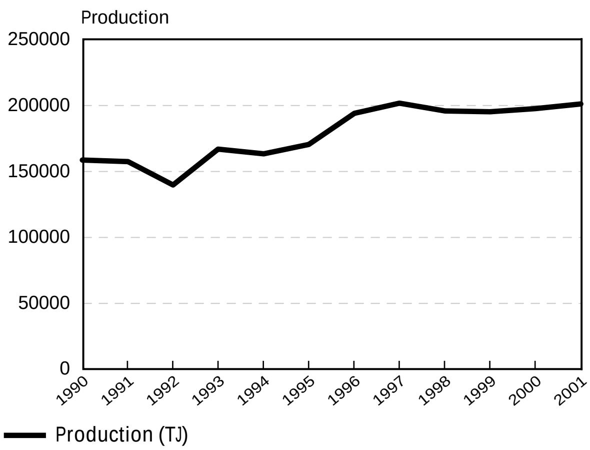
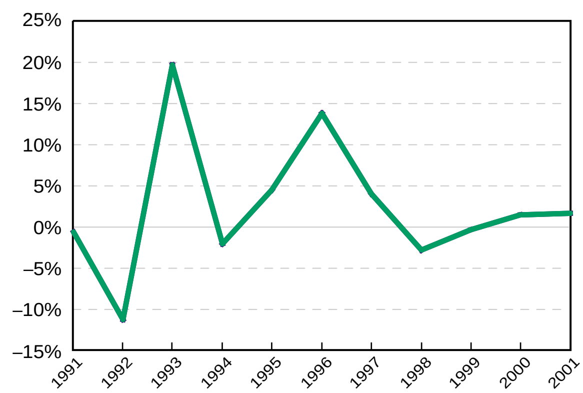
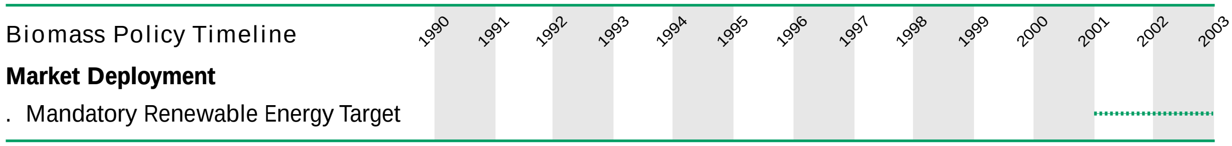


Figure 10. **Solid Biomass Production**
(Year to Year Change)





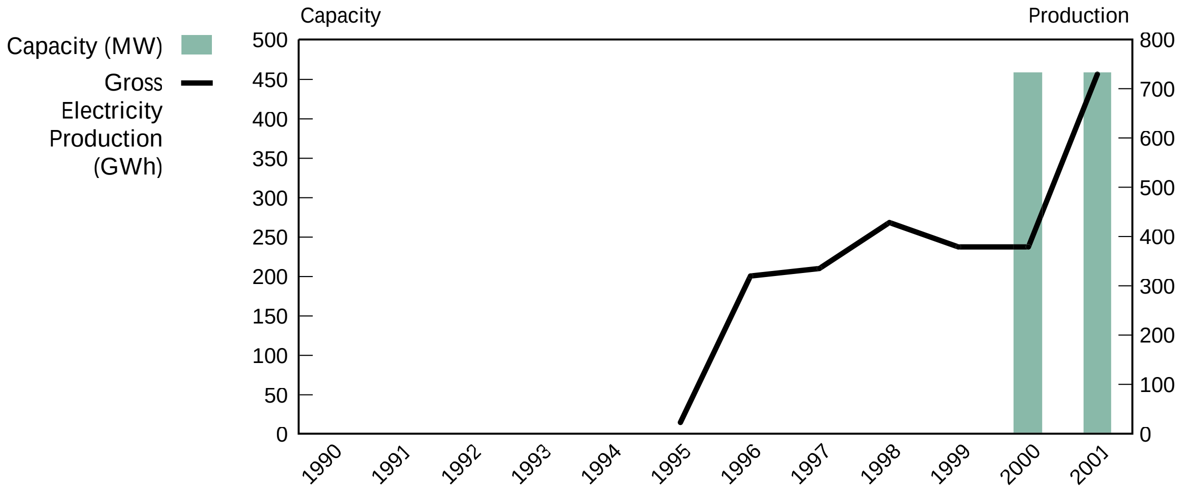
● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Biogas Electricity Production

Installed capacity for biogas was 458 MW in 2001. (IEA statistics for installed capacity for biogas only became available in 2000). Electricity generation from biogas has increased considerably from 23 GWh in 1995 to 729 GWh in 2001, an average growth rate of 78% per year.

Biogas is produced primarily from waste from food processing plants, livestock manure and human sewage. Most of the installed capacity is at sewage treatment plants, which are considered highly cost-effective.

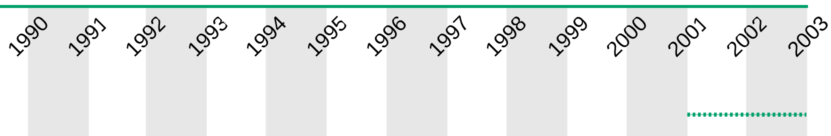
Figure 11. **Biogas Capacity and Electricity Production**



Biogas Electricity Policy Timeline

Market Deployment

. Mandatory Renewable Energy Target



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Within the context of the MRET, relevant state, territory and local government authorities are, to varying degrees, developing strategic waste management frameworks which prioritise actions for reducing and managing waste materials, including use of biogas for electricity generation. Construction of the plants has to a certain extent been boosted by the guaranteed market for excess electricity from the MRET, however, the treatment plants are part of broader pollution control measures.

Wind Power

The Australian wind market increased considerably at the end of the 1990s. Between 1994 and 2001, installed wind capacity grew from 2 MW in 1995 to 76 MW in 2001. In 2001, wind comprised 14.2% of energy supply from new renewables.

Growth appears to have coincided with the implementation of the MRET. Previously, there were no national premiums for wind power. However, some state-level green power schemes provided a significant premium for wind. These were particularly important in the years before MRET, but it did lead to double dipping for certain projects when the MRET came into force.

According to the Australian Wind Energy Association (AusWEA), the MRET has stimulated a substantial number of wind developments in Australia, with installed capacity increasing to 104 MW in 2002. According to AusWEA, this notable increase in the wind market was strongly linked to stimuli provided by the MRET. The AusWEA has speculated that without the MRET, the wind industry would have either stalled or collapsed. Wind has clearly been one of the big winners under MRET, based on cost competitiveness and strategic decisions made by large generators and their demonstrated confidence in wind technology. Wind was responsible for the creation of just over 10% of RECs within the MRET.

Figure 12. **Wind Power Capacity and Electricity Production**

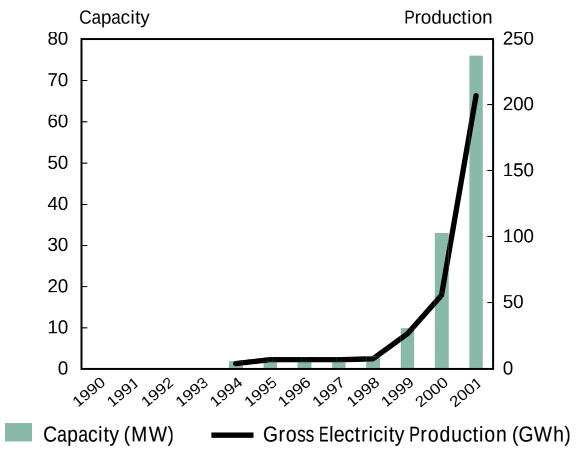
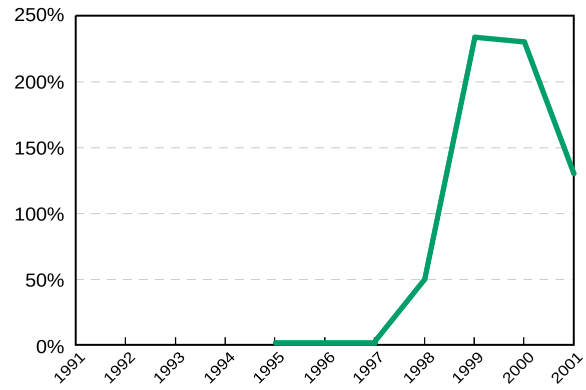
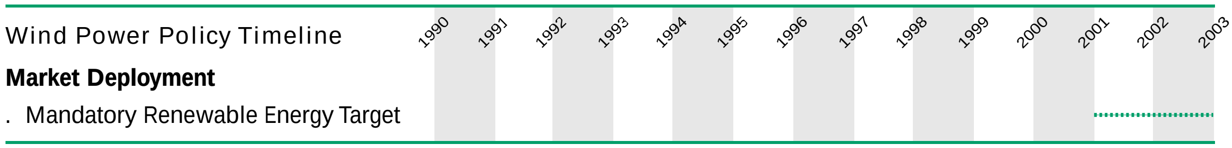


Figure 13. **Wind Power Capacity** (Year to Year Change)





Denotes a significant change to a policy, such as an extension, repeal or revision.

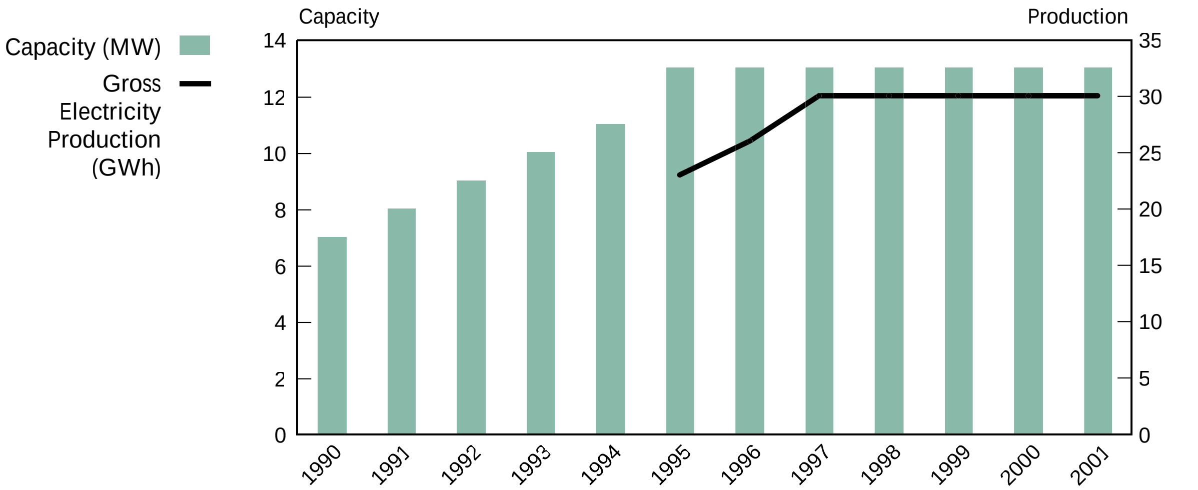
Solar Thermal Electricity Production

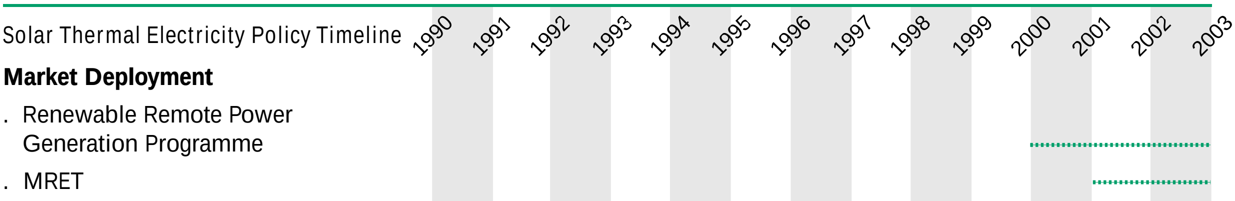
Installed capacity for solar thermal increased from 1990 to 1995 and has levelled off since then at 13 MW. Electricity generation from solar thermal sources increased from 23 GWh in 1995 and levelled off to around 30 GWh in 1997. Solar thermal accounted for 86% of energy supply from new renewables.

More than AUS$ 200 million has been committed to the Renewable Remote Power Generation Programme (RRPGP) which was introduced in 2000. The programme provides up to 50% of the capital cost of installing new renewable power facilities in off-grid applications. Funds are allocated to states and territories on the basis of the relevant diesel fuel excise paid in each region by public generators in the years 2000-2001 to 2003-2004. Solar thermal systems such as solar concentrators have benefited from this programme.

Small generation units (SGUs) have benefited from MRET measures, where a renewable generator is defined as an SGU if its energy source is hydro, solar or wind with a generation capacity of less than 10 kW and it generates up to 25 MWh of electricity each year. Special provisions within the MRET facilitate the up-front purchase of these SGUs. Although growth of the solar thermal market has coincided with the implementation of the MRET, there is uncertainty over whether the relationship is causal as there is doubt over whether the MRET provided a sufficient incentive for owners or suppliers to create Renewable Energy Certificates (RECs). The majority of the projects stimulated by the MRET are demonstration projects.

Figure 14. **Solar Thermal Capacity and Electricity Production**





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Solar Photovoltaic

Installed capacity of solar PV increased steadily between 1992 and 2001 at an average annual rate of 19%. Capacity was 34 MW in 2001.

Solar PV benefited greatly from the Photovoltaic Rebate Programme (PVRP). This is a AUS$ 41 million programme, introduced in 2000, which provides rebates to households and community organisations that install roof-top PV power systems. Demand in the grid-connected market picked up quickly due to this rebate programme. The programme, however, was over-subscribed and money was rationed for some months. The Australian government has announced a continuation of the programme for two years, but at lower grant levels.

According to Australian statistics, the PVRP and the Renewable Remote Power Generation Program increased PV installations by about 3 000 units between April 2001 and July 2003. But the Australian government has stated that there has also been a low uptake of SGUs under the MRET measure with most coming from the PV sector. Although the PV market has been sensitive to financial advantages from the PVRP and the Renewable Remote Power Generation Program, there is some doubt over whether the MRET was able to provide a sufficient enough incentive for owners or suppliers to create RECs.

Figure 15. **Solar Photovoltaic Capacity**

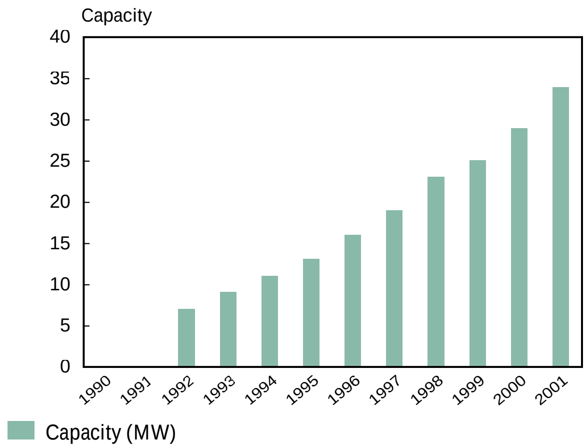
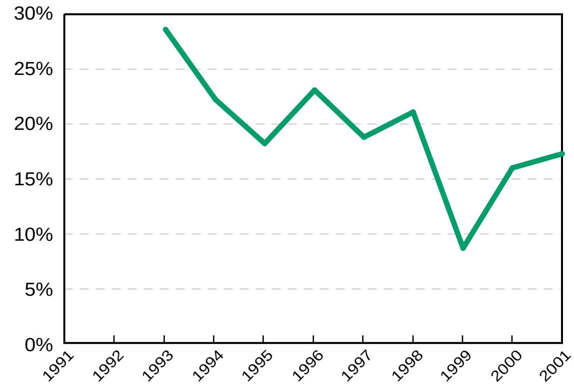


Figure 16. **Solar Photovoltaic Capacity**
(Year to Year Change)



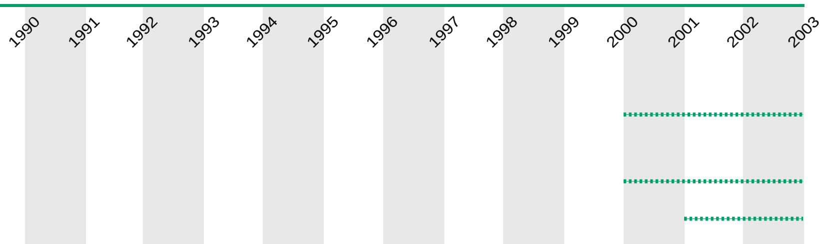
Solar PV Policy Timeline

Market Deployment

. PV Rebate Programme

. Renewable Remote Power Generation Programme

. MRET



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Australia Policy Chronology

Energy Research Development Corporation

Year 1990-1997

Policy Description Federal energy RD&D activities, including renewables, were carried out by the Energy Research and Development Corporation (ERDC) with additional indirect support from CSIRO (a government agency) and universities. However, severe budget constraints led the government to abolish ERDC in May 1997, as the government considered that ERDC had established a good foundation for industry to take on a greater role in funding its research.

Policy Type RD&D

RE Technology All renewables

National Greenhouse Response Strategy

Year 1992 – Present

Policy Description Progressive restructuring of the electricity and gas industries led to greater competition amongst generators, supply efficiency improvements, and innovative promotion of renewable energy. Continued energy market reform is a key element of Australia's greenhouse response and of the NGS. Further reforms outlined in the NGS include the delivery of consistent and compatible national frameworks for gas and electricity and removal of barriers to grid connection of small-scale generation, such as cogeneration and renewable sources. Programmes under the NGS include the Renewable Energy Promotion Programme, the Energy Card Programme, and the establishment of the Australian Cooperative Research Centre for Renewable Energy (ACRE).

Policy Type Regulatory and administrative rules

RE Technology All renewables

Renewable Energy Promotion Programme

Year 1992-1995

Policy Description Part of the National Greenhouse Response Strategy, this information and grant programme encouraged the use of commercially viable renewable energy technology by publicising and promoting stand-alone rural renewable energy systems.

Policy Type RD&D/Public awareness

RE Technology All renewables

Ethanol Production Bounty Scheme

Year 1994-1996

Policy Description The Ethanol Production Bounty Scheme ran from July 1994 to August 1996 and provided AUS$ 3 million to subsidise ethanol production. Approximately AUS$ 4 million was additionally committed over two years towards an RD&D programme.

Policy Type Capital grants

RE Technology Biofuel

Renewable Energy Initiative

Year 1994-1998

Policy Description This initiative supported the development of a robust renewable energy technology industry. AUS$ 10 million of additional funds were made available over seven years to support the establishment of a Co-operative Research Centre, with a primary objective to develop renewable energy.

Policy Type RD&D

RE Technology All renewables

Energy Card

Year 1995-1997

Policy Description The Energy Card was a low interest credit card available to customers for the purchase of solar water heaters, heat pumps and other renewable energy technologies. The AUS$ 6 million programme sought to demonstrate the feasibility of innovative financing for solar water heaters and other renewable energy and efficiency applications via low interest loans.

Policy Type Third-party finance

RE Technology All renewables

Purchase of Renewable Energy

Year 1995

Policy Description New South Wales (NSW) passed legislation in 1995 requiring electricity distributors and retailers to develop one, three and five-year plans for purchasing renewable energy as part of the procedure required to obtain an obligatory licence.

Policy Type Obligations

RE Technology All renewables

Solar Cell Initiative

Year 1995-1999

Policy Description This R&D initiative in New South Wales involved Pacific Power and academia, and provided AUS$ 46 million from 1995 to 1999.

Policy Type RD&D

RE Technology Solar photovoltaic

Green Power Scheme

Year 1997 - Present

Policy Description The New South Wales Government's Sustainable Energy Development Authority (SEDA) regulates its green power schemes. Since inception in 1997, approximately 15 000 domestic customers and 800 businesses have joined and there has been an investment of AUS$ 26 million in renewable energy projects associated with the schemes.

Policy Type Green pricing

RE Technology All renewables

Renewable Energy Innovation Investment Fund (REIIF)

Year 1997 - Present

Policy Description This programme provides funds to help with the commercialisation of renewable energy technologies that are in an early stage of development.

Policy Type RD&D

RE Technology All renewables

Renewable Energy Equity Fund

Year 1999 - Present

Policy Description The Renewable Energy Equity Fund (REEF) provides venture capital to small, innovative companies for the development of renewable technologies. The fund is managed by an independent company with supervision provided by the Industry Research and Development board and the AGO. The Commonwealth is both the regulator and a major investor. It has allocated AUS$ 17.7 million, which is matched by private equity on a 2:1 basis, amounting to a total of AUS$ 26.6 million over ten years. REEF targets the renewable energy industry sector and operates in the same way as other venture capital investment funds. The fund manager raises capital from investors and assesses small businesses in which to invest based on the expected rate of return. Eligible companies may receive a maximum investment of AUS$ 3 million or 10% of the initial capital (whichever is less).

Policy Type Capital grants

RE Technology All renewables

Cities for Climate Protection (CCP) Australia

Year 1999 - Present

Policy Description Cities for Climate Protection (CCP) Australia is an international trade-marked programme of the International Council for Local Environmental Initiatives (ICLEI) in collaboration with the Australian Greenhouse Office. By participating in CCP Australia, councils commit to progress through five milestones to reduce their greenhouse gas emissions:

- Assess the emissions produced by their own facilities (corporate emissions) and by the community.
- Establish an emissions reduction goal.
- Develop a local action plan.
- Implement the local action plan.
- Monitor and report on the implementation of the local action plan.

Policy Type General energy policy

RE Technology All renewables

Renewable Energy Action Agenda

Year 2000 - Present

Policy Description Industry and government work in partnership to develop a Renewable Energy Action Agenda (REAA), launched in 2000. The REAA Vision is “to achieve a sustainable and internationally competitive renewable energy industry which has annual sales of AUS$ 4 billion”. Over the last three years, the government has worked with the renewable energy industry to implement action agenda initiatives that aim to increase community commitment to renewable energy, encourage exports, improve the reliability and quality of renewable energy products and services, develop a renewable transport fuels industry, ensure that skilled people are available to support industry growth, and encourage a culture of market-driven innovation.

Policy Type Public awareness

RE Technology All renewables

Measures for a Better Environment Package

Year 2000 - 2004

Policy Description The federal budget adopted in 2000 allocated nearly AUS$ 800 million of additional funding to greenhouse gas reduction programmes over four years. These measures are known collectively as Measures For a Better Environment. They include:

- Greenhouse Gas Abatement Programme.
- Photovoltaic Rebate Programme.
- Remote Renewable Power Generation Programme.
- Renewable Energy Commercialisation Programme.
- Alternative Fuels Conversion Programme.

Policy Type Capital grants/Consumer grants/rebates

RE Technology All renewables

Greenhouse Gas Abatement Programme

Year 2000 - Present

Policy Description The Greenhouse Gas Abatement Programme (GGAP) is a major government initiative to reduce Australia's net greenhouse gas emissions by supporting activities that are likely to result in substantial emission reductions or substantial carbon sink enhancement, particularly in the first commitment period under the Kyoto Protocol (2008-2012). AUS$ 400 million has been allocated to the programme.

This environmental initiative is a key part of the Measures for a Better Environment package, announced in 1999 in association with the government's tax reforms.

GGAP targets opportunities for large-scale, cost-effective and sustained abatement across the economy. GGAP only supports projects that are expected to result in quantifiable and additional abatement not expected to occur in the absence of GGAP funding. Priority is given to projects that will deliver abatement exceeding 250 000 tonnes of carbon dioxide equivalents (CO_2-e) per annum. Projects that do not meet this threshold but meet other criteria at a high degree may be supported. GGAP employs a competitive selection process, with two key cost-effectiveness indicators deciding project selection:

- GGAP cost (AUS$) per metric ton of reasonably assured and additional CO_2-e estimated to be abated in 2008-2012.
- Net national cost (AUS$) per metric ton of reasonably assured and additional CO_2-e estimated to be abated in 2008-2012.

Policy Type Capital grants

RE Technology All renewables

Photovoltaic Rebate Programme

Year 2000 - Present

Policy Description The Photovoltaic Rebate Programme (PVRP) – (AUS$ 41 million funding) provides rebates to households and community organisations that install roof-top PV power systems. The level of rebate is based on peak PV output. The minimum system size is 450-Watt peak output. There is no maximum size, although the rebate of AUS$ 4.00 per peak watt (ppW) for new systems is capped at AUS$ 4 000 per residential system and AUS$ 8 000 per community building system. Extensions to existing PV systems can receive rebates of AUS$ 2.50 ppW capped at AUS$ 2 500 (1.0 kW). The community buildings component is similar in minimum size and rebates, but these are generally capped at AUS$ 10 000 (2 kW) unless exceptional circumstances apply.

Policy Type Consumer grants/rebates

RE Technology Solar photovoltaic

Renewable Remote Power Generation Programme

Year 2000 - Present

Policy Description The Measures For a Better Environment package includes a Renewable Remote Power Generation Programme. This programme provides up to 50% of the capital cost for installing new renewable power facilities in off-grid applications. Funds are allocated to states and territories on the basis of the relevant diesel fuel excise paid in each region by public generators in the years 2000-2001 to 2003-2004. To be eligible, installations must be able to demonstrate that they displace diesel power with renewables. Qualifying capital costs include renewable energy generation equipment, enabling/ancillary equipment (inverters, etc.) and essential expenditures such as installation costs. The programme does not fund solar hot water systems.

Policy Type Capital grants

RE Technology All renewables

Renewable Energy Commercialisation Programme

Year 2000 - Present

Policy Description The Renewable Energy Commercialisation Programme (RECP) is a AUS$ 48 million competitive grants programme, launched under the "Measures for a Better Environment" package. It is designed to assist with technology commercialisation and to foster the development of a renewable energy industry in Australia. Commercialisation grants vary between AUS$ 100 000 and 1 million. Projects are chosen for their strong commercial potential, contribution to diversification of the renewable energy industry and reduction of greenhouse gas emissions. Applicants must fund at least 50% of project costs. Funds under this component have been fully committed.

Policy Type	Capital grants
RE Technology	All renewables

Mandatory Renewable Energy Target

Year 2000 - Present

Policy Description

The Renewable Energy (Electricity) Act 2000 sets the framework for the Mandatory Renewable Energy Target (MRET). The government's renewable energy target seeks to raise the contribution of renewable energy sources in Australia's electricity mix by 9 500 GWh per year by 2010 and maintain this requirement until 2020. Under this measure, tradable Renewable Energy Certificates (RECs) are used to demonstrate compliance with the objective.

All wholesale electricity purchases on grids of more than 100 MW of installed capacity have to apply mandatory renewable energy targets since 1 April 2001. In order to meet their obligation, liable parties (wholesale purchasers) surrender Renewable Energy Certificates to the Renewable Energy Regulator. A Renewable Energy Certificate represents 1 MWh of electricity. The penalty payment for non-compliance is AUS$ 40 per MWh (non-tax deductible). The Office of the Renewable Energy Regulator administers the MRET.

Policy Type Obligations / Tradable certificates

RE Technology All renewables

Study on Ethanol

Year 2000 - Present

Policy Description

Australia's federal government funds a study of the commercial viability of increasing ethanol fuel production in the sugar industry. This study, estimated to cost AUS$ 20 000, is co-ordinated by the Australian Bureau of Agricultural and Resource Economics (ABARE). The initiative builds on an existing commitment of AUS$ 2 million for a ligno-cellulosic ethanol pilot plant.

Policy Type RD&D

RE Technology Biofuel

Green Electricity Market

Year 2001 - Present

Policy Description

This programme supports the development of a voluntary, industry-owned Green Electricity Market (GEM) that trades in "green electricity rights" with government funding under the Renewable Energy Commercialisation Programme (RECP). This trading incorporates the Renewable Energy Certificates under the Mandatory Renewable Energy Target (MRET).

Policy Type Obligations / Tradable certificates

RE Technology All renewables

Victorian Greenhouse Strategy

Year 2002 - Present

Policy Description Australia's Victorian State government has allocated AUS$ 100 million to climate change programmes over the period 2002 to 2004. The strategy contains 59 actions presented in ten "modules", including energy.

Policy Type General energy policy

RE Technology All renewables

Renewable Energy Industry Development (REID)

Year 2003 - Present

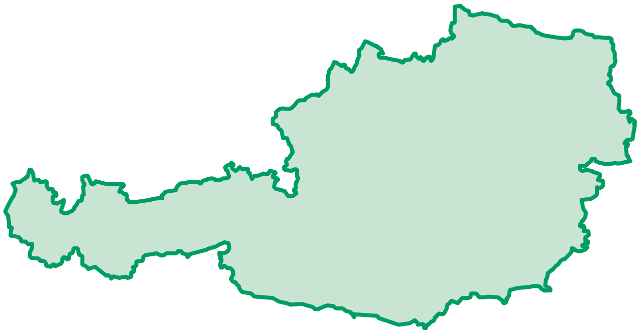
Policy Description The Renewable Energy Industry Development (REID) programme is a AUS$ 6 million competitive grants programme that supports the renewable energy industry by providing grants to Australian companies who can demonstrate that their projects will assist the development of the domestic renewable energy industry.

Industry development grants are typically AUS$ 100 000. Project applicants must not obtain significant individual financial or commercial benefits and project outcomes need to be disseminated to the wider Australian industry. Targeted at industry associations and community organisations, grants may address renewable energy market barriers, renewable energy resource assessment, best practice guidelines, training, standard setting and related topics.

Policy Type Capital grants

RE Technology All renewables

Austria



Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

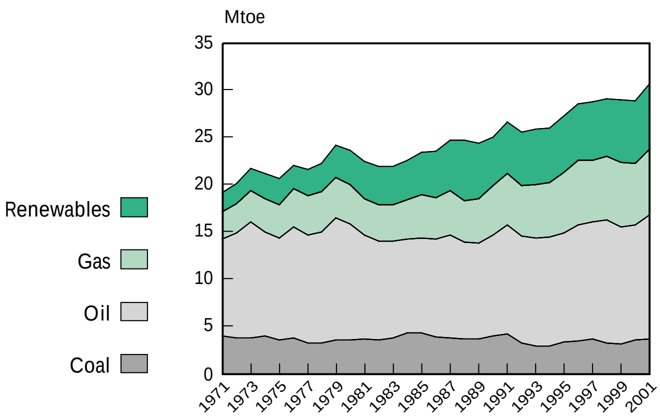
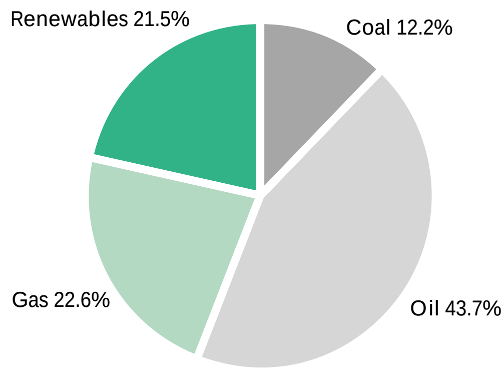


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1.
See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1970	1980	1990	1995	2000	2001	Imports
Coal	4.5	3.7	4.1	3.5	3.6	3.7	88.8%
Oil	9.2	12.2	10.6	11.5	12.2	13.1	89.0%
Gas	2.5	4.2	5.2	6.4	6.5	6.9	72.4%
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	-
Renewables	2.5	3.6	5.0	5.8	6.4	6.6	-
Biomass	*0.7*	*1.1*	*2.3*	*2.6*	*2.7*	*2.9*	
Hydro	*1.8*	*2.5*	*2.7*	*3.2*	*3.6*	*3.6*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.0*	*0.1*	*0.1*	
Total	**18.2**	**23.3**	**25.0**	**27.1**	**28.8**	**30.7**	**65.1%**
% Renewables	*13.2%*	*15.3%*	*19.9%*	*21.3%*	*22.0%*	*21.5%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*

Total primary energy supply (TPES) grew at an average annual rate of 1.9% from 1990 to 2001, from 25 Mtoe to nearly 31 Mtoe. Oil supply accounts for the largest share of TPES, 43% in 2001, but its share has declined from 52% in 1980 (Table 1). Natural gas represented 23% of TPES in 2001. Coal supply declined from 4.1 Mtoe in 1990 to 3.7 Mtoe in 2001, when it accounted for 12% of TPES. Hydropower represented some 12% of TPES in 2001 and biomass 9.4%. Wind and solar energy represented less than 1%.

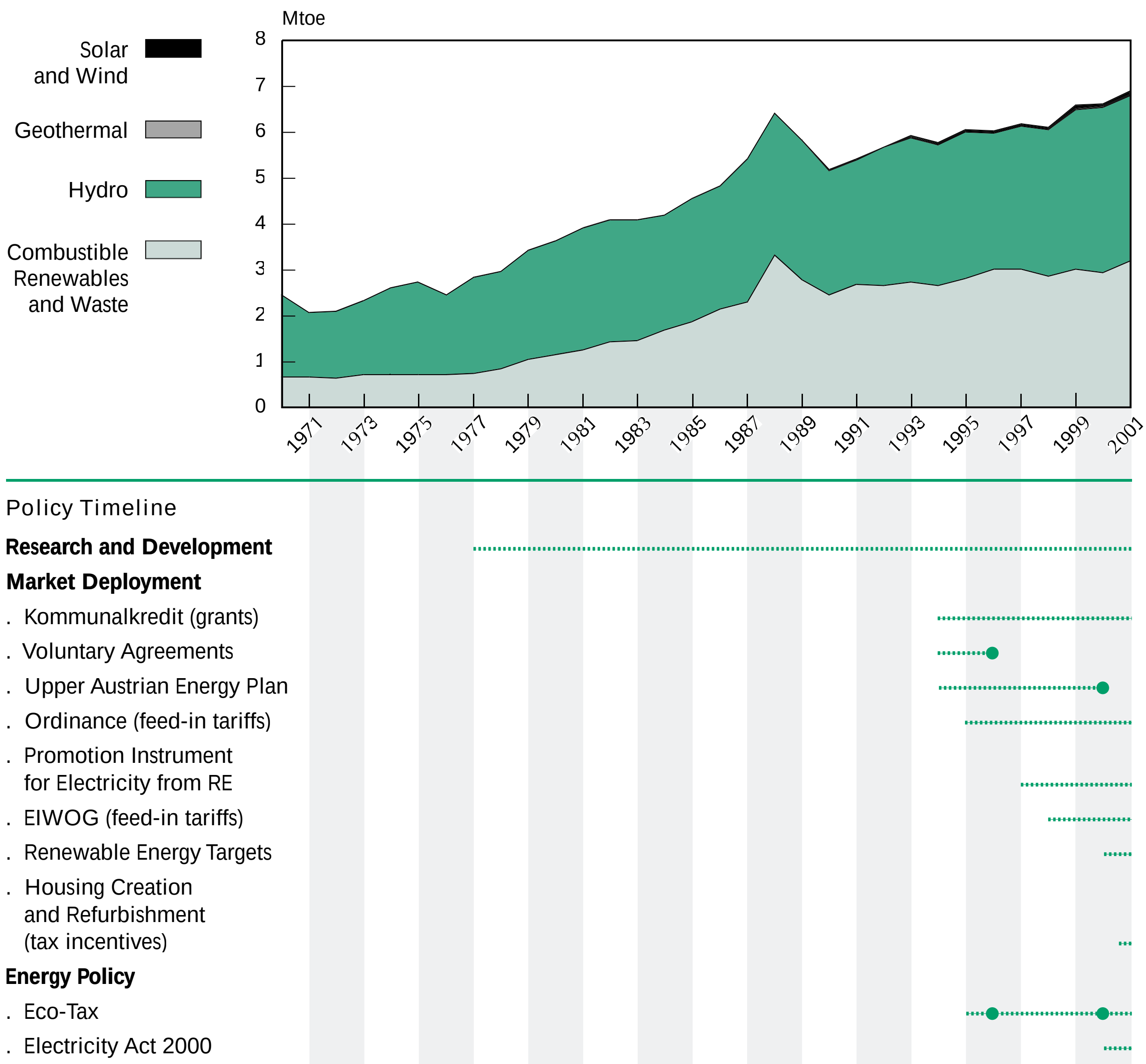
The share of renewables in TPES increased substantially over the past two decades, from 15% in 1980 and 21% in 1990 to almost 22% in 2001. This was largely due to Austria's success in exploiting its major bioenergy and hydropower resources. Renewable energy supply increased from 5 Mtoe in 1990 to 6.6 Mtoe in 2001, an average annual growth of 2.6%. The use of large-scale hydropower and biomass in Austria is among the highest in Europe. From 1990 to 2001, biomass supply grew from 2.3 Mtoe to

2.9 Mtoe, and hydropower production increased from 2.7 Mtoe to 3.6 Mtoe. Together, they comprised more than 98% of renewable energy supply in Austria in 2001. Solar thermal and wind power made minor contributions to renewable energy supply. Geothermal energy is minimally exploited in Austria.

Electricity generation is dominated by hydropower, which accounted for 67% of total generation in 2001. Fossil fuels accounted for some 30%. Biomass contributed 2.8%, but its share is expected to increase. Electricity generation from solid biomass-fired plants increased by nearly 3% per year from 1990 to 2001. Wind and solar energy contributed less than 1% of total electricity generation in 2001.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Renewable energy has historically played a prominent role in Austria's energy supply, concentrated primarily in large hydropower schemes and biomass use. Total renewable energy supply has increased steadily over the past few decades, largely due to policy support for indigenous resources and to high fossil fuel prices in the 1970s.

Renewable energy development has been a central theme of energy policy since the establishment of the Austrian energy guidelines in 1976. Renewables are particularly valued because of their role in reducing

CO_2 emissions. Because of the large proportion of renewables in TPES, Austria has one of the lowest CO_2 emissions per capita among IEA Member countries. Policies targeted toward the development of biomass heating and solar thermal technologies have resulted in substantial market growth. While biomass and hydropower are significant contributors to energy supply in Austria, solar PV and wind energy have exhibited little market growth until very recently due to ineffective policies.

Quotas and feed-in tariffs have been the main mechanisms to encourage electricity generation from renewables, although the introduction of a guaranteed market in conjunction with investment grants through the federally administered Kommunalkredit also spurred market growth. National quotas, however, were put in place without regard for unequal geographic resource allocation, *i.e.*, each state was required to have a mix of renewable power systems regardless of its ability (climatic or geographic) to support it. Feed-in tariffs were established based more on each Länder's specific political climate and natural resources than on optimising the renewable energy technology with geographic location. Austria has been working on streamlining the process through the Green Electricity Act 2002 with the establishment of national feed-in tariffs. The goal is to increase the share of solar and wind energy in total energy supply. The result has been dynamic market development since feed-in tariffs were enacted in 2003.

Austria's target under the *EU Directive for Electricity Produced from Renewable Energy Sources 2001* is to increase the share of renewables in electricity generation from 70% in 1997 to 78.1% in 2010.

Research and Development Trends

Austria spent a total of US$ 785 million (2002 prices and exchange rates) on government energy RD&D between 1977 and 2002. Energy research and development expenditures averaged US$ 40 million to US$ 45 million from 1977 to 1985, after which they dropped to a low of about US$ 12 million in 1990. Funding rebounded to about US$ 25 million in 1994 where it has since remained relatively stable. In Austria, 20% of its total RD&D budget in the 1977 to 2002 period was allocated to renewable energy RD&D.

Figure 4. **Austria - Government Energy RD&D Budgets**

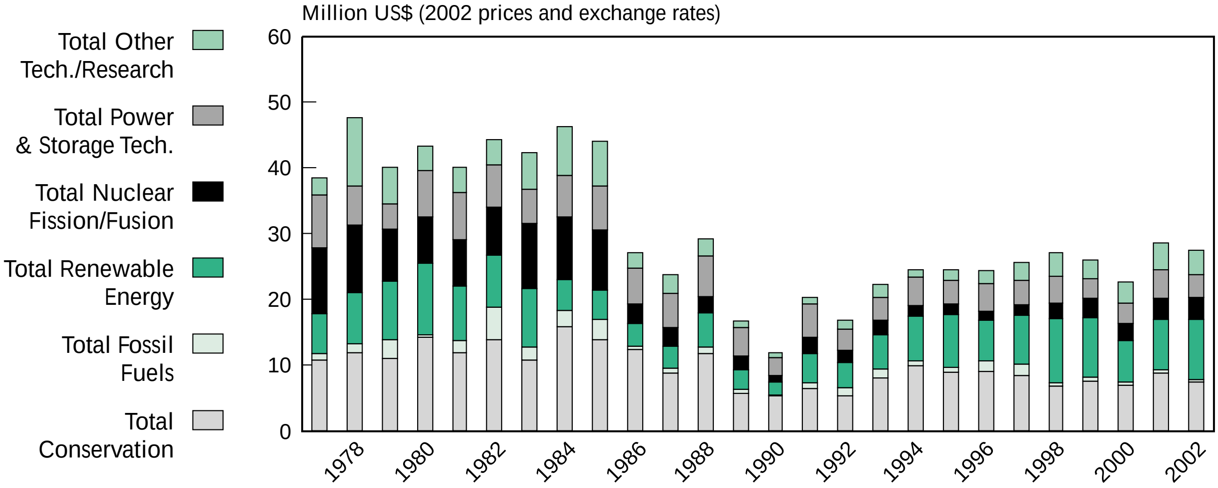
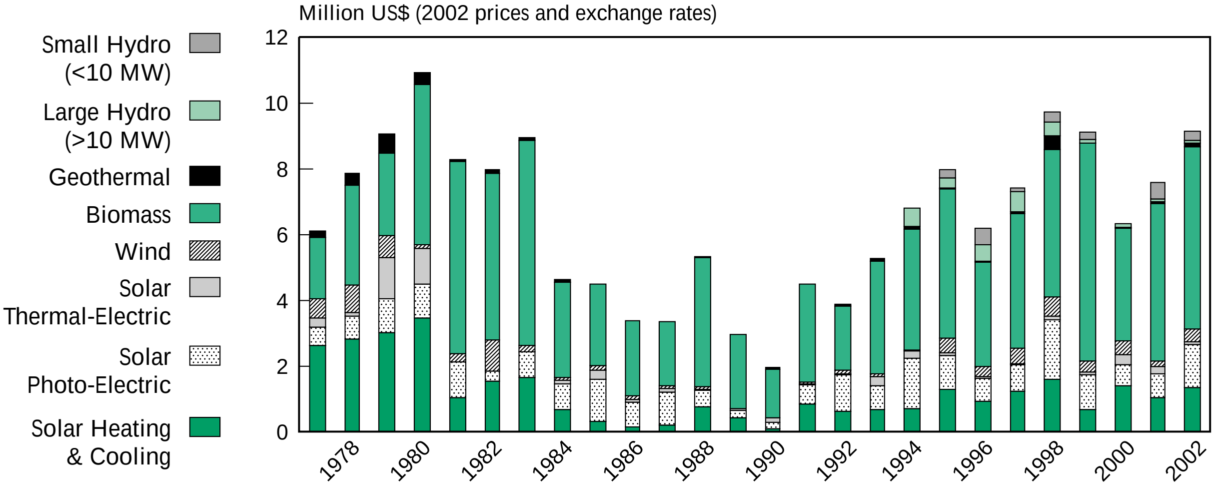


Figure 5. **Austria - Government Renewable Energy RD&D Budgets**



From 1977 to 2002, 56% of the total renewables RD&D budget was allocated to biomass technologies. Total funding was approximately US$ 95.2 million. Solar heating and cooling accounted for some 19%, followed by solar photovoltaics with 13%. Funding for hydropower and geothermal is minimal.

Austria participates in international collaborative RD&D in Bioenergy, Photovoltaic Power Systems, Solar Heating and Cooling and Wind Turbine Systems through the IEA Implementing Agreements.

Market Development Trends

Over the past decade, RD&D funding for advanced biomass, solar and heat pump technologies resulted in the market deployment of biomass heating systems, solar systems, heat pumps and solar PV for special applications. Austria has employed grants, tax incentives, feed-in tariffs and, more recently, portfolio standards to support the market deployment of renewables. The markets which are highlighted in this profile are biomass electricity and heat generation, wind power, solar thermal and solar PV.

In 1994, the Upper Austrian Energy Plan established a target to increase the use of renewable energy in the region. The target, which was met, included increasing the proportion of energy provided from renewable sources to 30% by 2000. The Upper Austrian Energy Plan was very successful through a combination of support measures from both national and local sources, combined with a high level of information dissemination to raise awareness in the region. Similar initiatives are now being implemented in other Austrian regions, supported through local or regional energy plans.

Since 1994, federal grants and incentives have been administered primarily by the Kommunalkredit for renewable energy producers, such as firms, associations and public entities. These federal grants typically constitute 30% of eligible costs and are awarded to entrepreneurs investing in small hydro plants, modern biomass-based heating systems which include small networks for district heating, biogas, sewage gas, geothermal systems, heat pumps, solar thermal above 10 m^2, photovoltaic and wind installations. The grants can also be combined with financial support from the Länder to cover up to 66% of eligible costs.

Beginning in January 1994, voluntary agreements between the Ministry of Economic Affairs and the Association of Electricity Utilities provided incentives of 100% of the delivery price for PV and wind power, and 20% of the delivery price for biomass and biogas for renewable electricity systems installed before end-1996. The payment of higher buy-back rates at these levels ceased at the end of 1999.

Feed-in tariffs in Austria were first introduced under the August 1995 Ordinance. The Ordinance established guaranteed minimum prices for electricity traded between provinces and produced from CHP stations and renewable electricity plants. For plants smaller than 2 MW, these prices ranged from 100% to 125% of the prices charged by the Verbundgesellschaft, the national electricity wholesale company, depending on the time of delivery. For plants larger than 2 MW, the rates were 100% of the prices charged by the Verbundgesellschaft. The Ordinance was refined in 1997 under the Promotion Instrument for Electricity from Renewables (PIER), which provided both a capital cost grant and a guaranteed tariff for renewable electricity fed into the grid. Projects were selected through a public competitive tender procedure where grants were awarded based on lowest capital cost for each technology type. The capital cost grants were capped at a 7% rate of return for fifteen years. In addition, electricity from these systems benefited from a guaranteed market and buy-back rates of fifteen years.

The PIER also provided capital investment subsidies for biomass, which were disbursed through the District Heating Promotion Act. Incentives under this Act ceased in 1996. Capital subsidies of 8% are still available for the construction, restoration or enlargement of small (0.5-10 MW) hydropower systems, and subsidies of up to 25% are available for micro (< 0.5 MW) systems that are both remote and environmentally friendly. In addition to federal promotional measures, provincial authorities may also provide subsidies or favourable loans for biomass heating plants.

The Electricity Act 1998 (EIWOG) adjusted feed-in tariffs to further stimulate electricity production from renewable energy producers. The EIWOG obliged system operators to purchase renewable electricity offered by independent power producers and to pay minimum feed-in tariffs. The tariffs were defined by each of the nine provinces and thus differed according to province. In addition to the tariff levels, provinces were also responsible for setting quota levels and conditions. The feed-in tariffs differed according to technology, type and duration of contract, and daily and seasonal demand.

In July 2000, the Austrian Parliament approved an amendment to the Electricity Act 1998, establishing the Electricity Liberalisation Act 2000. Under this Act, renewable energy obligations were put into force in December 2000. Distribution system operators are now required to purchase electricity from recognised renewables plants up to a certain share of their electricity sales to final consumers. In 2001, the share was at least 1% and in 2003 at least 2%. The share in 2005 will be at least 3% and in 2007 at least 4%. Purchase prices are regulated. The grid operators can resell the electricity to final consumers or to electricity traders. If the minimum percentage amount is exceeded, the grid operator can sell the excess amount to other operators of distribution grids. Qualifying plants include wind, PV, geothermal, biomass, biogas, digester and sewage gas, as well as co-firing and multi-fuelled plants using a high proportion of renewable fuels, and combustion of wastes containing a high percentage of renewable materials.

Personal tax incentives for the purchase of biomass and solar technologies were introduced in 2001 under the Housing Creation and Refurbishment Law. This support was redesigned and improved in 2003 under the Dwelling Improvement and Housing Promotion Subsidy. This recent policy is considered one of the most important in promoting the use of renewable energy sources in the residential sector.

In July 2002, the National Council and Federal Council passed the Green Electricity Act, amending the EIWOG and implementing the EU Directive 2001/77/EU *Generation of Electricity from Renewable Sources of Energy*. This Act replaced the legislation concerning renewable power within the scope of EIWOG and abolished the system based on provincial legislation. The Act governs public support for green energy and combined heat and power generation throughout the country. Through this Act, fees for renewables-based power, which varied from state to state, will be replaced with a uniform fee for power generated by combined heat and power plants, renewable sources and small hydropower plants. The total cost of support at the federal level is much lower than it would have been to achieve the same objective individually in each state. This is because the renewable potential can now be exploited according to geographical resource allocation (*i.e.*, wind power in eastern Austria and hydroelectric power in western Austria). The supply tariffs for the renewable plant operators are the same throughout Austria.

The objectives outlined in the Green Electricity Act are to generate 9% of renewables-based electricity from small-scale hydroelectric plants and 4% from other renewable plants. These targets are to be achieved by providing favourable supply tariffs until 2008. Large hydropower generation will be expected to generate enough electricity so that the overall objective of 78.1% of electricity from renewable sources can be reached by 2010.

The Act guarantees payment of feed-in tariffs for thirteen years at the following rates (per kWh):

- Small hydro power, depending upon the amount of electricity fed into the grid: from € 0.0315 to € 0.0568 for existing plants, from € 0.0331 to € 0.0596 for refurbished plants, from € 0.0378 to € 0.0625 for new plants.
- PV: € 0.47 for plants > 20 kW_{peak} € 0.60 for plants < 20 kW_{peak}.
- Wind: € 0.078 for new plants.
- Geothermal: € 0.07.
- Wood chips: € 0.102 to € 0.16.
- Waste with high bio-share: € 0.027 to € 0.128.
- Co-firing in fossil fuel plants: € 0.03 to € 0.065.
- Biofuels: € 0.10 for plants > 200 kW, € 0.13 for plants < 200 kW.
- Biogas: € 0.0725 to € 0.165.
- Landfill gas: € 0.03 for plants > 1 MW, € 0.06 for plants < 1 MW.

Energy Policy Context

An Eco-tax on oil products was introduced in 1995, and a tax on gas and electricity in 1996. The goal of the tax was to raise revenue, not to affect patterns of energy consumption. In 2000, the tax on gas and electricity was doubled. The competitiveness of biomass improved relative to alternative fuels due to the tax. Biodiesel was largely exempt from the mineral oil tax in the 1990s and received a total exemption starting in 2000.

Renewable Energy Markets

Biomass Electricity Production

Figure 6. **Solid Biomass Capacity and Electricity Production**

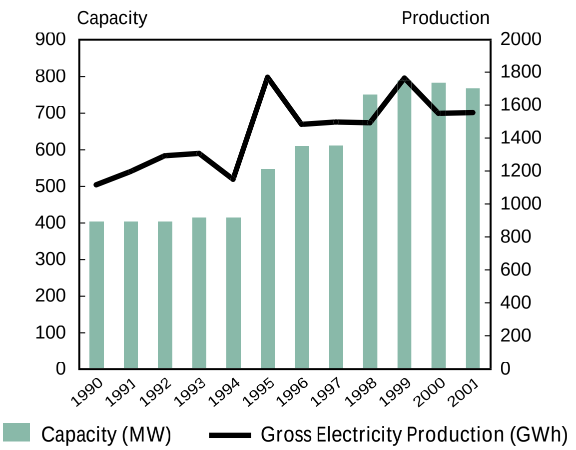
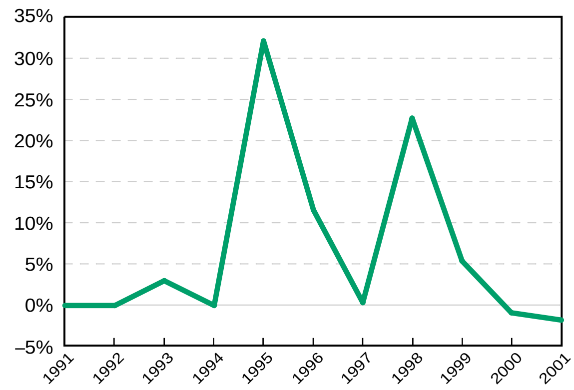
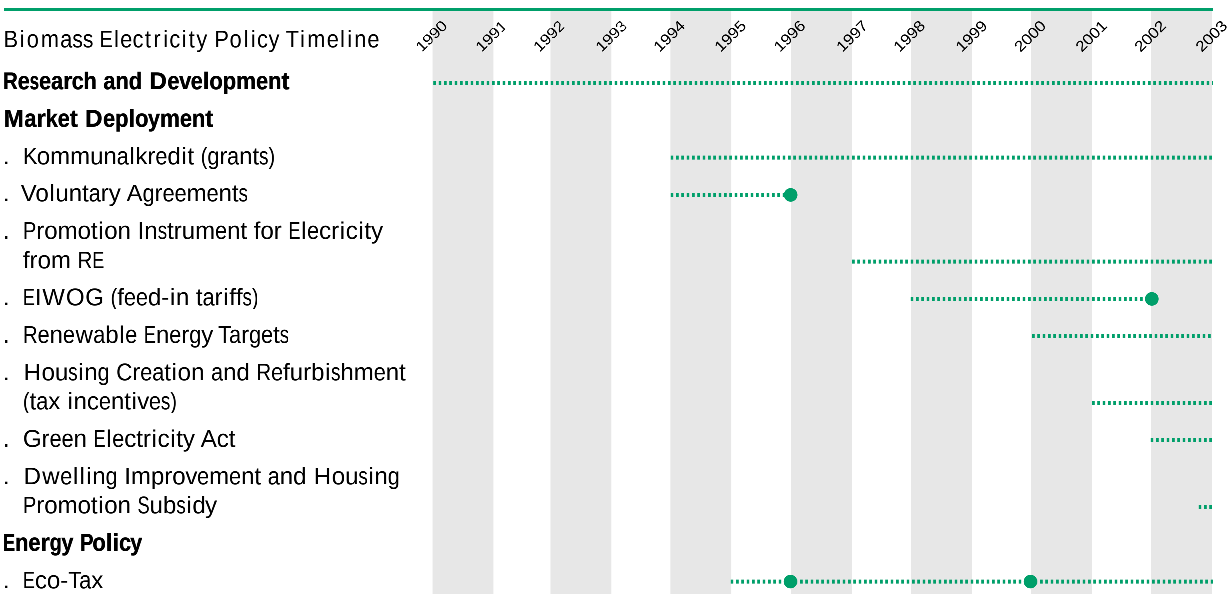


Figure 7. **Solid Biomass Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

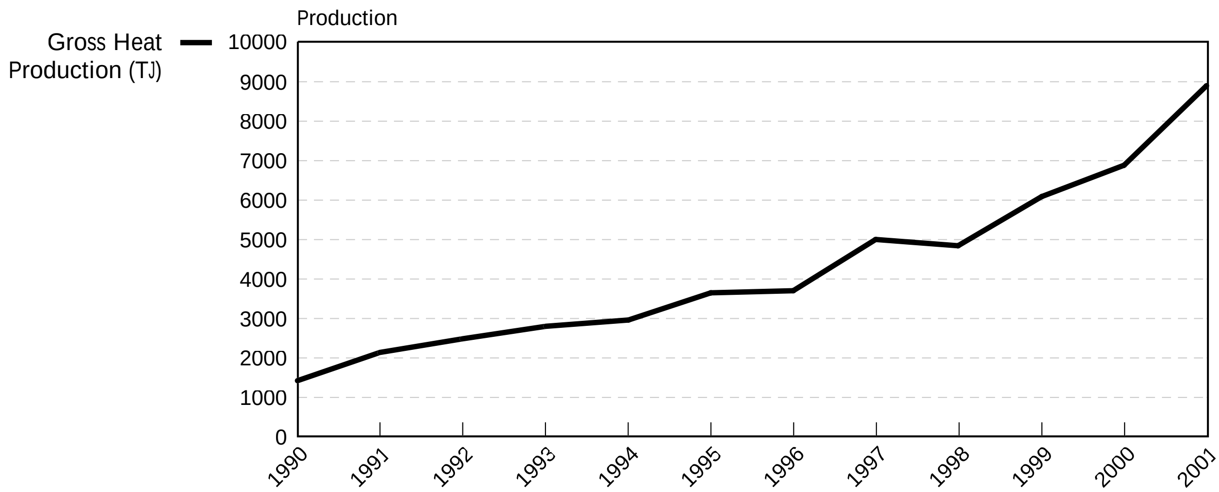
Solid biomass accounted for some 3.5% of total electricity generation from renewables in 2001. Net generating capacity of solid biomass increased from 400 MW in 1990 to 766 MW in 2001. Generation grew from 1 116 GWh in 1990 to 1 552 GWh in 2001, an average annual growth of more than 3%.

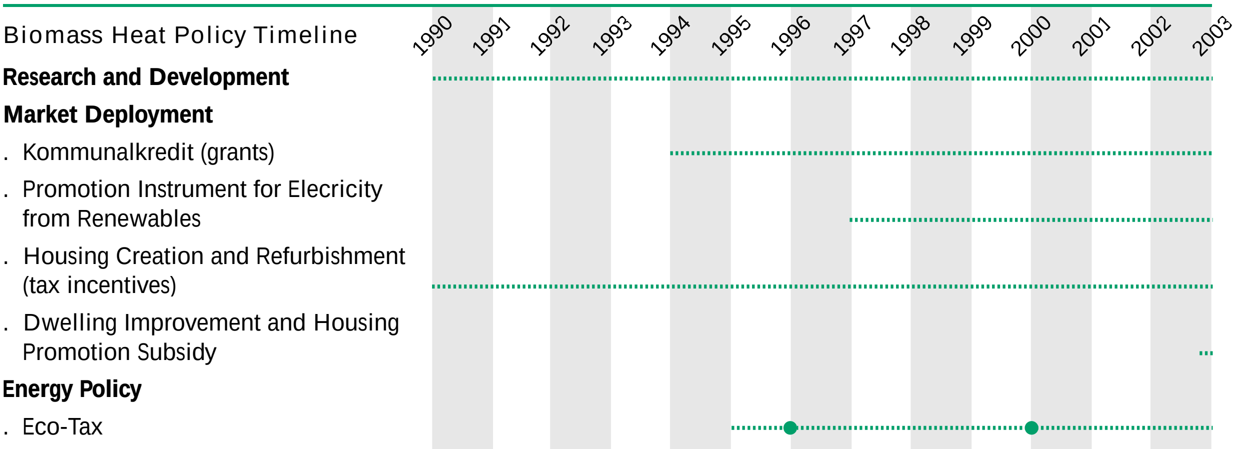
Electricity generation from biomass has experienced two market spurts in the last decade, in 1994 and 1998. The 1994 increase coincided with the introduction of a guaranteed market through a voluntary agreement between the Ministry of Economic Affairs and the Association of Electric Utilities. Under this agreement, 20% of the delivery price for biomass was supplied for a period of three years. The 1998 increase is ascribed to the combination of a tax on gas and electricity in 1996 and the implementation of the Promotion Instrument for Electricity from Renewables in 1997 which provided both a capital incentive and a guaranteed tariff for renewable electricity fed into the grid.

The Green Electricity Act of 2002 was very effective in stimulating a significant number of major biomass co-generation plants, especially in the wood products industry.

Biomass Heat Production

Figure 8. **Solid Biomass Heat Production**





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Heat production from solid biomass increased from 1 404 TJ in 1990 to 8 874 TJ in 2001, an average annual growth of 18.3%. The widespread use of biomass for heat in Austria has traditionally taken the form of heating using traditional wood stoves. Although the use of traditional wood stoves has declined and continues to do so, and the use of biomass has diversified, approximately 60% of heat consumption from biomass is still used for rural space heating. The remainder is used in the pulp and paper industry, particularly black liquor, process heat applications in the sawmill industry (wood drying), district heating facilities and, to a lesser extent, waste incineration plants.

During the 1980s, biomass received an important stimulus through federal, state and local support of Biomass District Heating Plants (BMDH), a heating scheme for rural villages. State support has been provided through financial incentives and the establishment of organisations dedicated to the management of BMDH. In 2001, there were 694 biomass district heating plants with 822 MW of installed capacity.

Through significant RD&D efforts, new fully automatic pellet-fired boilers have been developed and introduced into the market, reviving the use of biomass for domestic space heating. This successful market introduction was based on very attractive products, high consumer interest and grants of 20% to 30% of investment costs. New heating systems entering the market are subject to a licensing procedure by authorised testing institutions. These institutions publish the test results, which has created a competitive market for high-quality boilers resulting in considerable progress in combustion and control technology.

In the early 1990s, the federal governments of Upper Austria, Salzburg, Lower Austria and Styria, in co-operation with the authorised testing institution put forth a competition “Small Scale Wood Heating Systems”. Austrian developers and producers of small-scale biomass heating systems were challenged to develop marketable biomass heating systems of less than 15 kW.

A tax introduced on oil products in 1995 and on electricity and gas in 1996 has also spurred the biomass market by increasing the competitiveness of biofuels relative to oil. The 1997 Promotion Instrument for Electricity from Renewables included incentives for biomass heating plants.

In 2001, the Housing Creation and Refurbishment Law provided tax incentives for the purchase of biomass systems for heating. This incentive scheme was redesigned in the Dwelling Improvement and Housing Promotion Subsidy in 2003. The new incentives were significantly more effective and proved to be extremely efficient in the province of Salzburg, where more than 50% of all newly constructed houses were heated with biomass and solar energy in 2003. In most other provinces the level of subsidy is based on homeowners’ efforts to improve energy efficiency and to use renewable energy for heating and hot water demand. Styria, in principle, has excluded subsidies for new houses that use fossil fuels for heating.

Wind Power

Wind power plants produced 0.3% of total electricity generation in Austria in 2001, and 0.4% of generation from renewables. Generation capacity was 69 MW in 2001 and electricity generation was 172 GWh. Growth in wind power accelerated in the late 1990s, with average annual growth of 56% from 1998 to 2001. According to Austrian statistics, at the end of 2002, 422 grid-connected wind turbines with an installed capacity of 139 MW and annual electricity production of 179 GWh were in operation.

Wind power has been the target of recent policies to stimulate electricity production from renewable energy sources. A voluntary agreement between the Ministry of Economic Affairs and the Association of Electric Utilities provided 100% of the delivered price of wind power for a period of three years. The voluntary agreement was followed by the establishment of minimum quotas facilitated by feed-in tariffs through EIWOG in 1998, replaced in 2002 by the Green Electricity Act. These policies appear to be having a positive impact, as wind growth has been consistent over the past couple of years.

Figure 9. **Wind Power Capacity and Electricity Production**

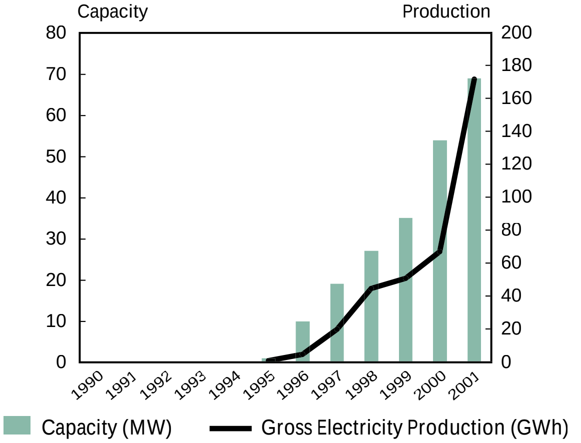
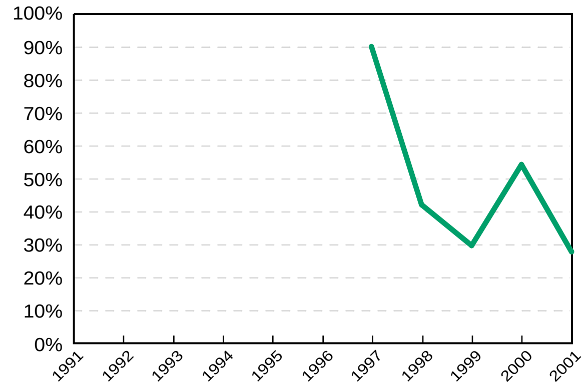
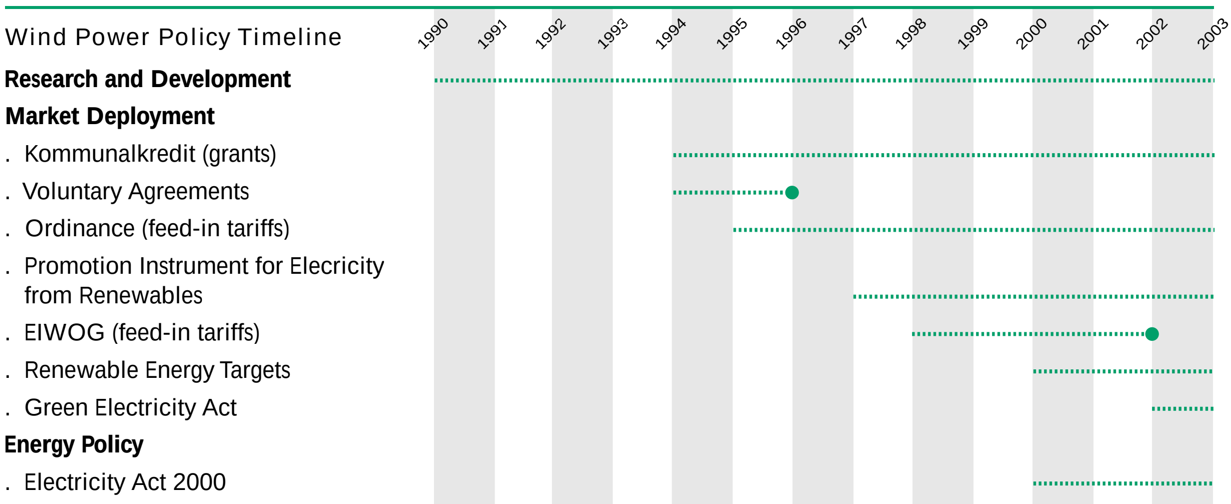


Figure 10. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Solar Thermal Production

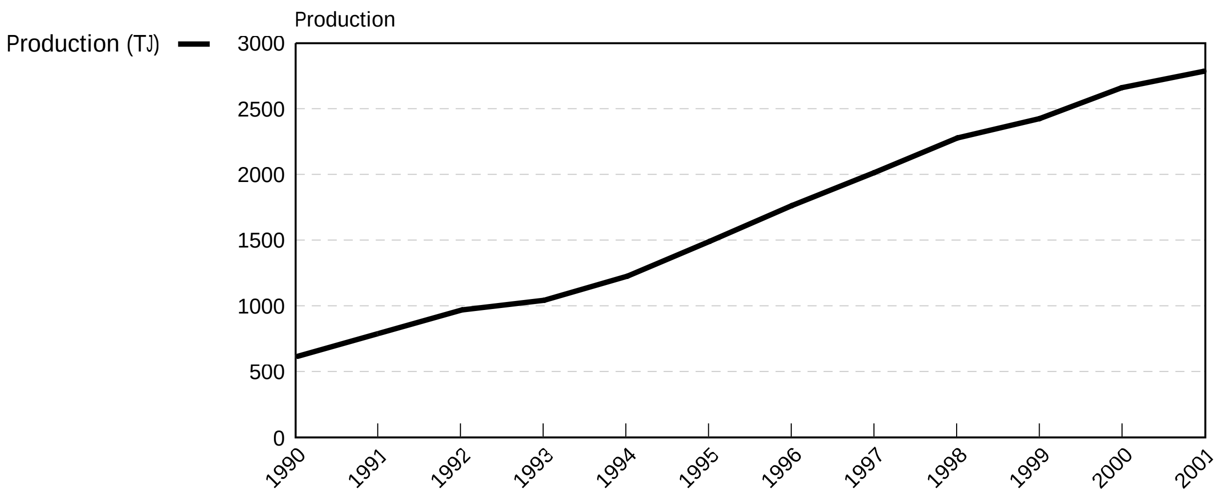
Solar thermal production increased from 621 TJ in 1990 to 2 785 TJ in 2001. In 2002, there were 2 535 million m² of installed solar collectors in Austria, of which 2 500 were in operation: 24% for swimming pool heating; 75% for water and space heating and 1% for drying biomass products. The development of large-scale collectors with up to 15 m² absorber areas has greatly reduced the cost of collectors in Austria.

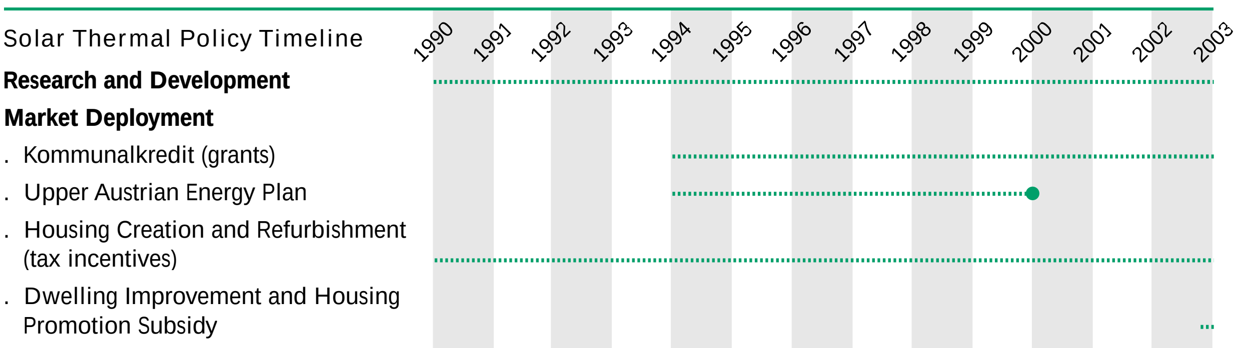
The successful deployment of solar thermal technologies in Austria is illustrated by its high panel surface per capita levels, the highest in the EU. New installations between 1987 and 1997 totalled 100 000 units. A combination of policies and financial incentives has been the basis for this rapid growth.

In 1994, the Upper Austrian Energy Plan established a target to increase the use of renewable energy in the region. As a result, by 2000 more than 500 000 m² of thermal solar collectors had been installed for space and water heating, mainly in residences. The region also had about 0.4 m² of installed solar collectors per inhabitant, one of the highest densities of solar collectors per capita in Europe. Tax deductions are offered under the Housing Creation and Refurbishment Act.

The rapid market deployment of solar thermal production is also a result of continuous and intensive RD&D efforts.

Figure 11. **Solar Thermal Production**





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Solar Photovoltaic

Solar PV capacity in 2001 was 7 MW. The first systems were introduced in the early 1990s and market growth was slow. Substantial recent support for PV has spurred rapid growth over the past couple of years. According to Austrian statistics, at the end of 2002, photovoltaic systems with a total capacity of about 10.8 MW were in operation, producing an annual output of about 7 634 MWh. Most PV systems (82%) were connected to the grid and 18% were stand-alone systems for different applications.[1]

Support for solar PV started in 1992 when the Austrian Ministry of Economic Affairs (MEA) launched the Solar Energy Programme for electric vehicles and for decentralised PV systems. The programme subsidised approximately 100 small residential grid-connected systems with funding from utilities and government

1.Growth in the capacity of grid-connected PV systems over the past decade was dramatic, from 348 kW in 1993 to 8.8 MW in 2002, an average annual rate of 43%. (Source: Gerhard Faninger, IFF-Universität Klagenfurt and Bundesverband Photovoltaik Österreich).

that covered about 58% of the investment costs. The total installed capacity was 203.6 kW and the average capacity was 2.28 kW. Average system costs were approximately € 17 800.

The Solar Energy Programme also provided capital subsidies for electric vehicles. The combination of both policies resulted in the installation of about 400 kW of PV by the end of 1994 and put in operation 200 electric cars by the end of 1995.

The photovoltaic market experienced annual growth of 26% between 1996 and 2000 attributable to general renewable energy policies such as the MEA voluntary agreement with the utilities. This agreement provided 100% of the delivered price of PV power for a period of three years. EIWOG established minimum quotas facilitated by feed-in tariffs in 1998, replaced in 2002 by the Green Electricity Act. The maximum capacity covered by the feed-in tariffs is 15 MW. This capacity limit and the feed-in tariff are believed to be responsible for the surge in PV installations in 2002. The number of installations in 2003 is estimated to have been even greater. The latest tariff was introduced on 1 January 2003 and by the middle of the month all of the eligible systems were recognised by the authorities as “eco-energy plants”. The systems must be installed by mid-2006.

Figure 12. **Solar Photovoltaic Capacity and Electricity Production**

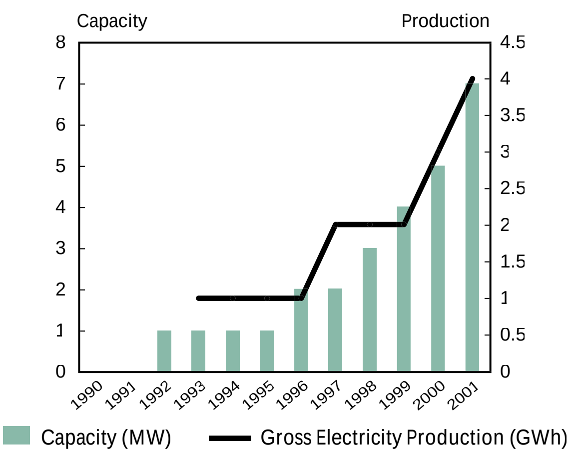
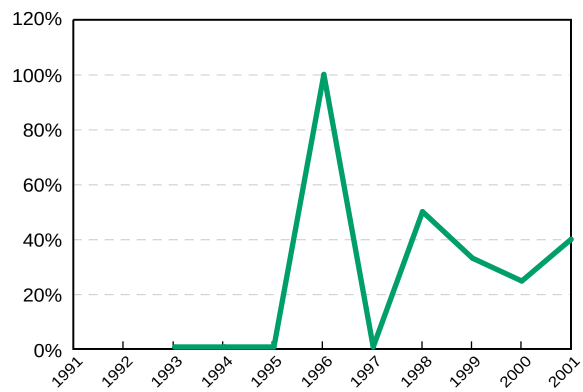
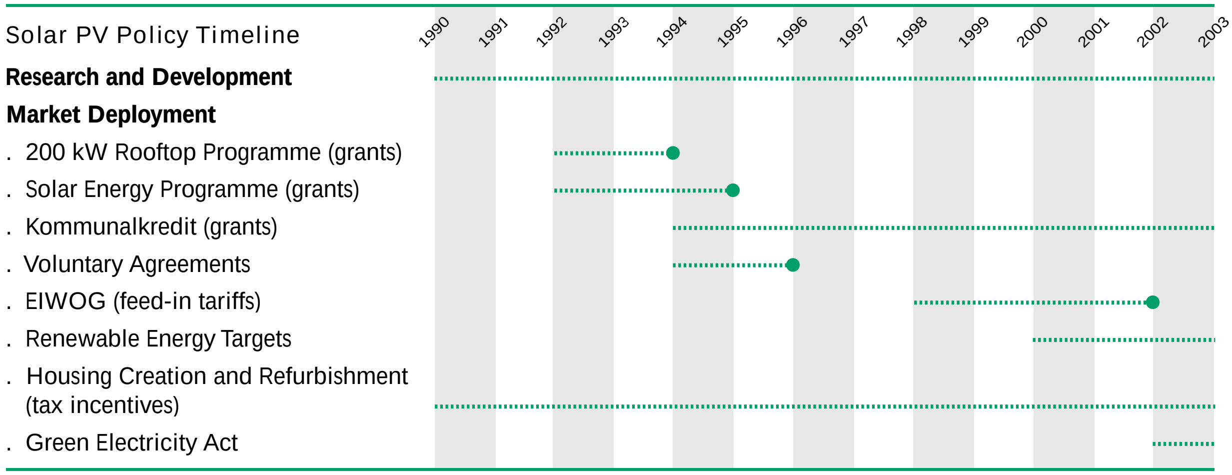


Figure 13. **Solar Photovoltaic Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Austria Policy Chronology

Solar Energy Programme

Year 1992-1995

Policy Description The Solar Energy Programme provided capital subsidies for PV systems and electric vehicles. The programme was financed by utilities, federal and provincial governments. Of the total subsidies disbursed under this program, it is estimated that ATS 2 million were used for electric vehicles. 200 were in operation by the end of 1995. The programme subsidised approximately 100 small residential grid-connected systems with funding from the utilities and government. The total installed capacity was 203.6 kW and the average capacity 2.28 kW. Average system costs were approximately € 17 800. Approximately 58% of investment costs were subsidised by authorities and electric utilities. Only around 400 kW of PV had been installed by the end of 1994.

Policy Type Capital grants

RE Technology Solar photovoltaic

Environmental Protection Law

Year 1993 - Present

Policy Description As the EIWOG scheme of feed-in-tariffs only affected production of electricity, this policy provided investment incentives to the heat producing part of a plant. Incentives for electricity production are granted only if a plant exceeds state of the art technology.

Incentives are granted at between 10% and 30% of eligible costs depending on the type of investment with the objective of stimulating innovative technology.

Policy Type Capital grants

RE Technology All renewables

Upper Austrian Energy Plan

Year 1994-2000

Policy Description In 1994, the Upper Austrian Energy Plan established targets to reduce fossil fuel consumption, improve energy efficiency and increase the use of renewable energy in the region. These targets, which were met, included reducing domestic energy use by 20% and increasing the proportion of energy provided from renewable sources to 30% by 2000. The Upper Austrian Energy Agency has been one of the main promoters of actions to achieve these targets, and has been very successful through a combination of support measures from both national and local sources, combined with a high level of information dissemination activities to raise awareness in the region.

More than 500 000 m^2 of thermal solar collectors had been installed in Upper Austria by 2000 as a result of the energy plan. They are used for space and water heating, mainly in residences. By 2000, the region had about 0.4 m^2 of installed solar collectors per inhabitant, one of the highest densities of solar collectors per capita in Europe. Similar initiatives are being implemented in other Austrian regions, supported through local or regional energy plans.

Policy Type Obligations

RE Technology Solar thermal

Kommunalkredit

Year 1994 - Present

Policy Description Federal grants and incentives for renewable energy producers such as firms, associations and public entities are administered primarily by the Kommunalkredit. These federal grants typically constitute 30% of eligible costs and are granted to entrepreneurs investing in small hydro plants, modern biomass-based heating systems which include small networks for district heating, biogas, sewage gas, geothermal systems, heat pumps, solar thermal above 10 m^2, photovoltaic and wind installations. These grants can also be combined with financial support from the Länder to cover 66% of costs.

Policy Type Capital grants

RE Technology All renewables

Voluntary Agreement between Ministry of Economic Affairs and Association of Electricity Utilities

Year 1994-1996

Policy Description This voluntary agreement provided subsidies of 100% of the delivered price for PV and wind power, and 20% of the delivered price for biomass and biogas for a period of three years for renewable electricity systems installed before the end of 1996. Since the programme ended in 1996, the payment of higher buy-back rates at these levels ceased at the end of 1999.

Policy Type Guaranteed prices/feed-in tariff

RE Technology Onshore wind
Solar photovoltaic
Biomass
Biofuel

Eco-Tax

Year 1995 - Present

Policy Description A modest tax on oil products was introduced in 1995 and a similar tax on gas and electricity in 1996. The goal of these taxes was to raise revenue, not to affect patterns of energy consumption. In 2000, the tax on gas and electricity was doubled for budgetary reasons, without exemption for renewable energy sourced electricity.

The competitiveness of biomass improved due to higher oil prices, so the tax made an economic difference for the biomass sector. Biodiesel differed slightly as it was largely exempt from the mineral oil tax for some time and received a total exemption starting in 2000.

Policy Type Fossil fuel taxes / Excise tax exemption

RE Technology Biofuel
Biomass

Ordinance of the Federal Minister for Foreign Affairs

Year 1995 - Present

Policy Description This Ordinance guarantees minimum prices for electricity that is traded between provinces and has been produced from autoproducer CHP stations and renewable electricity plants. For plants up to 2 MW these prices range from ATS 0.421/kWh to ATS 0.90/kWh (100-125% of the prices charged by the Verbundgesellschaft), depending on the time of delivery. For plants over 2 MW, the rates are 100% of the prices charged by the Verbundgesellschaft, or ATS 0.421-0.72/kWh.

Policy Type Guaranteed prices/feed-in tariff

RE Technology All renewables

RD&D Budget

Year 1995-1996

Policy Description Approximately 25% of Austria's federal energy R&D budget in 1996 was allocated specifically to renewable sources (down from 32% in 1995, but about triple the IEA average). This funding was split 52% for biomass and 27% for solar, with the remainder spent on wind, geothermal and hydro. Biomass funding in 1996 was ATS 50 million and included projects on the direct use of biomass (*e.g.*, by improving wood-burning stoves), as well as the production of liquid biofuels. Solar research was directed predominantly towards heating and cooling, and photovoltaics.

Policy Type RD&D

RE Technology All renewables

Promotion Instrument for Electricity from Renewables

Year 1997 - Present

Policy Description The Promotion Instrument for Electricity from Renewables (PIER) provides both a capital subsidy and a guaranteed tariff for renewable electricity fed into the grid and RD&D measures as incentives for renewable electricity generation. Projects are selected through a public competitive tender procedure where subsidies are awarded based on lowest capital cost for each technology type. The capital subsidies are capped at 7% rate of return for fifteen years. In addition, electricity from these systems benefits from a guaranteed market at a guaranteed buy-back rate for fifteen years.

Capital investment subsidies for biomass, for example, were disbursed through the District Heating Promotion Act (ended in 1996). Biomass subsidies totalled ATS 192.4 million (in 1997, 1 US$ = 12.2 ATS) in 1996 and ATS 142.8 million in 1995. These funds were disbursed via two programmes including incentives for biofuel production and the District Heating Promotion Act.

Capital subsidies of 8% are available for the construction, restoration or enlargement of small (0.5-10 MW) hydro systems, and subsidies of up to 25% are available for micro hydro (< 0.5 MW) systems that are both remote and environmentally friendly. In addition to federal promotional measures, provincial authorities may also provide subsidies or favourable loans for biomass heating plants.

Policy Type Guaranteed prices/feed-in tariff / Capital grants

RE Technology All renewables

Electricity Act 1998

Year 1998-2002

Policy Description The Electricity Act 1988 (EIWOG) put into place feed-in tariffs to stimulate electricity production from green power producers. The EIWOG obliged system operators to purchase renewable electricity offered by independent power producers and to pay minimum feed-in tariffs. These tariffs were defined by each of the nine provinces and thus differed. The feed-in tariffs differed according to technology, type and duration of contract, time of feeding in the electricity by season and time of day. Provinces set tariff levels, quota levels and conditions.

Policy Type Guaranteed prices/feed-in tariff

RE Technology Biomass
Geothermal
Onshore wind
Solar photovoltaic

Renewable Energy Targets

Year

2000 - Present

Policy Description

One of the measures introduced by the Energy Liberalisation Act in July 2000 (Electricity Act 2000) is the obligation to purchase green power and to reach minimum “eco-targets.”

Distribution system operators are required to purchase electricity from recognised eco-plants up to a certain share of their electricity sales to final consumers (shares are to be at least 1% in 2001; 2% in 2003; 3% in 2005 and 4% in 2007). Purchase prices are regulated. The grid operators can resell these amounts of electricity to final consumers or to electricity traders. If the minimum percentage amount is exceeded, the grid operator can sell the excess amount to other operators of distribution grids.

Qualifying eco-plants include wind, PV, geothermal, biomass, biogas, digester and sewage gas, as well as co-firing and multi-fuelled plants using a high proportion of biofuels, and combustion of wastes containing a high percentage of bio materials. The final decision on qualification is made by the provincial governments.

The eco-electricity market is monitored by Elektrizitats-Control GmbH. An equalisation levy is imposed on the grid operators unable to prove the required share of eco-electricity.

Policy Type

Obligations

RE Technology

Biofuel
Biomass
Geothermal
Offshore wind
Onshore wind
Solar photovoltaic
Waste

National Climate Strategy

Year

2000 - Present

Policy Description

The Austrian government is elaborating the National Climate Strategy based on a 1999 study, which is in the last stage of consultation with relevant stakeholders. The Climate Strategy consists of seven packages of measures (space heating/private consumption, electricity and heat production, transport, industry, waste management, agriculture and forestry, and other greenhouse gases).

Policy Type

Regulatory and administrative rules

RE Technology

All renewables

Labelling of Electricity Bills

Year 2000 - Present

Policy Description According to the Energy Liberalisation/Electricity Act 2000, electricity suppliers in Austria are required to show the primary energy mix used to generate the electricity they supply on their customers' electricity bills. Provincial governments are responsible for ensuring that this information is correct. In case of incorrect specifications, administrative fines are implemented; in case of repeated infractions the party will lose its right to supply. However, electricity suppliers have the option to show the average European energy mix used on the bills instead of the actual domestic energy mix.

Policy Type Public awareness

RE Technology All renewables

Federal Environment Fund

Year 2000 - Present

Policy Description The Federal Environment Fund is enabled to fund environment projects with a total budget frame of more than € 40 million annually. Over the past years, increasing priority has been given to projects related to climate change. In 2000, 70% of the funding was dedicated to projects with direct implications for GHG emissions, and that share will be extended. For the budget periods 2001 and 2002, the total budgetary frame has been increased to reach € 40 million and € 47 million, respectively, after an average of € 36 million during past years. All additional funding (€ 15 million for both years) will be channelled to climate change purposes. Over the past years, funding focused on biomass and biogas district heating, entrepreneurial biomass central heating systems, solar panels and energy efficiency measures, small hydro and wind power stations and thermal renovation of entrepreneurial buildings. Since the Austrian Electricity Law stipulates that feed-in tariffs have to be set at figures that make the production of electricity from renewable sources competitive, the Federal Ministry of Environment is planning to phase out subsidies for those technologies.

Policy Type Tradable certificates

RE Technology Hydro

Eco-Plants Feed-In Tariffs

Year 2001 - Present

Policy Description According to the Electricity Act 2000, the provincial governments set minimum prices (feed-in tariffs) for energy purchased by grid operators from plants recognised as eco-plants. These prices are based on the average cost of generating electricity from these plants, including the value of electricity used, as well as past or on-going subsidies.

If the expenses from purchasing the electricity at fixed tariffs exceed the revenue from sales, the grid operator will be reimbursed for the balance between the minimum of purchase price and the proceeds achieved. The required sums are raised by a surcharge on the network tariff (paid by the consumer) which is set by the provincial government. This surcharge is set annually on the basis of the additional expenses incurred in the previous year.

Only the Province of Vorarlberg introduced new feed-in tariffs. Valid from 1 October 2001 the tariffs in ATS per kWh were:

- Solid biomass: from 1.3 to 1.8 for existing plants; 1.3 - 2.2 for new plants.
- Liquid biomass: 1.7 for existing plants, 2 for new plants.
- Biogas: 1.2 -1.55 for existing plants, 1.71 -2.2 for new plants.
- Wind: 1.5 for new plants.
- PV: 7 for existing plants, 5 -10 for new plants, depending on capacity.

The equalisation levy for eco-electricity is ATS 1.59/kWh. The surcharge on the network tariff is Gr 1.11/kWh (ATS 0.008/kWh)

Policy Type Guaranteed prices/feed-in tariff

RE Technology Biomass
Onshore wind
Offshore wind
Solar photovoltaic

Trading of Small Hydropower Certificates

Year 2001 - Present

Policy Description Green certificate trading was introduced by the Electricity Act 2000. Electricity suppliers based in Austria have to include 8% of electricity generated by domestic small-scale hydropower plants in the energy sold to final customers. Final customers purchasing electricity directly from foreign suppliers are required to prove that 8% of the electricity they consume is generated by domestic small-scale hydropower plants.

“Small-scale hydropower certificates” are used as proof. Hydropower plants with a maximum capacity of up to 10 MW are designated by the provincial government, entitling their operators to issue such certificates. The designations are notified to Electrizitats-Control GmbH. Small-scale hydropower certificates are in units of 100 kWh. They have to be authenticated by the grid operator of the respective plant. The system is electronic and is monitored by Elektrizitats-Control GmbH. Certificates can be banked for up to two years. In the case of non-compliance, an equalisation levy is imposed upon electricity suppliers and final customers by the provinces.

Policy Type Tradable certificates

RE Technology Hydro

Climate Strategy 2010

Year 2001 - Present

Policy Description The burden-sharing agreement within the EU to meet Kyoto commitments requires Austria to reduce its greenhouse gas emissions by 13% below 1990 figures by the 2008-2012 period. Against this background the Federal Ministry of Agriculture, Forestry, Environment and Water Management in co-operation with the relevant ministries, unions and the Länder developed a strategy to meet the target. "Climate Strategy 2010" contains packages of measures for seven areas (room heating and other small consumers; electricity and heat production; waste management; mobility; industry, agriculture and forestry and other gases) and aims to achieve an annual reduction of more than 17 million tonnes of CO_2-equivalents.

Policy Type Regulatory and administrative rules

RE Technology All renewables

Third-Party Financing for Public Buildings

Year 2001 - Present

Policy Description The federal government launched this Programme on Third-Party Financing (contracting) in energy-saving investments for federal public buildings in 2001. It is assumed that around 20% of federal buildings (representing 50% of heated space in federal buildings) are eligible for typical energy-saving contracting, in which measures and investments with relatively short payback periods can be undertaken by a third party (a "contractor").

Public high schools have been most affected by this measure. In a pilot programme in Vienna, energy standards for 46 schools have been substantially improved. There are plans for the general renovation of 20% of federal buildings within the next ten years, although through a differentiated model of "guaranteed energy savings" rather than a typical third-party financing. The initiative may have the potential to accelerate growth in the contracting market to also effect municipal and private service-sector buildings. This initiative is expected to result in an annual total reduction in CO_2 emissions of 70 000-100 000 tons by 2012.

Policy Type Third-party finance

RE Technology All renewables

Pact on Tax Revenue Sharing

Year 2001 - Present

Policy Description This new pact on tax revenue sharing between the Federation, the Länder and the municipalities, allows more flexibility for housing support schemes. The Federal Act on Revenue Sharing now explicitly suggests spending part of the funds for greenhouse gas (GHG) mitigation measures. The Länder receive a total of € 1.78 billion annually from the Federation under the title of "housing support." Although that money can also be spent for purposes other than housing (on improving infrastructure, for example). The GHG mitigation effect from housing support schemes therefore largely depends on specific political intentions followed by the individual Länder. The conferences of the environment and finance ministers of the Länder governments have declared their political willingness to spend a relevant part of the money for climate change purposes in order to achieve the targets indicated in the Austrian Climate Strategy 2010.

Policy Type Obligations

RE Technology All renewables

Housing Creation and Refurbishment

Year 2001 - Present

Policy Description The personal income tax law specifies a variety of special expenses, for example the purchase of solar and biomass technologies for residences, that can be deducted from income. This is capped at € 2 920 per year for ordinary tax payers. An additional deduction of € 2 920 for single income households, and € 1 460 is granted if there are at least three children. Only 25% of the amount may be deducted from the income.

Policy Type Tax exemptions

RE Technology Biomass
Solar photovoltaic
Solar thermal

Green Electricity Act

Year 2002 - Present

Policy Description In 2002, the National Council and Federal Council passed the new Green Electricity Act. The main content of the EU Directive from October 2001 has been implemented and the proportion of energy generated from renewable energy sources increased. The Green Electricity Act governs the aid for green energy and combined heat and power generation throughout the country. Through this act, fees for eco-power, which vary from state to state, will be replaced with a uniform fee for power generated by combined heat and power plants, renewable sources and small hydro power plants. The total cost of aid for green energy, following a nation-wide attainment of the goal, is much lower than it would have been for attaining the objective individually in each federal state. The supply tariffs for the green plant operators are the same throughout Austria. The government support renewable generation plants with a maximum € 275 million per year, down from € 400 million per year.

The objectives set out in the Green Electricity Act are to generate 9% of electricity from small-scale hydroelectric plants and 4% from eco plants. This is to be achieved by providing aid in the form of supply tariffs until 2008 so that the overall objective of 78.1% of electricity from renewable sources can be reached (the rest being generated from large-scale hydro).

Other changes include:

- The certificate system for small-scale hydroelectric power stations expired at the end of 2002.
- As of 1 January 2003, there was no longer a quota obligation for the network operators and no compensation payments.
- All operators of green plants have the right to a listing of the certification of origin by the network operators.
- The electricity identification system, which specifies the source of energy used for electricity generation on consumer bills, will be standardised after a transitional period up to 1 July 2004 and then all electricity suppliers must identify a standard composition on consumer bills ("standard dealer mix").

The Act guarantees payment of feed-in tariffs for thirteen years at the following rates (per kWh):

- Small hydro power, depending upon the amount of electricity fed into the grid: from € 0.0315 to € 0.0568 for existing plants, from € 0.0331 to € 0.0596 for refurbished plants, from € 0.0378 to € 0.0625 for new plants.
- PV: € 0.47 for plants > 20 kWpeak, € 0.60 for plants < 20 kW_{peak}.
- Wind: € 0.078 for new plants.
- Geothermal: € 0.07.
- Wood chips: € 0.102 to € 0.16.
- Waste with high bio-share: € 0.027 to € 0.128.
- Co-firing in fossil fuel plants: € 0.03 to € 0.065.
- Biofuels: € 0.1 for plants > 200 kW, € 0.13 for plants < 200 kW.

-

- Biogas: € 0.0725 to € 0.165.
- Landfill gas: € 0.03 for plants > 1 MW, € 0.06 for plants < 1 MW.

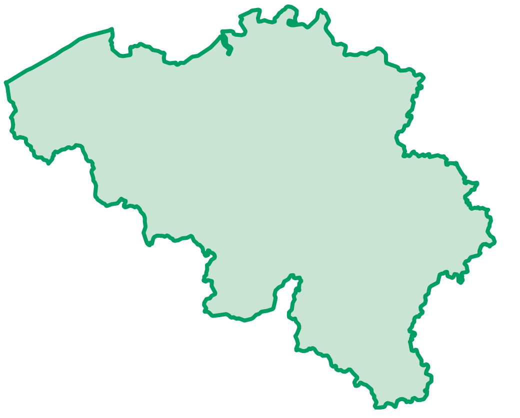
Policy Type Obligations / Tradable certificates / Guaranteed prices/feed-in tariff

RE Technology All renewables

Dwelling Improvement and Housing Promotion Subsidy

Year	2003 - Present
Policy Description	The redesign of existing subsidy schemes for construction of housing (responsibility of provinces) has been one of the most successful policy measures to promote renewable energy use by households. In the province of Salzburg in 2003 more than 50% of newly constructed dwellings were heated with biomass and solar. Some have excluded new houses from subsidies that do not use renewable energy for heating.
Policy Type	Consumer grants/rebates
RE Technology	Biomass heating Solar thermal

Belgium



Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

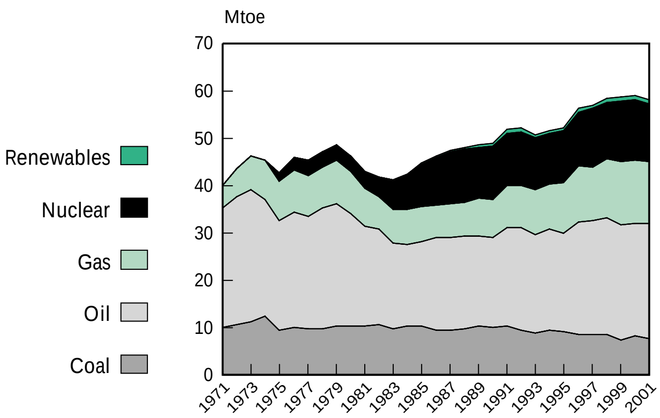
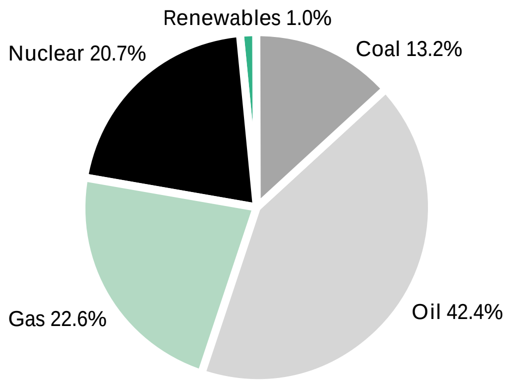


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1.
See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	**1970**	**1980**	**1990**	**1995**	**2000**	**2001**	**Imports**
Coal	12.3	10.5	10.2	9.1	8.4	7.7	100.0%
Oil	24.4	23.6	18.7	21.0	23.8	24.3	100.0%
Gas	3.4	8.9	8.2	10.6	13.4	13.2	99.6%
Nuclear	0.0	3.3	11.1	10.8	12.6	12.1	-
Renewables	0.0	0.1	0.6	0.7	0.6	0.6	-
Biomass	*0.0*	*0.1*	*0.6*	*0.7*	*0.5*	*0.6*	
Hydro	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Total	**40.2**	**46.1**	**48.7**	**52.6**	**59.3**	**59.0**	**88.2%**
% Renewables	*0.1%*	*0.2%*	*1.3%*	*1.3%*	*1.0%*	*1.0%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*

In 2001, TPES was 59 Mtoe, a 21% increase over its 1990 level. TPES increased on average by 1.6% per year from 1990 to 2001. Energy supply in Belgium in 2001 was mainly oil (41%), followed by natural gas (22%) and nuclear (20%). Coal (13%) and renewable energy sources (1%) also contributed (Table 1). The share of oil in TPES decreased significantly from 61% in 1970 to 38% in 1990. An increase in consumption in the transport sector in the 1990s, however, reversed this trend, and the share of oil in TPES was 41% in 2001. With few indigenous energy resources, more than 88% of Belgium's total energy supply is imported. Nuclear has progressively replaced domestic coal supply, and the use of indigenous coal was phased out by 1993. Prompted by the first oil price shock, nuclear power was introduced in 1975, but, it is scheduled to be phased out from 2014, when the first plants will be 40 years old.

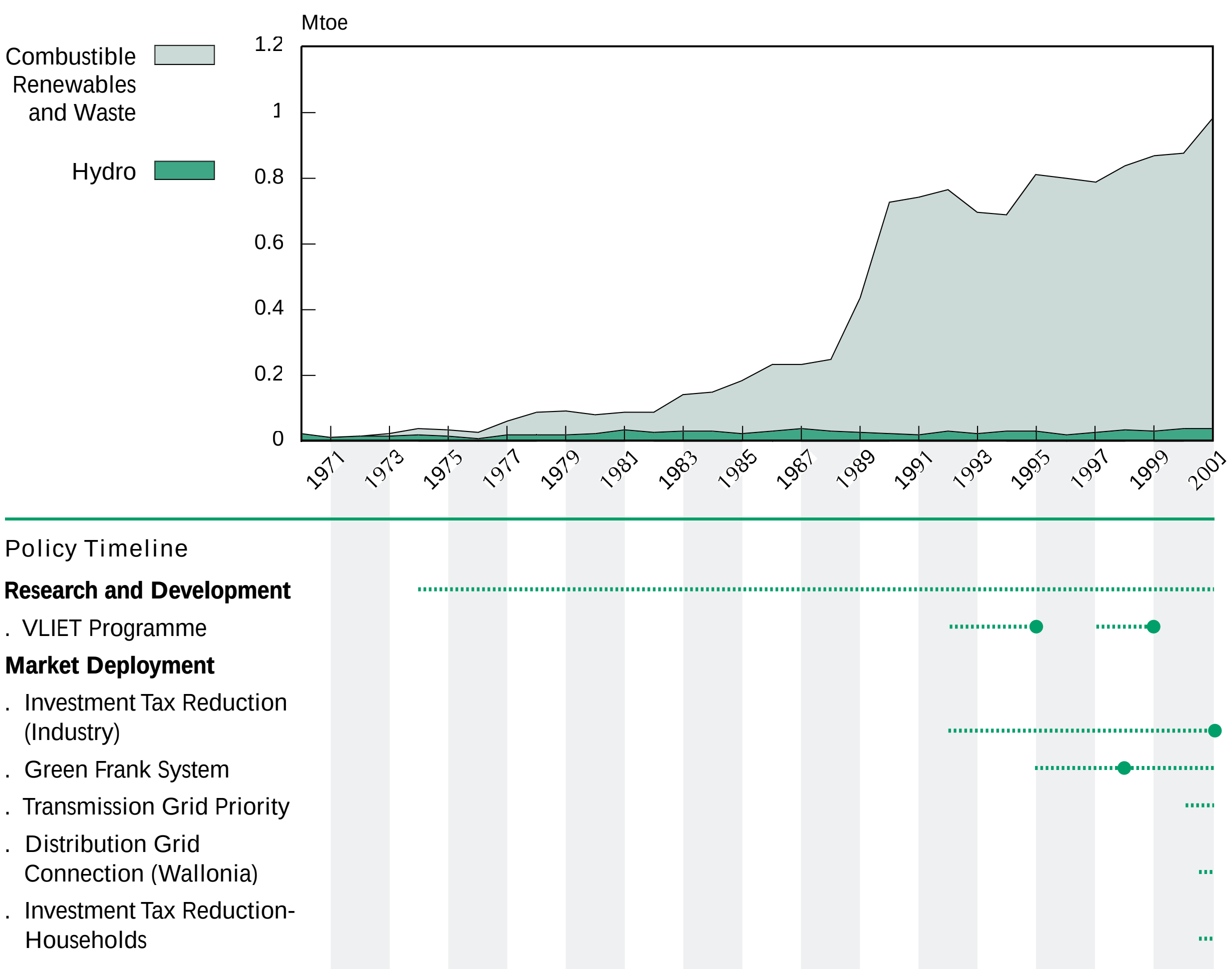
Renewables supply was relatively constant at 0.6 Mtoe during the 1990s. However, its share in TPES decreased from 1.3 in 1990 to 1.0% in 2001. The composition of renewables has not varied much between 1990 and 2001. In 1990, biomass was by far the most important renewable source, and, in 2001, it accounted for 92.8% of total renewable energy supply, followed by hydropower with 6.3%. The remaining 0.9% was primarily wind and solar energy.

In 2001, electricity consumption was 78.6 TWh, up 13.5% from its 1990 level. Nuclear power dominated total gross electricity generation, accounting for 58%, followed by gas (20%), coal (16%) and oil (2%), combustible renewables and waste (2%) and hydropower to 0.6%. The rapid increase of natural gas supply between 1970 and 2001 caused a major change in the generation fuel mix.

In addition to the environmental and local development benefits of renewables, they also have the potential to improve the trade balance, as Belgium imports the majority of its energy supply. But renewable energy is expected to encounter obstacles in this small densely populated country. Opposition has already manifested itself through the proposed CO_2 levy, which was proposed ten years ago and has not yet become a reality. The Federal government expects the regulatory framework for renewables to evolve in accordance with the proposed framework at the European level.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Government support spurred rapid growth in the new renewables market, with annual average growth of 16% in wind power capacity and 4% in solar thermal production between 1990 and 2001. Figure 3 indicates that biomass and waste accounted for 93% of total renewable energy supply in 2001, mostly wood and wood waste (~48%), and the biodegradable portion of MSW (~16%). Hydropower (excluding pumped storage) represented almost 4% of total renewable energy supply in 2001. According to Belgian energy experts, renewable waste energy sources contributed a total of 0.6 Mtoe or 1% of TPES, when non-renewable waste incineration is excluded. Small hydro represented 4.7% of total renewable energy generation in 2002, wind 0.7% and solar thermal 0.2%.

Electricity generation from renewables (excluding pumped storage and non-renewable waste) totalled 1.135 TWh in 2002, equalling 1.4% of total electricity generation, according to Belgian authorities.

Small hydro represented 32% of electricity generation from renewables and wind accounted for 5.0%. Belgium's national target as an EU member country is for 6% of electricity output to be based on renewable sources by 2010.

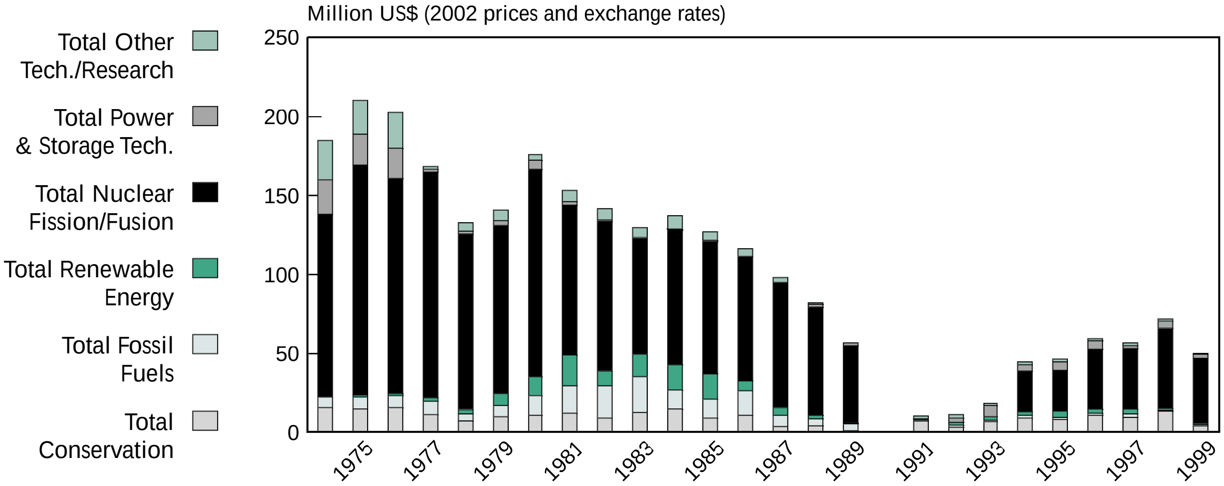
Research and Development Trends

Government energy RD&D budgets in Belgium totalled US$ 2.6 billion (in 2002 prices and exchange rates) between 1974 and 1999. In this period, US$ 135.8 million was allocated to renewable energy RD&D. While overall energy RD&D budgets decreased as a result of general budget cuts, the bulk of the decrease between 1990 and 1993 is attributed to data deficiencies and to a lack of reconciliation between regional and federal RD&D budgets, which occurred during the regionalisation process.

The regionalisation process of 1988 transferred responsibility of Belgian renewable energy policy to the three regional administrations (Flanders, Wallonia, and Brussels). Regional investments in RD&D are partly made through research centres. Together with market deployment policies, regional renewable energy RD&D constitutes the main policy to increase renewable electricity generation.

No RD&D expenditure data are available for Belgium in 1990. Additionally, government energy RD&D expenditures for nuclear research are unavailable between 1990 and 1994. According to Belgian authorities, RD&D budgets actually increased by an additional US$ 8.19 million between 1991 and 1994, with a subsequent increase of US$ 2.02 million between 1991 and 1994 for renewable energy RD&D.

Figure 4. **Belgium** - **Government Energy RD&D Budgets***

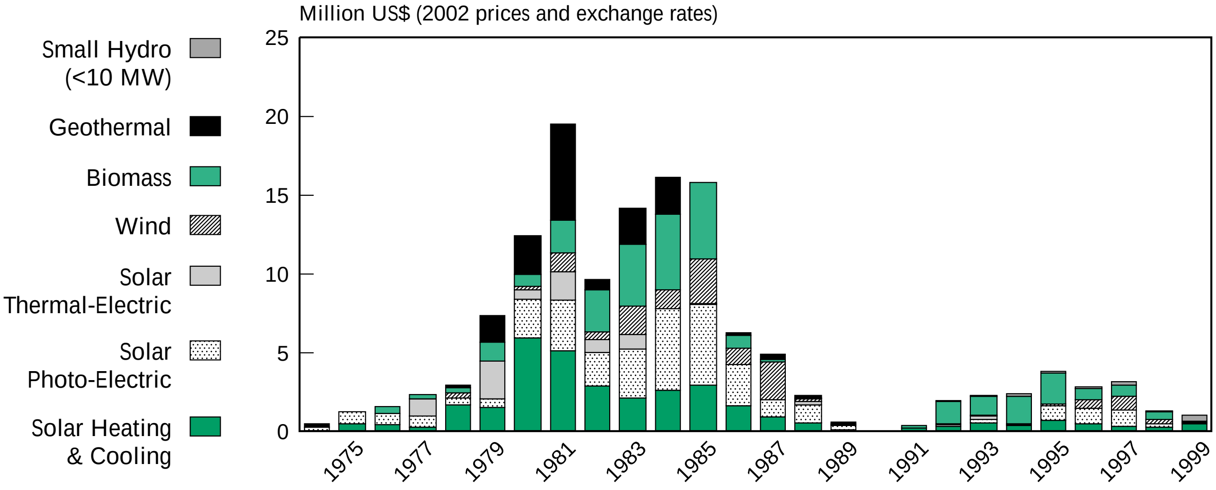


** Data are not available for 1990.*

Government RD&D expenditures for renewables peaked in the early and mid-1980s and then declined in the late 1980s, coinciding with the expansion of nuclear power. Government renewable RD&D expenditures averaged some US$ 2 million throughout the 1990s.

Among the renewable technologies, solar heating and cooling and PV received the highest level of funding. Geothermal was a priority in the early 1980s, but funding decreased significantly in 1985. Solar thermal and PV followed a similar trend although renewed interest, particularly in the Flemish region, brought about new funding, albeit at lower levels. Increased funding was also made available for biomass starting in 1994. Budget outlays for solar heating and cooling were steady over the period.

Figure 5. **Belgium - Government Renewable Energy RD&D Budgets***



** Data are not available for 1990.*

Government energy RD&D expenditures increased after the oil price shocks of the 1970s and focused primarily on nuclear energy and natural gas as substitutes for oil. Federal expenditures specifically targeted nuclear fission (fuels, materials, reactors, waste, safety) and fusion while university laboratories and research centres concentrated RD&D efforts on wind, biomass and solar technologies. Belgium participates in international collaborative RD&D through the Bioenergy and Solar Heating and Cooling IEA Implementing Agreements.

Regional Government Research and Development Trends

The renewables that receive policy attention and the measures implemented vary among regions according to natural resource endowments. Throughout the 1990s, the Flemish region focused the majority of their renewable RD&D activities on solar PV. Flemish RD&D funding for renewable energy, characterized by the VLIET and VLIET bis programmes, provided grants for research projects totalling 50-100% of total costs, although the primary aim was energy efficiency. Development projects were entitled to a refundable loan of 50% of investment costs. Loans were partially converted to grants, with the level depending on the success of the project.

The Walloon region funds research on solar thermal technology, through the Soltherm Programme which commenced in 2000. Biomass also received sustained attention from the RD&D institutions in the Flemish and, especially, in the Walloon region.

Market Deployment Trends

Major policy support for renewables followed the Rio Summit in 1992. The first market deployment strategy was preferential deduction rates for industry. In 2000, market deployment policies were expanded to include the use of economic incentives, regulations, green certificates schemes, and other indirect measures such as information dissemination and training. Federal market deployment activities are currently limited to electricity buy-back, the general structure of electricity tariffs, licences for offshore wind, fiscal deduction rates and minimal guarantees for the regional certificates scheme. All other activities fall under the jurisdiction of the regions.

The preferential deduction rates of 13.5% for industry targeted the use of equipment related to energy efficiency or environmental protection, including the use of renewables. These deduction rates, however, were used only on a very limited scale. The inadequacy of the programmed deduction rates can be explained by both the programmes broad aims and their inability to render renewables attractive relative to other energy sources, which were available at lower costs. Additionally, no effort was made to communicate the fiscal advantages of the preferential deduction rates to industry, even if they were low and provided non-specific renewable support. The Federal Law of 10/08/2001 gave similar support to households but has been used mainly to achieve energy efficiency goals.

In 1995, the Belgian government introduced premium buy-back prices for green electricity to the grid on the recommendation of the Control Committee of Gas and Electricity (CCEG). The 1995 recommendation lacked legal/regulatory support with respect to the conditions applying to electricity producers connected to the grid in cases of (emergency) purchases or sales to and from the grid, so it did not stimulate the renewable energy market. Modified in 1998, the Green Frank System doubled the buy-back prices from € 25 per MWh to € 50 per MWh for wind and small hydro electricity. It has been surmised that this doubling might have been the trigger in the increase in both the wind and small hydro markets, which have still remained far below the market for biomass generated power. Liberalisation of the market, however, led to the dissolution of the CCEG in 2003 and marked the end of the Green Frank, although buy-back prices expire only after a ten-year period. This programme was subsequently replaced by green certificate schemes.

Interest in the renewable energy sector has been revitalised in recent years with the development of the regulatory framework at the European level. A more comprehensive approach has been taken to increase the share of renewable energy in the electricity market, which includes priority grid access, mandatory buy-back of renewable electricity, and direct eligibility of renewable electricity to customers and suppliers on the market.

A 1999 federal law on electricity regulation granted renewable energy generated electricity priority to connect to the transmission grid. A regulatory framework was established to secure the operations of plants using renewables with respect to the electricity grid in an open market. Similar regulations were established for the distribution grids at the regional level. More specifically, the suppression of certain (albeit already low) fees at the federal level has helped to minimise transport and distribution fees. Since 1999, the federal government has ensured that all generators of electricity from renewables are progressively "eligible", *i.e.*, free to choose their electricity supplier if they need more electricity than they can generate.

The federal authorities also issued a decree in July 2002 (entered into force in July 2003), to facilitate the application of the regional green certificate systems. This decree obliges the national transport grid manager to buy green certificates at a minimum price (equivalent to € 0.02/kWh for biomass, € 0.05/kWh for wind energy and hydro and up to € 0.15/kWh for solar energy) at the request of renewables producers in Belgium. At the federal level, the decree also put in place the delivery of green certificates for electricity from offshore wind.

The 2002 policy instruments aim to make up for deficiencies in past measures by providing electricity producers with more financial security. As a net energy importer, improving and diversifying its energy supply mix remains a high priority for Belgium. The government perceives three main barriers to the penetration of renewables:

- Limited renewable energy endowments and land-use constraints.
- The existence of large centralised energy production systems or networks with good grid connections, which enable consumers to benefit from economies of scale.
- The low relative price of conventional energy.

Although intermittency has posed barriers to the development of renewables in other countries, it is not expected to do so in Belgium as electricity generated from intermittent sources of renewable energy is minor compared to overall electricity supply. This issue has thus been addressed at neither the federal nor the regional level.

Federal/Regional

While the federal government manages and determines the regulations related to the transmission grid, the general structure of tariffs, the nature and amount of the fiscal instruments, and the promotion of and responsibility for the use of renewables belongs to the regional authorities. Promotion of the use of renewables can differ by market deployment strategy and even more so by technology according to the region.

The Flemish region primarily promotes the use of solar energy and electricity through capital grants, grid priority for renewable sources, public awareness and education campaigns. The 1993 Decree (15.12.1993) grants companies investing in renewables incentives ranging from 10% to 20% depending on the size of the company. Solar PV has been singled out by this decree, where Flemish authorities provide an additional 65% of the installation cost of PV panels and electricity producers Electrabel and SPE provide 25%.

Complementary to the federal green certification system, the Flanders region implemented a green certificate system in its 2001 Decree in order to achieve, by 2010, 6% total electricity supply from renewables. A guarantee of origin system for electricity generated from renewables (EU Directive 2001/77/EC) has been put in place to further develop the green electricity market. Fines, on the order of € 100 per MWh are imposed for failure to comply with quotas.

In 2004, the Flemish region approved its Electricity Distribution Law, which stipulates the obligation of grid managers, in accordance with the 2001 Decree, to promote renewables generated electricity through the offer of free low voltage distribution. Grid access for suppliers of electricity from renewables is also set at a certain level. In conjunction with the suppression of fees at the federal level, the distribution law is expected to help minimise transport and distribution fees.

The Walloon region primarily promotes the use of solar water-heating and biomass, through capital consumer grants and public awareness and education campaigns. The Walloon Region fosters the use of wood and wood waste to generate electricity, with the aim of producing 5 500 GWh from biomass by 2010. Other targets are 370 GWh of generation from wind power, 225 GWh from biomethanisation of renewable waste and 440 GWh from hydro. These targets are based on the general green certificate scheme, priority access to the grid and eligibility acknowledgement given to green electricity producers. Concerning heat, the Walloon region plans to increase the share of renewables in the supply of low temperature heat from 6% (2000) to 9% by 2010.

The Walloon region's Soltherm Programme was set up to develop a sustainable solar water heating industry in the region over ten years, with the goal of installing 200 000 m^2 of solar panels by 2010.

Grants are provided to encourage the installation of solar panels and can be supplemented by local institutions and gas and electricity distribution companies. In addition to the incentive, other promotional measures include efforts to increase the quality of the systems, training activities and awareness campaigns.

The Walloon Region has been the most active in initiating information dissemination activities, offering interested entrepreneurs the support of specialised consultants, who have been appointed as facilitators to elaborate integrated renewable energy dossiers. The Region also regularly organises workshops dealing with energy policy and is supporting an NGO aimed at the valorisation of biomass (VALBIOM). There is also an effort to provide certain NGO's with information to disseminate on sustainable energy, particularly renewables, and related local, regional and federal level incentives.

Wallonia has also implemented a green certificate system with quotas put in place for the grid managers. The target is to have 12% of total electricity generation from renewables, including efficient CHP plants, by 2010. A guarantee of origin system for electricity generated from renewables (EU Directive 2001/77/EC) is intended to further develop the green electricity market. Similar to the Flemish region, failure to comply with quotas will result in fines, on the order of € 100 per MWh. The Walloon government will pay a price of € 65 for green certificates arising from new installations. This complements the federal decree by imposing on transmission grid managers the obligation to buy green certificates at minimum prices from any producer in Belgium. Biomass receives minimal aid at the federal level, compared to wind and PV. Appropriate waste management and progress in the deployment of CHP units burning biomass is expected to stimulate the market for heat generated from renewables.

The Brussels-Capital region is fairly small compared to Flanders and Wallonia. Brussels-Capital has introduced grants of 35% towards the purchase and installation of solar water-heating systems (subject to a maximum limit of € 992 per household) to encourage the use of renewables in residential buildings. Brussels is also planning a law that would establish green electricity consumption quotas: 2% in 2004, 2.25% in 2005 and 2.5% in 2006. To meet these quotas, suppliers will be obliged to buy the necessary amount of green certificates from green electricity producers. These quotas include efficient CHP plants.

As the responsibility for achieving the targeted renewables share lies with the grid manager mainly at the distribution (regional) and transmission (federal) levels, some time will be needed to instil confidence in potential investors. This will depend largely on the behaviour of the electricity market, future achievements in the security of supply and public service obligations, which include renewables and energy efficiency targets. Appropriate adjustments over time with respect to targets imposed on the grid managers and a guarantee to the solvability of the green certificates market will be required. The 2002 federal decree on green certificates as well as regional certificate programmes have brought some reassurance.

Past fiscal measures and incentives (including those coming from the local authorities) were favourable enough to induce some growth of renewables technologies. They were not, however, advantageous enough financially to induce continuous and steady growth of the renewable energy market nor did they specifically target the right players. It is too early to assess how the latest policies, with respect to connection to the grid, transport and distribution of green electricity and implementation of green certificates will accelerate the penetration of renewables within the competitive conditions of the current liberalised market. Although expected to increase the use of the renewable energy sources in Belgium, a weak point of the system is the lack of involvement on the part of consumers, although electricity bills in the country now display the technology used in the purchased electricity mix. Presenting consumers with the knowledge of origin of electricity can influence future technology choices. Public service obligations such as prioritising the connection to the distribution and transmission grids for renewables and market deployment activities like the green certificates schemes are important as it is understood that renewables are to contribute to the diversification of the energy mix of Belgium.

Renewable Energy Markets

Hydropower

Figure 6. **Hydropower Capacity and Electricity Production**

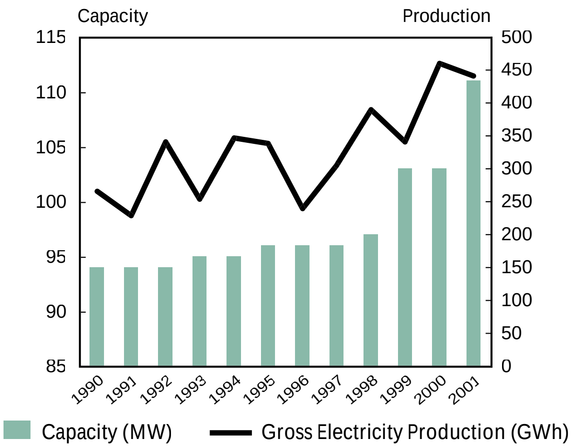
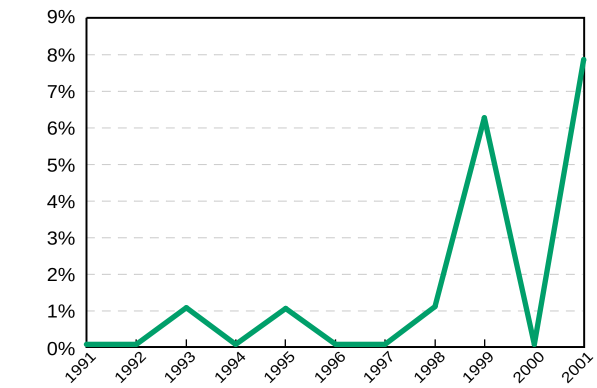
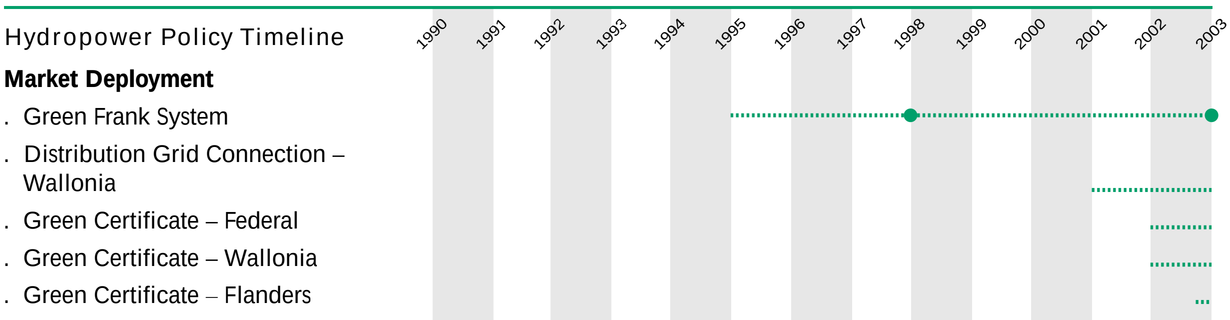


Figure 7. **Hydropower Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Hydropower is the second most important form of renewable energy in Belgium. Excluding pumped storage and all forms of waste in the energy supply, the share of hydropower accounted for 48% of renewables in 2001. Hydropower installed capacity increased by 1.5% per year between 1990 and 2001. Capacity increased by only 3 MW between 1990 and 1998, but by 14 MW between 1998 and 2001. Belgium's hydropower capacity is made up primarily of small hydropower plants and the potential for further expansion is limited. More than 99% of hydropower production is in the Walloon region, with the remainder in the Flemish region.

The Green Frank System was instituted in 1995 and established buy-back rates (€ 25/MWh) for electricity generated from all renewable energy sources. This policy measure was reinforced in 1998, subsequently doubling the buy-back rates for hydro facilities with an installed capacity of less than 10 MW to € 50/MWh. These higher buy-back rates drove the increase in new small hydro (micro) units after 1998.

The Green Frank System has been replaced by the regional Green Certificates system, which contain mandatory targets for grid managers. The federal decree on certification created a guarantee that is at least as favourable as the previous Green Frank System with regards to hydropower. Construction of new small hydropower plants are expected in the Flemish region, although potential is limited due to the flatness of the region.

Biomass Production

Figure 8. **Solid Biomass Production**

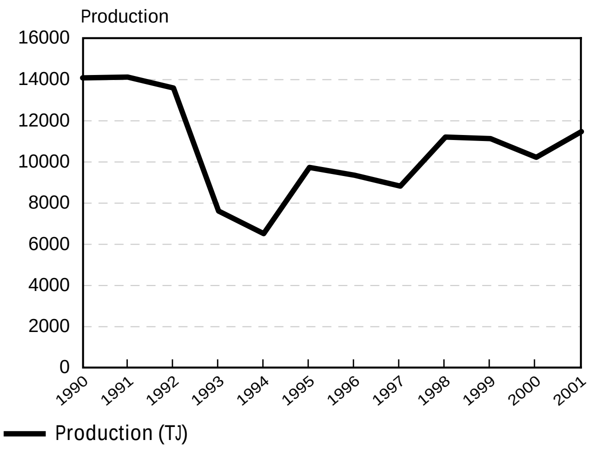
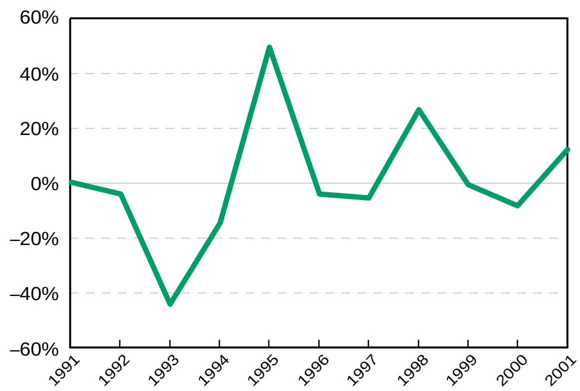
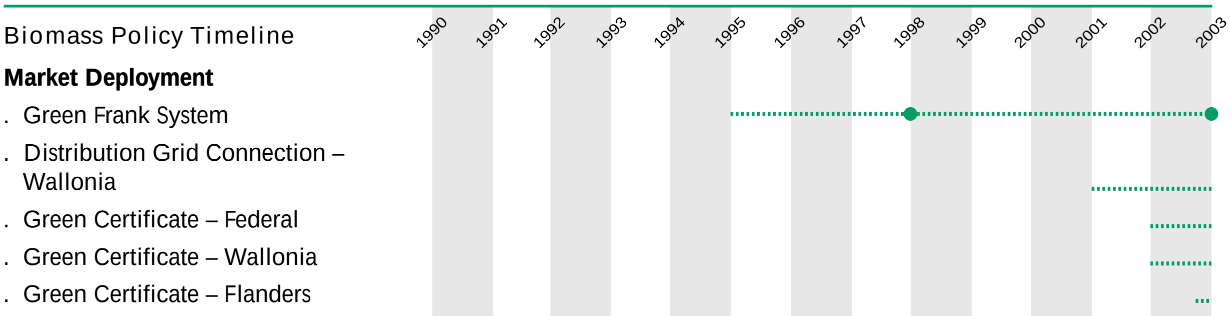


Figure 9. **Solid Biomass Production** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

In 2001, solid biomass accounted for some 80% of total renewable energy supply (excluding waste). Biomass production decreased slightly from 1990 to 2001, with very little annual variation. Imports have compensated for the decrease in production. Total wood and wood waste amounted to approximately 15 500 TJ in 2001, which, according to Belgian authorities, has been aggregated from various disparate data sources. Biomass statistics, however, are expected to be revised.

Although the biomass market has exhibited little dynamism between 1990 and 2001, many policy measures have been recently implemented. Thus, the biomass market may exhibit enough growth in the near future to be considered a mature market:

- Green certificates systems are currently operating in the Wallonia and Flanders regions. The regulators of the electricity markets in these regions are monitoring the market for green certificates and are interacting with policy-makers in order to adapt the mandatory targets for the grid managers at manageable levels.
- CHP certificates in Flanders aim to support high-efficiency CHP burning wood waste.
- The Walloon government has instituted a decree providing aid targeted at stimulating production of biomass in addition to its existing green certificates scheme.
- Active platforms and networks have been created in both Flanders and Wallonia on the topic of biomass addressing the issue of security of supply.

Biogas is one of few bioenergy technologies that have experienced some market growth in the 1990s. Growth accelerated after 1997, coinciding with the implementation of the Green Frank System. Furthermore, the federal government has taken the lead from the European Directive and adopted the deployment of the biofuels market as a high priority. The Clean Technologies Initiative, recently adopted by the federal government, is expected to set the framework to support industrial projects dealing with alternative fuels without imposing mandatory targets.

Wind Power

Figure 10. **Wind Power Capacity and Electricity Production**

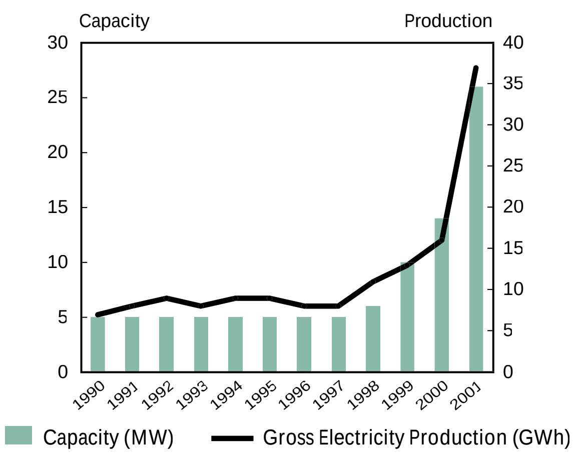
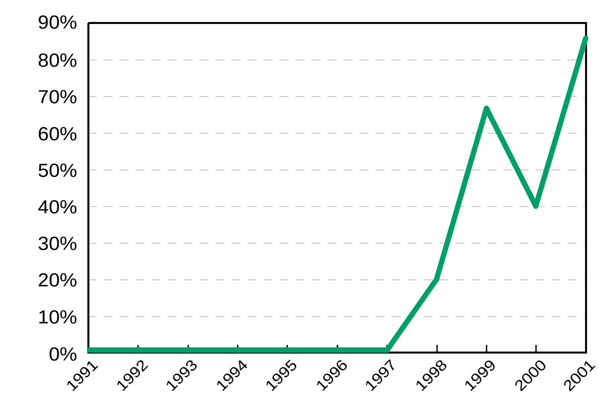
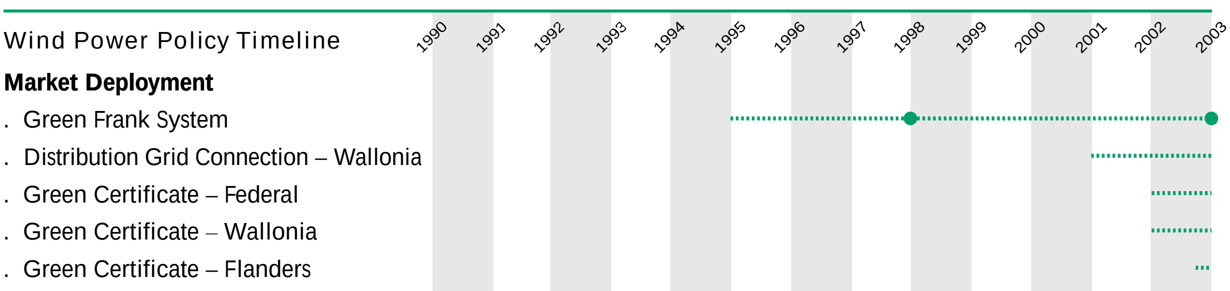


Figure 11. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Wind is the largest new renewables market in Belgium. In 2001, wind power contributed a little more than half a percent to total renewable energy supply. Wind capacity experienced an annual average growth of 16.2% between 1990 and 2001, albeit from very low levels. There was little growth in the Belgian wind market in the first half of the 1990s, while from 1997 through 2002, 31 MW of installed capacity was added for a total of 36 MW, according to Belgian data.

The first and primary wind farm in Belgium was built in 1986 and is located in the North Sea, approximately 2 km offshore in the outer harbour of Zeebrugge, a project planned and co-ordinated by the Belgian Ministry of Public Works. The Zeebrugge wind farm has a total installed capacity of approximately 5 MW connected to the electricity grid.

Belgium's wind market essentially started in 1997. The majority of wind installations are located in the Flemish region although two new wind farms have recently been built in the Walloon region and further projects are under study. The first wind farm project has, however, recently been suspended by the State Juridical Court due to public opposition. The second wind farm project, on the order of 300 MW, has been approved although procurement of its environmental licence is not yet complete. Eurostat estimates that Belgium has another 2.5 to 40 MW of installed capacity from small wind turbines that are not connected to the grid. Although difficulties in obtaining environmental permits are recognised, the Walloon Region has tentatively set an objective to install 200 MW of onshore wind capacity by 2010. The AMPERE Commission estimates that there is potential for 1 500 MW of wind capacity in Belgium by 2020.[1]

The Green Frank System was implemented in 1995 and was deemed fairly ineffective in promoting wind power. The doubling of buy-back rates, however, for wind turbines within the Green Frank System was credited with the increase in installed capacity in 1998. The effectiveness of this particular legislation was not long-lasting and the market needed further stimulation to continue to grow, which it received through the Green Certificate System. The federal decree on Green Certification, instituted in 2002, specified the conditions for issuing green certificates by the federal regulator (CREG) for offshore wind energy production. This system is expected to further stimulate the wind energy market.

Solar Thermal Production

Solar thermal production increased from 35 TJ in 1990 to 56 TJ, an annual average growth of 4.4%. Solar thermal production was relatively constant until 1998 and then increased steadily to 2001. Production is split between the regions with 50% in the Flemish region, 45% in the Walloon region and the remaining 5% in the Brussels region.

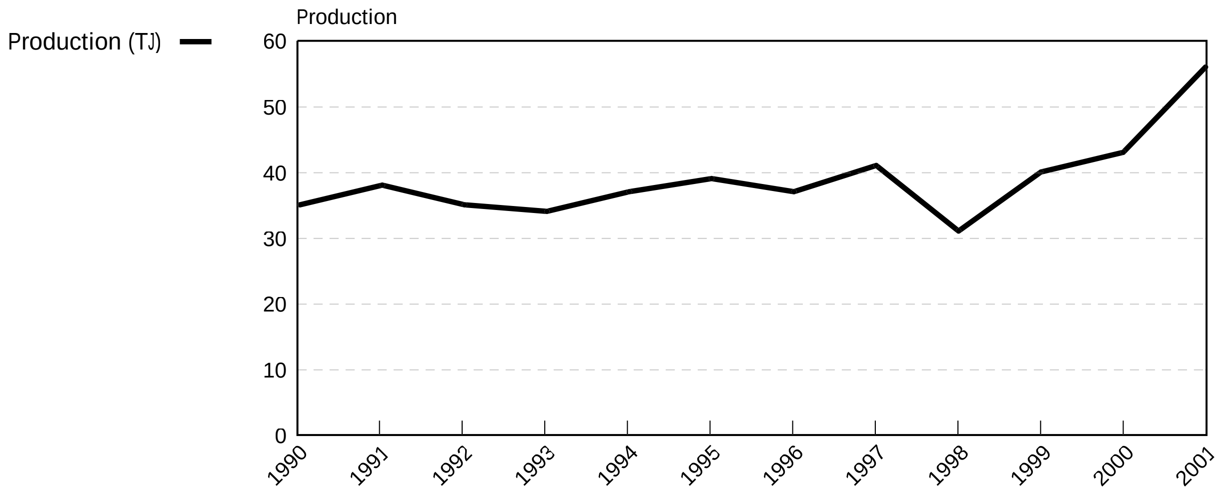
The Belgian government has only recently started to target the solar thermal market. The growth in the latter part of the 1990s was a result of the Green Frank System. This system, however, did not target the solar thermal market as specifically as it did the wind and hydropower market, so the effect was less dramatic.

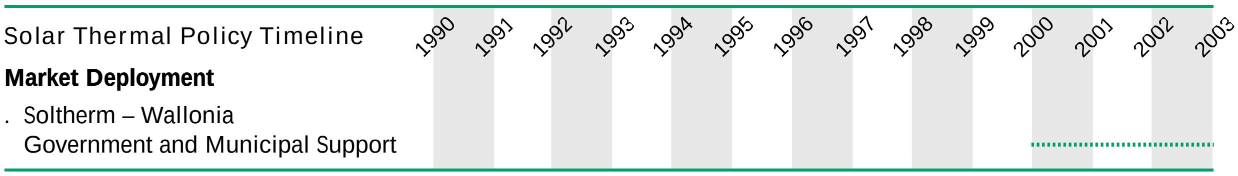
Promotional programmes for the solar thermal market have come about more recently and more as an initiative of the regions. The main programme is the Walloon Soltherm programme, established in May 2000. Its objective is to develop a sustainable solar water heating industry in the region over ten years. At present, 4 400 m^2 have been installed. The target is for 200 000 m^2 of panels to be installed in the region by 2010, with 75% of the capacity to be installed through building renovations, and 25% from new

1. *AMPÈRE Commission: Analysis of the Means of Production of Electricity and the Restructuring of the Electricity Sector Commission established by the Belgian government.*

construction through grants to communities and households ranging from € 1 500 to € 3 000. In the Flemish region, in addition to the support from energy distributors, grants are offered by one province and by most municipal authorities of € 625 minimum and € 250 to € 1 000, respectively. A similar support scheme is offered by the Brussels-Capital region.

Figure 12. **Solar Thermal Production**





Belgium Policy Chronology

Tax Deduction for Environment-Friendly Investments *(Federal)*

Year 1992 - Present

Policy Description This policy makes incentives available for environmentally sound investments by industry. It provides capital grants of up to 13.5% of investment costs. Investments are considered eligible if they deal either with energy efficiency, or energy resulting from non-polluting treatment of industrial and urban waste. The policy covers projects dealing with solar, wind, hydro energy, biomass (including biofuels) and geothermal energy technologies as well as RD&D activities that promote environmentally sound technologies.

Tax payers are allowed to spread the deductions out over several years. The policy also offers grants totalling 20.5% of the investment and 25.5% for especially innovative companies.

Policy Type Investment tax credits / Capital grants / RD&D

RE Technology All renewables

VLIET Programme

Year 1992-1995

Policy Description The VLIET programme put in place :

- Grants for research projects (50-100%).
- Development projects (50% refundable loans, which are converted to grants of 25% of investment cost for successful projects and 40% in case of failure).

This programme was replaced by VLIET bis (1997-1999), which was based on the same principles as the previous programme, but with a lower budget (BEF 67.5 million). The budget for the first phase (1992-1995) was BEF 132.5 million.

Policy Type RD&D / Capital grants

RE Technology All renewables

Decree 15.12.1993 *(Flemish Region)*

Year 1993 - Present

Policy Description The objective of the decree is to increase energy saving from fossil sources and to foster economic expansion.

Companies investing in energy efficiency and renewable energy are eligible to receive subsidies ranging from 10% for medium-sized and large organisations to 20% for small enterprises. The utility sector is excluded from this subsidy.

To aid in the further development of the PV market, the Flemish authorities provide an additional subsidy of 65% for the installation of photovoltaic panels, 25% of which is provided by the electricity producers Electrabel and SPE.

Policy Type Capital grants

RE Technology All renewables

Pilot Programme for Biofuels in Cars

Year 1995 - Present

Policy Description This pilot programme promotes biofuels for transport in public transport vehicles in the Wallonia region and in Brussels. In 1995, the Flemish government co-financed, with the partnership of the EU project ALTENER, a large-scale demonstration and test programme for biofuels in cars (total funding BEF 8.6 million).

Policy Type RD&D

RE Technology Biofuel

Wallonia's 1995 Environment Plan for Sustainable Development

Year 1995-2010

Policy Description Wallonia's 1995 Environment Plan for Sustainable Development, which was developed as a plan to reduce CO_2 emissions, includes an aim to increase renewable energy use to 3% of energy consumption by 2000 and 5% by 2010

Policy Type Obligations

RE Technology All renewables

Green Frank System

Year 1995-2003

Policy Description In January 1995, the Electricity and Gas Control Committee (CCEG) recommended the establishment of an additional incentive of 1 BEF per kWh (0.025 € per kWh) on top of the wholesale electricity production buy-back rate for renewable energy. Starting in 1998, electricity generated by wind and hydro facilities with an installed capacity of less than 10 MW received an extra 0.025 € per kWh. The total buy-back rate for PV was € 0.15 per kWh (including wholesale electricity cost).

In 2000, the total average buy-back rates were:

- Wind and hydro: € 0.0769-0.0850/kWh.
- Other renewable including biomass: € 0.0521-0.0602/kWh.
- PV: € 0.15/kWh.
- The average auto-producer buy back rate was between € 0.0273 and € 0.0354/kWh over the same period.

These buy-back rates were applicable to existing and new auto-producers, and were guaranteed over the first ten years of operation. For PV installations less than 3 kW, this guarantee covers the lifetime of the system installed.

The CCEG was dissolved in July 2003 and the Green Frank was suppressed as a system; although, the producers who were previously entitled to use this system can continue to do so for the total period not exceeding 10 years.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology All renewables

Electricity Market Regulation
(Federal)

Year 1999 - Present

Policy Description The electricity market law of 1999 was modified in 2001 to stipulate the implementation of public service obligations. It gave rise to technical regulations for connection to the transmission grid and the purchase of electricity, which prioritised green electricity.

Policy Type Regulatory and administrative rules

RE Technology All renewables

Offshore Wind Farm Authorisation Procedures

Year 2000 - Present

Policy Description This royal decree, promulgated in December 2000, determined the ad hoc conditions and procedures to deliver the required authorisations for the installation and operation of wind parks in offshore areas.

Policy Type Regulatory and administrative rules

RE Technology Offshore wind

Access to the Grid

Year 2000 - Present

Policy Description In April 2000, the federal government decided that all generators of electricity from renewable sources will become progressively free to choose their own electricity supplier if they use more electricity than they are able to generate. Consumers who buy a significant amount of their electricity from renewable sources are also eligible to choose their electricity supplier.

The Flemish Parliament approved the decree regarding the liberalisation of the electricity market and marked the following categories as eligible:

- Producers using quality CHP installations or renewables for electricity generation (up to a certain ceiling).
- Consumers of renewables-generated electricity by means of a CHP unit (for a certain amount of electricity) or consumers using heat from CHP units or renewables.
- Consumers using heat from a supplier who generates this heat by means of CHP units or renewables (for a maximum of 500 kWh electricity per GJ heat).

In Wallonia, a corresponding decree was approved and aims to gradually open the market for producers using CHP and/or renewables for electricity generation, as well as consumers using renewable electricity and/or electricity generated by means of a CHP unit, or using heat from CHP units or renewables.

Policy Type Regulatory and administrative rules

RE Technology All renewables

Soltherm Wallonia

Year 2000-2010

Policy Description The Walloon Soltherm programme was established in May 2000. The objective is to develop a sustainable solar water heating industry in the region over a ten-year timeframe. The target is for 200 000 m^2 of panels to be installed in the region by 2010. 75% of the capacity should be installed through building renovations and the remaining 25% from new construction.

Goals for the first year of the action plan (2000) included the installation of 150 pilot systems to create sufficient experience and enable the emergence of a viable private sector. The next phase included the training of new technicians, architects and public sector staff in charge of promoting these technologies. Once this has been completed, a promotional campaign will target all stakeholders from households, as well as private and public sector decision makers. The residential market will be targeted first, to be followed by the larger community-use projects.

Individual grants currently start from € 1 500 (for up to 4 m^2 of panels) and can be supplemented by local institutions (the communes and provinces) as well as gas and electricity distribution companies. Grants offered to households are between € 1 875 and € 3 000. The Walloon Region provides additional support to the municipalities active in using solar thermal energy. In 2003, most of the mixed “intercommunales” of gas and electricity distribution offered a € 1 250 grant to individuals and small and medium enterprises (SMEs). The Walloon Region also pays for solar auditing for communities.

Policy Type RD&D

RE Technology Solar thermal

Tax Reductions for Home Improvements

Year 2001 – FY2003

Policy Description A federal law (2001) provided tax reductions for fiscal year 2003 with a budget of € 37 million. The deduction rate is 15% for the replacement of old boilers (more than twenty years old) by new condensation boilers and for solar energy; 40% for the installation of double glazing, roof insulation, the installation of a central heating regulator, plus energy audits. The tax reduction is limited to € 600 per household per year.

Policy Type Tax exemptions

RE Technology Solar thermal
Solar photovoltaic
Concentrating solar

Green Certificates Scheme *(Flanders)*

Year 2001 - Present

Policy Description This decree both fosters the production of electricity from renewable energy and implements the Electricity Decree of July 2000. From the 1st of January 2002, every electricity supplier has the obligation to buy a certain amount of green certificates from green electricity producers. This amount is 0.8% from total electricity supply in 2002, 1.2% in 2003, 2% in 2004, to reach 6% in 2010.

The suppliers are obligated to surrender their certificates on an annual basis to the Flemish regulator (the VREG). If the supplier does not comply with this obligation, they are fined € 75 per missing certificate in 2003, € 100 in 2004 and € 125 in 2005. The fines go into a Renewable Energy Fund. VREG provides a list of suppliers and green electricity producers, prices of green certificates and a green certificate relational database on its website.

Policy Type Obligations / Tradable certificates

RE Technology All renewables

Green Certificates Scheme *(Wallonia)*

Year 2002 - Present

Policy Description The decree from July 2002 fosters green electricity, implementing the Electricity Decree from April 2001. This green certificates scheme aims to abate CO_2 emissions and obliges each supplier to meet a quota of green electricity within its total supply of electricity.

The Walloon government established a target of 3% at the start of the system (July 2003). Further targets have been established of 7% by 2007 and 12% by 2010. The objective of 12% is to be achieved by producing 8% from renewables and 20% from CHP. In the event of non-compliance with the quota obligation, the supplier will be fined € 100; which goes into an energy fund. The Walloon regulator checks the quota obligation every three months and publishes information about green certificates. Additionally, the Walloon government may soon allow green electricity producers the choice of participating in the green certificates system or benefit from a government support system at € 65/MWh.

Policy Type Obligations / Tradable certificates

RE Technology All renewables

Green Certificate Scheme
(Federal)

Year 2002 - Present

Policy Description The Royal Decree on the promotion of electricity produced from renewable energy sources was adopted in July 2002 and came into force 1 July 2003. It addresses two fundamental issues: first, it sets the conditions for issuing green certificates by the federal regulator (CREG) for offshore wind energy production, and second, it states that the grid operator is obliged to buy green certificates issued anywhere in Belgium at minimum prices of € 90/MWh for offshore wind energy, € 50/MWh for onshore wind energy, € 50/MWh for hydro, € 150/MWh for solar energy and € 20/MWh for biomass. The monitored green certificates are valid for five years and are not associated to fixed quotas.

Policy Type Obligations / Tradable certificates

RE Technology All renewables

Support for Solar
(Flanders)

Year 2002 - Present

Policy Description Grants for PV panels amounted to 65% of the total investment cost. This programme had a budget of € 1 million in 2002, which has been exhausted. Additionally, most of the communes provide grants of between € 250 and € 750.

For solar heating systems, a grant of € 625 was available and most of the communes provided between € 250 and € 750.

Policy Type Capital grants

RE Technology Solar photovoltaic
Solar thermal

Support for Solar
(Brussels Region)

Year 2003 - Present

Policy Description The Brussels Region gave grants totalling 35% of investment cost for the purchase and installation of solar water heating systems with a maximum grant not to exceed € 991.59 per household.

Policy Type Capital grants

RE Technology Solar thermal

Support for Pre-feasibility Studies
(Wallonia)

Year 1990 – Present (updated in 1994)

Policy Description The Walloon Region supports part of the costs of pre-feasibility studies carried out in the private sector to evaluate potential energy efficiency or renewable energy investments within a company. This incentive also applies to costs related to technical certification. The maximum available allowance amounts to:

- 75% of total feasibility study costs calculated on the basis of quotes provided by ministry-approved independent companies.
- 60% of total certification costs.

Policy Type Third-party finance

RE Technology All renewables

Investment Subsidy
(Wallonia)

Year 1992 – Present (updated in 2002)

Policy Description The Walloon Region subsidises 15% of the investments of any company aiming to increase either their renewable energy production or energy efficiency.

Policy Type Capital grants

RE Technology All renewables

Financial Support for Demonstration Projects
(Flanders)

Year 1992 - Present

Policy Description Industry and the tertiary sector can benefit from these grants of 50% of the cost of investment promoting the rational use of energy or use of renewable energy sources, primarily biomass.

Policy Type RD&D / Capital grants

RE Technology Biomass

Electricity Distribution
(Flemish Region)

Year 2004 - Present

Policy Description Since February 2004, grid managers (low voltage) are obliged, according to the application of the 2001 decree on the promotion of renewables-generated electricity, to offer free distribution of electricity from renewables sources. Additionally, grid access for the suppliers of electricity from renewable sources is fixed at a certain minimum level.

Policy Type Net metering

RE Technology All renewables

UREBA
(Walloon Region)

Year 2003 - Present

Policy Description This regional scheme focuses on investment support with a subsidy of 30% to 50% for investments in public buildings.

Policy Type Consumer grants/rebates

RE Technology All renewables

Canada

Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

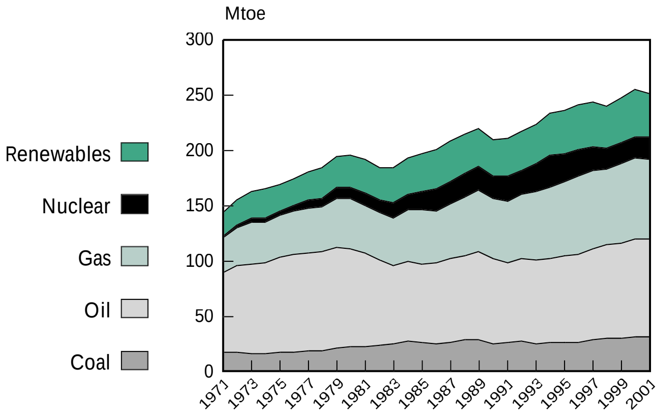
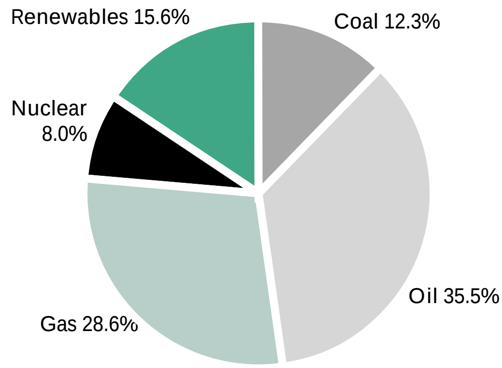


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1.
See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1970	1980	1990	1995	2000	2001	Imports
Coal	17.1	21.2	24.3	25.3	31.0	30.7	•
Oil	72.0	88.9	77.1	78.0	87.8	88.8	•
Gas	29.2	45.6	54.7	67.4	74.2	71.5	•
Nuclear	0.3	10.4	19.4	25.6	19.0	20.0	-
Renewables	21.1	29.2	33.7	38.6	42.0	39.1	-
Biomass	*7.5*	*7.6*	*8.1*	*9.7*	*11.2*	*10.5*	
Hydro	*13.6*	*21.6*	*25.5*	*28.9*	*30.8*	*28.6*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Total	**139.5**	**193.0**	**209.1**	**231.7**	**250.9**	**248.2**	•
% Renewables	*15.1%*	*15.0%*	*16.1%*	*16.5%*	*16.5%*	*15.6%*	

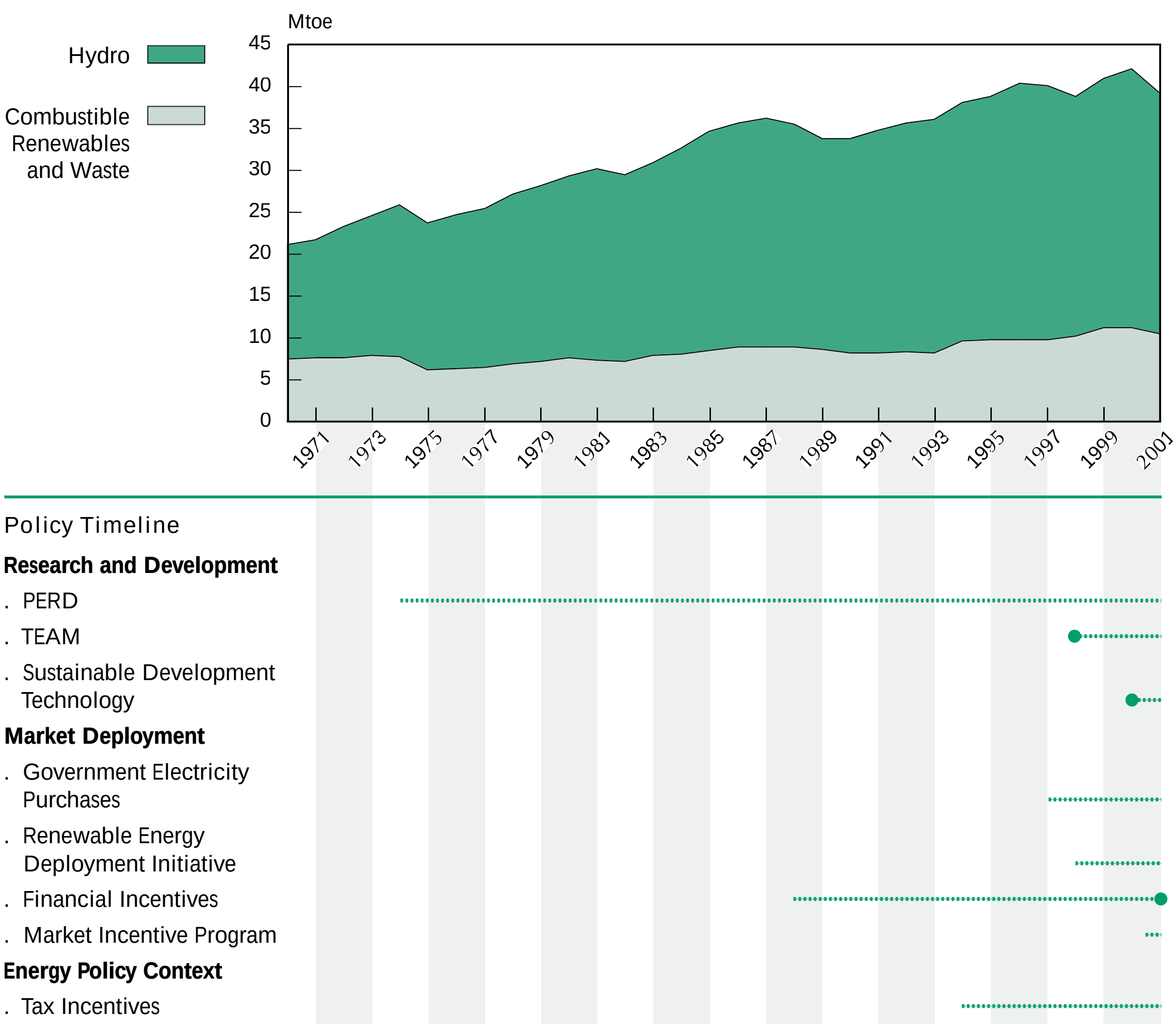
* *See Annex 2 for explanation of components in total and definition of biomass.*
• *Net Exporter*

Total primary energy supply (TPES) in Canada grew at average annual rates of 3.3% in the 1970s, 0.8% in the 1980s and 1.8% in the 1990s. TPES in 1990 was 209 Mtoe and increased to 248 Mtoe by 2001. Canada is well endowed with conventional fossil fuel and uranium resources and is a net exporter of these fuels. As such, energy production represents an important component of the overall economy.

Because of this domestic energy abundance, only the traditional renewable energy sources, large hydropower and biomass use in the paper and forest products industries, have penetrated the energy supply market to any great extent. Renewable energy sources contributed 33.7 Mtoe in 1990 to TPES and 39 Mtoe in 2001. Renewable energy development has kept pace with the production of the other sources so renewables have consistently represented about 15% to 16% of TPES since 1970. In fact, hydropower is the dominant source of electricity generation in Canada, representing nearly two-thirds of total generation. In 2001, renewables accounted for 58% of electricity production.

Renewable Energy Supply

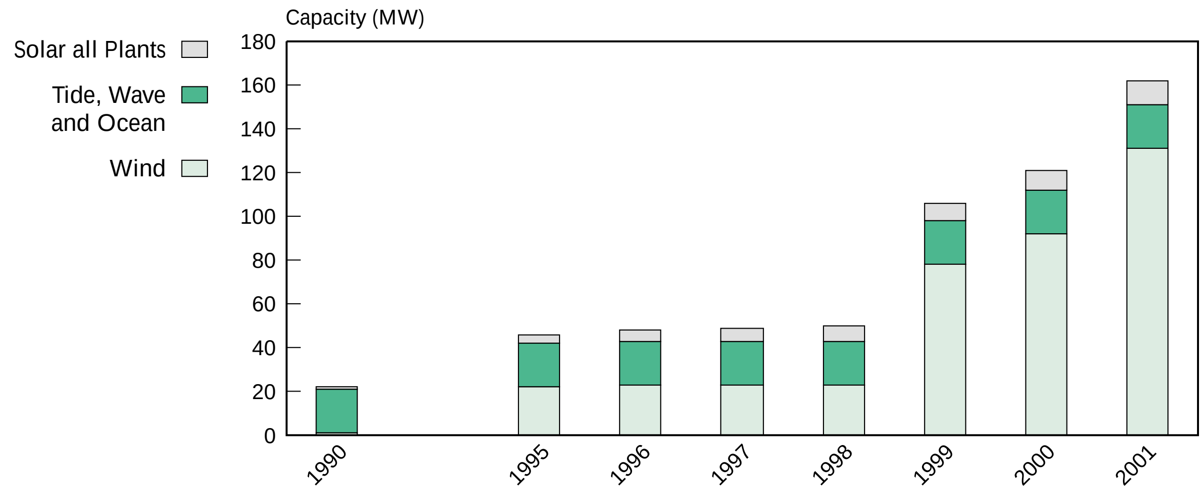
Figure 3. **Total Renewable Energy Supply and Policy Timeline**



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Hydropower and combustible renewables and waste account for the largest shares in renewable energy supply in Canada. In 2001, hydropower was 73% and combustible renewables and waste was 27% of total renewable energy supply. Hydropower generation capacity was 67.2 GW, combustible renewables was 1.2 GW and wind power capacity was 78 MW. Solid biomass production has increased from 340 703 TJ in 1990 to 438 020 TJ in 2001. The wood products and pulp and paper industries account for the majority of solid biomass use, primarily in the forms of wood waste and black liquor.

Figure 4. **Net Generating Capacity of Renewable and Waste Products**



Note: A change in data collection methods at the IEA occurred in 1999 with the separation of net generating capacity between small and large hydro. Capacity data for small hydro are not available prior to 1999.

Canada has one of the world's few tidal power facilities at the Bay of Fundy (18 MW capacity). There have been no specific policies or measures aimed at tidal power in Canada and there have been no new tidal projects since the commissioning of the Bay of Fundy plant. There are some objections to tidal power development including ecological objections to building more tidal plants along the coast because of potential impacts on aquatic life. These concerns, coupled with the high capital costs associated with tidal facilities mean that the likelihood of tidal energy contributing significantly to Canada's power in the near future is low.

However, there is growing interest to exploit the potential wave and tidal resources in British Columbia. Encouraged by the rising electricity demand on Vancouver Island and as part of the initiatives on green energy technologies, BC Hydro examined the feasibility of exploiting wave and tidal current energy in the province and developed relevant resource maps. In 2002, BC Hydro signed a memorandum of understanding (MOU) with two technology owners to build two wave demonstration plants. Though these MOUs were cancelled in 2003 because of the implementation of a new provincial energy policy restricting BC Hydro's direct involvement in new energy generation, efforts by private companies to enable development of ocean energy in British Columbia are continuing. Presently there are five different companies who are in the process of developing wave and tidal technology and/or projects in the province.

Research and Development Trends

Canada spent a total of US$ 8.79 billion (2002 prices and exchange rates) on government energy RD&D between 1974 and 2002. In this period, 7.4% of its total RD&D budget was allocated to renewable energy.

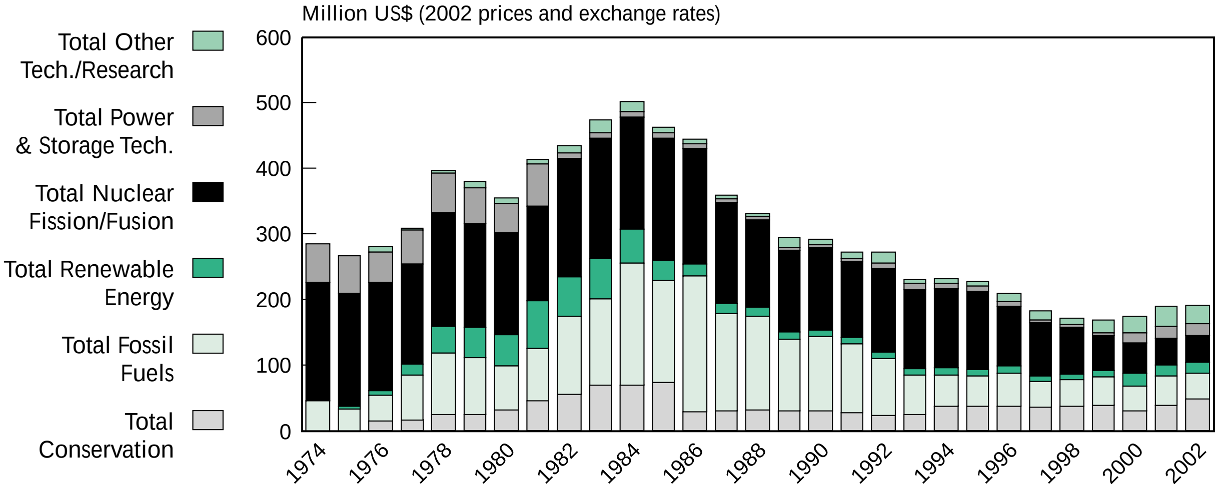
The overall trend of government RD&D expenditures for renewables peaked in the early 1980s and declined notably after 1985. Government RD&D budgets for renewables have been considerably reduced since 1985.

Among the renewable technologies, biomass received the highest level of funding at US$ 254 million, or 40%, in the 1974 to 2002 period. Solar heating and cooling was funded at US$ 178 million, representing 28% of renewable energy RD&D. Wind was the third largest recipient with 13% of the renewable RD&D expenditures from 1974 to 2002.

Assistance programmes for research and development in renewable energy have been in place for more than twenty-five years. The main funding organisation is Natural Resources Canada through the federal

Programme of Energy Research and Development (PERD). The main component of this RD&D effort is the Renewable Energy Technologies Programme (RETP). It supports efforts by Canadian industry to develop and commercialise advanced renewable energy technologies such as active solar, wind power, bioenergy and small hydro that can serve as cost-effective and environmentally responsible alternatives to conventional energy generation. In the mid-1980s, at the peak of energy RD&D expenditures, the federal government's total budget for renewable energy was in excess of US$ 60 million per year. Current federal support for RD&D is on the order of US$ 23 million annually.

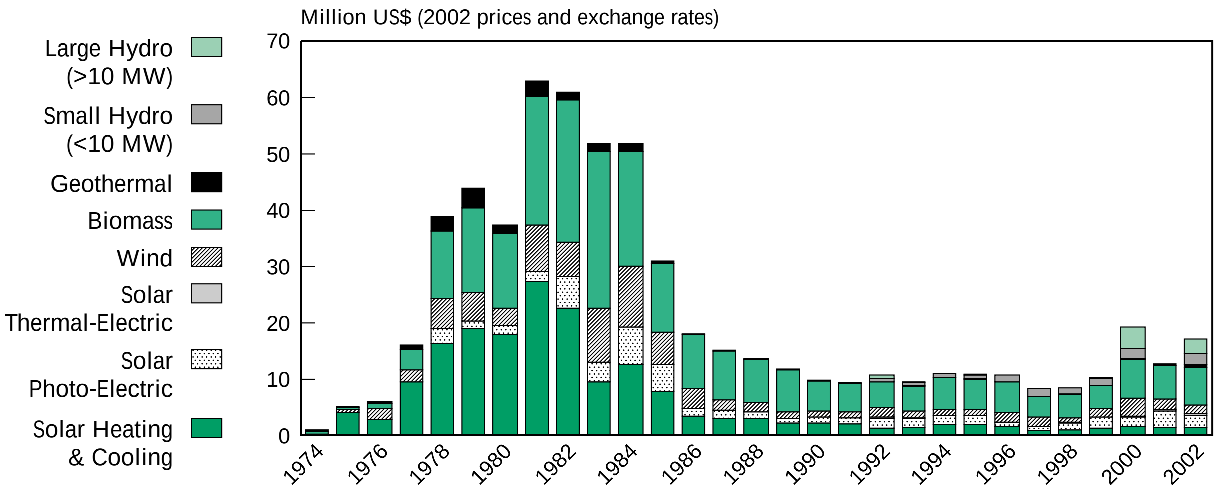
Figure 5. **Canada – Government Energy RD&D Budgets**



Under its climate change initiatives, the federal government has announced a number of programmes in support of renewable energy technologies. In 2000, the federal government invested about CAN$ 5 million dollars over five years to help develop technologies which would help reduce GHG emissions, including renewable energy technologies such as biogas production.

The main support programme for demonstration is Technology Early Action Measures (TEAM). Its objective is to help accelerate the demonstration and commercial deployment of new technologies.

Figure 6. **Canada – Government Renewable Energy RD&D Budgets**



Sustainable Development Technology Canada was founded in 2000. This arm's length organisation aims to stimulate the development and demonstration of Canadian technologies related to climate change and air quality.

The Industrial Research Assistance Programme (IRAP) is a generic technology development programme administered by the National Research Council. It provides assistance to small- and medium-sized companies to advance their technologies.

Another major generic technology development programme that often provides assistance to renewable energy projects is Technology Partnerships Canada (TPC) administered by Industry Canada. It provides repayable financial assistance for the development of technologies directly associated with improved industrial processes. Support for environmental and sustainable alternatives is a programme priority.

Announced in 2003, the Climate Change Technology and Innovation Initiative will support the long term development of greenhouse gas reduction technologies in five areas with a total budget of CAN$ 250 million over five years. Three of these five areas will address renewable energy: decentralised energy production, biotechnology and hydrogen economy.

In addition, Canada participates in international collaborative RD&D in Bioenergy, District Heating and Cooling, Hydropower, Ocean Energy Systems, Photovoltaic Power Systems, Pulp and Paper, Solar Heating and Cooling and Wind Turbine Systems through the IEA Implementing Agreements.

Market Deployment Trends

Because Canada is a country rich in energy resources, the primary impetus for renewable energy development has been market economics. Thus, development of large hydropower projects has been pursued and the paper and forest products industries have used biomass waste facilities for process heat and in combined heat and power systems. Although energy security is not a domestic concern, Canada is a signatory of the Kyoto Protocol and thus has committed to reduce its emissions of greenhouse gases, which has provided impetus for the adoption of policies for promoting renewable energy production.

Among the most prominent policies adopted for renewables are: The Renewables Energy Deployment Initiative (REDI) (1997), which provides incentives for the adoption of solar thermal systems and high-efficiency and low-emitting biomass combustion systems; a Wind Power Production Incentive (2002), the programme also established minimum (1 MW to 10 MW) and maximum (300 MW) wind energy quotas to be met by each province; and government purchases of electricity from renewables.

REDI provides incentives for solar low thermal applications (*e.g.*, solar water heating and pre-heating of ventilation air in commercial buildings) and bioenergy. Between 1998 and 2002, REDI supported 35 biomass projects translating into an increased capacity of about 66 MW and energy savings of around 480 TJ per year; 59 solar water and air heating projects totalling 840 m^2 of collector systems and leading to estimated annual energy savings of 2.5 TJ per year.

After the negotiation of the Kyoto Protocol in 1997, federal, provincial and territorial energy and environment ministers set up multi-stakeholder Issue Tables to develop options to reduce greenhouse gas emissions. Of particular interest are the reports by the Electricity, Buildings and Municipalities Tables, which outlined several measures to encourage market-emerging renewable energy sources. The work of the Issue Tables paved the way for CAN$ 1.5 billion worth of federal climate change initiatives, announced in 2000 and 2001. Several of these initiatives, described below, are designed to develop markets for emerging renewable energy sources.

- **Extension of REDI**
  (See Policy Chronology for further information.)

- **Government Purchasing**
  The objective of this initiative is to purchase electricity from emerging renewable energy sources for federal facilities across Canada. About 20% of the electricity that the government purchases will be generated from emerging renewable energy sources. This is expected to amount to 450 gigawatt hours (GWh) per year.

- **Market Incentive**
  An incentive will be offered to electricity distributors interested in stimulating sales of electricity from emerging renewable sources in the residential and small business markets. The federal incentive, combined with the efforts of other stakeholders, is expected to produce green electricity sales of 3 200 GWh a year by 2010. This estimate assumes that 5% of residential customers will switch to electricity that is from new renewable sources for a portion of their electricity needs. It also assumes that all other levels of government and large industrial customers will follow the same lead.

- **On-site Generation in Federal Facilities**
  The government will install a small number of on-site generation systems in its facilities. These systems will use such technologies as solar photovoltaic panels, small-scale wind turbines and micro-hydro turbines. They will be installed in off-grid situations where economics are favourable and in grid-connected situations where they will raise public awareness of such systems. About 100 kilowatts (kW) of capacity is expected to be installed.

- **Interconnection Guidelines**
  The government will work with interested jurisdictions to help provide access to the electricity grid for generating low- and non-greenhouse gas emissions systems. For on-site generation, the government will help develop technical guidelines on interconnecting such systems with the grid. Distributed power proponents identified a key barrier to the wider use of on-site generationsystems: not understanding the proper interconnection needs.

- **Wind Power Production Incentive**
  This is a renewable electricity production incentive to encourage the construction of 1 000 megawatts (MW) of new wind energy capacity in the 2002 to 2007 period. The incentive amounts to about one cent for each kilowatt hour (kWh) produced by new wind energy facilities in their first ten years of operation. It should provide for about half of the current cost gap for wind power produced under good resource and economic conditions.

- **Canadian Renewable Energy Network (CanREN)**
  Created through the efforts of Natural Resources Canada and its stakeholders, the purpose of this network is to increase the understanding of renewable energy to accelerate the development and commercialisation of renewable energy technologies. CanREN offers general information on renewable energy sources, highlights the technologies and applications being developed to harness these sources, and presents Canadians with the knowledge and support they need to make renewable energy part of their everyday lives.

Energy Policy Context

From an energy policy point of view, public interest in renewable resources emerged and grew during the oil price crises of the 1970s and early 1980s. Canadians, like citizens of other International Energy Agency (IEA) Member countries, have been keenly interested in renewable energy for a long time. Even though many Canadian provinces had been deriving most of their electricity from hydroelectric power, the first crises of the 1970s ignited a strong interest in all forms of renewable energy. In the late 1970s the federal government and most provincial governments responded to the strong public interest for the substitution of oil and other fossil fuels with renewable energy sources. It was recognised at the time, through resource assessment surveys, that Canada had large physical reserves of biomass as well as ample potential for solar, wind, geothermal and other forms of sustainable energy to develop and commercialise. A number of initiatives were started then to research, develop, demonstrate and commercialise renewable energy technologies. The federal government expenditures in support of renewable energy in the early 1980s allocated about CAN$ 100 million per year to expedite the development of technologies and encourage their market penetration.

Under the evolving policy objectives of “energy self-reliance”, “security of energy supplies”, “energy diversity”, “sustainable development”, “clean air” and “climate change” initiatives, the Canadian government introduced many programmes over the last decades in support of renewable energy. These programmes took the form of cost-sharing research, development and demonstration for new energy technologies and, in some cases, fiscal measures that provided tax incentives to encourage the broad market penetration of renewable energy. Other related activities included informing the public about the merits of renewable energy, facilitating the development of standards and training tools and streamlining regulations.

In addition to federal government resources, Canada’s ten provincial and three territorial governments play a key role in the development and commercialisation of renewable energy. While federal jurisdiction on the energy market refers to international and inter-provincial trade and facilities, provincial governments are responsible for energy production and distribution within the province. Any regulatory initiatives to increase production must be undertaken at the provincial level. In the case of hydropower, the provincial governments, through their hydro utilities, are the main players in developing and managing these resources. In the past, provincial programmes for emerging renewable energy technologies usually complemented federal government efforts. They were aimed primarily at demonstration projects and/or consumer information initiatives. Although many provincial programmes related to emerging renewable energy technologies have, for the most part, been eliminated, a few provinces maintain some core expertise and programmes. Being close to the local scene where projects are taking place, they continue to provide valuable assistance in terms of project selection, monitoring and dissemination of results.

Initial objectives for market share of emerging renewable energy in Canada were optimistic and successes were not always commensurate with expectations. The lack of quick breakthroughs in technology improvements, as well as the expanding availability of natural gas and low oil prices moderated expectations for quick market acceptance of new products, especially those based on emerging technologies. On the positive side, renewable energy in Canada has constantly grown in applications where it made economic sense, such as the use of biomass residues in thermal and electrical applications, solar heating of swimming pools and innovative hydro projects (> than 20 MW).

Current overall impressions are that renewables are viable energy sources in a growing number of applications and offer many environmental benefits as well as increased local economic opportunities. As in many IEA Member countries, Canada looks at renewable energy development and commercialisation as one of the key drivers to help address Kyoto and other global environmental objectives. Many of the current programmes in support of renewable energy in Canada are driven by realistic expectations and the stakeholders involved have a better understanding of the timeframe required to perfect new technologies and compete in the marketplace.

The Conference Board of Canada published an overview of renewable energy in Canada in 2003. It provides an excellent description of existing federal and provincial measures to promote the deployment of renewable energy, including details on provincial feed-in tariffs and green power purchases by governmental organisations. An alternative to feed-in tariffs is used by utilities in British Columbia and Quebec. Utilities decide on a desired volume of power to be sourced from renewables, then acquire this on contracts of varying lengths from renewable energy suppliers.

Provinces also have their own support mechanism to promote renewables. British Columbia, Alberta and Newfoundland and Labrador have green electricity procurement policies for government uses. Several provinces are considering implementing renewable portfolio obligations (*e.g.*, Ontario, New Brunswick). Quebec is supporting the addition of 1 000 MW of wind electricity capacity by 2012.

Renewable Energy Markets

Hydropower

Figure 7. **Hydropower Capacity and Electricity Production**

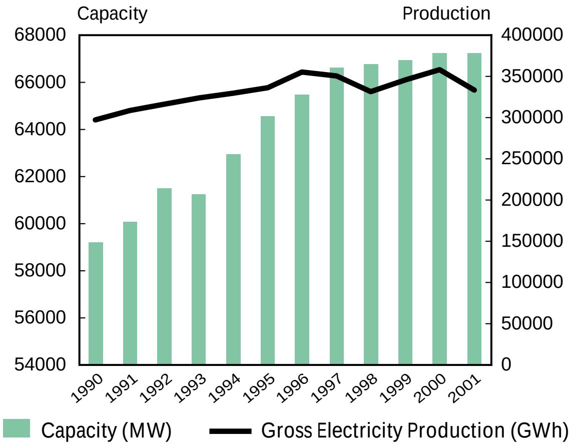
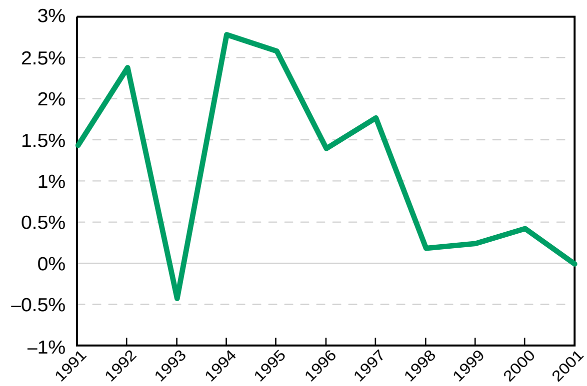
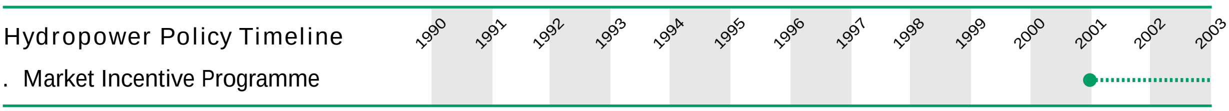


Figure 8. **Hydropower Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Hydropower from large-scale projects is already the leading form of electricity generation in Canada. Being successful and well established, large hydro producers are well positioned to make a contribution to climate change concerns without direct financial support from the federal government. On average, about 600 MW of large hydro is being developed each year.

Small hydro includes plants with a generating capacity of 50 MW or less. Small hydro opportunities using innovative technologies exist in Canada. Most of these opportunities have been disregarded by electric utilities during the second part of the twentieth century in favour of large-scale projects. Recently there has been interest in alternative applications for small hydro such as water supply and waste-water treatment plants and development of small hydro at remote non-grid connected areas currently using expensive diesel fuel.

On average, more than 150 MW of small hydro is being developed each year, which represents about CAN$ 300 million in annual business and a reduction in greenhouse gas emissions of more than 700 000 tonnes of CO_2 annually.

Provincial and Territorial governments are showing an interest in developing their small hydro potential and Natural Resources Canada (NRCan) is actively working with them to support this development. For example, BC Hydro is actively promoting green power; Nunavut is investigating its small hydro potential; and NRCan is participating in hydro policy development with provincial governments such as Ontario's Ministry of Natural Resources as it examines small hydro potential.

NRCan has also developed a CAN$ 25 million Market Incentive Programme (MIP) for Distributors of Emerging Renewable Electricity Sources as part of the government's Action Plan 2000 on Climate Change. The goal of this measure is to encourage electricity distributors to experiment with measures to stimulate sales of electricity from renewable energy sources, including small hydro. Funding is available through the MIP until 2006.

As part of the strategy for the electricity sector, the Action Plan 2000 on Climate Change expanded the Renewable Energy Deployment Initiative (REDI) for federal facilities to include on-site electricity generation that uses emerging renewable energy systems, including micro-hydro.

Biomass Production

Figure 9. **Solid Biomass Production**

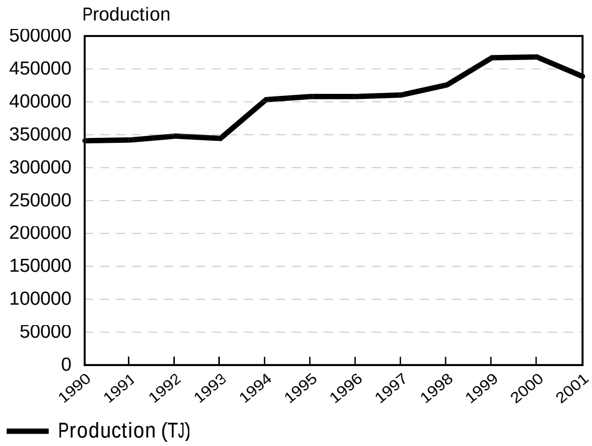
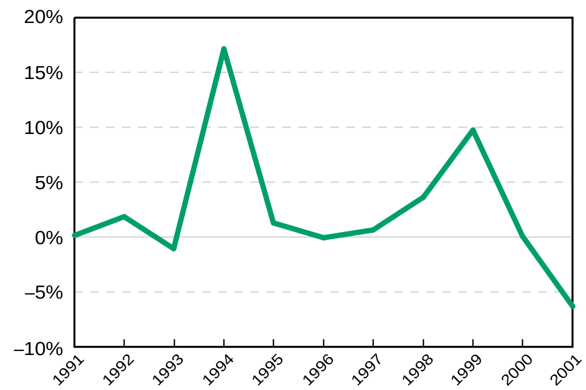
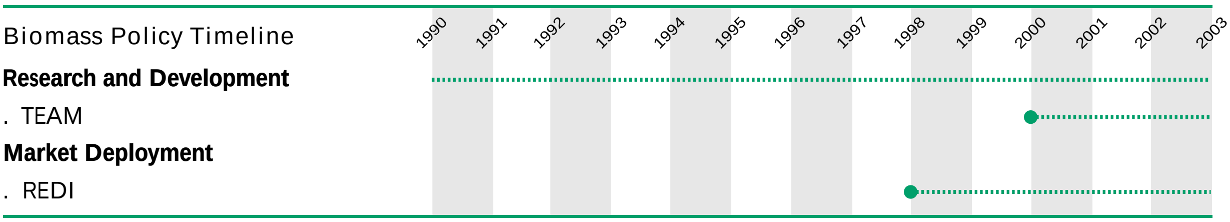


Figure 10. **Solid Biomass Production** (Year to Year Change)





Denotes a significant change to a policy, such as an extension, repeal or revision.

Canadian manufacturers, particularly those in the pulp and paper industry, use industrial wood waste, such as wood chips, sawdust, bark and pulping liquor, to produce about 400 petajoules (PJ) of biomass energy per year – 5% of primary energy demand in Canada. Second, wood is used for residential space heating, which has long been part of the Canadian way of life. About three million Canadian households use wood as a primary or second source of home heat, which translates into about 90 to 100 PJ of energy production annually.

The REDI programme has helped promote the development of biomass for heating purposes. It has supported 35 projects, which from 1998 to 2002 developed 66 MW of capacity. The value of the facilities is CAN$ 7.2 million and the incentive paid by REDI was CAN$ 1.21 million.

Energy from Wastes

Bioenergy derived from wastes is gaining momentum in Canada. Energy recovery from landfill sites, biogas generated by various sources and combustion of municipal solid wastes is proving to be a sensible way of dealing with an environmental problem. According to Canadian officials, total electricity generation from wastes is currently about 750 GWh with a potential to double over the next decade. Demonstration projects have been supported by the Technology Early Action Measures (TEAM) Programme.

Liquid Biofuels Production

Ethanol

Support for ethanol dates back to the mid-1990s when the government removed the excise tax (main fiscal measure) on the ethanol portion of blended gasoline and established a programme to protect producers from any future change in this policy. The current production capacity totals about 200 million litres per year. The federal government will support the construction of new fuel ethanol facilities as part of a competitive process under the Ethanol Expansion Programme announced in 2003.

Biodiesel

Before biodiesel can become commercially viable in Canada, more research and development must be done to find cost-effective ways to produce it and to make sure it works in cold weather. The commissioning of a commercial-scale biodiesel production facility, with an annual capacity of 60 million litres, is planned in 2004. The plant will produce biodiesel from vegetable oils and waste animal fat. Biodiesel has been tested in buses in Montréal and in Saskatoon.

Wind Power

Figure 11. **Wind Power Capacity and Electricity Production**

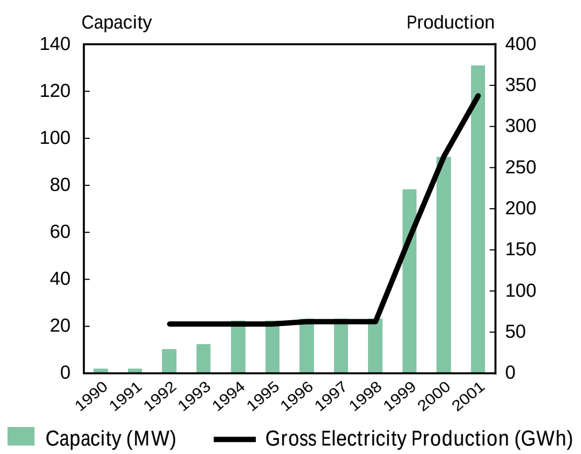
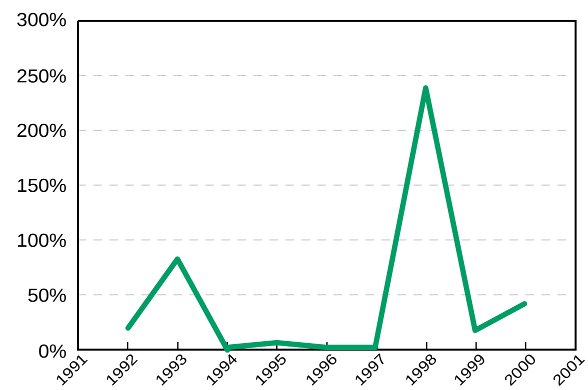
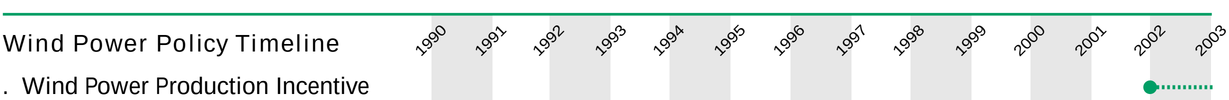


Figure 12. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Installed wind power capacity has increased from 1 MW in 1990 to 131 MW in 2001.

The Wind Power Production Incentive (WPPI) is the most important policy measure to support wind power development. Started in 2002, WPPI is a grant programme to support the installation of 1 000 MW of wind capacity over five years. One year after the launch of the programme, it appears that the 1 000 MW target will be achieved earlier than planned. A number of proposals have been submitted from various regions of Canada. One example of a wind power scheme is the SaskPower Cypress Wind Project in Saskatchewan.

Natural Resources Canada led a national consultation process on wind energy in 2003 in order to identify R&D needs, opportunities and priorities, and seek opportunities for Canadian industrial development. The consultation involved federal and provincial organisations, the Canadian Wind Energy Association and private sector representatives. The endpoint of the consultation process was an inter-departmental meeting to present and discuss national priorities and build support across federal departments for a Wind Innovation Strategy for Canada. This strategy is under development.

Solar Photovoltaic

Figure 13. **Solar Photovoltaic Capacity and Electricity Production**

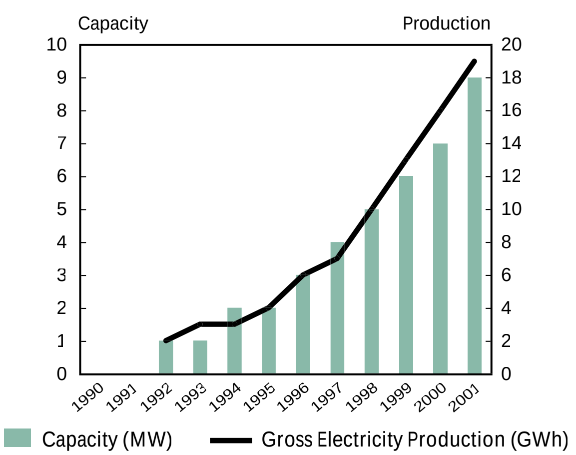
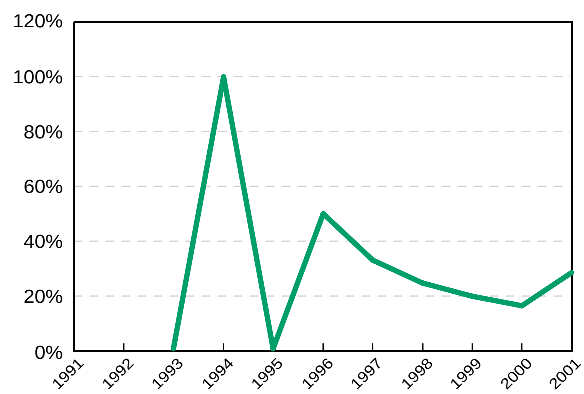
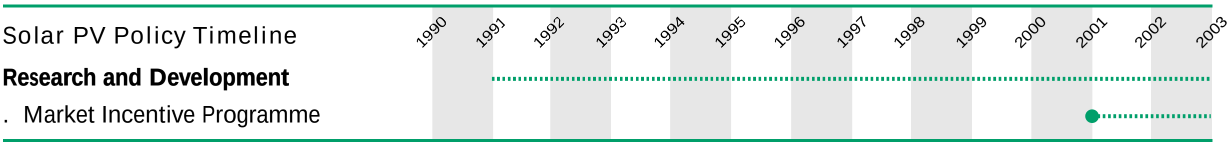


Figure 14. **Solar Photovoltaic Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

In 1995 installed solar photovoltaic (PV) capacity was 2 MW and gradually increased to 9 MW in 2001.

The CANMET Energy Technology Center supports the development and use of photovoltaic technology. Two strategic approaches are used. The first aims to advance technology deployment in Canada. The second involves exploiting PV technology potential nationally and internationally. All efforts are directed toward facilitating user's understanding of the technology.

The main activities include:

- RD&D on PV technology and systems.
- Modelling and optimisation of PV – generator set hybrid systems in cold climates.

- Development of certification and installation standards for PV systems.
- Development of national guidelines for interconnection to the grid of distributed power sources.
- Assessment of opportunities for PV in building applications.
- Promotion of the use of PV, wind and micro-hydro in federal facilities.
- Follow-up of Canadian activities and market status.
- Information dissemination to the Canadian PV industry.

Ocean Energy

Canadian coasts and offshore areas contain enormous, exploitable renewable primary energy resources. Relevant forms of ocean energy are tide, wave, tidal (marine current) and salinity. In Canada, an 18 MW tidal plant was built at the Bay of Fundy in 1984. Though the conversion technology is the most developed due to its similarity to conventional hydro power, this type of energy conversion may cause significant changes to the estuarine ecosystem and there are few suitable locations on the Canadian coasts.

Both Canada's coast lines and offshore areas have favourable wave energy resources. For example, average near-shore wave power for the west coast of Vancouver Island is 33-kW/metre width of wave front. The total incidental wave power for Vancouver Island is estimated at 6-8 GW.

With respect to tidal currents, a recent resource assessment for Vancouver Island and the British Columbia mainland has identified 55 sites with a current speed of > 2 m/s. The estimated energy potential from these sites is more than 2 GW. Twelve specific sites, each having more than 10 MW potential, have been identified.

The other form of available ocean power for Canada is salinity power. Osmotic pressure difference between fresh water and seawater is equivalent to 240 m of hydraulic head. Thus a stream flowing at 1 m^3/s into ocean could produce 1 MW of electricity. Conversion technologies (membrane or turbine) are at an early stage of development.

There is significant interest in the west coast of Canada for harnessing wave and tidal current resources to generate electricity and for other applications, such as integration with wind and solar, for desalination and for aquaculture, and for hydrogen production. Recently, a British Columbia ocean energy system core group was formed to drive this interest. Technologies for wave and tidal current energy conversion process are at pre-commercial stage and various technological, market and policy barriers exist at present for harnessing these primary renewable energy sources.

Canada Policy Chronology[1]

Program of Energy Research and Development (PERD)

Year 1974 - Present

Policy Description The Program of Energy Research and Development (PERD) is a programme that conducts R&D in all areas of energy except nuclear fission. The majority of federal funding for technology initiatives for renewables originates from PERD.

PERD is a unique federal energy science and technology programme which designs and funds work done inter-departmentally by twelve federal departments and agencies in support of Natural Resources Canada's energy priorities. The Office of Energy Research and Development administers PERD's annual budget of CAN$ 57.6 million and evaluates PERD programmes against identified performance indicators. CAN$ 5 million are invested annually in R&D related to renewable energy technologies.

Policy Type RD&D

RE Technology All renewables

Income Tax Act

Year 1994 - Present

Policy Description The Income Tax Act contains the only non-R&D programme initiated in the 1980s that is still in existence today. It is an accelerated capital cost allowance for certain renewable energy assets.

The federal Income Tax Act provides an accelerated capital cost allowance (30% capital cost allowance rate computed on a declining balance basis) for certain types of renewable energy equipment used to generate electricity or to produce thermal energy for direct use in an industrial process. A range of renewable energy conversion and energy efficiency equipment is eligible for inclusion, such as certain co-generation systems, small-scale hydropower installations, wind energy conversion equipment, certain photovoltaic and active solar heating equipment and equipment used in certain landfill gas applications.

The Income Tax Act also allows the first, exploratory wind turbine of a wind farm to be fully deducted in the year of its installation, in a manner similar to the one in which the first, exploratory well of a new oil field can be written off.

The eligibility has been broadened to include certain fixed-location fuel cells and ancillary fuel reformation and electrolysis equipment acquired after 18 February 2003.

1. Provincial governments have also developed their own measures to promote the development and deployment of renewable energy in the market.

Policy Type Investment tax credits

RE Technology Hydropower
Offshore wind
Onshore wind
Solar photovoltaic

Government Purchases of Electricity from Renewable Sources

Year 1997

Policy Description Following a recommendation in 1994 by the Task Force on Economic Instruments and Disincentives to Sound Environmental Practices, Natural Resources Canada (NRCan) studied the feasibility of having the federal government buy some of its electricity from emerging renewable energy sources (ERES). After consulting with electrical utilities and the renewable energy industry, NRCan announced its intention to start pilot projects to purchase electricity from renewable sources. ERES include wind, solar, water, biomass and geothermal where the electricity is generated from emerging and innovative applications.

In 1997, NRCan began purchasing electricity from ERES from ENMAX, Calgary's electric system. The ten-year agreement with ENMAX is for the production of 10 000 megawatt hours of electricity from renewable sources for NRCan´s Alberta facilities. Environment Canada also signed an agreement with ENMAX for 2 000 megawatt hours of green electricity for their electricity requirements in Alberta. Together, NRCan and Environment Canada agreements will displace more than 10 000 tonnes of CO_2 annually.

In 2000, NRCan signed a ten-year agreement with SaskPower, Saskatchewan's electric utility and is receiving about 32 000 megawatt hours annually of wind power for its facilities in Saskatchewan.

Early in 2001, NRCan signed an agreement with Maritime Electric from Prince Edward Island to purchase electricity from ERES. This ten-year agreement is for the production of 13 000 megawatt hours annually of wind power. The pilot projects in Saskatchewan and Prince Edward Island will deliver about 40 000 tonnes of greenhouse gas emissions reductions annually.

Under *Action Plan 2000 on Climate Change*, it is expected that the federal government will purchase an additional 400 000 megawatt hours or so of electricity from ERES. Assuming a continued focus on the displacement of high-carbon electricity, these 400 000 megawatt hours will come from several provinces, particularly Nova Scotia, Ontario and New Brunswick, with additional purchases in Alberta. These purchases will result in a further reduction in greenhouse gas emissions of about 200 000 tonnes annually.

The goal of the Government purchases of electricity from ERES is to:

- Provide a "first customer" to help interested utilities gain experience with different electricity products.
- Achieve emissions reductions in federal operations.
- Leverage first purchases to create viable green power markets.

Policy Type Government purchases

RE Technology All renewables

Renewable Energy Deployment Initiative

Year 1998-2007

Policy Description The Renewable Energy Deployment Initiative (REDI) was announced in 1997, and came into effect in 1998. It is a six-year, CAN$ 24 million programme designed to stimulate the demand for renewable energy systems for space and water heating and cooling.

Under REDI, NRCan undertakes market development activities, in co-operation with renewable energy industry associations and other partners, and provides an incentive for specific renewable energy systems. To encourage the private sector to gain experience with active solar and large biomass combustion systems, businesses are eligible for a refund of 25% of the purchase and installation costs of a qualifying system, up to a maximum refund of CAN$ 80 000. NRCan provides a similar incentive to federal departments and to public institutions. Some incentives are also provided to the residential sector for pilot projects delivered by partners.

In remote communities, businesses, institutions and other organisations may be eligible for a refund of 40% of the purchase and installation of a qualifying system, up to a maximum refund of CAN$ 80 000.

In 2001, the government, through its Action Plan 2000 on Climate Change, announced an investment of CAN$ 2 million over five years to extend the voluntary Renewable Energy Deployment Initiative (REDI) to industrial organisations.

CAN$ 25 million was earmarked in 2003 for the continuation of the REDI until 2007. REDI has played an important part in developing the growing market for reliable and cost-effective renewable energy technologies, including solar water and space heating systems, ground source heat pumps, and high-efficiency/low-emission biomass combustion systems. Funding details for future years will depend upon the results of an independent review, the results of which are expected in March 2004.

Policy Type Consumer grants/rebates/Voluntary programmes

RE Technology All renewables

National Fuel Cell Research and Innovation Initiative

Year 1999

Policy Description In 1999, the government launched the National Fuel Cell Research and Innovation Initiative, announcing a CAN$ 30 million investment to further strengthen industry's R&D. As part of the initiative, a new National Fuel Cell Research Facility at the National Research Council's Innovation Centre at the University of British Columbia was inaugurated. Funding for the project is provided from existing programmes.

Policy Type RD&D

RE Technology Hydrogen

Support to Geothermal Energy

Year 2000-2003

Policy Description In 2000, the government signed a three-year agreement with the Geothermal Heat Pump Consortium for the promotion of the use of geothermal energy for heating and cooling. The consortium is to develop a package of marketing services to accelerate take-up of geothermal energy systems.

Policy Type Voluntary programmes

RE Technology Geothermal

Sustainable Development Technology Canada

Year 2000 - Present

Policy Description Sustainable Development Technology Canada (SDTC) is an arm's-length foundation created under the Canada Foundation for Sustainable Development Technology Act.

The objective of the Foundation is to stimulate the development and demonstration of Canadian technologies related to climate change and air quality. The Foundation also acts as a catalyst for creative and collaborative solutions designed to deliver positive environmental and economic benefits to Canadians.

Eligible recipients are partnerships that include the private sector and academic and non-governmental organisations. Eligible projects are aimed at advancing the development and demonstration of new technologies.

Policy Type RD&D

RE Technology All renewables

Green Municipal Funds

Year 2000 - Present

Policy Description In the 2000 federal budget, the government established two complementary funds to stimulate investment in innovative municipal infrastructure projects and environmental practices for Canadian municipal governments and their public and private sector partners. The government is providing CAN$ 250 million to encourage projects and studies in communities. The funds leverage investments from municipal, provincial and territorial governments, and stimulate public and private partnerships. There are two funds: the Green Municipal Enabling Fund (GMEF) – CAN$ 50 million; and the Green Municipal Investment Fund (GMIF) – CAN$ 200 million.

GMEF provides grants for cost-shared feasibility studies to improve the quality of air, water and soil through greater energy efficiency, the sustainable use of renewable and non-renewable resources and more efficient water, waste and waste-water management.

GMIF supports the implementation of innovative environmental projects. Through GMIF, a municipal government can borrow at preferred interest rates of 1.5% below the Bank of Canada bond rate. Partners are also eligible for loans at attractive rates. The Fund also provides grant funding for pilot projects with significant environmental impact and replication on a regional or national basis.

Policy Type Capital grants / Third-party finance

RE Technology All renewables

Market Incentive Program

Year 2001 - Present

Policy Description The purpose of this programme is to provide incentives to electricity retailers to purchase or produce electricity based on emerging renewable electricity sources from new or expanded generating capacity, or to promote the sales of electricity from emerging renewable energy sources. By offering financial incentives to electricity retailers to purchase or produce electricity from emerging renewable energy sources (ERES) from new generating capacity, this initiative aims to increase the competitiveness of ERES to residential and small business customers under green power programmes. The objective is to provide a short-term financial incentive up to 40% of the eligible costs of an approved project.

Policy Type Capital grants

RE Technology Offshore wind
Onshore wind
Solar photovoltaic
Biofuel
Hydro

Future Fuels Initiative

Year 2001 - Present

Policy Description

The Future Fuels Initiative is part of the government's Action Plan 2000 on Climate Change. It aims to increase Canada's annual ethanol production and use four-fold (by 750 million litres). That could mean 35% of Canada's total gasoline supply would contain 10% ethanol. The programme is jointly delivered by Natural Resources Canada and Agriculture and Agri-Food Canada.

The Future Fuels Initiative renews the National Biomass Ethanol Program (NBEP) to help overcome lender resistance to investing in ethanol plants because of uncertainty about excise tax policy. Currently, there is an excise tax exemption on the ethanol portion of blended gasoline. The NBEP provides for CAN$ 140 million in contingent loan guarantees to encourage financing for new plants that produce ethanol from biomass such as plant fibre, corn and other grains.

The Future Fuels Initiative also adds CAN$ 3 million over five years to provide market information to retail consumers. It provides for activities such as public education on fuel ethanol, analysis of fuel ethanol markets and producer economics and provides a liaison with provinces/territories and industries that are interested in ethanol plant expansion.

In 2003, the federal government announced that CAN$ 11.9 million would be invested to support research and provide incentives for industrial-scale bio-diesel pilot plants, and support demonstrations of its effectiveness to encourage broader use of this cleaner-burning alternative to conventional diesel.

Policy Type Excise tax exemption / Third-party finance / RD&D

RE Technology Biofuels

Federal House in Order Programme

Year 2001-2006

The government will invest a further CAN$ 50 million over five years to expand the Federal House in Order programme, launched with an initial investment of CAN$ 44 million in 2001. The eleven departments involved in this initiative have already reduced emissions by 24%.

The government will take up some of the specific measures related to renewable energy to put its own house in order include the following:

- Increasing the use of lower-emitting vehicles in the federal fleet and reducing GHG emissions from fleet operations.
- Continuing to work toward fulfilling a commitment to meet 20% of federal electricity requirements from emerging low- or non-emitting sources.

Policy Type Government purchases

RE Technology All renewables

Wind Power Production Incentive (WPPI)

Year 2002-2007

Policy Description The Canadian government launched the Wind Power Production Incentive (WPPI) in 2002. It is expected to boost the country's installed wind capacity by 500% over five years. The fifteen-year, CAN$ 260 million (US$ 170 million) programme is designed to support the installation of 1 000 MW of new wind power. The WPPI is expected to leverage about CAN$ 1.5 billion (US$ 1 billion) of capital investments across the country.

The WPPI only covers about half the cost premium for wind power in Canada, which reflects a decision by the federal government to try to spur complementary actions in the provinces. Projects commissioned between 1 April 2002 and 31 March 2003 received CAN$ 0.012/kWh (US$ 0.008/kWh) for the first ten years of their operation. The incentive payment drops to CAN$ 0.010/kWh (US$ 0.0065/kWh) for projects commissioned between 1 April 2003 and 31 March 2006, and then to CAN$ 0.008/kWh (US$ 0.005/kWh) for wind farms that begin operation during the last year of the programme, which ends 31 March 2007. The programme sets aside a minimum capacity of 10 MW for each province and 1 MW for each of Canada's three northern territories. To avoid the possibility that rapid take-up in a few provinces will reduce opportunities in others, a maximum of 300 MW of qualifying capacity per province has also been set.

The WPPI rules set out a number of other criteria for qualifying projects and producers. The minimum capacity for eligible wind projects is 500 kW, except in northern and remote locations, where projects as small as 20 kW are eligible. The maximum amount payable to any one producer over the course of the programme is CAN$ 64 million (US$ 42 million).

Policy Type Guaranteed prices/feed-in tariff

RE Technology Onshore wind

Aboriginal and Northern Communities

Year 2003-2007

Policy Description The government supports efforts by aboriginal and northern communities to improve their energy efficiency and use alternative energy sources. The CAN$ 30.7 million Aboriginal and Northern Community Action Program (ANCAP) will expand partnerships over the next four years with Aboriginal peoples and Canadians in northern regions to build an effective response to climate change, at the same time enhancing quality of life by reducing energy costs and improving local air quality.

Through the ANCAP, the government will work with all aboriginal and northern communities, with particular emphasis on supporting the approximately 130 remote aboriginal and northern communities that rely on diesel generation as they work to improve their energy efficiency and adopt alternative energy sources to reduce their dependence on diesel fuel.

This initiative will focus on four key areas to address climate change challenges facing northern and aboriginal communities with action in:

- Community energy planning and management.
- Renewable energy and improved technology applications (*e.g.*, small hydro, wind, solar, variable generators).
- Enhanced energy efficiency of existing and new aboriginal facilities.
- Capacity building, training and tools.

The original CAN$ 3.7 million Aboriginal and Northern Climate Change Programme was a successful pilot project initiated under the government's Action Plan 2000 on Climate Change that helped aboriginal and northern communities participate in climate change activities.

Policy Type Consumer grants/rebates

RE Technology All renewables

Climate Change Technology and Innovation

Year 2003 - Present

Policy Description The government wants to help industry meet climate change targets, as well as lay the foundation for new, cleaner technologies and economic opportunities. The government will invest in technology and innovation with a focus on five areas critical to achieving climate change goals. Those areas related to renewable energy technologies include:

Hydrogen Economy: to build knowledge and accelerate the development and commercialisation of fuel cells and other technologies that will form the basis of the emerging hydrogen economy, including technologies to produce hydrogen from renewable energy sources. Investments will be available to support public and private sector partnerships to develop and demonstrate hydrogen technologies and infrastructure in integrated, real-world settings. Taken together, these investments will build on Canada's first-mover advantage internationally and ensure it remains at the forefront of the transition to the hydrogen economy.

Decentralised Energy: development and demonstration of decentralised energy production systems. These systems make more efficient use of locally available energy resources and renewable sources such as wind, solar and landfill gas. They can be used in residential, commercial and industrial applications and in combined heat and power applications.

Biotechnology: to support the development and demonstration of bio-based energy systems and technologies. This covers a broad range of technologies, including biomass and waste conversions; cellulosic ethanol from biomass and other biofuels; bio-processes; biomass production, harvesting and transportation; and energy from biomass. This investment is complemented by investment in biodiesel technologies.

Policy Type RD&D

RE Technology All renewables

Climate Change Action Fund – Technology Early Action Measures (TEAM)

Year 2003 - Present

Policy Description Under its climate change initiatives, the government announced several programmes in support of renewable energy technology development and demonstration. The main programme for R&D is Technology Early Action Measures, under the Climate Change Action Fund. The programme funds technology projects that promise to reduce GHG emissions, nationally or internationally, while sustaining economic and social development. The programme aims to help accelerate the demonstration and commercial deployment of new technologies. Proposed projects must be sponsored and co-funded by government R&D programmes.

www.climatechange.gc.ca

Policy Type RD&D

RE Technology All renewables

Canadian Renewable Energy Network

Year 2003 - Present

Policy Description The Canadian Renewable Energy Network (CanREN) was created through the efforts of Natural Resources Canada and its stakeholders. Its purpose is to increase the understanding of renewable energy to accelerate the development and commercialisation of renewable energy technologies.

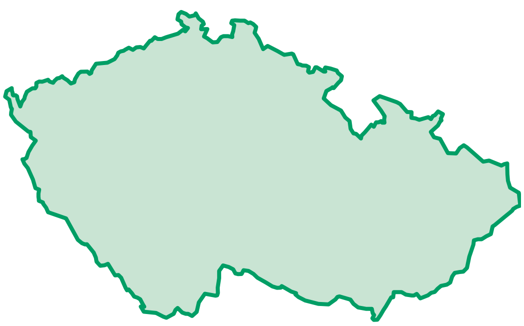
CanREN promotes what NRCan and its partners are doing to advance the role of renewable energy in Canadian society. It offers general information on renewable energy sources, highlights the technologies and applications being developed to harness these sources, and presents Canadians with the knowledge and support they need to make renewable energy part of their everyday lives.

www.canren.gc.ca

Policy Type Public awareness

RE Technology All renewables

The Czech Republic



Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

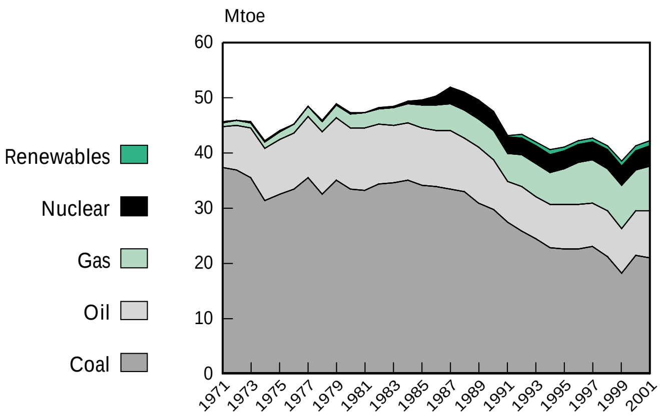
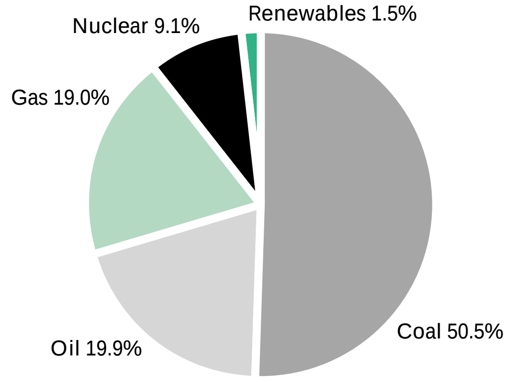


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1. See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1971	1980	1990	1995	2000	2001	Imports
Coal	37.3	33.4	29.8	22.6	21.5	21.1	•
Oil	7.4	11.1	9.0	8.0	7.9	8.4	97.7%
Gas	0.8	2.6	5.3	6.5	7.5	8.0	96.3%
Nuclear	0.0	0.0	3.3	3.2	3.5	3.8	-
Renewables	0.1	0.2	0.1	0.6	0.6	0.6	-
Biomass	*0.0*	*0.0*	*0.0*	*0.4*	*0.4*	*0.5*	
Hydro	*0.1*	*0.2*	*0.1*	*0.2*	*0.2*	*0.2*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Total	**45.6**	**47.3**	**47.4**	**41.0**	**40.4**	**41.4**	**25.8%**
% Renewables	*0.2%*	*0.4%*	*0.3%*	*1.4%*	*1.3%*	*1.5%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*
• *Net Exporter*

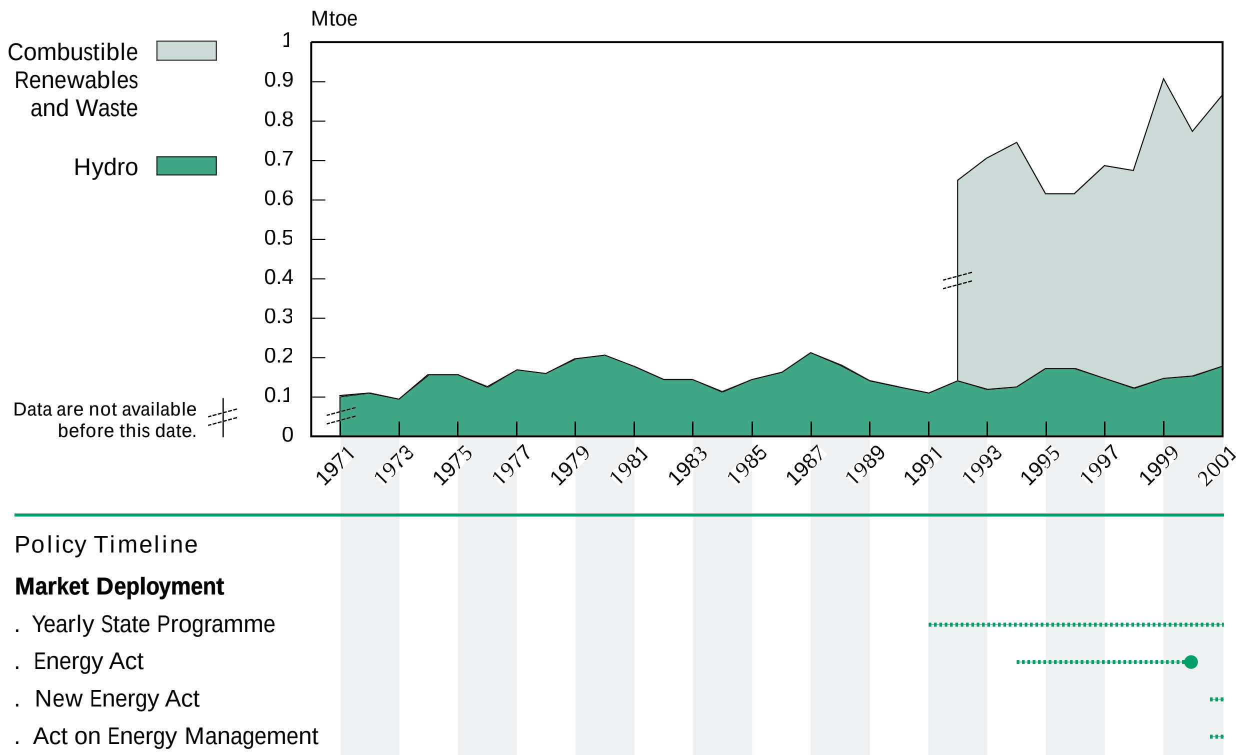
In 2001, total primary energy supply (TPES) was 41 Mtoe, down from 47 Mtoe in 1990, an average decline of 1.1% per year. A decade of transition has modified both the energy supply and the fuel mix. Between 1990 and 2001, energy production, mainly coal, decreased by 20% while energy imports increased by 25%. The Czech Republic has limited domestic energy resources, mainly solid fuels, which make up half of TPES. Coal accounts for the majority of domestic energy production. The share of coal in TPES in 2001 was 51% while oil represented 20% of TPES, followed by natural gas at 19% and nuclear power at 9%. This remained largely the same in 2002, according to Czech energy officials.

In 2001, renewable energy represented 1.5% of TPES, mostly from biomass and hydropower. Data for 2002 from the Czech Republic indicate that renewables accounted for 2.7% of TPES. Czech energy authorities confirm that the renewable energy market remained static between 1990 and 1993 and experienced little growth between 1994 and 2002. The composition of renewables in the supply mix has remained relatively unchanged.

Electricity generation has traditionally been dominated by fossil fuels, though their share declined from 82% in 1990 to 71% in 2001. Nuclear power increased its share from 7% in 1990 to 9% in 2001 and has continued to grow. According to Czech data for 2003, fossil fuels accounted for 67% of electricity production. Total production of electricity grew from 62.6 TWh in 1990 to 74.2 TWh in 2001 and has grown more steeply to 83.2 TWh in 2003. The renewable energy contribution to electricity generation accounted for 3.5% of electricity production in 2001. In 2003, the renewables contribution decreased to 3.1% of electricity production with 2.2% from hydropower and 0.9% from biomass.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

In 2001, renewables represented 1.5% of TPES, mostly biomass at 72% and hydropower at 28%. The contribution of hydropower has remained relatively constant. Data indicate market growth for biomass and waste of about 3.4% per year between 1992 and 2001 (data not available before 1992). Primary energy supply from new renewables, mostly wind power, increased about 22% per year between 1998 and 2003. These growing markets may be attributable to the new renewable energy programmes introduced in 1991. The government aims to increase the share of renewable energy sources to at least 5-6% of TPES and 8% of the electricity production by 2010 in an effort to converge with EU renewable energy targets and policies.

Renewable generated electricity accounted for 3.4% of gross electricity production in 2001. Hydropower and biomass were and continue to be the main contributors of renewable generated electricity. Hydropower accounted for almost 80% of the renewable energy contribution to electricity while biomass comprised the remaining 20% in 2001.

Research and Development Trends

The National Research & Development Programme provides funding for projects selected from all sectors of the national economy. Although there is no special budget for energy projects, the programme's priorities include nuclear safety, the use of coal and renewable energy sources and energy efficiency. The total amount spent on research and development in the area of renewable energy is not known, but it is estimated to have been used largely for demonstration projects.

Market Deployment Trends

The Czech government's market deployment efforts to promote the use of renewable energy rely on the State Programme to Support Energy Saving and Use of Renewable Sources of 1991, which offers investment incentives and excise and sales tax exemptions. In 2001, in the context of the Kyoto protocol and EU accession, the Czech Republic expanded their market deployment efforts to include technology-differentiated feed-in tariffs, tax incentives and direct investment incentives.

A number of factors have restricted the growth of the renewable energy market in the Czech Republic, which, if not addressed, may impede the achievement of the renewable energy objectives. Insufficient financial and human resources at the Czech Energy Agency have limited the effective implementation of renewable energy programmes. The current over-capacity of some 15 500 GWh in electricity supply provides little or no incentive for either energy conservation or new generation from renewables. The market dominance of České Energeticke Zavody (ČEZ), the primary power utility, impedes growth of the renewable electricity and heat market and hinders the entrance of new power producers. In 2001 ČEZ owned almost two-thirds of the total installed capacity in Hungary.

The State Programme to Support Energy Saving and Use was the first and only programme during the 1990s to promote renewable energy production. The programme is renewed annually and currently supports the following incentives:

- Obligation for distribution companies to purchase electricity and heat generated from renewables based on regulated buy-back tariffs.
- Exemption from excise taxes for biodiesel fuel (methanol from rape seed).
- Reduced import duties on renewable energy equipment.
- Five-year tax relief (income and property) for investment in renewables (including small hydro < 1 MW).
- Reduced VAT rate (5% instead of 22%) for small facilities (hydropower: 0.1 MW, wind: 0.075 MW, and all solar and biomass units).
- Exemption from property tax for five years for the conversion of building heating systems from solid fuel to renewable energy.
- Reduced VAT rate of 5% paid by final consumers of biomass heat from a district heating system.
- Direct investment incentives for non-profit organisations, municipalities and individual end-users.

Support for renewable energy projects was provided as grants. Between 1991 and 2001, CZK 365 million supported 603 renewable energy projects, most of which were small hydropower projects.

Although data suggest that the biomass market was favourably influenced by the incentives and buy-back tariffs set out in the State Programme and the Energy Act, the overall renewable energy market exhibited little growth in the 1990s. The annual renewal and adjustment of the incentive levels created uncertainty at a time when predictability was vital for the growth of renewables in the energy market.

To strengthen efforts to promote renewables, the Energy Act of 1994 made purchases of electricity from renewable and secondary sources of energy technically feasible. Growth of the biomass market occurred after the passage of both the Annual State Programme and the 1994 Energy Act.

Little activity in the renewables market and the intent to converge with EU policies, brought forth a more comprehensive and integrated approach to encourage the use of renewables. The New Energy Act (2001) defined a framework for the liberalisation of the electricity and gas markets based on EU principles. It set out as goals, energy efficiency and the reduction of negative impacts of energy production on the environment in conjunction with a reorganisation of the energy sector via deregulation of prices, privatisation and liberalisation. Full liberalisation of the market is scheduled for 2006 and is expected to significantly change the policy framework for renewable energy.

The New Energy Act also stipulated the creation of the Energy Regulation Office (ERO), which defines the conditions for the obligatory purchase of electricity and heat from renewables and CHP. The ERO establishes feed-in tariffs for renewables, which are renewed annually and adjusted for inflation and renewable technology development. These feed-in tariffs are a reflection of the Czech Republic's efforts to act in accordance with EU discussions on the future of fixed feed-in tariffs as the primary instrument for the promotion of renewable electricity production. Feed-in tariffs in January 2004 were: biomass - CZK 2.40/kWh (if co-fired CZK 2.00); wind - CZK 2.70/kWh; small hydro - CZK 1.50/kWh; and solar PV - CZK 6.00/kWh.

The Act on Energy Management (2001) was responsible for the creation of energy efficiency standards for heat and electricity production. This was done through the elaboration of the National Programme for Energy Efficiency and the Use of Renewable and Secondary Energy Sources, the formulation of a State Energy Policy and regional policies for renewables. The National Programme document defines government objectives for energy conservation and the use of renewable and secondary energy sources and is reassessed every two years.

This State Energy Policy, a strategic document with a long-term outlook, was approved in March 2004. It sets out future scenarios of energy sector development to 2030 to include:

- The share of imports in TPES will grow from 30% to a maximum of 60%.
- A reduction of energy intensity of GDP by 3% - 3.5% annually.
- The share of renewable energy is to be 5-6% in 2010 and 15-16% in 2020.

Regional energy plans for all fourteen regions and towns, as mandated by the 2001 Act on Energy Management, are to include provisions for voluntary regional energy plans for smaller regions and towns. These regional plans are required to incorporate the goals and actions of the State Energy Policy. The Act also obliged regional energy plans to evaluate the use of renewables in each respective area. The content of and methodology for the preparation of regional energy plans are described in the government regulation.

Within the context of the Kyoto Protocol and accession to the EU, the Czech government committed to expand the use of renewable energy. The Czech Republic ratified the Protocol and adopted a new climate change strategy in October 2001. In 2002, a new Clean Air Act was adopted to harmonise and transpose the relevant *acquis communautaire* prior to EU accession into Czech legislation. The government set up the necessary conditions for the implementation of the flexibility mechanisms of the Kyoto Protocol. It has approved several projects, including a Joint Implementation (JI) project with the Netherlands on district heating systems using biomass and four projects with the Prototype Carbon Fund (PCF). (JI projects offer emission reduction credits to the donor country for financing projects in other countries under the Kyoto Protocol.)

In November 2003, the Czech Government approved the Act on the Promotion of Electricity and Heat Energy Produced from Renewable Energy Sources, which is in the Parliamentary approval process. The Act currently sets a target of 8% of electricity consumption by 2010 from renewables, to be achieved primarily through increases in biomass, hydropower and wind energy as indicated in Table 2.

Table 2. **Contribution of Renewables to Electricity Consumption, 2000 and 2010**

Type of renewable	2000 (GWh)	2010 (GWh)
Wind	0.6	930
Small Hydro (> 10 MW)	826	1 120
Hydro (< 10 MW)	1 165	1 165
Biomass	5.9	2 200
Geothermal	0	15
Photovoltaic	0	15
Total	**1 998**	**5 445**

Source: Ministry of Industry and Trade-Czech Republic (2004).

Support for renewables from this Act is based on higher feed-in tariffs to be paid by distributors and CEPS (the national transmission company) for electricity and heat generated from renewables. These tariffs are to continue until 2006 to coincide with the full opening of the Czech electricity market.

Starting in 2006, only small producers with a capacity less than 200 kW and photovoltaic installations will be able to benefit from feed-in tariffs and guaranteed sales. Electricity from other renewable sources will be sold at market price, but will also have the right to sell green certificates issued at regulated prices. ERO will set an annual quota for the purchase of green certificates for selected suppliers of electricity. Green certificate prices will differ according to the type of renewable sources used for generation. Suppliers who fail to meet the quota from their own purchases can buy certificates on the market or face penalties equal to three times the amount of the yearly unfulfilled quota. The draft of the new law guarantees investors in renewables to recover initial costs and make a basic profit within fifteen years.

Intermittency

Intermittency is not a current issue for the Czech power system as there is a negligible amount of intermittent generated electricity. Some problems could arise as potential wind farms reach capacity of several hundreds of MWs. The Czech government expects the individual investor to negotiate with the appropriate provider of reserve capacity and other auxiliary services to provide back-up for the intermittent conditions. The 2004 Act on the Support for Electricity and Heat (passed in 2003) includes a provision obliging the ERO to estimate and include the cost of intermittency in the feed-in tariff and green certificate prices within the framework of the obligatory purchase of electricity from renewables.

Distributed Generation

Czech energy legislation has a provision for priority grid connection for electricity generated from renewables. No special provisions have been made to counter the high cost of connection, which is uniform for generators of all types. The ERO is required to include the cost of connection within the feed-in tariff and green certificate prices.

Public Awareness

Public awareness of renewable energy issues is low. Consumers have little involvement in choosing energy suppliers and energy sources. The increase of electricity tariffs for consumers related to renewable energy sources at present is negligible (less than one percent). So far, the plan for wider use of green electricity has encountered no public opposition. If increased use of renewables for electricity drives up consumer prices by 10%, which is expected to occur within the next five years, some authorities are concerned that it could cause financial difficulties for low-income families. The Czech government anticipates that serious analysis and perhaps some type of social compensation will be needed.

Renewable Energy Markets

Hydropower

Figure 4. **Hydropower Capacity and Electricity Production**

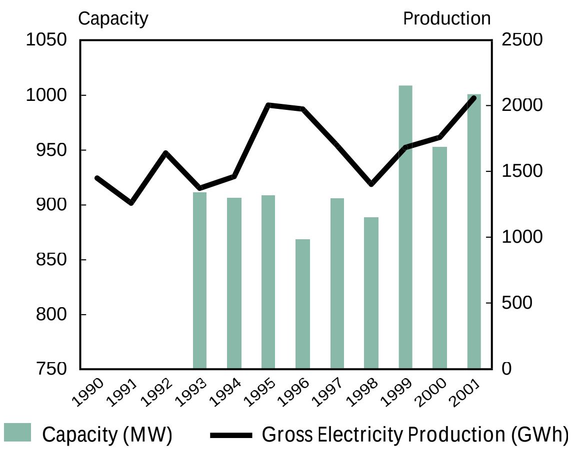
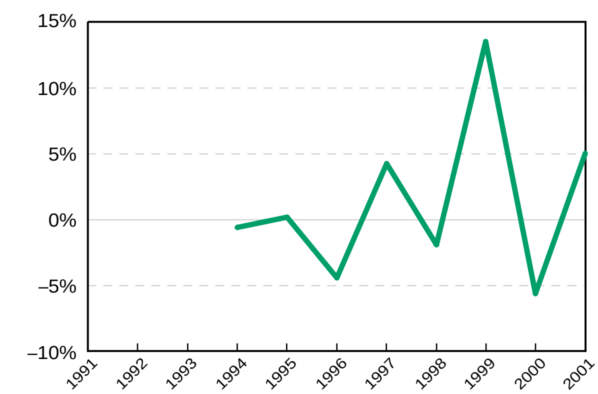
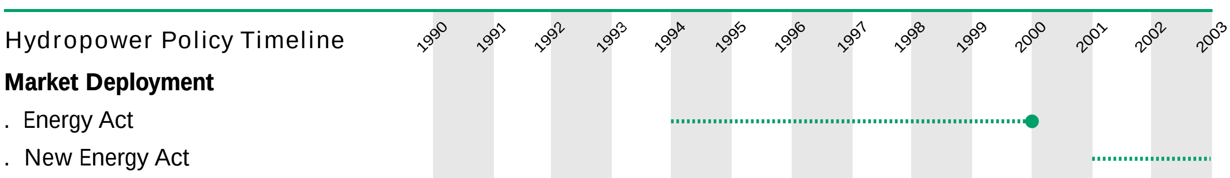


Figure 5. **Hydropower Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Hydropower generation has increased on average 5.2% per year between 1993 and 2001. Hydropower contributed 2.3% to total electricity production in 1990, and this percentage share has remained relatively steady reaching 2.8% in 2001. Variations in electricity generation strongly depend on annual precipitation cycle, the growing use of surface water for irrigation and industrial needs. For example, in 2003 hydropower production was 794 GWh compared with 2 846 GWh in 2002. This decrease was due to dry climatic conditions and damage to several primary hydropower generators.

Hydropower has long been used for electricity generation in the Czech Republic, mainly in medium-sized units located on the Vltava River and three pumped storage facilities. Generally, both the pumped storage capacity and the hydropower stations on dams and canals serve primarily as a source of peak or semi-peak load electricity. This has helped to stabilise their operation on the Czech electricity market and to generate a higher income.

The Czech government has identified a number of potential small and micro hydropower stations, which could be constructed as run-of-river plants at reasonable costs. Between 1991 and 2001, a number of small hydropower projects were supported through the State Programme of Energy Savings and Utilisation of Renewable Sources of Energy. Additional investment projects are expected to appear and hydro electricity generation is expected to grow by 20%, benefiting from increased incentives from the new Act on the Promotion of Generation of Electricity and Heat Energy from Renewable Sources. The Act includes a new system of “green certificates” and guarantees investors that they can expect to recover initial costs and make a profit within fifteen years.

Biomass Production

Figure 6. **Solid Biomass Production**

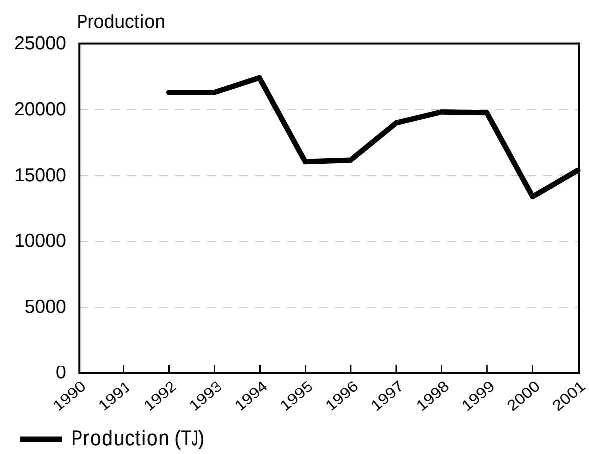
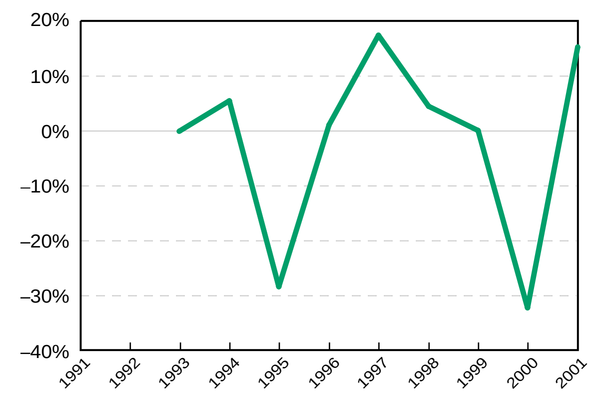
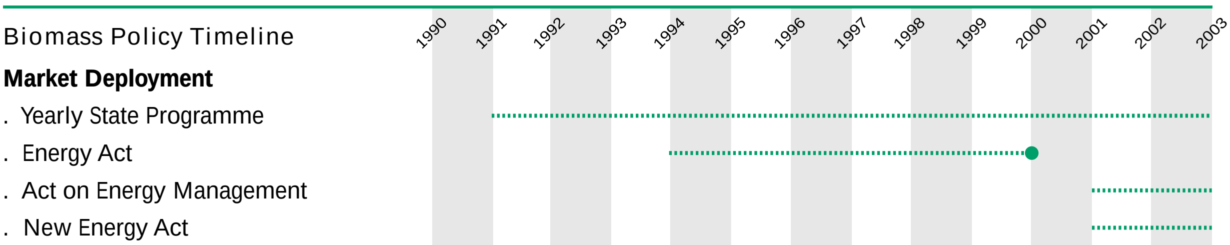


Figure 7. **Solid Biomass Production**
(Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

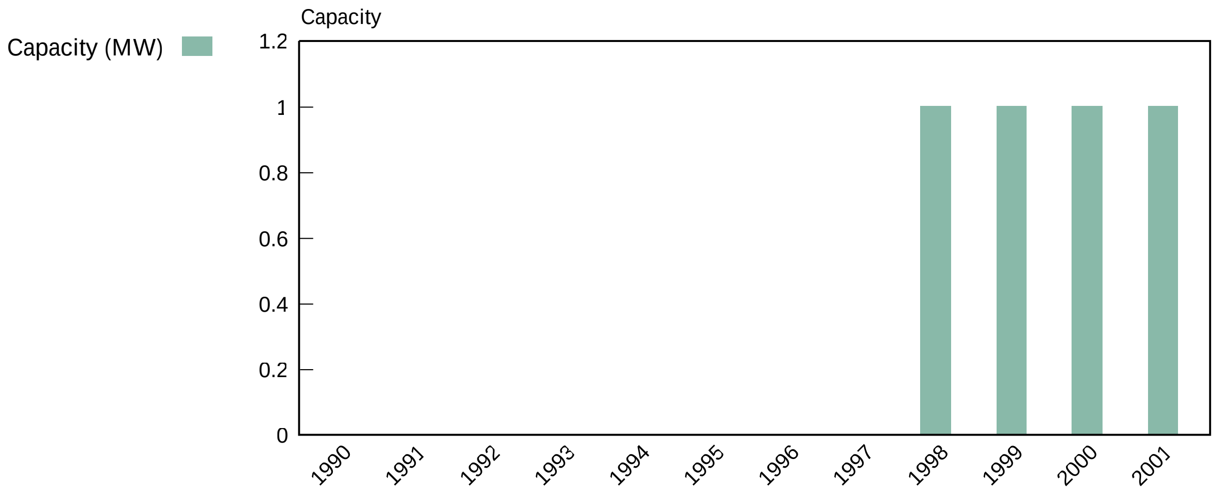
Biomass represents nearly 90% of the total potential of renewables in the Czech Republic, though biomass production actually decreased between 1992 and 2001 (no data are available prior to 1992). Biomass in the Czech Republic consists mainly of agricultural waste (straw) and forest products (wood and wood waste). Biomass electricity generation is negligible, less than 0.7% of total electricity generated in 2001. Biomass heat generation, on the other hand, is the most prominent renewable and has grown steadily from 572 TJ in 1993 to 3 362 TJ in 2001, a 42% share of heat production from renewables in 2001.

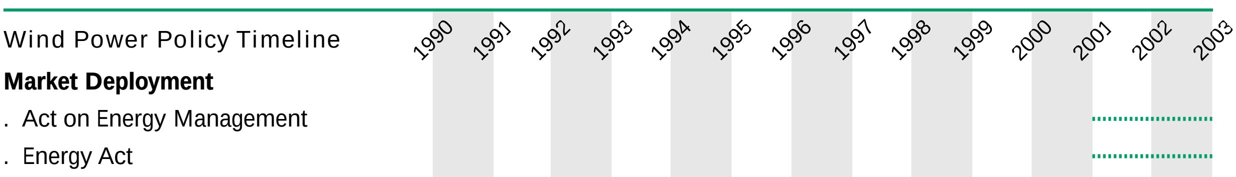
The 2004 Act on the Promotion of Electricity and Heat and the state funds that support the cultivation of energy crops are expected to create favourable conditions for the bioenergy market. Within the framework of the 2004 Act, electricity and heat from renewables is expected to amount to 85 PJ by 2010, of which 75% is expected to come from biomass. Some estimates are that up to 20% of electricity produced from biomass will be generated in co-firing facilities, mostly fluidised-bed combustion technology, with installed capacities of 50 MW or more. However, the biggest share of biomass is expected to be from small installations that produce electricity or heat and from co-generation plants.

Solid biomass and biogas are expected to be used primarily for electricity and heat generation while most liquid bio-fuels are to be used as automotive fuel. Relatively good conditions exist for the cultivation of quick growing "energy" crops in the Czech Republic especially on fields that are not well-suited to the cultivation of corn relative to other EU countries with more favourable agricultural conditions. An increase in bioenergy farming is viewed as offering energy and environmental advantages and opportunities to ameliorate unemployment problems in the agricultural sector.

Wind Power

Figure 8. **Wind Power Capacity**





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Wind power installed capacity in 1998 was 1.2 MW. IEA data for wind power electricity generation in the Czech Republic is incomplete. According to Czech authorities, wind power had a total installed capacity of 5.6 MW in 2002 and 10.63 MW in 2003, and electricity generation from wind increased from 0.1 GWh in 1998 to 3.9 GWh in 2003.

The Czech Republic does not have particularly favourable conditions for wind power generating facilities. Only individual wind turbines have been and are likely to be installed. Potential exists for the construction of wind farms in mountainous areas, such as Krusne hory, Jeseniky a Zdárské vrchy. Grid connection costs for these sites would be high. As well, these mountainous areas have been subject to much public opposition against development from local inhabitants and environmental protection legislation.

The new Act on the Promotion of Electricity and Heat Energy from Renewable Energy Sources addresses most of the barriers to wind power development and is expected to create a favourable environment for investors. In energy balance scenarios used for the preparation of new State Energy Policy, it is estimated that wind power capacity could reach 1 000 MW with an economic potential of 1 200 MW. The State Energy Policy (2004) targets the wind power market and expects electricity production from wind power to reach 1.44 TWh in 2030.

Czech Republic Policy Chronology

State Programme to Support Energy Savings and Use of Renewable and Secondary Sources

Year 1991 – Present

Policy Description The State Programme to Support Energy Saving and Use of Renewable and Secondary Sources set up by the Ministry of Industry and Trade in co-operation with other ministries was established in 1991. It is revised each year. The programme for 2000 included energy-saving measures in production, distribution and consumption of energy; wider use of renewable and secondary sources of energy; development of co-generation of heat and electricity; counselling; implementation of low-energy technologies; and educational and promotional activities. The programme is executed by the Czech Energy Agency (CEA) and other ministries. The State Environment Fund is an important participant.

Currently it provides the following incentives for renewables:

- Obligation for distribution companies to purchase electricity and heat generated from renewables based on regulated buy-back tariffs.
- Exemption from excise taxes for biodiesel fuel (methanol from rape seed).
- Reduced import duties on renewable energy equipment.
- Five-year tax relief (income and property) for investment in renewables (small hydropower plants restricted to capacities > 1 MW).
- Reduced VAT rate (5% instead of 22%) for small facilities (hydropower: 0.1 MW; wind: 0.075 MW; and all solar and biomass units).
- Exemption from property tax for five years for the conversion of building heating systems from solid fuel to renewable energy.
- Reduced VAT rate of 5% paid by final consumers of biomass heat, provided that it is a part of district heating system.
- Direct investment incentives for non-profits, municipalities and individual end-users.

Policy Type Obligations / Guaranteed prices/feed-in tariffs / Excise tax exemption / Tax exemptions / Sales taxes / Property tax exemptions / Consumer grants/rebates

RE Technology All renewables

Energy Act

Year 1994-2000

Policy Description According to the Energy Act (222/1994 Coll.), the supplier (distribution company) was obliged, if possible from a technical point of view, to purchase electrical energy produced from renewable and secondary sources of energy.

Policy Type Net metering

RE Technology All renewables

Energy Management Act

Year 2001 - Present

Policy Description The Energy Management Act (Act No. 406/2000), which entered into force in January 2001, established standards for energy efficiency of heat and electricity production, transmission, distribution and use, energy planning requirements, and energy auditing obligations.

It also set out the obligation to formulate a "National Energy Policy," a strategic document with a twenty-year outlook to express the goals of the state in energy management in accordance with economic and social development needs and protection of the environment. It stipulates the preparation of a "National Programme for Energy Efficiency and Use of Renewable and Waste Energy Sources". Amendments are expected in 2005.

The Act also stipulates mandatory regional energy plans for all fourteen regions and for fourteen towns.

Policy Type General energy policy

RE Technology All renewables

Energy Management Act - Audits

Year 2001

Policy Description The Energy Management Act aims to introduce obligatory energy audits in buildings and production sites. The secondary legislation on audits is more specifically the Decree of the Ministry of Industry and Trade N°. 213/2001/Sb., which contains details related to energy auditing. All private facilities with an annual energy consumption of 35 TJ or more are obliged to hire a state-approved auditor to prepare the facility's energy audit every eight years. The same holds for public facilities with an annual energy consumption of 1.5 TJ per year or more.

Policy Type Regulatory and administrative rules

RE Technology All renewables

New Energy Act

Year 2001

Policy Description The Energy Act, which came into force in January 2001, sets out conditions for business activities and state administration and regulations in energy sub-sectors, such as electricity, gas and heat, as well as the rights and obligations of individuals. It defines a framework for the liberalisation of the electricity and gas markets and supports the use of renewable energy sources and CHP. It defines conditions for the obligatory purchase of electricity and heat produced from renewables and from CHP. The Energy Act also includes the creation of the Energy Regulation Office.

Since 2003 electricity consumers with an annual consumption of more than 9 GWh have the right to choose their supplier. This threshold will gradually be lowered. Full liberalisation of the market is scheduled for 2006. Access to the networks by generators was liberalised in 2003. Generators of electricity from CHP and from renewable sources have the right to sell their electricity to the local distributor. The introduction of competition to the natural gas market will start in 2005. Substantial amendments of the Energy Act are expected in 2004.

Policy Type Obligations

RE Technology All renewables

Secondary Legislation on the Methodology for the Purchase of Electricity from Renewables and CHP

Year 2001

Policy Description This Ministerial Decree (No. 252/2001 Coll.) pertains to the purchase of electricity produced from renewable energy sources and combined heat and power (CHP) generation. The decree provides the framework for the administration of power and pricing and tariffs for electricity from renewable and CHP sources.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology All renewables

National Programme for Economical Energy Management and Use of Renewable and Secondary Energy Resources

Year 2002-2005

Policy Description The “National Programme” defines objectives for energy conservation and the use of renewable and secondary energy sources. It complies with economic and social requirements according to the principle of sustainable development and the protection of the environment, and is based on national energy and environmental policies. The most important objectives include a target for renewable energies of 2.9% of energy consumption by 2005, and a reduction in energy intensity. The priority is to promote renewable energy sources and energy-saving projects. Instruments to achieve targets include subsidies from the state budget. The next programme is being prepared and will be valid for 2006 to 2009.

Policy Type Obligations

RE Technology All renewables

Act on the Promotion of Electricity and Heat Energy Produced from Renewable Energy Sources

Year 2004

Policy Description In November 2003, the Czech Government approved the Act on the Promotion for Electricity and Heat Energy Produced from Renewable Energy Sources, which is currently in the Parliamentary approval process. The Act includes an indicative target of an 8% share from renewables in electricity consumption by 2010. Support for renewables is based on higher and differentiated feed-in tariffs paid by distributors and CEPS (transmission company) for electricity and heat generated from renewables. It will continue until the full opening of the Czech electricity market in 2006.

Starting in 2006, only small producers with capacity less than 200 kW and photovoltaic installations will have the right to benefit from feed-in tariffs and the obligatory purchase of their electricity. Electricity from other renewable sources will be sold at market price, but will have the right to sell the green certificates. Selected electricity suppliers will be given a yearly quota for purchases of green certificates with regulated prices set by the Energy Regulation Office (ERO). ERO will also set differentiated prices for the certificates according to the type of renewable used for generation. Suppliers who fail to meet the quota from their own purchases can buy certificates on the open market or face penalties which are equal to three times the amount of the yearly unfulfilled quota. The draft of the new law guarantees that after the law comes into effect, all investors in renewables will recover their initial costs and make a basic profit within fifteen years. This policy is expected to be promulgated in mid-2004.

Policy Type Obligations / Guaranteed prices/feed-in tariffs / Tradable certificates

RE Technology All renewables

State Energy Policy

Year 2004

Policy Description The new State Energy Policy approved by the Government in March 2004 has as one of its highest priorities the increased use of renewables and it sets measures to promote this aim. The State Energy Policy set targets of 15-16% contribution to TPES from renewables sources to be achieved by 2030 and 17% for the share of renewables in electricity consumption. The Policy envisions that biomass will play the most important role in the growth of renewables. It contains incentives and measures to be used for the promotion of renewables as described in the legal and policy acts above.

Policy Type Obligations

RE Technology All renewables

Denmark

Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

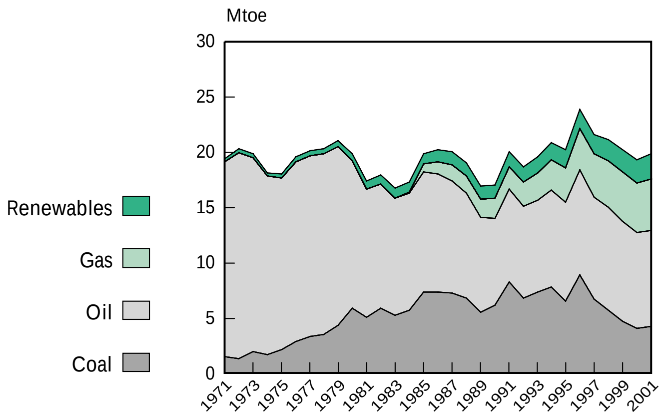
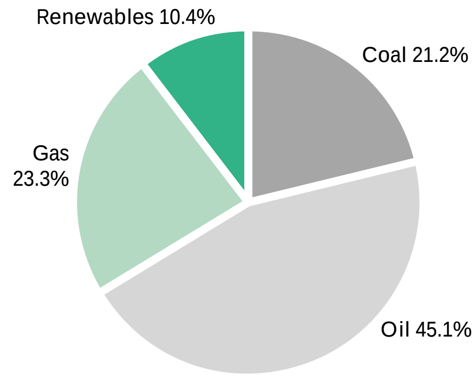


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1. See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1970	1980	1990	1995	2000	2001	Imports
Coal	2.2	5.9	6.1	6.5	4.0	4.2	96.7%
Oil	18.1	13.4	7.9	8.9	8.7	8.7	•
Gas	0.0	0.0	1.8	3.2	4.4	4.6	•
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	
Renewables	0.3	0.6	1.1	1.5	2.0	2.1	
Biomass	*0.3*	*0.6*	*1.1*	*1.3*	*1.5*	*1.7*	
Hydro	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.1*	*0.2*	*0.5*	*0.5*	
Total	**20.3**	**19.8**	**17.6**	**20.1**	**19.4**	**19.8**	•
% Renewables	*1.6%*	*3.0%*	*6.6%*	*7.1%*	*9.9%*	*10.4%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*
• *Net Exporter*

With the exception of imported coal supplies, Denmark has been self-sufficient in its overall energy supply since 1997, primarily due to production of oil and gas in the North Sea. Danish production of oil, natural gas and renewable energy in 2001 was about 37% higher than its total energy consumption, making it a net energy exporter. It is expected that total Danish energy production will be up to 50% more than consumption in the years to come.

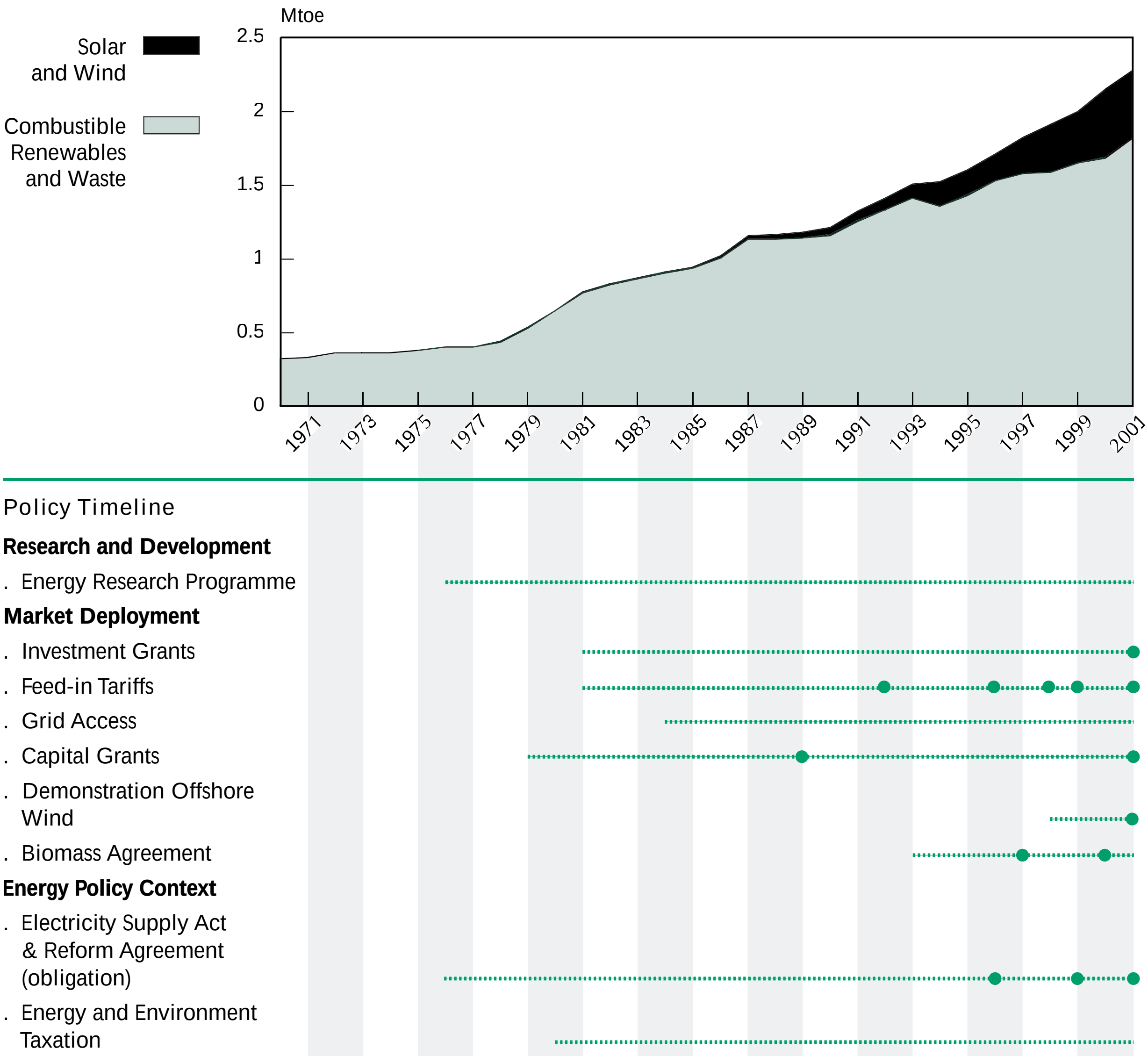
Oil accounted for 44% of TPES in 2001 (Table 1), more than half of which was used for transport. Natural gas was 23% of primary energy demand in 2001, its share having more than doubled over the past decade. Coal is the only major energy resource that is imported. The share of heat in total final consumption is high and district heating networks cover most of the densely populated areas. About 2.4 Mtoe of district heat was delivered to Danish households and businesses in 2001, one of the highest amounts in the world. A large and increasing portion of the district heat is produced through CHP production, with some 20% of it based on biomass and waste.

Renewable energy sources increased from 1.1 Mtoe in 1990 to 2.1 Mtoe in 2001. As a share of TPES this represents an increase from 6.6% to 10.4% of Denmark's primary energy supply. Biomass and wind power make the largest contribution to total renewable supply.

Electricity generation in Denmark is mainly based on coal and gas, which together accounted for 72% of total generation in 2001. Denmark opted in 1983 not to use nuclear power for electricity generation. Renewable energy represented 16% of total electricity generation in 2001, mostly from wind and biomass.

Renewable Energy Supply

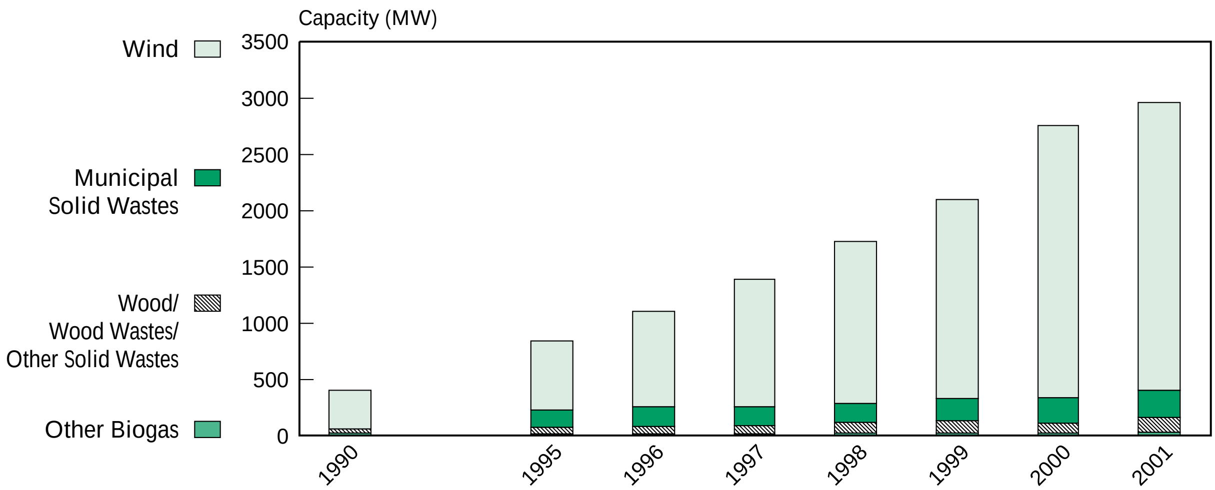
Figure 3. **Total Renewable Energy Supply and Policy Timeline**



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Biomass makes the largest contribution to total renewable supply, about 78.1%. In 2001, biomass production was 40 579 TJ and gross electricity generation from biomass was 571 GWh. Denmark had nearly 2.6 GW of wind turbine capacity installed by 2001, and wind generation corresponded to 66.7% of total electricity generation based on renewables. Municipal solid waste capacity was 242 MW and solid biomass capacity was 133 MW in 2001.

Figure 4. **Net Generating Capacity of Renewable and Waste Products**

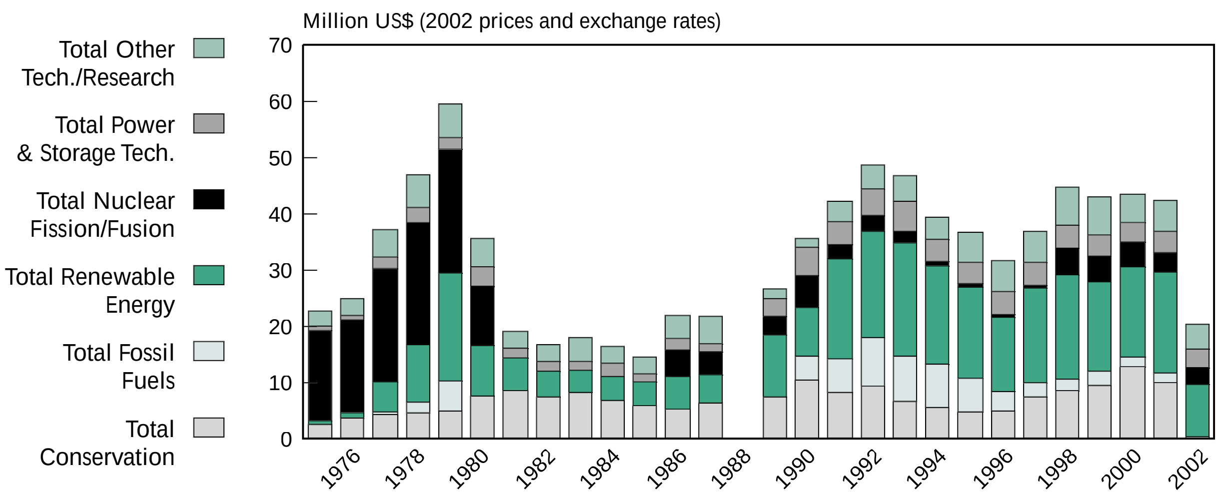


Note: A change in data collection methods at the IEA occurred in 1999 with the separation of net generating capacity between small and large hydro. Capacity data for small hydro are not available prior to 1999.

Research and Development Trends

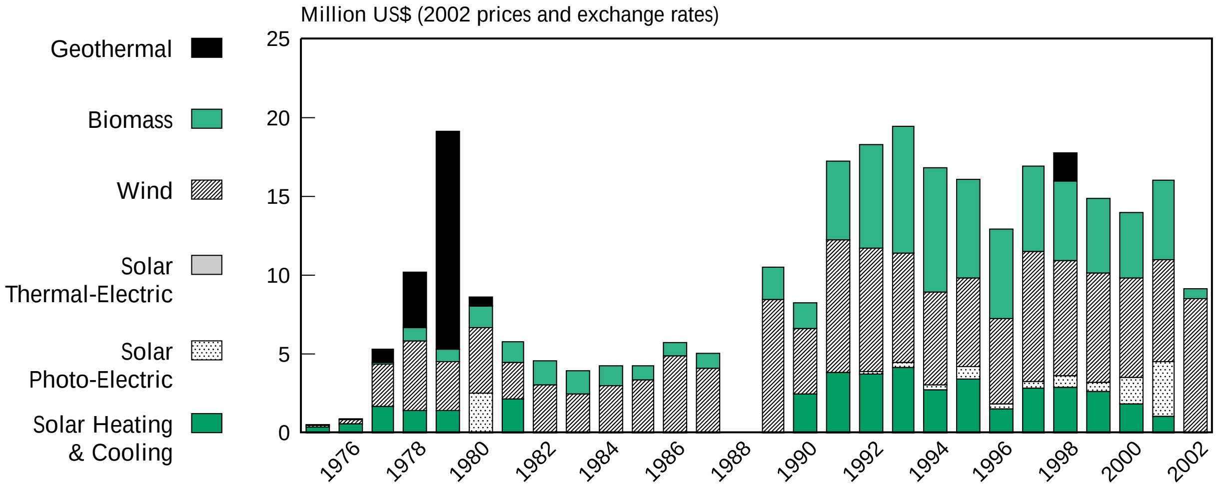
The Danish Government spent a total of US$ 890 million (2002 prices and exchange rates) on energy RD&D between 1975 and 2002. In this period, 33.3% of its total RD&D budget was allocated to renewable energy RD&D. The overall trend of government RD&D expenditures for renewables increased significantly from 1989 and retained a fairly stable level from 1991 to 2002 when RD&D spending declined notably reflecting the priority changes of the new government. However, government funds for RD&D increased again in 2004. In addition, funds from the Public Service Obligation, which are not considered government funds, recently have been applied to renewables RD&D, for example in several large biomass demonstration projects.

Figure 5. **Denmark** - **Government Energy RD&D Budgets***



** Data not available for 1988.*

Figure 6. **Denmark - Government Renewable Energy RD&D Budgets***



** Data not available for 1988.*

Among the renewable technologies, wind received the highest level of funding at US$ 134 million, or 45.3%, in the 1975 to 2002 period. Biomass was funded at US$ 79.6 million, representing 26.9% of renewable energy RD&D.

In addition, Denmark participates in international collaborative RD&D in District Heating and Cooling, Ocean Energy Systems, Photovoltaic Power Systems, Solar Heating and Cooling and Wind Turbine Systems through the IEA Implementing Agreements.

Market Deployment Trends

Thanks to strong government incentives prior to 2001-2002, renewable energy sources have increased their share in energy supply through favourable pricing and a priority for renewables in power production. The penetration of wind power has been greater than anticipated and targets have been surpassed. This is in part because the cost of wind generation has fallen. But the subsidy reduction did not keep pace, resulting in even more generous incentives for wind power. Biomass targets were not met, however. This is because district heating plants have been slow to convert to CHP production based on straw, chips and similar material, owing to technical and financial obstacles. The technical problems have recently been resolved to some degree but the financial obstacles remain, and revolve around uncertainty with respect to payments for heat and electricity deliveries.

From 1979 to 2001, the government had a programme of capital grants for the installation of different kinds of renewable energy sources. Capital grants for wind turbines were stopped in 1989, while capital grants for renewables such as PV, wood stoves and heat pumps continued to 2001. There is a long tradition for the use of agreement in Danish energy policy, and although the agreements do not serve as traditional legal instruments, they have had an important impact on expanding the market for renewable energy. In 1984 there was an agreement between wind turbine owners, manufacturers and electricity supply companies on access to the grid. In 1985, the utilities agreed to install 100 MW of wind turbines over a five-year period, and in 1990, a second 100 MW agreement entered into force. A third utility phase of an additional 200 MW was installed in 2000.

Investment incentives for some renewable energy technologies followed from the Act on Utilisation of Renewable Energy Sources. The incentives varied between 15% and 30% of the construction costs for standardised renewable energy equipment and up to 50% for development projects. For standard equipment, subsidies were up to 30% of eligible costs for biomass gas plants and 16% for biomass installations. The maximum grant was DKK 1 million. All investment subsidies were terminated in 2002.

In 1992 the purchasing agreements were cancelled and since then, the utilities have been obliged by law to pay wind turbine owners a kWh price of 85% of the electricity price for household consumers, excluding charges and with a deduction for administrative costs. In addition, there was a public subsidy for electricity production from private wind turbines of DKK 0.17 + 0.10/kWh. As a result, in 1998, the average selling price of electricity from private wind turbines was about DKK 0.58/kWh.

The Electricity Act 1996 broadened the tariffs to cover geothermal, tidal, biogas, hydro, biomass and solar PV technologies. Utilities had to give priority access to renewable sources and to pay a favourable buy-back rate. This system was changed in 2001 and new tariffs were adopted.

Energy Policy Context

The Electricity Reform Act 1999 established the role of renewable energy sources under the liberalised electricity market. It was agreed that a market-based mechanism would be introduced for trade in renewable energy and a market would be developed for green certificates. The reform changed the existing fixed tariff scheme. Under the new system, a minimum fixed price of DKK 0.33 was guaranteed for renewable electricity. Green certificates were planned to be issued to producers of electricity and consumers would be required to buy 20% of their electricity from renewable energy suppliers. The market price for certificates was to be fixed between DKK 0.10 and 0.27/kWh. If consumers did not fulfil their purchase commitments, they would have to pay DKK 0.27 for each kWh for which they did not purchase renewable energy certificates. These funds were to be placed in a renewable energy fund, the purpose of which was to buy renewable energy certificates from producers.

In 2001, a new government was elected, and overall priorities for energy policy have changed. The energy and environmental ministries were separated. Energy policy now focuses more on economic efficiency, market-based solutions and international approaches to environmental issues. Under the new political system, the green certificate market and its future will be reconsidered in the context of electricity reform. The market for green electricity was scheduled to start in 2003, but is now on hold, perhaps until a European trading scheme is in place. Until a decision is taken on the green certificate market, the price for electricity from renewables is the market price plus an environmental bonus.

Renewable Energy Markets

Biomass Production

Figure 7. **Solid Biomass Production**

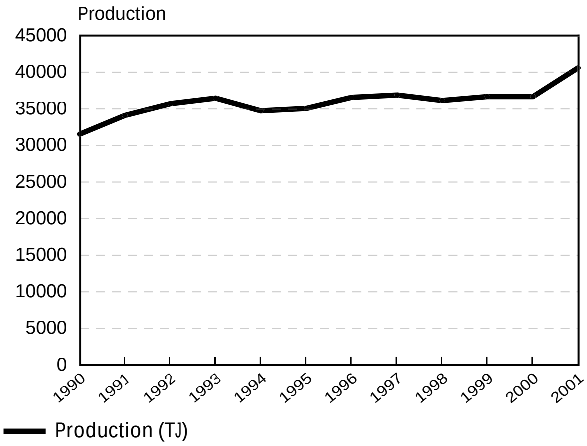
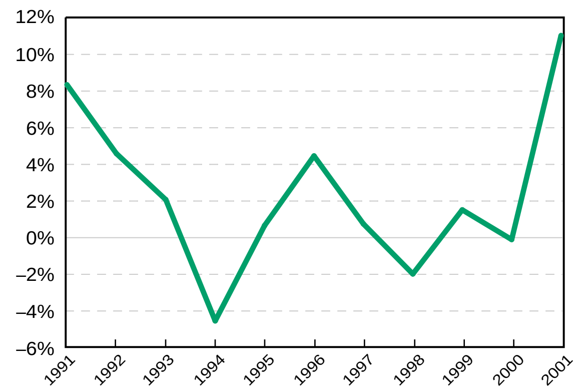
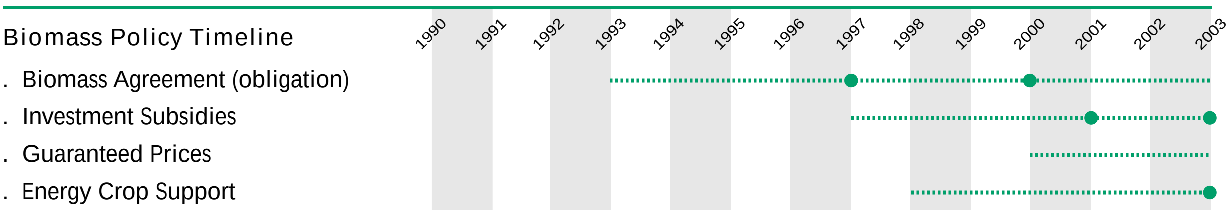


Figure 8. **Solid Biomass Production**
(Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Production of biomass increased from 31 472 TJ in 1990 to 40 579 in 2001, about 2.3% growth per year.

Biomass accounts for by far the largest share of energy generated from renewables in Denmark. It is mostly surplus from agriculture and forestry, industry and households: straw, waste wood from forests and industry, animal manure and organic wastes. Energy crops are produced to a very limited extent from willow crops in short rotation forestry. In 1997 a small demonstration programme was introduced to investigate the production of energy crops prior to a decision to expand their use after 2005.

The use of straw in district heating plants began in the 1980s and in the 1990s utilities started using straw in combined heat and power (CHP) plants. The use of straw in CHP plants is expected to increase in coming years due to the objectives set out in the Biomass Agreement. Utilities are obliged to buy at least 1 million tonnes of straw per year from 2005.

Wood chips mainly come from the thinning of forests. Their importance as a fuel in Denmark has continued to increase over the last two decades. Chips are mainly used for heat purposes, but wood chips are also used in co-generation, district heating and CHP plants.

Wood pellets are made from wood waste in industry. The market has been growing rapidly such that a considerable amount of the wood waste to make pellets is now imported from Canada, the United States, Sweden and the Baltics. Incentives have been offered since 1995 with a decline in the subsidy amount as objectives were achieved. Pellets are burned in small boilers, small district heating systems and a few CHP plants.

Biomass Electricity Production

Figure 9. **Solid Biomass Capacity and Electricity Production**

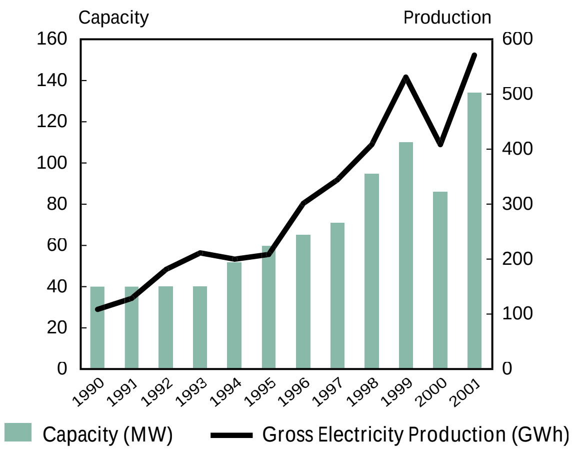
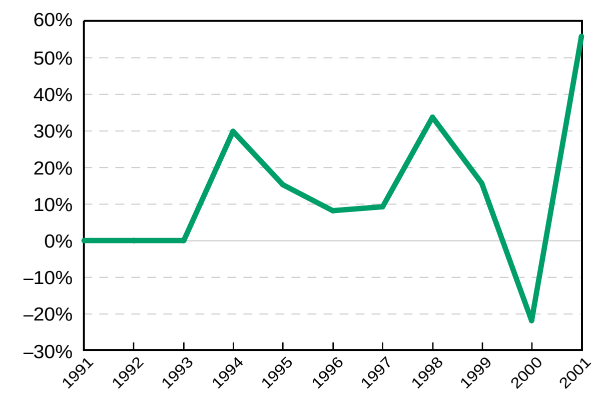
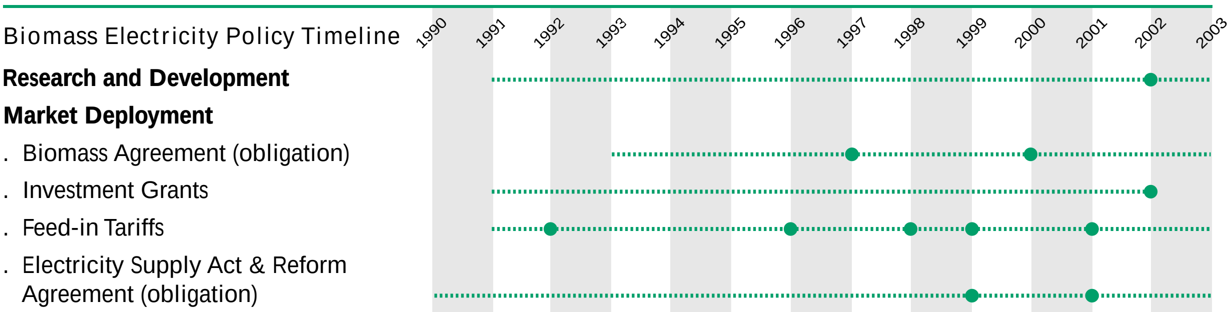


Figure 10. **Solid Biomass Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

About half of Denmark's electricity generation is from combined heat and power (CHP) plants, the highest CHP share in power generation in the world. The use of CHP combined with district heating has long been Denmark's main instrument to limit primary energy use and its environmental effects, and has benefited from strong government support. A large and increasing portion of Denmark's district heat is produced through large combined heat and power production. In 1980, 55% of the district heating systems were heat-only plants; by 1998 this portion had declined to 13%.

The use of biomass for the co-production of power and district heating grew rapidly in Denmark when the electricity companies were ordered by the government to use biomass – straw and to a lesser extent wood – in centralised CHP plants. The Biomass Agreement (1993) aimed to increase electricity generation from biomass so that by 2000, electric utilities would incorporate the use of 1.2 million tonnes of straw and 0.2 million tonnes of wood (total about 20 000 TJ) annually. The target was not met: total production of solid biomass in 2000 was 35 714 TJ, of which about 14 634 TJ was used for electricity generation (41%). The time limit to meet this obligation was extended to 2005.

A new Biomass Agreement in 2000 (along with the Electricity Reform Agreement) provides the framework for future electricity supply from biomass. On the basis of the agreement, the target is to be reached by 2004 and two or three large biomass plants are to be established by 2005. Over a ten-year production period, a minimum price of DKK 0.33/kWh is to be established as well as a minimum price of DKK 0.10 for green certificates. Individual plants will receive a further negotiated permanent supplement. A tendering process is to be used to ensure that more than the initial two to three plants are constructed. Electricity from biomass-based plant currently sells at a price of about DKK 0.60/kWh.

Biomass, straw in particular, is a more difficult fuel to burn than coal, oil and natural gas due to lower calorific value and contents that react aggressively and corrosively in typical plant operations. Denmark's two big electricity producers have been conducting comprehensive RD&D programmes to address the challenge. One company experiments with supplemental firing with straw in coal-fired boilers. The other company works with a biomass-only plant. Over the last decade the average efficiency in straw-fired steam turbine plants has increased from 20-25% to 25-32% in small plants, while more modern, large boiler plants can reach efficiencies of 42-50%.

Biomass Heat Production

Figure 11. **Solid Biomass Capacity and Heat Production**

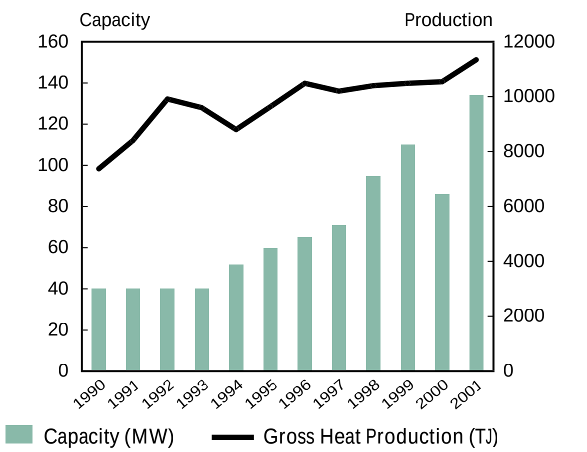
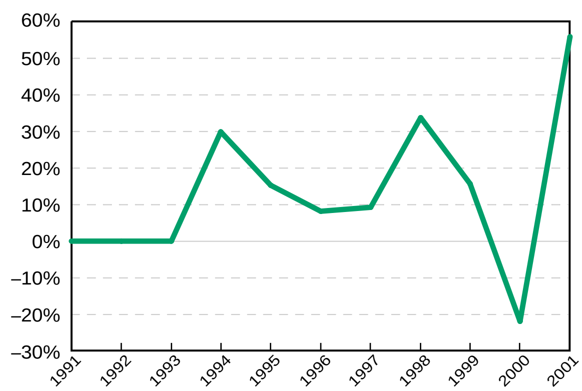
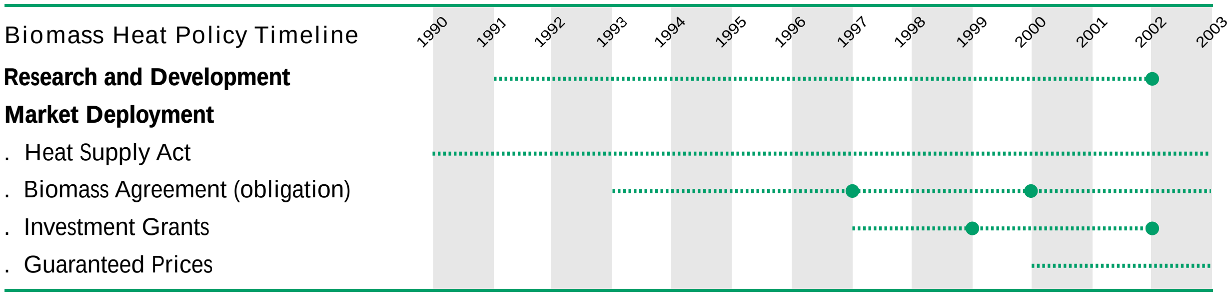


Figure 12. **Solid Biomass Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

The share of heat in total final energy consumption is unusually high in Denmark at 16%. This is due to Denmark's vast use of district heating, which was promoted through the National Heat Supply Act (1988). It included a national heat plan and the possibility for local governments to mandate connection to the district heating network for new and existing buildings. Most of the densely populated areas of the country are served by district heating networks. There has been a significant change in the fuels used in the production of district heat in the period since 1980. According to Danish statistics, the composition in 2002 was: 38% renewable energy, of which 23% was waste combustion; 30% natural gas; 24% coal and 7% oil.

In addition to the use of biomass in large-scale CHP plants (discussed in previous section), other programmes have been established to support private investment in biomass-fired heating plants. These programmes support the extension of biomass to district heating areas and areas not served by the collective supply system. Regional subsidies were offered (until 2001) for up to 21% of costs of installations in households and 26% for installations in companies, for a total cost of about DKK 25 million per year. In 2001, Denmark had 50 heating plants operating on wood chips, 25 on wood pellets, and 75 straw-fired plants.

Incentives for investment in biomass follow from the Act on Utilisation of Renewable Energy Sources (1997 and 1999 executive orders). These subsidies for standardised renewable energy technologies vary from 15% to 30% of the construction costs and up to 50% for development projects. For biomass equipment the subsidy was to up to 16% with a maximum grant of € 132 450. Many investment subsidies were cut in 2002.

Biogas Electricity Production

Figure 13. **Biogas Capacity and Electricity Production**

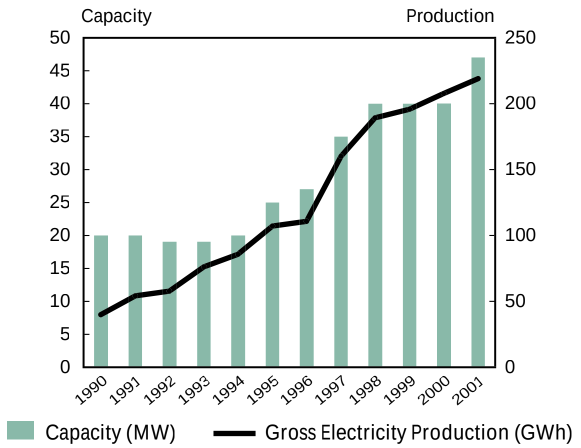
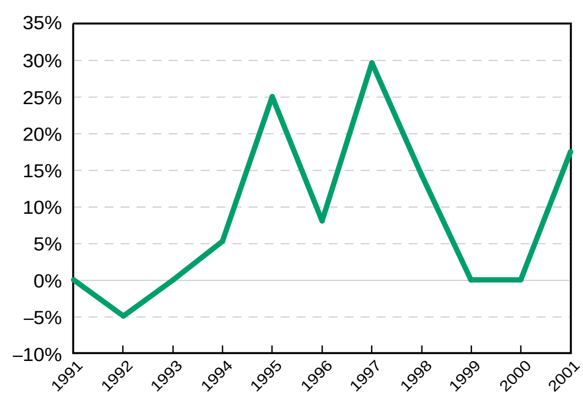
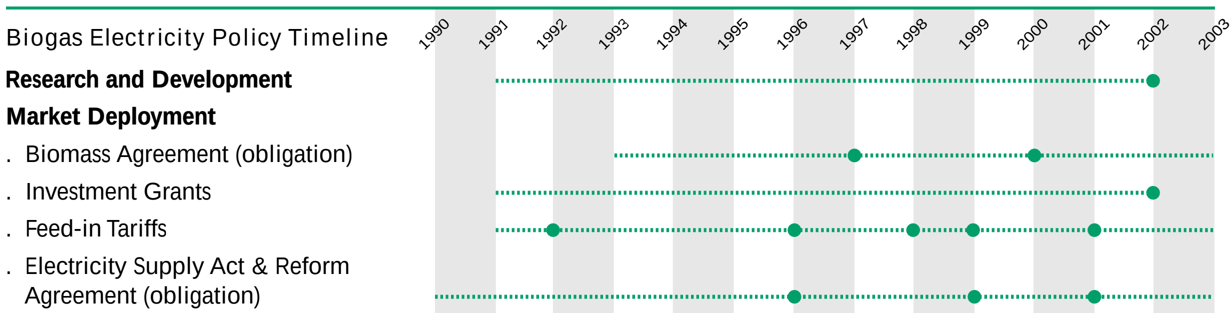


Figure 14. **Biogas Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Biogas production increased from 752 TJ in 1990 to 3 047 in 2001, an average annual growth of more than 13.6%. About 85% of this gas is used for electricity generation and installed capacity was 47 MW in 2001.

Large-scale joint biogas plants, which convert animal manure and organic industrial waste into biogas and fertilizer, have been undergoing swift technological development since the mid-1980s. Denmark has twenty joint biogas plants that were built with 20-40% investment subsidy between 1984 and 1998. A co-ordinated follow-up programme has collected experience, provided economic analysis, harmonised research activities, launched demonstration programmes and disseminated knowledge among key players and manufacturers, resulting in a marked improvement of the biogas process. These activities were financed by the Energy Research Programme and the Development Programme for Renewable Energy.

There are more than 60 small farm biogas plants in addition to the large-scale biogas plants.

There was concern that the uncertainty about the corporate framework conditions in the liberalised electricity market could prevent potential players such as farmers and other investors from developing biogas plants, which in addition to the energy and fertilizer benefits help to deal with the special environmental problems associated with intensive animal husbandry in a densely built-up community. To establish market-based conditions that create cohesion between the advantages to society and the corporate economic operating conditions, the government introduced a fixed price system for electricity sold to the public grid from biogas plants in 2003.

Wind Power

In 2001 the total installed capacity of wind turbines in Denmark was 2 556 MW and wind generation corresponded to 11.4% of electricity production. This is the highest share in any IEA Member country. According to Danish statistics, wind turbine capacity was 2 886 MW in 2002 which represents 21.8% of electricity capacity. In 2002 offshore wind capacity was 214 MW, up from 50 MW in 2001.

Denmark's development of wind energy has been an energy policy and a commercial success story. Since the first wind turbines were industrially constructed around 1980, there has been tremendous growth, particularly since 1990. Modern Danish wind turbines produce about 100 times as much electricity as the first industrial wind turbines from 1980, and over the last decade the global sales of Danish wind turbines have grown from about 200 MW per year to 3 600 MW. Danish wind manufacturers and their international subsidiaries have 50% of the global wind market with a turnover of € 1.5 million in 2000. Danish wind turbines have become a major export commodity with currency earnings of about DKK 12 billion in 2001.

The Danish Government has employed numerous policy instruments to achieve its wind energy targets. It has used successfully and flexibly both demand pull and technology push instruments. For more than 25 years, RD&D provided continuity for technology improvements and a stimulus for innovations. For example, Risø National Laboratory, the centre of Danish technological development, established a Test Station in 1978 for wind turbines that was responsible for type approvals that were a precondition for obtaining plant and production subsidies. (Now, certification is required for connection to the Danish grid, and the process has evolved into a commercial activity for test station and certification institutes.) Risø's wind know-how was combined with its traditional front-line competencies in the fields of meteorology and materials technology with the expertise of technical universities in fluid mechanics. Risø functioned as a technological service centre for the nascent Danish wind turbine industry, whose individual companies at that point did not have the resources to undertake technological development. Risø and Danish turbine producers have co-operated on a large number of RD&D projects co-financed by the Energy Research Programme. RD&D has been directed towards basic research rather than actual turbine or component development and has enjoyed a relatively stable level of support.

Figure 15. **Wind Power Capacity and Electricity Production**

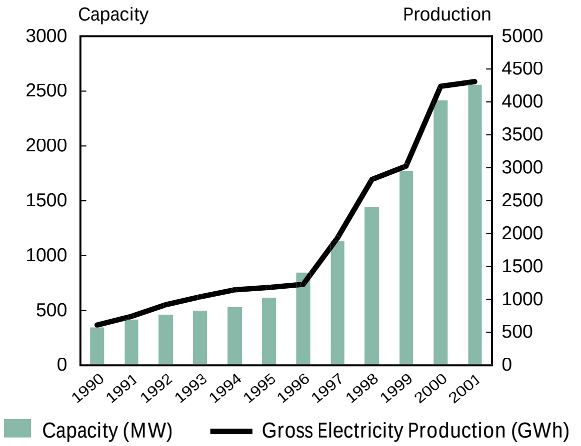
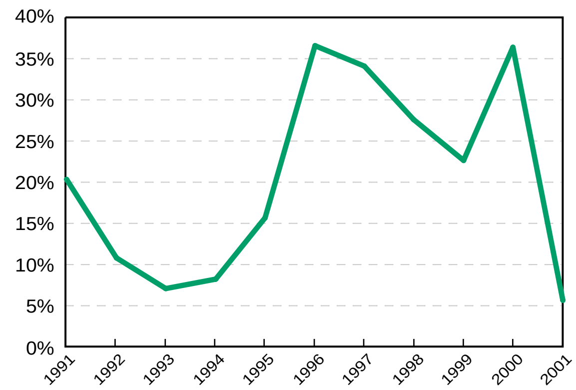
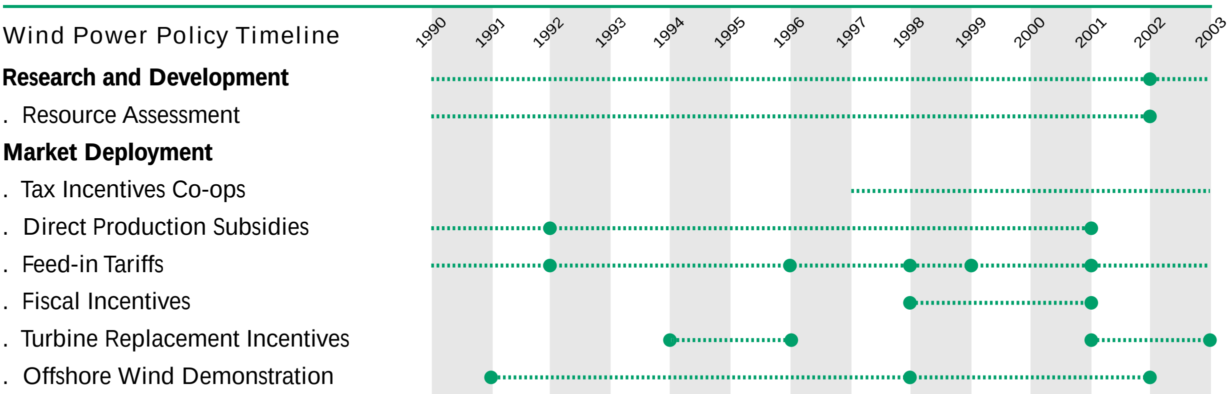


Figure 16. **Wind Power Capacity** (Year to Year Change)





Denotes a significant change to a policy, such as an extension, repeal or revision.

The technological development of Danish wind turbines led to explosive growth in demand in the 1990s in both domestic and export markets. Within Denmark, the technical developments were coupled with market deployment strategies that ensured investors guaranteed sales and a premium price. Utilities agreed to buy wind power from privately-owned wind turbines at a purchase price equivalent to about 85% of the retail price of electricity. The feed-in tariffs were adjusted in 1996 and 1998. From 1979 to 1989, the government also offered an installation subsidy of 30% of total project costs, which resulted in about 2 567 turbines receiving subsidies of DKK 275.72 million (in 2002 prices). Direct production subsidies have continued: existing turbines are paid DKK 0.60/kWh for a specified number of 12 000 to 25 000 full-load hours depending on turbine size. Utilities are now required by law to connect private wind turbines to the grid and to receive and pay for wind-generated electricity.

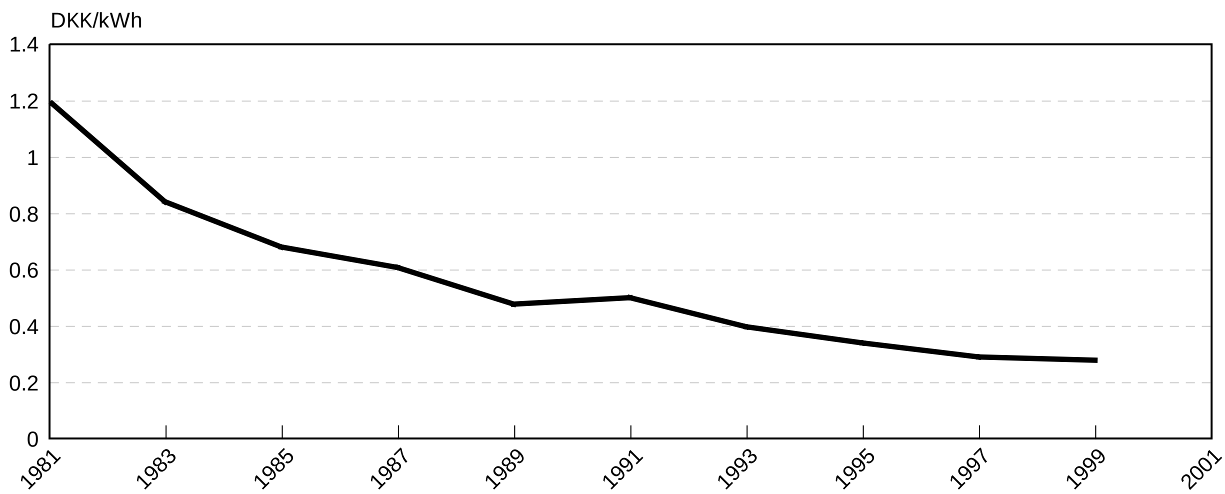
Throughout these development years, the Danish state financed the additional costs involved. Following the liberalisation of the electricity market and reflecting the maturing of the wind turbine technology, the economic commitment shifted to electricity consumers. The support scheme is undergoing reorganisation so that, following a transition period, wind turbines will have to produce on market terms, but with an environmental bonus that capitalises on the societal benefits of wind energy.

Policy Instruments Used to Promote Wind Turbine Technology and Installations

Demand pull instruments	Technology push instruments
Incentives	*Incentives*
• Direct subsidies	• R&D programmes
• Taxation	• Programme for household turbines
• Replacement of small and old turbines	• Test station for wind turbines
• Aid programmes	• International co-operation
Other regulation	*Other regulation*
• Resource assessment	• Approval scheme
• Local ownership	• Standardisation
• Agreements with utilities	
• Regulation of grid connection	
• Electricity purchase arrangements/green certificates	
• Information programmes	
• Spatial planning procedures	

In 2001 the total installed capacity amounted to more than 6 000 units with a capacity of 2 556 MW. However, many of them were small and inappropriately located. This led to a scheme to encourage replacement of the smaller turbines by larger, more modern ones. In 2002, this led to 1 300 turbines with an overall capacity of about 100 MW being replaced by about 300 turbines with an overall capacity of 300 MW.

Figure 17. **Onshore Wind Power Price Development, Denmark, 1981-2000**



Source: Danish Energy Authority

The price of electricity production from newly developed Danish onshore wind turbines has fallen substantially from about € 0.16/kWh (DKK 1.2/kWh) in 1981 to under € 0.04/kWh in 2000. As well, efficiency continues to grow in step with the turbines' increasing size.

Offshore Wind

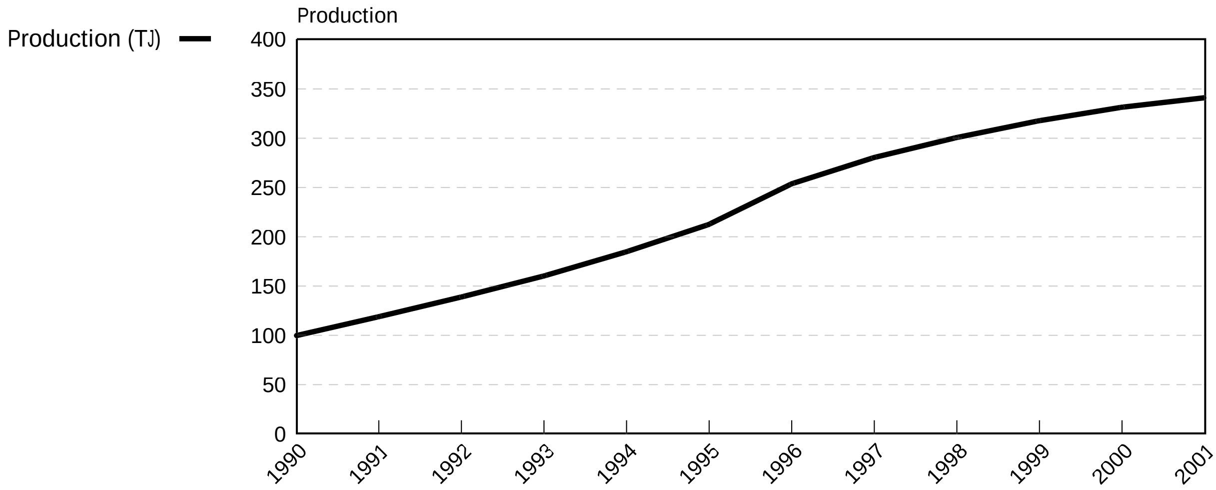
Interest in the potential for offshore wind development has grown more or less in step with the up-scaling of turbines. MW-size turbines can dominate the landscape so offshore development appeared to be a precondition to continued large-scale development of wind energy in Denmark. Onshore wind development seems to be close to saturation in terms of sites and the problems of siting large turbines in densely populated areas.

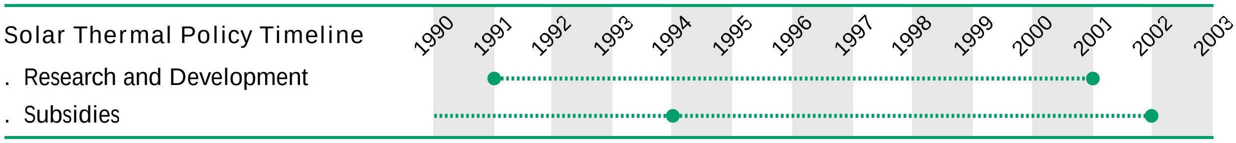
During the 1990s, Denmark undertook two pilot projects that provided important knowledge about the economic and environmental conditions for developing offshore wind farms. Mapping of potential major sites for offshore wind farms in 1997 identified an immediate potential of about 4 000 MW. Since 2001 the pilot projects have been followed with two large-scale demonstration projects using 2 – 2.3 MW-sized turbines. Turbines of up to 3 MW are to be tested in near-shore areas in the coming years.

In 1998 the government set a target of 750 MW to be supplied by offshore wind farms by 2008. Following orders from the government to the power suppliers, two demonstration projects were completed in 2002 and 2003 with a total capacity of 320 MW. But in relation to the liberalisation of the electricity market, the government annulled the obligation on power suppliers to construct all 750 MW and decided to employ a tendering process for further offshore wind farms.

Solar Thermal Production

Figure 18. **Solar Thermal Production**





Denotes a significant change to a policy, such as an extension, repeal or revision.

Solar thermal production increased from 100 TJ in 1990 to 341 TJ in 2001. There are about 30 000 solar thermal installations that provide domestic water heating and about one-third are used for both hot water and space heating. About DKK 57 million per year was set out in the 1995-1997 energy plan to support solar thermal installations in the form of basic grants, a standard subsidy and funds from the Development Programme for Renewable Energy. Standard grants were cancelled in 2002.

To increase the number of large solar heating systems, for example in public buildings, and in connection with biomass-fired district heating systems, Denmark provided subsidies in the 1979 to 2002 period. The cost of this initiative was about DKK 6 million annually between 1998 and 2000. In addition, from 1979 to 2002 Denmark provided subsidies for up to 30% of the cost of investment for solar heating systems for household heating in areas not served with district heating. This amounted to about DKK 20 to 25 million from 1998 to 2000, plus subsidies of some DKK 2 million per year for information campaigns.

Denmark Policy Chronology

The Energy Research Programme (ERP)

Year 1976 - Present

Policy Description The Energy Research Programme supports the implementation of Danish energy policy. It supports energy projects with strategic/practical perspectives over a two- to three-year time frame. Areas of focus include: oil and natural gas, environmentally benign heat and power production, wind, buildings and solar energy, energy and society, and energy efficiency in products and industrial processes. Financial support of up to 100% is available, though the average support level is about 50% of eligible costs.

Policy Type RD&D

RE Technology All renewables

Electricity Supply Act

Year 1976 (see reforms of 1996, 1999 and 2001)

Policy Description The 1976 Electricity Supply Act provided the framework for the control of the electricity sector, where only licensed companies were allowed to produce, transmit and distribute electricity through the public grids. The Minister of Energy was authorised to use security of supply justifications to oblige electricity supply companies to include specific energy types in their supply mix and to take measures to improve the energy efficiency of supply.

Major changes to the Act in 1989 introduced the obligations for power suppliers to purchase power from renewables generation and CHP. Power from wind turbines was excluded as it was already regulated in detail through the Act on Utilisation of Renewable Energy Sources.

In 1994, environmentally sound development of electricity supply was included as the main objective of the Act. The Minister was able to impose obligations on utilities to take measures pertaining to fuel use, energy efficiency and renewable energy development.

In 1996, the EU directive to liberalise the electricity market was adopted and Denmark modified its legislation accordingly.

Policy Type RD&D

RE Technology Onshore wind
Biomass
Now, all renewables

Capital Grants for the Installation of Wind Turbines

Year 1979-1989

Policy Description This programme administered capital grants for 15-30% of the installation of wind turbines.

Policy Type Capital grants

RE Technology Onshore wind

Heat Supply Act

Year 1988

Policy Description Measures first introduced in the 1988 Heat Supply Act encourage district heating using renewables by prohibiting installation of electric heating in specified residential areas. The prohibition is still in force.

Policy Type Regulatory and administrative rules

RE Technology All renewables

The Biomass Agreement

Year 1993-2005

Policy Description In 1993, the government set an objective to increase biomass use from 50 PJ to 75 PJ by 2000 (10% of total fuel consumption) and to establish two to three large biomass plants before 2003. The two main electricity suppliers (Elsam and Elkraft) were to incorporate the use of 1.2 million tonnes of straw and 0.2 million tonnes of wood in large-scale power plants. These objectives were not met.

Modifications to the Biomass Agreement in 1997 and 2000 provided more flexibility in the choice of biomass procured. The targets were maintained but the time for fulfilment was prolonged until 2005.

With the modification in 2000, the costs to the utilities for fulfilment of the Biomass Agreement were transferred to electricity consumers as an extra charge.

A feed-in tariff provides a ten-year guarantee of DKK 0.30/kWh settlement price and an additional DKK 0.10/kWh until the green certificates market is established and green certificates replace this portion.

Policy Type Obligations / Guaranteed prices/feed-in tariffs

RE Technology Biomass

Replacement of Small Obsolete Wind Turbines

Year 1994-1996

Policy Description This programme offers grants for 15% of the costs or DKK 200 000, whichever is lower, to subsidise the replacement of obsolete wind turbines with more advanced turbines.

Policy Type Capital grants

RE Technology Onshore wind

Act on Support for Utilisation of Renewable Energy Sources

Year 1981-2001

Policy Description This framework legislation aims to support the establishment of renewable energy technologies and systems. The act contains specific conditions for obtaining grants to establish renewable energy installations. The subsidy level is adjusted periodically to correspond with the economics of each technology. The Act sets out conditions for capital grants, technology development, analysis, evaluations, test facilities and information dissemination.

The 2001 budget was directed to:

- Standard grants for renewable installations that provide up to 30% of approved expenses for solar thermal installations; 16% for biomass; 15% for heat pumps; and 30% for biogas plants. The maximum grant is € 132 450.
- R&D projects (about 34% of the total budget).
- Grants for renewable energy knowledge centres, and test and certification centres (about 34% of the total budget).

Feed-in tariffs were:

Wind: existing onshore plants (before January 2000) were paid a total fixed price of DKK 0.60/kWh (market price plus supplement); new plants were guaranteed a total of DKK 0.33/kWh for the first 22 000 full load hours. In addition, producers receive DKK 0.10/kWh until the green certificate market is initiated.

Offshore wind was guaranteed DKK 0.353/kWh for the first 22 000 full load hours; in addition, producers also received DKK 0.10/kWh until the green certificate market is established.

Offshore plants financed under previous rules only receive DKK 0.10/kWh until the green certificate market is in place.

Biomass: electricity from biomass is paid about DKK 0.30/kWh, in addition to the DKK 0.10/kWh until the green certificate market is implemented. In addition, a DKK 30 million per year programme to support Danish biomass plants has been set up. The average payment to producers is about DKK 0.60/kWh. The price settlement for biomass plants will be further clarified in future legislation.

The Act established renewable energy supply as a Public Service Obligation and allowed the expenses to be passed on to consumers as an extra charge, which is integrated in the price.

The entire scheme was terminated in 2002.

Policy Type Capital Grants / Guaranteed prices/feed-in tariffs / RD&D

RE Technology Solar thermal
Biomass
Offshore wind
Onshore wind

Electricity Supply Act

Year 1996 (see reforms of 1999 and 2001)

Policy Description The Electricity Act in 1996 took the first step towards introducing a more competitive market, while at the same time providing for prioritisation of renewables and environmentally sound energy in the electricity supply. The Act provided that utilities had to give priority access to renewable energy production and pay a favourable buy-back rate of 85% of the consumer price of electricity in the area. (This formalised renewable electricity grid access that had been in practice since the 1980s.) The Act came into force in 1998.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology All renewables

Wind Energy Co-operative Tax Incentive

Year 1997

Policy Description Under this legislation, individuals who participate in wind energy co-operatives (Bürgerwind) are exempt from tax for the first € 400 per year of income and the remainder is taxed at 60% of regular tax rate.

Policy Type Tax exemptions

RE Technology Offshore wind
Onshore wind

SOL-300 Project

Year 1998-2000

Policy Description The SOL-300 project met its objective to deploy 300 rooftop photovoltaic systems on existing residences. It provided education and training in PV technology and system mounting and testing.

Policy Type RD&D/Public awareness

RE Technology Solar photovoltaic

Agreement on Offshore Wind Turbines

Year 1998-2002

Policy Description This framework was a binding agreement among the government and the two main electricity providers to install 750 MW of offshore wind by 2008 as the first phase of a planned installation of 4 000 MW of offshore wind turbines before 2030. Two demonstration projects have been completed with a total capacity of 320 MW. In 2002 the government annulled the obligation to construct all 750 MW and instead will employ a tendering process.

Policy Type	Obligations/RD&D
RE Technology	Offshore wind

Energy Taxes

Year

Energy taxes have been levied for decades.

Policy Description

Taxation of energy products has a long history in Denmark, dating back to the first tax on petrol introduced in 1917. As of 1980, taxation of a large number of products through the economy was motivated in part by environmental considerations and to save resources, especially energy. Energy taxes comprise taxes and duties on carbon dioxide, sulphur, electricity, natural gas, petrol and specific petroleum products.

In 1991, energy taxes were reformed into an energy and carbon tax to reflect Denmark's environmental concerns. A large share of the tax revenues was used for energy efficiency measures and since the tax system came into effect in 1992 it has been expanded.

Denmark embarked on a "green" tax reform to shift the tax burden away from income and towards resource use. This system was put into place between 1994 and 1998. Energy taxes were raised progressively, particularly on coal and electricity consumption, leading to an average increase in taxation on heating and power of 30% from 1994 to 1998. The main effect was that households paid lower income taxes and higher environmental taxes.

Based on the *Green Tax Package 1995*, another reform of the tax system was undertaken between 1996 and 2000 which aimed to increase energy conservation in businesses and industry. The main features were higher CO_2 taxes, introduction of a substantial tax on natural gas, differentiation of the energy and carbon taxes according to energy use and phase-in of a sulphur tax. This tax structure has remained, but the tax rates have increased.

Tax Rates in 2002:

- Energy tax: about € 6.8/GJ.
- Standard CO_2 rate: € 13.3/tonne.
- Sulphur tax: € 2.66/kg of sulphur or € 1.33/kg of SO_2.

Taxation of electricity is calculated on the basis of the fuel used in production.

A large part of the additional revenues from the *Green Tax Package* are transferred back to companies through reduced taxation on labour, special subsidies for SMEs and subsidies for energy efficiency measures. The CO_2 tax is differentiated according to two principles: the process for which the energy is used and whether or not the company has entered into a voluntary agreement to apply energy efficiency measures. The difference between the tax rate with and without voluntary agreements grew significantly between 1996 and 2001.

The largest share of tax revenue transfers occurs through reduced taxation on labour. A smaller share is redirected to the industry and service sectors to provide subsidies for energy efficiency measures. About DKK 1.8 billion (€ 242 million) was set aside for these subsidies for 1996-2000. The Danish Energy Agency (now the Danish Energy Authority) established a list of 40 standard solutions for energy efficiency improvements and determined which projects qualify. Eligible projects must increase energy efficiency, reduce CO_2 or SO_2 emissions or be of a developmental character. Companies can also suggest individual solutions. Applications for support rose from 2 800 in 1996 to 7 000 in 2000.

In an evaluation carried out in 1999, the government estimated that the *Green Tax Package 1995* resulted in a net decrease of the overall tax burden by DKK 335 million and that CO_2 emissions from industry in 2005 would be reduced by 3.8%, corresponding to 2.3 million tonnes[1]. Half of this is due to the taxes and the rest to the subsidy and voluntary agreement schemes.

According to a parliamentary decision (Whitsun package) in 1998, energy taxes continued to rise after the phase-in period of the Green Tax Package 1995. For example, households' energy taxes on stationary fuel use rose by 15% to 25% between 1998 and 2000.

In 2002, the new government established a general freeze on all taxes. This is a freeze in nominal terms and will therefore lead to reductions in CO_2 and energy taxes in real terms.

In 2003 the Ministry of Taxation launched an overhaul to reduce the complexity of the Danish tax system. A group has been established with a view to reduce administrative burdens and to improve transparency in relation to energy, CO_2 and sulphur taxes. A proposal for simplification is expected in early 2004.

Policy Type Fossil fuel taxes

RE Technology Offshore wind

Electricity Act Reform: Energy Supply Act

Year 1999-2001

Policy Description This agreement established the framework for the manner in which consumer protection, environmental considerations and security of supply are to be safeguarded in the liberalised electricity market. It transformed the subsidy scheme for renewables from fixed payments to a type of renewables portfolio standard to be phased in. The legislation introduced CO_2 quotas, tradable emissions allowances and renewable energy certificates for a "green" electricity market. To meet their quotas, electricity distributors may develop renewable supply options or purchase renewable generation credits as proxies. Price premiums for renewables are passed down to electricity consumers. It was assumed that a green certificate market would be functioning by 2003.

1. *Danish Energy Authority:* Green Taxes for Trade and Industry – Description and Evaluation*, Copenhagen, June 2000.*

In 2001 a Parliamentary hearing concluded that the renewable certificate scheme was impracticable and it has not been implemented. Until a final decision is taken, transitional regulations on power purchase rates and premium payments for renewables are set out in Executive Orders.

Policy Type Obligations / Guaranteed prices/feed-in tariffs

RE Technology All renewables

Adaptation of the Electricity Act Reform

Year 2001-2003

Policy Description In anticipation of the green certificates market and EU approval of the rules for payment of green electricity, new tariffs were adopted in 2001. The support is generally lower than in previous periods. For example, the tariff for new onshore wind electricity production is about 30% lower than for existing turbines.

Electricity production subsidies were to be replaced by renewable certificates with a minimum value of DKK 0.10 and a maximum of DKK 0.27/kWh. However, the renewable energy certificate system has not been implemented.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology All renewables

SOL-1 000 Project

Year 2001-2005

Policy Description The SOL-1 000 is a successor demonstration project to SOL-300 with an objective of 1 000 new PV roof-top system installations. An important element is the development of solar architecture and building integrated systems.

Policy Type RD&D

RE Technology Solar photovoltaic

Replacement of Wind Turbines

Year 2001-2003

Policy Description Rapid development of wind turbine technology led to a need for replacement of turbines from previous generations of technology. In 2001 a grant scheme for the replacement of old and badly placed wind turbines was introduced. An owner who replaced an old small turbine was granted an additional surcharge of DKK 0.17/kWh for 12 000 full-load hours for a new wind turbine connected to the grid between April 2001 and January 2004. The surcharge was given for a proportion of the capacity of the new turbine corresponding to two-three times the installed capacity of the decommissioned turbine.

Further more, the regulation set out that, pursuant of the Electricity Supply Act, the wind turbines would not be guaranteed fixed feed-in tariffs or price surcharges after ten years of operation.

Policy Type Consumer grants/rebates/Guaranteed prices/feed-in tariffs

RE Technology Onshore wind

National Strategy for Sustainable Development

Year 2002

Policy Description The Danish National Strategy for Sustainable Development aims to establish a framework for societal development that secures economic and social development along with a high level of environmental protection. It takes into account that sustainable development is a common international goal and that Denmark has a strong obligation to promote this development at the international level.

In 2002, the Danish government presented a set of indicators coupled with the sustainable development strategy.

Policy Type Public awareness

RE Technology All renewables

Net Metering for Small-scale PV

Year 1999-2003 + 2003-2007

Policy Description Under this programme, self-generated private electricity is purchased at the same price as the utility company sells its standard electricity. This effectively allows the consumer to run the meter backwards when generating more electricity than is used. No payment for net production per year.

Policy Type Net metering

RE Technology Solar photovoltaic

National RD&D Strategies for Renewable Energy Technologies

Year 2003-2004

Policy Description The Danish Energy Authority, in collaboration with the two main utilities (Public Service Obligation – funded) has elaborated RD&D strategies for fuel cells, biomass, wind energy and photovoltaics. Strategies for bio-fuels, wave energy, hydrogen and the interplay of different renewable energy sources in integrated systems are planned to be developed.

Policy Type RD&D

RE Technology All renewables

European Union

Renewable Energy Policy Context

Background to Activities at a European Union Level

At the time of writing the European Union (EU) consisted of 15 Member States, to be joined on 1 May 2004 by 10 accession countries. These countries work together at many levels, with administrative support from the European Commission (EC), which reports both to the Council of Ministers, representing the Member States, and to an elected European Parliament.

The European Commission is responsible for proposing policies and legislation, which are then formally adopted (after negotiation) by the Council and the Parliament. Once adopted at the EU level, each Member State is required to implement policies and to transpose EU Directives into national legislation, within their own systems and structures.

The European Commission is also responsible for managing a number of community programmes, which are funded from a budget to which all Member States contribute. Such programmes support activities of common interest, for example research, co-operation with developing countries and aid to regions of the EU which are lagging behind.

EU Renewable Energy Programmes

Concerning renewable energy, the Commission has supported research and technological development (RTD) since the 1970s. It continues today to give a high priority to both long- term and short-term research for renewable energy and energy efficiency technologies. This research is managed by the Commission through a series of four-year framework programmes. The current RTD programme runs from 2003 to 2006, with a budget of € 810 million for Sustainable Energy Systems, within which an important part is allocated to renewable energy.[1] In addition, support is given to research for small and medium enterprises (SMEs) and for international co-operation (INCO), both of which include work on renewable energy.

In addition to R&D for renewable energy technologies, since the early 1990s the Commission has supported activities aimed at tackling non-technological barriers to the growth of renewable energy markets. This work is managed through the ALTENER programme, which for the period 2003-2006 forms an integral part of the Energy Intelligent Europe (EIE) programme.[2]

In the context of the regional support within the EU, the Commission has encouraged those responsible to give priority to the renewable energy sector, recognising its importance for local job creation, the environment and the security of energy supply.

Similarly, it has been recognised by the EU that sustainable energy services are essential to achieving the Millennium Development Goals in co-operation with developing countries, for example through the Cotonou agreement and the European Development Fund. An important commitment by the EU to sustainable energy services for poverty alleviation was made at the Johannesburg summit in 2002, where the EU Energy Initiative for Poverty Eradication was launched, as well as the Johannesburg Renewable Energy Coalition (JREC). Programmes are currently being developed and implemented to fund these commitments, including COOPENER, which forms an integral part of the EIE programme.

1. http://fp6.cordis.lu/fp6/home.cfm
2. http://europa.eu.int/comm/energy/intelligent/index_en.html

EU Renewable Energy Policies

Building on its early work of supporting RTD on renewable energies, the EU began working towards a policy framework for renewable energy in the early 1990s, which culminated in the publication of the *White Paper and Action Plan for Renewable Energy Sources* in 1997.[3] This document, which was adopted by the Council and Parliament, forms the basic policy framework within which much of the recent work on renewable energy at an EU level has been based. The main component of the White Paper was an overall goal of doubling the contribution of renewable energy in final EU energy consumption (from 6% to 12%) by 2010. It also established an Action Plan for achieving this goal, including the Campaign for Take-Off, which ran from 1997 until the end of 2003. This White Paper also set targets for each renewable energy technology. Progress against these targets was reported to the Council and the Parliament in a Commission Communication in February 2001.[4]

Following important developments in the energy sector in the late 1990s, the Commission published for consultation a Green Paper on the Security of Energy Supplies in December 2000, resulting in a *Communication* in 2001 summarising the results.[5] These documents both confirmed the important role of renewable energy in the future EU energy economy and the need to accelerate the growth of renewable energy markets in order to diversify EU energy supplies and improve energy security.

Based on this policy framework, the Commission began work in 1999 to put in place legislation designed to achieve the agreed policy goals.

Renewable Energy Legislation

The first pioneering EU legislation in the renewable energy sector was the *EU Directive for Electricity Produced from Renewable Energy Sources*, adopted in September 2001.[6] It includes indicative targets for the percentage of renewable energy in gross electricity production of each EU Member State by 2010 (Table 1). The legislation also establishes requirements concerning:

- Guarantee of origin of renewable electricity.
- Simplification of administrative procedures for approving the construction of renewable electricity generators.
- Transparency of pricing for connections to the electricity grid.
- Reporting on progress towards the agreed targets.
- Requirement that the Commission make recommendations by October 2005 concerning whether or not national support schemes for renewable energies should be harmonised across all EU member states.

3. *White Paper for Community Strategy and Action Plan COM (97) 599 Final.*
4. *Communication from the Commission on the Implementation of the Community Strategy and Action Plan COM (2001)69(01).*
5. *Green Paper towards a European Strategy for the Security of Energy Supply COM (2000)769.*
6. *Directive 2001/77/EC on the Promotion of the Electricity Produced from Renewable Energy Sources in the Internal Electricity Market.*

Table 1. **Reference Values* for EU 25 Member States' National Indicative Targets**
(Electricity Production from Renewable Energy Sources = RES-E)

	RES-E 1997 (TWh)**	**RES-E 1997*** (%)**	**RES-E 2010*** (%)**
Belgium	0.86	1.1	6.0
Czech Republic	2.36	3.8	8.0
Denmark	3.21	8.7	29.0
Germany	24.91	4.5	12.5
Estonia	0.02	0.2	5.1
Greece	3.94	8.6	20.1
Spain	37.15	19.9	29.4
France	66.00	15.0	21.0
Ireland	0.84	3.6	13.2
Italy	46.46	16.0	25.0
Cyprus	0.002	0.05	6.0
Latvia	2.76	42.4	49.3
Lithuania	0.33	3.3	7.0
Luxembourg	0.14	2.1	5.7
Hungary	0.22	0.7	3.6
Malta	0	0	5.0
Netherlands	3.45	3.5	9.0
Austria	39.05	70.0	78.1
Poland	2.35	1.6	7.5
Portugal	14.30	38.5	39.0
Slovenia	3.66	29.9	33.6
Slovakia	5.09	17.9	31.0
Finland	19.03	24.7	31.5
Sweden	72.03	49.1	60.0
United Kingdom	7.04	1.7	10.0
Community	**355.20**	**12.9**	**21.0**

(*) In taking into account the reference values, Member States make the necessary assumption that the State aid guidelines for environmental protection allow for the existence of national support schemes for the promotion of electricity produced from renewable energy sources.
(**) Data refer to the national electricity production from renewables in 1997.
(***) The percentage contributions of renewables to gross electricity production in 1997 and 2010 are based on the national renewables-based production divided by gross national electricity consumption. In the case of internal trade (with recognised certification or origin registered), the calculation of these percentages will influence 2010 figures by Member State but not the Community total.

The second Directive which addresses the use of renewable energies in the EU is the *Directive on Biofuels*, which was adopted in 2003.[7] This Directive requires all EU suppliers of transport fuels to include 2% of biofuels by 2005 and 5.75% by 2010 in their delivered fuels to final users. This Directive was complemented

7. Directive 2003/30/EC of the European Parliament and Council of 8 May 2003 on the Promotion of the Use of Biofuels and Other Renewable Fuels for Transport.

later in 2003, by an important revision to the existing *Directive on the Taxation of Transport Fuels*, which allowed member states to reduce the levels of excise tax on biofuels.[8] These directives were foreseen in 2002 by a *Communication* which set out a strategy for biofuels in the transport sector.[9]

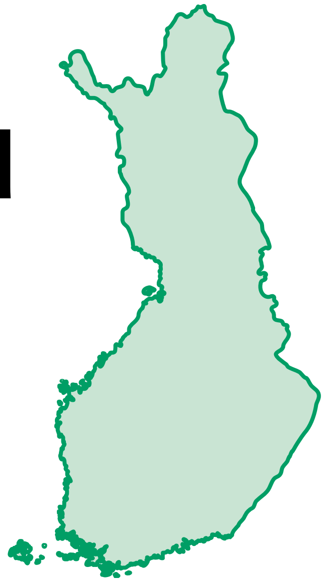
Renewable energy also has an important role to play in the buildings sector. This was recognised in the *Directive on the Energy Performance of Buildings* which was subsequently adopted in May 2003.[10] This Directive requires the certification of buildings and renewable energy systems to be included in the methodology, which must be used in each Member State to produce such certificates.

It is clearly recognised that all of the EU legislation concerning the use of renewable energy sources should be implemented together with the efficient management of energy demand. Hence the use of renewable energy sources is also encouraged in the *Directive on Cogeneration* which was adopted in February 2004.[11]

Work is continuing on the development of the EU policy and legislative framework, which will encourage the use of sustainable energy and the next Directive is expected to address the provision of energy services. Discussions are also underway concerning how to bring forward policies and legislation to accelerate the markets for renewable heating and cooling.

8. *Council Directive 2003/96/EC of October 2003 on Restructuring the Community Framework for the Taxation of Energy Products and Electricity.*
9. *Communication of the European Commission of 7 October 2001 on an action plan and two proposals for Directives to foster the use of alternative fuels for transport, starting with the regulatory and fiscal promotion of biofuels COM2001 547 Final.*
10. *Directive on the Energy Performance of Buildings COM 2002/91/EC.*
11. *Directive on Co-generation 2004/8/EC.*

Finland



Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

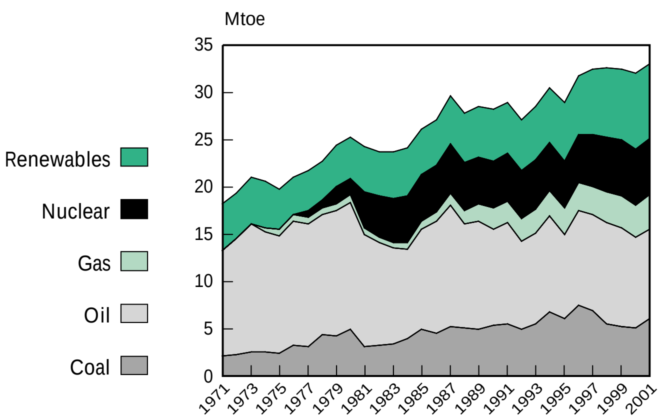
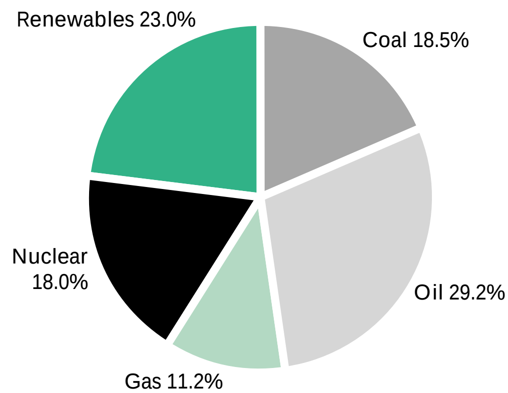


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1.
See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1970	1980	1990	1995	2000	2001	Imports
Coal	2.3	4.9	5.3	6.1	5.1	6.1	68.9%
Oil	10.7	13.4	10.3	8.9	9.6	9.4	100.0%
Gas	0.0	0.8	2.2	2.8	3.4	3.7	100.0%
Nuclear	0.0	1.8	5.0	5.0	5.9	5.9	-
Renewables	5.0	4.4	5.5	6.1	7.8	7.6	-
Biomass	*4.2*	*3.5*	*4.6*	*5.0*	*6.5*	*6.4*	
Hydro	*0.8*	*0.9*	*0.9*	*1.1*	*1.3*	*1.1*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Total	**18.1**	**25.4**	**29.2**	**29.6**	**33.0**	**33.8**	**56.7%**
% Renewables	*27.6%*	*17.2%*	*19.5%*	*21.2%*	*24.4%*	*23.0%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*

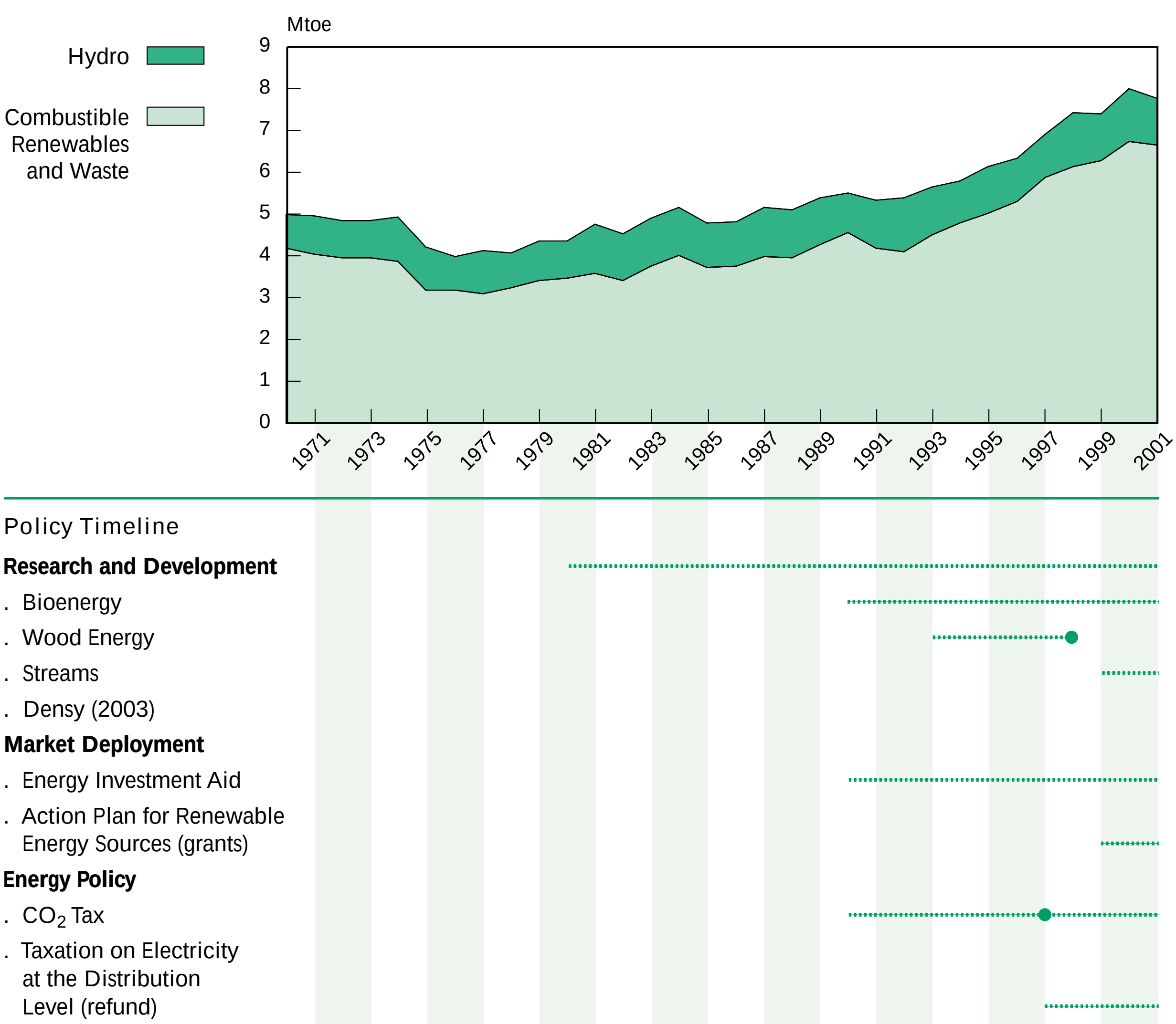
Total primary energy supply (TPES) in Finland increased from 29 Mtoe in 1990 to 34 Mtoe in 2001, an average annual growth of 1.3%. Its energy mix is quite diversified compared with many other IEA member countries. Oil, mostly for transport, represented 28% of TPES in 2001 (Table 1). Renewable energy had the second highest share at 22%, while coal (and peat) accounted for 18% and nuclear for 17%. Natural gas demand is growing, mostly for power generation. In 2001, natural gas accounted for 11% of total energy demand. Finland imports all of its oil, coal, and gas, but because of its high share of renewables, import dependence was 57% in 2001. Finland has the highest share of biomass in TPES among the European Union countries.

Renewable energy supply is a major contributor to TPES, 7.6 Mtoe in 2001, and its share grew from 19% in 1990 to 22% in 2001. The increase in share is almost entirely due to strong growth in the supply of biomass, although there was also a steady increase in hydropower generation. Biomass accounted for 84.9% of renewable supply in 2001. The industrial and residential sectors represented three-quarters of biomass use. Electricity generation from solid biomass, however, has grown considerably over the past decade. Capacity increased from 983 MW in 1990 to 1.5 GW in 2001.

Electricity generation in Finland was 74.5 TWh in 2001. Nuclear power represented 31%. The share of renewables was 30%, mostly biomass-fired and hydropower. Coal, gas and peat also contribute. The Finnish electricity market was opened to competition in 1994. Electricity prices are low in comparison with many other European countries. Thus, only hydropower and, to a lesser extent, biomass-fired electricity generation, are competitive with conventional fuels.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



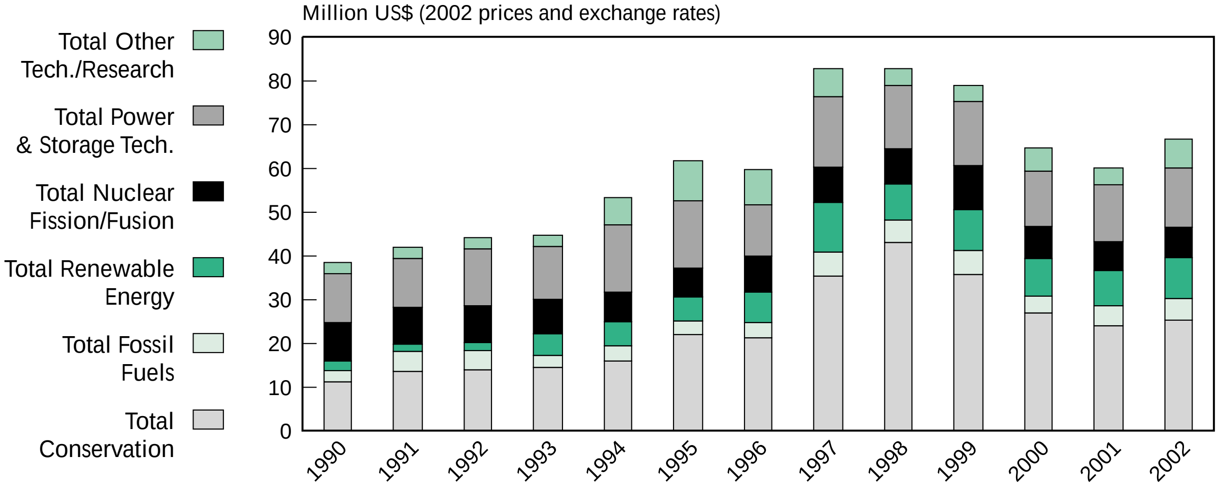
● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Renewable energy represents almost a quarter of TPES. Biomass accounts for nearly 85% of renewable use, mostly in the pulp and paper industry where half of total industrial energy is consumed. Hydropower contributes another 15%. Wind power and solar energy play a minor role in renewables supply. In 2001, Finland had 2.9 GW of hydropower, 1.5 GW of biomass-based power, 39 MW of wind power and 3 MW of solar PV.

Research and Development Trends

Finland spent a total of US$ 777 million (in 2002 prices and exchange rates) on government energy RD&D between 1990 and 2002. In that period, 10.7% of the total energy RD&D budget was allocated to renewable energy.

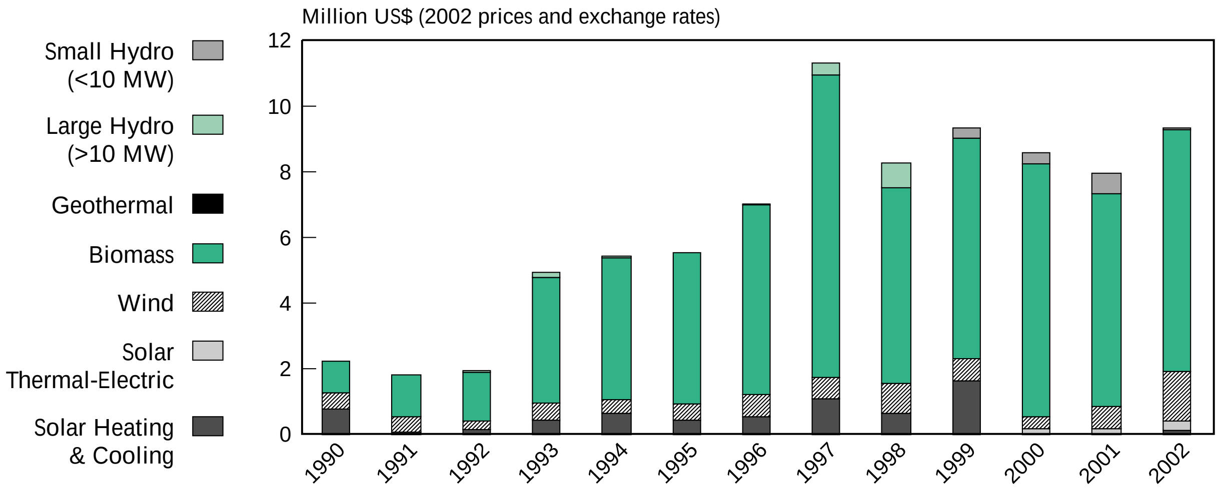
Figure 4. **Finland - Government Energy RD&D Budgets**



Government energy RD&D expenditures peaked in the late 1990s and declined after 1999. The RD&D budget for renewables gradually increased in the 1990s with a peak in 1997.

Among the renewable technologies, biomass received the highest level of funding at US$ 65.4 million, or 78%, in the 1990 to 2002 period. Wind was funded at US$ 6.6 million, representing 10% of renewable energy RD&D. Solar heating and cooling was the third largest recipient with 8% of the renewable RD&D expenditures from 1990 to 2001. A relatively smaller portion of RD&D spending was allocated for the deployment of small hydropower plants.

Figure 5. **Finland - Government Renewable Energy RD&D Budgets**



RD&D funding for renewable energy is focused primarily on developing competitive renewable energy technologies through technology development. In the past, funding was aimed at improving the efficiency of boilers and biomass systems, and today biomass technologies in Finland are highly efficient. The objective of current funding is to lower the costs of harvesting of wood and wood wastes and to improve the logistics of transporting biomass. There is also considerable work being done on lowering the costs of combustion and gasification technologies for both large and small-scale heat and co-generation facilities. Current RD&D programmes involved with renewable energy sources are Wood Energy (1999-2003), concentrating on small-scale production and use of wood fuels, Streams (2001-2004), on recycling technologies and waste management, and Densy (2003-2007), on distributed energy systems.

Market Deployment Trends

Since the 1980s, renewable energy policies in Finland have mainly been in the form of tax exemptions and capital grants or investment assistance. In the early 1990s, two national policy programmes were created to promote renewable energy, the Bioenergy Promotion Programme and the Wind Power Programme. The Bioenergy programme aimed to increase biomass use by 25% by 2005 from the 1992 level. By 2001, wood and wood waste consumption was already 58.2% higher than the 1992 level. The wind programme aimed to construct 100 MW of wind power capacity by 2005. Finland had an estimated 44 MW of wind capacity in 2003.

The Finnish Action Plan for Renewable Energy Sources was launched in 1999 and revised in 2002. The plan was integrated into the National Climate Strategy of 2001. It aims to increase the use of renewable energy by 50% from the 1995 level by 2010. The cornerstone of this plan is to enhance the use of biomass, which accounts for 90% of the proposed increase. To expedite the Action Plan, the following measures have been implemented:

- Development and commercialisation of renewable energy technology.
- Energy taxation favourable to renewables.
- Investment aid of initial capital costs.

The Energy Investment Aid was implemented in the beginning of the 1990s to provide public aid for technological development within the energy sector. Through this programme, the Finnish government aims to reduce the risk of investing in new technologies through public funding support for the building of new renewable energy plants. Government grants of up to 40% of the investment costs are available for renewable energy sources depending on the maturity level of the technology.

A number of programmes have been instituted to promote heat generation from renewables. Wood fuels, recycled fuels and biogas used for heat generation are not taxed. The Energy Investment Aid also targets and promotes heat generation investments.

The government is currently considering renewable energy purchase obligations, whereby sellers of electricity would be obliged to source a certain percentage of the electricity sold from renewable plants.

Energy Policy Context

From 1990 to 1997, a CO_2 tax based on the carbon and energy content of the fuel was instituted by the Finnish government. Renewables were exempt from the tax. In 1997, the carbon tax was replaced by a tax on electricity at the distribution level, with a refund being granted to electricity from renewable sources (€ 0.042 per kWh for biomass and small hydro, and € 0.069 per kWh for wind). An amendment was made to the tax exemption system in 2002 with the refund for logging chips increasing to the higher end of the refund system (€ 0.069 per kWh). The refund system was further expanded to include electricity produced from recycled fuels and biogas.

Finland's first national climate strategy was published in March 2001. In addition to the policies and measures related to climate change objectives, the strategy contains an Action Plan for Renewable Energy Sources. Energy conservation measures and the use of renewable energy sources are expected to account for 50% of the emissions reductions by 2010.

Renewable Energy Markets

Hydropower

Figure 6. **Hydropower Capacity and Electricity Production**

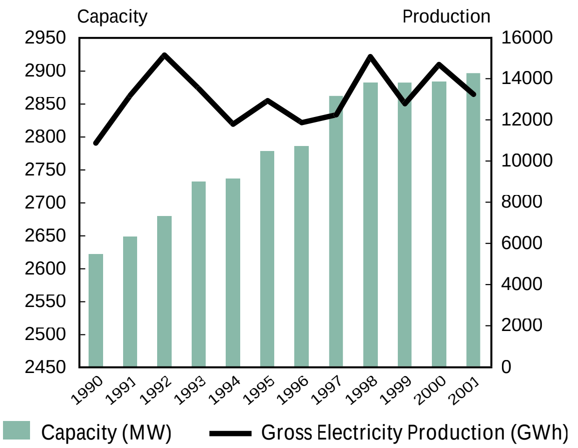
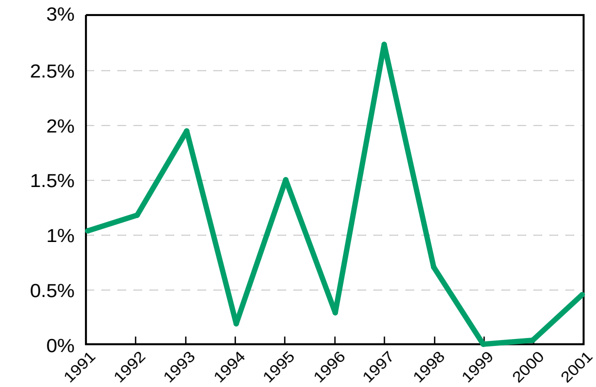


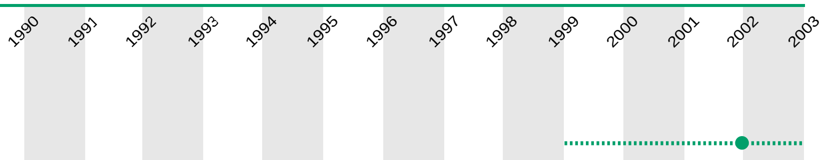
Figure 7. **Hydropower Capacity** (Year to Year Change)



Hydropower Policy Timeline

Market Deployment

. Action Plan for Renewable Energy Sources (grants)



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Hydropower accounted for 17.7% of electricity generation from renewables in 2001. Capacity increased from 2.6 GW in 1990 to 2.9 GW in 2001. Electricity generation increased from 10 859 GWh in 1990 to 13 205 GWh in 2001, an average annual growth of 1.8%. Generation, however, is estimated to have fallen to 10 792 in 2002. There is considerable annual fluctuation in hydropower generation in Finland.

Hydropower capacity in Finland in 2003 is estimated to have been about 3 GW, with small-scale hydropower (<1 MW) accounting for some 10%, or 300 MW. Small-scale hydropower is subject to the same promotional activities (energy refunds and investment incentives) as other renewable energy sources.

The national target for small-scale hydropower is specified in the revised Action Plan for Renewable Energy Sources. The target for 2010 is 570 MW of installed capacity with a subsequent 2.2 TWh of electricity generation.

Strong environmental concerns limit the extent of new hydropower capacity in Finland. Some additional production, however, will be attained by renovation or repowering of existing plants.

Biomass Electricity Production

Electricity generation from biomass is a major contributor to overall generation in Finland. In 2001, solid biomass-fired generation was 8 189 GWh, exhibiting a growth of more than 5.2% per year since 1990.

Figure 8. **Solid Biomass Capacity and Electricity Production**

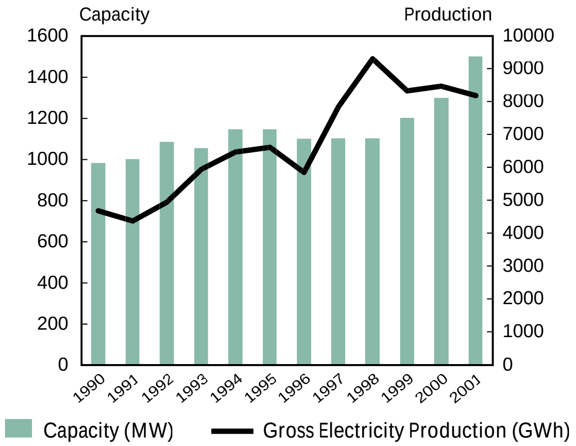
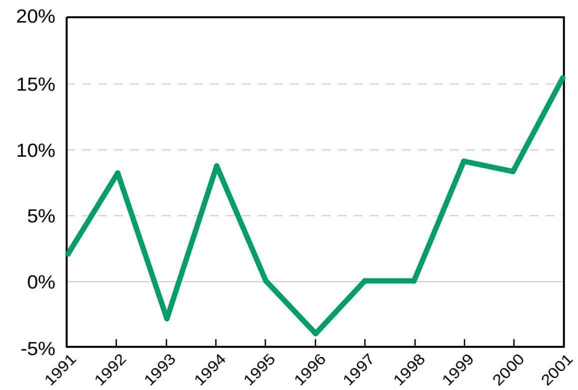
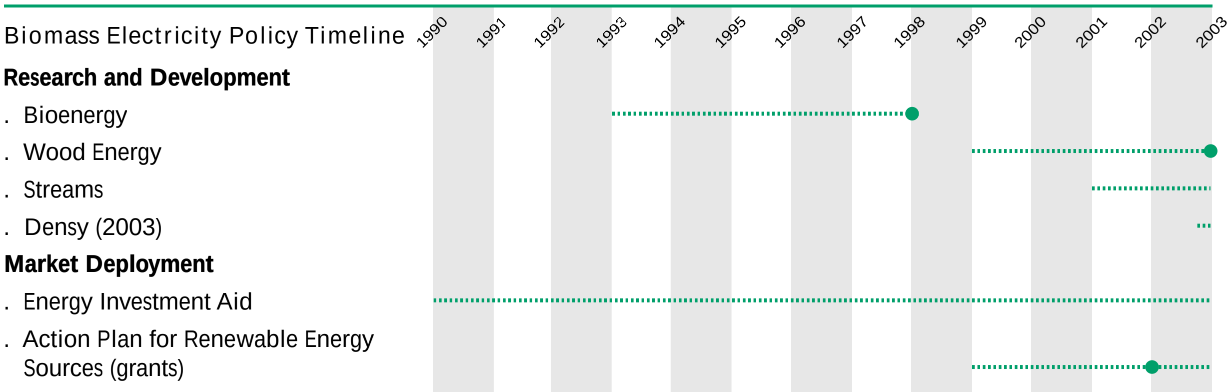


Figure 9. **Solid Biomass Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

In 1997, biomass electricity generation became eligible for a refund of € 0.042 per kWh on the electricity tax at the distribution level. The refund system was amended in 2002 and the refund for logging chips was increased to € 0.069 per kWh. The refund system was also further expanded to include electricity produced from recycled fuels and biogas. There was a sharp increase in the biomass-electric market post-1998, after the refund was put in place.

The Finnish Action Plan for Renewable Energy Sources was launched in 1999 and revised in 2002. The Action Plan was integrated into the National Climate Strategy of 2001. It aims to increase the use of renewable energy by 50% from the level of 1995 by 2010. The cornerstone of the plan is to enhance the use of biomass, which accounts for 90% of the proposed increase. Investment subsidies are provided under the Action Plan for wood-fired plants. Energy generation from biomass receives over half of all energy subsidies.

Wind Power

Electricity generation from wind power was 70 GWh in 2001, less than 1% of total electricity generation from renewables. Wind capacity was 39 MW in 2001. There was some growth in wind power capacity in the 1990s, but since 1999 growth has slowed. In 2003, estimated generation was about 86 GWh and estimated capacity was 44 MW.

Figure 10 suggests that the wind market may have benefited from a number of RD&D and market deployment policies throughout the 1990s. The NEMO 2 programme focussed on the technological and economic potential of using new energy systems, specifically wind and solar PV, in northern conditions. This programme promoted wind energy primarily through R&D and demonstration projects. The Energy Investment Aid, instituted in the early 1990s, aimed to promote the take-up of new technologies by reducing the risk to investors through government support. A tax incentive for electricity production by renewable energy sources was introduced in 1997. This incentive works by taxing electricity at the distribution level which is subsequently refunded for electricity generation from renewable sources. The refund is technology specific, with wind power receiving on the order of € 0.069 per kWh, on the high end of the refund scale.

The Finnish Action Plan for Renewable Energy Sources was launched in 1999 and revised in 2002. The target for wind energy deployment is set at 500 MW by 2010.

Figure 10. **Wind Power Capacity and Electricity Production**

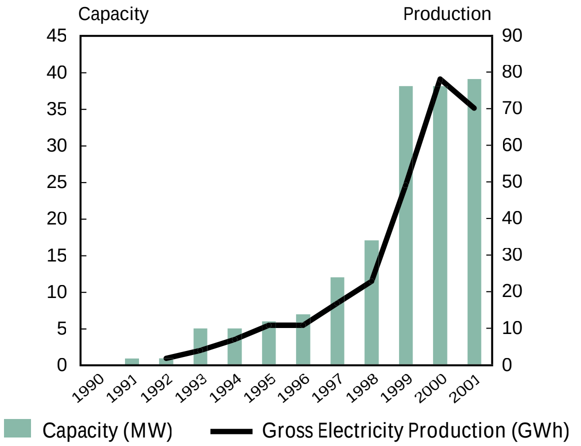
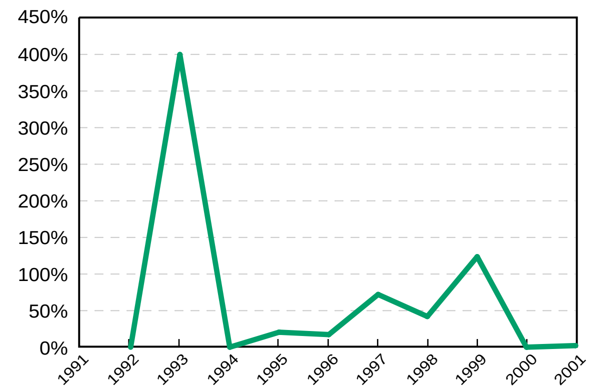
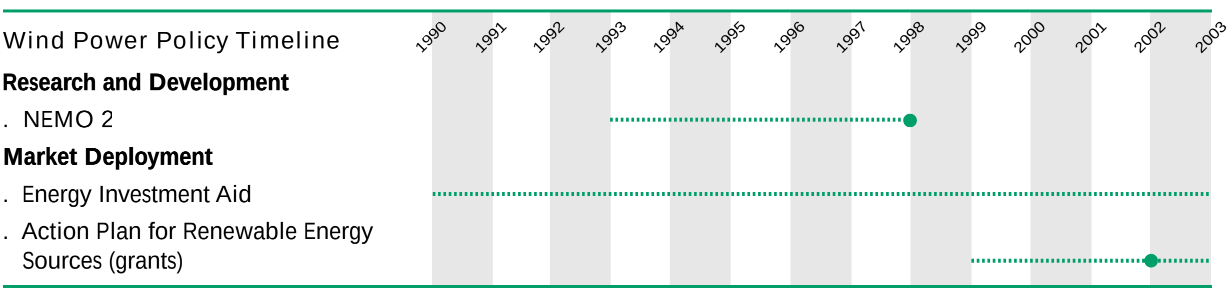


Figure 11. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Finland Policy Chronology

CO_2 Tax on Fossil Fuels

Year 1990-1997

Policy Description In 1990, Finland introduced the world's first carbon tax on fossil fuels at a rate of US$ 6.10 per tonne of carbon emissions.

Policy Type Fossil fuel taxes

RE Technology All renewables

Wind Power Programme

Year 1993-2005

Policy Description This programme aims to construct 100 MW of wind power capacity in Finland before 2005.

Policy Type Obligations

RE Technology Offshore wind
Onshore wind

Bioenergy Promotion Programme

Year 1994-2005

Policy Description This programme aims to increase the use of bioenergy by 25% between 1992 and 2005.

Policy Type Obligations

RE Technology Biofuel
Biomass

Combined CO_2 and Energy Tax

Year 1994-1997

Policy Description This combined CO_2 and energy tax was based upon the carbon and energy content of fuel. Renewable energy was exempt from this tax.

Policy Type Fossil fuel taxes

RE Technology All renewables

Taxation on Electricity at the Distribution Level (amendments 1/98 and 9/98)

Year 1997 - Present

Policy Description The revised tax replaced the 1994 combined CO_2 and energy tax. It is levied at the distribution level with a refund granted to electricity from renewable sources (€ 0.042 per kWh for biomass and small hydro, and € 0.069 per kWh for wind).

Policy Type Fossil fuel taxes

RE Technology All renewables

Finnish Energy Strategy

Year 1997 - Present

Policy Description The energy strategy laid out the following role for renewable energy:

- Guiding energy production structure towards an energy balance with a lower carbon content.
- Promotion of the use of bioenergy and other indigenous energy.
- Maintaining a high standard of energy technology.
- Ensuring the security of supply in the energy sector.

Policy Type General energy policy

RE Technology All renewables

Energy Investment Aid

Year 1990's - Present (several amendments)

Policy Description Energy aid is discretionary state aid, intended to develop less CO_2-intensive energy production and consumption.

It can be granted for energy savings measures, the take-up of new technology or to increase the security and versatility of energy supply. The aid focuses on new technologies and is used to reduce risks associated with them. Aid can be granted within the limits of the parliamentary authorisation included in the state budget.

Only enterprises and corporations are eligible for aid. Subsidies are up to a maximum of 40% of investment costs. Projects involving innovative technology have priority.

In 1998, investment aid for renewable technologies was FIM 110 million (€ 17 million). The 1999 Action Plan for Renewable Energy Sources planned for FIM 200 million (€ 33 million) per year of government investment aid.

Public funding is also made available to renewable energy plants through regional and local incentives.

A new financial instrument is to award a €15-30 million demonstration grant every three years for a project using innovative technologies. This is to allow projects to adapt new large-scale technologies to Finnish conditions and to commercialise them.

Policy Type Capital grants/RD&D

RE Technology All renewables

Action Plan for Renewable Energy Sources

Year 1999 - Present (revised 2002)

Policy Description This programme aims to increase the market competitiveness of renewable energy sources as part of the National Climate Strategy of 2001. The target is to increase the use of renewable energy by 50% from the 1995 level (20% of TPES) by 2010.

Grants for renewable energy applications account for FIM 200 million (€ 33 million) and subsidies in energy taxation account for FIM 300 million (€ 50 million) annually. The cornerstone of the programme is to enhance use of biomass, which accounts for 90% of the target. Installations using heat pumps cover 4% of the planned extra capacity and both wind farms and hydropower plants each account for 3% of the target. It is expected that solar cell technology will provide 0.5% of the future increase.

Policy Type Obligations/Capital grants/Investment tax credits

RE Technology All renewables

National Climate Strategy

Year 2001-2004

Policy Description Finland's first national climate strategy was published in 2001. According to the business-as-usual scenario of the strategy, Finland's GHG emissions in 2010 would be 14 Mt CO_2 above the 1990 Kyoto target (+0% increase on 1990 levels). The strategy contains the policies and measures to reach the Kyoto target. Increases in energy conservation and the use of renewable energy sources are expected to account for 50% of the emissions reductions by 2010. Programmes for promoting these measures are already in place. The other half of reductions would come from measures related to electricity production. The strategy includes two options: switching from coal to gas or increasing the capacity of nuclear power.

The strategy will be revised in 2004.

Policy Type Obligations

RE Technology All renewables

Pilot Project on Renewable Energy Certificate Systems

Year 2001-2002

Policy Description Finnish market players have participated in a European-wide pilot project on renewable energy certificates, and have successfully set up a national system and proceeded to actual certificate trading. The pilot phase lasted until the end of 2002. The Ministry of Trade and Industry and the National Technology Agency have participated in the funding of the project.

Policy Type Tradable certificates

RE Technology All renewables

Energy Tax Subsidy for Renewable Electricity

Year 2002 - Present

Policy Description Parliament decided to raise all energy taxes by approximately 5% as of 1 January 2003. In keeping with the National Climate Strategy, the scope of energy tax subsidies in electricity generation was expanded to include electricity produced from recycled fuels and biogas. The subsidy for electricity produced from logging chips was also increased (€ 0.069 per kWh). The calculation of taxable fuels in combined heat and power production was changed to provide an additional incentive for CHP.

Policy Type Tax exemptions

RE Technology All renewables

Finnish RD&D Programmes

Bioenergy - RD&D Programme

Year 1993-1998

Policy Description The main objective of the BIOENERGY programme was to develop new technology solutions for biomass fuels.

The BIOENERGY research programme resulted in three new final harvest methods already in commercial usage: the MOHA chipper lorry, CHIPSET chipharvester and EVOLUTION multi-purpose chipharvester. The equipment fulfils the cost objective of the programme in short-distance transportation: fuel now costs FIM 45/MWh.

Thanks to the techniques developed in the programme, and lower taxation, the competitiveness of wood for energy has improved substantially. The experiences gained and technological developments, which have lowered production costs and improved profitability, have also improved the operations of heating entrepreneurs. As a result of development work, the investment costs of district heating have also been cut.

The BIONENERGY programme developed a new technique in which oil boilers can be used with biofuel in 0.2-5 megawatt sized plants and district heating. The programme developed a new oil product, pyrolysis oil, which expands the use of biofuels in large properties. The programme also developed Tarkkaturve ("efficient peat") methods by which the utilisation of peatland and swamps can be conducted more efficiently and in an environmentally-friendly way.

Policy Type RD&D

RE Technology Biomass

NEMO 2 - RD&D Programme

Year 1993-1998

Policy Description The NEMO 2 programme explored the technological and economic potential of using new energy systems in arctic conditions. In addition to R&D, the demonstration of new applications is an essential part of the programme's content.

Policy Type RD&D

RE Technology Offshore wind
Onshore wind
Solar photovoltaic

LIEKKI 2 - RD&D Programme

Year 1993-1998

Policy Description Finland has an excellent international standing within many branches of combustion engineering. LIEKKI 2 has been developing energy conversion technology which is based on combustion and gasification and employs energy conversion technology that places a minimal load on the environment.

Policy Type RD&D

RE Technology Biomass

Waste to REF & Energy - RD&D Programme

Year 1998-2001

Policy Description The National Technology Agency (Tekes) technology programme Waste to REF and Energy performed RD&D on technologies that could lead to new business opportunities. The programme was operated between 1998 and 2001 to consider solutions to waste management that included the use of waste for energy purposes. Goals for the programme were partly guided by the national waste management plan. The plan’s objective was to raise the use of municipal waste from slightly under 40% to 70% by 2005. This meant that € 300 to 500 million in investment would be needed to use the energy recovered from waste. In addition, the EU landfill directive called for a reduction in landfill waste and measures to reduce wastes.

The annual turnover of waste management in Finland totals approximately € 1 billion. A total of € 16 million was granted as funding to fifty RD&D projects under the Waste to REF and Energy technology programme. Finland has the world's leading expertise on bio-energy technologies.

Policy Type RD&D

RE Technology Waste

Wood Energy - RD&D Programme

Year 1999-2003

Policy Description The National Wood Energy Technology Programme focused on developing the production technology and improving the quality of forest chips from logging residues and small-sized trees.

In 1998, energy use of forest chips in Finland amounted to 0.5 million solid-m^3. The target of the programme was to reach 2.5 million m^3 by 2003. Thus, the annual use of forest chips was to increase five-fold in five years. The target was to be achieved primarily by increasing the production of chips from logging residues from regeneration areas because of their better cost competitiveness. In addition, technology was also developed to promote the energy use of small-sized trees from early thinning because of the great silvicultural benefits involved.

Increasing the use of forest chips required further reduction of costs. The cost of chips made from logging residues was competitive against peat and fossil fuels in favourable conditions, but large-scale use presupposed recovery of forest fuels from more difficult stand conditions and over longer distances as well.

The programme also aimed to develop quality control and storage of wood fuels. The quality of chips can be seen as a cost factor, since the energy obtained from the chips, emissions and reliability of delivery all depend upon fuel properties. Quality improvement was not confined solely to forest chips. It is just as important for the process residues from the forest industry. For this reason the scope of the programme also included bark, sawdust and other solid wood residues from the forest industry that are suitable for fuel.

Policy Type RD&D

RE Technology Biomass

Small-scale Production and Use of Wood fuels - RD&D Programme

Year 2002-2004

Policy Description The Finnish Wood Energy Technology Programme is paying increased attention to the small-scale production and use of wood fuels. An important aim is to develop solutions which are economically competitive, reliable and acceptable in terms of emissions for small-scale (usually under 1 MW) wood fuel production, storage, processing, distribution and heat production.

Companies' RD&D needs are surveyed to foster research and product development activities and to develop national and international business operations. Problems and development needs are studied and companies are encouraged to implement product development projects, which can be carried out by a single company or jointly by company integrates. Product development projects can be the companies' own projects or joint projects with other companies in their field. The total budget for 2002-2004 is about € 5.2 million, Tekes's share amounts to € 2.9 million.

Policy Type RD&D

RE Technology Biomass

Climtech - RD&D Programme

Year 1999-2002

Policy Description This programme conducted RD&D for new technologies related to climate change goals. The programme was carried out from 1999 to 2002. Funding from the National Technology Agency (Tekes) was € 4 million out of the total budget of € 5 million.

Policy Type RD&D

RE Technology All renewables

Streams - Recycling Technologies and Waste Management

Year 2001-2004

Policy Description STREAMS is a technology programme initiated by Tekes to develop new, internationally competitive technology and business opportunities related to municipal waste streams. STREAMS is partly financed by Tekes and partly by the participating enterprises.

Several different technology areas are part of the STREAMS programme, including biotechnology, information technology, material technology as well as technologies for monitoring and analysing. In addition to pure technology projects, STREAMS will cover the development of new service and consulting concepts and products.

The sorting and reuse of different waste types, such as paper, metals, glass, plastics and textiles are an essential part of the programme.

The total value of the programme is planned to amount to € 26 million, Tekes' share is approximately half.

Policy Type RD&D

RE Technology Waste

Densy - RD&D Programme

Year 2003-2007

Policy Description DENSY is the Finnish national technology programme for distributed energy systems. It comprises local small-sized units for producing power, heat or cooling. A wide selection of fuels and production technology are covered. The total budget is estimated to exceed € 50 million.

The programme focuses on system integration and commercial services of distributed generation of power, heating and cooling. The focal areas of the programme are: system solutions, integration, industrial production, business concepts, using ICT-technologies and demonstrations.

The main objectives of the programme are to assist Finnish industry, especially SMEs in developing products and services for a global market to make Finnish technology known, to build a world-class innovation environment and to produce commercial products for several niche-markets by 2010.

Policy Type RD&D

RE Technology All renewables

France

Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

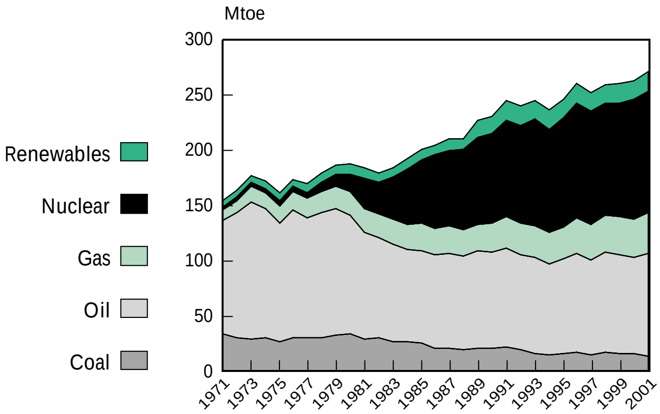
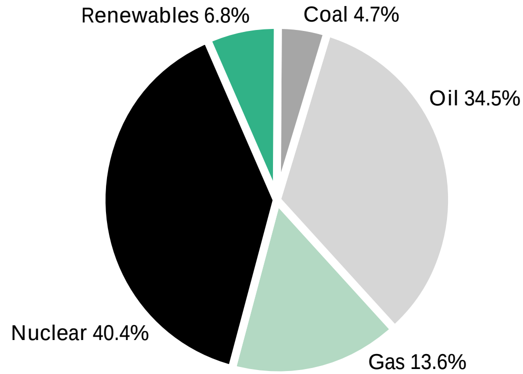


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1.
See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	**1970**	**1980**	**1990**	**1995**	**2000**	**2001**	**Imports**
Coal	37.1	32.9	20.2	16.0	15.0	12.7	88.2%
Oil	93.6	108.1	87.3	85.0	87.2	93.8	100.0%
Gas	8.2	21.6	26.0	29.6	35.4	37.1	92.9%
Nuclear	1.5	16.0	81.9	98.3	108.2	109.7	-
Renewables	6.6	8.9	15.7	17.9	17.5	18.6	-
Biomass	*1.7*	*2.8*	*10.9*	*11.4*	*11.5*	*12.0*	
Hydro	*4.9*	*6.0*	*4.6*	*6.3*	*5.8*	*6.4*	
Geothermal	*0.0*	*0.0*	*0.1*	*0.1*	*0.1*	*0.1*	
Wind/Solar	*0.0*	*0.0*	*0.1*	*0.1*	*0.1*	*0.1*	
Total	**147.0**	**187.7**	**227.1**	**240.8**	**257.4**	**266.0**	**50.3%**
% Renewables	*4.5%*	*4.7%*	*6.8%*	*7.2%*	*6.6%*	*6.8%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*

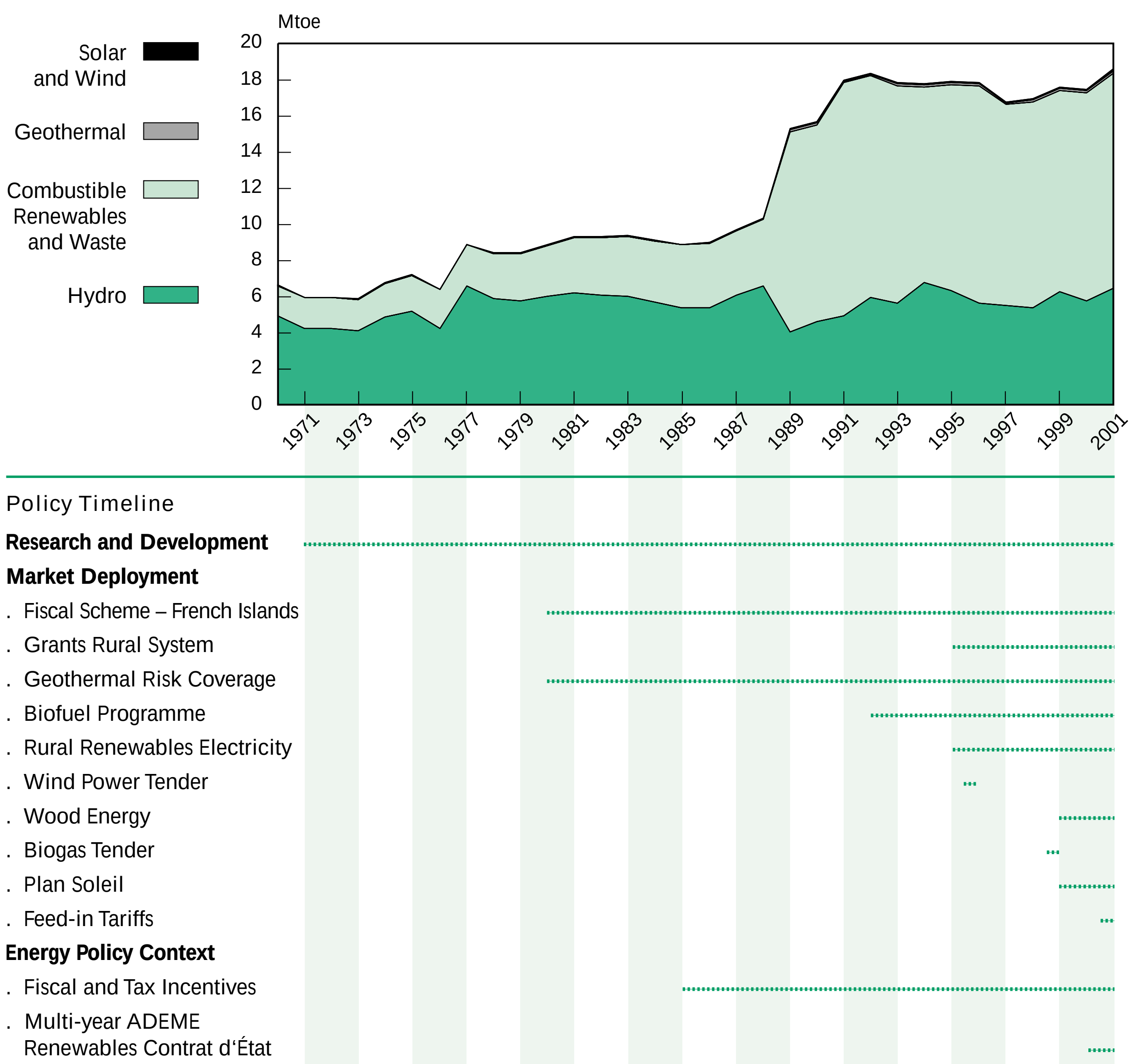
Total primary energy supply (TPES) increased from 147 Mtoe in 1970 to 266 Mtoe in 2001, an average annual growth of 1.9%. Nuclear accounts for 40% of France's TPES, the largest percentage of nuclear power of any country. France undertook its nuclear programme in the 1970s, partly as a response to the oil price crises and to energy security concerns. The programme began to expand rapidly in about 1980, so that by the early 1990s nuclear had become the principal source of primary energy, eclipsing oil. Coal's share of TPES dropped from 25% in 1970 to less than 5% in 2001. The share of natural gas increased from 5.6% in 1970 to almost 14% in 2001. France's fossil fuel supply is almost entirely imported.

Renewables have increased from 15.7 Mtoe in 1990 to 18.6 Mtoe in 2001, maintaining a share of TPES at 6.8%. The renewables contribution is primarily from biomass and hydro sources.

In 2001, nuclear accounted for more than 75% of electricity generation. Coal accounted for about 4.5% and oil for 1%. Hydropower provided about 13.5% of electricity production.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



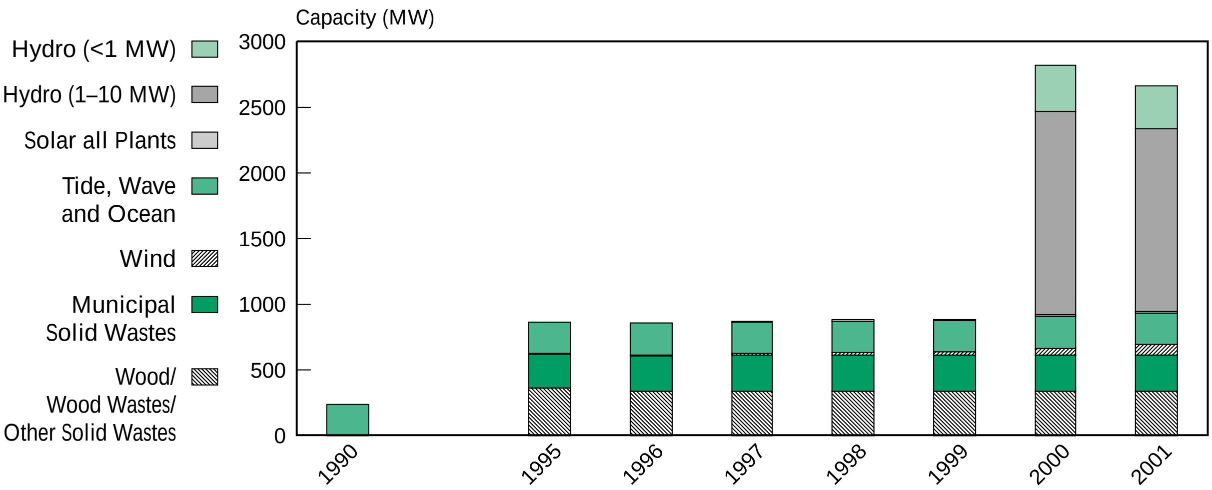
● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Biomass and hydropower account for the largest shares in renewable energy supply in France. In 2001, biomass was 64% and hydro power was 35% of total renewable energy supply. Renewables for electricity production in 2001 included: hydropower generation capacity at 21 GW (excluding pumped storage), and municipal solid waste at 272 MW. Municipal solid waste production increased on average by 4.7% per year from 1990 to reach 79 869 TJ in 2001.

France is well endowed with renewable resources, and has had some success in developing them, *e.g.*, off-grid PV applications on la Reunion and the biomass programme for biofuels and wood energy. In recent years, solar thermal applications were boosted through a national initiative called "Plan Soleil" and electricity generation from renewables was promoted on the overseas islands as well as in mainland France. Electricity generation from biomass is essentially in the overseas territories where sugar residues are burned in three plants. As well, there is on-site production in the pulp and paper industry in mainland France. France is the largest producer of biodiesel, a methyl ester from vegetable oil. France has adopted a national target as an EU member country to reach 22.1% of electricity output from renewable sources by 2010.

Hydropower is considered a mature technology in France, and continues to make a significant contribution. Installed capacity was about 21 000 MW in 2001. The only other renewable making a significant contribution to primary energy supply is combustible renewables and waste; most of which is in the form of wood heating in rural regions, as well as about 272 MW of electricity generation.

Figure 4. **Net Generating Capacity of Renewable and Waste Products**



Note: A change in data collection methods at the IEA occurred in 1999 with the separation of net generating capacity between small and large hydro. Capacity data for small hydro are not available prior to 1999.

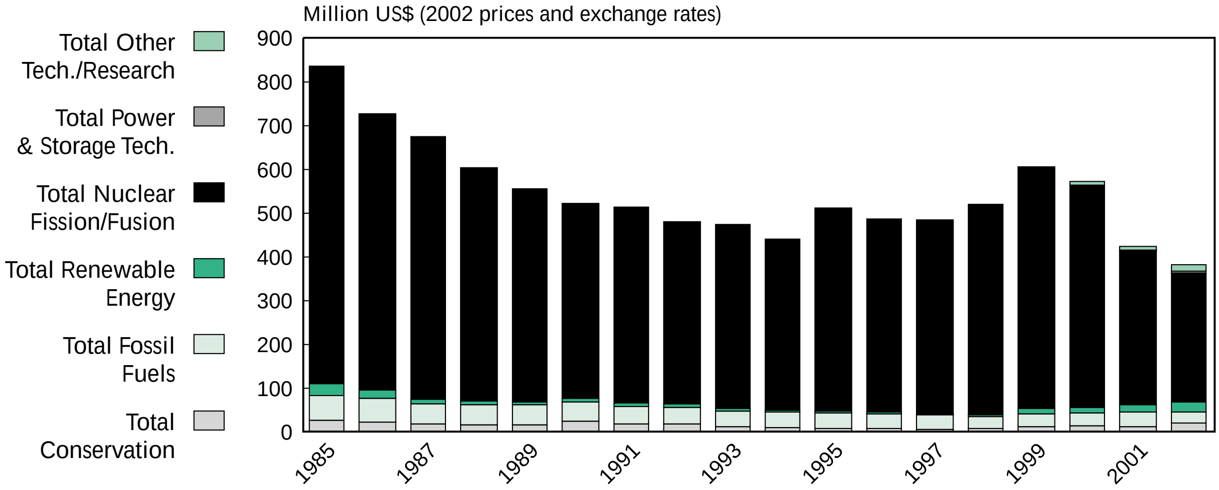
Research and Development Trends

France reports having spent a total of US$ 9.8 billion (2002 prices and exchange rates) on government energy RD&D between 1985 and 2002 (data not available before 1985). The share of renewable energy RD&D in total energy RD&D was less than 2% over the period. Government RD&D expenditures for renewables declined steadily from 1985 until 1998, but increased to 2002.

Among the renewable technologies, biomass received the highest level of funding at US$ 65.2 million, or 34.4%. Solar photo-electric was funded at US$ 63.8 million, representing 33.6% of renewable energy RD&D funding. Geothermal was the third largest recipient with 16.9% of the renewable RD&D expenditures.

The main research institutions include the laboratories at the French Atomic Energy Commission (CEA), French National Center for Scientific Research (CNRS), universities, L'Institut Français du Pétrole (IFP), Bureau de Recherches Géologiques et Minières (BRGM), and the Agency for Environment and Energy Management's (ADEME). Renewable energy research and development is focused on solar energy, wind,

Figure 5. **France – Government Energy RD&D Budgets**

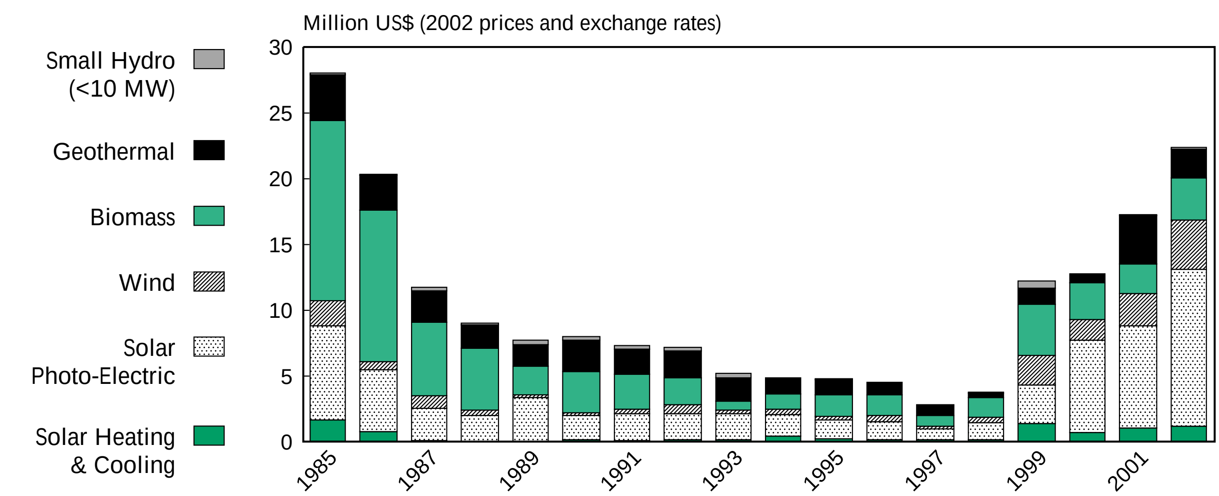


biomass, hydrogen and fuel cells, and geothermal (hot dry rock at Soultz site in Alsace). The research on renewables is often structured in networks.

In 2002, research institutions had an overall budget for energy of € 940 million (including government budgets and industrial contracts). The budget was allocated: € 580 million for nuclear, € 230 million for fossil fuels, € 50 million for renewables, € 40 million for energy efficiency and € 40 million for hydrogen and fuel cells. The government contribution to this budget was about € 600 million.

In addition, France participates in international collaborative RD&D in Bioenergy, Hydropower, Photovoltaic Power Systems, Solar Heating and Cooling and SolarPACES through the IEA Implementing Agreements. Much of France's research on renewables is conducted in the context of the European framework programmes.

Figure 6. **France – Government Renewable Energy RD&D Budgets**



Market Deployment Trends

Much of France's renewable energy market deployment efforts have been directed to the overseas departments. France has been promulgating policies to support renewables since the 1980s, when a risk fund for geothermal went into effect and fiscal schemes were designed to promote renewables in the overseas French departments.

Lower taxation for biofuels has been in place since 1992 and a programme to stimulate biofuels technology has operated since 1994. Beginning in 1995, investment grants were available for rural electrification projects based on renewable energy. The first competitive tender for wind power was launched in 1996. ADEME's budget for renewables was considerably increased in 1999, and a series of policies were established to address specific technologies, including biomass, solar thermal energy and biogas.

These early deployment policies had a limited effect on renewable energy markets. Since the late 1990s, market deployment policies for renewables appear to have been more effective. A programme for rural electrification from renewables resulted in an increase in installed capacity from 700 kW to 1.1 MW per year from 1999 to 2002. A solar thermal initiative in 2000 called Plan Soleil and another initiative for wood use in small-scale district heating systems were also implemented. The most recent renewables deployment activities concern electricity generation from wind, hydropower and geothermal energy on the island of Guadeloupe. It is, however, too soon to measure clear trends from these deployment efforts.

The Electricity Law in 2000 confirmed non-discriminatory access to the grid for electricity production from renewables and set the stage for higher feed-in tariffs. Standardised rules concerning the cost sharing of the grid connection and reinforcement between the producer and the grid operator were published in 2001-2002.

In addition, the Electricity Law of 2000 provided for guaranteed purchases and feed-in tariffs for projects up to 12 MW. These tariffs were put in place in 2001 and revised in 2002. The tariffs are based on the cost of production, including investment and operation that Electricité de France (EdF) would incur to provide equivalent power and may be subject to a bonus when the plant contributes to objectives of the Electricity Law. Network operators (EdF and other distribution network operators) are obliged to purchase electricity at the defined tariffs. The Law also established the principle of competitive tenders for any power class. Other recent policies include tax credits or reductions for the purchase of renewable equipment and a public/private investment fund.

Currently, there are feed-in tariffs for all renewables except large hydro. Tariffs range from € 0.045/kWh for municipal waste to € 0.0310/kWh for PV. Purchase contracts given by EdF last for a minimum of 10-15 years, with a maximum of 20 years for PV or small hydro. For example, wind power starts at € 0.0838/kWh for the first five years, after which it drops to between € 0.03 and € 0.083/kWh, depending on the quality of the sites and turbine productivity. There are also national incentives related to investment costs (*i.e.*, for PV, small hydro and biogas), which can be supplemented by local authorities (regions or departments).

Competitive tenders were launched in 2003 for: onshore wind (500 MW); offshore wind (500 MW); biomass (200 MW) and biogas (50 MW) for projects to be built before 2007. Calls for tender are not limited to French energy producers, but can include any person established in an EU member state or country that is party to an international energy treaty with France.

Incentives to promote wind power are in place, but there are public acceptance difficulties which slow the construction of new plants and require careful consideration and information for the public. The legislative conditions for building wind power facilities were completed in 2003 and a ministerial circular to local authorities has clarified the administrative procedures.

Most of the incentives for wind power have been established too recently to measure impacts. By 2003, only about 239 MW of wind power had been installed, though there were many projects in the planning stages.

A recently launched call for tender, a feed-in tariff and the Loi Paul/Girardin in the overseas territories are expected to spur growth in biomass electricity generation. The Loi Paul/Girardin provides personal income reduction for private investments in the overseas territories, limited to 60% of the income paid by individuals. This fiscal instrument is primarily used by renewable energy operators to attract individual investment.

There was a recent increase of solar thermal applications in mainland France in the 2000-2003 period. About 83 000 m^2 of solar collectors were installed in 2003 both on the continent and in overseas departments. Thermal renewables are promoted through grants, particularly in two multi-year programmes managed by ADEME on wood and solar thermal, and regulatory and fiscal measures.

Energy Policy Context

General policy issues are dealt with in the context of European directives (renewable energy in the electricity system, biofuels and energy efficiency in the building sector). The directives are the main driving force for France's renewable energy policy.

A multi-year programme (ADEME) in 2003 established capacity target increases for each renewable electricity technology by 2007: biogas 50-100 MW; biomass 200-400 MW; wind onshore 2 000-5 000 MW, geothermal 10-60 MW; hydropower 200-1 000 MW; solar PV 1-50 MW. Clearly wind energy is the priority technology, followed by biomass.

A national debate organised in 2003 concerning a new energy strategy – options for the long term – is expected to lead to the adoption of a new framework energy law which will give a key place to energy efficiency and the promotion of renewable energy.

Renewable Energy Markets

Hydropower

Figure 7. **Hydropower Capacity and Electricity Production**

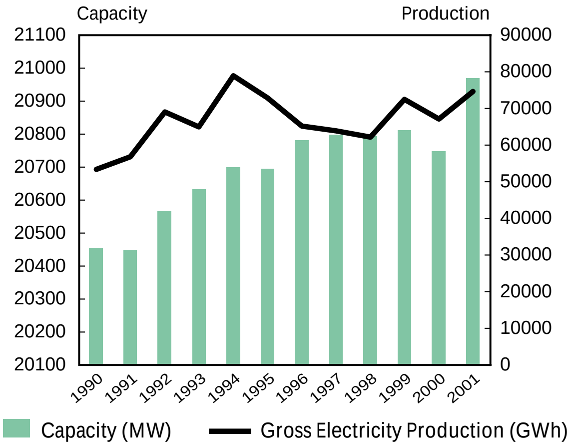
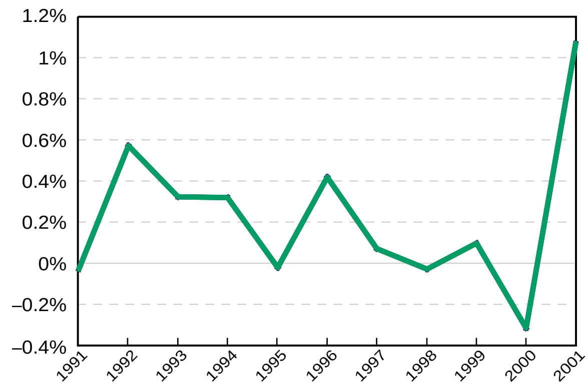


Figure 8. **Hydropower Capacity** (Year to Year Change)



Hydropower Policy Timeline	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
. Target														●
. Feed-in Tariffs														●

● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Hydropower capacity increased slightly from 24 987 MW in 1990 to 25 638 MW in 2001. Generation from hydropower accounted for 13.5% of total electricity generation and for 95% of generation from renewables.

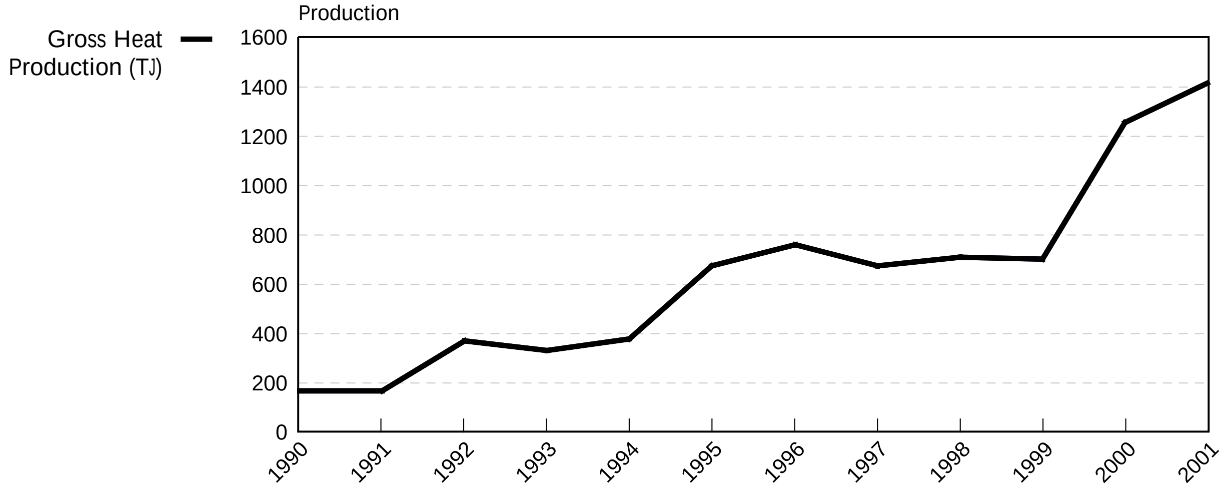
From 1970 to 2001, large hydro plants (> 10 MW) represented, on average, 90% of hydropower production. Hydro facilities between 1 and 10 MW accounted for about 7% of the production. The Rance is the only installation in the world generating electricity from tidal waves, and is counted as hydropower.

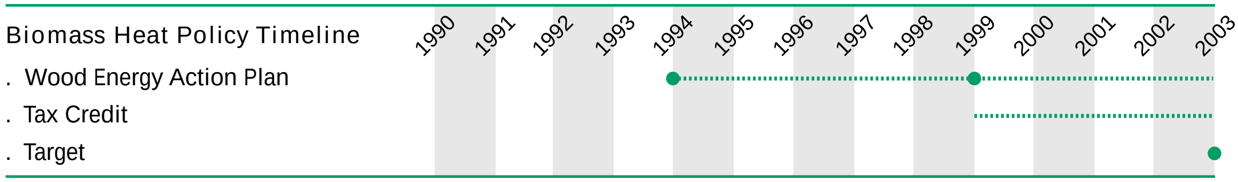
There is no perspective of additional capacities for hydropower >100 MW in continental France. There remains potential for mid-size hydropower development equalling about 2 000 MW, but project implementation faces strong local opposition. In the French overseas territories (Guyana, Guadeloupe, Corsica and la Reunion), new projects in the 0.5 to 10 MW range show potential.

Biomass Heat Production

Heat production from solid biomass was 1 465 in 2001. Heat production has increased by 22% per year since 1990.

Figure 9. **Solid Biomass Heat Production**





Denotes a significant change to a policy, such as an extension, repeal or revision.

To complement a 1994-1998 plan for wood energy and local development, a new action plan was launched in 1999 for a six-year period to develop thermal uses of biomass (wood waste, forest residues) on domestic, collective and industrial fields.

For district and industrial heating, the programme foresees the installation of 1 000 new wood-based heating systems by 2006. This is estimated to deliver savings of 300 000 toe per year and an annual reduction in CO_2 emissions of 700 000 tonnes. It offers assistance in the form of technical advice and investment subsidies. In addition, an experimental action titled “Call for Tender - Carbon Energy” has been launched for the wood drying industry for selected biomass projects based on the price of CO_2 tonne.

For domestic heating, the programme seeks to maintain the same national wood consumption by 2006 and to improve the energy and environmental efficiency of wood combustion. It includes a communication plan by supporting best practices for wood combustion for public/privates operators. Quality labels have been established with manufacturers for wood devices.

Wind Power

Electricity production from wind was 2 GWh in 1993 and increased steadily to reach 125 GWh in 2001. Wind energy has a high potential in France both onshore (50-60 TWh of potential) and offshore (90 TWh).

Figure 10. **Wind Power Capacity and Electricity Production**

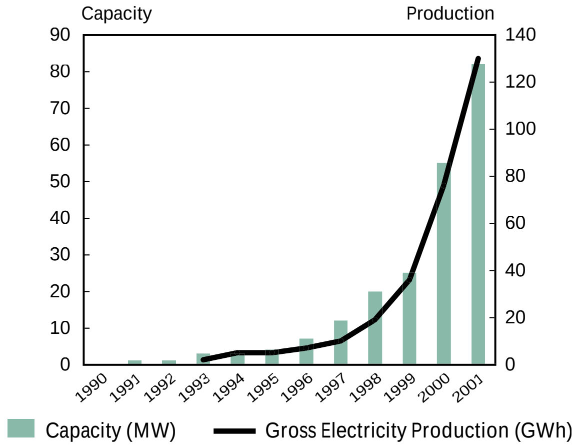
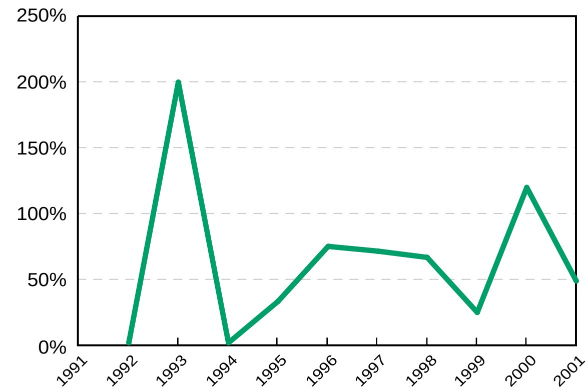
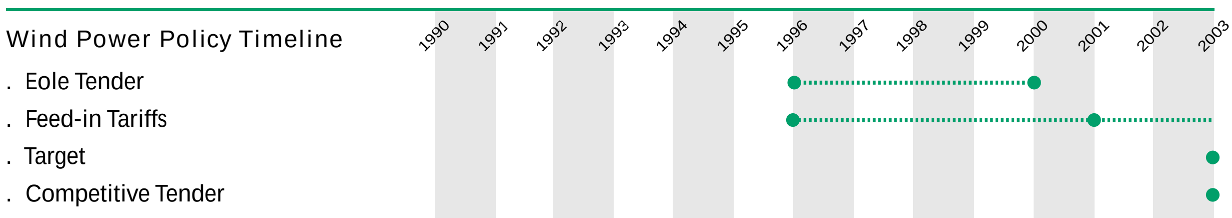


Figure 11. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

A call for tender in 1996 through the Eole 2005 Programme stimulated development of onshore wind power capacity. The goal of the Eole 2005 Programme was to increase the supply of large-scale grid-connected wind electricity to 250 MW by 2005 with projects being selected based on electricity price criteria. The data suggest that the increase in installed capacity from 4 MW in 1995 to 81 MW in 2001 may have been attributable in part to the benefits provided by the Eole 2005 Programme.

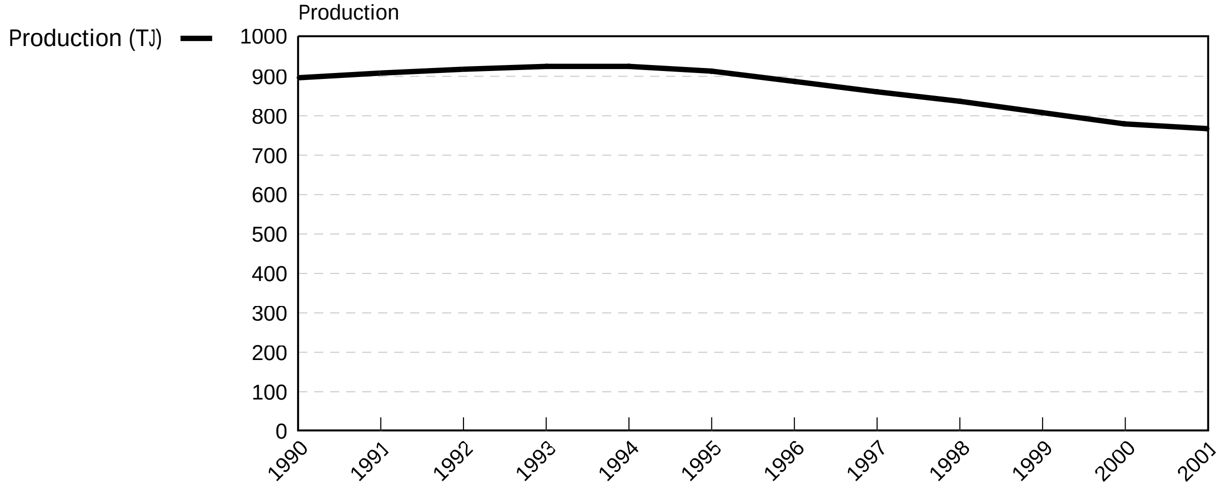
According to French authorities, by 2003 239 MW of wind power had been installed. Competitive tenders for 500 MW of onshore and 500 MW of offshore wind developments were launched in 2003.

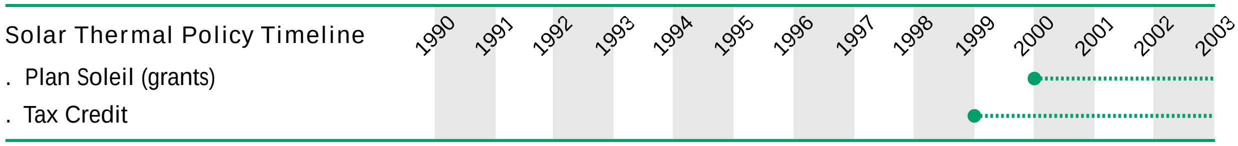
The Eole 2005 Programme came to an end with the new regime put in place by the Electricity Law of 2000. The policy approach is based on feed-in tariffs for projects up to 12 MW and on calls for tenders above this size for both onshore and offshore wind power developments.

Solar Thermal Production

Solar thermal production decreased slightly from 894 TJ in 1990 to 765 TJ in 2001. In the French overseas departments (DOM), the Chauffe-eau Solaires Programme was implemented in 1999 with an objective of 13 000 installations by 2003 for solar collector surface of 45 000 m^2. The programme operates by providing investment grants in support of solar thermal installations. The programme's initial objectives were met in 2000.

Figure 12. **Solar Thermal Production**





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

The French targeted their mainland market, which expanded rapidly following the launch of a national initiative, called *Plan Soleil*, in 2000 that provides grants for the purchase of individual and collective solar thermal systems on the mainland. The programme has the following objectives: 112 000 m^2 of solar collectors installed by 2006 (per year) and a cumulative objective of 330 000 m^2 (from 2000 to 2006). This is expected to lead to an installed capacity of 1 000 000 m^2 of solar collectors by 2006.

Solar Photovoltaic

Photovoltaic capacity increased from 3 MW in 1995 to 14 MW in 2001. The government expects the grid-connected market to grow by 10 MW per year by 2010.

The solar PV market has been targeted by a number of market deployment policies including capital grants, feed-in tariffs, reduced VAT tax for equipment and investment tax credits. France instituted a rural electrification scheme in 1995 which is currently on-going to provide grants supporting up to 65% of eligible investment costs. Rural electrification developments that employ renewable energy sources receive funding from the FACE (Fonds d'Amortissement des Charges d'Electrification) specific fund.

Most other deployment policies came into effect after 1999, which may have worked in concert with the rural electrification scheme. The other policies consist of tax credits in the form of reduced sales tax and tax exemptions for equipment for renewable energy production and the Electricity Law of 2000 that provides feed-in tariffs benefiting the PV market. Feed-in tariffs were revised in 2001 to € 0.305/kWh in overseas departments and Corsica, € 0.0155/kWh for mainland France accompanied by a grant of € 4.60/watt for direct grid-connected installations.

Figure 13. **Solar Photovoltaic Capacity and Electricity Production**

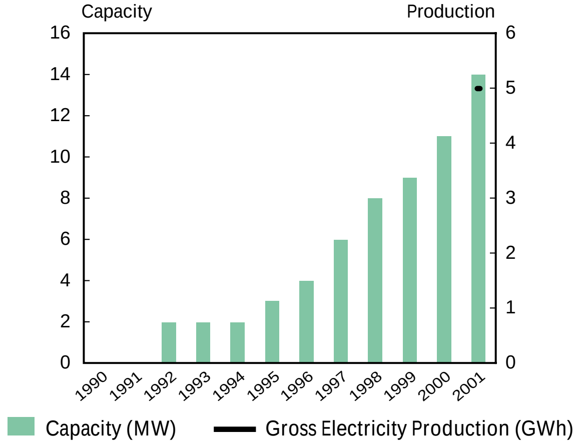
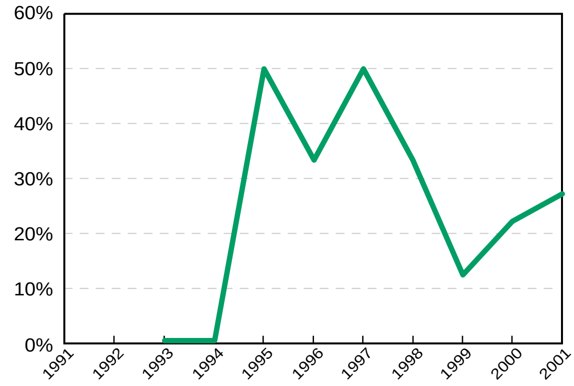


Figure 14. **Solar Photovoltaic Capacity** (Year to Year Change)



Solar PV Policy Timeline

Denotes a significant change to a policy, such as an extension, repeal or revision.

France Policy Chronology

Renewable Energy Development in Overseas French Islands

Year 1980s - Present

Policy Description This fiscal scheme was designed for financial, institutional or industrial companies to develop investments for renewable energy in French islands. This scheme has been operating since the 1980s and is still in place today

Policy Type Investment tax credits

RE Technology All renewables

Risk Coverage Fund

Year 1980s -2012

Policy Description The risk coverage fund is dedicated to low enthalpy geothermal plants (with heat distribution networks). It was designed in the early 1980s to cover the risks associated with the long-term exploitation of geothermal sources. The risk coverage scheme was extended in 2000 for 10 years until 2012.

Policy Type Third-party finance

RE Technology Geothermal

Biofuel Production Programme

Year 1990s - Present

Policy Description This national financial programme aims to develop investments for biofuel production (diester and ethanol). Biofuel production progressed significantly from 1994 to 2000. Consumption of ethanol derived from beets and wheat rose from 38 500 to 90 437 tonnes and consumption of rapeseed and sunflower oil esters rose from 64 400 to 308 870 tonnes.

Policy Type Capital grants

RE Technology Biofuel

Rural Electrification Using Renewables

Year 1995 - Present

Policy Description Rural electrification bodies using renewables (PV, hydro or wind) receive funding from the FACE specific fund (decision taken at national level). The grants support up to 65% of investment cost.

Policy Type Capital grants

RE Technology Hydro
Solar photovoltaic
Onshore wind

Wind Energy Programme

Year 1996-2000

Policy Description In 1996 the government launched the "EOLE" Programme, which aimed to increase the supply of large-scale grid-connected wind electricity to at least 250 MW by 2005. Projects were selected based on electricity price criteria. The length of the contracts is often 25 years. The EOLE tender contracts resulted in prices of about € 0.45/kWh. As of 2002, a feed-in tariff was put in place to support projects under 12 MW. In 2003, it was decided to also launch calls for tenders (onshore and offshore) for larger projects.

Policy Type Bidding systems/Guaranteed prices/feed-in tariffs

RE Technology Offshore wind
Onshore wind

TIPP (Tax on Petroleum products)

Year 1998 - Present

Policy Description TIPP (tax on petroleum products) is the main tax on petroleum products used as fuel (diesel, petrol, LPG; heavy and light oil) or heating fuel. The tax on fossil fuels was modified in 1998 and provides funds to ADEME to support programmes for energy conservation and renewable energy deployment.

Policy Type Fossil fuel taxes

RE Technology All renewables

Wood Energy Programme

Year 1999 - Present

Policy Description To complement a 1994-1998 plan for wood energy and local development, a revised action plan was launched in 1999 for a six-year period to develop thermal uses of biomass (wood waste, forest residues).

- For district and industrial heating, the programme foresees the installation of 1 000 new wood-based heating systems by 2006. This is estimated to deliver savings of 300 000 toe per year and an annual reduction in CO_2 emissions of 700 000 tonnes. It offers assistance in the form of advice/decision tools and investment subsidies. In addition, an experimental action titled "Call for Tender - Carbon Energy" has been launched for the wood drying industry sector to select biomass projects based on the price of CO_2 per tonne.

- For domestic heating, the programme seeks to maintain the same national wood consumption by 2006 and to improve the energy and environmental efficiency of wood combustion. It includes a communication plan for supporting best practices in wood combustion for public/privates operators. Quality labels have been established with manufacturers for wood devices.

Policy Type Capital grants

RE Technology Biomass

Chauffe-eau Solaires dans les DOM

Year 1999 - Present

Policy Description This programme grants investment support for solar thermal installations in France's overseas departments (DOM). By 2003, the volume of solar water heaters installed was 13 000 representing a surface of solar collectors of 45 000 m^2. The programme's initial objective had already been met in 2000.

Policy Type Consumer grants/rebates

RE Technology Solar thermal

Reduced VAT for Residential Renewable Energy Equipment

Year 1999

Policy Description Reduced rates of VAT are applied to equipment for renewable energy production and use that is installed in primary or secondary residencies. The VAT rate is 5.5% in France and Corsica, and 2.1% in Guadeloupe, Martinique and Reunion.

Policy Type Sales taxes

RE Technology All renewables

Biogas Programme

Year 1999

Policy Description

- The Agency for Environment and Energy Management (ADEME) and Electricité de France (EdF) launched a biogas from landfill call for tender for new power capacity of 15 MW.
- ADEME and Gaz de France (GdF) agreement: co-operation on survey on anaerobic digestion (technical, marketing, R&D aspects).
- Support for biogas plants: advice/decision tools for implementation, subsidies for investment costs resulted in four anaerobic digestion units of 20 000 to 110 000 tonnes from biowaste (MSW, agricultural wastes) with

additional support from the European Commission, local authorities and public agency water treatment funds.

Policy Type Bidding systems/Capital grants

RE Technology Waste

Renewable Energy Purchasing Conditions

Year 1999

Policy Description This policy provided the enabling conditions for EdF to purchase electricity produced from renewable sources such as hydro, co-generation, waste incineration and photovoltaics.

Policy Type Regulatory and administrative rules

RE Technology All renewables

Solar Water Heaters: “Plan Soleil”

Year 2000

Policy Description In 1999, approval was given by the government to the French Agency for Environment and Energy Management (ADEME) to launch Plan Soleil. This plan is designed to support the development of solar hot water heaters. The first phase of this programme, specific to individual solar hot water heaters, was extended to collective applications of solar water heating. The objective is to reach 112 000 m^2 per year of collector surfaces installed and 330 000 m^2 between 2000 and 2006.

Policy Type Capital grants

RE Technology Solar thermal

Biogas Agreement

Year 1999 - Present

Policy Description A waste management company and the state-owned utility, Electricité de France (EdF), signed an agreement to develop renewable energy from landfill methane. The "biogas project" operating during 1999 was centred near the town of Plessis Gassot, home to France's largest municipal waste landfill. The waste management company, which operates the landfill, invested FRF 200 million in the infrastructure to capture the methane gas and burn it to produce 10 MW of electricity. EdF agreed to buy all the electricity production for a term of 12 years at a guaranteed price. A second facility at the same site is expected in 2004.

Policy Type Guaranteed prices

RE Technology Waste

Electricity Law 2000

Year 2000 - Present

Policy Description Part of this law concerns renewable electricity installations for which the network operators (EdF and other distribution network operators) are obliged to purchase electricity at fixed feed-in tariffs. Among other things, it regulates the free access of independent energy producers to the grid and laid the foundation for higher feed-in tariffs for electricity production from renewables and a new tender scheme for renewable energy production capacity.

Policy Type Guaranteed prices/feed-in tariff

RE Technology All renewables

Lois (Laws) Paul and Girardin

Year 2000 and 2003

Policy Description The laws Loi Paul (2001) and Girardin (2003) provide a personal income reduction for private investments in the overseas territories. The income tax reduction is limited to 60% of the income paid by the individuals. This fiscal instrument is largely used by renewable energy operators to attract individual investment.

Policy Type Tax exemptions

RE Technology All renewables

Contrat de Plan Etat-ADEME

Year 2000-2006

Policy Description This multi-year contract provides incentives to foster investments in renewable energy projects (under ADEME). Several renewable energy schemes have been defined and implemented, and a general agreement has been reached on objectives to be met and funds to be raised and employed in the 2000-2006 period.

Policy Type Capital grants

RE Technology All renewables

Crediting System in Favour of Energy Management – FOGIME

Year 2001 - Present

Policy Description The FOGIME was created in 2000 in co-operation with the French development bank for small and medium size enterprises (SMEs) and ADEME. The guarantee fund for investments in energy sustainability (efficiency and renewables) has a budget of approximately € 17.8 million, of which € 7.62 million comes from ADEME and € 10.21 million come from a branch of the development bank for SMEs (BDPME). This fund guarantees up to € 242 million for loans to the private sector. Its goal is to provide SMEs with the option to obtain loans for energy efficiency and renewable energy investments.

This guarantee is only available for SMEs created more than three years ago. Eligible investments include: high performance production, use, recovery and energy storage equipment; energy efficient modifications of production processes and renewables.

The guarantee covers medium and long-term risks (2-15 years) and insures the risk taken by the financial institution providing the loan. The guarantee covers 70% of the loan in comparison to 40% average coverage rates for other SME projects covered by BDPME.

Policy Type Third-party finance

RE Technology All renewables

Renewable Energy Feed-in Tariffs

Year 2001 - Present

Policy Description All sites qualifying for the mandatory buy-back rates must be under 12 MW of nominal capacity and have been built after the law was adopted. The following feed-in tariffs have been established:

- *Wind Energy:* production sites can obtain a 15-year contract which guarantees a € 0.0838/kWh rate for the first five years. The tariff for the next ten years depends on wind conditions. Plants working at full capacity for less then 2 000 hours will continue to get € 0.0838/kWh, while those at full capacity for 3 600 hours per year will receive € 0.0541/kWh. These tariffs apply for the first 1 500 MW of nationally installed capacity, thereafter all tariffs decrease by 10% (only for new projects). These tariffs were applicable until December 2002. The rates decrease 3.3% per year to reflect technology learning.
- *Small Hydro:* production sites built after publication of the law or for the marginal production from retrofits increasing production by more than 10% can obtain a 20-year contract which guarantees € 0.0610/kWh for sites with a capacity under 500 kW and € 0.0549/kWh for larger ones. An incentive for regularity of production of up to € 0.0152/kWh is available in winter.
- *Combustible Waste:* production sites are guaranteed rates of up to € 0.0456/kWh for medium voltage connections and € 0.0418/kWh for high voltage connections.
- *Biogas from waste:* production sites can obtain a 15-year contract which guarantees a € 0.046/kWh rate (without thermal valorisation) or € 0.058/kWh (engine, turbine).

- *Biomass:* production sites can obtain a 15-year contract which guarantees a rate of € 0.049/kWh to € 0.0647/kWh (bonus for 70% heat valorisation).
- *Solar (PV or any radiative technology):* The rate is € 0.305/kWh in the overseas departments and Corsica, and € 0.0155/kWh in mainland France. It also provides a grant of € 4.6/watt for direct grid-connected installations.

Policy Type Guaranteed prices/feed-in tariff

RE Technology All renewables

Campaign SOS Climat

Year 2001 - Present

Policy Description This campaign aims to raise public awareness of climate protection issues and to inform them of the positive impact that renewable energy utilisation can have on the climate.

Policy Type Public awareness

RE Technology All renewables

Fonds d'Intervention pour l'Environnement et la Maîtrise de l'Energie (FIDEME)

Year 2001 - Present

Policy Description FIDEME is a fund for environment and energy efficiency, and a specific financial scheme to support private investors (maximum financial share of 25% of the total project costs). Its goal is to promote investments in environment and energy efficiency projects according to classic financial appraisal techniques but with a higher level of risk acceptance, which is balanced by higher commissions and interest rate. In 2001 this mix of private and public funds amounted to € 45 million with € 15 million coming from ADEME, and € 30 million from two partner financiers.

Policy Type Consumer grants/rebates

RE Technology All renewables

Extension of the Law on Reduced VAT for Residential Renewable Energy Equipment

Year 2002-2003

Policy Description The finance law of 2003 reduced VAT rates applied to equipment for renewable energy production, and use in residences was extended until 31 Dec 2003. The VAT rate is 5.5% in France and Corsica and 2.1% in Guadeloupe, Martinique and Reunion.

Policy Type Sales taxes

RE Technology All renewables

Extension of Tax Credit in Favour of Renewable Energy Equipment in New Housing

Year 2002

Policy Description The finance law of 2003 extended the tax credit for renewable energy equipment in new residences that covers 15% of eligible expenses.

Policy Type Tax exemptions

RE Technology All renewables

Extension of Tax Credit for Large Collective Equipment, Renewable Energy Equipment, Thermal Insulation and Heating Regulation Equipment

Year 2002-2005

Policy Description The finance law of 2003 extended the tax credit for the acquisition of large collective equipment, renewable energy equipment and thermal insulation and heating-regulation material to 31 December 2005.

Policy Type Investment tax credits

RE Technology All renewables

Bioproducts R&D Programme

Year 2002 - Present

Policy Description Agriculture for Chemical and Energy (AGRICE), a scientific interest group made up of public and private sector members, supports research on new uses for renewable plant-based products other than foodstuffs. The scope of AGRICE's activity covers primarily the industrial conversion of crop production to chemical (lubricants, surfactants, solvents), energy products (liquid and solid biofuels) and materials (agrimaterials, biopolymers).

AGRICE's brief is to stimulate applied technological research. The consortium first tackled work aimed at substituting plant-based products derived from fossils resources. This strategy has been progressively widened to take into account the inherent characteristics of plant-based products. AGRICE's action spans the study of agronomic improvements, project economics, markets and energy and environmental assessments.

Policy Type RD&D

RE Technology Biofuel
Biomass

Call for Tender for Renewable Electricity

Year 2003

Policy Description A call for tender for renewable energy plants larger than 12 MW. Projects less than 12 MW qualify for feed-in tariffs. Responses are expected in mid 2004 and projects are to be completed by 2007.

Onshore wind (2 × 500 MW)
Offshore wind (500 MW)
Biomass (200 MW)
Biogas (50 MW)

Policy Type Bidding systems/Guaranteed prices/feed-in tariff

RE Technology Onshore wind
Offshore wind
Biomass
Waste

Germany

Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

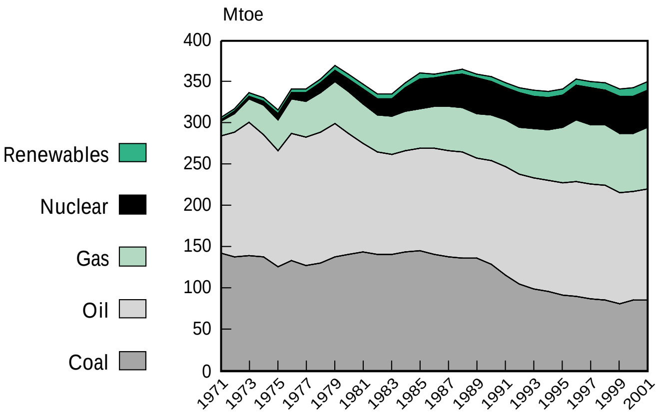
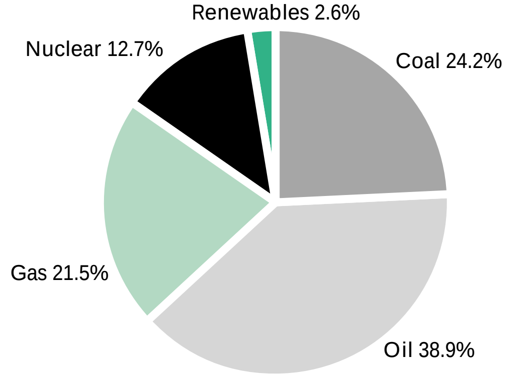


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1.
See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1970	1980	1990	1995	2000	2001	Imports
Coal	147.8	141.0	128.5	91.6	84.8	85.0	30.3%
Oil	137.9	147.1	126.5	135.6	131.7	134.5	98.8%
Gas	12.3	51.2	55.0	67.3	71.8	75.6	77.0%
Nuclear	1.7	14.5	39.8	39.9	44.2	44.6	-
Renewables	4.0	5.4	5.8	6.5	9.0	9.2	-
Biomass	*2.5*	*3.8*	*4.3*	*4.4*	*6.2*	*6.3*	
Hydro	*1.5*	*1.6*	*1.5*	*1.9*	*1.9*	*1.8*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.2*	*0.9*	*1.1*	
Total	**304.4**	**360.4**	**356.2**	**342.3**	**343.4**	**351.1**	**61.9%**
% Renewables	*1.3%*	*1.5%*	*1.6%*	*1.9%*	*2.6%*	*2.6%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*

Total primary energy supply (TPES) in Germany was 356 Mtoe in 1990 and 351 Mtoe in 2001. Indigenous resources include renewable energy sources, hard coal, lignite and some natural gas, but Germany is a net energy importer (Table 1). Oil dominated TPES with 38% share in 2001. Natural gas accounted for 22%. Coal represented nearly a quarter of primary energy demand, down from a 36% share in 1990. This is due to the rapidly decreasing use of lignite, which had dominated energy supply in former East Germany. Nuclear power accounted for 13% of TPES in 2001. Renewables' share of TPES increased from 1.6% in 1990 to 2.6% in 2001.

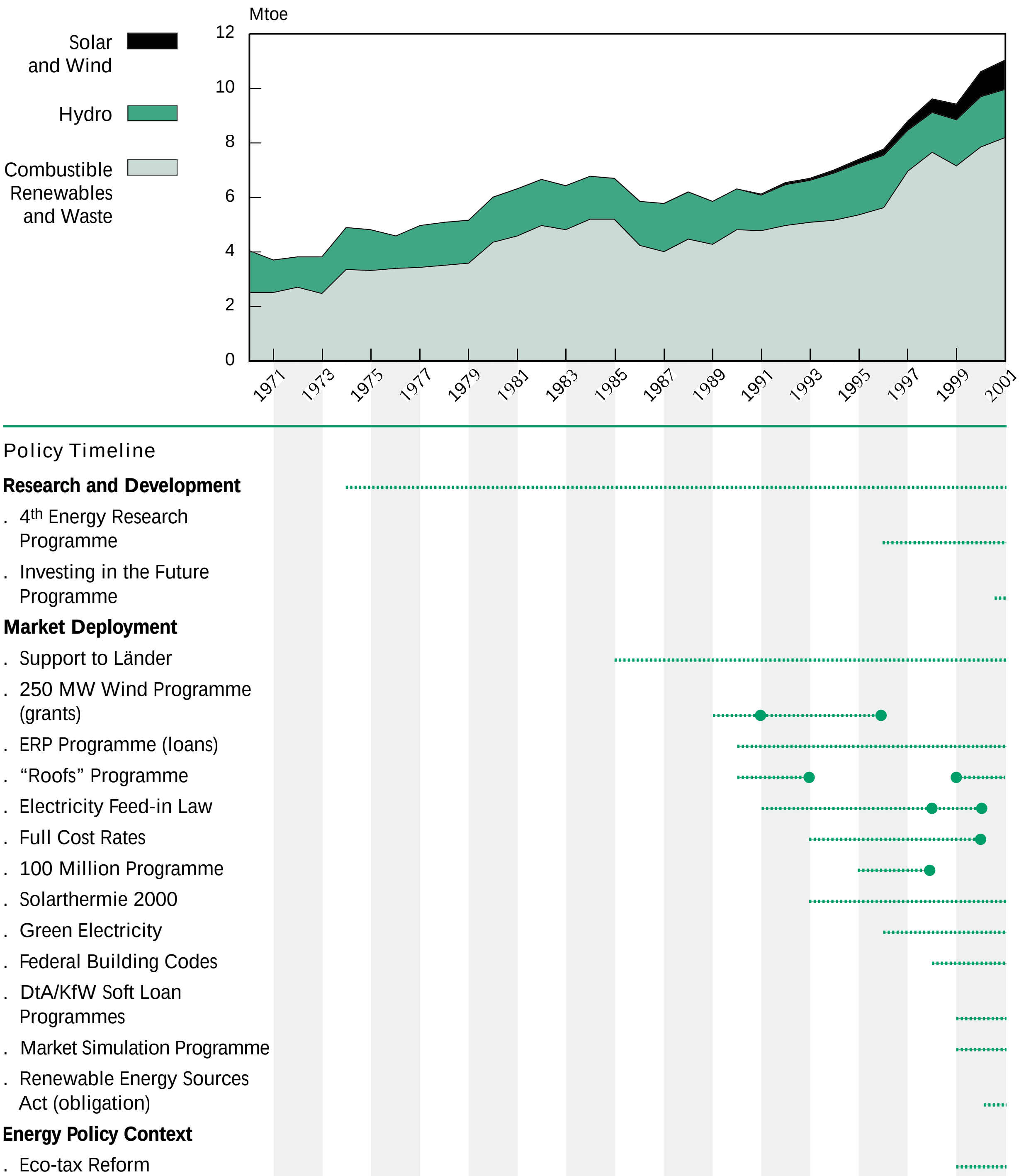
Renewable energy supply grew from 5.8 Mtoe in 1990 to 9.2 Mtoe in 2001, due to substantial growth in biomass use and the very rapid growth of wind power. Biomass represented 69% of renewable energy supply, mainly used for heating purposes in the residential sector, followed by hydropower (19%) and solar and wind power (12%).

Coal is the main fuel used for electricity generation (52%), followed by nuclear at 29% and natural gas at 10% of total electricity generation in 2001. The electricity market was fully liberalised in 1998. An agreement between the government and the electricity supply industry limits the remaining generation of nuclear power plants leading to a total phase-out of nuclear power by 2021.

Due to a combination of different policy instruments, there has been rapid and continuous growth in the contribution of renewables to electricity supply in Germany. The share of renewables almost doubled from 1990 to 2001, when they represented 6% of total electricity supply. According to German statistics, wind capacity grew on average by more than 50% per year between 1990 and 2003. More than a third of globally installed wind power capacity is in Germany. Two-thirds of the total photovoltaic capacity installed in the European Union is in Germany. The German government has committed itself under the *EU Directive for Electricity Produced from Renewable Energy Sources 2001* to increase the share of renewable energy in electricity supply to 12.5% by 2010 and to 20% by 2020.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**

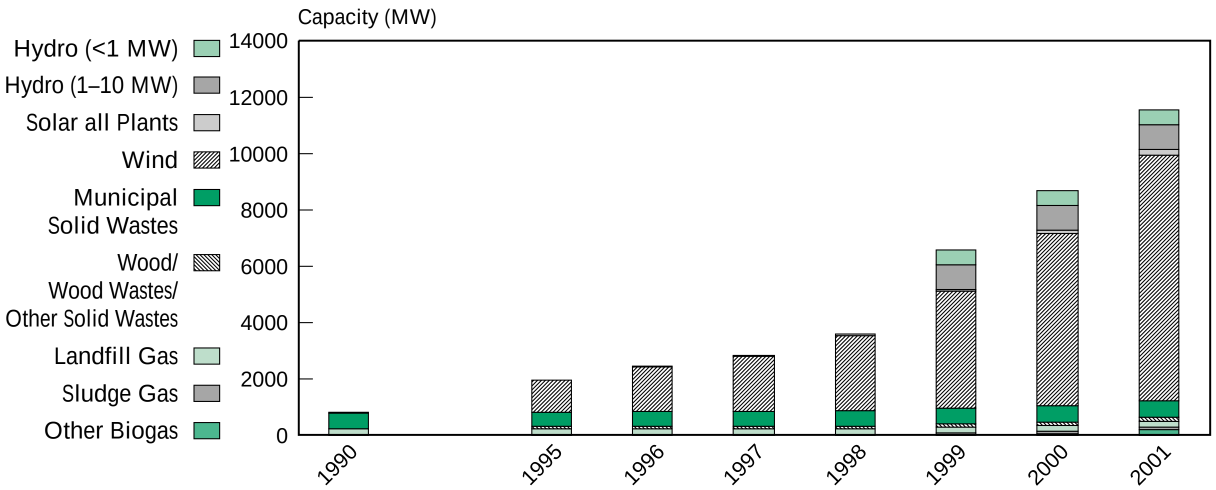


● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Renewable energy supply was 9.2 Mtoe in 2001. Supply increased at an average annual rate of 4.2% from 1990 to 2001. Electricity generation from renewables grew by 5.3% per year over the period. Much of the growth in renewables in the 1990s is attributed to the 1991 Electricity Feed-In Law. The Feed-In Law and its successor, the Renewable Energy Sources Act 2000, have been the major drivers behind growth in renewable energy for electricity generation. Renewables were also supported through soft loans for wind, hydropower and biomass-fired power plants and through grants and soft loans for photovoltaic installations, *i.e.*, the "1 000 Roofs Programme" and "100 000 Roofs Programme".

Figure 4 shows installed capacity for renewables, excluding large hydropower, from 1990 to 2001. Wind power capacity increased from 48 MW in 1990 to 8.7 GW in 2001. There was 534 MW of micro-hydro capacity (> 1 MW) and 887 MW of small-hydro capacity (1-10 MW) in Germany in 2001. Municipal solid waste (MSW) capacity was 585 MW, largely unchanged from its 1990 level of 550 MW. Solid biomass capacity was 150 MW, landfill gas 209 MW, sludge gas 78 MW and other biogas 200 MW in 2001. Solar capacity from all plants was 195 MW.

Figure 4. **Net Generating Capacity of Renewable and Waste Products**



Note: A change in data collection methods at the IEA occurred in 1999 with the separation of net generating capacity between small and large hydro. Capacity data for small hydro are not available prior to 1999.

According to German statistics, renewable energy accounted for 7.9% of total gross electricity generation in 2003.[1] Hydropower represented 3.5%. Wind power has been the fastest growing renewable energy source in Germany, representing 3.1% of total electricity generation in 2003. The share of wind power in renewable-based electricity generation is expected to surpass hydropower in the very near future. Biomass accounted for 1.2% of electricity generation in 2003. Germany had the largest installed photovoltaic capacity in Europe, some 400 MW in 2003, generating 332 GWh. In 2003, the total installed capacity of hydropower was 4.6 GW (excluding pumped storage), wind power 14.6 GW and biomass 1.9 GW. The first geothermal power plant came on-line in November 2003.

1. *The 2003 data in this section are German renewable energy statistics.*

Production of solid biomass grew from 123 259 TJ in 1990 to 190 882 TJ in 2001, steady growth of 4% per year. Solid biomass comprises mainly wood, residues from forestry, wood residues from industry and wood wastes. Solid agricultural residues, *e.g.*, straw, have only recently been used for energy production. About 95% of solid biomass is used for heating purposes. Some one-half of total biomass production is consumed in the residential sector.

In 2003, heat generation from renewable energy sources was 66.4 TWh, some 4% of final energy demand for heating purposes. Biomass dominates the heat market, with a share of 84%, but growth in the market for solar thermal collectors has been rapid. In 2003, the total installed area was 5.6 million m^2 and production was 2.5 TWh. Geothermal resources, including near surface use, contributed with 1.5 TWh, 0.1% of final energy demand for heating purposes.

Prior to 2003, geothermal energy was used entirely for heat production. Large deployment of geothermal power generation is envisaged in the near future mainly sponsored by the enhanced remuneration of the Renewable Energy Sources Act 2000. This Act marks the first time that assistance was offered to geothermal producers. Under the Act, producers operating generation plants with capacity of 20 MW or less receive € 0.089/kWh. Operators of larger plants receive € 0.072/kWh.

There are thirty large geothermal heating plants using deep hydrothermal resources in Germany. A large number of heat pumps using the energy close to the surface were deployed in the early and mid 1980s. But low heating oil prices in the late 1980s and unreliable heat pump systems on the market resulted in more systems being decommissioned than installed until the mid 1990s. The market for heat pumps was revived through the "100 million programme" in 1995 and through advertising campaigns by the electricity supply industry.

Research and Development Trends

Germany spent a total of US$ 22.6 billion (2002 prices and exchange rates) on government energy RD&D between 1974 and 2002. About 10% of the total German RD&D budget over this period was allocated to renewable energy RD&D.

Figure 5. **Germany - Government Energy RD&D Budgets**

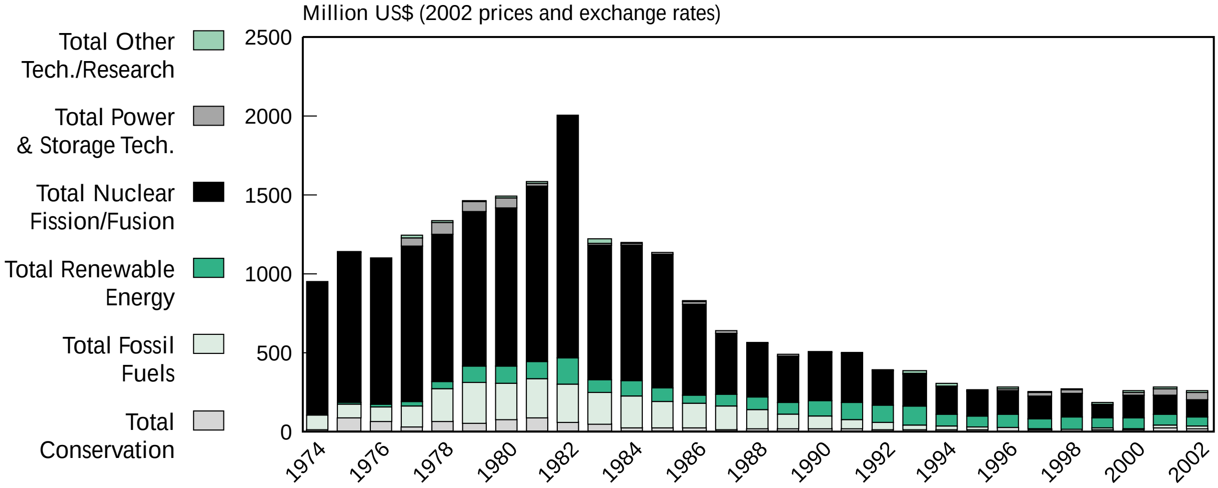
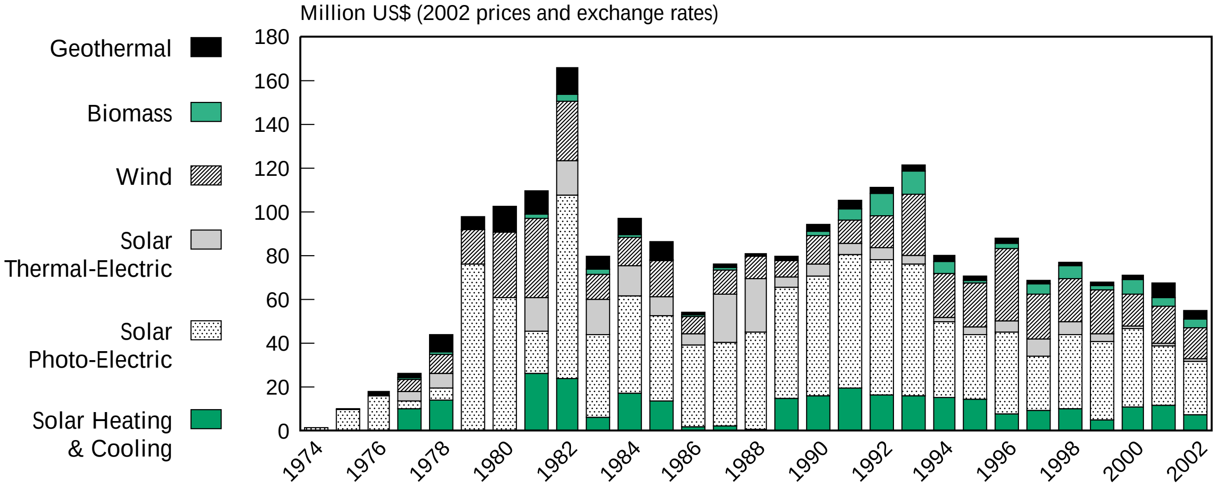


Figure 6. **Germany - Government Renewable Energy RD&D Budgets**



Government RD&D expenditures for renewables peaked in the early 1980s and declined notably in the 1980s and 1990s. The government RD&D budget for renewables, however, did not exhibit such a rapid decline. Budget outlays for renewable energy RD&D averaged US$ 82 million from 1990 to 2002.

Among the renewable technologies, solar PV received the highest level of funding at US$ 1.1 billion, or 49%, from 1974 to 2002. Wind was funded at US$ 446 million, representing 20% of renewable energy RD&D. Solar heating and cooling was the third largest recipient with 13% of the renewable RD&D expenditures from 1974 to 2002. Funding peaked in 1982 with outlays of US$ 166 million, half of which went to RD&D for solar PV.

Market Deployment Trends

Since the oil price crises in the 1970s, a great deal of effort has been devoted to research and development of renewable energy in Germany, and by the mid-1980s, many different technologies were ready for market deployment. But as energy prices declined in the late 1980s, these technologies were not competitive. Surplus capacity in electricity production exacerbated the ability of renewables to compete with conventional fuels. Policy support in the form of investment incentives was offered to renewable energy technologies. In 1989, a subsidy (€ 0.031/kWh) was made available for the first 100 MW of installed wind power in Germany within the "100 MW field test programme". In 1991 the programme was extended to 250 MW. Improved rules for access to the public grid also supported development.

Programmes to support the application of renewables in the heating sector have been in place from the early 1990s, but the level of support increased substantially in the late 1990s. Support took the form of grants within the “Marktanreizprogramm” and within the general housing support as well as soft loans within the “ERP-Umwelt- und Energiesparprogramm” and the “DtA-Umweltprogramm”. In addition, almost all federal states (“Länder”) and many local municipalities launched support programmes for renewable energy technologies. The total public support for these technologies was € 1 517 million in 2002, of which € 1 031 stemmed from the Renewable Energy Sources Act.

Production of Liquid Biofuels

Germany produced 500 000 tonnes of liquid biofuels in 2001, doubling its 2000 production level. According to German statistics, production was 550 000 tonnes in 2002 and 650 000 tonnes in 2003, when it represented almost 1% of total final energy demand for transport fuels.

Historically, Germany has strongly promoted biodiesel. Both pure and blended biodiesel is increasingly available at petrol stations. German Volkswagen was the first European car manufacturer to approve the use of biodiesel in its vehicles. The German government promotes the use of liquid biofuels for use in motor vehicles through tax exemptions amounting to € 0.77/litre for rapeseed methyl ester. Biodiesel is sold in some 250 filling stations. In November 2003, the government proposed changes to the tax law in accordance with a new EU Directive. The change would entail a 100% tax exemption for biofuels from petrol taxes for a period of six years. The exemption would be granted to blends of up to 5% bio-ethanol, and exclusively for undenatured alcohol.

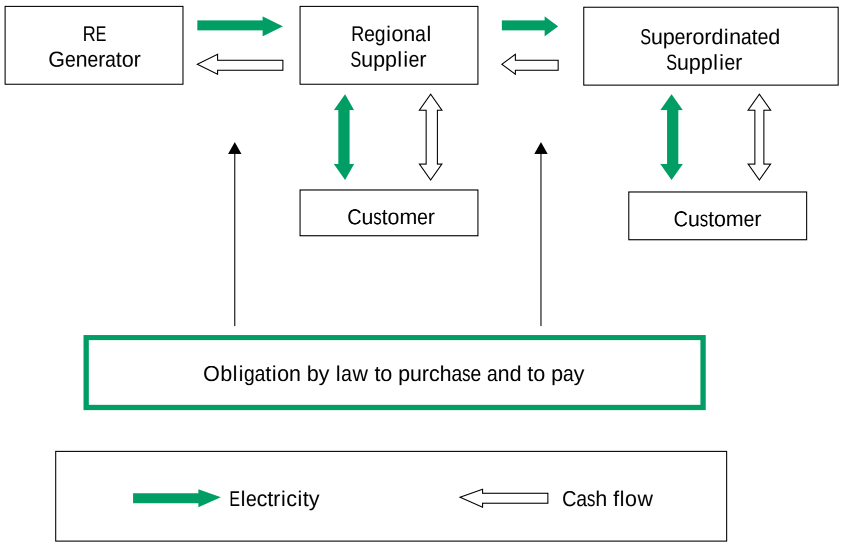
The central policy to promote the deployment of electricity from renewable energy has been a feed-in tariff fixing a minimum price for electricity from renewable energy sources. The Parliament introduced the Electricity Feed-In Law (EFL) in 1991 with the support of a broad coalition of political parties. It was amended in 1998 and revised in the Renewable Energy Sources Act (EEG) in 2000, although the original support mechanism remained the same. The EFL aimed to increase the use of renewables in the national electricity supply system and to deploy renewable energy technologies on the market, thereby creating a new industry.

The EEG expanded the reasons for supporting renewable energy to include sustainable development of the electricity supply system. This regulation ensured grid access for electricity generated from hydropower, biomass, biogas, wind power or solar radiation. Moreover, it obliged the electricity supply company operating the public grid to pay premium prices for the electricity supplied from these renewable energy facilities. The premiums in the EFL were calculated annually as a percentage of the mean specific revenues for all electricity sold via the public electricity grid in the previous year. The percentage ranged between 65% and 90% depending on the technology. The financial burden imposed by the Law was exclusively borne by electricity suppliers and their customers (Figure 7).

A number of issues arose after the Law was introduced in 1991. Growth in wind power led to a situation where under the law, electricity customers in northern Germany, where the majority of wind power installations are located, had to pay a considerably higher share of the total costs than electricity customers in the southern part of the country.

As an intermediate solution, a “double cap” was introduced in the EFL in 1998, limiting the amount of renewable energy electricity that had to be remunerated according to the Law. Regional electricity suppliers only had to purchase a maximum share of 5% of their total electricity supply from renewable energy electricity producers. The same cap applied to preliminary suppliers, leading to a total cap of 10%. With the liberalisation of the electricity market in 1998, the question of equal distribution of burdens also became more important.

Figure 7. **Cash Flows and Energy Flows in the 1991 Electricity Feed-in Law**



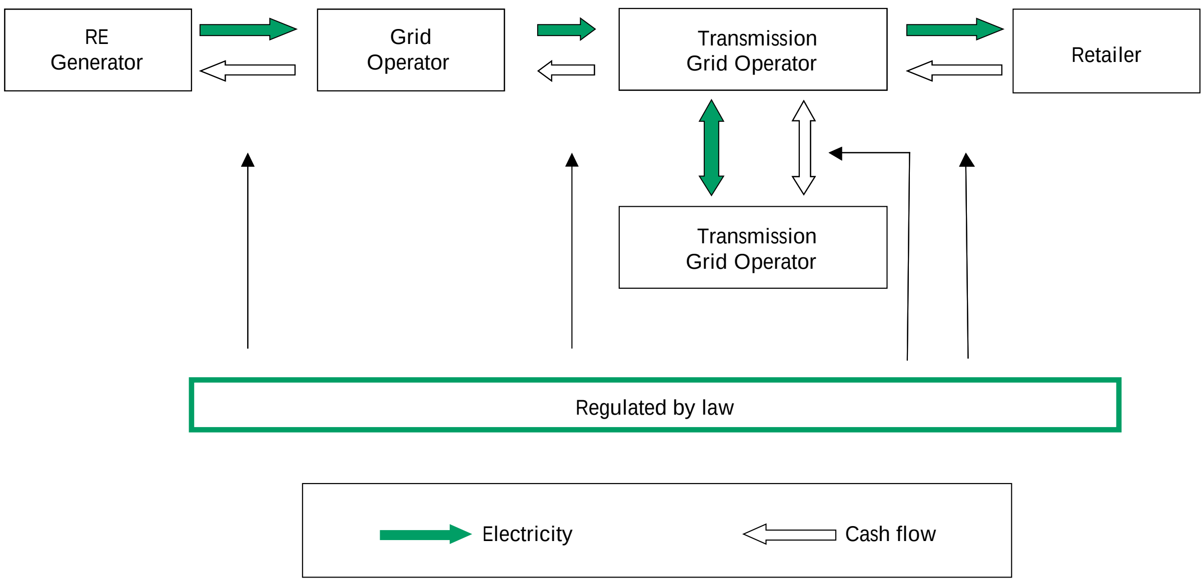
The regulated electricity prices had maintained constant remuneration levels over the years, and thus had provided investors with stable and certain revenue streams. However, the introduction of competition led to a decline in the mean electricity prices, which were the basis of the remuneration. Renewable energy remuneration levels therefore declined. Since renewable energy generators based their investment calculations on stable remuneration over the lifetime of the power plants, which was reasonable under a monopoly situation, the decline of renewable energy remuneration caused severe financial problems for some generators. Another problem with the EFL was specific to wind power. Since the generation cost of wind power depends to a great extent on the wind speed at the specific sites, the remuneration was often insufficient for turbines on inland sites, whereas some plants on coastal sites made extra profits.

To accommodate these issues, the EFL was revamped and broadened to the Renewable Energy Sources Act (Erneuerbare Energien Gesetz - EEG) in 2000. Reflecting the new structure of electricity markets, the obligation to purchase renewable energy electricity is now imposed on grid operators and electricity suppliers (Figure 8). This leads to a mechanism where the renewable energy generator delivers electricity to the grid operator, who then passes the renewable energy electricity on to electricity suppliers.

The scope of the regulation was broadened to include geothermal power plants and large biomass plants. Cost-based tariffs were introduced, which means that the level of the remuneration is calculated on the basis of the electricity generation costs of the individual technology. All renewable energy generators, except wind power, get the same specific remuneration over a twenty-year period. A high remuneration is paid for a fixed total production of electricity. After reaching the limit the remuneration is decreased and the lower remuneration is paid until 20 years after the commissioning of the plant.

The level of remuneration in the EEG is higher for some technologies compared to the levels in the EFL. Photovoltaic equipment built in 2004 receive € 0.434/kWh, small hydro € 0.0767/kWh, geothermal power between € 0.0716/kWh and € 0.0895/kWh, and electricity generated from biomass between € 0.084/kWh and € 0.101/kWh. For an individual plant, the remuneration level stays fixed for twenty years.

Figure 8. **Cash Flows and Energy Flows in the Renewable Energy Sources Act**



This principle does not apply to wind power. The specific wind speed at the individual plant site is used to determine the duration of remuneration paid for wind power. On average across sites, wind power receives € 0.084/kWh over a twenty-year lifetime.

Since 2002, the remuneration paid for newly commissioned plants has been reduced annually by a certain factor to provide stronger incentives for cost reductions. This factor is 5% for photovoltaic installations, 1.5% for wind power plants and 1% for biomass-fuelled plants. A board consisting of the Electricity Supply Industry, renewable energy generators, public officials and researchers periodically reviews the remuneration level and related issues.

The EEG also stipulates obligations concerning grid connection and reinforcement. Plant operators have to pay for the grid connection, but the grid operator has to bear the cost of grid reinforcement if necessary.

The EFL was mainly intended to help independent power producers. However, plants operated by the electricity supply company could obtain the premium prices if they were situated outside the supply area of the individual company. The EEG does not distinguish on the basis of plant ownership, meaning that any plant technically eligible for the remuneration will be remunerated under the Law.

In addition to the EFL and EEG, other policies were introduced to promote the market deployment of renewable energies in the electricity sector, to support further research and development and to establish renewable energy technologies in a political framework. The 1 000 Roofs Programme in 1991 offered investment grants for around 2 000 photovoltaic installations. After several years of minimal federal support for PV and low deployment of PV technology, the 100 000 Roofs Programme was established in 1999. It aimed to support the installation of an additional 300 MW of PV by 2003. It provided soft loans with an interest rate reduction of up to 4.5%, 100% coverage, ten-year loan term, and first two years without discharge. These loans were equivalent to a subsidy of 23% of the investment. Together with the favourable remuneration under the EEG, this support led to rapid growth of PV installations, with some 388 MW installed by end of 2003.

Two federal banks award soft loans with low interest rates (2 percentage points below market level) and favourable payment conditions. Access to capital is very important for deploying renewable energies, since capital costs are often high. Small independent power producers in particular suffer from a lack of access to inexpensive capital. The building codes were changed in Germany, giving renewable energy technologies the same legal status as other power generation technology. Moreover, the municipalities were forced to allocate potential sites for wind power facilities in their land development plans. The requirements on such sites were legally defined.

Due to a combination of support measures, Germany has seen rapid growth of electricity generation from renewables in the past decade. According to German statistics, electricity generation from renewable energy increased from 16.2 TWh (2.9% of total gross electricity generation) in 1990 to 37.5 TWh (6.6%) in 2001. 17.8 TWh of electricity from renewable energy was remunerated under the EEG in 2001 (Table 2).

Table 2. **Electricity Production and Remuneration under the EEG, 2001**

	Electricity (GWh)	**Share (electricity)**	**Remuneration (€ million)**	**Share (remuneration)**
Biomass	1 400	7.9 %	132	8.6 %
Hydropower	4 200	23.6 %	322	20.9 %
Landfill gas, sewage gas, coal pit gas	1 700	9.5 %	104	6.8 %
Wind power	10 456	58.7 %	952	61.8 %
Photovoltaic	60	0.3 %	30	1.9 %
Total	**17 816**		**1 540**	

The potential for large hydropower plants is almost fully exploited. Moreover, environmental regulations on the use of water resources for energy production are very strict in Germany to protect the few remaining natural watercourses. Installed capacity of hydropower has not grown significantly in the past ten years. However, the number of hydropower plants has increased by 20% since 1990. Most of this growth is due to the renovation of abandoned hydropower plants on small streams.

The remuneration under the EFL was not sufficient to motivate investors in biomass technologies to the same extent as in wind power. The most favourable rates for biomass are in combined heat and power plants (CHP). A district heating system is often needed to distribute the generated heat, posing additional obstacles. Organising the supply of appropriate biofuels is a complex process. Moreover, a wide range of different biofuels, conversion technologies and applications exist, hindering the standardisation of projects.

Given the current generation costs of photovoltaic power plants in Germany, it is evident that the remuneration under the EFL was not sufficient to establish this technology in the electricity market. The "1 000 Roofs Programme" and more recently the "100 000 Roofs Programme" provide high investment subsidies to owners of photovoltaic power plants. These subsidies, in combination with more favourable remuneration under the EEG, are expected to increase market penetration of this technology.

Calculating with € 0.051/kWh as a reasonable mean avoided cost, the additional costs under the EFL were € 270 million in 1999, implying that the price of a generated kilowatt-hour increased by € 0.0005/kWh. The total remuneration was € 1.5 billion, leading to a surcharge of € 0.003/kWh of supplied electricity in 2001. Depending on the market price of electricity, the extra cost ranged from € 0.0018 to € 0.0026/kWh of supplied electricity.

Renewable Energy Markets

Hydropower

Figure 9. **Hydropower Capacity and Electricity Production**

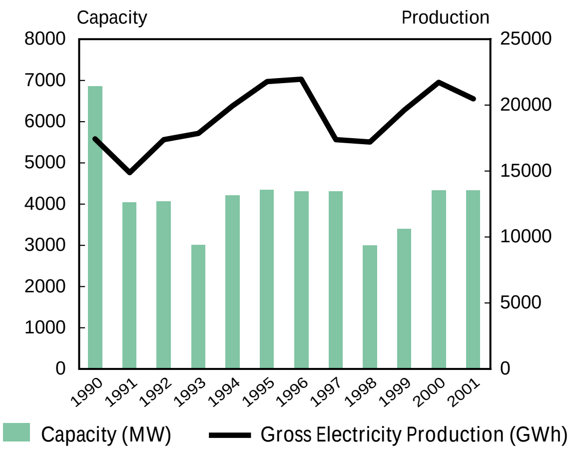
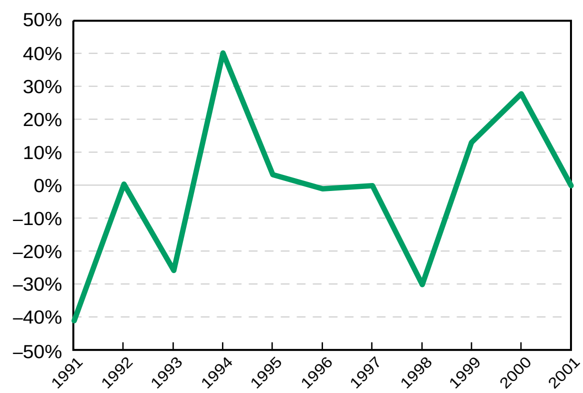
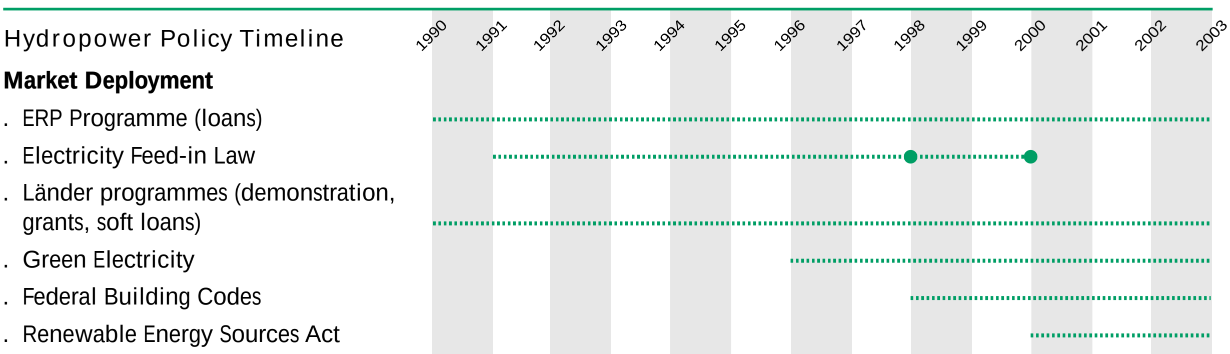


Figure 10. **Hydropower Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Total capacity of hydropower (excluding pumped storage) was 4.3 GW in 2001. Hydropower represents some two-thirds of total electricity generated from renewable energy sources.

Run-of-river power plants represent 80% of total generation from hydropower plants followed by storage (14%) and pumped storage power plants (6%, only natural inflow accounted). The bulk of production comes from 403 hydropower plants with a capacity larger than 1 MW. Energy supply companies operate most of these plants. In addition, there are approximately 5 500 hydropower plants with a capacity less than 1 MW. Most hydropower plants are located in southern Germany.

Most hydropower sites have been fully exploited, but there is some potential for small plants that have been abandoned. In the former German Democratic Republic, around 3 500 small hydropower plants in operation before World War II were no longer operating at the time of reunification. Since then, some

300 plants have been reactivated. There is also some potential for upgrading hydropower plants larger than 1 MW that are operating with outdated technology.

Before the introduction of the Electricity Feed-In Law, access to the grid was a major barrier for small hydropower plants. Obtaining access is still costly and time consuming. Investors are also required to submit environmental assessment plans.

Under the Renewable Energy Sources Act of 2000, generation from hydropower is remunerated at the following rates: € 0.0767/kWh for plants less than 500 kW, € 0.0665/kWh for plants in the range of 500 kW to 5 MW. This represents a substantial increase in the remuneration under the Electricity Feed-In Law. The Renewable Energy Sources Act has particularly provided stimulus for modernisation and reactivation of small hydropower plants. A planned amendment to the Renewable Energy Sources Act could also give favourable remuneration to plants larger than 5 MW, but only to the share of total generation that is added due to a modernisation of the power plant. Thus, incentives for the modernisation of existing large hydropower will be provided.

Soft loans are provided for installation and upgrading of hydropower plants within different programmes. Within the “ERP-Umwelt- und Energie-sparprogramm”, 281 installations with a total credit volume of € 142 million have been supported between 1990 and 2001. The “DtA-Umweltprogramm” provided 159 projects with € 84 million credit at the same time. The support of these two programmes can be cumulated. The Market Stimulation Programme “Marktanreizprogramm” of October 1999 provides support for hydropower plants smaller than 500 kW. Until May 2001, grants were provided for hydropower plants within this programme. After May 2001, only soft loans were provided. By the end of 2001, 112 applications for support had been accepted.

The Lander supported hydropower development with a total of € 50 million between 1991 and 2001, but this support has declined in recent years.

Biomass Electricity Production

Electricity generation from solid biomass increased from 129 GWh in 1990 to 804 GWh in 2000, then declined to 639 GWh in 2001. Biomass capacity in 2001 was about 150 MW.

According to German statistics, in 2002 electricity generation from solid biomass was 1.2 TWh, representing 0.2% of total electricity production. The government estimates that there was 300 to 350 MW of installed capacity in 2002.

Support for biomass (both heat and electricity generation) from the Lander was € 235 million between 1991 and 2001. Under the Renewable Energy Sources Act, power plants based on solid biomass (mostly wood) receive up to € 0.10/kWh of generation, a considerable increase compared to the Electricity Feed-In Law. The Market Stimulation Programme set up in 1999 provides soft loans and grants for biomass plants. Grants are provided up to € 61/kWe. Soft loans may finance the entire investment. This Programme together with the Renewable Energy Sources Act has led to a major increase in biomass-fired power plants since 1999. Market growth has also been driven by clear definitions on eligible biomass technologies within the EEG, which stipulated an additional ordinance on biomass.

Research on electricity from biomass is focussed primarily on gasification technologies.

Figure 11. **Solid Biomass Capacity and Electricity Production**

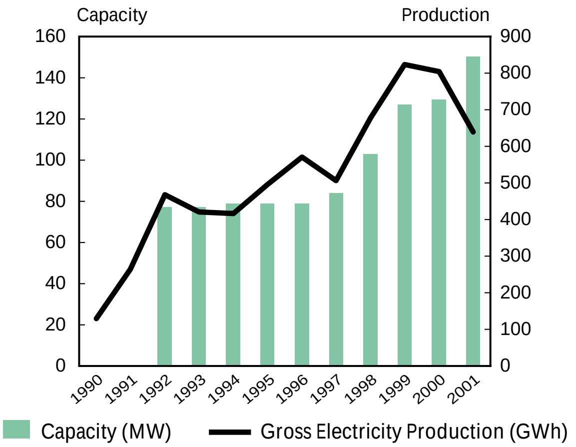
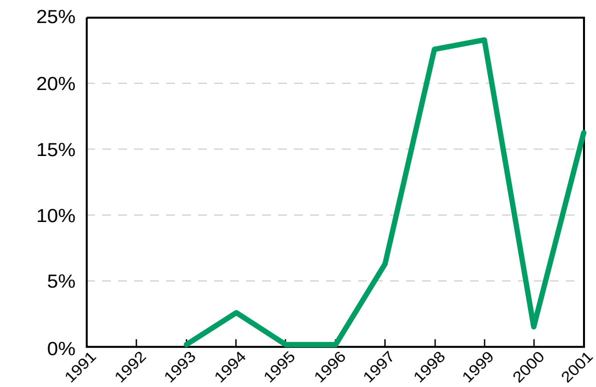


Figure 12. **Solid Biomass Capacity** (Year to Year Change)



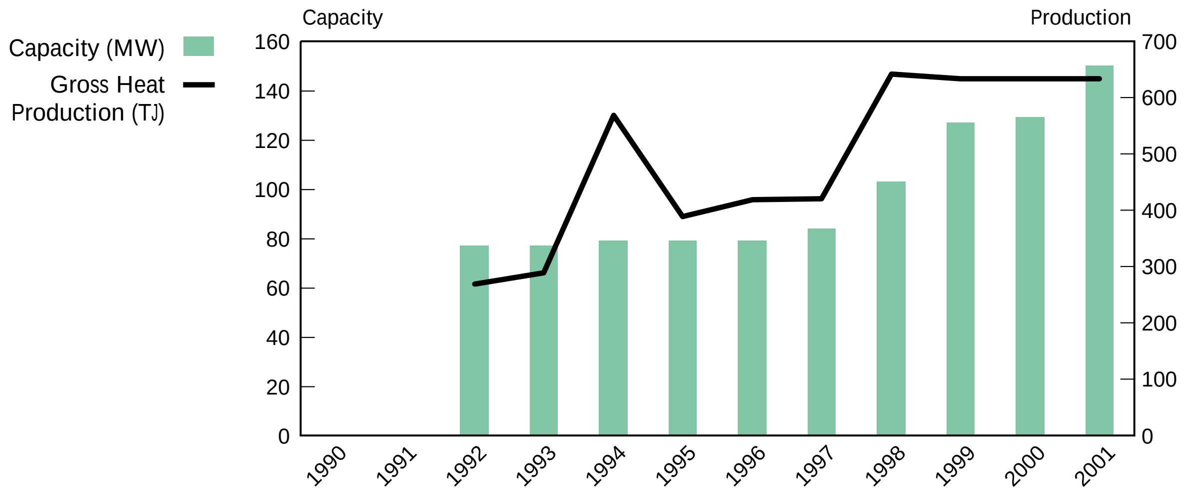
● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

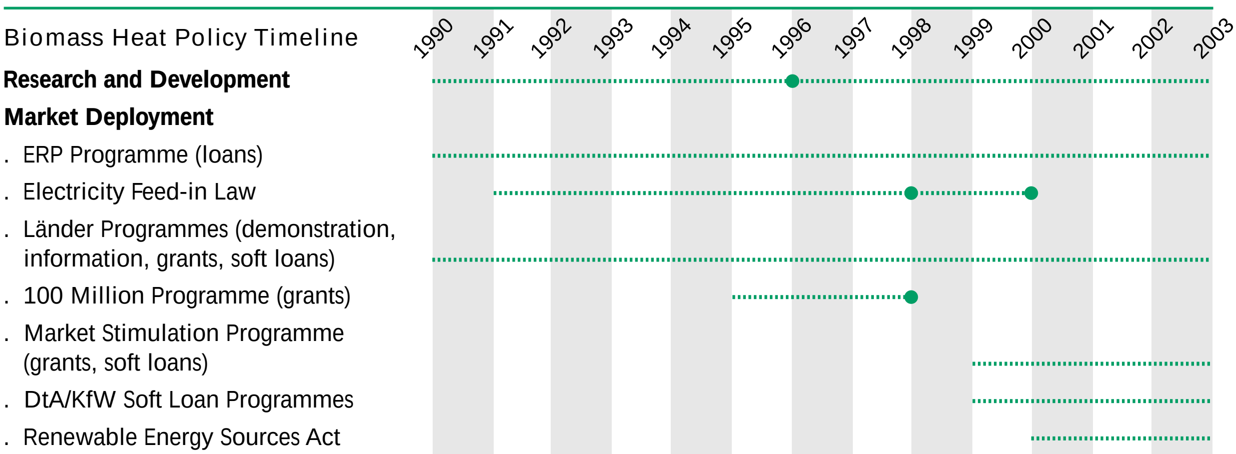
Biomass Heat Production

Heat production from solid biomass increased from 388 TJ in 1995 to an estimated 634 TJ in 2001. According to German statistics, in 2002 solid biomass contributed 187 PJ to heat generation, representing 3.4% of total heat production. Approximately seven million fireplaces and woodstoves are installed in private households in Germany. Annual sales of these products are between 200 000 and 300 000 units. Many of these installations, however, are used irregularly. The market for biomass boilers with automatic feeders has grown recently. Some 9 000 pellet boilers less than 35 kW are estimated to have been installed between 1998 and 2001. Moreover, some 80 large CHP plants were installed between 1998 and 2001.

The Market Stimulation Programme provides grants between € 42/kW$_{th}$ and € 61/kW$_{th}$ for biomass-fuelled heaters, depending on technology and plant size. Biomass-fired CHP plants may receive up to € 185/kW$_{e}$. In total, 15 700 biomass-fired heating systems have been supported between 1999 and 2002. This programme has been the main driver behind the recent improvement in modern biomass boiler technology. Biomass CHP plants under 20 MW also benefit from the Renewable Energy Sources Act. Support for biomass (both heat and electricity generation) from the federal states was € 235 million between 1991 and 2001. A code on the quality of pellets and wood chips is being created by the German Associations of Engineers (VDI), among others.

Figure 13. **Solid Biomass Capacity and Heat Production**





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Wind Power

Wind capacity increased on average by 60.5% per year from 1990 to 2001, from 48 MW to 8.7 GW. The government estimates that in 2002 total installed capacity was 11.9 GW and that wind power plants generated 3% of total electricity generation. One-third of globally installed wind power capacity is in Germany.

Figure 14. **Wind Power Capacity and Electricity Production**

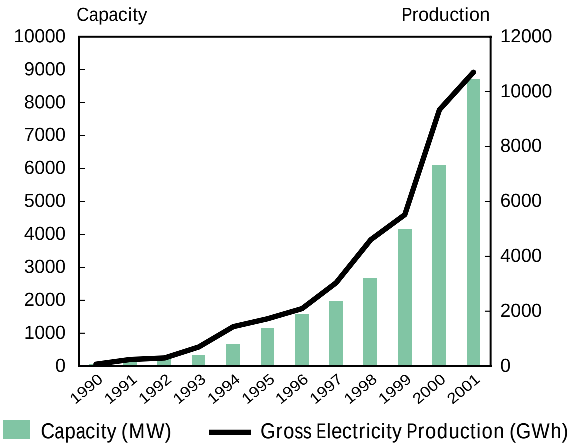
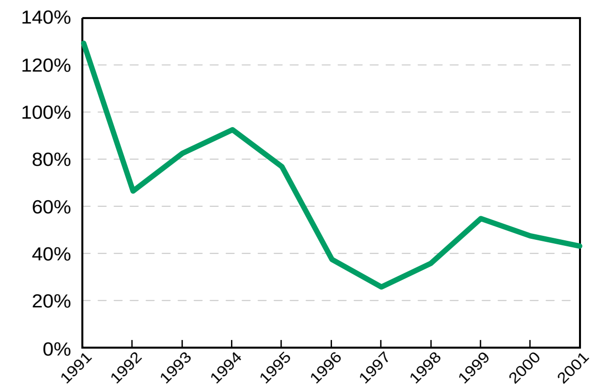
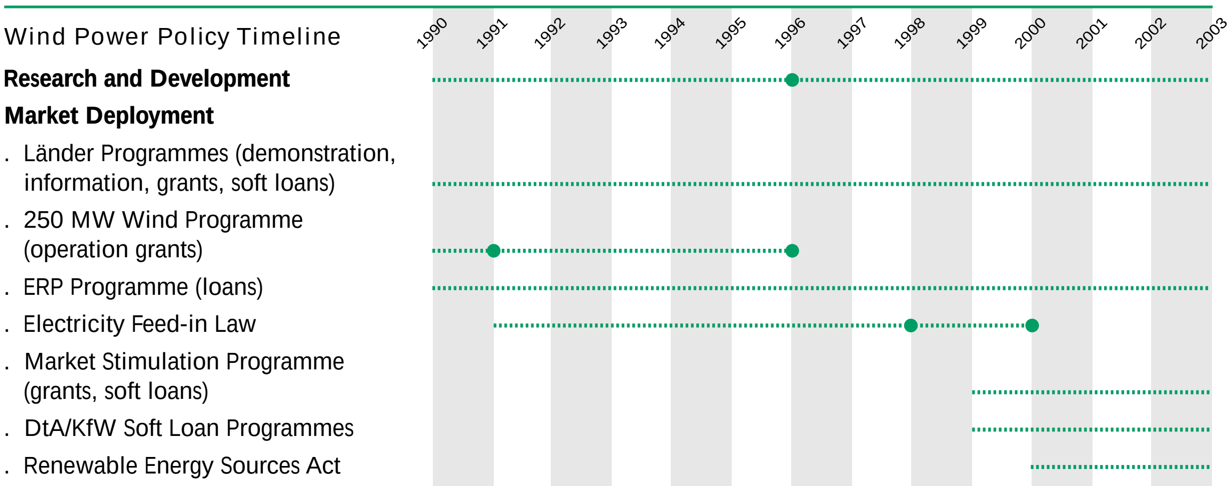


Figure 15. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

The rapid growth has triggered technological development of wind power in Germany. The average size of new power plants increased from 170 kW in 1992 to almost 1.2 MW in 2001. Development of the German wind power market has also contributed to global technical development. Independent power producers have entered the power market, fostering further development. Around 40 000 new jobs were created in the German wind power industry by 2002. Annual turnover was € 5 billion in 2002. Almost 20% of the wind turbines manufactured in Germany are exported.

The 250 MW Wind Programme provided the initial impetus for Germany's wind energy market. The programme was established in 1989 as a 100 MW Wind Programme but was extended to the 250 MW Wind Programme in 1991. It provided grants for the installation and operation of wind turbines at suitable sites. The last grants were approved by the end of 1996 for turbines that had to be connected to the grid by mid-1998. The grants could be combined with remuneration under the Electricity Feed-in Law.

Because of its favourable rates, the 1991 Electricity Feed-in Law is considered the driving force behind the rapid increase in wind power in Germany. The Renewable Energy Sources Act 2000 further strengthened market deployment. Under this Act, electricity producers of wind power receive € 0.09/kWh during the first five years of operation. Depending on the quality of the site, the rate is reduced, and it could fall to € 0.06/kWh for the best sites. Coastal plants receive less support than typical inland plants. Offshore wind power plants receive the higher remuneration at least for a period of nine years to acknowledge the challenges attributed to the deployment of offshore wind power. The specific remuneration for new power plants is decreased annually by 1%.

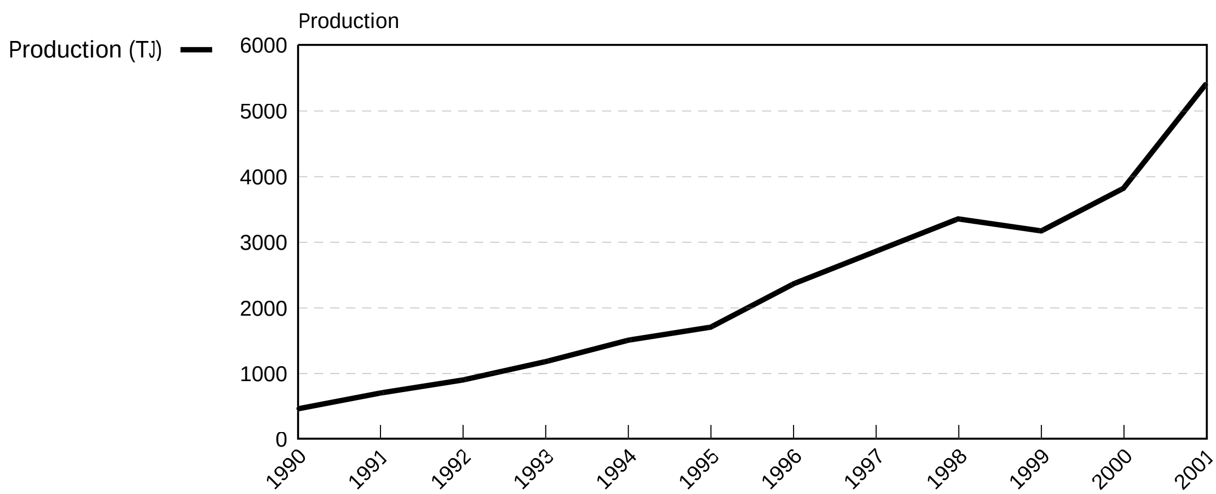
Investment support is provided through the ERP-Environment and Energy Saving Programme as well as through the ERP-Environment Programme. These programmes have spurred much of the recent development in wind energy capacity. Under these programmes, up to 80% of total investment costs may be financed at low interest rates, one to two percentage points below the current market level.

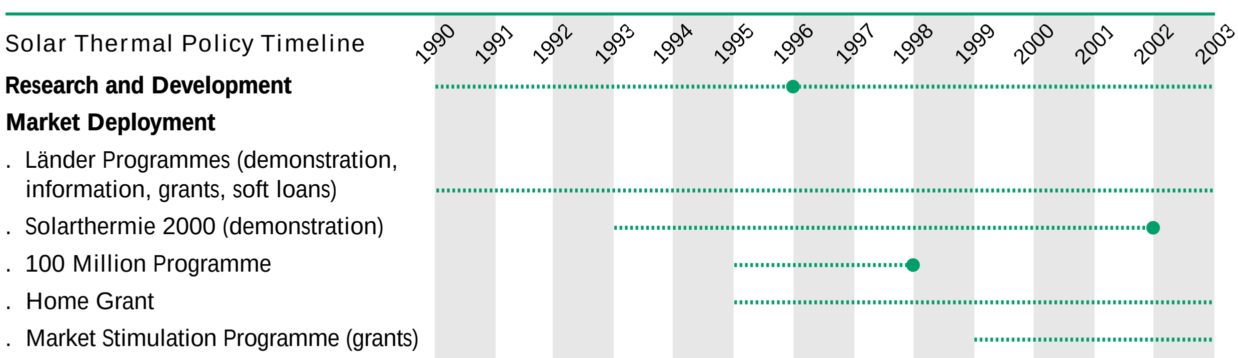
The rapid deployment of wind power technology can also be attributed to changes in the building codes awarding wind power plants the same legal rights as fossil and nuclear power plants.

The federal states provided financial support for wind power of € 260 million between 1991 and 2001.

Solar Thermal Production

Figure 16. **Solar Thermal Production**





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Solar thermal production grew by 25% per year from 1990 to 2001. Total production in 2001 was 5 400 TJ. Government incentives since the early 1990s have resulted in accelerated growth. Production of collectors has doubled since 1996.

"Solarthermie 2000" was launched in 1993 by the Federal Ministry for Research and Technology as part of its large-scale demonstration programme for the development of low temperature heat from active systems, especially in the eastern federal states. Tax incentives support the building of private homes. The main target of "Solarthermie 2000" is to improve the economic viability of solar thermal systems.

Table 3. **Solar Collector Capacity in Germany, 1990 - 2003 (1 000 m^2)**

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
338	466	582	749	940	1 156	1 453	1 817	2 191	2 638	3 283	4 207	4 754	5 600

In 1995, the 100 Million Programme encouraged the purchase of solar collectors and heat pumps by providing capital grants of up to 30% of the investment costs. Since 1999, the Market Stimulation programme has provided € 92/m^2 for the purchase of solar collectors. The programme was revised several times over the past five years.

The federal states have also provided considerable financial support for solar thermal collectors amounting to a total of € 234 million between 1991 and 2001.

Solar Photovoltaic

From 1990 to 2001, solar PV capacity grew by more than 50% per year, and electricity production from solar PV grew by nearly 60% per year. Total capacity was 195 MW in 2001. While the share of solar PV in total renewable use is still quite small compared to biomass and wind, growth has been spectacular since 1990. A combination of feed-in tariffs and production subsidies has spurred this growth.

In 1991, the large scale PV demonstration programme, the 1 000 Roofs Programme, offered subsidies for production costs of 60% in the east federal states and 50% in the western federal states. When the programme was completed in 1995, 2 100 units with total peak generating power of 5.3 MW had been installed. The 100 000 Roofs Programme commenced in 1999 with the goal of increasing capacity by 300 MW by the end of 2003. The objective was to install 100 000 solar PV projects with average capacity of 3 kWp. When the programme ended in July 2003, 55 000 installations with a total capacity of 261 MW had been supported.

The Electricity Feed-In Law of 1991 granted approximately € 0.09/kWh to photovoltaic power fed into the grid. On its own, this feed-in tariff was insufficient to adequately foster PV deployment. The Renewable Energy Sources Act 2000 increased the remuneration to € 0.51/kWh in 2000. This rate decreases annually by 5% for newly built systems. This remuneration together with grants and soft loans provided within the 100 000 Roofs Programme has resulted in rapid growth of PV systems since 1999. Slight increases in the remuneration under the Renewable Energy Sources Act are expected to promote further deployment.

PV technology has been a focus of public promotion of RD&D in the renewable energy field. Voluntary programmes such as the Green Electricity Programme and Full Cost Rates were very important in the 1990s in bridging time gaps in public support and in providing independent funds. However, since the introduction of the EEG, the importance of these programmes has diminished.

Figure 17. **Solar Photovoltaic Capacity and Electricity Production**

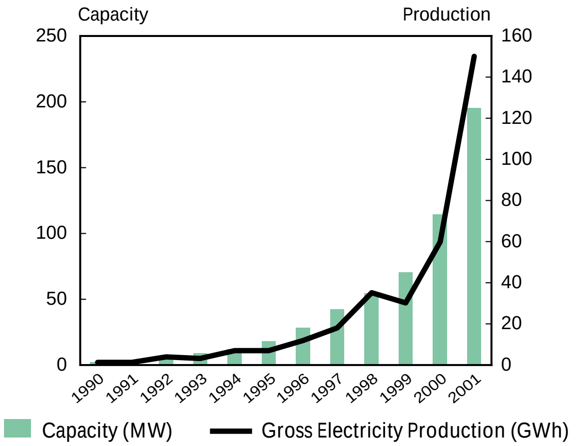
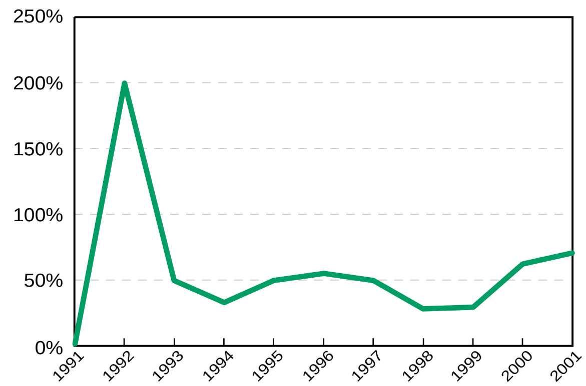


Figure 18. **Solar Photovoltaic Capacity** (Year to Year Change)



Solar PV Policy Timeline

Research and Development

Market Deployment

. Länder Programmes (demonstration, information, grants, soft loans)

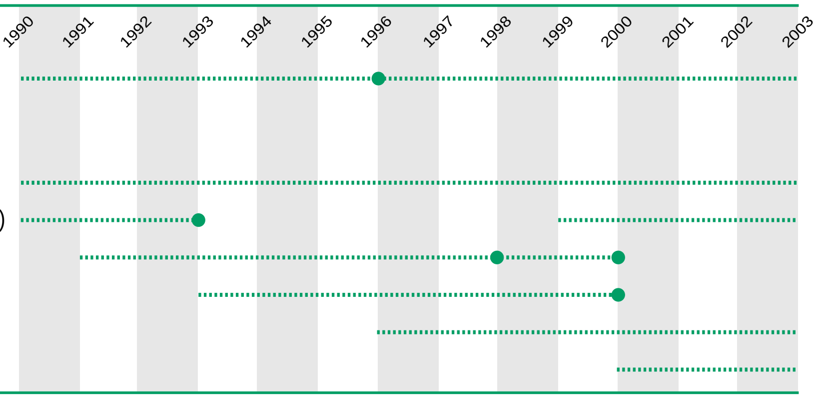
. "Roofs" Programmes (grants, soft loans)

. Electricity Feed-in Law

. Full Cost Rates

. Green Electricity

. Renewable Energy Sources Act



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Germany Policy Chronology

Support of the Federal States ("Länder")

Year 1985 - Present

Policy Description While funds available at the federal level or due to federal law have been the main driver for the deployment of renewable energy technologies, the federal states (Länder) have also provided considerable support. Some states have been more active than others. Table 4 shows combined support for renewable energy technologies by all federal states.

Table 4. **Support for Renewables by Federal States (€ million)**

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	1991-2001
Wind power	13.2	16.4	40.0	46.7	39.9	27.1	31.0	20.4	14.9	7.7	2.4	259.6
Hydro power	4.9	4.7	8.2	5.8	5.4	3.7	3.8	4.7	3.9	2.6	2.2	49.8
Solarthermal	5.7	17.6	22.6	20.4	25.5	31.2	25.4	31.6	23.2	18.8	12.6	234.6
Photovoltaic	5.4	10.5	9.0	9.9	9.0	14.6	19.6	15.6	19.4	22.8	27.9	163.7
Biomass	2.8	7.0	18.0	17.6	38.9	30.6	38.6	37.8	28.2	38.4	37.1	295.0
Heat pumps	1.0	2.8	2.4	2.6	2.4	4.2	2.3	4.2	3.6	6.6	9.0	41.1
Geothermal	0.5	1.7	2.1	2.8	2.3	3.8	0.2	0.3	0.7	0.4	1.8	23.6
Education	1.5	1.7	1.4	1.6	3.2	4.3	6.8	5.1	3.9	6.2	6.2	41.9
R&D	12.5	20.5	28.1	27.1	27.1	21.8	30.0	53.2	53.0	38.0	23.1	334.4
Others	49.5	48.4	48.7	46.5	28.0	23.3	26.8	15.7	8.8	23.6	29.7	349.0
Total	**96.9**	**131.4**	**180.5**	**181.0**	**181.6**	**164.6**	**184.4**	**188.4**	**159.6**	**165.2**	**151.9**	**1 785.5**

Policy Type RD&D / Third-party finance / Capital grants

RE Technology All renewables

250 MW Wind Programme

Year 1989-2006

Policy Description This programme was initiated in June 1989 as a "100 MW Wind Programme" and was extended to the 250 MW Wind Programme in February 1991. The programme provided grants for the installation and operation of wind turbines at suitable sites. The last grants were approved at the end of 1996 for turbines that had to be commissioned by mid-1998. A "Scientific Measurement and Evaluation Programme" (WMEP) is part of the support scheme. All turbines that receive financial support will be monitored for ten years.

The programme provided grants of DEM 200 (€ 102)/kW, up to a ceiling of DEM 100 000 (€ 51 300) for facilities larger than 1 MW. Grants up to 60% of the total investment to a maximum of DEM 90 000 (€ 46 000) were provided.

Alternatively, the programme provided operating subsidies of DEM 0.06 (€ 0.031) (DEM 0.08 [€ 0.041] until 1991) for every kWh fed into the public grid.

This programme promoted 1 560 wind turbines with a total capacity of 362 MW.

Policy Type Capital grants

RE Technology Onshore wind

ERP-Environment and Energy-Saving Programme

Year 1990 - Present

Policy Description The public bank Deutsche Ausgleichsbank (DtA) (Kreditanstalt für Wiederaufbau KfW from 2003) provides low-interest loans to specified renewable energy projects. Only private companies may apply. The credit term for these loans ranges between ten and twenty years with a two to five year redemption holiday. The interest rate is 2% below market level and there is a 50% lending limit. These loans may be combined with the ERP-Environment Programme.

Policy Type Third-party finance

RE Technology Onshore wind
Offshore wind
Hydro
Biomass
Solar thermal
Solar photovoltaic

1 000 Roofs Programme

Year 1991-1993

Policy Description This large-scale demonstration programme for photovoltaics provided subsidies for production costs of 60% in the former GDR and 50% in western Germany. When the programme ended in 1993, about 2 250 units with a total peak capacity of 5.8 MW had been installed. All installations were monitored.

Policy Type RD&D

RE Technology Solar photovoltaic

Electricity Feed-In Law (EFL) (Stromeinspeisungsgesetz)

Year 1991-2000

Policy Description This regulation ensured grid access for electricity generated with renewables. Moreover, it obliged utilities operating the public grid to pay premium prices for the electricity supplied from these renewable energy power plants. No monies from public budgets were involved, as the burden imposed by the law was exclusively borne by electricity suppliers and their customers. The premiums in the EFL were calculated annually as a percentage of the mean specific revenues for all electricity sold via the public electricity grid in the previous year, *i.e.*, the average electricity price for all customers. In this way, the remuneration changed every year. Wind power plants and solar power plants received the highest remuneration with 90% of the mean specific revenues, followed by small hydro, biomass and biogas power plants smaller than 500 kW with 75%, (remuneration rose to 80% some years later). Hydro, biomass and biogas power plants larger than 500 kW, but smaller than 5 MW, received 65% of the mean specific revenues. Table 5 shows the evolution of premium prices from 1991 to 2000.

Table 5. **Development of Premium Prices under the Electricity Feed-in Law**

Technology	(a) %	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
		€cents/kWh									
Hydro & Biomass < 500 kW	75/80	7.08	7.05	7.06	7.21	7.85	7.82	7.80	7.63	7.51	7.33
Hydro & Biomass 500 - 5 MW	65	6.13	6.10	6.12	6.25	6.38	6.36	6.33	6.20	6.10	5.96
Wind & Solar	90	8.49	8.45	8.47	8.66	8.84	8.80	8.77	8.58	8.45	8.25

(a) Percentage of specific mean annual revenues for all electricity supplied in the previous year.

Premium prices decreased after 1996. This was because electricity prices had declined due to the phasing out of the coal levy ("Kohlepfennig"), and later due to the liberalisation of power markets. This law did not cover plants larger than 5 MW. Thus, most generation facilities based on renewable energy sources that existed at the time of introduction of the Electricity Feed-In Law were excluded. Thus, it was ensured that mainly new facilities would benefit from the law. The duration of the remuneration for an individual plant was not fixed; however, the constitutional protection of legitimate expectations provided some certainty to renewable energy generators.

The law was amended in 1998, as the EFL had placed a significant, although unequal, financial burden on some utilities (especially those near the coast where the majority of wind turbines were situated). A "double cap" was introduced in the EFL, limiting the amount of renewable energy electricity that had to be remunerated according to the law. Regional electricity suppliers only had to purchase a maximum share of 5% of renewable energy electricity of their total electricity supply. The same cap applied to preliminary suppliers, leading to a total cap of 10%. This way, the total burden from the law was limited for individual utilities and their customers. The 10% threshold was almost reached in certain areas in northern Germany in 2000, which would have created a barrier for the further deployment of wind power technology.

The law was the driving force behind the rapid expansion of wind power technology in Germany.

The Renewable Energy Sources Act based on the same general principles (but without the cap) replaced the EFL in 2000.

Policy Type Guaranteed prices/feed-in tariff

RE Technology All renewables

Solarthermie 2000

Year 1993-2002

Policy Description This programme aimed to demonstrate the feasibility of large-scale solar thermal heating systems in residential and public buildings, as well as the feasibility of solar driven small district heating systems. It also analysed the long-term behaviour of solar thermal collectors. Sixty-three large installations and seven district heating systems, some of them with seasonal thermal storage, were promoted. All projects are scientifically monitored. The targeted cost level is € 13/kWh heat for future installations.

Grants of up to 50% of the investment costs were provided.

The successor programme "Solarthermie2000plus" was launched February 2004.

Policy Type RD&D / Capital grants

RE Technology Solar thermal
Solar photovoltaic
Concentrating solar

Full Cost Rates (Kostendeckende Vergütung)

Year 1993-2000

Policy Description Under this legislation a tariff was granted to electricity from photovoltaic installations. The remuneration level was approximately € 1/kWh. Twenty-five municipal utilities had introduced such schemes by the end of 1999. Often they were forced by the local parliaments to do so. Approximately 1 000 photovoltaic installations with a total capacity of 4.5 MW were installed as a result of these programmes.

The programmes became obsolete after the introduction of the 100 000 Roofs Programme and the enhanced remuneration according to the Renewable Energy Sources Law.

Policy Type Guaranteed prices/feed-in tariff

RE Technology Solar photovoltaic

Home Grant ("Eigenheimzulage")

Year 1995 - Present

Policy Description Under this programme households may receive federal grants for purchasing houses and flats. The grant is up to € 256 per year over eight years if solar thermal collectors or heat pumps are installed. Heat pumps need to supply at least four times the energy they require as electrical input. The grant is paid out annually by reducing personal tax payments.

Policy Type Consumer grants/rebates

RE Technology Solar thermal

100 Million Programme

Year 1995-1998

Policy Description This federal program, administrated by the Ministry of Economics, encouraged increased use of renewable energy via capital subsidies (up to a limit which varied by technology). Particular emphasis was given to solar collectors and heat pumps, small hydropower installations, large wind turbines (450 kW to 2 MW), PV installations greater than 1 kW, and biomass installations. Solar water heaters for swimming pools and geothermal applications were excluded.

Policy Type Capital grants

RE Technology All renewables

Fourth Energy Research Programme

Year 1996-2004

Policy Description This programme, established in 1996, set the framework for public RD&D support for energy technologies. A successor is planned for mid-2004.

Table 6 gives an overview of the development of federal RD&D funding for renewable energy technologies. It includes funding for hydrogen and fuel cells. These figures contain some support described for other programmes, *e.g.*, 250 MW Wind Programme, Solarthermie2000, 1 000 Roofs Programme.

Table 6. **Federal RD&D Expenditures on Renewable Energy Technologies**

	1989	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**Total**
Photovoltaic	42.2	47.0	53.2	56.8	57.6	33.9	29.6	30.3	25.3	34.5	28.8	37.0	29.1	505.2
Wind RD&D	6.3	9.3	5.0	4.8	3.8	5.6	3.5	2.8	2.8	2.3	2.3	3.1	4.8	56.4
Wind 250 MW programme	0.1	1.9	4.1	8.4	12.7	14.0	16.4	22.7	18.0	17.9	16.4	11.9	7.6	152.0
Solar thermal collectors						0.5	1.8	2.7	2.0	2.4	1.8	1.2	1.5	13.9
Bioenergy	0.7	4.3	8.2	12.8	3.1	2.7	–	–	–	–	–	–	–	31.8
Geothermal	1.4	2.9	3.4	2.6	2.4	2.9	1.9	2.1	1.9	1.7	1.6	2.3	3.5	30.4
Other	56.3	59.7	67.3	61.2	62.6	60.3	56.5	58.0	46.1	41.5	38.0	44.2	56.4	708.2
Total	**107.0**	**125.1**	**141.1**	**146.4**	**142.1**	**119.9**	**109.7**	**118.6**	**96.2**	**100.2**	**88.9**	**99.8**	**102.9**	**1 497.9**

Policy Type RD&D

RE Technology All renewables

Green Electricity

Year 1996 - Present

Policy Description Under this programme electricity from renewable energy sources is marketed as green electricity at premium prices. This is an additional offer by utilities and electricity suppliers. Such programmes do not necessarily lead to new capacity of renewable energy plants since electricity may be also marketed from existing plants. There have been two phases in the dissemination of these offers in Germany, prior to and after the liberalisation of the electricity market in 1998.

In the initial phase, utilities marketed green electricity with green tariffs. They offered the electricity with a surcharge and the funds from the surcharge were supplemented by the utility and used for installing new renewable energy capacity, mostly photovoltaic. The utility could pass the burden on to electricity customers.

After deregulation, independent electricity suppliers also started to market green electricity. In 2000, 132 different companies offered green electricity. The market share, however, was less than 1% of total electricity supply.

Several independent certification schemes exist to ensure independent monitoring of the origin of the electricity. Moreover, some of these certification schemes monitor whether the funds are invested in new plants.

Although not a government programme, the state has supported green electricity in two respects. Before liberalisation, regulatory authorities accepted extra costs from green tariffs. After liberalisation, state agencies started to purchase green electricity.

Policy Type Green pricing

RE Technology All renewables

Federal Building Codes

Year 1998 - Present

Policy Description The 1998 amendment of the federal building codes (Baugesetzbuch) excluded wind power plants and hydropower plants from the general ban on building in the undeveloped outskirts ("Außenbereich"). Thereby, both of these technologies achieved the same legal status as nuclear power plants. Biogas plants may attain the same privilege if they are mainly fuelled with substrate from the surrounding areas.

Municipalities may overrule these privileges by disclosing suitable areas for renewable energy installations in their land use planning. Wind power installations cannot be contested as long as no such municipal plans are in place.

Policy Type Regulatory and administrative rules

RE Technology Onshore wind
Hydro
Biomass

100 000 Roofs Programme

Year 1999-2003

Policy Description The 100 000 Roofs Programme expanded the 1 000 Roofs Programme of 1991. The programme supported the installation or extension of PV systems larger than 1 kW. Loans with interest rates of 4.5% below market conditions were offered, with a repayment period of ten years and a two-year repayment holiday. The possible share of financing was up to 100% to a maximum sum of € 500 000. Furthermore, the costs eligible for the loan were limited to € 6 750/kW for installations smaller than 5 kW, and to € 3 375/kW for installations larger than 5 kW. This limit was reduced by 5% every year starting in 2001. Initially, the tenth instalment need not have been paid but this stipulation was abandoned in 2001. The programme was targeted to support 300 MW of additional capacity.

When the programme ended in July 2003, 55 000 installations with a total capacity of 261 MW had been supported.

This support could be combined with other programmes, particularly with the favourable conditions in the Renewable Energy Sources Act. This programme led to a boom in the photovoltaic market in Germany.

Policy Type Third-party finance

RE Technology Solar photovoltaic

Diverse Soft Loan Schemes

Year 1999 - Present

Policy Description Beyond the two ERP soft loan schemes and the CO_2 Building Restructuring Programme, several other soft loans schemes exist which indirectly support renewable energy technologies. Among these are the "DtA Umweltschutz-Bürgschaftsprogramm," the KfW-Mittelstandsprogramm, the KfW-Umweltprogramm, which applies to enterprises, and the KfW-Infrastrukturprogramm, which applies to municipalities. Investments in environmentally-sound technologies including renewable energy technologies are supported with soft loans and loan guarantees.

Credit terms range from ten to twenty years and interest rates are 1 to 2% below market interest levels. The Kreditanstalt für Wiederaufbau (KfW), Deutsche Ausgleichsbank (DtA) operates the programmes.

Policy Type Third-party finance

RE Technology All renewables

Eco-Tax Reform

Year 1999 - Present

Policy Description With the passage of the eco-tax reform, taxes (“Mineralölsteuer”) on gasoline, diesel, natural gas and liquid gas were increased. At the same time, a special tax on electricity (“Stromsteuer”) was introduced. The first stage of the reform increased the tax on diesel and gasoline by € 0.0307/litre, for heating oil by € 0.0205/litre, natural gas € 0.00164/kWh, and for liquid gas € 0.01278/kg. The electricity tax was € 0.0102/kWh. In late 1999, the second stage of the eco tax reform was adopted, increasing the tax rate annually by € 0.0307/litre, € 0.0026/kWh in the following four years. On 1 January 2004, the tax was € 0.006698/litre for gasoline and € 0.004857/litre for diesel. The tax on electricity was € 0.0205/kWh on the same date. Heating oil is taxed € 0.06125/litre and natural gas € 0.55/kWh. Some exemptions, reduced tax levels, and compensations for energy intensive industry, commuters and low-income households apply.

In 2002, biofuels were exempt from the oil tax until the end of 2008. The law requires that the federal finance ministry draw up a report with the help of other relevant ministries every two years to chart progress in the market introduction of biofuels, and to examine price developments of biomass, crude oil and automobile fuels. The first report was due March 2004. If deemed necessary, the ministry may recommend adjusting the size of the tax break for biofuels.

Since the law increases the price of fossil energy, it enhances the competitive position of renewable energy technologies in the heating and transport markets. Biodiesel particularly benefits since taxes on transport fuels are high. Electricity generation from renewable energy does not benefit directly from the tax because all electricity is taxed irrespective of the fuel used for generation. However, eco-tax revenues from electricity generated with renewable energies are used to finance the “Marktanreizprogramm”.

Policy Type Fossil fuel taxes

RE Technology All renewables

Market Stimulation Programme (“Marktanreizprogramm”)

Year 1999 - Present

Policy Description As a successor of the “100 Million Programme,” the Market Stimulation Programme (Marktanreizprogramm), under the auspices of the Ministry of Economics and Technology, was introduced in 1999. Initially an annual budget of € 100 million was allocated over 5 years.

For several reasons it was not possible to exempt renewable energy power plants from the eco tax. Nevertheless it was felt that this additional income should be used to the benefit of renewable energy technologies. Thus the annual € 100 million represents the estimated additional tax revenue from renewable energy power plants due to the tax reform.

Under this scheme, individuals and small and medium-sized businesses may apply for grants and soft loans for solar collectors, biomass boilers, biogas plants, heat pumps driven with renewable electricity and geothermal heating systems. In addition, schools may apply for grants to install photovoltaic plants. Grants are administrated by the Bundesamt für Wirtschaft and loans by the Kreditanstalt für Wiederaufbau.

Originally grants were awarded as follows: flatplate solar collectors < 100 m^2 € 128/m^2; > 100 m^2 € 64/m^2; vacuum solar collectors < 75 m^2 € 167/m^2; > 75 m^2 € 82/m^2; electrical heat pumps < 13 kW € 102/kW; > 13 kW € 51/kW; manual biomass boiler < 50 kW € 41/kW; automatic biomass boiler < 100 kW € 62/kW; > 100 kW € 61/kW; biomass driven combined heat power plants > 100 kW € 185/kW; biogas plants up to 30% of the investment costs. Additionally, larger installations were awarded with soft loans with interest rates 1% below market level. As a result the level of support ranges between 10% and 40% of the investment.

Almost 80 000 installations were supported by end of 2001, almost entirely solar thermal collectors.

The programme has been amended several times since its introduction, altering the eligible technologies and the level of support.

Policy Type Third-party finance / Capital grants / Consumer grants/rebates

RE Technology Biomass
Solar photovoltaic
Solar thermal
Geothermal

CO_2 Building Restructuring Programme (${CO_2}$ Gebäude Sanierungsprogramm)

Year 2000 - Present

Policy Description The CO_2 Reduction Programme primarily targets energy saving measures in buildings. Renewable energy technologies for heating purposes also may benefit, however, the credit volume for renewable energy installation was only 2% of the total credit volume awarded. The Kreditanstalt für Wiederaufbau operates the programme.

Loans are provided with an interest rate 2% below market interest level.

Policy Type Third-party finance

RE Technology All renewables

Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz EEG)

Year 2000 - Present

Policy Description This Act targets a 12% share for electricity produced from renewable energy by 2010. The Act replaces the Electricity Feed-In Law of 1991. The obligation to give grid access to renewable energy plants and purchase the electricity at premium prices is shifted from the utilities to the grid operators. The tariffs are set for each individual technology, based on its actual generation cost (Table 7). For an individual plant, the remuneration level stays fixed over twenty years, with the exception of wind power. A high remuneration is paid for a fixed total production of wind electricity. After reaching the limit the remuneration is decreased. The lower remuneration will be paid up to twenty 20 years after commissioning the plant. The remuneration paid for wind power on an average site is € 0.084/kWh over a twenty-year lifetime. Since the remuneration for an individual plant is not adjusted for the inflation rate this means a decrease of remuneration in real terms. From 2002 on, the remuneration paid for newly commissioned plants has been reduced annually to provide stronger incentives for cost reductions. This factor is 5% for photovoltaic installations, 1.5% for wind power plants and 1% for biomass-fuelled plants. Since inflation is not considered, the real price decrease is higher than depicted by these rates.

Table 7. **Remuneration Paid under the Renewable Energy Sources Act**

Technology	Size	Remuneration in 2004	Annual reduction factor for newly commissioned plants
Hydro, sewage gas, landfill gas, marsh gas	< 0.5 MW 0.5 – 5 MW	€ 0.0767 /kWh € 0.0665 /kWh	–
Biomass	< 0.5 MW 0.5 – 5 MW > 5 MW	€ 0.101 /kWh € 0.089 /kWh € 0.084 /kWh	1 % p.a.
Solar	< 5 MW	€ 0.457 /kWh	5 % p.a.
Wind	No limits	€ 0.059 to € 0.087 /kWh[1]	1.5 % p.a.
Geothermal	< 20 MW > 20 MW	€ 0.0895 /kWh € 0.0716 /kWh	–

[1] *Depending on specific wind conditions on site.*

The Act also stipulates obligations concerning costs of grid connection and reinforcement. Plant operators have to pay for the grid connection, but the grid operator has to bear the cost of grid reinforcement if necessary.

No public budgets are involved. The Act solves the problem of unequal distribution of burdens (as in the EFL) by requiring all electricity suppliers to have the same share of electricity from renewable energy in their fuel mix. For this purpose, grid operators need to balance amounts of electricity remunerated according to the Act in such a way that the share of the EEG electricity is equal on all grids on a three-month basis. Then all electricity suppliers using the public electricity grid are obliged to purchase an equal share of EEG electricity at a price equal to the average remuneration paid for all EEG electricity. This system has the effect that, not only the costs, but also the benefits, in the form of the generated electricity, are shared equally. This distribution mechanism can be characterised as an ex-post quota, where electricity suppliers know only ex-post the share of renewable energy electricity they are obliged to purchase. With this design, there is no need to calculate the "real" value of the electricity fed-in. On the other hand, the physical distribution of the renewable energy electricity among all suppliers gives rise to additional costs. The extra costs of regulation are not explicitly known.

An additional ordinance issued in 2001 specifies which biogenic substances and which technical processes are eligible for remuneration according to the Renewable Energy Sources Act.

Originally, the remuneration to photovoltaic plants was limited to total capacity of 350 MW. In 2002, this cap was increased to 1 000 MW. In November 2003, remuneration for photovoltaic installations was further differentiated depending on site specifics.

Every two years, the parliament re-evaluates the Act on the basis of a report that is prepared by the Ministries of Economics and Technology, in close consultation with the Ministry of Environment and the Ministry of Agriculture.

Policy Type Obligations / Guaranteed prices/feed-in tariff

RE Technology All renewables

Investing in the Future Programme (Zukunfts-Investitions-Programm, ZIP)

Year 2001-2003

Policy Description This programme offered special funding from 2001 to 2003 for energy research in different fields. This funding is in addition to energy R&D financed through the scheduled federal budget. The following technologies benefited from this programme: geothermal electricity generation, solar thermal electricity generation, offshore wind power and photovoltaic. The environmental impact of renewable energy technologies was investigated. Hydrogen technology and fuel cells were also investigated.

Policy Type RD&D

RE Technology Geothermal
Offshore wind
Solar thermal
Solar photovoltaic

Combined Heat Power Law (KWK Modernisierungsgesetz)

Year 2002 – Present

Policy Description This law replaces the 2000 law on combined heat power (CHP) ("KWK-Vorschaltgesetz"). Both laws are primarily intended to promote large CHP plants that were affected by decreasing electricity prices as a consequence of liberalisation. At the same time the share of CHP-produced electricity is to be increased, aiming at lowering CO_2 emissions by 23 million tonnes by 2010. Half of this target is to be achieved by the CHP law, the other half by a voluntary agreement with industry.

The importance of this law for renewable energy technologies is minor since the Renewable Energy Sources Act (EEG) provides more favourable conditions for these technologies. Only renewable energy technologies not covered by the EEG may benefit. This includes co-firing of biomass in fossil-fuelled power plants and biomass-fired CHP larger than 20 MW.

The law requires grid operators to purchase electricity from CHP plants and pay a premium on top of the market price. Premiums depend on technology and the age of the plant (Table 8). The premium cannot be combined with other support, particularly not with the EEG.

Table 8. **Evolution of Premiums for CHP Plants (€cents/kWh)**

	2002	2003	2004	2005	2006	2007	2008	2009	2010
Plants erected before 31 Dec 89	1.53	1.53	1.38	1.38	0.97	–	–	–	–
Plants erected after 31 Dec 1989	1.53	1.53	1.38	1.38	1.23	1.23	0.82	0.56	-
Modernised plants	1.74	1.74	1.74	1.69	1.69	1.64	1.64	1.59	1.59
Plants erected after 1 April 2002	2.56	2.56	2.4	2.4	2.25	2.25	2.10	2.10	1.94
Plants < 50 kW_{el} erected between 1 April 02 and 31 Dec 2005	5.11 for 10 years after commissioning								
Fuel cell plants	5.11 for 10 years after commissioning								

The burden from paying the premium is spread equally over all grid operators with the same principle as with the EEG.

Policy Type Guaranteed prices/feed-in tariff, premiums

RE Technology Biomass

Solarthermie 2000plus

Year 2004

Policy Description	This programme is a successor of the “Solarthermie2000” programme. It aims to increase the annual solar contribution to heat and hot water demand with individual solar thermal installations from the current 10-30% to 60%. In particular, seasonal storage is sponsored. Grants up to 50% of the investment costs are provided.
Policy Type	RD&D / Capital grants
RE Technology	Solar thermal Solar photovoltaic Concentrating solar

Greece

Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

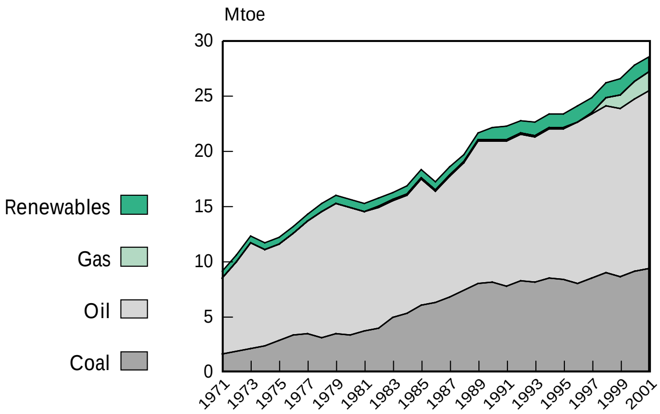
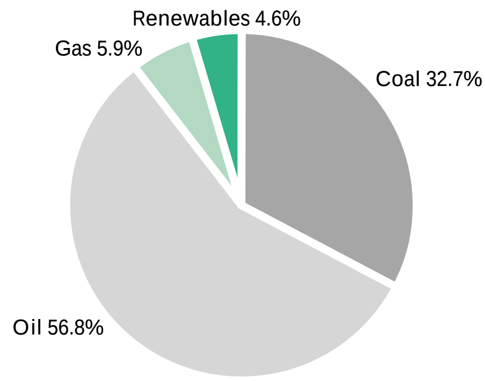


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1.
See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1970	1980	1990	1995	2000	2001	Imports
Coal	1.3	3.3	8.1	8.4	9.0	9.3	9.2%
Oil	6.1	11.6	12.8	13.7	15.6	16.1	100%
Gas	0.0	0.0	0.1	0.0	1.7	1.7	99.4%
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	-
Renewables	0.7	0.7	1.1	1.3	1.4	1.3	-
Biomass	*0.4*	*0.4*	*0.9*	*0.9*	*0.9*	*1.0*	
Hydro	*0.2*	*0.3*	*0.2*	*0.3*	*0.3*	*0.2*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.1*	*0.1*	*0.1*	*0.2*	
Total	**8.1**	**15.7**	**22.2**	**23.5**	**27.8**	**28.7**	**76.9%**
% Renewables	*8.4%*	*4.8%*	*5.0%*	*5.5%*	*5.0%*	*4.6%*	

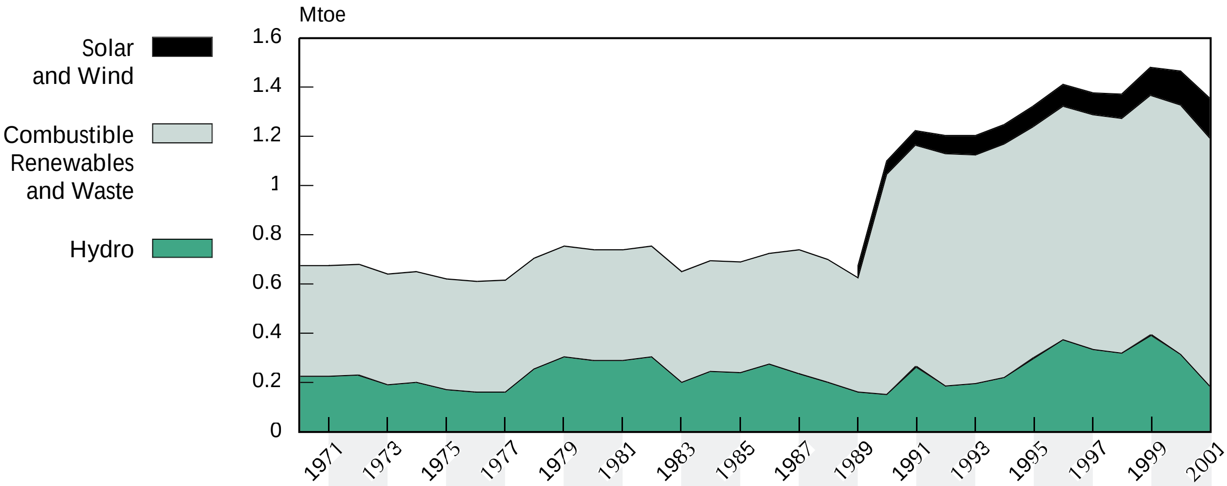
* *See Annex 2 for explanation of components in total and definition of biomass.*

Total primary energy supply (TPES) nearly doubled from 1980 to 2001, from 15.7 Mtoe to almost 29 Mtoe, an average annual growth of 2.9%. Greece depends heavily on imported energy, especially oil, which accounts for more than half of TPES. Coal accounted for about 32% of TPES in 2001 (Table 1) down from 37% in 1990. In the late 1990s, Greece introduced natural gas into its energy mix, and in 2001 it accounted for 5.9% of primary energy supply.

Renewable energy supply increased from 1.1 Mtoe in 1990 to 1.3 Mtoe in 2001, but its share in TPES declined slightly. The fall in share was due to a decline in hydropower generation and a levelling off of biomass supply. The recent emergence of natural gas for power generation was also a contributing factor. Biomass made the largest contribution to total renewable energy supply in Greece, at 1 Mtoe in 2001. Nearly all biomass is consumed in the industrial and residential sectors. Recent policies promoting wind and solar power boosted wind capacity to 270 MW in 2001, from 27 MW in 1995, and solar thermal production to 4 201 TJ in 2001, from 2 363 TJ in 1990. Wind power accounted for 26% of total electricity generation from renewables in 2001.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply* and Policy Timeline**



Policy Timeline

Research and Development

Market Deployment Policy

. Economic Development Law

. 1st Operational Programme for Energy

. Law 2364/95 (tax exemptions)

. Development Law 2601/98

. Operational Programme for Energy and Competitiveness

. Law 2773/99 (feed-in tariffs)

. National Operational Programme for Energy and Competitiveness

Energy Policy Context

. Climate Action Plan

● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

* *Note: The break in the biomass data in Figure 3 in 1990 is mainly due to a statistical revision. Following a survey by Eurostat in 1995, the volume of domestically used biomass was revised. This volume was used to calculate data from 1990 to 1994. Data prior to 1990 were not revised.*

Renewable energy provided less than 5% of TPES in 2001. Biomass and hydroelectricity accounted for most of the renewable energy produced, with biomass (mainly in the form of wood used for heating in the household sector) accounting for two-thirds of the total. Excluding biomass and large hydropower, the contribution of other sources was 12.5% of the total power generation from renewables in 2001.

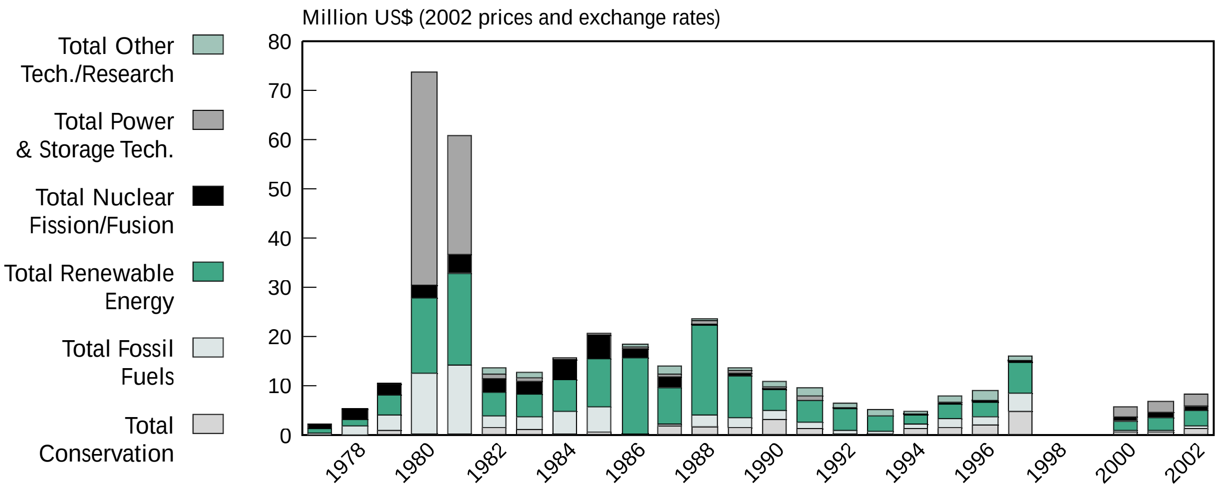
Greece's target under the *EU Directive for Electricity Produced from Renewable Energy Sources 2001* is 20.1% of total electricity generation from renewables by 2010. The share of renewables in electricity generation in 2001 was 5.5%, but it is estimated to have risen to 7.3% in 2002. Achieving the target will require a considerable increase in renewable energy supply over the next decade.

Prior to the EU target, Greece's 1995 Climate Action Plan established a target for increasing the share of renewable energy (including large-scale hydro) in TPES to 10% by 2000. The share of renewables in TPES, however, was less than 5% in 2001.

Research and Development Trends

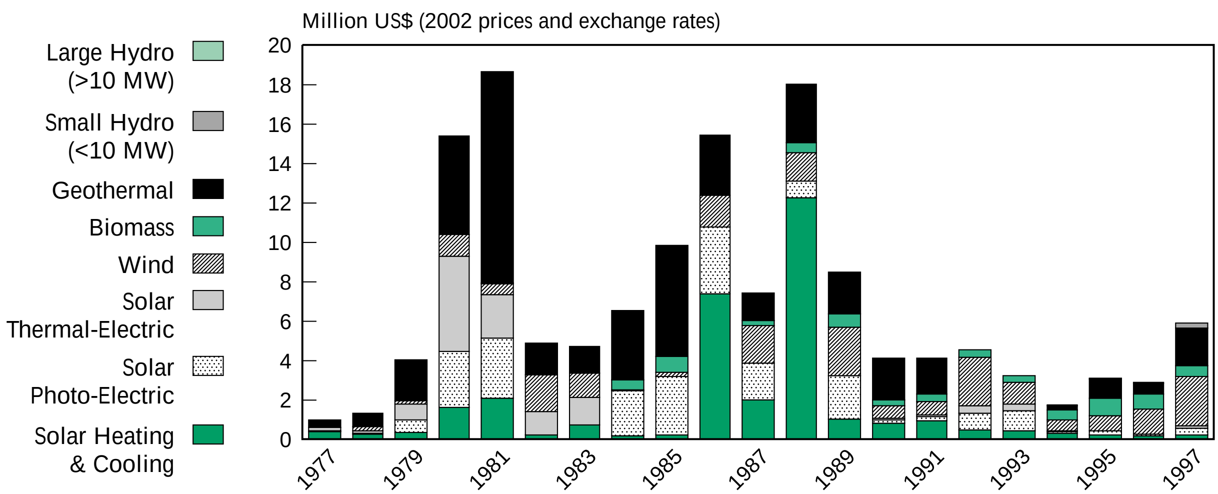
Greece spent a total of US$ 373 million (in 2002 prices and exchange rates) on government energy RD&D between 1977 and 2002. In this period 41.1% of its total RD&D budget was allocated to renewable energy.

Figure 4. **Greece - Government Energy RD&D Budgets***



** Data for 1998 and 1999 are not available.*

Figure 5. **Greece - Government Renewable Energy RD&D Budgets**



Government RD&D expenditures for renewables peaked in the early 1980s and declined notably in the 1990s. Among the renewable technologies, geothermal received the highest level of funding at 33% in the 1977 to 2002 period. Solar heating and cooling was funded at US$ 32 million, representing 22% of renewable energy RD&D. Solar PV and wind each accounted for about 16% of the renewable RD&D expenditures from 1977 to 2002.

Funding for research and development has not played a significant role in developing and deploying renewable energy technologies in Greece.

Market Deployment Trends

The government has focused on market-based mechanisms to promote wind, solar thermal and small hydropower technologies. Large hydropower production and residential biomass use account for some 87% of total renewable energy supply in Greece. These technologies do not receive policy support. National policies and measures target those technologies that account for the remaining 13% of total renewable energy supply. Today, these renewables are mainly promoted through financial incentives, such as tax breaks, direct subsidies, priority dispatching, RD&D and an attractive feed-in tariff system. The two main financial-support instruments that provide public incentives for renewable investment projects are the National Development Law of 1994 and the National Operational Programme for Competitiveness (NOPC) of 2000.

The Centre for Renewable Energy Sources (CRES) was set up in 1987 to promote renewable energy applications (solar, wind, hydro, geothermal, biomass) and energy efficiency. The CRES acts as the official co-ordinating body for the promotion of renewables in Greece.

The Economic Development Law of 1990 provided the framework for the provision of incentives for investments in renewable energy technologies. The main incentives were a tax exemption for investments and low interest rate loans for the installation of solar systems. The incentive rate depended on the level of regional development, varying between 40% and 55% of the total cost of the project. This law significantly affected the development of wind energy in Greece. Twelve wind parks with a total installed capacity of approximately 90 MW were approved with an average funding of 40% of total project costs. The installation of central solar systems (especially in hotels) was also promoted by this law.

The first Operational Programme for Energy (OPE) of 1994-1998 (Law 2244/94) constitutes the cornerstone of Greek national policy for the stimulation of renewable energy sources. It was the main regulatory tool for the production of electricity by independent producers. It provided incentives to encourage investments in renewables generated electricity by defining tariff rates. The law also opened up the electricity market to the private sector, even though the Public Power Corporation (PPC) remains the exclusive electricity buyer and retailer. Under this law, production by both auto-producers and independent producers of up to 50 MW was liberalised. Auto-producers were allowed to counterbalance 80% of the electrical energy produced using renewables (90% for local authorities, government organisations and farm co-operatives) with their electricity consumption from the PPC network.

Since 1995, Law 2364 has provided tax exemptions to households for the purchase of renewable equipment, such as solar water heaters. Three-quarters of the purchase value of renewable equipment can be deducted from taxable income. The deduction corresponds to the proportion of ownership for legal entities, where 75% or 100% is amortised from profits over a period of years. The deduction is estimated to reduce installation costs by up to 30%. In 1998, two incentive systems were implemented to increase market penetration of renewables and co-generation: the Development Law 2601/98 (which replaced

Law 1892/90), and the Operational Programmes for Energy and Competitiveness. These mechanisms provide a maximum 35% grant for investments in power generation and a maximum 75% deduction from taxable income for the residential and service sectors for solar heating systems.

Law 2773/99 established buy-back systems for electricity generated from renewables, both on-grid and off-grid. For on-grid generation, the Public Power Corporation (PPC) pays the generator a price composed of an energy charge and a capacity charge. The energy charge is equal to 90% of the energy part of the medium-voltage domestic end-use tariff. The capacity charge is 50% of the capacity part of the same tariff. In the non-interconnected islands PPC pays only the energy portion. The price paid by PPC is 70% of the low-voltage end-use tariff, except for co-generators using renewable energy who receive 90% compensation. In 2001, the average buy-back tariff was € 0.0616/kWh in the interconnected system and € 0.0731 on the islands.

The National Operational Programme for Competitiveness (NOPC) of 2000 provides grants to private investments for renewable energy technologies and for co-generation plants of less than 50 MW, with grant levels differing according to technology. Wind parks and conventional solar thermal units are eligible for public grants of 30% on total investment costs. Small hydro, biomass, geothermal, high-tech solar thermal units and passive solar systems are eligible for grants of 40%. Photovoltaic systems are eligible for grants of 50%. The level of the incentive is independent of the geographical region of the country. The total budget for renewable energy applications under this programme is € 505 million.

After market liberalisation, there was an increase in the number of licensing applications for power generation from renewable sources. This suggests that current policies will ultimately lead to an increase in electricity generated from renewables. The Greek government recognises that current licensing procedures for renewables are still too complex. They plan to shorten the procedure and establish a "one-stop shop" for permits and licences. Law 2941/2001 has simplified the licensing procedure, but a number of licences and permits are still required before renewable power generation facilities can be installed.

There is a concerted effort in Greece to identify the potential of new energy sources. The Centre for Renewable Energy Sources is responsible for investigating the technical and economic aspects of this potential. Since 1999, the CRES has carried out studies and pilot projects concerning the exploitation of renewable energy sources. Because of its geography, Greece has considerable wind and solar energy resource potential.

Renewable Energy Markets

Hydropower

Figure 6. **Hydropower Capacity and Electricity Production**

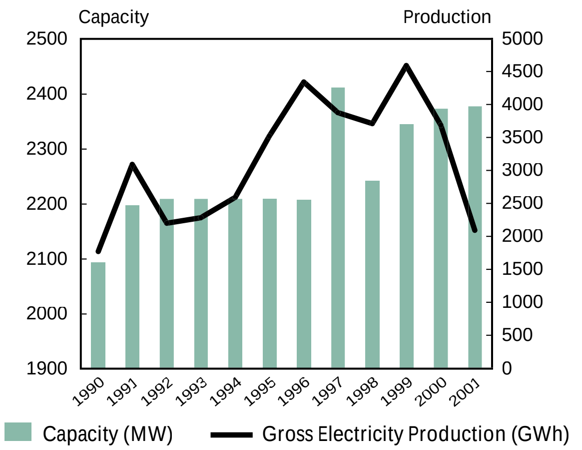
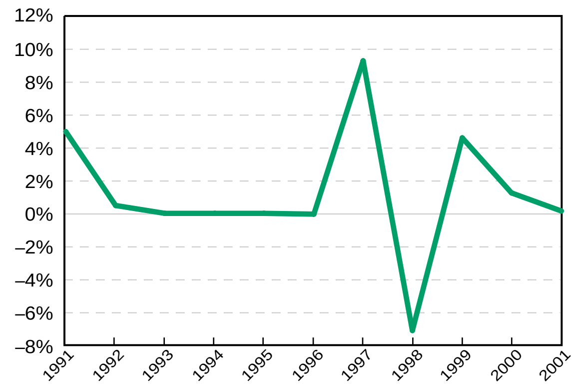
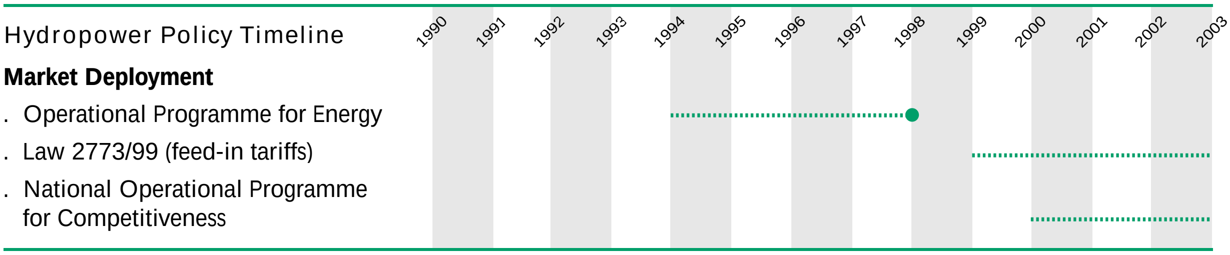


Figure 7. **Hydropower Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Electricity generation from hydroelectric plants was 2 097 GWh in 2001. Most of the plants belong to the Public Power Corporation. Capacity increased from 2 093 MW in 1990 to 2 377 in 2001. Hydropower represents only some 4% of total electricity generation in Greece, but it accounts for about three-quarters of electricity generation from renewables. Small hydropower plants (< 10 MW) accounted for only 2.5% of total hydropower capacity in 2001.

The main policy instruments that affect small hydropower installations are investment incentives and feed-in tariffs. Law 2773/99 fixed feed-in tariffs for electricity generation from renewables. Hydropower plants have priority in network dispatching if their installed capacity is less than 10 MW. The Public Power Corporation pays the generator a price which is composed of an energy charge and a capacity charge. The price paid by PPC is 70% of the low-voltage end-use tariff. In 2001, the average buy-back tariff was € 0.0616/kWh in the interconnected system and € 0.0731 on the islands.

Investment incentives were established under the Operational Programme for Energy (1994-1998) and the National Operational Programme for Competitiveness (2000-2006). These were in the form of grants totalling up to 40% of project costs for private investments in small hydropower plants.

Wind Power

Figure 8. **Wind Power Capacity and Electricity Production**

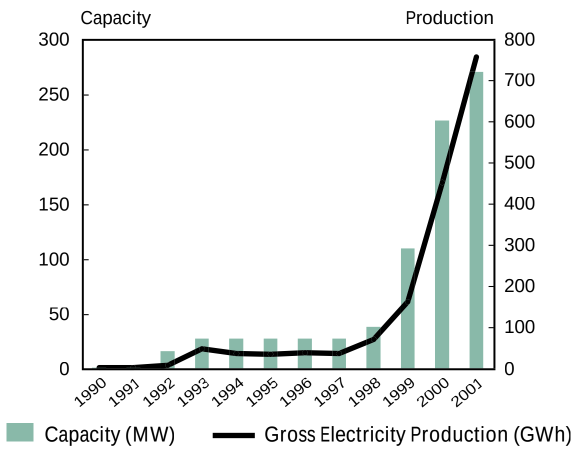
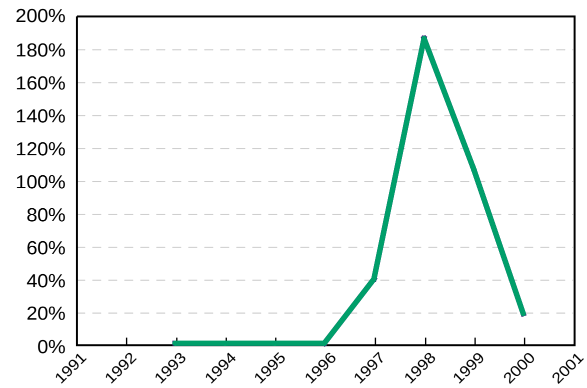
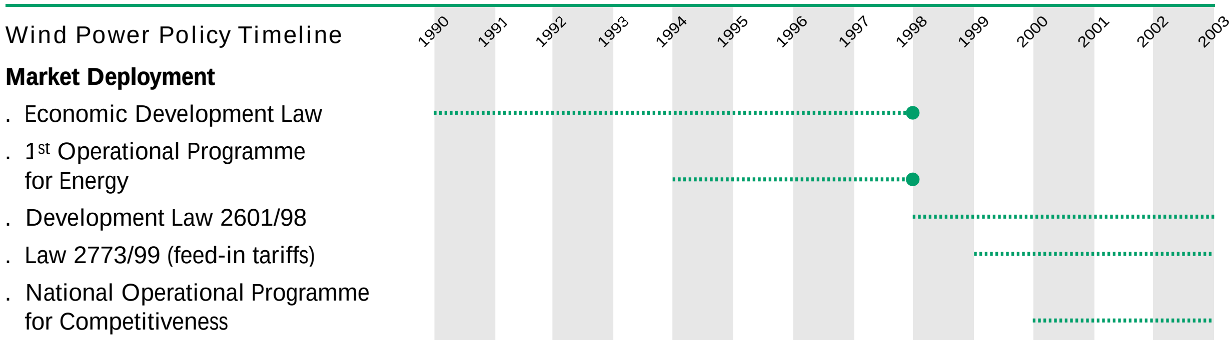


Figure 9. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Wind capacity increased to 270 MW in 2001 from 27 MW in 1995. Generation from wind power was 756 GWh in 2001. There were two main reasons for the sharp increase in the installed capacity of wind energy in the late 1990s: funding from the Operational Programme for Energy of 1994-1998 and feed-in tariffs. It is expected that the Operational Programme for Competitiveness (2000) will also have a strong impact on wind energy development. Current wind capacity represents only a small proportion of the potential energy resource. According to the Public Power Corporation, wind power plants could generate up to 30% of the Aegean islands' energy requirements, a ten-fold increase on current capacity.

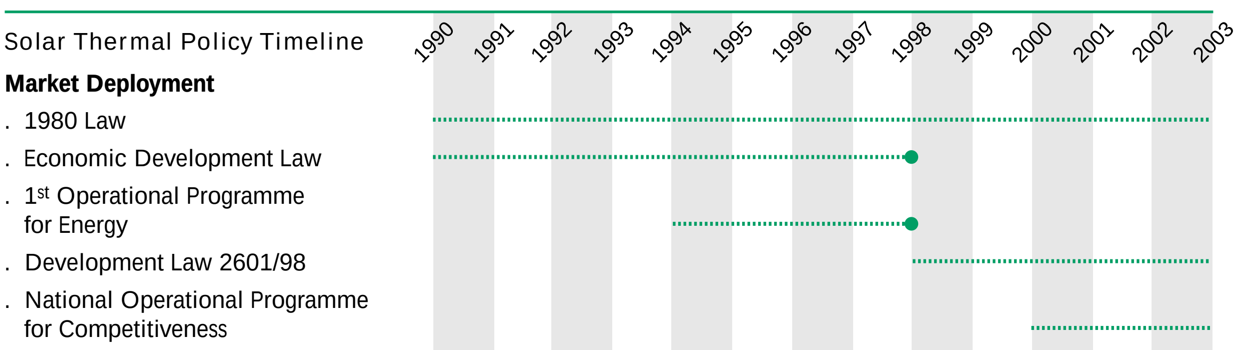
The Development Law (Law 1892/1990) was of great importance to the early development of wind energy. In the framework of this law, twelve wind parks of approximately 90 MW were approved with an average funding of 40% of total project costs. These parks are currently in the phase of completion or commissioning.

By March 2000, seven wind parks of about 50 MW had been included in the New Development Law 2601/98. The main funding mechanism was provided by the Operational Programme for Energy. Funding was offered in the form of capital grants averaging 35% of investment costs. The National Operational Programme for Competitiveness will continue to be the main funding tool in the immediate future for wind energy installations.

Private investors are beginning to take advantage of financial incentives, provided by the Greek government and the EU, to develop wind power. While, in the past, PPCs owned the majority of wind facilities, private investors now predominate. Production of turbine equipment is developing at a rapid pace in Greece.

While wind power has considerable potential in Greece, there are many environmental and other constraints that block its deployment. Given the strong public opposition towards wind power installations in some regions, the government introduced a 2% tax on electricity production from renewables under the Law 2773/99. The effects of this 'compensation' tax are not yet visible. But as local governments tax the generators and use the revenue for community projects, the tax may lead to greater public acceptance of wind power.

Solar Thermal Production



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

The use of solar thermal applications is considerable in Greece, due to its favourable climatic conditions. Solar thermal production increased from 2 363 TJ in 1990 to 4 201 TJ in 2001, an average annual growth of 5.4%. The main policy that had a dramatic impact on the market for domestic solar water heating equipment was a tax exemption on the installation cost. This was introduced by law in the 1980s and has contributed significantly (in combination with high solar potential) to the installation of solar water heating systems.

Solar energy is principally used for hot water production, with 20% of Greek households using solar water-heaters. The use of solar water heating systems started in 1974 and Greece had an installed surface of 2.98 million m^2 in 2001 (Table 2). This amounts to 29% of the total installed surface in the fifteen EU member states and 28% of total heat production.

The Old Development Law (Law 1892/1990) also made an important contribution to the promotion of central solar systems, especially in hotels. The main incentives were a tax exemption on investments and low interest rate loans made available for the installation of solar systems. It is expected that the new Development Law 2601/98 will contribute towards further increases in large solar heating applications.

Table 2. **Solar Water Heating Systems (Installed Surface Area)**

	Total Area (m^2)	Active Area
1990	1 758 755	1 664 152
1991	1 963 957	1 861 356
1992	2 143 826	2 053 892
1993	2 270 108	2 206 967
1994	2 379 618	2 324 863
1995	2 482 690	2 431 154
1996	2 589 152	2 535 921
1997	2 696 270	2 642 711
1998	2 827 871	2 762 070
1999	2 900 897	2 864 384
2000	2 961 038	2 930 968
2001	3 001 388	2 981 213

Source: Centre for Renewable Energy Sources.

The Operational Programme for Energy (1994-1998) also funded a number of central solar systems mainly in hotels and in industrial applications. Investment incentives are also offered in the National Operational Programme for Competitiveness (2000). Although the domestic solar water heater market is very active, the central solar system market is still reliant on these incentives for market development and growth.

Greece Policy Chronology

Exploitation of Geothermal Potential (Law 1475/84)

Year

1984 - Present

Policy Description

This law asserts that the exclusive right of exploitation of geothermal energy belongs to the state, which, in turn, reserves the right to assign this to other public sector entities. In such cases, these entities have to prove the benefits of such investments. It must be assured that water quality will not be affected and rights cannot be undertaken for less than 15 years.

Policy Type

Regulatory and administrative rules

RE Technology

Geothermal

Law 1559/85

Year

1985 - Present

Policy Description

This law regulates matters concerning alternative forms of energy and special matters concerning the production of electricity from conventional fuels, among other things. It allows third parties to produce a limited amount of electrical power from renewables energy sources. Production is essentially limited to the satisfaction of producers' needs and any surplus energy can only be sold to the Public Power Corporation (PPC), not to third parties.

The capacity of grid-connected renewable energy power plants of auto producers cannot exceed three times the total installed capacity of the producer's equipment/energy needs when the resource is wind, solar or hydro; for geothermal energy the limit is twice the installed capacity and for co-generation to the same capacity. In accordance with Law 1416/84 local governments can produce with the aim of selling all production to the PPC.

Policy Type

Net metering

RE Technology

Geothermal
Hydro
Offshore wind
Solar photovoltaic
Concentrating solar
Onshore wind
Solar thermal

Siting of Wind Turbines (Law 2689/87)

Year

1987 - Present

Policy Description This legislative measure defines criteria for the siting of wind turbines within the boundaries of inhabited areas, in uninhabited, rural areas and in industrial areas.

Policy Type Regulatory and administrative rules

RE Technology Onshore wind

Founding Decree of the Centre for Renewable Energy Sources (CRES)

Year 1987 - Present

Policy Description The CRES is a legal entity whose primary aim is to promote renewable applications (solar, wind, hydro, geothermal, biomass) and energy efficiency.

Policy Type Regulatory and administrative rules

RE Technology Biomass
Geothermal
Hydro
Offshore wind
Onshore wind
Concentrating solar
Solar photovoltaic
Solar thermal

Old Development Law (Law 1892/1990)

Year 1990-1998

Policy Description The Economic Development Law ("Modernisation, Development and Other Regulations") provided the framework for the provision of subsidies for productive investments. Subsidy rates depended on the level of development of the region concerned, and were between 40% and 55% of the total budget of the project. The law's principal objective was to modernise, develop and regulate investments for renewable energy production and electricity generation. It provided investment subsidies and tax deductions of up to 40% and 100% respectively.

This law was significant to the development of wind energy in Greece. In the framework of this law, twelve wind parks of approximately 90 MW have been approved with an average funding of 40%. Moreover, the installation of central solar systems (especially in hotels) was also promoted by this law. The main incentive was the tax exemption for the investments and the low interest rate loans for the installation of solar systems.

Policy Type Capital grants/Investment tax credits

RE Technology All renewables

The Public Power Corporation's Programme for the Development of Renewable Energy Sources

Year 1994-2003

Policy Description This programme formed part of the electricity utility's ten-year Development Plan for 1994-2003. The programme for renewables concerned wind energy, PV, geothermal energy and hydro power. According to the plan, a total of 306 MW installed capacity of large hydro, 17 MW small hydro and 37 MW of wind parks were in operation by 2003. These installations added about 85 ktoe to the amount of energy produced by renewables in Greece.

Policy Type Regulatory and administrative rules

RE Technology Onshore wind
Offshore wind
Solar photovoltaic
Geothermal
Hydro

Law 2244/94

Year 1994 - Present

Policy Description "Law 2244/94 constitutes the cornerstone of Greek national policy for the stimulation of renewable energy sources and it can be said to be the first step in the development of a systematic framework of action." It was the main regulatory tool for the production of electricity by independent producers.

The law aimed to provide incentives to motivate investments in renewable energy electricity generation (tariff rates are defined at pragmatic values) and it opened up the electricity market to the private sector even though the Public Power Corporation (PPC) remains the exclusive electricity buyer and retailer.

Through this law, production by both auto-producers and independent producers was liberalised up to 50 MW. Auto-producers may counterbalance 80% of the electrical energy produced using renewables (90% for local authorities, government organisations and farm co-operatives) with their electricity consumption from the PPC network. Other provisions of the law included the removal of restrictions for the exploitation of small water falls, the simplification of bureaucracy involved in the permitting of renewable energy installations and the setting up of an improved pricing system.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology All renewables

Operational Programme for Energy (OPE): Fiscal Incentives for Renewables and Energy Conservation

Year 1994-1998

Policy Description

The Operational Programme for Energy (OPE) established within the framework of the 2nd Community Support Framework, provided capital cost grants for the promotion of renewable energy and energy conservation.

Up to 1999, 125 renewable energy projects were approved (130 MW wind, 72 MW small-hydro, 46 MWh biomass district heating, 42 MW CHP with biomass, 5 MWh other biomass projects, 42 solar central active systems, 8 projects for PV systems and 5 projects for passive solar systems). In addition, approximately 300 projects for energy conservation and substitution of fossil fuels and electricity by natural gas in the industrial and tertiary sectors were approved.

Policy Type

Capital grants

RE Technology

Offshore wind
Onshore wind
Hydro
Biomass
Solar photovoltaic

Law 2364/95

Year

1995 - Present

Policy Description

This law establishes the Board for Energy Planning and Control (BEPC). Since 1995, Law 2364 has provided tax exemptions to households buying renewable equipment such as solar water heaters; 75% of the purchase value of renewable equipment can be deducted from taxable income.

This legislation incorporates one of the most direct incentives for the development of renewable energy technologies to date. Article 7, paragraph 17 of Chapter B states, "the costs of the purchase and installation of domestic appliances for the use of natural gas and renewable energy sources can be deducted (up to 75%) from the individual's taxable income. This includes installations for common use and the percentage of deduction corresponds to the proportion of ownership for legal entities, 75% or 100% is amortized from profits over a period of years." It has been estimated that this benefit can yield a real reduction in installation costs of up to 30%.

Policy Type

Tax exemptions

RE Technology

All renewables

Aid to Market Penetration of Renewables - New Development Law 1998

Year

1998 - Present

Policy Description

Incentive systems have been implemented by the Development Law 2601/98 to increase the market penetration of renewables and co-generation. This law replaced the previous one (Law 1892/90), and the Operational Programmes for Energy and Competitiveness. These mechanisms provide a maximum 35% grant for investments in power generation and a maximum 75% deduction from taxable income for the residential and service sectors for solar heating systems.

Greece does not intend to establish a green certificate system in the near future but considers it a viable option in the long term.

Policy Type Capital grants/Tax exemptions

RE Technology All renewables

Plan for Domestic Actions

Year 1999 - Present

Policy Description Greece has put into place the necessary directives for streamlining the procedures for renewable energy penetration, and is in the process of financing a new comprehensive national plan for domestic actions to reduce greenhouse gas emissions by almost 25 Mtoe of CO_2 by 2012.

Policy Type Regulatory and administrative rules

RE Technology All renewables

Renewable Energy Pilot Projects

Year 1999 - Present

Policy Description Several studies and pilot applications regarding the exploitation of renewable energies have been carried out by the Centre for Renewable Energy Sources (CRES), which is the official coordinating body for the promotion of renewable energies in Greece.

Policy Type RD&D

RE Technology All renewables

Law 2773/99

Year 1999 - Present

Policy Description This law, enacted in 1999:

(1) Gives renewables priority in network dispatching if the installed capacity does not exceed 50 MW, or in the case of hydropower 10 MW. The priority right also covers the power surplus of auto-producers within these same capacity limits. The law obliges the Transmission System Operator and the Public Power Company to provide connection to new generators but, in practice, the development of wind power in some mountain and island areas is slowed down by the need to simultaneously extend transmission networks.

(2) Established buy-back systems for electricity generated from renewables in the interconnected and non-interconnected networks. In the interconnected network the Public Power Corporation (PPC) pays the generator a price which is composed of an energy and a capacity charge. The energy charge is 90% of the energy part of the medium-voltage domestic end-use tariff and the capacity charge is 50% of the capacity part of same tariff. In the non-interconnected islands, PPC pays only for energy, not capacity. The price paid by PPC is 70% of the low-voltage end-use tariff, except for co-generators using renewable energy who receive 90% compensation. In 2001, the average buy-back tariff was € 0.0616/kWh in the interconnected system and € 0.0731/kWh on the islands.

(3) Introduced a 2% tax on electricity production from renewables at the local level. The revenues are used for projects to increase public acceptance of wind power.

Policy Type Net metering/Guaranteed prices/feed-in tariff

RE Technology All renewables

National Operational Programme for Competitiveness

Year 2000-2006

Policy Description Measure 2.1 of the Subprogramme of the NOPC/CSF III (2000-2006) is devoted to providing grants to private investments in renewables, the rational use of energy and small-scale (< 50 MW) co-generation. The total budget of the programme is approximately € 3 445 million; € 505 million for renewable applications, € 340 million for rational use of energy and € 343 million for CHP, mainly with natural gas.

The main provisions concerning renewable energy investments include:

- Wind parks, conventional solar thermal units: 30%.
- Small hydro, biomass, geothermal, high-tech solar thermal units, passive solar: 40%.
- Photovoltaics: 50%.
  (eligible investment costs vary by technology)

The level of the subsidy is independent of the geographical region.

- Own capital required: 30% (minimum) of the total investment cost.
- Minimum investment cost required: € 44 000.
- Maximum investment cost subsidised: € 44 million.

Compared to the first Operational Programme for Energy (OPE 1994-1999), the new programme gives more support to geothermal, PV and passive solar systems. As in the first OPE its objective is to stimulate renewable energy technology investment.

Policy Type Consumer grants/rebates

RE Technology All renewables

Law 2941/2001

Year 2001 - Present

Policy Description This law supplemented Law 2773/99 with certain provisions concerning renewables, including:

- The definition of general terms and conditions, for which it may be allowed to install renewable energy facilities on forestry lands.
- The characterisation of all renewable energy projects as public utility status, which gives them the same rights and privileges in land expropriation procedures as those given to public works, independent of the legal status of the project owner (private or public).

Policy Type Regulatory and administrative rules

RE Technology All renewables

New Law on the Exploitation of Geothermal Potential (Law 3175/2003)

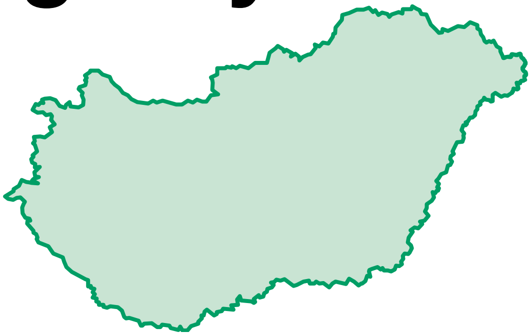
Year 2003 - Present

Policy Description The exclusive right of the state for the exploitation of geothermal energy is asserted again in this law; however, the state can assign this role to private investors.

Policy Type Regulatory and administrative rules

RE Technology Geothermal

Hungary



Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

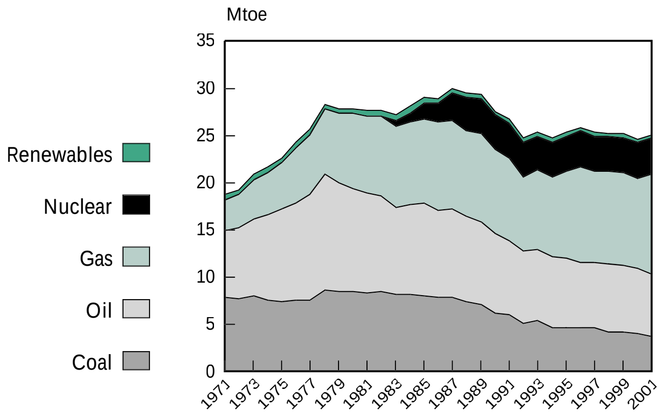
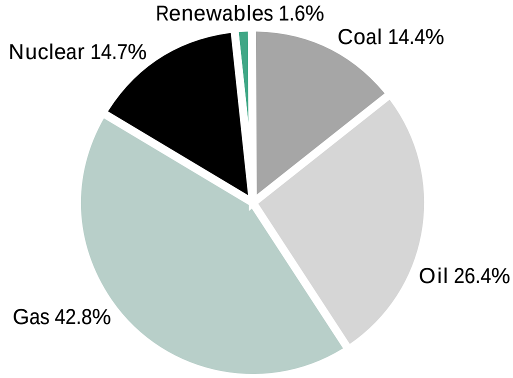


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1.
See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1970	1980	1990	1995	2000	2001	Imports
Coal	8.0	8.4	6.1	4.5	4.0	3.6	27.6%
Oil	6.0	10.9	8.5	7.5	6.9	6.6	71.5%
Gas	3.1	8.0	8.9	9.2	9.7	10.7	72.6%
Nuclear	0.0	0.0	3.6	3.7	3.7	3.7	-
Renewables	0.5	0.5	0.4	0.5	0.4	0.4	-
Biomass	*0.5*	*0.5*	*0.4*	*0.5*	*0.4*	*0.4*	
Hydro	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Total	**17.9**	**28.5**	**28.5**	**25.6**	**24.9**	**25.3**	**54.4%**
% Renewables	*2.8%*	*1.9%*	*1.4%*	*2.1%*	*1.8%*	*1.6%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*

Total primary energy supply (TPES) in Hungary, which is mostly derived from fossil fuels, decreased by 1.1% per year between 1990 and 2001. Coal and oil represented large but decreasing shares, at 14% and 26% in 2001 respectively (Table 1). The increasing natural gas share accounted for 42% of TPES in 2001 and nuclear accounted for 15%. The majority of Hungary's oil and gas demand is met by imports although Hungarian authorities believe that the percentage of energy imports may be underestimated by almost 20% and actually account for as much as 73% of TPES.

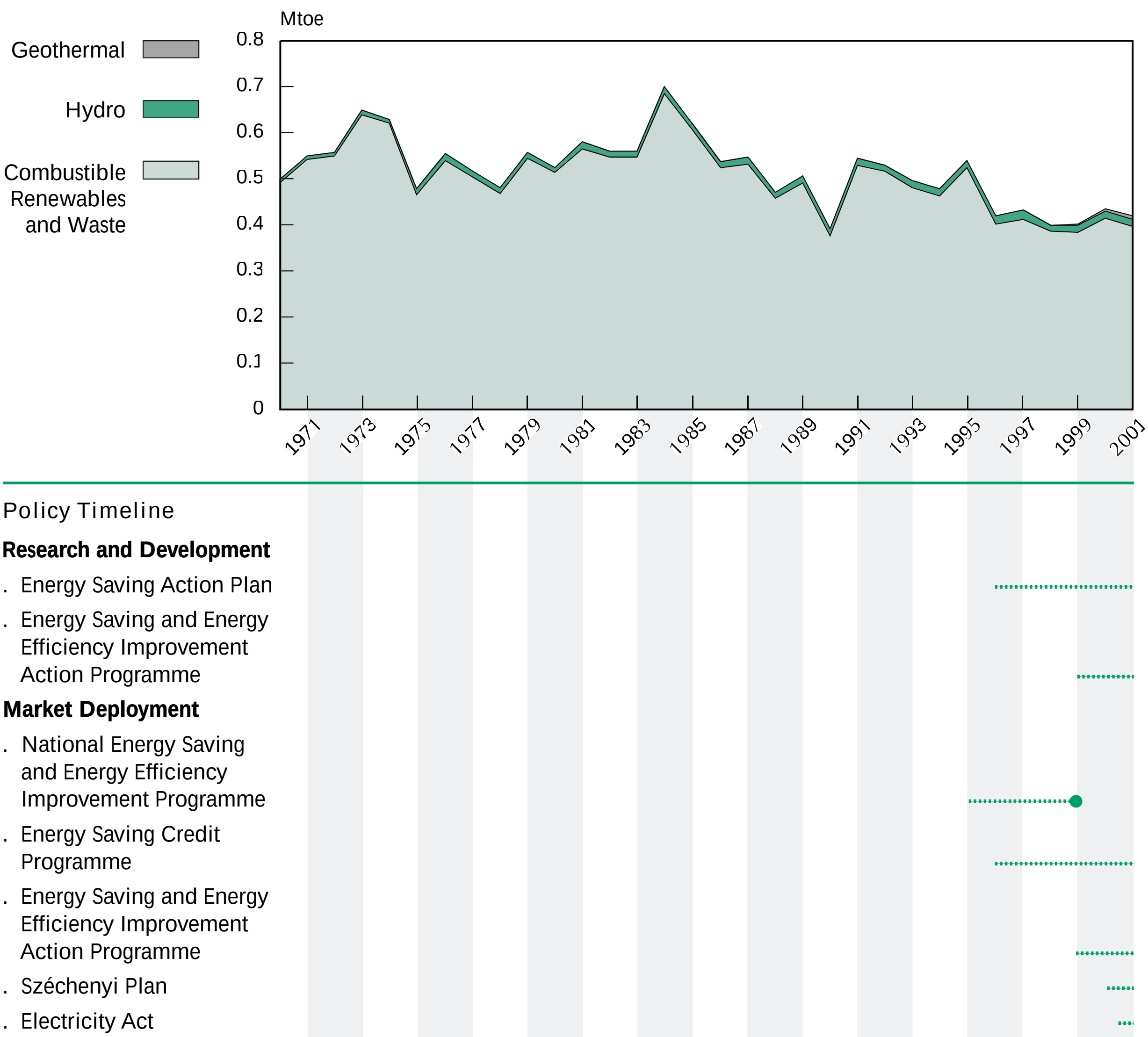
In a scenario implementing policies to mitigate CO_2 emissions and promote energy diversification, the government projects primary energy supply to grow at an annual rate of approximately 1% to 2020 to reach 27 Mtoe in 2010 and 29 Mtoe in 2020.

In 2001, renewable energy represented 1.6% of TPES. Renewables in Mtoe grew at a rate of 0.4% per year between 1990 and 2001. According to Hungarian authorities, the 1.6% share represents only commercially-traded renewable energy sources. The renewables share is estimated to be about 3% of TPES if non-commercially traded renewable energy, such as agricultural or forest waste products, and fuel wood used by the residential sector in small boilers are taken into account.

A total of 36 418 GWh of electricity was generated in 2001. Nuclear dominated, accounting for 39% of the electricity produced, 25% by coal, 24% by natural gas and 12% by oil. The contribution of renewables to total electricity generation amounted to 0.9% in 2001, primarily through small run-of-the-river hydroelectricity plants. The share of renewables in electricity has remained relatively steady between 1990 and 2001.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

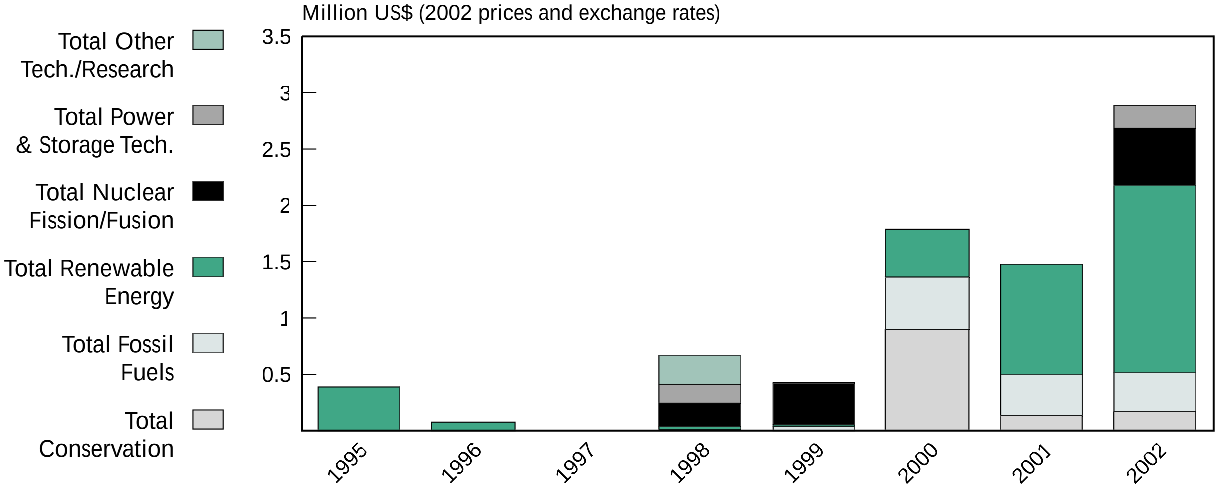
Between 1970 and 2001, energy supply from renewables has exhibited a downward trend, decreasing by 0.6% per year. According to IEA statistics, solid biomass and industrial waste constituted 95% of the renewable share in TPES, hydropower 3.8%, geothermal 1.4%, and new renewables 0.4%. Renewable sources contributed 1.6% to TPES in Hungary in 2001, though, if non-commercially traded sources of renewables were taken into account the contribution would be about 3% according to Hungarian authorities. Accurate calculations of the renewables contribution to TPES are difficult. First, reporting methods in Hungary do not separate out renewable from non-renewable waste within the combustible renewables and waste category. Second, IEA statistics do not take into account non-commercially traded sources of renewables.

Electricity generation from renewable sources totalled 313 GWh in 2001, 0.9% of total electricity generation. Electricity generation from renewables in Hungary is dominated by small run-of-river hydroelectric plants (capacity < 5MW). Hydropower amounted to approximately 0.5% of gross electricity production, *i.e.*, 186 GWh. Of the renewables share in electricity generation, hydropower represented 66%, incineration 112 GWh (30%), sewage gas 7 GWh (2.47%) and the other renewable technologies at less than one percent. Hungary, as an EU Accession Country, has agreed to a national indicative target for electricity production from renewable energy sources at 3.6% by 2010 from the current 0.5%. This is expected to result in a 1% increase per year over a ten-year period.

Research and Development Trends

In 1995, Hungary initiated efforts to develop and promote renewable energy sources with the adoption of official energy policies. Government energy RD&D budgets in Hungary amounted to US$ 7.7 million (in 2002 prices and exchange rates) between 1995 and 2002. Renewable energy has received the bulk of the government energy RD&D budget almost every year since 1995, with notable exceptions from 1997 to 1999. Additional RD&D funding for conservation and fossil fuels was provided in 2000. Renewables retained the largest share of government RD&D funding in 2002 with more than 50% of the total funding.

Figure 4. **Hungary - Government Energy RD&D Budgets***

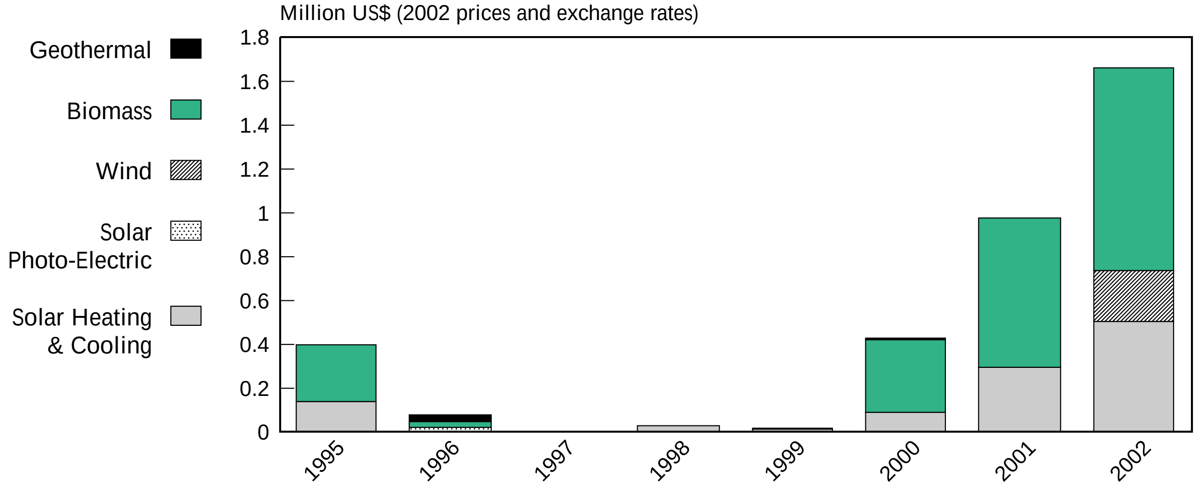


** Data are not available for 1997.*

Government RD&D expenditures for renewables followed the same overall trend as for total energy budgets. Government RD&D budgets for renewables started in 1995, and then dropped to very low levels until 2000 and increased significantly in 2001 and 2002.

Approximately 46% of the total government energy RD&D budget (US$ 3.57 million) was allocated to renewables RD&D. Biomass retained the largest share almost every year, except between 1996 and 1999 when overall government budgets decreased and government RD&D funding was redistributed. Solar Heating and Cooling also commanded consistent funding over this period. Geothermal received some RD&D funding in 1996. Wind energy was allotted 14% of the total renewable RD&D budget in 2002.

Figure 5. **Hungary - Government Renewable Energy RD&D Budgets***



** Data are not available for 1997.*

Historically, RD&D activities received little financial or institutional support from the government. Those early efforts in renewable RD&D were hampered by other competing national priorities. Until recently, no coherent or comprehensive RD&D plan existed to develop renewable energy technology and market priorities.

The government responded to this need and emphasised a new commitment to RD&D as a policy measure to define clear technology and market priorities to promote the use of renewables. The National Energy Saving and Energy Efficiency Improvement Programme was established in 1995 in the framework of the Energy Policy Concept, the Energy Saving Credit Programme and the Energy Saving Action Plan. This programme offered support to RD&D activities in the form of interest free loans. This was followed by the 1999 Energy Saving and Energy Efficiency Improvement Action Programme that specifically prescribed the involvement of renewable energies in RD&D programmes to ultimately facilitate the dissemination of renewable energy facilities.

Market Deployment Trends

The bulk of Hungarian renewable energy policies have been instituted within the last eight years. They are characterised by grants to the renewable energy industry, low interest rate loans, tax incentives and feed-in tariffs. As a result of these programmes and policies, several investments in renewable energy projects have been carried out since 2000.

The Energy Saving Credit Programme (ESCP) of 1996 offers low interest rate loans for energy efficiency projects, which have been used mostly for investment in reconstruction of heating systems and modernisation of lighting systems. The main clients of the ESCP have been municipalities, and results have been satisfactory, although the upper limit of the fund (HUF 25 million) was considered to be on the low side. With the replacement of the ESCP by the government's Energy Saving and Energy Efficiency Improvement Action Programme, adopted in 1999, the number of applications increased dramatically, which posed a challenge to the funding and evaluation process.

The Energy Saving and Energy Efficiency Improvement Action Programme defined targets to be achieved by 2010, which include increasing renewable energy production from the current 28 PJ to 50 PJ per year. Funding was provided by the Ministry of Economy and Transport with an initial budget allocation of

HUF 1 billion for 2000. The budget increased to HUF 2 billion. The main actions for renewables are to increase heat production from biomass, geothermal energy, wastes and solar energy. The Roofs Solar Collector Programme aims to install 20 000 solar collectors on rooftops by 2010.

The energy portion of the Széchenyi Plan managed by the Ministry of Economy and Transport provided support for renewable energy projects through a one-time grant. This plan supported 30% of investment costs for renewable energy projects, with the ceiling differing according to type and purpose of project. In 2000, HUF 350 million (about US$ 1.5 million) was available for projects with the aim of increasing the use of any renewable source of energy. This plan was replaced by the lower funded National Energy Saving Programme (NEP) in 2003. Within this programme, the NEP-6 and NEP-7 sub-programmes offer investment incentives to municipalities, individuals and businesses. These sub-programmes received funding on the order of HUF 140 million for NEP-6 and HUF 180 million for NEP-7. The structure changed in 2004. The NEP-5 sub-programme targets municipalities and individuals, while NEP-6 targets entrepreneurs. Budgets amount to HUF 100 million for each sub-programme.

The Ministry of Environment and Water provides similar support for renewables. To avoid duplication of public funding, the total amount of public financial support may not exceed 50% of the total costs of development, excluding any reclaimable VAT, or 65% in the case of small and medium-sized undertakings. Applicants must have their own financial sources amounting to at least 25% of the total project cost.

The 2001 Electricity Act offers independent electricity producers using renewables with a capacity above 100 kW the possibility to benefit from a technology specific feed-in tariff, which will expire in 2010. Adjusted annually for inflation, the tariff is paid by the main electricity producer (MVM) when a power plant is connected to the transmission network or by the local service provider if the independent producer is connected to the distribution network. The purchase of renewable electricity is mandatory.

Given the current cost of renewable energy projects, however, the tariff is not sufficient to render them fully independent of other support mechanisms. Nor has the feed-in tariff been deemed very effective, as a level of uncertainty is associated with the Ministry of Economy and Transport decree that regulates the tariff. The Ministry has the power to change the prices as well as the period of guarantee at any time. Although favourable grants and loans for investors exist, banks are less reluctant to provide loans for projects whose returns cannot be safely calculated. Additional barriers to the deployment of renewable energy in Hungary include the high cost associated with renewable energy compared with lower cost imports, land use and land ownership questions, high extra costs associated with some renewable energy sources such as geothermal (mining and water extraction taxes, etc.).

Public Awareness

Educating the public on the benefits of renewable energy was a goal spelled out in 1995 in the Energy Savings Action Plan. Little has come from this initiative and awareness among the Hungarian population on the benefits of renewable energy is weak. Nuclear energy is considered the “green” source of energy and is thus favoured over renewable energy.

Intermittency

Intermittency is not currently considered a problem although it is envisaged that it could become a challenge when wind becomes a more commonly used source of renewable energy. No steps are currently being taken to address this issue though some experts feel that this may influence the government’s choice of which renewable energy technologies to pursue.

Distributed Generation

Grid connection of renewables is not currently an issue in Hungary. The primary use of renewables is biomass, generally used in association with coal combustion, which has direct access to the grid.

Energy Policy Context

The EU Directive 2001/77/EC sets out Hungary's target to double its renewable energy proportion from the current 3.6% to 7.2% by 2010. Also, by 2010, the government has developed their own aim to increase the share of renewables in TPES to at least 5%. This target has been integrated as part of the government's Energy Conservation and Energy Efficiency Improvement Action Programme. The government has established market priorities to meet their obligations by first concentrating on growth of the biomass market, second on the increased use of hydropower and the development of wind energy.

EU accession has changed the renewable energy outlook in Hungary. The transposition of the acquis communautaire and the unification of Hungarian markets with EU markets, including conformity with the EU renewable energy source directive, are acting as the main drivers for renewable energy development in Hungary.

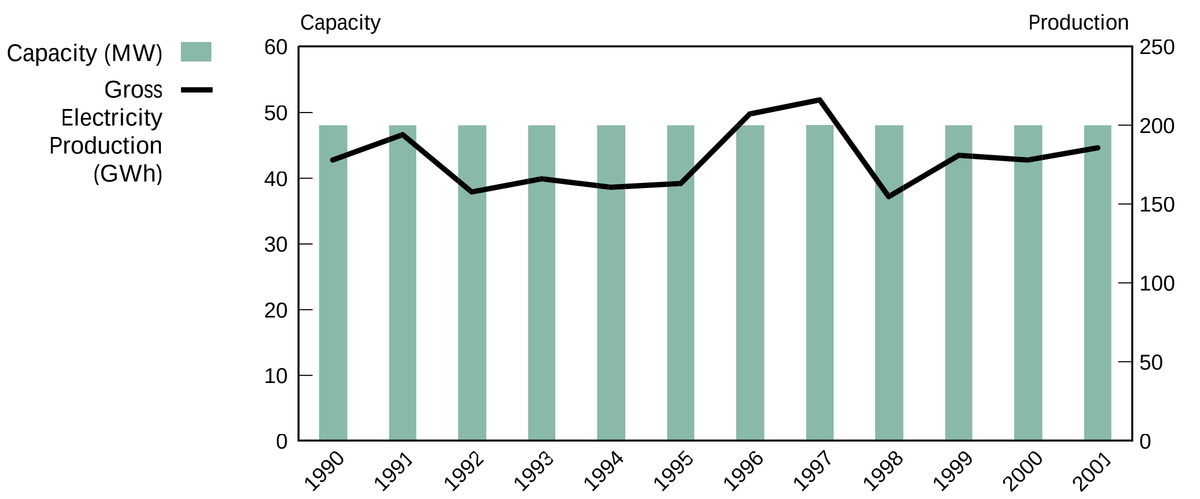
Renewables have been further supported by a reorganisation of the government structure. The government operates within a clearly defined National Development Plan. Within the hierarchical structure of the Plan there are seven Operational Programmes (OPs). Prior to 2000, renewable energy was classified as a component under the Natural Resources OP. Now renewable energy has a higher classification under the Environment and Infrastructure OP, signalling a rise in importance in how renewable energy is viewed within the government.

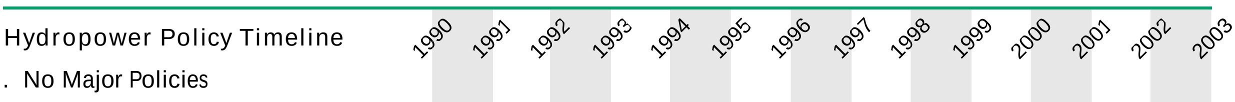
It is expected that EU accession will offer Hungary the opportunity to reform energy prices through the elimination of direct subsidies to better reflect the real cost of energy. To this end, the Ministry of Environment and Water introduced a New Environment Burden Tariff in 2004. Regulated by the 2003/89 decree, this tariff applies to air, water and soil pollution and is levied on NO_x, CO_2 emissions and solid substances. This tariff is ramped up each year to reach 100% by 2008. The majority of costs, however, remain externalised and will continue to remain so long as certain energy carriers retain political sensitivity.

Renewable Energy Markets

Hydropower

Figure 6. **Hydropower Capacity and Electricity Production**





Installed hydropower capacity was unchanged at 48 MW between 1990 and 2001. Hydropower accounted for 3.9% of the renewable share in TPES and 66% of the renewable share in overall electricity production. Installed capacity at the most important hydro facilities at Tiszalök, Kisköre and Kesznyét is 27.5 MW, of which effective capacity is 20 MW annually and they produce on average about 186 MWh per year of electricity. The average capacity of small hydro plants is 1.8 MW.

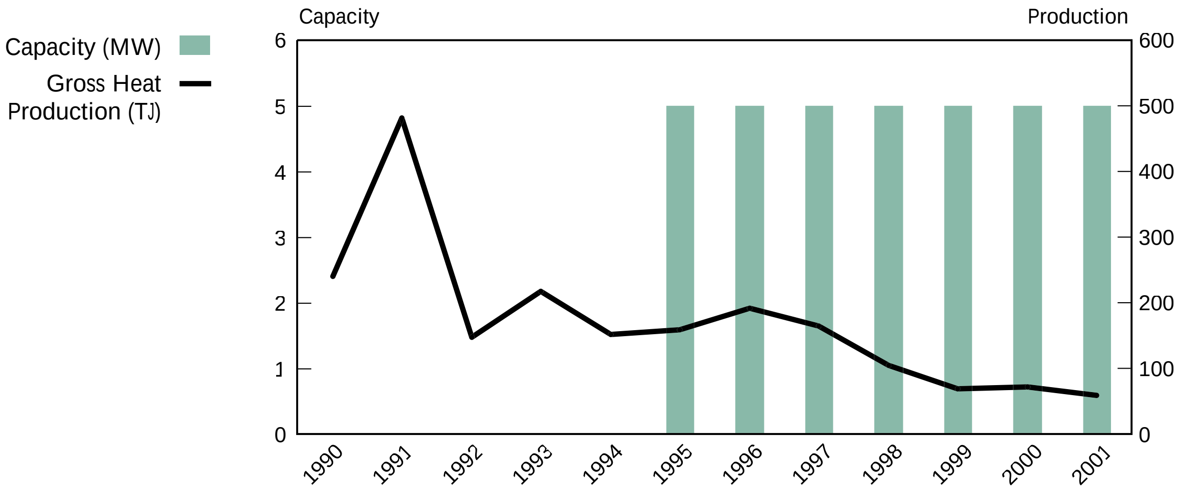
Results from the PHARE-Twinning Project of the Energy Centre in Hungary indicate that the theoretical hydropower potential in Hungary is about 1 000 MW of capacity and 7 500 GWh per year of production. It is estimated that only 5-6% of the potential hydro energy can be exploited. Hungary's geographical conditions are such that new hydropower projects consist primarily of small plants, with the possibility of re-use of water from existing hydropower plants. It is estimated that hydropower can be increased by approximately 30%, *i.e.*, 56 GWh through retrofitting existing plants and wide penetration of mini hydro plants.

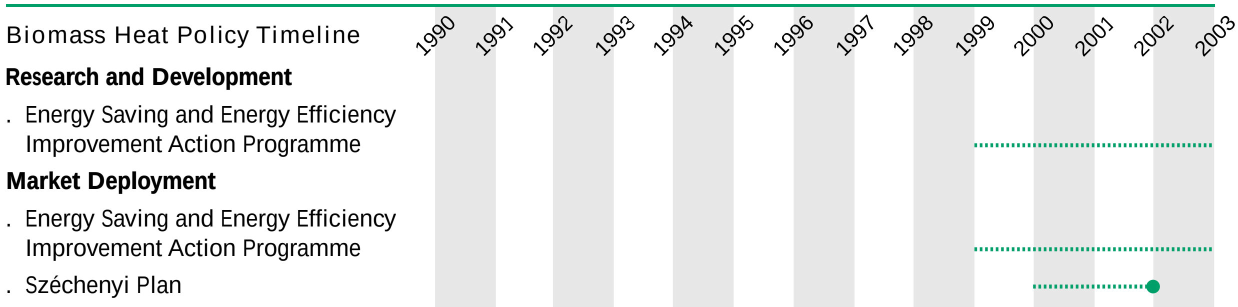
Hydropower is considered a mature technology and generally does not receive support. Small hydro (> 5 MW) can compete for investment support for the funds that are available for all renewable technologies.

Biomass Heat Production

Figure 7 shows installed capacity for biomass at 5 MW from 1995, when capacity data first became available. Heat production from biomass has been declining on average 12% per year between 1990 and 2001. This reflects the wider availability of gas in rural areas. In villages where gas is available, almost 90% of homes are connected to the pipeline.

Figure 7. **Solid Biomass Capacity and Heat Production**





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Energy from biomass accounts for the major share of renewable energy consumption and is principally derived from wood processing for heat generation. Biomass used for energy purposes in Hungary also includes firewood, energy crops, agricultural and forestry by-products and wastes. According to the Energy Centre in Hungary (Interreg 3a), only a small portion of the biomass potential for heat generation is being used. Biomass potential is good enough to significantly benefit agriculture by the cultivation of set-aside lands and increased employment.

Wood waste is increasingly being used with coal combustion in power plants to increase the lifetime of old power plants and reduce fuel cost. Hungary is experimenting with three projects that involve fuel-switching:

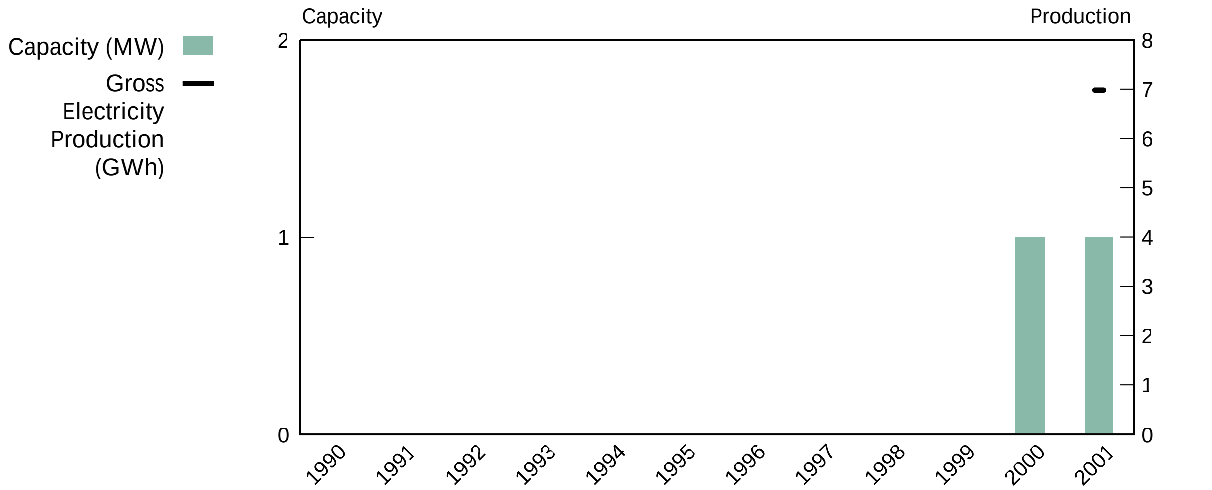
- Borsod power plant (Kazincbarcika) retrofit of a 30 MW unit to use fuel wood.
- Pécs power plant plans to invest in a 50 MW unit using firewood, for which trial operations are expected to begin in mid-2004.
- Bakony power plant (Ajka) plans to switch from coal to wood chips in a 30 MW unit.

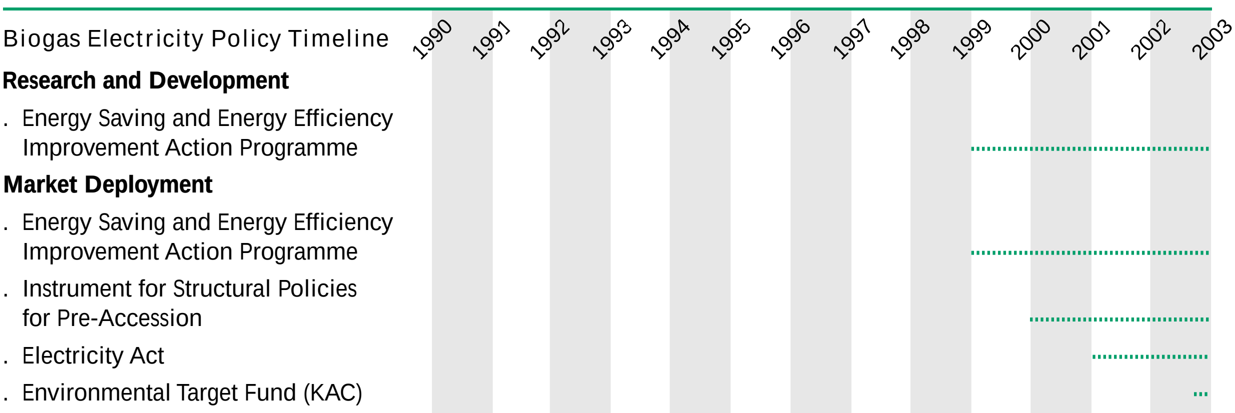
Fuel wood is also used in some district heating plants totalling about 30 MW of capacity. Renewables are considered as a possible substitute for natural gas, where gas could serve as a complementary supplemental resource for peak consumption. Solid waste comprised the largest share of heat production at 90%, although selective collection remains an issue.

The use of biomass from wood processing is expected to increase with investments in modern wood-fired boilers and small power plants, although at present Hungary's energy policies are too recent to see results. The Energy Saving and Energy Efficiency Improvement Action Programme includes a target to increase heat production from biomass, in addition to geothermal, waste and solar energy.

Biogas Electricity Production

Figure 8. **Biogas Capacity and Electricity Production**



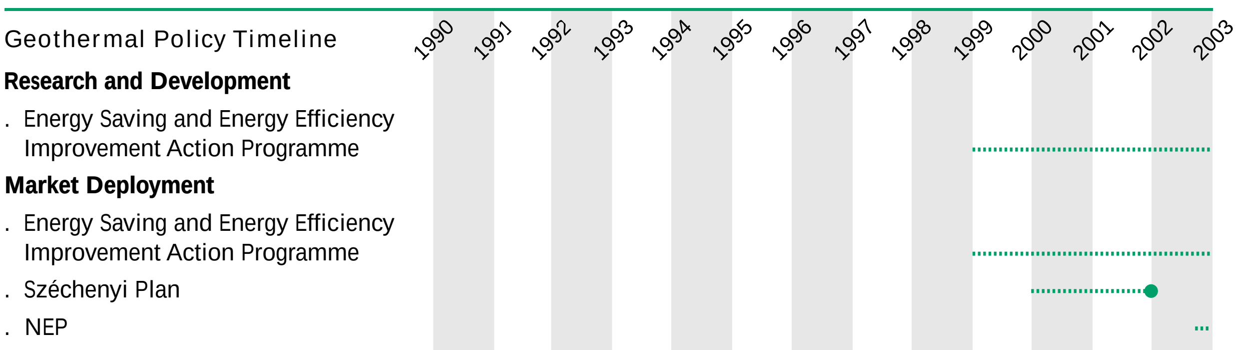


The biogas industry started in 2000 with an installed capacity of 1 MW, which increased to 2 MW in 2002. Electricity generation from biogas was 7 GWh in 2001 and 9 GWh in 2002.

Approximately fifteen to twenty companies produce biogas, usually for conversion to electricity. Other than chemical industry products, biogas is produced from a wide variety of organic materials including manure, by-products, wastes and sewage. The raw material for liquid biogas production is generally liquid manure or food industry liquid with organic content, whose dry material level is between 2 and 8%, and the organic material content is between 40 and 60%. The biogas, gained from the cleaning process of the water, contains methane, which is ultimately used for energy production. New landfills are being provided with a gas collecting system during construction.

According to the PHARE-Twinning Project, Hungary targeted biogas from sewage and landfills as a means to reach EU waste and sewage treatment goals. Prior to EU accession, the Environmental Target Fund and the Instrument for Structural Policies for Pre-Accession (ISPA) covered biogas, while post accession policies consist of the Energy Saving and Energy Efficiency Improvement Action Programme. According to Hungarian authorities, these policies were responsible for the creation of the biogas industry in 2000. In new sewage treatment systems to be constructed by 2010, biogas-generating equipment will be installed and it is estimated to produce an additional 50 GWh of electricity.

Geothermal Production



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Geothermal accounts for 1.4% of the renewable share in TPES and production has been a stable 3 600 TJ between 1990 and 2001.

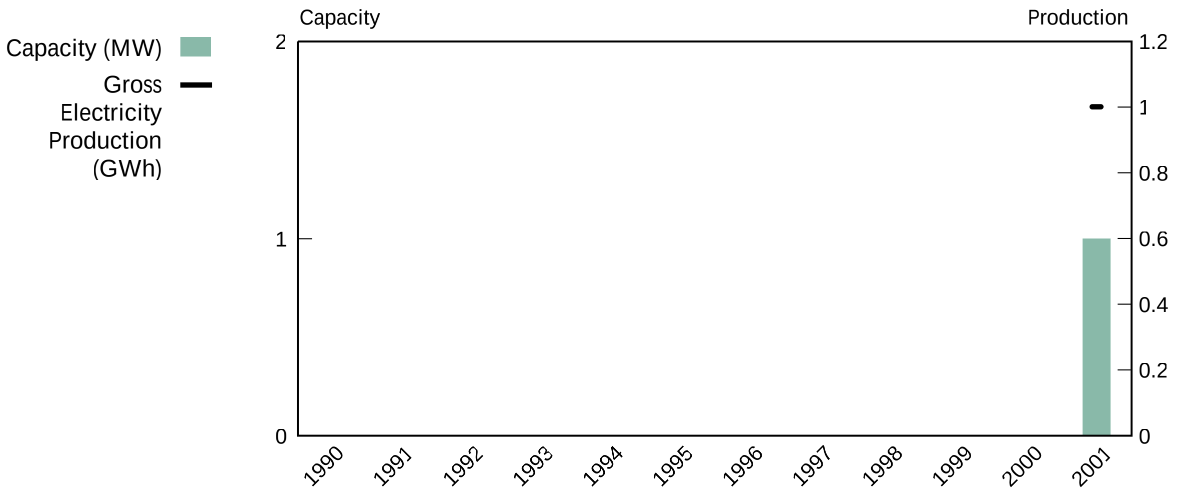
Hungary has some of the largest reserves of geothermal energy in Eastern Europe. Most of the resources are of low to medium temperature and not suitable for electricity generation. Though the potential is high for direct heat applications, it has not been significantly developed. Around 20% of geothermal energy is currently used in agriculture for crop drying or greenhouse heating. The remainder is used in applications such as spas. Geothermal heat pump applications are also expanding in the residential sector.

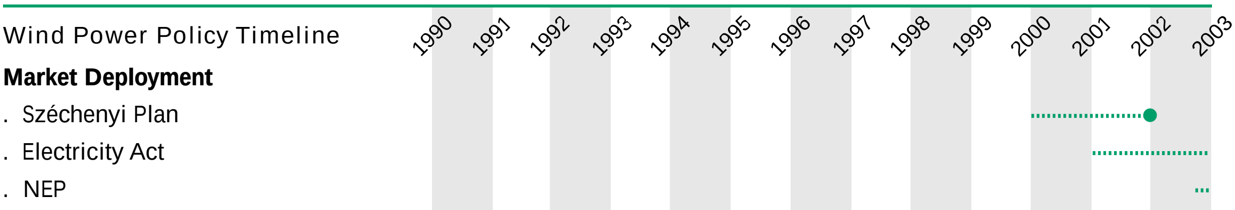
Geothermal development in Hungary can benefit from investment grants available through the tourism section of the Széchenyi Plan for small and medium-sized enterprises (SME) for regional and rural development. Several new thermal baths have been constructed as a result of these investment grants. Structural funds for geothermal electric projects exist through the Energy Saving and Energy Efficiency Improvement Action Programme.

While geothermal energy is included as part of the Energy Saving and Energy Efficiency Improvement Action Programme and the NEP, there are barriers to the growth of the geothermal market. They include legal inconsistencies concerning jurisdiction of geothermal wells (the Mine Act) and efforts to preserve the environmental integrity of geothermal wells to maintain the salt content within the wells. Grants are in place to promote the development of the geothermal industry; however, geothermal users have to pay mine-allowance, water reserve tax and sewage fees, which may undermine other advantages such as grants and low interest rate loans offered by the government.

Wind Power

Figure 9. **Wind Power Capacity and Electricity Production**





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In 2001 wind power capacity was 1 MW with 1 GWh of electricity generation. There has not been a countrywide comprehensive assessment of Hungary's wind potential, and measurements have been made only at the height of 30-50 metres. The calculated potential is 70 W per m^2 year on the Great Plains, and 160-180 W per m^2 year in north-western Hungary. It is reported that by 2003 there were six operating wind turbines with a total installed capacity of 3.2 MW, located in Kulcs (600 kW), Inota (200 kW), Mosonszolnok (2 × 600 kW) and Mosonmagyaróvár (2 × 600 kW).

Incentives for wind energy projects are available through the National Energy Saving Programme (NEP) and Structural Funds within the Environment and Infrastructure Operative Programme. The Ministry of Environment and Water has approved the establishment of 200 wind turbines in Hungary, although actual construction and installation is entirely dependent on investment from companies. According to the Energy Centre, a significant barrier to investment lies in the difficulty in obtaining approval from environmental inspectors, who tend to view wind power developments as environmentally destructive. The Hungarian government has undertaken informational and educational activities to facilitate wind power development.

Hungary Policy Chronology

German Coal Aid Revolving Fund

Year 1991 - Present

Policy Description This energy saving programme started in 1991 with an original target to provide financing for the private sector to support energy efficiency investments and reduce environmental pollution. The German Coal Aid Revolving Fund (GCARF) is administered by the Hungarian Credit Bank. Its scope has been expanded to include municipalities. The main objectives are to replace traditional energy sources with renewable or waste-related energy sources, to induce energy saving in businesses and to reduce energy waste at the lowest possible cost. The preferential interest is one-third of the central bank's base rate with an additional 2.5% interest. From 1991 to 2002 the total amount of investments approved for "live projects" was HUF 14.4 billion, of which HUF 11.9 billion was made up of preferential credits.

In 2000, the GCARF allocated more than HUF 1 billion in preferential credit for SMEs, which resulted in energy savings of 325 TJ per year and total investment of HUF 1.6 billion. In 2001, a total of HUF 0.89 billion was spent on renewable investments from preferential credit. In 2002, the amount of the preferential credit was increased to HUF 1.51 billion. A total investment of HUF 3.53 billion resulted in 1.04 PJ energy savings.

Policy Type Third-party finance

RE Technology All renewables

The National Energy Saving and Energy Efficiency Improvement Programme

Year 1995-1999

Policy Description Established in the framework of the Energy Policy Concept (Resolution 2399/1995) the major objectives include: least-cost planning and demand-side management; cost-based energy pricing to motivate energy efficiency; development of a new energy statistics and information system; introduction of individual metering and regulation in new apartment blocks with district heating supply; implementation of minimum standards for the insulation of new buildings; energy efficiency labelling of household appliances; energy savings awareness raising and education; improving energy efficiency in municipalities via the Energy Saving Credit Programme; increasing the use of renewable energy; and prioritising energy efficiency in state financed R&D programmes.

Policy Type General energy policy, RD&D

RE Technology All renewables

Energy Saving Action Plan

Year 1996 - Present

Policy Description The Energy Saving Action Plan focuses on the penetration of renewables, energy efficiency improvements, energy efficiency labelling and education, information, and technology innovation.

It is unclear to what extent the objectives of the Programme have been achieved. According to critics, in general performance has been poor, attributed to a lack of co-ordination among the institutions involved, limitations to the application of DSM by utilities, problems with enforcing building standards, a lack of awareness campaigns to accompany the introduction of labels, and a lack of substantial incentives for renewable energy.

Policy Type Public awareness

RE Technology All renewables

Energy Saving Credit Programme

Year 1996 - Present

Policy Description In the framework of the Energy Saving Credit Programme (ESCP) programme, the total investment spent on energy efficiency projects has been HUF 4.692 billion (€ 17.6 million), of which HUF 3.554 billion was for preferential credit. So far, the ESCP has focused on funding energy savings programmes at the municipal level, modernisation of district heating systems and the development of energy service company (ESCO) financing. The funds are provided by a local bank – winner of an annual tender through which the interest rate of the loan (the lowest offer) is set. Part of the subsidy is a grant provided by the Economic Development Fund of the Ministry of Economic Affairs. Applications are evaluated by the bank and by an Inter-Ministerial Committee which analyses the technical feasibility and the level of energy saving.

Policy Type Third-party finance

RE Technology All renewables

Pilot Panel Programme

Year 1996-2000

Policy Description This policy made low-interest funding available for the energy-efficient refurbishment of buildings constructed from pre-fabricated panels, including insulation and heating system modernisation. The interest rate was set below 10%. The budget was approximately US$ 10 million.

Policy Type Third-party finance

RE Technology All renewables

Hungarian Energy Efficiency Co-finance Programme

Year

1997 - Present

Policy Description

The HEECP programme was launched by the International Finance Corporation (IFC) Environmental Projects Unit with a total of US$ 5 million funding for the pilot phase from the Global Environmental Facility (GEF). The funds are allocated: US$ 4.25 million for guarantee reserves, US$ 300 000 for technical assistance and US$ 450 000 for programme administration and operations over a four-year period.

After successful termination of the pilot phase, the guarantee facility has been expanded to US$ 16 million. Under the guarantee programme, participating local financial institutions execute Guarantee Facility Agreements with the IFC. HEECP provides partial guarantee support to credit provided by the financial institutions for energy efficiency projects (50% in the pilot phase and 35% under HEECP-2). The rationale is to overcome barriers to energy efficiency project financing, which are due to credit risk barriers. These include weak or uncertain end-user credit, the gap between perceived and real credit risk and lack of properly structured and credit-worthy projects, coupled with the relatively high transaction costs and risks associated with energy efficiency projects. The guarantee programme addresses the problems associated with credit risk. The technical assistance component aims to provide expertise and to make small grants available for marketing of services by participating financial institutions, project identification, development and investment preparation, general energy efficiency market promotion activities, and programme evaluation activities. Technical assistance funds are also provided to ESCOs. HEECP also seeks ways to promote expanded energy efficiency markets in Hungary in co-operation with other commercial, governmental and NGO agencies. Other GEF-financed programmes include the UNDP/GEF Public Sector Energy Efficiency Programme and the IFC/GEF.

Policy Type

RD&D / Third-party finance / Capital grants

RE Technology

All renewables

Hungarian Energy Policy Principles and the Business Model of the Energy Sector

Year

1999 - Present

Policy Description

In 1999, the government adopted an energy policy following domestic and EU developments (*e.g.*, privatisation of the Hungarian energy sector, the EU liberalisation Directives, the Kyoto commitments). The core objective is to prepare the Hungarian energy sector for EU accession. Consequently, major emphasis has been given to guidelines for establishing competitive markets and price regulation for electricity and natural gas. Energy conservation, renewable energy, district heating and environmental protection are also a part of the policy.

Policy Type Regulatory and administrative rules

RE Technology All renewables

Energy Saving and Energy Efficiency Improvement Action Programme

Year 1999-2010

Policy Description This programme was established in the framework of government resolution 1107/1999 following the National Energy Saving and Energy Efficiency Improvement Programme of 1995. The new programme defines the following targets by 2010:

- Reduce energy intensity by 3.5% per year, assuming an annual growth of GDP of 5% and a growth rate of energy consumption of 1.5% per year.
- Save 75 PJ per year (1.8 Mtoe) of primary energy.
- Reduce emissions by 50 kt per year of SO_2 and 5 Mt per year of CO_2.
- Increase renewable energy production from 28 PJ to 50 PJ per year (1.2 Mtoe per year).

Initial funding for the Action Programme was provided by the Economic Development Fund of the Ministry of Economy and Transport. The initial budget allocation was HUF 1 billion per year in 2000. The budget for 2001 increased to HUF 2 billion, and was supplemented by an additional HUF 3 billion from the Housing Programme of the Széchenyi Plan, which was earmarked for funding of energy efficiency measures in the housing sector.

The Housing Programme is managed by the Building Department of the Ministry of Economy and Transport. The decree also establishes the possibility of using part of the planned Environmental Emission Fee for the Programme. The Energy Saving and Energy Efficiency Action Programme includes fifteen actions. The main highlights of the actions relating to the promotion of renewables are:

- Increased heat production from biomass, geothermal, wastes and solar energy.
- "20 000 roofs with solar collectors" by 2010 programme.

Policy Type RD&D / Capital grants

RE Technology Biomass
Geothermal
Waste
Solar thermal
Solar photovoltaic

Funding under the Energy Saving Strategy and Action Plan

Year 2000 - Present

Policy Description In 2000, the Hungarian government allocated HUF 1 billion (US$ 4 million) from the state budget to support energy efficiency and renewables as planned in the Energy-Saving Strategy programme adopted in 1999. The programme aims to increase energy efficiency by 3.5% a year, reduce CO_2 emissions by 5 Mt per year and increase renewables from 28 PJ in 1999 to 50 PJ in 2010. An action plan adopted in 2000 includes grants to perform energy audits, improve the energy management of local governments and increase energy efficiency.

The Hungarian government plans to allocate HUF 5 billion a year (US$ 20 million per year) from 2002 to 2010 to finance the programme.

Policy Type Consumer grants/rebates

RE Technology All renewables

Széchenyi Plan

Year 2000-2002

Policy Description The Széchenyi Plan was an economic development plan in which the government indicated the areas where it considered development most essential to become economically competitive with the rest of Europe.

It provided support for renewable energy projects through application for a one-time grant aid programme. This plan supported up to 30% of investment costs in renewable energy, with the upper limit differing depending on the type and purpose of the project.

In 2000, HUF 350 million (approximately US$ 1.5 million) was available for competitive applications, to increase the use of any renewable sources of energy. The grant could not exceed HUF 35 million (approximately US$ 160 000), unless justified.

Policy Type Capital grants

RE Technology All renewables

ISPA: Instrument for Structural Policies for Pre-Accession

Year 2000-2006

Policy Description This policy finances major environmental and transport infrastructure projects. With an annual budget of € 1.040 billion, ISPA comes under the responsibility of the Regional Policy Directorate General.

Together with PHARE and aid for agricultural development, Agenda 2000 proposed structural aid for EU applicant countries amounting to some € 1 billion per year for the period 2000-2006. This aid is mainly directed to align the applicant countries with community infrastructure standards, particularly – and by analogy with the Cohesion Fund – in the transport and environmental spheres. Following on from the European Council's conclusions, the European Commission proposed a regulation on an instrument for structural policies for pre-accession (ISPA), based on Article 235 of the Treaty. Given its similar objectives, it was considered appropriate for ISPA to broadly follow the approach of the revised Cohesion Fund.

Policy Type Capital grants

RE Technology All renewables

Electricity Act - Green Certificates Scheme

Year 2001 - Present

Policy Description The Hungarian Parliament approved the new Act on Electricity in 2001. The Act entered into force on 1 January 2003 and allows the gradual introduction of competition. The first step was opening up 35% of the market. The Act includes the possible use of a green certificates system, which will be regulated by a secondary legislative process.

Policy Type Tradable certificates

RE Technology All renewables

Electricity Act

Year 2001 - Present

Policy Description The 2001 Electricity Act offers the possibility for independent electricity producers using renewables with a capacity above 100 kW to benefit from a feed-in tariff. The tariff is the same for all renewable energy sources and is adjusted annually for inflation. It is paid by the main electricity producer (MVM) when a power plant is connected to the transmission network, or by the local service provider if the independent producer is connected to the distribution network. The purchase of renewable electricity is mandatory. The tariff is regulated by the Ministry of Economy and Transport.

The 2001 Electricity Act also includes a reference to the intent to move towards a portfolio-based system, met by a renewable energy obligations and tradable green certificates. The details have not yet been set out.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology All renewables

UNDP/GEF Public Sector Energy Efficiency Programme

Year 2001 - Present

Policy Description This programme runs in parallel to the National Energy Saving and Energy Efficiency Action Programme. It aims to help Hungary improve energy efficiency in the public sector by removing barriers to improved energy efficiency in municipal and public buildings, including schools and hospitals. The main objectives are to improve the development of an energy efficiency policy; increase awareness and improve co-ordination of the energy efficiency policy; the identification, development and financing of energy efficiency projects in municipalities; and to improve the knowledge base on energy management and energy efficient technologies. The Energy Centre is the implementing agency for the project, under the auspice of the Ministry of Economy and Transport. The programme also intends to reach out to municipalities and local advice centres and networks. The budget is approximately US$ 4.6 million.

Policy Type Public awareness

RE Technology All renewables

KAC-Environmental Target Fund

Year 2003 - Present

Policy Description In 2003 the fund became part of the "Green Source" environmental programme of the Ministry of Environment and Water. It subsidises the KAC and the Water Management Target Fund (VICE).

In 2003, in the framework of the KAC, there were calls for applications under six topic areas, which were financed by HUF 4.11 billion:

- Green Village, green city.
- Waste management.
- Healthy environment.
- Nature protection.
- Social programmes.
- Landscape settlement.

In 2003, in the framework of the VICE, there were calls for applications under four topic areas, which were financed by HUF 4 332 billion:

- Investments to improve water supply.
- Establish sewage systems.
- Placing and cleaning sewage.
- Investments for water protection.

Policy Type Capital grants

RE Technology All renewables

National Energy Saving Programme

Year 2003 - Present

Policy Description The programme was established to replace the energy portion of the Széchenyi Plan. The National Energy Savings Programme (NEP) NEP-2003-6 targets municipalities and individuals and NEP-2003-7 targets entrepreneurs and provides subsidies for renewable energy investments to replace conventional energy sources, reduce environmental pollution and adapt to the energy policy of the European Union. The budget for NEP-6 was HUF 140 million and HUF 180 million for NEP-7. In 2004, NEP 2004-5 (municipalities and individuals) and NEP 2004-6 (for entrepreneurs) offers grants for renewable energy investments, with budgets of 100 million HUF per sub-programme.

Policy Type Consumer grants/rebates / Capital grants

RE Technology All renewables

New Environmental Tariff in Hungary

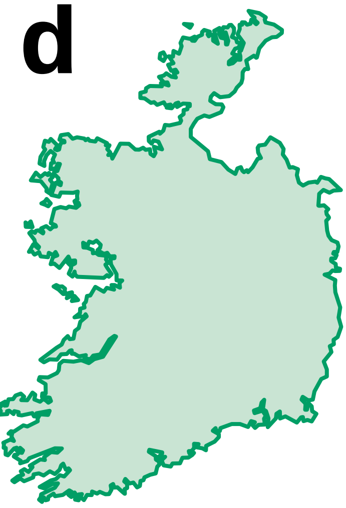
Year 2004 - Present

Policy Description The New Environmental Burden Tariff was introduced in 2004. This tariff applies to air, water and soil pollution and is regulated by the 2003/89 decree. An established percentage of the tariff rate is to be paid in 2004 and is to planned to reach 100% by 2008. The tariff is to be paid every three months by registered polluting sources (*e.g.*, industrial facilities) for No_x and CO_2 emissions and solid substances.

Policy Type Fossil fuel taxes

RE Technology All renewables

Ireland



Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

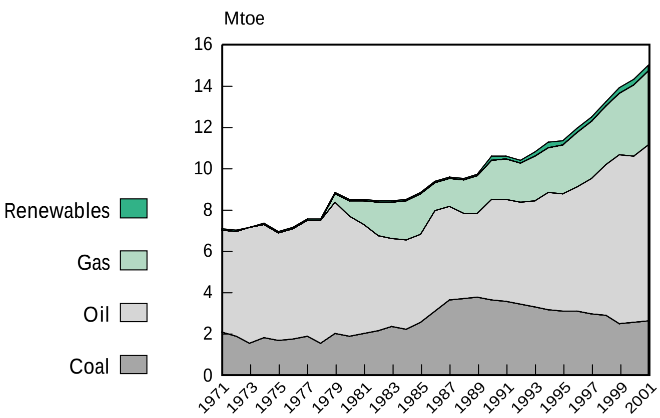
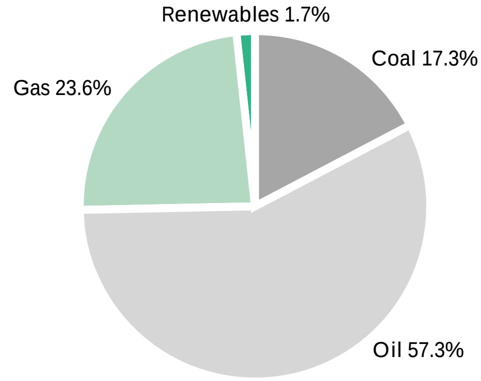


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1.
See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1970	1980	1990	1995	2000	2001	Imports
Coal	2.1	1.9	3.7	3.1	2.6	2.6	70.7%
Oil	4.1	5.8	4.9	5.7	8.1	8.7	100.0%
Gas	0.0	0.7	1.9	2.3	3.4	3.6	81.6%
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	-
Renewables	0.1	0.1	0.2	0.2	0.3	0.3	-
Biomass	*0.0*	*0.0*	*0.1*	*0.2*	*0.2*	*0.2*	
Hydro	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Total	**6.3**	**8.5**	**10.6**	**11.4**	**14.3**	**15.0**	**91.9%**
% Renewables	*1.1%*	*0.9%*	*1.6%*	*2.0%*	*1.8%*	*1.7%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*

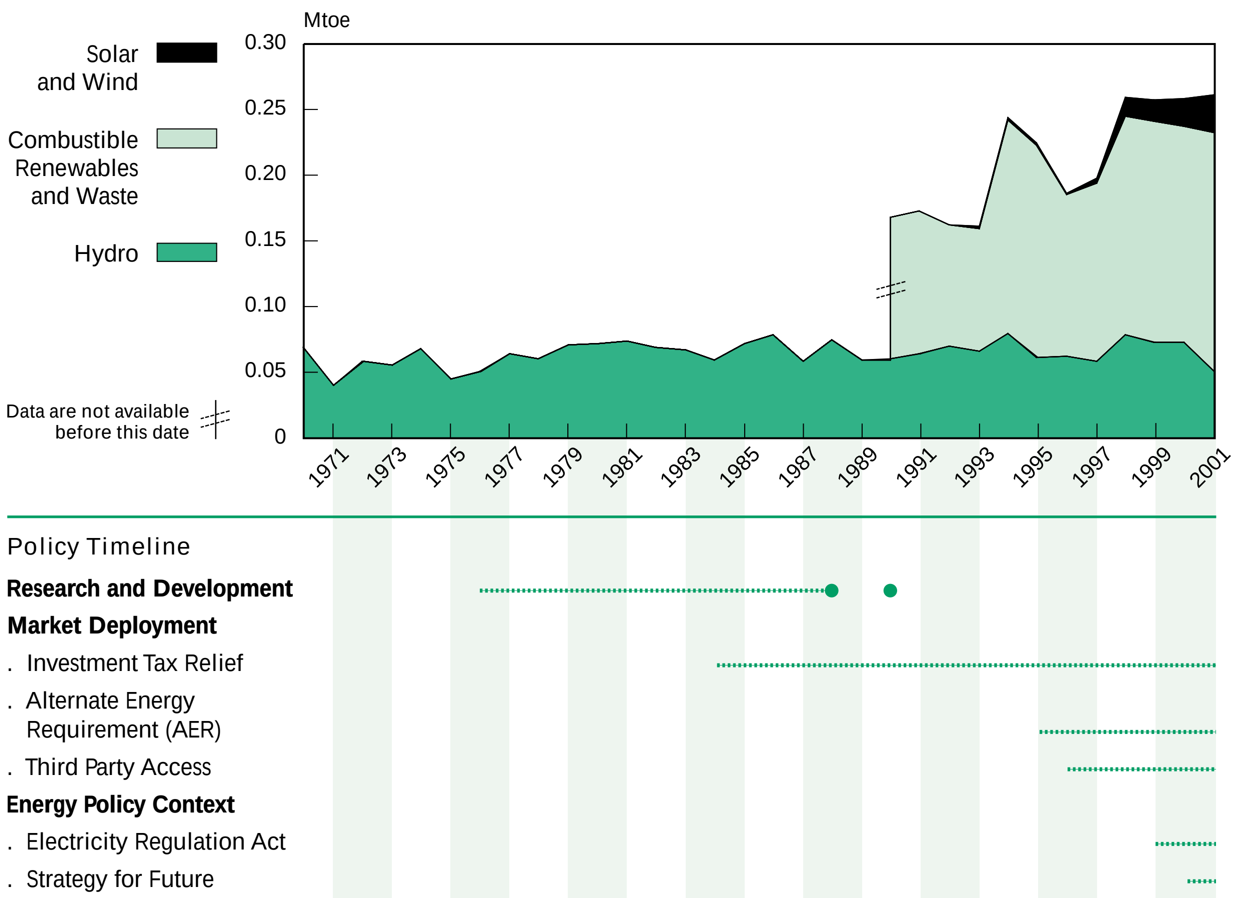
Total primary energy supply (TPES) in Ireland increased by 4.2% per year on average during the 1990s and by 5.5% in 2001. Oil was the dominant energy source and increased its share from 46% in 1990 to 58% in 2001 (Table 1). Primary consumption of oil almost doubled its contribution over the period with an average annual growth rate of 5.1%. The share of coal in TPES declined from 35% in 1990 to 17% in 2001. Natural gas use increased from 1.9 Mtoe in 1990 to 3.6 Mtoe in 2001, accounting for 24% of TPES in 2001.

The contribution of renewable energy to primary energy supply has remained at less than 2% over the period, from 0.2 Mtoe in 1990 to 0.3 Mtoe in 2001. Most of the renewable contribution is from traditional biomass and hydropower.

In 2001, coal was the largest fuel source for electricity generation, accounting for 38% of the power produced. Natural gas was second at 37% and oil products third with 21%. Generation from both natural gas and oil has increased rapidly in recent years. Renewable energy's contribution to electricity production ranged from 4.1 to 5.6% in the 1990 to 2000 period reflecting fluctuations in hydropower. Wind power and landfill gas generation have increased considerably since 1998, but only accounted for about 1.8% of electricity production in 2001.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**

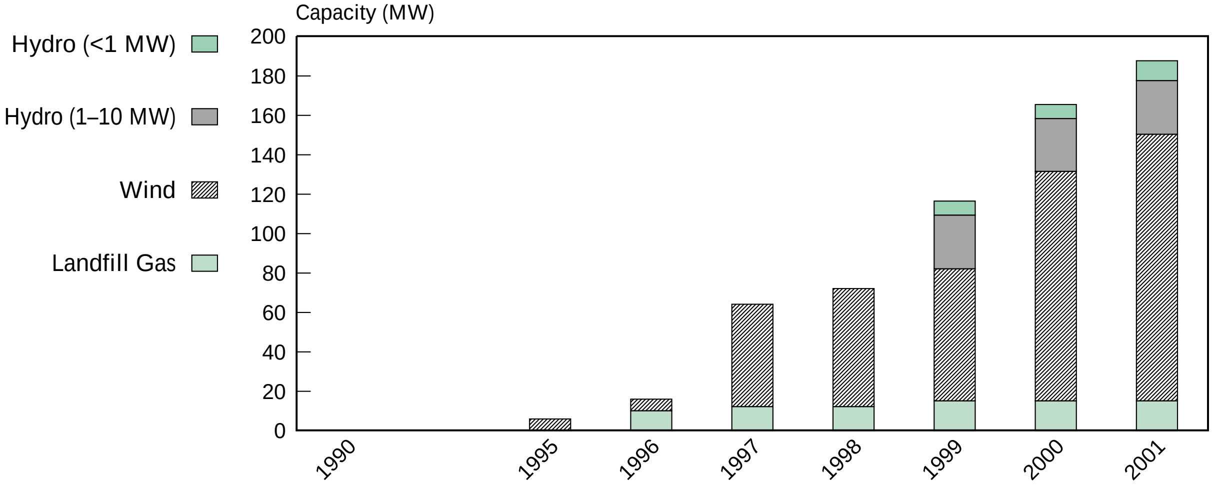


● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Hydropower and biomass account for the largest shares in renewable energy supply in Ireland. In 2001, hydropower was 20% and biomass was 69% of total renewable energy supply. Hydropower generation capacity was 236 MW (excluding pumped storage), gas from biomass, largely landfills, was 15 MW and wind power capacity was 135 MW. Production of solid biomass has increased from 4 416 TJ in 1990 to 6 365 TJ in 2001. Solid biomass use is for process heat in the wood processing industry and residential space heating in open fires.

The contribution from renewables is projected to rise, under the influence of government policies and support measures, to about 3.4% of primary energy and 10.6% of electricity consumption by 2005 to meet established EU and national government targets.

Figure 4. **Net Generating Capacity of Renewable and Waste Products**



Research and Development Trends

Ireland spent a total of US$ 94.5 million (in 2002 prices and exchange rates) on government energy RD&D between 1974 and 2002. About 32% of the total RD&D budget in this period was allocated to renewable energy RD&D. The overall trend of government RD&D expenditures for renewables peaked in the early 1980s and declined notably after 1983. There was no significant funding between 1990 and 2001.

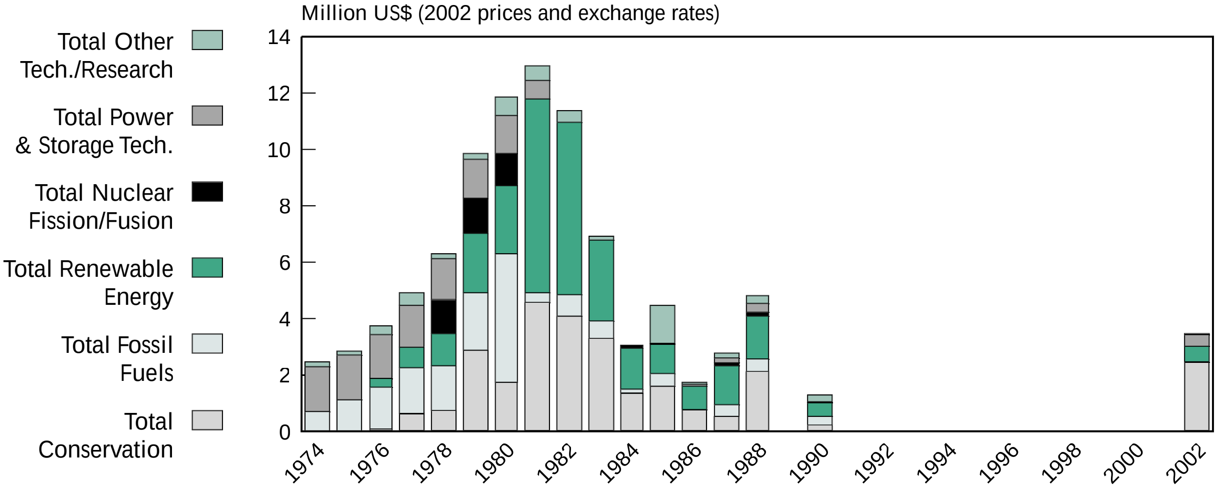
Among the various renewable technologies, biomass received the highest level of funding at US$ 13.6 million, or 46%, in the 1974 to 2002 period. Wind was funded at US$ 8.4 million, representing 28% of renewable energy RD&D.

The Sustainable Energy Act of 2002 gave Sustainable Energy Ireland (SEI), formerly the Irish Energy Centre, the remit to promote and assist renewable energy RD&D activities in Ireland. The government noted that the historically low rate of provision for RD&D in Ireland had contributed to a relative failure to exploit the full range of sustainable energy opportunities, on both the demand and supply sides. The new RD&D programmes administered by SEI aim to address this failure by assisting in the exposition and development of a least-cost path to achieving CO_2 emissions reduction in a more sustainable energy economy.

The main aims of the Renewable Energy Research, Development and Demonstration Programme are to stimulate deployment of renewable energies that are close to market and to assess and develop technologies which have prospects for the future. Strategies for this programme were developed in 2001 and were the subject of public consultation prior to its launch in July 2002. The strategies are to be refined in 2004.

The Programme was allotted an indicative budget of € 16.25 million up to 2006 and is expected to support projects in wind, biomass, solar, ocean, small hydro, ambient heat (heat pumps) and geothermal energy. It includes provisions for hybrid or cross-sector RD&D actions and for community renewable energy schemes.

Figure 5. **Ireland – Government Energy RD&D Budgets***



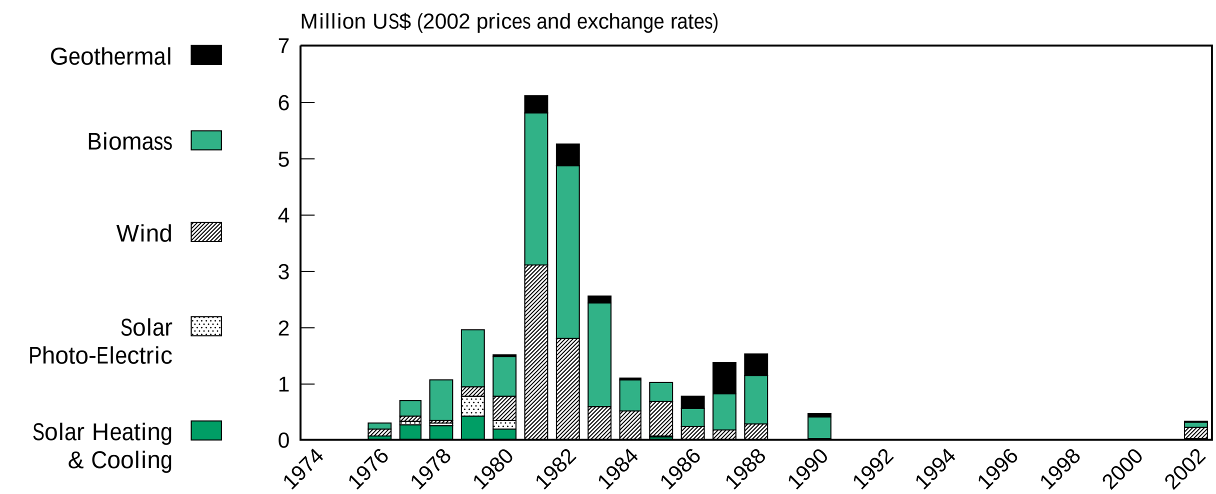
** Data are not available for 1989 and 1991-2001.*

Priority is given to supporting:

- Research aimed at developing policy options for enhanced deployment.
- Research to define the market structure for renewable energy technologies with high penetration potential.
- Research aimed at cost reduction, improved reliability and/or opening new markets.
- Demonstration of non-technical innovation.
- Feasibility studies for renewable energy projects.
- Demonstration aimed at high risk, high reward projects.

In addition, Ireland participates in international collaborative R&D in Wind Turbine Systems, Biomass and Ocean Energy Systems through the IEA Implementing Agreements.

Figure 6. **Ireland – Government Renewable Energy RD&D Budgets***



** Data are not available for 1989 and 1991-2001.*

Market Deployment Trends

The primary fiscal instrument used to support renewable energy technologies is the competitive tendering approach of the Alternative Energy Requirement Programme (AER). It is funded through a Public Service Obligation (PSO) payment made by all electricity consumers. The current policy (2004) requirement is for future support mechanisms for renewables after the AER. There is a Ministerial consultation process (www.dcmnr.gov.ie) underway which will help move forward the Renewable Energy Sources-EU Directive.

AER I was launched in 1995 and aimed to secure an additional 75 MW of electricity generation capacity by 1997. A total of 22 projects were commissioned under the scheme, with a combined total installed capacity of 70.62 MW, of which 60 MW was associated with renewable energy projects and the remainder were CHP. AER II sought to achieve an additional 30 MW from a single biomass power plant, but was unsuccessful.

The AER III target was to secure a further 100 MW of new installed capacity from renewable energy sources by the end of 1999. A number of projects were delayed and some failed to secure planning permission. By the end of 2001, AER III renewable energy projects with a combined installed capacity of 42 MW were commissioned. The AER scheme delivered an additional 102 MW by the end of 2001. A further competition, AER IV focused on CHP plants and delivered 18 MW, thus increasing the CHP delivered by AER to 29 MW.

The *Green Paper on Sustainable Energy* (1999) sought *inter alia* to secure an additional 500 MW of electricity generating capacity in the period 2000-2005 by means of AER competitions, direct sales to final customers and successful EU Fifth framework projects. In addition, the Green Paper called for an exploration of novel CHP uses and testing the offshore wind energy potential. These targets are supported through the AER V and VI competitive tender rounds.

The AER V call for tenders for 255 MW of new renewable generating capacity was launched in May 2001 and results were announced in February 2002. AER V offered 15-year power purchase agreements with the Electricity Supply Board Public Electricity Supply (ESB PES) at the successful applicants' bid price, with 25% of the output attracting an annual inflation adjustment based on the consumer price index (CPI). ESB PES was the monopoly supplier to the portion of the market that had remained closed to competition, called the franchise market. ESB has renamed this supply group ESB Customer Supply (ESB CS). All applicants to this call were required to hold planning permits for proposed developments. This was a new requirement in AER V in order to improve on the success rate of AER III. Contracts were awarded for 365 MW, allowing the 255 MW target to be comfortably reached and even surpassed.

AER VI, announced in April 2003, called for a total capacity of 578 MW including the 365 MW from AER V. Successful bidders from AER V were allowed to submit a new bid under AER VI for the same project. The new offer was also for a 15-year power purchase agreement with ESB CS; however the full bid price would attract CPI, and in addition, the bidder could chose a front weighting price provision that increased the price by 35% for the first 7.5 years of the contract and decreased the price by 35% for the remaining 7.5 years. This was to improve investor confidence that affected a number of AER V projects following the removal of a tax incentive, which had not been designed to support renewable energy projects specifically but was being incorporated into some AER V project financing arrangements. The AER VI results were announced in July 2003. In total, contracts for 365 MW were awarded, 152 MW of which were from bidders holding AER V contracts. Thus currently there are a total of 578 MW under contract from the two rounds: 213 MW in contracts remaining under AER V and 365 MW in contracts under AER VI.

In July 2003 an additional offer of 140 MW to AER VI bidders in the large wind, small-scale wind, and biomass categories was announced. This would bring the total MW under contract in AER V and VI to 718 MW.

Energy Policy Context

Ireland launched a national programme to intensify its promotion of renewable energy in electricity production technologies in the mid-1990s with the publication of “Renewable Energy - A Strategy for the Future”. Since then there have been progressive developments of policies and programmes, primarily in the electricity market. Key steps have been the policies and targets set out in successive national and international documents on energy and climate change policy, legislation, and European Directives.

Ireland’s policy to promote the development of renewable energy contributes to a number of mutually-reinforcing policy commitments including:

- Increasing the percentage of total primary energy requirement (TPER) to be derived from renewable sources from 2% in 2000 to 3.75% by 2005.
- Increasing the installed renewable energy electricity generating capacity by an additional 500 MW between 2000 and 2005.
- Limiting greenhouse gases emissions to a 13% increase over 1990 levels by 2008-2012.
- Reducing annual CO_2 emissions by 1 million tonnes from the business as usual case through increased deployment of renewable energy.
- An indicative target to contribute a minimum of 13.2% of green electricity to total electricity consumption by 2010.
- Exploring the offshore wind resource.
- Regional sustainability and environmental protection.

The introduction of a policy targeting the construction of new renewable energy-based electricity generating stations commenced in the mid-1990s. The current support measure, the Alternative Energy Requirement Programme (AER) (1995–2003), aims to:

- Strengthen security of supply.
- Obtain supplies of energy from indigenous sources.
- Further diversify energy sources.
- Reduce environmental damage.
- Contribute to the objectives of the national CO_2 abatement strategy.
- Contribute to EU targets set out in the Altener programme.
- Ensure that the added-value of these indigenous resources is maximised for the country.

A review of the effectiveness of the AER programme to deliver wind energy targets in particular was carried out by the *Renewable Energy Strategy Group* in 2000. The full remit of this ministerial appointed group was to develop an integrated strategy addressing the significant technical and non-technical barriers that faced wind power development. The focus was on wind power due to the expectation that wind farms would deliver the bulk of the Green Paper’s additional 500 MW target for renewable energy by 2005.

The principal conclusion of the Group was that three key elements, *Electricity Market*, *Electricity Network and Spatial Planning*, need to be integrated into a planned approach for wind energy deployment. This approach sees spatial planning considerations as crucial in determining suitable areas where wind farms may be accommodated. These decisions should be taken according to the availability of the resource (wind), the strength of the electricity networks, landscape and other planning considerations. The locations thus identified should then determine the appropriate grid infrastructure required. Within the context of the agreed planning framework, the market mechanisms chosen should aim to minimise the cost of achieving the target deployment of wind energy.

A number of key recommendations outlined in the Group's report *Strategy for Intensifying Wind Energy Deployment* have been incorporated into energy policy and addressed a number of key barriers:

- Obtaining planning permission became a prerequisite for entering the AER V and AER VI competition, to address the mismatch in AER III between projects with planning approval and those with guaranteed market access.
- The project and ownership cap sizes of previous rounds that restricted large-scale wind farms were removed from AER V and VI.
- *A Grid Upgrade Programme for Renewable Energy* is to facilitate wind farm grid connection where bottlenecks exist. The programme establishes a mechanism to address the challenge that existed for developers where they must raise the entire capital expenditure for any upgrade forming part of a potentially shared connection with money subsequently remitted as others connect to the facility.
- Areas deemed *strategic, preferred, open for consideration* and *no-go* have been identified by a number of local authorities, thus providing clarity and removing a level of uncertainty associated with the spatial planning system.

The net result of these policies has been an accelerated level of wind energy activity in Ireland. Wind farms with a combined installed capacity of more than 2 000 MW have secured planning permission. Planning is no longer a barrier to wind energy deployment in Ireland. However, the challenge of designing an appropriate and effective market support mechanism remains significant, as does integration into the electricity grid.

Current Considerations

The Commission for Energy Regulation is undertaking the formation of a new electricity market, which will be an energy only gross pool market with locational marginal pricing and co-optimised reserve. A special group to investigate the interaction between renewable energy technologies and market rules has been convened to develop detailed market rules.

There are numerous technical obstacles to additional wind implementation with what is essentially an island network. These issues range from concerns about low voltage fault ride-through and frequency control to voltage and power factor control. Robust solutions for these concerns are required in order to mitigate decreased system security and reliability.

Within this context, the Commission for Energy Regulation (CER) recently placed a moratorium on further grid connection agreements for wind farms. The moratorium was founded on stability and reliability concerns voiced by the transmission system operator, ESBNG. This moratorium was put in place for a three-month period ending on 31/3/04.[1] The requirement for dynamic models that can be used in software simulations at the ESBNG has become the issue of primary concern. In a parallel process, the ESBNG has undertaken a rigorous process to formulate a new grid code for wind, which specifies technical requirements. These specifications, scheduled for completion in April 2004, will impact on wind turbine development and implementation.

1. *Information on the moratorium can be found at www.cer.ie, www.eirgrid.com.*

Renewable Energy Markets

Hydropower

Figure 7. **Hydropower Capacity and Electricity Production**

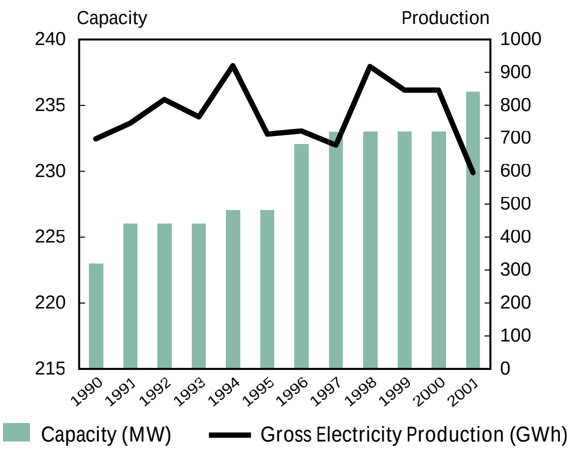
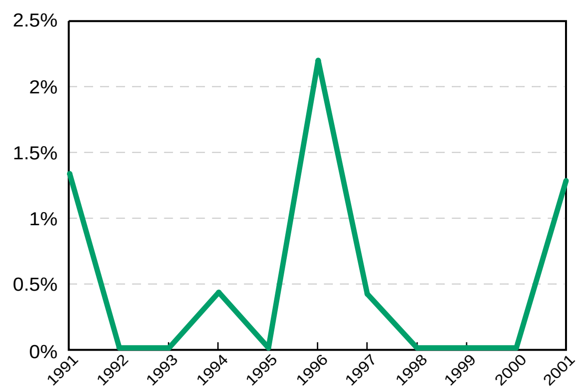
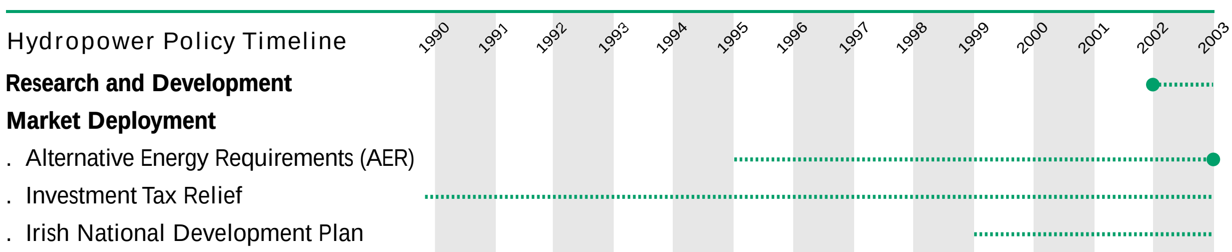


Figure 8. **Hydropower Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Small hydropower was first developed in Ireland in 1907 when two Kaplan turbines were installed at Cahir Mills in County Tipperary. These early plants were used for industrial applications, especially grain milling and wood processing. By 1990, more than 220 MW of generation capacity, mostly large-scale, had been installed (excluding a 292 MW pumped storage facility). These installations grew only slightly during the 1990s, reaching 236 MW in 2001. Of the total installed capacity, 200 MW are from hydropower facilities with capacities larger than 10 MW.

The share of electricity generated by hydropower has gone from 4.9% in 1990 to 3.6% in 2000 and 2.4% in 2001, reflecting the static level of hydropower in a growing electricity sector.

Under the six phases of the AER, ten hydro projects were constructed with an installed capacity of 4 MW. However, the price cap of hydropower has risen to € 0.7018/kWh in the most recent round (2003-2005), which is hoped to be high enough to spur new development. It is estimated that there is about 70 MW of additional "practicable" hydropower resource.

Biogas Electricity Production

Figure 9. **Biogas Capacity and Electricity Production**

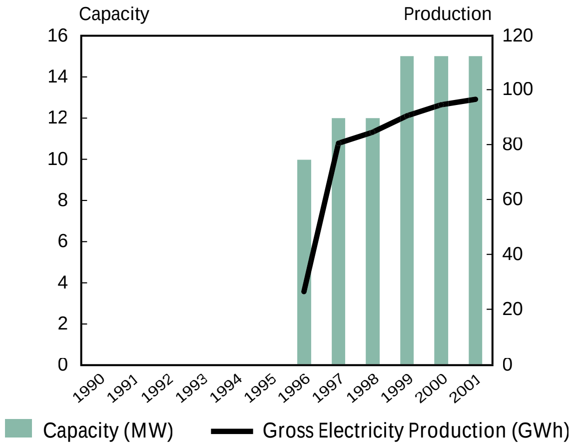
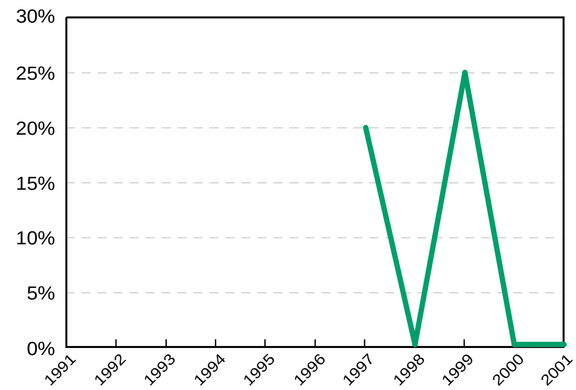
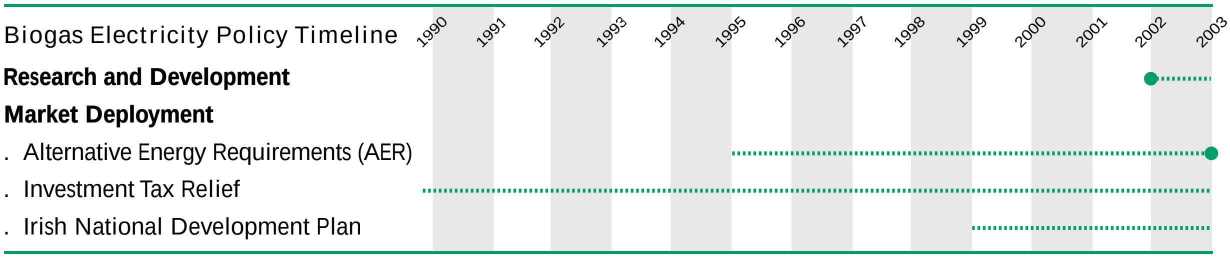


Figure 10. **Biogas Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

The main bioenergy development for electricity generation has been the exploitation of landfill gas. Since 1996 and through the AER programme (AER I-III), 15 MW of landfill gas fuelled capacity has been installed. An additional 5.5 MW is expected to be added as a result of the AER VI round.

There has been very limited development of electricity from anaerobic digestion systems in Ireland with a total installed capacity of about 6 MW. It is hoped that development can be stimulated given the benefits in both renewable energy and environmental terms (avoided methane emissions). To this end AER VI, included a specific category of Biomass Anaerobic Digestion and set a relatively high price cap of € 0.07/kWh.

While there is currently no electricity generation from solid biomass, the AER VI round also included a biomass category, which sought the development of CHP from biomass such as forest industry residues and dry agricultural residues (*e.g.*, straw). The price cap was set at € 0.07/kWh and the capacity to be supported is 28 MW. It is expected that almost 27 MW of this allocation will be developed.

Solid biomass for energy in Ireland to date has been limited to the production of useful heat. This has been almost exclusively in the wood processing industry, although with some domestic heating. In 2001, the most recent year for which data is available, almost 6.4 PJ of solid biomass was used to provide useful heat.

Wind Power

Figure 11. **Wind Power Capacity and Electricity Production**

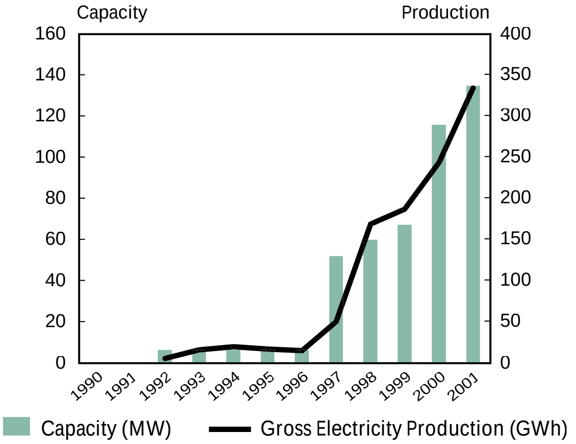
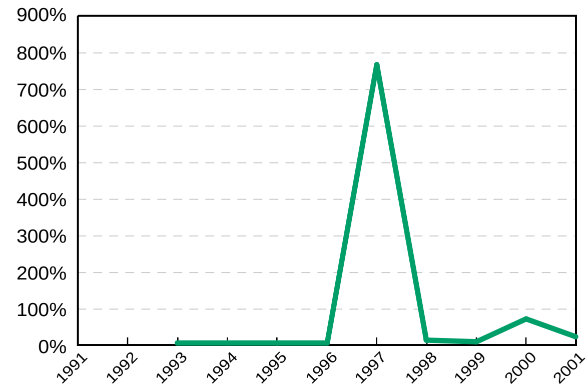
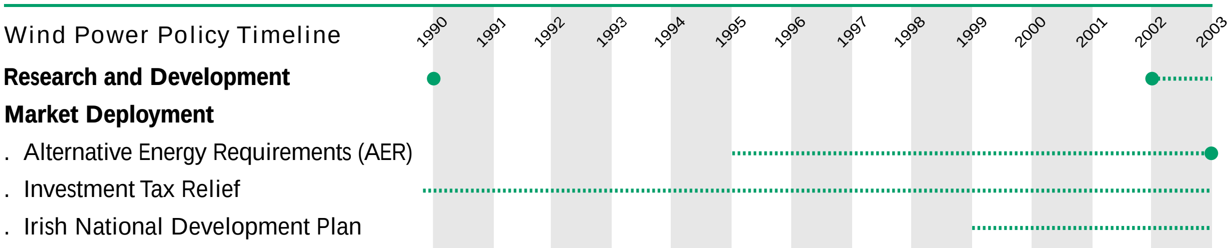


Figure 12. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Ireland benefits from having one of the most favourable wind regimes in Europe for electricity generation. Several successful pilot-scale projects and a limited national demonstration programme in the 1980s gave promising results but were not followed by large-scale developments. From the late 1980s an obligation was placed upon the then state monopoly electricity company, ESB, to purchase renewable electricity, which effectively amounted to a feed-in tariff.

AER contracts have been the primary source of funding power purchase agreements in the Irish context (detailed in the Energy Policy Context section). AER I in 1994 had an initial aim of securing contracts for wind generation capacity totalling 30 MW. Due to demand, this was increased and wind projects representing 46 MW of capacity were built. AER III in 1999 authorised contracts totalling 90 MW for wind power projects but only 38 MW were developed. AER I-III delivered 84 MW of wind capacity. In addition, wind farms totalling 23 MW have been constructed with European Union third, fourth and fifth Framework support and guaranteed market access provided by the Irish Government. A number of wind farms have also been commissioned, totalling 59 MW, the electricity from which is sold to a green electricity supplier, who sells it to final customers under the liberalised electricity market structure.

Under AER V, projects totalling 353 MW of generating capacity from wind power were awarded contracts and 84 MW have been built or are under construction. A total of 191 MW of grid-connected wind power capacity had been installed at the end of 2003.

Contracts for wind generation capacity totalling 334 MW were awarded in the AER VI tender round in 2003. This tender round was the first to include a category for offshore wind power for which two projects of 25 MW each were approved for award of contracts.

The estimated contribution from wind power to national electricity demand in 2003 was 465 GWh. This represents a 20% increase from 2002 production levels and accounted for 1.8% of electricity demand in 2003.

Recent Trends in Deployment

Grid connection agreements committed to by wind farm developers, if acted upon, will result in 326 MW of wind generation capacity being connected in 2004. As connection agreements include financial penalties for non-performance, it is expected that a majority will be developed. Onshore wind farms totalling 75 MW in capacity are currently under construction. The largest wind farm in Ireland, the 60 MW Derrybrien project, is among these. This project received a setback late in 2003 when a significant peat-slide occurred on the site, infiltrating a local water course and giving rise to serious local disquiet. As a significant number of wind projects in Ireland are being developed on upland blanket bog sites, this incident may have repercussions for future permitting of wind farms within the planning system.

Construction of phase 1 the Arklow Bank 25 MW wind farm was completed in 2003 and in April 2004 was in the final stages of commissioning. This is the first such development in Ireland and it is also the first offshore deployment of a 3.6 MW wind turbine. The ultimate capacity for this wind farm under the terms of its lease is 520 MW. The 60 MW phase 2 has a scheduled grid connection date of 2005. Two other offshore wind farms, the Kish Bank and the Bray Bank, both being developed on the east coast, each won price support contracts at an indicative price of € 0.08/kWh for 25 MW capacity apiece under the AER VI competitive tendering round in July 2003. These will have to be commissioned by 2006 in order to avail themselves of the AER VI power purchase agreement.

Table 2. **Wind Connections in the Republic of Ireland, November 2003**

	Transmission (MW)	Distribution (MW)	Total (MW)	Cumulative Total (MW)
Connected	39	127	166	166
Signed Agreements	305	228	534	700
Live Offers	32	43	75	775
Applications in process	144	279	422	1 197
Applications being checked	83	15	98	1 295

Source: ESBNG

Ireland Policy Chronology

Business Expansion Scheme Tax Relief

Year 1984-2006

Policy Description The Business Expansion Scheme (BES) was introduced in 1984 as an incentive to private investors to invest long-term equity capital in companies (particularly new and smaller ones) operating in certain sectors of the economy that would otherwise find it difficult to raise such funding and would instead have to rely on loan finance. The scheme was initially set to operate for three years and has been renewed on a regular basis since then. Investments in renewable energy companies qualify for BES relief. Individual investors holding a BES equity investment for a minimum period of five years can benefit from tax relief, at their marginal tax rate, in respect of investments up to € 31 750 per year. The aggregate amount that a company can raise under the BES was increased under the Finance Act 2004 from € 750 000 to € 1 000 000.

Policy Type Investment tax credits

RE Technology All renewables

Alternative Energy Requirement (AER) Programme

Year 1995-2003; 2003-2005

Policy Description Six Alternative Energy Requirement (AER) competitions were held between 1995 and 2003. Under the AER scheme, winning bidders are entitled to a 15-year power purchase agreement whereby the ESB buys the electricity output of the winning facility at the bid price. The additional cost of electricity procured under the AER schemes is spread across all electricity consumers. The prices paid by the ESB are increased annually in line with the Consumer Price Index. For each competition a quota is set for the amount of electricity to be sourced from each technology, *e.g.*, wind, hydro, biomass/waste.

In AER I, the unit price was fixed and applicants were entitled to bid for capital grants. In subsequent competitions, a price cap for each renewable technology was set instead of a fixed price.

Winning bidders in AER III were also entitled to apply for a capital grant under the ERDF Economic Infrastructure Operational Programme 1994-1999.

Under AER V, the securing of planning permission as a precondition for entering the competition was introduced.

Under AER VI (2003-2005), front weighting of the bid price was provided for, allowing a price increase of 35% for the first 7.5 years of the contract followed by an associated decrease of 35% for the remaining 7.5 years. AER VI aims to ensure that the 500 MW target for renewables based electricity-generating capacity is reached by 2005. (www.dcmnr.gov.ie/energy)

Policy Type Bidding system

RE Technology All renewables

Third-Party Access

Year 1996-Present

Policy Description A decision was made by the Irish Government in 1996 to make third-party access for new renewable energy projects legally possible (*i.e.*, electricity can be sold at a premium price to a customer other than the national grid).

Policy Type Regulatory and administrative rules

RE Technology All renewables

Tax Relief

Year 1998-2002 (extended to 2006)

Policy Description The tax relief scheme, part of Finance Act 1998, came into effect in 1999. Corporate equity investments in certain renewable energy projects, namely hydro, solar, wind power and biomass, are eligible for tax relief in the form of a deduction from a company's profits for an investment in new ordinary shares in a qualifying company. The relief is capped at 50% of all capital expenditure (excluding land), net of grants, on a single project up to I£ 7.5 million. Investment by a company or group of companies in more than one qualifying energy project is capped at I£10 million per year. The Department of Public Enterprise certifies qualifying renewable energy projects and thereafter the Revenue Commissioners administer the tax relief.

With the reduction in corporation tax over the last number of years, the benefits associated with this scheme have diminished.

The tax relief scheme was extended in 2002 until December 2004.

Policy Type Investment tax credits

RE Technology Hydro
Offshore wind
Onshore wind
Solar photovoltaic
Biomass

Electricity Regulation Act 1999

Year 1999 - Present

Policy Description The Electricity Regulation Act benefits renewable energy in the following ways:

- Full deregulation of the electricity market for renewable electricity in advance of full liberalisation of the overall electricity market.

- Priority dispatch given to electricity generated from renewables.
- The establishment of the Commission for Energy Regulation (CER) with a remit to encourage R&D in renewables.

In the liberalisation of the electricity market in Ireland, special consideration was given to renewable electricity suppliers in granting them access to all consumers in advance of full market opening. Renewable electricity generators and suppliers are also advantaged in that they only have to balance aggregated annual renewable electricity supply and demand to qualify as a “green” electricity supplier, rather than that for each half hour metering and trading period. One renewable electricity supplier has been successful in developing a renewable electricity market and is also involved with the development and operation of wind farms. However, few other wind farm owners have opted to sell generated electricity within the deregulated electricity market, as the guaranteed term of the government price support scheme is the best vehicle for attracting financing. Also, the base level price, or “spill price,” which non-dispatchable electricity generators can command when selling their electricity within the electricity market without a supply contract is currently considered too low to be viable. The independent electricity supply market is in the early stages of development with few relationships formed between renewable electricity generators and independent suppliers.

Policy Type Regulatory and administrative rules

RE Technology All renewables

Irish National Development Plan Elements

Year 1999

Policy Description The National Development Plan allocated a total investment of € 67 million for renewable energy sources from 2000 to 2006. The main items supported by this fund are:

- Reinforcement and upgrade of grid to support increased use of renewables.
- Support the delivery of additional renewable energy supplies.
- Encourage new participants in renewable energy market by supporting small-scale projects.

Policy Type Regulatory and administrative rules

RE Technology All renewables

Green Paper on Sustainable Energy

Year 1999 - Present

Policy Description A Green Paper on Sustainable Energy published by the Department of Public Enterprise proposed the introduction of a carbon or energy tax scheme along with a tradable permit system to provide an incentive for industry to reduce emissions. One possibility discussed in the paper is to use revenue generated from a carbon tax or permit scheme to fund grants for energy audits and investments in energy equipment.

The Green Paper set some targets for renewable energy sources in Ireland, which include:

- Increasing the percentage of total primary energy requirement (TPER) to be derived from renewable energy sources to 3.75% by 2005 from 2% in 2000.
- Increasing the percentage of electricity generated from renewable sources from 6.3% in 2000 to 12.39% by 2005. This includes installing an extra 500 MW of renewable electricity capacity by 2005.

Policy Type Obligations

RE Technology All renewables

Promotion of European Programmes

Year On-going

Policy Description Sustainable Energy Ireland (SEI) is the statutory authority responsible for the promotion of the Sustainable Energy Systems element of the European sixth framework programme (FP6) in Ireland.

SEI has made various efforts to create awareness of the FP6, and to encourage high quality Irish participation, including:

- Information dissemination on recent developments/new calls for proposals.
- Hosting a number of national information days for new calls for proposals.
- Initiating a competitive feasibility study process to enable the Irish energy research community to prepare high quality proposals.
- Targeted e-mails to specific technology groups, containing information on particular conferences, publications, etc.
- National contact point service – provides continuing support to all prospective proposers in terms of advice and help in preparing proposals, via telephone, e-mail and face-to-face meetings.
- Networking/partner search – facilitates partner search by advising prospective proposers of potential partners and by attending various brokerage sessions organised by the Commission.
- National delegate role – representation at the Energy Programme Committee meeting;

SEI is also responsible for the promotion of the recently launched energy framework programme, Intelligent Energy for Europe (EIE).

Policy Type Public awareness

RE Technology All renewables

Strategy for Intensifying Wind Energy Development Report

Year 2000 - Present

Policy Description In July 2000, the Renewable Energy Strategy Group published a report "Strategy for Intensifying Wind Energy Deployment" examining the aspects of, and constraints to, further development of wind energy in Ireland. The strategy recommended is designed to meet the targets set for the deployment of renewable energy at least cost, and focuses on three key elements: electricity markets, electricity networks and spatial planning. The aim is to secure an additional 500 MW of renewable-energy-based electricity-generating capacity by 2005.

Policy Type Regulatory and administrative rules

RE Technology Offshore wind
Onshore wind

House of Tomorrow Programme

Year 2001-2006

Policy Description The House of Tomorrow Programme offers support for research, development and demonstration projects aimed at generating and applying technologies, products, systems, practices and information leading to more use of sustainable energy in Irish housing. The main focus of the programme, which has a proposed five-year budget of € 21.1 million, is on stimulating widespread uptake of superior energy planning, design, specification and construction practices in both the new-home-building and home-improvement markets.

Policy Type RD&D

RE Technology All renewables

Sustainable Energy Ireland

Year 2002 - Present

Policy Description The Sustainable Energy Act established a new government body: Sustainable Energy Ireland (SEI) (formerly the Irish Energy Centre). SEI's functions are to:

- Promote and assist environmentally and economically sustainable production, supply and use of energy.
- Promote and assist energy efficiency and renewable sources of energy.
- Promote and assist the reduction of greenhouse gas emissions and transboundary air pollutants associated with the production, supply and use of energy.
- Promote and assist the minimising of the impact on the environment of the production, supply and use of energy.

- Promote and assist research, development and demonstration of new energy technologies.
- Provide advice, information and guidance to government officials and to energy suppliers and users.

Policy Type Public awareness

RE Technology All renewables

Renewable Energy Research, Development & Demonstration

Year 2002 - Present

Policy Description Under the National Development Plan, € 16.25 million has been made available for an RD&D programme for renewable sources of energy and related topics.

The main aim of this programme is to stimulate the deployment of renewables that are close to the market and to assess and develop technologies that have significant prospects for the future.

Partial funding is available for two types of projects:

- Projects demonstrating particular renewable energy technologies or applications which, although at or near commercial viability and having potential for replication, currently face market barriers due to lack of expertise, knowledge or market confidence.
- Research and development into innovative technologies, systems or marketing approaches which support the commercial exploitation of renewables, including applied research and development, technology transfer and adaptation and market research/feasibility studies.

Full funding is available for the following two types of project:

- Public good research studies and investigations that contribute to the development and delivery of strategies, policies, standards and practices encouraging the deployment of renewable energy (mainly commissioned by separate Invitations for Tender).
- Commissioned public good research activities directed at increasing the value and impact of the programme results, which will ultimately be used to inform policy (commissioned by separate Invitations for Tender).

Policy Type RD&D

RE Technology All renewables

Italy

Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

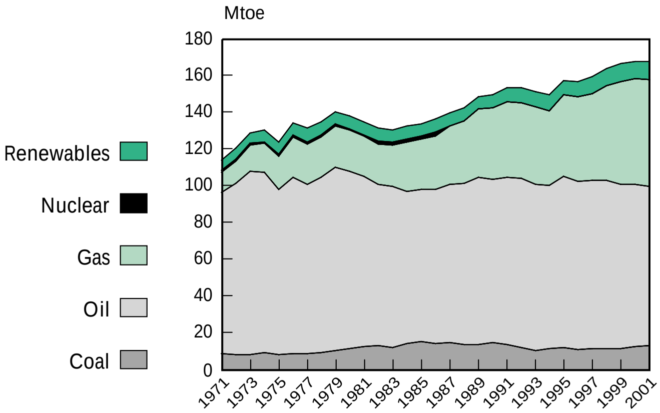
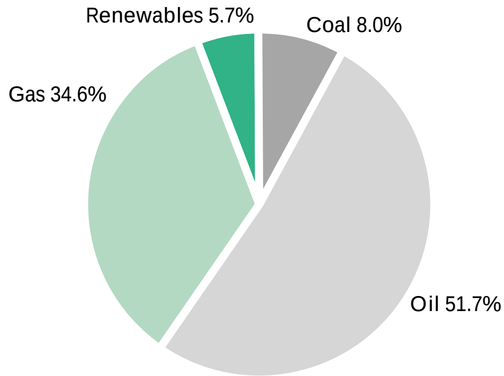


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1.
See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	**1970**	**1980**	**1990**	**1995**	**2000**	**2001**	**Imports**
Coal	9.2	11.7	14.6	12.3	12.6	13.4	100.0%
Oil	82.5	96.4	89.3	92.8	88.2	86.5	97.0%
Gas	10.6	22.7	39.0	44.6	57.9	58.1	77.1%
Nuclear	0.8	0.6	0.0	0.0	0.0	0.0	-
Renewables	6.1	7.1	6.5	7.8	9.1	9.7	-
Biomass	*0.3*	*0.9*	*0.8*	*1.3*	*2.1*	*2.3*	
Hydro	*3.5*	*3.9*	*2.7*	*3.2*	*3.8*	*4.0*	
Geothermal	*2.3*	*2.3*	*3.0*	*3.2*	*3.1*	*3.2*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.0*	*0.1*	*0.2*	
Total	**109.6**	**139.0**	**152.6**	**160.9**	**171.7**	**172.0**	**85.3%**
% Renewables	*5.6%*	*5.1%*	*4.3%*	*4.9%*	*5.4%*	*5.7%*	

** See Annex 2 for explanation of components in total and definition of biomass.*

In 2001, total primary energy supply (TPES) in Italy was 172 Mtoe. Growth in total primary energy supply has slowed considerably over the past two decades. Compared with average annual growth of 2.4% from 1970 to 1980, TPES grew by 1% a year from 1980 to 2001. Primary energy supply is dominated by oil, which represented more than one-half of TPES in 2001. Demand for gas, however, rose steadily, from 39 Mtoe in 1990 to 58 Mtoe in 2001, an average annual growth of nearly 4%. The share of coal was 8% in 2001, down from 10% in 1990 (Table 1).

Renewables in TPES increased from 6.5 Mtoe in 1990 to 9.7 Mtoe in 2001. This was faster than growth in overall energy supply, so the share of renewables grew from 4.3% in 1990 to 5.7% in 2001. Growth in the share of renewables in TPES over the past decade was largely due to the rapid increase in the use of solid biomass, MSW[1] and biogas. Hydropower accounts for the largest share of renewables, but geothermal and biomass are also significant contributors. In 2001, hydropower represented 41% of total renewable supply, geothermal, 33%, and biomass, 24%. Italy is the fourth largest producer of geothermal energy among IEA countries. From 1997 to 2001, wind power capacity grew fivefold, but, according to Italian statistics, growth slowed in 2002. Solar and wind energy accounted for some 2% of renewable energy supply in 2001.

In 2001, electricity generation was predominately from gas (38%) and oil (28%). Italy exploited hydropower for 17% of its generation. Electricity generation from renewable energy sources grew by more than 4.2% per year from 1990 to 2001, compared with average annual growth of 2.2% for total electricity generation.

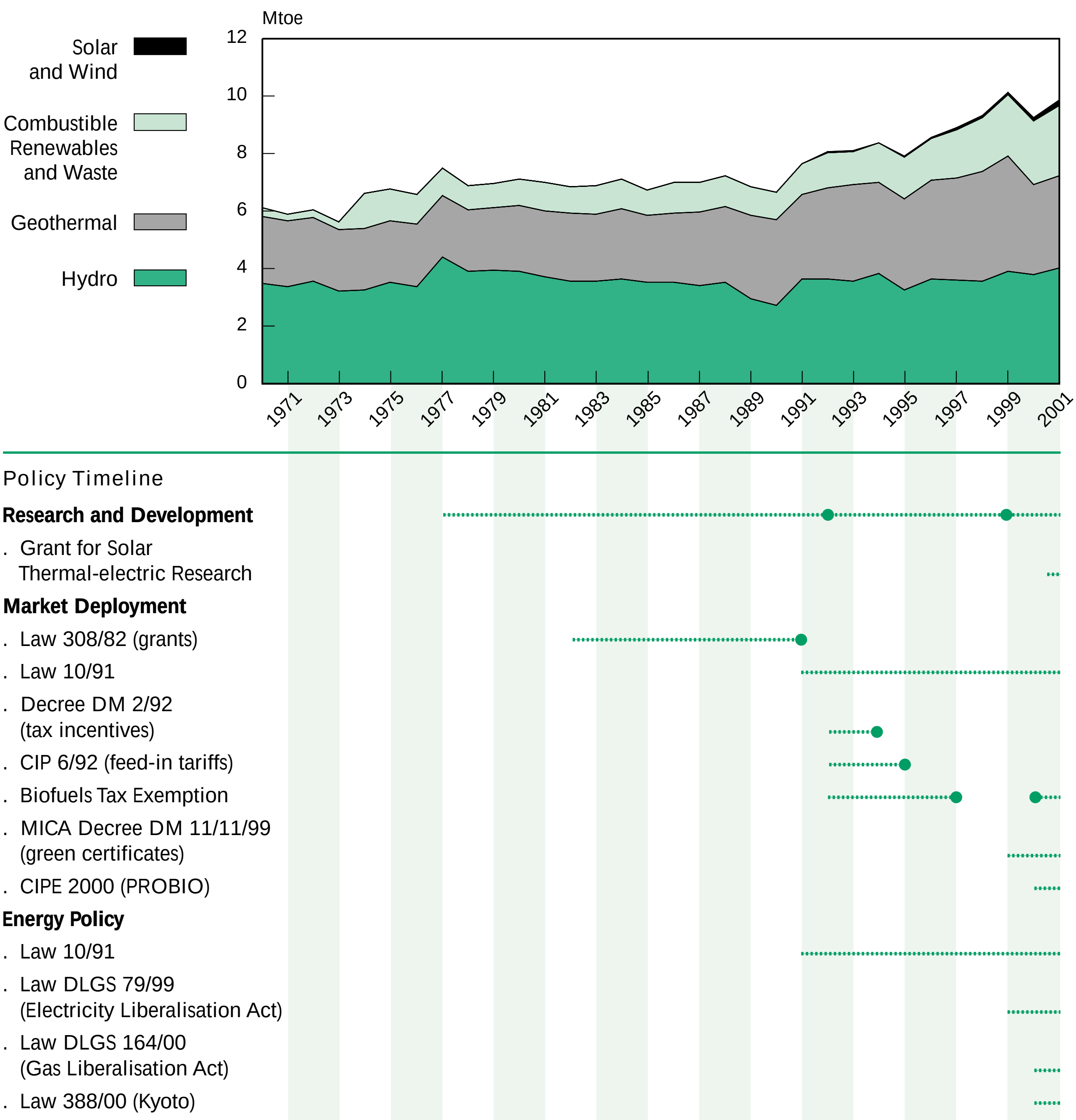
Italy does not use nuclear power. Following the nuclear accident at Chernobyl, an Italian referendum held in November 1987 showed widespread opposition to all nuclear development. In response, the government issued a National Energy Plan (PEN) in August 1988. The plan placed a five-year moratorium on the construction of nuclear plants. The government stopped construction of Trino Vercellese 2 and Montalto di Castro and closed Latina. Suspension of the two operating plants of Trino Vercellese 1 and Caorso occurred in 1990.

Italy has limited domestic energy resources. Net imports accounted for some 85% of energy demand in 2001, 59% of imports are oil, 31.5% gas. The Italian government is seeking to diversify the energy mix and to improve supply security by increasing the variety of import sources for oil and gas and by expanding the use of renewable energy. The greatest barrier to market deployment of renewables in Italy is the complicated and lengthy licensing procedures.

1. The non-renewable portion of municipal solid waste is not included in Table 1. See Annex 2 for details.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



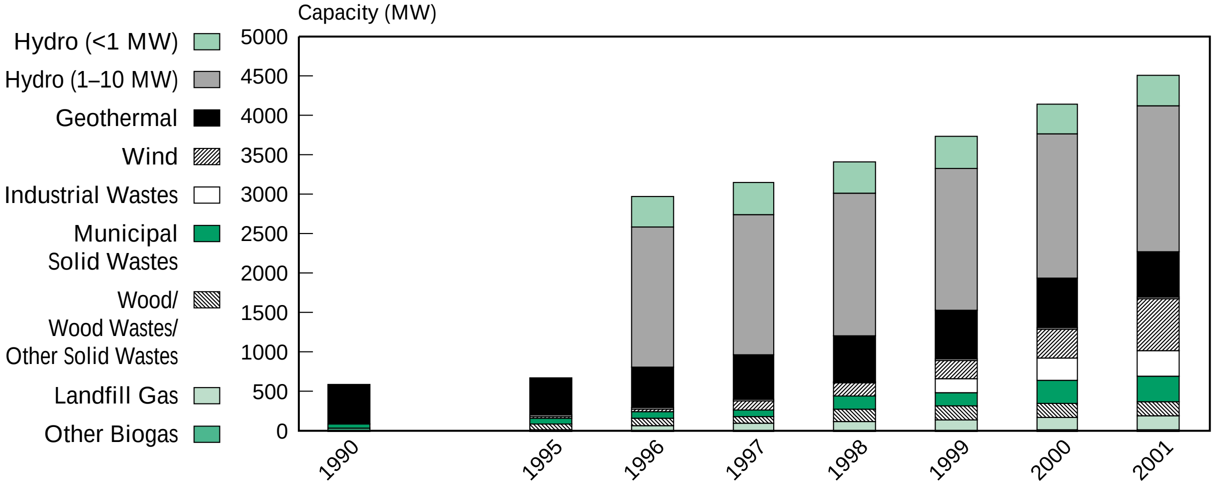
● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Note: In the policy timelines, Ministerial decrees are denoted by (Ministry) Decree DM (date) and parliamentary laws are represented by Law (date). Legislative decrees have the same effect as parliamentary laws and are denoted by Law DLGS (number, date).

Renewable energy supply increased from 6.5 Mtoe in 1990 to 9.7 Mtoe in 2001. Hydropower and geothermal are the largest contributors, but the supply of biomass has grown faster over the past decade. The residential sector is the largest final user of biomass with 1.4 Mtoe in 2001. Solar and wind energy still contribute very little to renewable energy supply.

Most of the recent growth in electricity generating capacity from combustible renewables and waste (CRW) and wind was a result of the 1992 legislation on feed-in tariffs (CIP6/92). The CIP legislation is still showing success in inducing the planning and construction of new capacity. Figure 4 shows net generating capacity of renewables and waste in Italy over the past decade (excluding large hydropower). In 2001, installed generating capacity of CRW was 320 MW of industrial waste, 222 MW of MSW, 180 MW of solid biomass and 198 MW of landfill gas. About one half of biomass production in the electricity sector is used in co-generation plants. Installed capacity of geothermal plants increased from 496 MW in 1990 to 573 MW in 2001. Wind capacity in 2001 was 664 MW.

Figure 4. **Net Generating Capacity of Renewable and Waste Products**



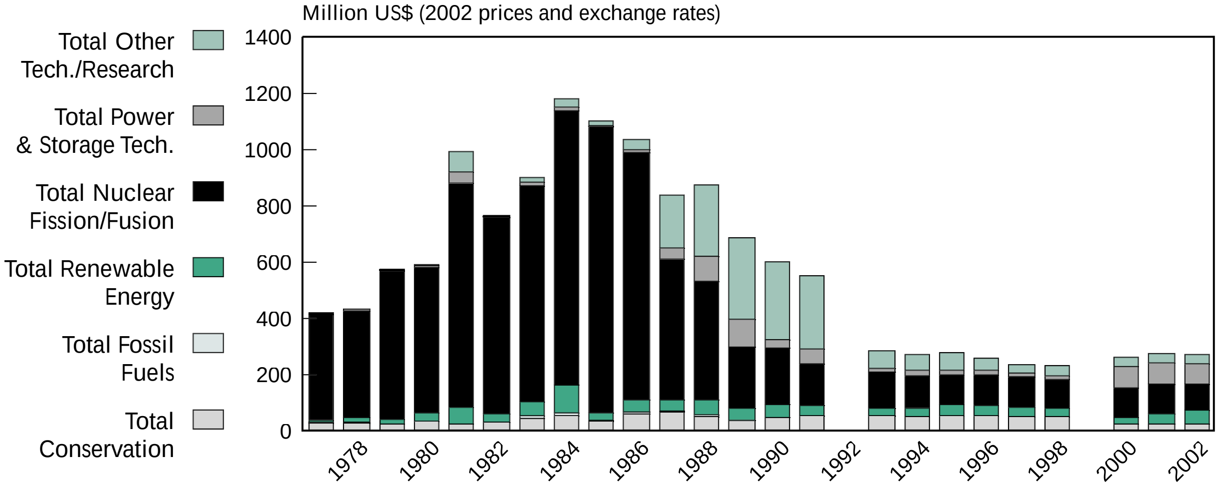
Note: Capacity data for small hydro are not available prior to 1996.

Research and Development Trends

Italy allocated about US$ 14 billion (2002 prices and exchange rates) to energy RD&D from 1977 to 2002. Budget outlays in 2002 were US$ 270 million. Funding for RD&D fell considerably in the late 1980s, due primarily to a decline in funding for nuclear research. The share of funding for renewable energy RD&D, however, increased considerably. The share averaged between 3% and 5% in the 1970s and 1980s, but rose to 15% in the mid-1990s. There was no budget data reported for energy RD&D in 1992 and 1999.

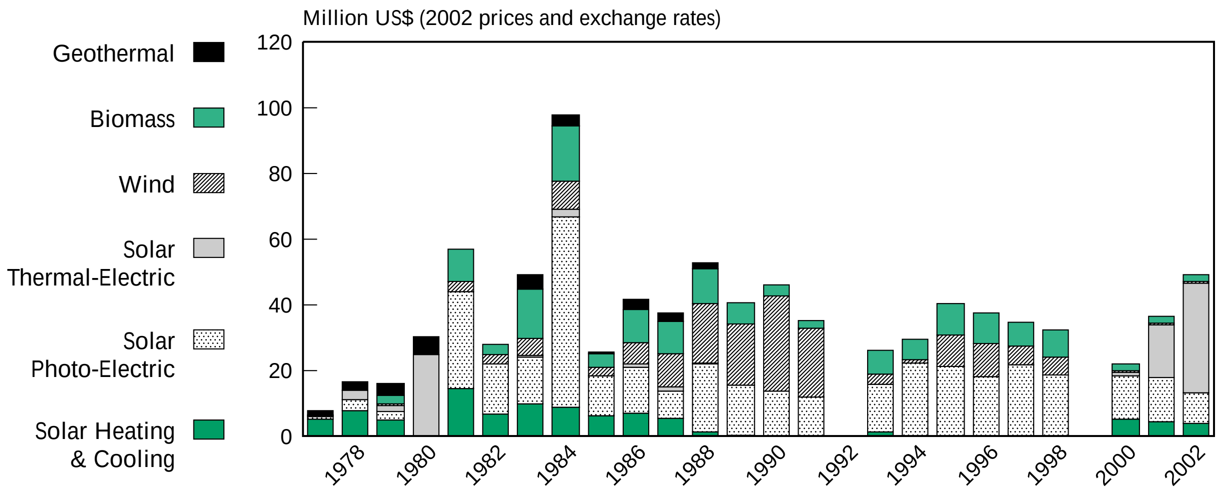
The budget for renewable energy RD&D was US$ 49 million in 2002. In Italy, some US$ 890 million was allocated to renewable energy RD&D from 1977 to 2002. Over the period, RD&D for solar PV was 42% of the budget. Another 18% was budgeted for wind research and some 17% for biomass research. The RD&D renewable budget increased substantially in 1984, mostly because funding for solar PV research quadrupled. Italy has the fourth largest budget among IEA countries for solar PV. More recently, budget outlays for RD&D of solar-thermal electric technologies have increased. In 2002, RD&D on solar-thermal electric received more than 62% of the renewable energy RD&D budget.

Figure 5. **Italy** - **Government Energy RD&D Budgets***



** Data are not available for 1992 and 1999.*

Figure 6. **Italy - Government Renewable Energy RD&D Budgets***



** Data are not available for 1992 and 1999.*

Market Deployment Trends

Over the past two decades, Italy has employed the following market deployment strategies for renewables:

- Favourable lending schemes, financing and capital grants.
- Tax incentives.
- Feed-in tariffs based on avoided costs.
- Green certificates.

The incentives have supported the markets for solar PV and wind. More recent support includes geothermal and small hydropower technologies.

From 1982 to 1989, the government invested US$ 113 million to finance 295 renewable energy projects. Financing and capital grants were limited to power plants with capacity of less than 3 MW (Law 308/82). These early support schemes did not have an appreciable impact on renewable energy markets, particularly because of the modest scale of financial resources and the heavy bureaucratic management of the various programmes. Because electricity producers were offered a full price recovery from the higher costs incurred as a result of the oil price increases in the late 1970s, the impact of renewables policies was further dampened.

In January 1991, two laws were passed which set the framework for the Italian energy sector. Laws 9/91 and 10/91 promoted distributed electricity generation and put in place the conditions for a liberalised electricity market. Industrial companies and municipal utilities were allowed to produce power for their own needs and any excess electricity generated was bought by the national grid. The laws set the framework for public incentives for renewable energy, energy efficiency and co-generation. Tax incentives were then introduced on a small scale in the early 1990s, largely aimed at sectors other than energy. The Ministerial Decree DM 152/92 granted personal tax exemptions for purchases of renewable systems. The income tax reduction was 50% and was in effect from 1992 to 1994. The reduction applied to individuals and private companies.

A more committed approach to the deployment of renewables was the CIP 6/92 legislation, which dealt with the pricing of electricity for all energy sources. The CIP 6/92, in application of Law 9/91, introduced guaranteed fixed prices for electricity produced during the first eight years of operation by renewable and "assimilated" plants. Assimilated plants are co-generation plants with a total energy index above 51%.[2] Because the CIP6 included assimilated technologies, a major consequence of the scheme was to promote CHP. About 80% of the support went to co-generation (including the use of tar and other heavy residues from oil refineries) and 20% went to renewable energy technologies.

The CIP6 legislation applies to plants in operation after 30 January 1991. ENEL, the state-owned electricity company, has a mandatory purchase requirement. The tariff is a combination of avoided costs, based on conventional energy prices[3], and resource-specific incentives for eight years. The avoided costs are adjusted annually. Incentive and avoided costs are also adjusted for inflation. For their first eight years, renewable power plants are granted tariffs based on avoided costs, representing prices that ENEL would have paid if it did not purchase the energy from third parties. The feed-in tariffs vary from about € 0.10/kWh for small hydropower (< 3 MW), to about € 0.12/kWh for wind and about € 0.17/kWh for geothermal electricity and biomass.

The mechanism of mandatory purchase of electricity from renewable and assimilated plants, combined with favourable incentives, was very successful in stimulating applications. The mechanism, however, was stopped in 1995 due to a lack of resources. Because of the lengthy authorisation process and construction delays, many projects were postponed for years. Actual capacity installed by 1995 was much less than the sum of eligible plants. Although no specific support mechanisms were implemented for projects initiated between 1995 and 1999, many projects proposed before 1995 were built during this period. Nevertheless, in 2000, only 50% of the renewables-based electricity plants eligible under CIP6 had been constructed or were operating.

March 2000 was the initial deadline for all plant construction to be authorised under the CIP6 scheme, although plants could be built after this date. The deadline, however, was postponed until 31 December 2002.

2. In 1992, the average energy index of thermal plants was around 30%, whereas in 2004 the reference is around 50% for new conventional plants.
3. The reference used at the time was the cost of the last CCGT plant built by ENEL.

The government also mandated a period of two years between authorisation and construction. Therefore, not all of the authorised capacity has been constructed to date. Incentives will be paid until 2012 (*i.e.*, eight years after the final plant is constructed).

As of March 2004, renewables-based plants in operation or under construction with CIP6 support amounted to 3 000 MW of generation capacity. The approximate distribution across technologies was hydropower 1 300 MW, wind 700 MW, geothermal 600 MW and combustible renewables and waste 400 MW. In 2002, total electricity produced by plants receiving the CIP6 incentive (including plants built after 1999 and thus eligible for green certificates) was 8.5 TWh.[4]

The legislative Decree DLGS 79 of March 1999 (Bersani Law) changed the type of support for renewables from guaranteed fixed prices to the obligation to buy a fixed quantity of renewable energy through the Tradable Green Certificate (TGC) system. Under this Decree, the CIP6 and the green certificates system have been linked in order to ease the entry of the certificates.

Under the Tradable Green Certificate scheme, the obligation falls on producers and importers exceeding 100 GWh. The scheme is based on the following principles:

- "Certification of the origin" of renewable energy flows.
- Separation between certificate trading and physical energy flows.[5]

Since January 2001, electricity operators producing or importing more than 100 GWh per year from non-renewable sources have the obligation (Article 11 of the Bersani Law) to provide a percentage of new renewable energy, generated either from new plants or from re-powering or re-starting older plants that have not been in operation for five years. GRTN, the electricity grid operator, was vested (MICA Decree 11.11.99 of the Ministry of Industry) with responsibility for certifying new, re-powered, renovated or reactivated plants, based on renewables and commissioned after 1 April 1999.[6] The Decree also specified the rules for self-certification of the electricity liable to the renewables obligation, in compliance with the criteria established by the National Authority for Electricity and Gas (Autorita per Energia Elettrica e il Gas, AEEG) concerning co-generation.

In 2002, the MAP[7] Decree DM 8.3.2002 amended and supplemented some aspects of the MICA Decree, introducing a new category of projects among those eligible for green certification. The category of partial renovation is limited to hydropower and geothermal plants. The Decree also laid down new provisions for certification of co-combustion plants.

Legislation in 2003 (Decree DLGS 29.12.2003 n. 387, implementing the EC Directive 2001/77), contains several major points:

- Quotas were set for 2005 to 2007 (see below). A decree in December 2004 will determine the quota for the period 2007-2009 and in December 2007 for the period 2010-2012.
- Measures were implemented to facilitate authorisation procedures, *i.e.*, there is now a unified procedure involving public authorities at all levels (national, regional, provincial, communal). Authorisation must be given within a period of six months.
- Information and communication campaigns on renewable energy will be carried out in 2004, 2005 and 2006.

4. *Source: Luciano Barra, Ministero Attività Produttive.*
5. *The only exception is for imports of renewable energy, where the contract of purchased energy is annexed to the certificate.*
6. *Ministero dell'Industria del Commercio e Artigianato (Ministry for Industry and Trade).*
7. *Ministry for Productive Activities (MAP) is the current name for the former Ministry for Industry and Trade Activities.*

In 2002, the quota was set at 2% of production or imports, deducting exports, own consumption and co-generation (corresponding to 3.3 TWh). Legislative Decree DLGS 29.12.2003 n. 387 set the following obligation quotas: 2.35% for 2005, 2.7% for 2006 and 3.05% for 2007. Table 2 shows the characteristics of the plants that are entitled to receive green certificates as of 31 May 2003.

Table 2. **Plants Eligible for Green Certificates as of 31 May 2003**

	Number of installations	Plants in operation	Total expected electricity generation (GWh)	Electricity generation of operating plants (GWh)
Hydro	227	165	1 717.8	879.9
Geothermal	3	3	418.6	418.6
Wind	116	21	7 480.2	272.2
CRW	78	55	1 758.8	1 127.7
Solar PV	5	4	1.3	1.2
Total	**429**	**248**	**11 376.7**	**2 699.6**

Source: GRTN.

The obligation can also be fulfilled by buying the corresponding amount from other renewable energy producers through the tradable green certificates system. TGCs are issued in units of 100 MWh and are freely tradable bearer bonds (stocks), which can change owners several times before redemption. Certificates exceeding the obligation can be traded or banked. Moreover, additional certificates can be placed on the market by the grid operator GRTN. These certificates are sold at a fixed price.

The CIP6 incentives remain in force, but they are now subsumed under the TGC scheme. Hence, the TGC scheme actually includes two types of TGCs: private Green Certificates, related to plants not eligible for CIP6 incentives that are admitted ex-ante or ex-post and are owned by private power operators; and Green Certificates related to plants eligible for CIP6 incentives that are owned by GRTN.

Green certificates related to imported energy are admitted only if they are derived from plants that started operation after 1 April 1999, and if the plants are in countries promoting renewable energy sources with similar market-based mechanisms. Moreover, the energy must be produced in a country that allows Italian power plants to trade certificates on a reciprocal basis.

In order to fulfil the obligation, certificates must be redeemed. If the quota obligation is not respected, a penalty is imposed by AEEG, according to the provisions set by Article 4 of DLGS 29.12.03 n. 387. The amount of the penalty is left to the discretion of AEEG.

In 2002, the mandatory quota amounted to 3.3 TWh, and 35 operators had to fulfil the obligation. In 2003, 9 140 TGCs were issued from private plants, corresponding to electricity production from new renewable energy plants of 914 GWh. In the same year, 23 287 compensation certificates were issued and sold by GRTN.[8] The price was € 84.18/MWh, based on average energy production prices under the CIP6 mechanism.

8. These certificates correspond to electricity production of 2 329 GWh produced from renewable plants financed under the CIP6 scheme, but built after 1 April 1999.

During the presentation of its 1999 *Report on the Environment,* ENEL signed an agreement with the Ministry of the Environment to cut greenhouse gas emissions. Emissions of CO_2 are to be reduced by 20% from 1990 levels as part of a programme that involves increasing production efficiency in all of its plants and investing in renewables. It is estimated that this agreement will cost ENEL some US$ 3.8 to 4.8 billion by 2006.

The Italian state has amended its constitution to allow for a more federalist structure. Regional governments are now in charge of developing specific legislation concerning renewable energy ("Legislazione concorrente"). With the adoption of Law 112/98, a clear distinction of legislative competencies at different levels for energy issues was established. According to the new structure, electricity production, transport and supply are basically regulated by regional laws, with the exception of main principles, which are determined by the national government. The division is:

- The national government defines objectives and streamlines national energy policy and adopts all the necessary acts for effective programming at the regional level.
- The regions have administrative responsibilities for energy matters, including renewables.

Energy Policy Context

A progressive carbon tax was approved in December 1998 and inaugurated in 1999. The tax is expected to be fully phased-in by 2005. It will apply to coal, natural gas and fuel oil. The existing tax structure on other fuels will be retained. The proposed annual steps toward final 2005 values, however, have not yet taken place.

Renewable Energy Markets

Hydropower

Figure 7. **Hydropower Capacity and Electricity Production**

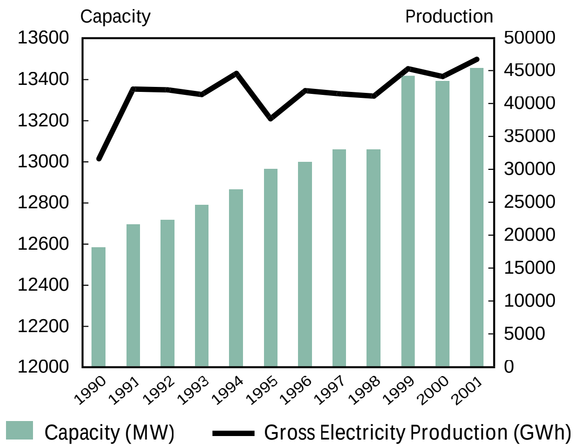
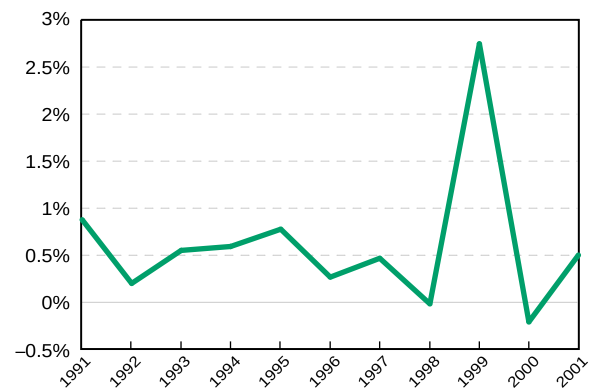
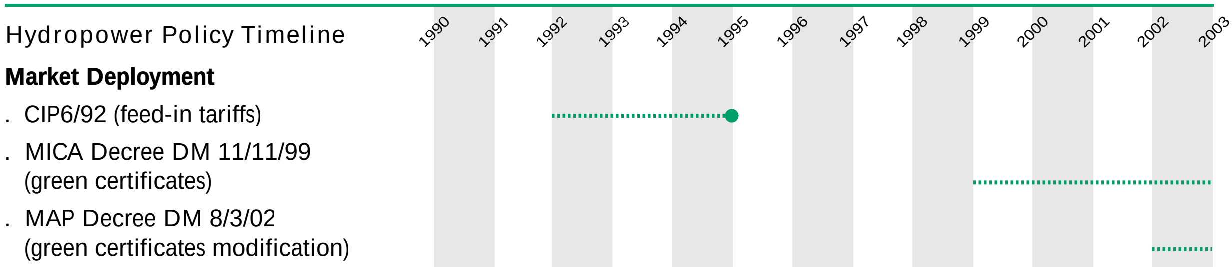


Figure 8. **Hydropower Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Hydropower accounts for the largest share of renewable energy supply in Italy at 41.6%. Hydropower capacity was 13.5 GW in 2001, up from 12.6 GW in 1990. Electricity generation was 46.8 TWh, accounting for some 85% of electricity generation from renewable sources in 2001. Hydropower generation grew by 3.6% on average from 1990 to 2001. According to GRTN, electricity generation from hydropower was 47.3 TWh in 2002.

Compared with previous decades growth in capacity has slowed in the 1990s. Most additional capacity in the last decade has been in small hydro capacity. In 2002, hydropower plants with capacity of less than 1 MW accounted for 4% of total capacity (including pumped storage). Plants between 1 and 10 MW represented 16%.

Some 1 300 MW of hydropower capacity has been constructed or is under construction as a result of the favourable terms of the CIP6/92 legislation. The incentive for small hydro is about € 0.10/kWh and is in effect for eight years.

Under MICA Decree DM 11.11.99, hydropower plants built after 1 April 1999 qualify for support under the TGC scheme. Under the MAP Decree DM 8.3.2002, the re-powering and refurbishment of all plants older than thirty years began to receive support under the Tradable Green Certificate system. As of May 2003, GRTN reports that the annual production of qualified operating plants was 880 GWh.[9]

Biomass Electricity Production

Figure 9. **Solid Biomass Capacity and Electricity Production**

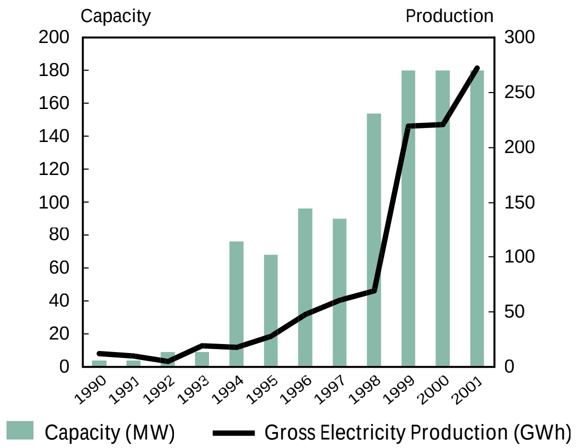
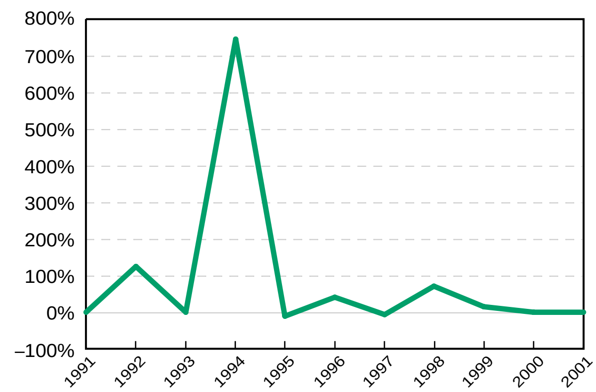
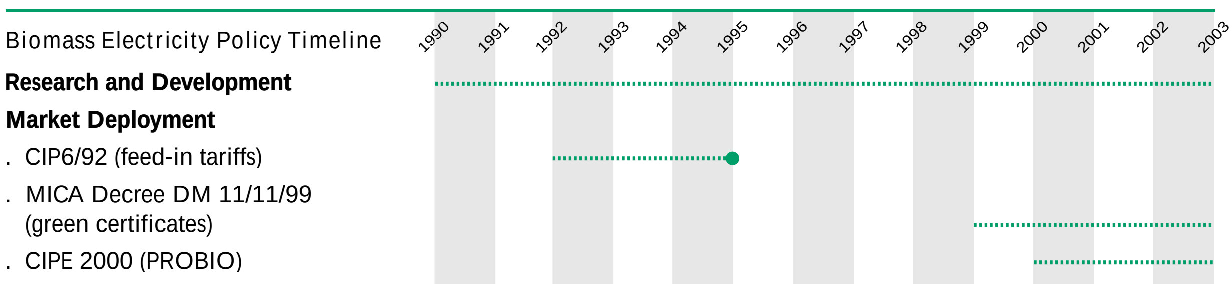


Figure 10. **Solid Biomass Capacity** (Year to Year Change)





Denotes a significant change to a policy, such as an extension, repeal or revision.

Electricity generation from solid biomass represented less than 1% of total generation from renewables in 2001. Total capacity increased from 4 MW in 1990 to 180 MW in 2001. Generation from solid biomass increased from 12 GWh in 1990 to 272 GWh in 2001 (Figure 9).

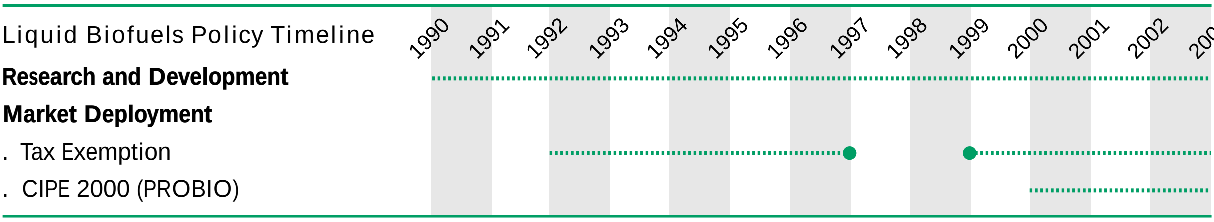
According to GRTN data, the CIP6/92 incentives resulted in the construction of at least 400 MW of eligible solid biomass and MSW plants.[9] Total capacity of biomass and MSW plants in 2002 was about 667.5 MW, of which 326.6 MW was exclusively for power generation. The rest was co-generation. Power generation from solid biomass and MSW was about 2 638 GWh, of which 1 108 GWh was produced in plants exclusively for power generation. The rest was produced in co-generation plants.

9. Solid biomass and MSW are not separated in GRTN data, so the capacity and generation data in this paragraph differ from the IEA data in Figures 9 and 10.

The Biomass Fuels National Plan (PROBIO) (CIPE resolution of February 2000) offers capital grants to reduce the costs of deploying biomass technologies. The objective of the Plan is to substitute fossil fuel consumption in the agricultural, transport and energy sectors.

Under the Tradable Green Certificate system, the annual expected production of qualified CRW plants in operation as of 31 May 2003 was 1 128 GWh (Table 2). The expected production of qualified plants not yet in operation is 633 GWh.[10]

Liquid Biofuels Production

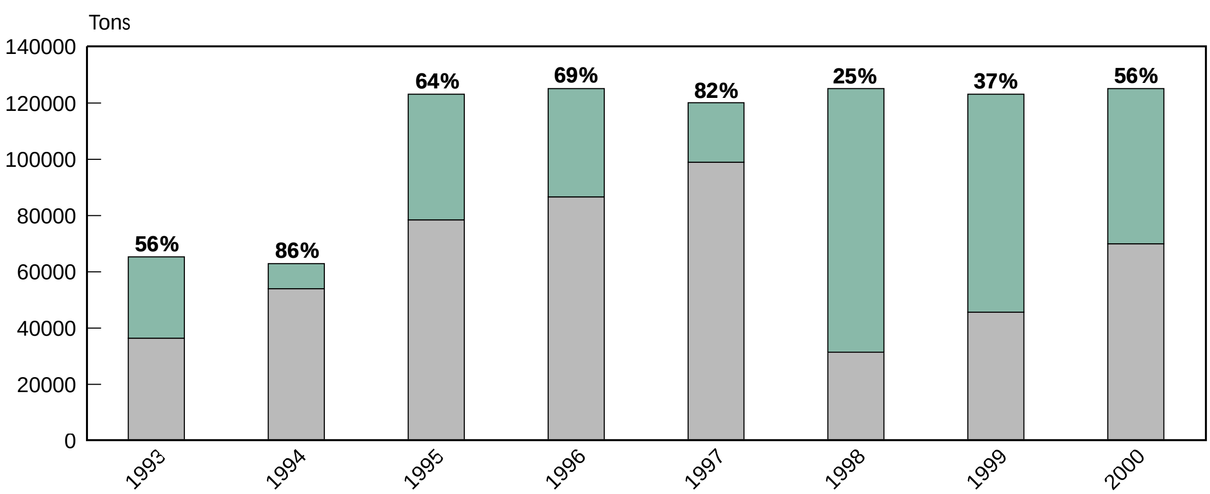


Denotes a significant change to a policy, such as an extension, repeal or revision.

Note: IEA data for biofuels production in Italy are unavailable. The data in this section are from the Associazione Italiana dell'Industria Olearia – Italian Oil Industry Association (ASSITOL).

In 1993, there were eight plants producing some 36 000 tonnes of biodiesel in Italy. Biodiesel production increased to 170 000 tonnes in 2001. There are currently seven biodiesel production plants in operation. The primary feedstock is rapeseed, which is rarely cultivated in Italy. Some 70% of the feedstock is imported from Germany and France.

Figure 11. **Percentage of Eligible Biodiesel Production Supplied to the Market**



Note: The grey area represents the amount of biodiesel supplied to the market. The combined grey and green area represents the amount eligible for the tax exemption.
Source: ASSITOL.

10. *GRTN data include municipal solid waste (*Dati Statistici sull' Energia Elettrica in Italia*, 2002).*

The biodiesel tax exemption has been the driving force behind the evolution of the biofuels market in Italy. The Law DLGS 513 12.92 introduced an excise tax exemption for biodiesel, limited to a production quota of 125 000 tonnes per year. The tax exemption was contested by the Economic Commission and was suspended in 1997/98.[11] The exemption was reintroduced in 1999 with a three-year pilot project, which promoted the use of biodiesel in urban areas. Over the past decade, the total amount exempt was about € 300 million, or about 1 million tonnes of biofuels.

Figure 11 shows the share of biodiesel production out of the total amount eligible for the tax exemption. For example, in 1995, production was 78 000 tonnes, while the amount that could have been produced and benefited from the tax exemption was some 125 000 tonnes. Thus, 64% of the quota was supplied to the market. When the tax exemption was rescinded, production declined dramatically to 25% of the quota in 1998.

The Financial Law 2001 increased the tax exemption production quota for biodiesel to 300 000 tonnes per year from July 2001 to June 2004. Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport set the following reference targets for biofuels:

- 2% (calculated on the basis of energy content) of all petrol and diesel for transport placed on the market by 31 December 2005.
- 5.75% of all petrol and diesel for transport by 31 December 2010.

This Directive must be put in force by national legislation by 31 December 2004.

Italy aims to increase its production of ethanol. The Biofuels Tax Exemption provided an exemption of 43% for three years to support ETBE production. However, the market for biodiesel is much larger and the incentive, 100% excise exemption, much higher.

Finally, biofuels are mentioned in two framework laws at the national and European level:

- The Italian Fiscal Reform Law on excise taxes explicitly mentions the promotion of eco-compatible fuels.
- Council Directive 2003/96/EC restructures the Community framework for the taxation of energy products and electricity.

Geothermal Electricity Production

The first industrial geothermal plant in Italy dates back to 1913. Electricity generation from geothermal has made a small but steady contribution to total renewable energy use in Italy since the 1950s. Over the last decade, geothermal electricity production grew by 3.1% per year, reaching 590 MW in 2000.

Market growth in geothermal electricity was expected to be more substantial in the late 1990s, given the liberalisation of the electricity market in Italy and the associated reorganisation of ENEL. But, from 1995 to 1999, 229 MW of geothermal capacity was decommissioned.

Under the CIP6/92 legislation, some 600 MW of geothermal capacity has been constructed or is under construction. The amount of the incentive is about € 0.17/kWh for eight years. Under the Tradable Green Certificate system, the yearly-expected production of qualified operating plants as of May 2003 was 419 GWh (Table 2).[12]

Geothermal power plants qualify for support under the TGC system. Moreover, the MAP Decree extended the support for partial refurbishment and re-powering of older plants.

11. Thus, the quota was theoretical in 1998 and 1999.

12. This includes electricity production from CIP6/92 plants constructed after 1 April 1999, which are the basis for the compensation certificates issued directly by GRTN. Source: GRTN.

Figure 12. **Geothermal Capacity and Electricity Production**

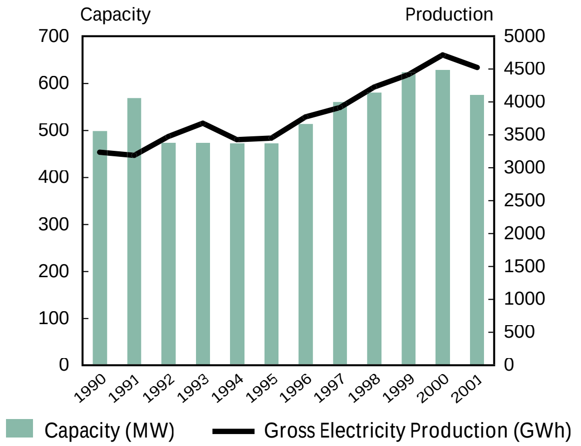
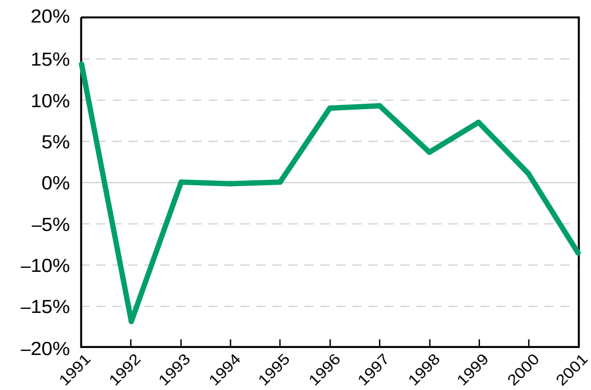
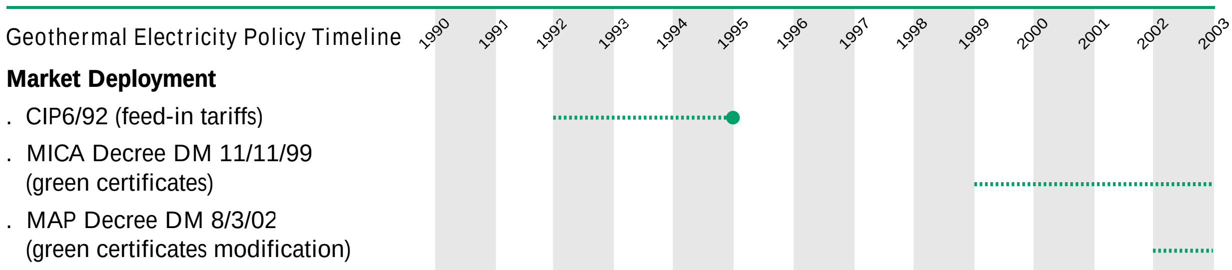


Figure 13. **Geothermal Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Wind Power

Wind capacity increased from 3 MW in 1990 to 664 MW in 2001. Nearly 50 MW of capacity came on-line in both 1996 and 1997. More than 300 MW came on-line in 2001. Electricity generation from wind power grew from 2 GWh in 1990 to 1 179 GWh in 2001, and its share in total electricity generation from renewables was 2.1% in 2001. GRTN data show that capacity increased to nearly 800 MW in 2002 and that gross production from wind power plants increased to 1 404 GWh.

Under the CIP6/92 legislation, some 700 MW of wind power has either been constructed or is under construction. The amount of the incentive is about € 0.10/kWh for eight years and € 0.05/kWh for the following years.

Growth in the wind industry was minimal in the mid-1990s despite the CIP6/92 provisions, mainly because of long permitting procedures and grid connection problems in rural areas. Wind plants particularly suffered because of their large land requirements and small unit capacity. The developers of power plants of small sizes had to undergo the same time-consuming permitting process as required for large conventional power plants. Because of a decline in the cost of wind power technology, development accelerated rapidly in the late 1990s.

Figure 14. **Wind Power Capacity and Electricity Production**

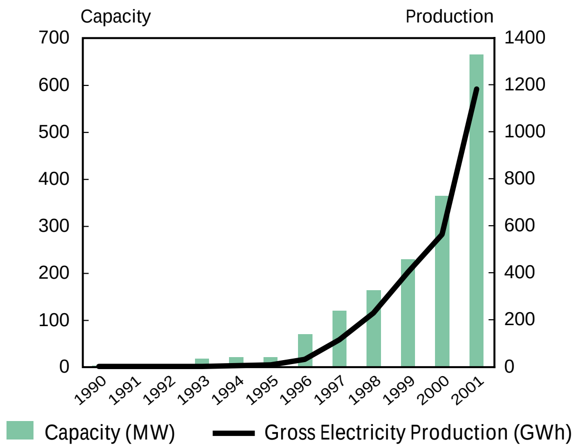
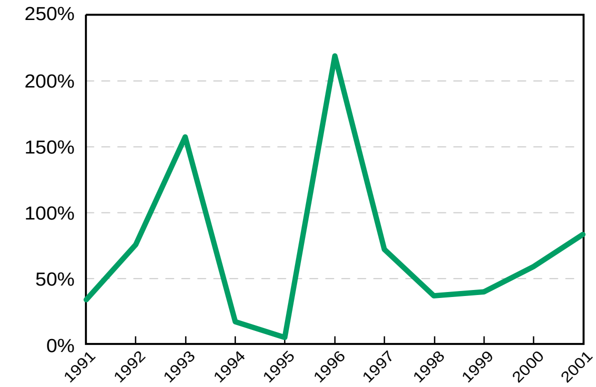
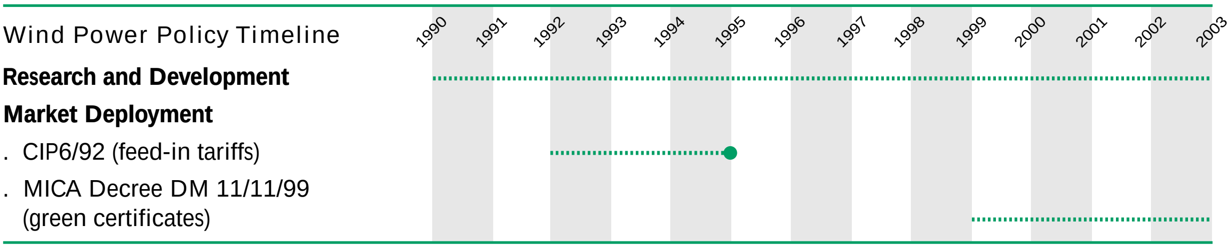


Figure 15. **Wind Power Capacity** (Year to Year Change)





Denotes a significant change to a policy, such as an extension, repeal or revision.

Most of the investors in wind energy capacity are private companies with both national and foreign shareholders. These companies have recently been adding capacity at very high rates. Investors are interested in the potential profits within the framework of the new quota support system.

More than 60% of the electricity production that is eligible under the tradable green certificate scheme is expected to come from wind power. As of May 2003, constructed wind plants eligible under the TGC system produced 272 GWh (Table 2). The deployment of wind power plants is still hampered by difficult authorisation procedures, however, and by social acceptance problems at the local level. This particular issue has been addressed by a recent legislative decree (Decree DLGS 387 of 29.12.2003 adopting EC Directive 2001/77/EC) that introduces time limits for authorisation procedures and standardised stakeholder consultation processes through the mechanism of "Conferenza dei Servizi". GRTN estimates that electricity generation from wind will be more than 7 400 GWh per year by 2010.

Solar Photovoltaic

Solar PV capacity in Italy increased from 4 MW in 1990 to 20 MW in 2001. In the 1990s, the Italian PV market was strongly boosted by financial support from the European Community and ENEL projects. RD&D funding has been primarily from Ente per le Nuove tecnologie, l'Energia e l'Ambiente (the Italian National Agency for New Technologies, Energy and the Environment, ENEA). More recently, growth in PV installations has been dependent on financial support from the Italian 10,000 PV Roofs Programme.

Figure 16. **Solar Photovoltaic Capacity and Electricity Production**

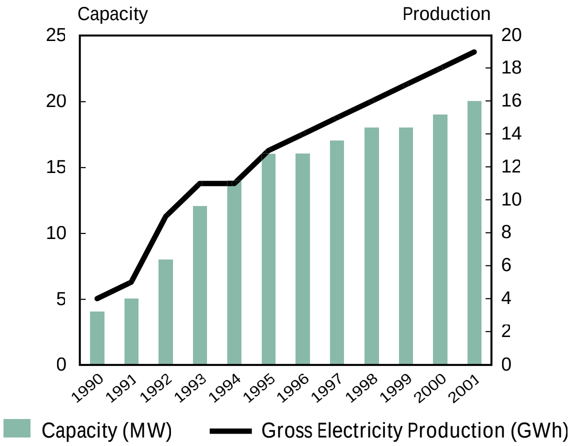
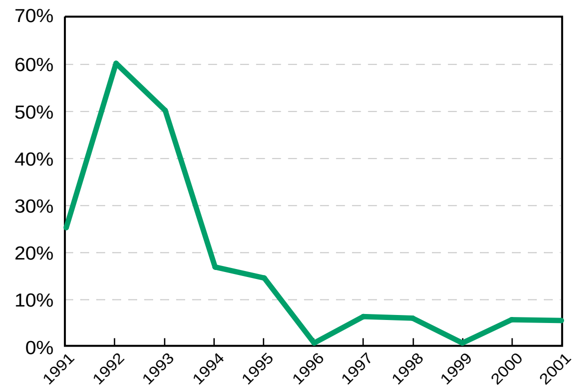
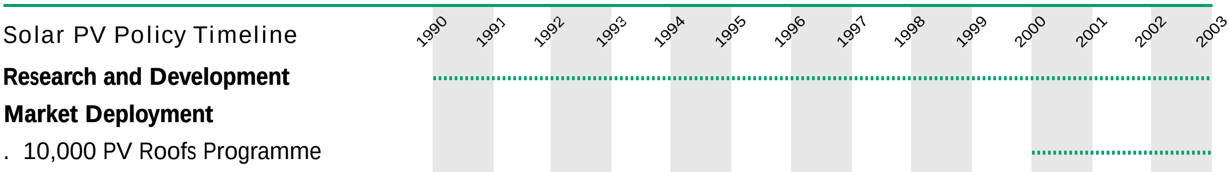


Figure 17. **Solar Photovoltaic Capacity** (Year to Year Change)





Denotes a significant change to a policy, such as an extension, repeal or revision.

The Roofs Programme, initiated in March 2001, promotes grid-connected photovoltaic systems integrated in building structures, ranging from 1 kW to 20 kW. The purpose of the programme is to promote a wide diffusion of integrated photovoltaic applications and to create a viable market that will allow companies to include solar PV in their long-term investment planning. Electricity produced is covered under a net metering arrangement.

An overview of support measures by the Ministry for Environment and Territory (MATT) and by regional governments from 2001 to 2004 is summarised in Table 3. Some 25 MW of PV capacity were expected to be installed over this period. Total financial support was nearly € 120 million. The subsidy was capped at € 8 000 (US$ 7 400) per kW (of the total installation cost) for systems between 1 and 5 kW. Larger systems were eligible for support up to € 7 230 (US$ 6 700) per kW.

Some 5 000 new systems were installed in 2002, with capacity of 3.5 MW. The tenders were such a success that the number of applications exceeded the available resources. Thus, the incentive was reduced to 65% for 2003. MATT reports that the additional capacity installed was 4.5 MW in 2003.

PV systems are still far from competitive in Italy. For this reason, they have not been included under the tradable green certificate scheme, but have benefited from other types of support. The capital subsidies, however, were suspended in 2004. Instead, the Ministry for Environment and Territory, the Ministry of Productive Activities and the National Authority for Electricity and Gas are discussing the introduction of a feed-in tariff for PV systems.

Table 3. **Funding for Solar PV from 2001 to 2004**

Programme	**Target**	**Financial support**	**Subsidy**	**Expected installed capacity (MW)**
National Tender	Public administrations, Universities	€ 10.5 M	75%	1,7
Regional Tenders 2002-2003	All subjects (private + public)	€ 30 M	70%	6
Regional Tenders 2003-2004	All subjects (private + public)	€ 48 M	65%	11
Tender "High architectural design"	Public administrations, Universities	€ 1.6 M	85%	0.15
Fondo 598 Ambiente (Carbon Tax 2003)	Small and medium-sized enterprises	€ 10 M	60%	3
Refinancing National Tender (FY 2002 funds, still not implemented)	Public administrations, Universities	€ 19 M	75%	3.2
DM 24/04/2001 Decree on Energy Efficiency	All subjects (private + public)	n.a	n.a	negligible
TOTAL		**€ 119.1 M**		**25.05**

Italy Policy Chronology

Law 308/82

Year 1982-1989

Policy Description In 1982, the Law 308/82 was passed to establish regulations for the energy sector through the use of institutional rules and financial incentives.

A total of ITL 179 billion was assigned to finance 295 renewable energy projects. Responsibility for the financing was shared between the Ministry of Industry and the Italian regions. Law 308/82, although limited to power plants of less than 3 MW, was said to have anticipated the liberalisation of electricity generation through the lifting of restrictions on independent electricity producers by private operators.

Policy Type Capital grants

RE Technology All renewables

Piano Energetico Nazionale

Year 1988-2000

Policy Description Italy’s National Energy Plan (PEN) 1988 established energy guidelines whose implementation is dependent upon the adoption of certain legislation, *i.e.*, Law 10/91 and 9/91. PEN's broad policy objectives focussed on reducing energy consumption, protecting the environment and human health, promoting endogenous energy sources, diversifying energy imports, and opening up the energy market to increased competition.

Although this policy has been acknowledged to have played a significant role in the liberalisation and privatisation of the energy sector, the PEN was neither enforced nor financed as initially planned.

Policy Type Regulatory and administrative rules

RE Technology All renewables

Law 9/91 and Law 10/91

Year 1991 - Present

Policy Description Law 9/91 and Law 10/91 achieved great success in promoting distributed electricity generation and preparing the conditions needed for a liberalised electricity market. Industrial companies and municipal utilities were allowed to produce power for their own needs and excess electricity generated would be bought by the national grid.

The Laws, along with CIP 6/92, are concerned with the rational use of energy, energy saving, renewable energy sources and assimilated sources. Law 9/91 created reference rules for the electricity sector with the goal of implementing Italy's National Energy Policies (PEN).

Policy Type Net metering

RE Technology All renewables

Law 10/91

Year 1991-1995

Policy Description Law 10/91 was passed in 1991 to continue the process of promoting renewable energy started by the Law 308/82 through funding grants for renewable energy investments. The regions allocated the grants. Funds equalled 30-40% of eligible costs, except for PV projects where the grants equalled 80% of eligible costs.

Policy Type Capital grants

RE Technology All renewables

Ministerial Decree DM 15/2/92

Year 1992-1994

Policy Description This Decree provided a fiscal reduction on personal income tax of 50% for two fiscal years. Expenses arising from household energy saving and/or the purchase of renewables-based systems could be deducted from the taxable base of personal revenues, applicable to individuals and private companies.

Policy Type Tax exemptions

RE Technology All renewables

Inter-ministerial Price Committee

Year 1992-1995

Policy Description The Inter-ministerial Price Committee Provision (CIP 6/92) in 1992 established rules for energy generation, criteria for electricity prices and obligated ENEL to purchase electricity from independent producers at set prices. The prices were based on avoided costs, representing prices that ENEL would have paid if it had not purchased the energy from third parties. These avoided costs comprise costs of plants including capital, operation and maintenance, and fuel costs. A premium is included as an incentive for the higher costs of different renewable energy technologies, but this premium is only paid in the first eight years of plant operation.

The price paid to plants is dependent upon the plant type, whether the plant contributes to base or peak load and whether all electricity or only excess electricity is sold to the grid.

The incentive is production based, *i.e.*, the more electricity the plant produces, the higher the incentives. The growth of Italy's energy production from wind has been attributed to CIP 6/92.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology All renewables

Financial Law of 8 Dec. 1995 No. 549

Year 1996 - Present

Policy Description Renewable energy projects and energy conservation projects are financed through excise levies on petrol. This law additionally allowed the regions to impose a regional tax on petrol and natural gas. This law also signified the end of financing of renewables and energy conservation projects through Law 10/91.

Policy Type Fossil fuel taxes

RE Technology All renewables

Provision of CIPE 137

Year 1998 - Present

Policy Description This provision resulted from the Kyoto Protocol and commits Italy to a reduction of 18-20 Mt of CO_2 through the specific use of renewable energy sources.

Policy Type Obligations

RE Technology All renewables

Legislative Decrees 112 and 96

Year 1998 - Present

Policy Description These legislative decrees in 1998 and 1999 specify the institutional arrangement, *i.e.*, jurisdiction, of the state, regions and local authorities. The legislative decree 112/98 sets out that the "state is responsible for the elaboration and definition of energy objectives and guidelines and for action to address and co-ordinate energy planning at the regional level." The region is charged with the responsibility of drawing specific regional energy plans including renewables potential. Decree 96/99 specifies how the transfer of competencies is to be accomplished.

Policy Type Regulatory and administrative rules

RE Technology All renewables

Financial Law 449/97

Year 1998-1999

Policy Description Financial law 449/97 was passed in 1998. It allowed individuals and private companies to deduct expenses related to renewable energy uses, *e.g.*, building retrofitting expenses from their revenues over a five-year period.

The law allowed a fiscal reduction of 41% of the cost (VAT included) related to building restructuring carried out during 1998 and 1999. The reduction applied only to building owners who had to pay personal taxes and was subdivided into five to ten annual rates. The reduction was limited to costs of € 77 468 per building unit per person per year. About 200 000 requests were submitted in 1998. This law was not specifically designed for energy purposes, but to support the construction sector.

Policy Type Property tax exemptions
Tax exemptions

RE Technology Solar thermal
Solar photovoltaic
Biomass

CIPE - White Paper on Renewable Energy

Year 1999 - Present

Policy Description The CIPE (resolution 126 of August 1999) sets the targets for supply of each renewable energy technology by 2008-2012.

Policy Type Obligations

RE Technology All renewables

CIPE Resolution

Year 1999 - Present

Policy Description CIPE resolution of December 1999, also known as the "National Programme for the Valorisation of Agricultural and Forestry Biomass (PNVBAF)" and the "National Programme for the Energy Valorisation of Biomass (PNERB)," fixes goals for the reduction of greenhouse gases (3-4% by 2010/12), recouping of renewable energy from agro-forestry products and by-products, and development of eco-compatible agricultural methods and increasing the use of energy crops.

Policy Type Obligations

RE Technology Biomass

Decree 1999

Year 1999 - Present

Policy Description This decree, passed in September 1999, concerns the provisions and norms of Environmental Impact Valuations. It states that EIV regulations are applicable to certain categories of industrial plants, including wind power plants. The decree may deter the development of wind projects in Italy due to more stringent regulations.

Policy Type Regulatory and administrative rules

RE Technology Offshore wind
Onshore wind

Financial Law 448/98

Year 1999 – Present

Policy Description This Law reduced the percentage deduction for individuals and private companies for renewables and energy saving measures related to houses and buildings from Financial Law 449/97 from 41% to 36%. The Law also reviewed fiscal rates on oil to harmonise energy products taxation in the EU context.

An excise tax was introduced in 1999 at € 0.52 per tonne of coal, petroleum coke and orimulsion with the level to rise progressively until 2005. The proceeds from the tax were about ITL 2 180 billion for 1999 and ITL 2 271 billion in 2000 and 2001.The funds gathered from this tax will be used to fund a reduction of manpower cost, a reduction in employers' insurance contribution and a contribution to finance environmental projects.

A series of subsequent Decrees rescinded the expected annual increases in the excise tax.

Policy Type Fossil fuel taxes

RE Technology All renewables

2% Renewables Target - Green Certificates

Year 1999 - Present

Policy Description The 1999 Electricity Liberalisation Act and Decrees from Italy's Ministries of Trade and Industry and of Environment (MICA Decree 11/11/99) required Italian energy producers and importers to ensure that 2% of all electricity supplied to the national market came from renewable sources as of 2002. The government can increase the quota to meet the renewable energy target (see Law 387 2003). Suppliers can fulfil the obligation by buying green certificates from entitled new renewable energy plants, by building new renewable energy plants, or by importing electricity from new renewable energy plants from countries with similar instruments on the basis of reciprocity.

The MAP Decree 18/3/02 integrated and partially modified the MICA Decree 11/11/99, by introducing the category of partial refurbishment (only for geothermal and hydropower), to be granted tradable green certificates.

Policy Type Obligations / Tradable certificates

RE Technology All renewables

Carbon Tax

Year 1999 - Present

Policy Description A progressive carbon tax approved in 1998 was inaugurated in 1999 and will be fully phased-in by 2005. This new tax applies to all energy products; the existing tax structure on other fuels will be retained.

Carbon tax rates on fossil fuels are (in ITL):
Coal (tonne) 1999: 5 084;
Natural Gas (m^3) 1999: 0.87;
Fuel oil (tonne) 1999: 1 286;

The expected annual increase in tax rates did not occur.

Policy Type Fossil fuel taxes

RE Technology All renewables

Voluntary Climate Pact

Year 1999 - Present

Policy Description In 1998, industry organisations, environmental NGOs, and other groups in Italy concluded an agreement with the government, under which they agree to curb CO_2 emissions; improve energy efficiency in the industrial, energy, and transport sectors; and promote the use of renewable energy. This pact serves as a framework for specific voluntary agreements with individual signatories, such as one agreement involving twenty specific projects to be carried out by a company's energy and chemicals division. The projects include measures to promote energy efficiency and the use of renewable energy as well as plans for the development of products such as biofuels made from recycled vegetable oil, zinc-based batteries for electric cars, and a laundry detergent designed to be used at low temperatures.

Policy Type Voluntary programmes

RE Technology All renewables

Voluntary Agreement - ENEL

Year 1999 - Present

Policy Description Italy's ENEL signed an agreement with the Ministry of the Environment to cut greenhouse gas emissions, an accord which will require an investment of ITL 8 to 10 trillion (US$ 3.8-4.8 billion) by 2006. The announcement was made during the presentation of ENEL´s 1999 *Report on the Environment*. According to the agreement, emissions of carbon dioxide will be reduced by 20% from 1990 levels as part of a programme that will require all ENEL´s plants to increase production efficiency and invest in renewable resources.

Policy Type Voluntary programmes

RE Technology All renewables

Biofuels Tax Exemption

Year 2001-2004

Policy Description The financial law for 2001 supports biofuels production through excise tax exemption for three years. The total amount exempted was about 1 million tonnes. In 2002, the European Union approved the biodiesel tax programme, totalling about 80% of all biofuels tax incentives included in the financial law.

Policy Type Excise tax exemption

RE Technology Biofuel

Fund for Greenhouse Gas Emissions Reduction, Energy Efficiency and Sustainable Energy

Year 2000 - Present

Policy Description A financial law, approved at the end of 2000, established a fund for the reduction of atmospheric emissions and the promotion of energy efficiency and sustainable energy sources. The fund is financed from 3% of the receipts accruing from the carbon tax law. Among other activities, the fund will finance up to 80% of the cost of programmes for installation of solar collectors (mostly PV), particularly in southern Italy, and reforestation programmes to increase absorption of CO_2.

Policy Type Capital grants

RE Technology Solar photovoltaic

Tax Reduction for Fuels with Lower Environmental Impact

Year 2001-2004

Policy Description The financial law approved in 2000 established a reduced excise tax (€ 289.2 per 1 000 litres) for fuels having a low environmental impact, such as bio-ethanol, ETBE and biofuel additives to unleaded gasoline. The law exempt such fuels from

	the excise taxes up to 0.3 Mt per year to be used as transportation or heating fuel in the period 1 July 2001-30 June 2004.
Policy Type	Excise tax exemption
RE Technology	Biofuel Biomass

Tax Credit for Geothermal Energy and Biomass

Year	2000 - Present
Policy Description	Under the financial law approved in 2000, users connected to either a geothermal or biomass fuelled district-heating grid receive a tax credit equal to € 20.65/kWh of power committed.
Policy Type	Green pricing / Tax exemptions
RE Technology	Biomass Geothermal

CIPE Resolution

Year	2000 - Present
Policy Description	CIPE resolution of February 2000, also known as the Biomass Fuels National Plan (PROBIO) aims to promote the deployment of biomass to replace fossil fuels through incentive systems. This is projected to affect mainly the agricultural, transport and energy sectors.
Policy Type	Capital grants
RE Technology	Biomass

10 000 PV Roofs Programme

Year	2000 - Present
Policy Description	This regulation (Decree of Ministry of Environment 99, 2000) liberalises electricity production from small PV installations and fosters the implementation of the project "10 000 PV roofs" promoted by the Ministry of the Environment and ENEA (the Italian National Agency for New Technologies, Energy and Environment). The regulation covers local exchanges (purchase, sale) of electricity between the grid manager and small auto-producers of electricity from photovoltaic plants of less than 20 kW of installed capacity. Electricity produced is covered under a net metering arrangement. The directorial decree 22 December 2000 funded the PV roof programme with € 32.5 million. Installations on the order of 8-9 MW were expected in 2002.
Policy Type	Net metering

RE Technology Solar photovoltaic

Grants for Solar Thermal-electric Research

Year 2001 - Present

Policy Description € 100 million was provided in 2001 by the Italian Parliament to ENEA (the National Agency for New Technology, Energy and the Environment) for the development of solar thermal-electric generation.

Policy Type Capital grants

RE Technology Solar thermal

Financial Law 388 of 23 December 2000

Year 2001-2003

Policy Description This law contains articles aimed at promoting renewable energy applications and financing specific programmes related to meeting Italy's Kyoto commitments.

This law also has as its objective the funding of research and development activities by assigning funds to ENEA for research and project studies in the field of thermoelectric solar power plants and fuel cell applications.

Policy Type RD&D

RE Technology Solar thermal

Ministry of Industry Decrees of 2001

Year 2002-2006

Policy Description Two decrees in 2001 defined quantitative targets, functioning and implementation of programmes related to energy conservation and efficiency as they relate to the opening of the electricity and gas markets. Solar-thermal, photovoltaics and biomass are eligible for support. The targets are gradual and progressive from 2002-2006.

Policy Type Obligations

RE Technology Solar thermal
Solar photovoltaic
Biomass

Legislative Decree Implementing Directive 2001/77/EC

Year 2003 - Present

Policy Description

The Decree (387, which entered into force on 31 January 2004), sets out in twenty articles a national framework for the promotion of renewable energy sources and particularly for their use in micro-generation plants. The decree adopts a definition of renewable energy sources and electricity produced from renewables contained in article 2 of the EC Directive 2001/77/EC. Consistent with the Directive, the Decree sets a timetable for the periodic reporting, review and monitoring, by the Ministry of Productive Activities, of progress towards the implementation of the objectives. It also sets for the period 2004-2006 a 0.35% annual rate of increase of the minimum share of electricity produced from renewable energy sources that should be fed to the national grid and deadlines for the MPA to plan further increments over the periods 2007-2009 and 2010-2012.

Sanctions are established for non-compliance and applied by the Regulatory Authority (AEEG) based on the reports of the grid manager (GRTN). To assess the exploitable energy potential from biomass, an ad-hoc experts committee has been created to help design appropriate legislation. A six-month deadline is also set for the adoption of legislation and criteria (minimum requirements, possibility to accumulate incentives, preferential tariffs, capacity targets, use of green certificates) for granting incentives to power produced from solar energy.

The Decree includes specific provisions which favour hybrid plants (*i.e.*, those producing part of their power from renewables) over fossil fuel plants in dispatching. A five-year programme agreement between the MPA and ENEA on RD&D measures to support renewables and energy efficiency has been established. Regional targets for renewable-based electricity are encouraged and regional governments can establish their own plans for renewables support.

Specific articles address the issue of certification of origin for electricity produced from renewables, which can be requested for plants producing more than 100 MWh per year from GRTN. Conditions under which the electricity produced can be sold in the power market or purchased by GRTN are indicated. Specific rules are set for the streamlining of authorisation procedures for plants and infrastructure devoted to power production from renewables.

Article 17 of the Decree extends the benefits granted to renewables to waste and fuels derived from waste, including the non-biodegradable fraction of urban, agricultural and industrial waste mentioned in articles 31 and 33 of the legislative Decree no. 22 of 5 February 1997. This is subject to another decree (to be adopted by MPA in the future) specifying the exact types of waste admitted and the allowable emission limits from plants that use them as fuels. However, the energy sources assimilated to renewables in Law 10/91 and the goods, products and substances originating in production of energy are excluded from the benefits of DLGS 387. This removes a peculiarity of earlier legislation that granted the same subsidies as those given to renewables to CHP (whatever the fuel used and including refinery waste such as tar).

Policy Type Obligations

RE Technology All renewables

Japan

Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

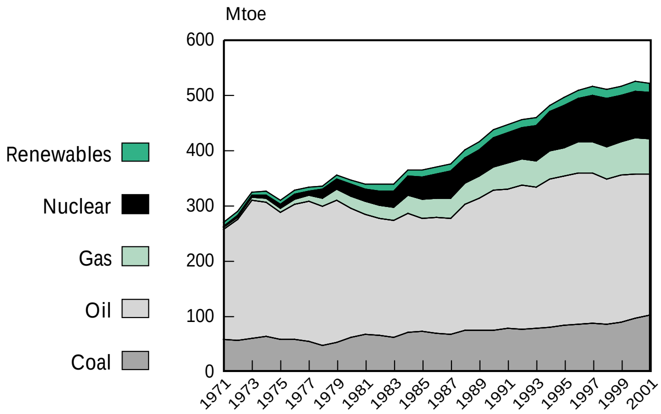
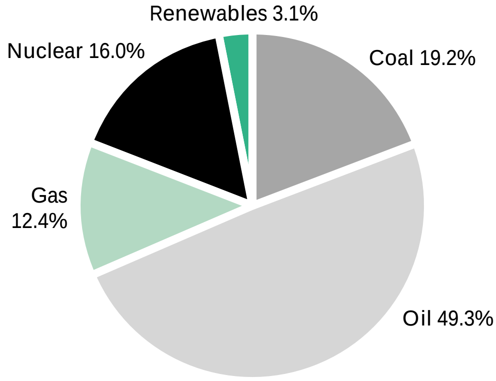


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1. See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1970	1980	1990	1995	2000	2001	Imports
Coal	61.6	59.6	74.0	82.6	95.7	100.2	98.2%
Oil	184.9	235.7	253.0	270.3	261.6	256.1	100%
Gas	3.0	21.4	43.3	52.0	65.9	64.8	95.7%
Nuclear	1.2	21.5	52.7	75.9	83.9	83.4	-
Renewables	6.5	8.4	13.6	14.6	16.8	16.0	-
Biomass	*0.0*	*0.0*	*4.4*	*4.5*	*5.5*	*4.9*	
Hydro	*6.5*	*7.6*	*7.7*	*7.1*	*7.5*	*7.2*	
Geothermal	*0.0*	*0.8*	*1.5*	*2.9*	*2.9*	*3.0*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.1*	*0.9*	*0.9*	
Total	**257.2**	**346.5**	**436.5**	**495.3**	**524.2**	**520.7**	**80.1%**
% Renewables	*2.5%*	*2.4%*	*3.1%*	*2.9%*	*3.2%*	*3.1%*	

** See Annex 2 for explanation of components in total and definition of biomass.*

In the 1990s, Japan's total primary energy supply (TPES) increased on average by 1.6% per year, from 436.5 Mtoe in 1990 to 520.7 Mtoe in 2001. Oil demand accounted for half of TPES in 2001, although its share has fallen from 68% in 1980 and 58% in 1990 (Table 1). Coal is an important fuel, mostly for power generation. Its share in TPES increased from 17% in 1990 to 19% in 2001. Natural gas demand rose by 3.7% per year from 1990 to 2001, and accounted for 12% of TPES in 2001. The share of nuclear power in TPES was 16% in 2001. Growth in renewable energy demand was strong in the 1990s, but renewable energy represented only 3.1% of total energy demand in 2001. The Japanese government has indicated that it aims to increase the share of renewable energy to 7% by 2010.

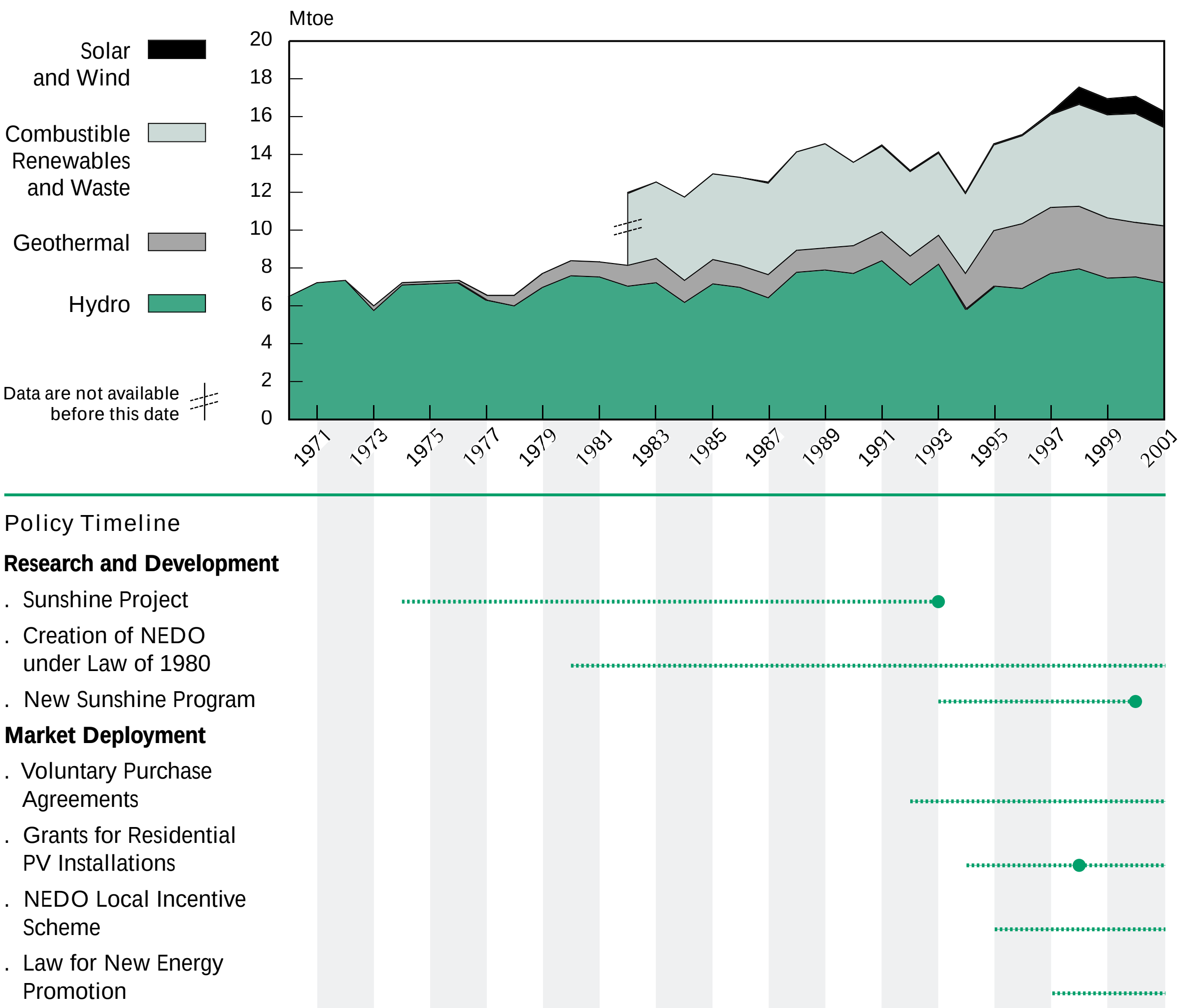
Renewable energy supply grew from 13.6 Mtoe in 1990 to 16 Mtoe in 2001, largely due to growth in the use of biomass and geothermal. In 2001, biomass represented 32% of total renewable energy use. Most of the current use of solid biomass is black liquor and woody waste in the pulp and paper industry. Hydropower represented the largest share of renewable energy with 45%. Geothermal resources accounted for 19%. Solar PV and wind power have expanded over the last decade, but still accounted for only 5% of total renewable energy supply in 2001.

During the 1980s, rising electricity demand was met through the development of nuclear power, which accounted for 31% of electricity generation in 2001. Coal and gas accounted for 23% and 25% respectively. Renewable energy accounted for about 10% of total electricity generation in 2001, of which hydropower was 8% and the rest was mostly solid biomass and municipal solid waste. Geothermal accounted for 0.3% of electricity generation in 2001.

Japan depends on imports to satisfy 80% of its energy demand, which makes security of supply an issue of critical importance. The main rationale for supporting renewable energy in Japan is to reduce energy import dependency. Yet, Japan has considerable geographical barriers to the uptake of renewable energy compared to other IEA countries. It is a small island nation with rugged terrain that limits access to some hydro, geothermal and wind energy sites. The regions with good access for these technologies tend to be already developed for residential or agricultural use. Japan has deep water off its coast making offshore wind development difficult and expensive. The stock of resources for biomass energy is limited and competes with other land uses. However, recent emphasis on the integration of environmental and energy objectives favours the expansion of renewable energy sources.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

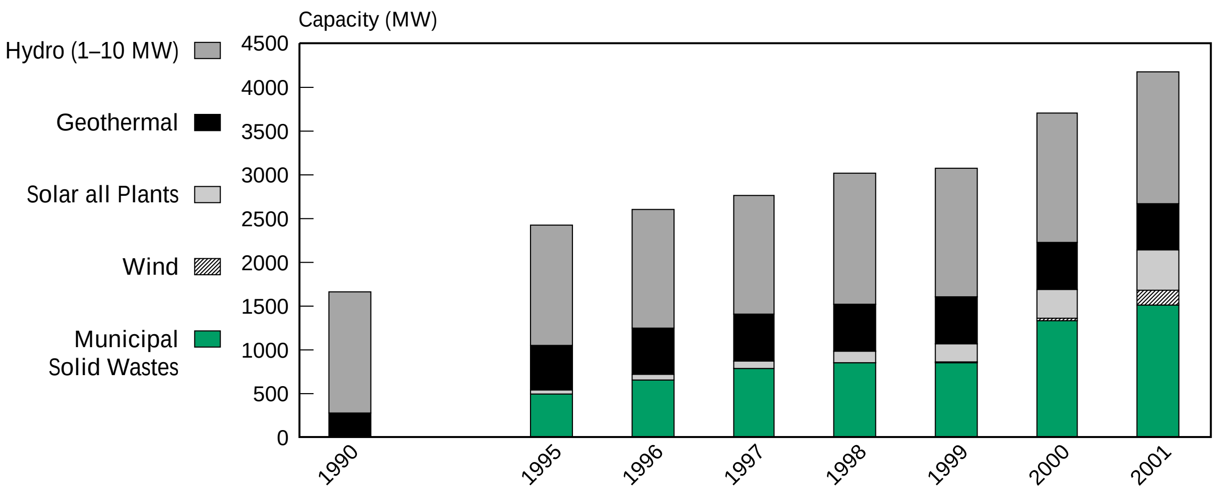
Hydropower and biomass account for the largest shares in renewable energy supply. In 2001, hydropower was 45% and biomass was 31% of the total renewable energy supply. Hydropower generation capacity was 21 GW (excluding pumped storage) and municipal solid waste was 1.5 GW. Production of biomass has not changed significantly over the past decade and was some 204 550 TJ in 2001. The pulp and paper industry accounts for three-quarters of solid biomass use, primarily black liquor (a by-product of the production process) and some woody waste. Biomass consumption declined in 2001 due to lower pulp and paper output, a result of a general economic decline.

Since the New Sunshine Program commenced in 1993, electricity generation from geothermal has increased considerably. Capacity increased from 270 MW in 1990 to 533 MW in 2001. Electricity generation from geothermal increased to 3 432 GWh in 2001, up from 1 741 GWh in 1990, an average annual growth of 6.4% per year.

Solar and wind power account for a very small percentage of renewable energy supply. In 1997, the Law for New Energy Promotion defined new renewable energy sources to include wind and solar photovoltaic (PV). The budget for PV increased from JP¥ 2 billion in 1997 to JP¥ 3.2 billion in 2001. The PV market experienced rapid growth increasing from an estimated 43 MW capacity in 1995 to 452 MW in 2001. Wind capacity also received substantial government support and capacity increased from 6 MW in 1999 to 175 MW in 2001.

Figure 4 shows the growth in generation capacity of renewable energy technologies over the last decade (excluding large hydropower). Municipal solid waste (MSW) capacity increased from 491 MW in 1995 to 1.5 GW in 2001. Average annual growth in MSW capacity was higher than growth in other fuels for electricity generation in the late 1990s. Electricity generation from geothermal showed strong growth in the mid-1990s, but has levelled off at about 3 400 GWh per year since 1998.

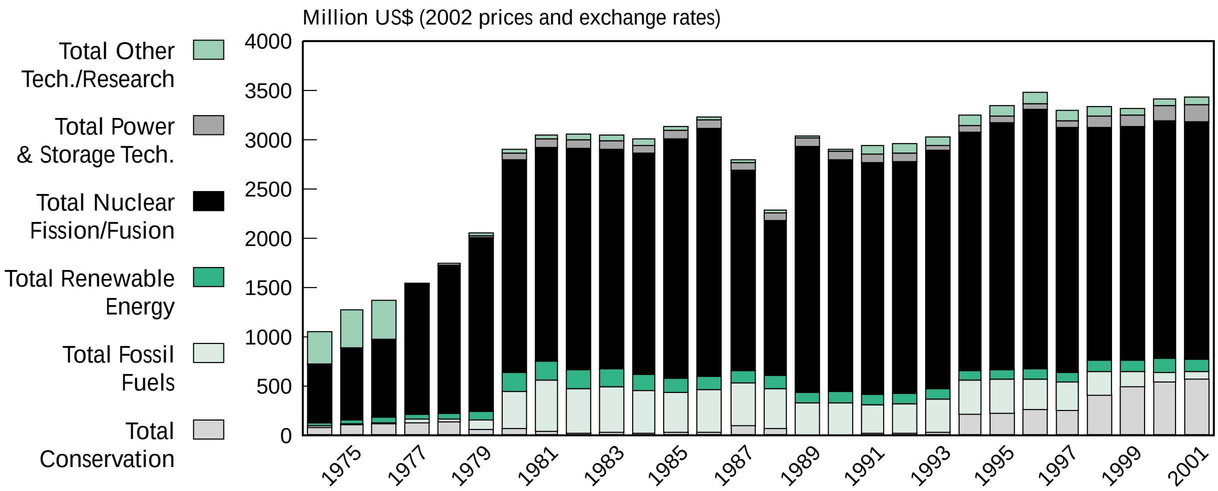
Figure 4. **Net Generating Capacity of Renewable and Waste Products**



Research and Development Trends

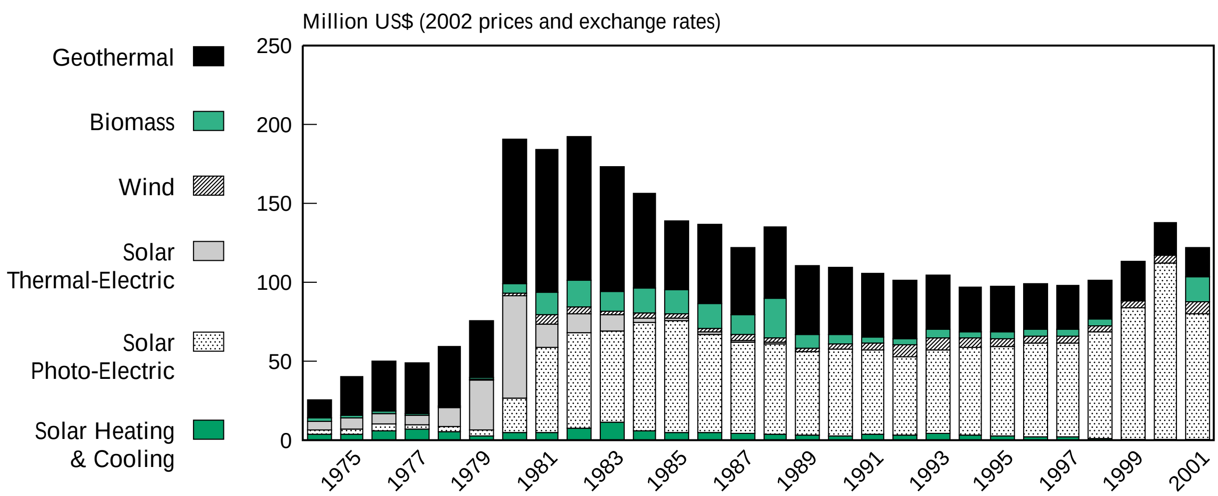
In 2001, Japan had the largest energy RD&D budget among IEA countries, US$ 3.4 billion (in 2002 prices and exchange rates). This represented about 40% of total IEA funding for energy RD&D. From 1974 to 2001, Japan spent more than US$ 77 billion on energy RD&D. Funding for renewables, however, has represented a small share over the past three decades (Figure 5). On average, from 1974 to 2001, RD&D spending for renewable energy technologies was 4.1% of total energy RD&D funding. The renewable share of the total energy RD&D budget peaked in 1982, but still only represented some 6%.

Figure 5. **Japan - Government Energy RD&D Budgets**



From 1974 to 2001, Japan allocated US$ 3.2 billion to renewable energy RD&D. On average over the period, PV received 43% of funding and geothermal benefited from 37% of the total RD&D expenditure. In 2001, Japan allocated US$ 128 million for renewable energy RD&D, of which 62% was for PV, 15% for geothermal and 12% for biomass technologies. The RD&D budget for biomass technologies averaged US$ 40 million through the 1990s.

Figure 6. **Japan - Government Renewable Energy RD&D Budgets**



Following the first price oil shock of 1973, the Ministry of International Trade and Industry, which is now the Ministry of Economy, Trade and Industry (METI), launched the Sunshine Project. It presented a long-term plan for RD&D of renewable energy technologies. Japan has focused primarily on public-private collaboration for RD&D, mostly for PV and wind power.

As a response to the second oil price shock, the Japanese government enacted the Law Concerning Promotion of Development and Introduction of Oil Alternative Energy in 1980. It boosted the funding for renewable energy technologies from US$ 81 million in 1979 to US$ 193 million in 1980. The law established the New Energy Development Organization (NEDO), which was renamed the New Energy and Industrial Technology Development Organization in 1988. NEDO has actively implemented various RD&D projects including PV and wind and has played an important role in reducing costs and improving the efficiency of renewable technologies. Funding for renewable energy RD&D increased dramatically in the 1980s, especially for geothermal and solar thermal.

Launched in 1993, the New Sunshine Program set out a comprehensive long-term RD&D plan for renewable energy. It aimed to develop PV technology that could produce electricity at a cost that was competitive with conventional sources by 2000. The New Sunshine Program expired in 2000. Moving away from the comprehensive approach, renewable energy RD&D is now more technology-specific with separate guidelines and goals for each technology.

Recent Support for Biomass Technologies

Eleven projects have been allocated funding by METI through NEDO, seven in 2001 and four in 2003. These projects focus on R&D for co-firing technology, small-scale distributed power generating systems, biomass gasification, and biodiesel fuel and fuel ethanol production from cellulosic biomass. NEDO contracts these projects to private entities. In fiscal year (FY) 2003, about US$ 26.5 million (JP¥ 2.82 billion) was allocated for these projects. Biomass for energy is generally used in small-scale operations, as Japan's mountainous terrain makes it difficult to collect large amounts of wood. Biomass for energy is promoted through technological development of small-size, high efficiency conversion applications.

Now biomass makes only a very minor contribution to total electricity generation in Japan, but its role is expected to expand in order to meet the government's renewable energy targets. Biomass-fired generation is included in the 2002 Special Measures Law concerning the Use of New Energy by Electricity Retailers (RPS Law), which obliges electricity suppliers to supply 1.35% of electricity from renewables. In addition to the RPS Law, support for biomass is provided for pilot generation plants, field tests for biomass co-generation systems, and the installation of biomass energy systems and full-scale facilities.

In 2002, the Biomass Nippon Strategy was initiated to promote the use of biomass. Concerned government authorities co-operate to take measures to prevent global warming, establish a recycling–oriented society, encourage new industries and stimulate the agriculture, forestry and fishery sectors.

The current RD&D budget structure is three-pronged: technical development; field tests; and promotion and implementation. For 2004 the requested budget for new energy sources (excluding hydrogen and fuel cells) was US$ 309 million (JP¥ 32.9 billion). This is proportioned at about 72% for R&D and 28% for field tests and demonstration projects. In addition, US$ 835 million (JP¥ 92.4 billion) has been requested to provide subsidies to companies and municipalities for the purchase of new energy systems.

Japan participates in international collaborative RD&D in Bioenergy, Geothermal, Hydropower, Ocean Energy Systems, Photovoltaic Power Systems, Solar Heating and Cooling and Wind Turbine Systems through the IEA Implementing Agreements.

Market Deployment Trends

Japan has employed the following market deployment strategies to promote renewable energy technologies over the past decade:

- Voluntary agreements between the public and private sectors.
- Capital grants to end-users and industry.
- Investment incentives for renewable energy installations.
- Portfolio standard.

The areas that have received support include solar photovoltaic, wind, geothermal, small hydropower and, since 2002, biomass.

The first deployment strategy was initiated in 1992, when electric utilities made voluntary purchase agreements with renewable energy generators. The primary method of implementation was through government “request” to energy suppliers to buy electricity generated from renewables. Utilities purchased the renewables generated electricity at the retail price to households. The contract period extends from fifteen to seventeen years, particularly for wind power generators. These voluntary purchase agreements made a large contribution to the penetration of solar and wind technologies in the 1990s.

In 1994, the government started a programme of capital grants to stimulate the domestic PV market. Grants were also available to consumers for the purchase of on-grid PV power systems. After a trial programme from 1994 to 1996, the grants started in 1997 and continue today. In 1995, NEDO started providing incentives for renewable energy projects based on plans made by local governments. The projects reflect local conditions and are typically aimed at the development of solar and wind energy. Funding for grants in 2002 was US$ 11.6 million (JP¥ 1.2 billion).

The Law Concerning Promotion of the Use of New Energy, enacted in 1997, classified PV, wind power and the thermal use of waste as new energies. New energy sources were defined as domestically produced and emitting little or no CO_2, but with higher costs than conventional energy sources. The law has played a major role in the introduction and dissemination of new energy technologies. In 2002, the law was amended to include biomass and the use of snow ice cryogenic energy. The new energy sources that are highlighted in this profile are solar PV, wind power, and electricity and heat production from biomass energy.

The Special Measures Law Concerning the Use of New Energy by Electricity Retailers (RPS Law) was passed in 2002. The law introduced a portfolio standard whereby electricity retailers are obliged to supply 1.35% of electricity by solar, wind, geothermal, biomass or small to medium sized hydropower. Electricity retailers must meet their annual obligation by generating renewable electricity, buying renewable electricity, or buying renewable certificates. The obligation amount will be set for each year until 2010. The portfolio standard represents an additional policy layer and does not supersede previous support for renewable energy sources. RD&D funding and market deployment incentives will continue. Because the RPS Law does not specify which renewable energy technology should be chosen to meet the obligation, it is expected to reduce costs by enhancing competition among renewable energy sources.

The Japanese government has set indicators for new energy sources. The target is to have 3% of total primary energy supply based on new energy sources by 2010. The specific renewable energy targets are 4 820 MW of PV, 4 390 000 kilolitres (kl) of solar thermal production, 3 000 MW of wind power, 4 170 MW of waste power generation, 140 000 kl of waste thermal production, 330 MW of solid biomass generation, 670 000 kl of biomass thermal production, 4 940 000 kl of black liquor and some woody waste.

Renewable Energy Markets

Hydropower

Figure 7. **Hydropower Capacity and Electricity Production**

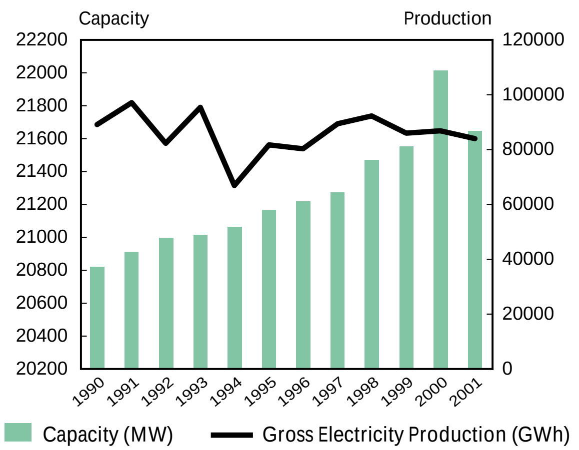
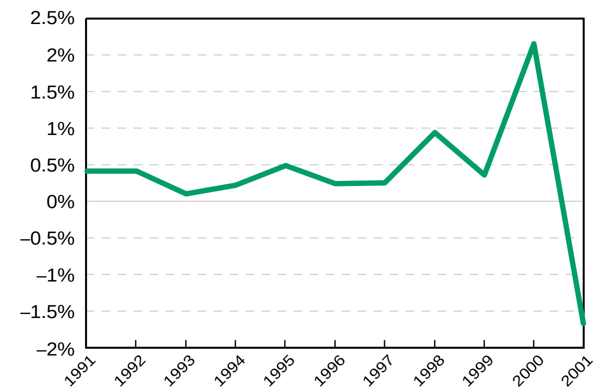
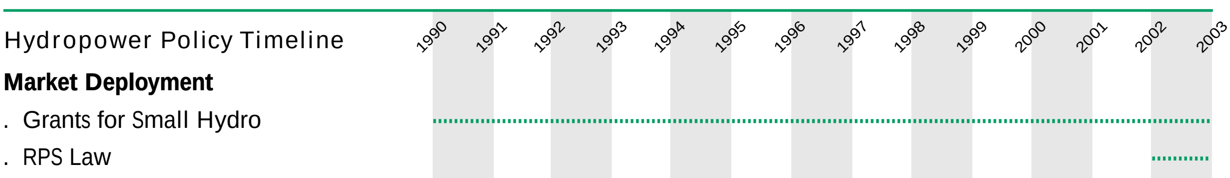


Figure 8. **Hydropower Capacity** (Year to Year Change)





Denotes a significant change to a policy, such as an extension, repeal or revision.

Hydropower capacity, excluding pumped storage, increased from 20.8 GW in 1990 to 22 GW in 2000, but declined to 21.7 GW in 2001. Generation was 84 TWh in 2001. The target for 2010 is to increase hydropower capacity by 3 GW. Japan considers hydropower to be an important energy source for power generation because it is indigenous, provides a stable supply of electricity at low cost and does not emit CO_2.

In Japan, most of the economically feasible sites for large-scale hydropower have already been developed. The strategy is to develop 19 030 MW of small-to-medium hydro, of which 990 MW is currently under construction. Development costs for these plants are expected to be higher than at existing sites, because the plants will be built in more remote, inland areas.

Since 1980, the government has offered capital grants to facilitate hydropower development. The incentives are based on size and location of the plant and are calculated as a percentage of total capital cost. For plants less than 5 MW, the subsidy is either 20% or 30%. For plants larger than 5 MW and smaller than 30 MW, the subsidy is either 10% or 20%. Advanced technologies are eligible for a subsidy of up to 50%. Refurbishment of hydro-turbines and generator capacity expansions of more than 20% are also subsidised according to plant size. In addition to these capital grants, the government conducts studies and surveys on the development of small-to-medium scale hydropower plants.

Hydropower plants under 1 MW are included in the Special Measures Law Concerning the Use of New Energy by Electricity Retailers (RPS Law) of 2002, which obliges electricity retailers to supply 1.35% of electricity from renewables.

Geothermal Electricity Production

Figure 9. **Geothermal Capacity and Electricity Production**

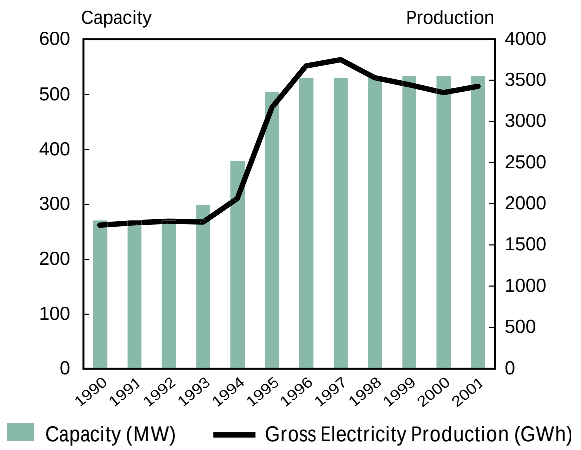
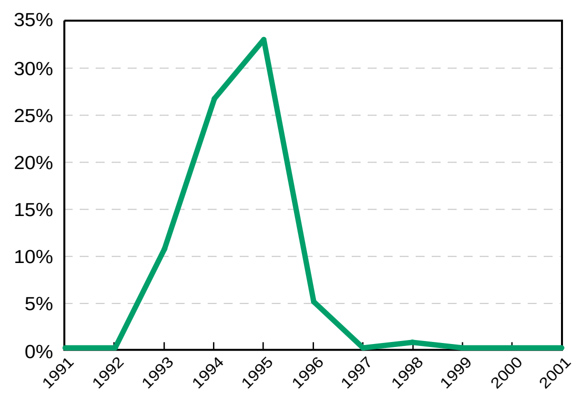
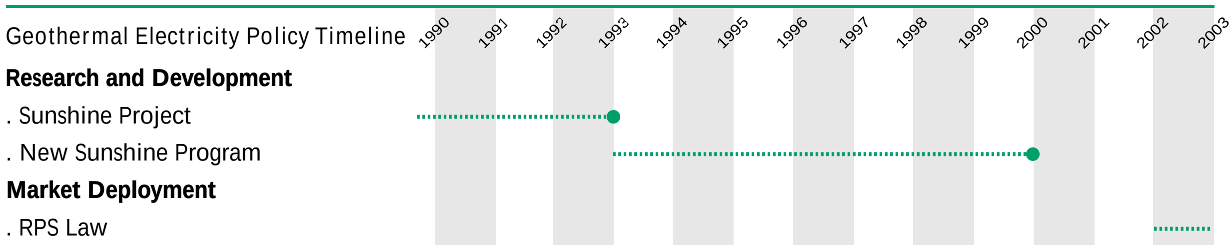


Figure 10. **Geothermal Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Geothermal capacity increased from 270 MW in 1990 to 533 MW in 2001, average annual growth of 6.4%. Capacity doubled from 1990 to 1996, but has remained at about 530 MW since 1998. Electricity generation grew by 6.4% per year, on average, from 1 741 GWh to 3 432 GWh in 2001. It accounted for 3.4% of total renewables generation in Japan in 2001, compared with 1.7% in 1990.

Japan has major geothermal resources. The first plant, 20 MW, was built in 1966 in Iwate in the north. The majority of geothermal plants are state-owned. The 1980 Law Concerning Promotion of Development and Introduction of Oil Alternative Energy covered geothermal technologies. The New Sunshine Program from 1993 to 2000 provided a major impetus to growth in geothermal energy. The programme supported technology innovation, particularly for exploration and development. MITI also funded surveys of geothermal resources and supported construction of geothermal generation plants, thus lowering the risk of development.

About 20 MW of additional capacity are targeted to be developed by 2010, mostly by utilities. Special types of geothermal plants are included in the 2002 Special Measures Law concerning the Use of New Energy by Electricity Retailers (RPS Law), which obliges electricity retailers to supply 1.35% of electricity from renewables.

Social acceptance is an important part of the development of geothermal power in Japan. The government has invested considerable efforts to increase awareness of the benefits of geothermal plants to local communities. Development of geothermal power must accommodate the fact that local communities want excess heat to be used for swimming pools and spas.

Direct use of geothermal heat does not qualify for policy support in Japan.

Wind Power

Figure 11. **Wind Power Capacity and Electricity Production**

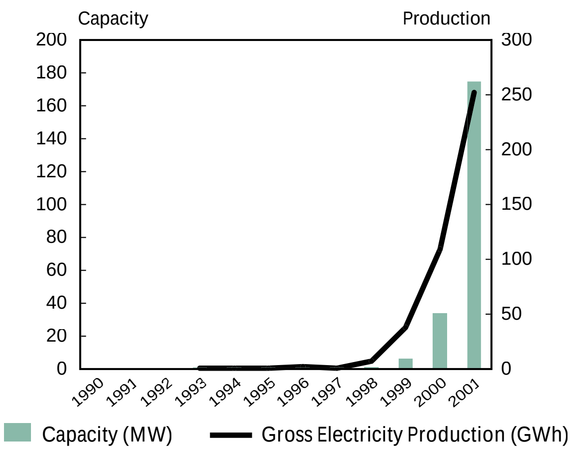
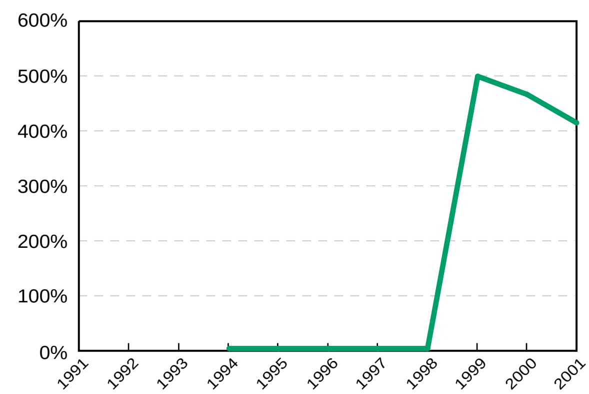
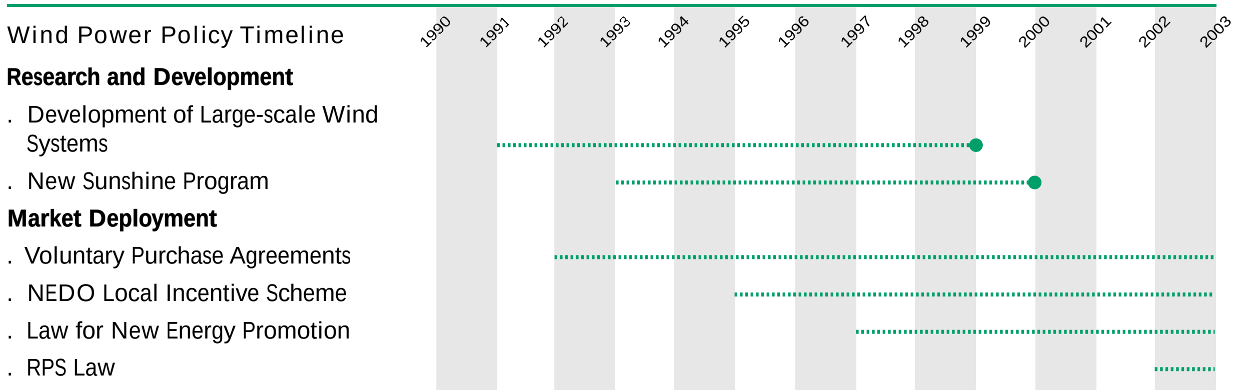


Figure 12. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Note: The data in the above figures are based on IEA statistics as of April 2004. Data are currently being revised due to recent submissions from the Japanese government. Therefore, some information in this profile may differ from Japanese statistics.

Wind power capacity increased from 6 MW in 1999 to 175 MW in 2001. Generation from wind power grew from 38 GWh in 1999 to 252 GWh in 2001. Wind power plays a minor role in renewables electricity generation. Most plants are concentrated on Hokkaido Island and Tohok in the north and on the southern tip of the country. Due to mountainous terrain, wind volatility can be quite high.

RD&D support for wind power commenced in the early 1990s with wind turbine system control technology development and a wind quality survey (*i.e.*, nationwide wind condition atlas). The development of large-scale wind systems began to receive support in 1991. The New Sunshine Program increased budgetary outlays for research and development and for surveys of wind potential. In 1999, funding was provided through the New Sunshine Program for technical development of electricity generation systems for remote islands.

In 1992, power companies started voluntary agreements with renewable energy generators using wind power and residential PV power systems. The primary method of implementation was through a government “request” to energy suppliers to buy electricity generated from renewables. Utilities purchased the renewables generated electricity at the retail price to households. The utilities fixed the contract period for fifteen to seventeen years, particularly for wind power generators.

Since 1995, NEDO has financed wind power field tests, and by 2001 wind power plants were built in thirty-one areas. The 1997 Law Concerning Promotion of the Use of New Energy defined wind power as a new energy source, making it eligible for incentives offered under the law. Since 1997, NEDO has provided subsidies to private sector firms for one-third of the cost of installing turbines, and to local governments for one-half of the cost. As a result of these subsidies, growth in the wind market has accelerated.

The Special Measures Law concerning the Use of New Energy by Electricity Retailers (RPS Law), enacted in 2002, obliges electricity retailers to supply 1.35% of electricity from renewables. With this additional layer of support for renewables, wind power capacity is expected to expand.

Some resistance to large-scale wind generation exists, due to perceived low power quality. The major concern has been intermittency. In 2003, the government allocated a special budget for wind. NEDO will use these funds for a demonstration project, which will focus on using Redox flow battery technology to decrease intermittency.

Solar Photovoltaic

Installed PV capacity in Japan accounted for nearly half of global PV capacity in 2001. Capacity increased from 19 MW in 1992 to 452 MW in 2001, an average annual growth of more than 40%. The PV market is dominated by on-grid residential use, which accounted for 86% of the market in 2002. Industrial and business use represented some 7%, and public use another 3%.

The rapid increase in capacity has been supported by Japan’s growing domestic PV industry. Japan is the largest manufacturer of PV cells in the world. In 2002, its manufacturing capacity for PV systems was about 250 MW. The prices of solar cells, PV modules and PV systems have been steadily decreasing due to considerable government support for research and development.

PV cell technology RD&D commenced under the Moonlight and Sunshine Projects in the 1970s and 1980s. The New Sunshine Program vastly increased funding for RD&D. In 2000, the New Sunshine Program ended, and the Ministry of International Trade and Industry (MITI) established the Program for Development and Dissemination of PV Systems. This programme aims to develop and deploy competitive PV technologies and to develop advanced PV cells and systems. RD&D has focused particularly on low-cost module production technology such as thin film technology, since crystalline PV cells are not expected to be able to compete with conventional technologies for electricity generation.

Figure 13. **Solar Photovoltaic Capacity**

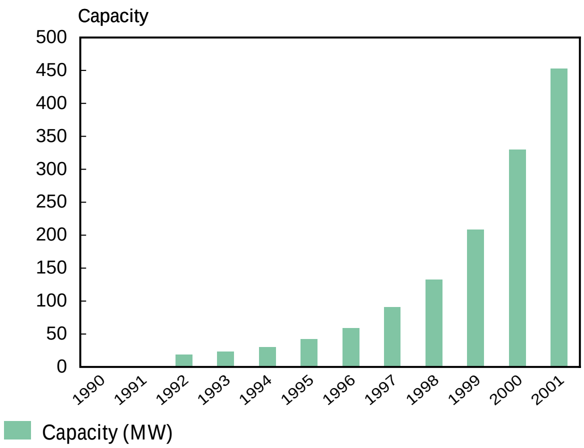
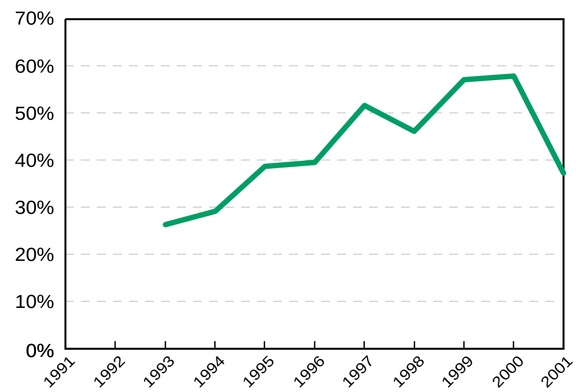
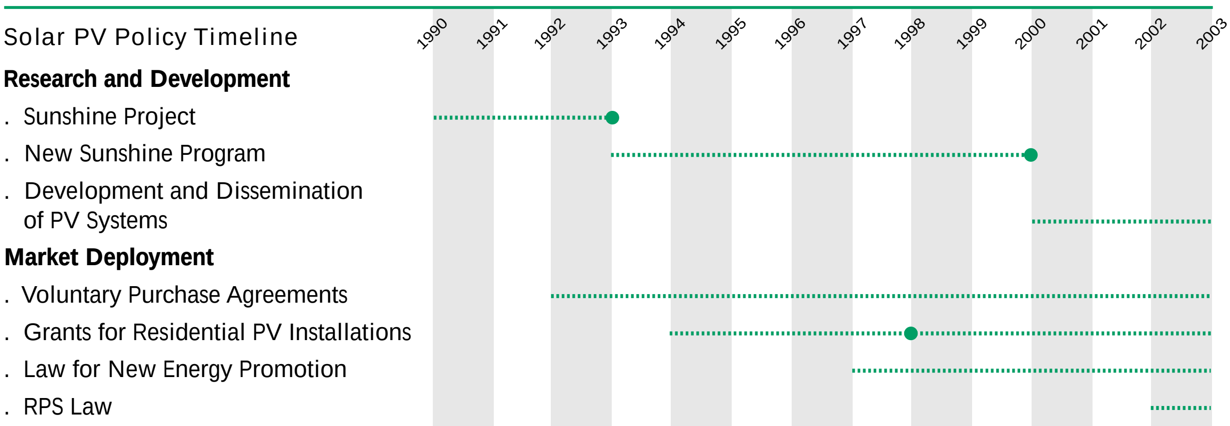


Figure 14. **Solar Photovoltaic Capacity**
(Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Note: The data in the above figures are based on IEA statistics as of April 2004. Data are currently being revised due to recent submissions from the Japanese government. Therefore, some information in this profile may differ from Japanese statistics.

The market for PV is expected to expand through the implementation of field tests for industrial and other applications using advanced PV technologies and through demonstration tests of grid-connected, clustered PV systems. In addition to RD&D funding, the PV market has been supported through net metering, capital grants and voluntary agreements with generators.

Government incentives for the purchase of household PV systems were offered on a trial basis from 1994 to 1996. Incentives were set at 50% of the installation cost during this period. The amount and scope of the incentives were expanded in 1997 and the subsidy was capped at JP¥ 340 000/kWh. The subsidy has declined since 1999 (Table 2). In 2002, the cost of electricity from a residential PV system was about JP¥ 49/kWh, compared to a daytime peak from conventional energy of about JP¥ 23/kWh.

Table 2. **Residential PV System Dissemination Project**

	1997	1998	1999	2000	2001	2002
Incentive	one-third of installation cost (Max. ¥ 340 000 per kW)	one-third of installation cost (Max. ¥ 340 000 per kW)	one-third of installation cost (Max. ¥ 340 000 per kW)	Max ¥ 270 000 per kW*	¥ 120 000 per kW	¥ 100 000 per kW
Cumulative installed capacity (MW)	32.8	56.9	114.6	189	280	421.4

** In 2000, the incentive was reduced to ¥180 000 per kW according to subscriber interest and the price of PV systems. It was reduced again to ¥ 150 000 per kW at the end of the year.*

Figure 15. **Evolution of the PV Incentive Scheme and Total Capacity**

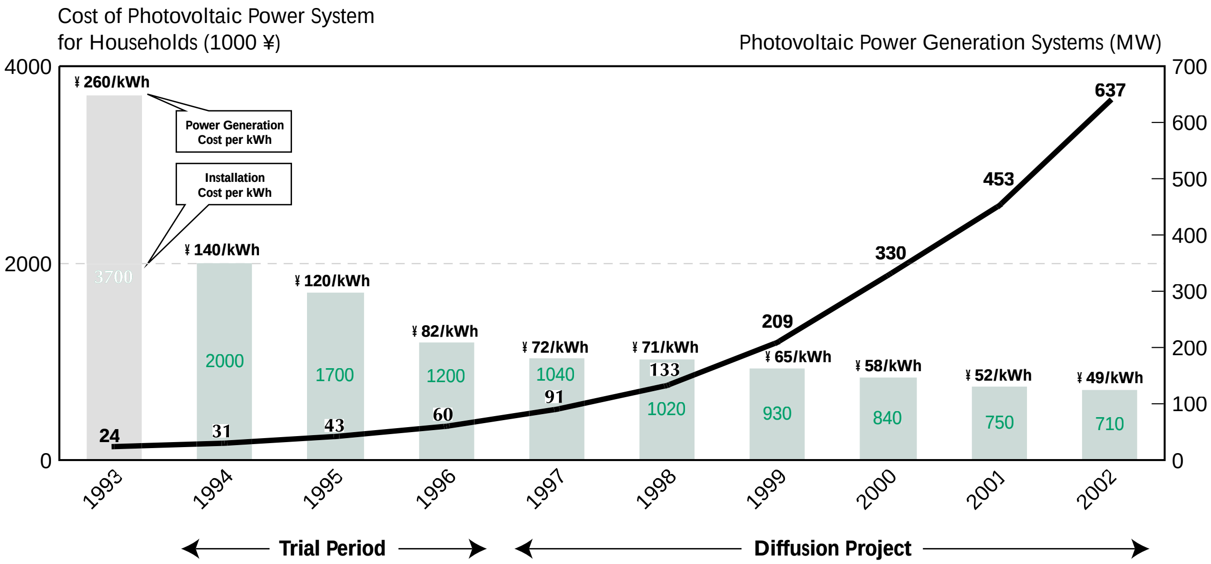


Figure 15 shows the decline in the cost of PV installations in Japan from JP¥ 3 700 000/kW in 1993 to JP¥ 710 000/kW in 2002. Generation costs have also declined considerably. The government has put in place an incentive system for private sector companies and local governments, in addition to the subsidy for residential use. For private sector companies, grants cover up to one-third of the installation cost, and 90% of the debt is guaranteed. For local governments, grants cover up to one half of the installation cost.

PV is included in the 2002 Special Measures Law concerning the Use of New Energy by Electricity Retailers (RPS Law) that obliges electricity retailers to supply 1.35% of electricity generated from renewables.

Japan Policy Chronology

Law and Establishment of NEDO

Year

1980 - Present

Policy Description

After the oil price crises in the 1970s, the Japanese government enacted the “Law Concerning Promotion of Development and Introduction of Oil Alternative Energy” in 1980 and implemented measures for development and introduction of alternatives to oil including renewable energy. In October 1980, the New Energy Development Organization (NEDO; from 1988, the New Energy and Industrial Technology Development Organization) was established under the Law. NEDO has actively implemented various RD&D projects for PV, wind and other renewable energy technologies and has played an important role in reducing costs and improving renewable technologies.

Policy Type

RD&D

RE Technology

All renewables

Joint Research Grant Program for FY 2003

Year

1989 - Present

Policy Description

NEDO has conducted the International Joint Research Grant Program since 1989. The programme contributes to the advancement of industrial technology at the international level. The goal is to create new key industrial technologies through funding to international research teams.

In 2003, grants were awarded for research on industrial technology in the areas of basic research and global environment:

Basic Research: basic research which will lead to the creation of new industries. For FY2003, eligible research fields are nanotechnology, materials and information technology. The amount of support is about JP¥ 24 million.

Global Environment: practical research on industrial technology concerning the production, generation and utilisation of oil-alternative energy, excluding electric power generation technologies, which contributes to conservation and improvement of the global environment. The amount of support is about JP¥ 30 million.

Eligible teams must consist of four or more researchers of at least two different nationalities. Research laboratories must be located in two or more countries and one of them must have its head office in Japan. Each team can receive a grant for a maximum of three years.

Policy Type

RD&D

RE Technology

All renewables

New Sunshine Program

Year 1993-2000

Policy Description

In 1974, the Ministry of International Trade an Industry (MITI), from 2001 the Ministry of Economy, Trade and Industry (METI), launched the "Sunshine Project," a long-term comprehensive plan for the research and development of new energy technologies. The "Moonlight Project" was established in 1978 to boost energy conservation efforts. An RD&D system focusing on global environment technologies was established in 1989.

In 1993, the "New Sunshine Program" integrated the three above-mentioned projects. This new programme aimed at sustainable growth and the resolution of energy and environmental problems.

The short-term target of the programme by 2000 (phase 1) was to develop PV technology that could produce electricity at a cost competitive with conventional electricity rates of JP¥ 20-30/kWh. Phase 1 RD&D was focused on:

- Solar cell (thin-film and super-high efficiency solar cell manufacturing technologies, solar cell evaluation systems, etc).
- PV power generation (system evaluation, BOS, demonstrative research).
- Development of low energy consumption manufacturing for SOG-Si.
- Technology for high-efficiency multi-crystalline silicon solar cells.

When RD&D Phase 1 came to a close in 2000, a continuation of RD&D funding from fiscal year (FY) 2001 through FY 2005 was approved.

NEDO is responsible for implementing renewable energy policy via the New Sunshine Program. The ultimate responsibility lies with the Ministry of International Trade and Industry (MITI). The New Energy Foundation (NEF) also assists in renewable policy implementation. The total RD&D budget for the New Sunshine Programme was about JP¥ 56 billion in 1996.

The government promotes the penetration and use of new energy technologies through the New Sunshine Program. However, renewables RD&D, which totalled JP¥ 13.2 billion in 1997, only accounts for 3% of total energy-related RD&D (the vast majority – over three-quarters – is funding for nuclear power research). Of government renewable RD&D funding, solar electricity research received the most support (an estimated JP¥ 8.2 billion in 1997), followed by geothermal energy. The solar energy programmes aim to reduce the production cost of PV to JP¥ 100-200/Wp by 2000, compared to JP¥ 600/Wp in 1992.

Policy Type RD&D

RE Technology Solar photovoltaic

Subsidy Programme for Residential PV Systems

Year 1994-2002

Policy Description The subsidy is offered to individuals and owners/developers of housing complexes. It covers part of the cost of PV modules, its peripheral equipment, distribution lines and installation work. The subsidy covered 50% of the cost from 1994 to 1996 and one third of the cost from 1997 to 1999.

In 2000 the subsidy rate was JP¥ 270 000/kW in the first half of the year, up to 10 kW and JP¥ 180 000/kW, up to 4kW in the second half of the year. It was further reduced to JP¥ 150 000/kW, (up to 4kW) before the end of the fiscal year.

In 2001 the subsidy was reduced to JP¥ 120 000/kW.

In 2002 the subsidy was further reduced to JP¥ 100 000/kW.

The subsidy is given to newly installed systems only, which meet technical specifications established by NEF.

Policy Type Consumer grants/rebates

RE Technology Solar photovoltaic

Wind Power Field Tests

Year 1995 - Present

Policy Description A wind power field test was conducted in 1995 in Japan. In 2001, wind power plants were built in 31 areas with differing local conditions. Operational data are being collected. Financed by NEDO, field tests are conducted with industry every year.

Policy Type RD&D

RE Technology Onshore wind
Offshore wind

The Law Concerning Promotion of the Use of New Energy

Year 1997 - Present

Policy Description This law defined the role of the government, municipalities and private sector in promoting the use of new energy. The law also specified the types of new energy such as PV and wind power. Use of biomass energy and snow ice cryogenic energy were added by amendment in 2002.

Policy Type Consumer grants/rebates

RE Technology Solar photovoltaic
Onshore wind
Offshore wind
Waste
Biomass

Solar thermal
Biofuel
Hydrogen

Promotion for Development and Dissemination of PV systems

Year 1997 - Present

Policy Description METI has operated a programme for the development and dissemination of PV systems for several years. The budget in FY1999 was JP¥ 28.49 billion; in FY2000 it was JP¥ 28.8 billion; FY2001 - JP¥ 32.20 billion; FY2002 - JP¥ 35.90 billion.

The programme has 3 objectives:

1) Technological development of PV:

- technological development for accelerating the dissemination of PV systems, the 2003 budget was JP¥ 1.07 billion.
- PV system technologies for mass deployment – reliability, cell and system evaluation, recycle and reuse process, etc: FY2003 budget was JP¥ 1.26 billion.
- R&D for power generation technology: introduced in FY2001 with a budget of JP¥ 5.05 billion; in FY2002 the budget was JP¥ 7.30 billion, in FY2003 the budget was JP¥ 5.09 billion.

2) Demonstrative Research

- International Joint Demonstrative Research of PV systems. The budget in FY2000 was JP¥ 0.28 billion; in FY2001 it was JP¥ 0.28 billion; in FY2002 the budget was JP¥ 0.80 billion and in FY2003 it was JP¥ 1.90 billion.
- PV Field Test Program for Industrial and Other Applications. The budgets were: FY1999 - JP¥ 2.41 billion; FY2000 - JP¥ 4.00 billion; FY2001 - JP¥ 1.99 billion; FY2002 - JP¥ 4.50 billion.
- PV Field Test Project on Advanced Photovoltaic Power Generation Technologies: introduced in FY2003 with a budget of JP¥ 3.50 billion.
- Demonstrative research on Clustered PV systems: FY2003 budget was JP¥ 2.37 billion.

3) Introduction and Promotion

- Introduction and promotion of PV systems for residences
- Support for introduction of PV systems by innovative enterprises and local government, to encourage others to follow the example.
- Support for NGO's activities to promote grassroots introduction of PV systems.

Policy Type RD&D

RE Technology Solar photovoltaic

Awards Provided by the Ministry of Environment for Initiatives

Year 1998 - Present

Policy Description Since 1998, the Japanese Minister of Environment has, awarded initiatives every year to each sector. These awards have greatly contributed to the reduction of greenhouse gas (GHG) emissions by enhancing public awareness or introducing renewable energy technologies.

Policy Type Public awareness

RE Technology All renewables

Open Sea Tests of Offshore Wave Power Device

Year 1998-2002

Policy Description In 1987, research started on an offshore floating wave power device called "Mighty Whale" at the Japan Marine Science and Technology Center (JAMSTEC). The "Mighty Whale" converted wave energy into electrical energy. It was equipped with a wave height dissipation function to produce a relatively calm sea at the site. The prototype for open sea tests was built and moored on the test site at the end of July 1998. The maximum total declared generated power is 110 kW. This open sea test ended on March 2002. The "Mighty Whale" was removed from this test site in 2002.

Policy Type RD&D

RE Technology Ocean energy

Project for Developing Small and Medium-sized Hydroelectric Power Plants

Year 1999 - Present

Policy Description This project promotes the development of hydropower plants. The initial investment development costs are high, which results in relatively higher unit generation costs when compared to other power sources. NEDO subsidises the construction of small and medium-sized hydropower plants by public electric power operators.

Policy Type Capital grants

RE Technology Hydro

Project for Geothermal Power Generation Development

Year 1999 - Present

Policy Description This project promotes the development of geothermal power generation, which requires large capital investments and a long lead time from the start of development to the operational stage. NEDO subsidises activities for developing geothermal power generation by electric power operators, developers, industry bureaus, or entities who install in-house power generating plants.

Policy Type Capital grants

RE Technology Geothermal

Energy Efficient Photovoltaic

Year 1999 - Present

Policy Description Multi-crystalline photovoltaic currently have a conversion efficiency of 13%. Japan is working to improve the equivalent level of conversion efficiency of multi-crystalline PV on thin-film and on CIS phosgene (which is low cost but has a low efficiency).

Policy Type RD&D

RE Technology Solar photovoltaic

Subsidies for Environmentally-Friendly Community Energy Projects

Year 2000 - Present

Policy Description In 2000, the Japanese government provided incentives for environment-friendly community energy projects such as regional heat supply systems and waste power generation plants. The purpose of this policy is to make the best possible use of waste heat or surplus electricity production. Funding for this programme is JP¥ 1 751 million.

Policy Type Consumer grants

RE Technology Waste

Renewable Energy Sources for Signs/Markings in Seaways

Year 2000 - Present

Policy Description In 2000, a voluntary agreement was established to change the energy source of signs and markings in seaways (*e.g.*, buoys and lighthouses) from conventional energy sources to renewables such as solar or ocean/tide energy.

Policy Type Voluntary programmes

RE Technology Solar photovoltaic
Ocean energy

Comprehensive Review of Japanese Energy Policy

Year 2001 - Present

Policy Description In 2001, the Japanese government revised its long-term energy policy to meet its commitments under the Kyoto Protocol. The revised outlook emphasises the following areas:

- Further promotion of energy efficiency and conservation policies.
- Additional introduction of renewable energy.
- Fuel switching.

Policy Type Obligations

RE Technology All renewables

Subsidy for RD&D

Year 2001 - Present

Policy Description In 2001, METI provided subsidies for RD&D projects that contribute to energy saving or the deployment of renewables. Examples of projects and funding include RD&D on:

- The polymer electrolyte fuel cells, with funding of JP¥ 3.1 billion in 2001.
- The efficient conversion of biomass energy, with funding of JP¥ 2.0 billion in 2001.
- The practical use of space for photovoltaics with funding of JP¥ 0.5 billion in 2001.

Policy Type RD&D

RE Technology Hydrogen
Biomass
Solar photovoltaic

Introduction of Solar Power in Government Office Buildings

Year 2001 - Present

Policy Description The Japanese government is taking steps to introduce solar power into its government office buildings to ensure energy security and to promote renewables. In this initiative, the Japanese government introduced 410 kW capacity of solar power in thirteen eligible offices. The amount of electricity production is expected to be 0.43 million kWh and it will provide 0.15% of electricity consumed in these buildings. This programme is also encouraging other institutions to introduce solar power.

Policy Type Government purchases

RE Technology

Solar photovoltaic
Solar thermal

Special Measures Law Concerning the Use of New Energy by Electricity Retailers

Year

2002 - Present

Policy Description

The Special Measures Law Concerning the Use of New Energy by Electricity Retailers, passed in 2002, obliges electricity retailers to supply a certain percentage of renewable energy (Renewable Portfolio Standard). The targets will be set annually from 2004 to 2010 to attain 12.2 billion kWh of electricity generation produced by renewable energy by 2010. Qualifying renewables are wind, solar, biomass, small and medium sized hydropower and geothermal energy. A certificate system was introduced under this law.

Policy Type

Obligations / Tradable certificates

RE Technology

Offshore wind
Onshore wind
Solar photovoltaic
Solar thermal
Concentrating solar
Biomass
Hydro
Geothermal

New Energy Indicator

Year

2002 - 2010

Policy Description

In the New Energy Indicator, the government set the target of about 3% (or 19.1 million kl oil equivalent) of new energy forms in total primary energy supply in fiscal year 2010 (excluding hydroelectric and geothermal energy). In 2000 the corresponding figure was approximately 1.2%.

The 2010 targets for each type of new energy resources are:

- PV: 4820 MW (from 452 MW in 2001).
- Solar thermal use: 4 390 000 kl (from 820 000 kl in 2001).
- Wind: 3000 MW (from 312 MW in 2001).
- Waste power generation: 4 170 MW (from 1 108 MW in 2001).
- Waste thermal use: 140 000 kl (from 45 000 kl in 2001).
- Biomass generation: 330 MW (from 71 MW in 2001).
- Biomass thermal use: 670 000 kl.
- Others (black liquor, waste wood, etc) 4 940 000 kl (from 4 460 000 kl).

Policy Type

Obligations

RE Technology

Solar photovoltaic
Onshore wind
Offshore wind
Waste
Biomass
Solar thermal

Promotion for the Local Introduction of New Energy

Year

2002 - Present

Policy Description

To promote new energy sources, NEDO subsidises renewable energy projects at the local level. Public entities, private sector companies and NGOs are eligible for a subsidy to promote PV, biomass, waste and wind power generation, fuel cells, solar thermal, natural gas co-generation, waste thermal, waste fuel production, biomass thermal use, clean energy vehicles, water-source heat pumps and energy conservation measures

The subsidy rate is up to 50% of the cost for installation, deployment, public awareness and related activities.

The budgetary allocation for five projects in FY2002 was:

- Project for Promoting the Local Introduction of New Energy: JP¥ 12.62 billion.
- Project for Supporting Regional Activities for Prevention of Global Warming: JP¥ 536 million.
- Project for Promotion of Non-Profit Activities on New Energy and Energy Conservation: JP¥ 2.3 billion.
- Project for Establishing New Energy Visions at the Local Level: JP¥ 1.16 billion.
- Advisory Project for Introducing Leading-edge New Energy Technologies: JP¥ 380 million.

Policy Type

RD&D / Consumer grants/rebates / Capital grants

RE Technology

Solar photovoltaic
Onshore wind
Offshore wind
Hydrogen
Solar thermal
Waste
Biomass

Project for Supporting New Energy Operators

Year

2003 - Present

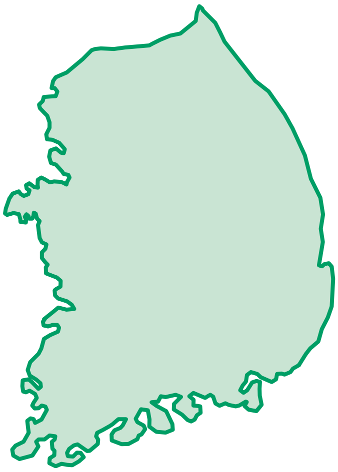
Policy Description

METI implemented an incentive programme for private sector firms that invest in advanced new energy technologies and facilities, such as PV systems, wind power, solar heat, differential temperature energy, natural gas co-generation, fuel cells, waste generation, use of waste heat, and production of waste fuel.

The incentive rate is up to 1/3 of the installation cost. 90 % of the debt is guaranteed.

Policy Type	Capital grants
RE Technology	Solar photovoltaic Onshore wind Offshore wind Hydrogen Biomass Solar thermal Waste

The Republic of Korea



Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

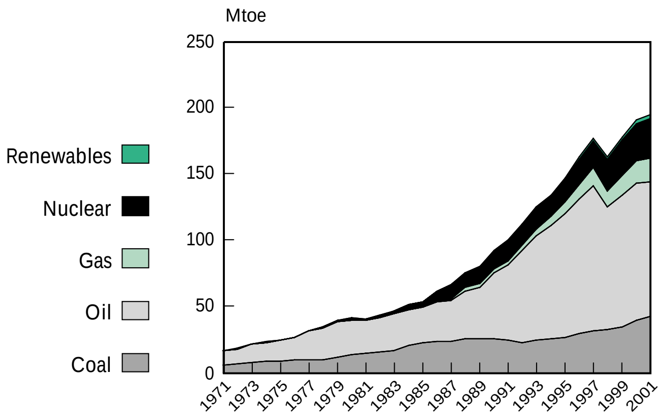
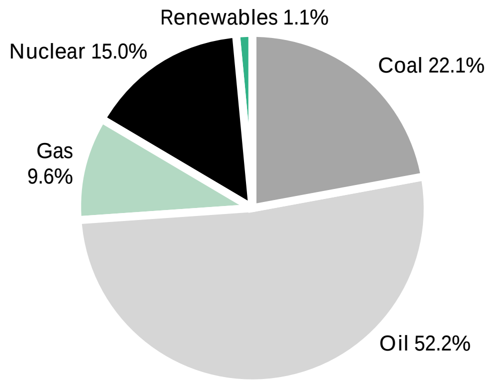


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1.
See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	**1971**	**1980**	**1990**	**1995**	**2000**	**2001**	**Imports**
Coal	6.3	13.5	25.5	26.5	39.4	43.0	91.0%
Oil	10.6	26.8	50.0	94.5	103.8	101.1	100.0%
Gas	0.0	0.0	2.7	8.3	17.0	18.7	100.0%
Nuclear	0.0	0.9	13.8	17.5	28.4	29.2	-
Renewables	0.1	0.2	0.5	0.9	2.1	2.2	-
Biomass	*0.0*	*0.0*	*0.0*	*0.7*	*1.7*	*1.8*	
Hydro	*0.1*	*0.2*	*0.5*	*0.2*	*0.3*	*0.4*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Total	**17.0**	**41.4**	**92.6**	**147.9**	**191.2**	**194.8**	**84.4%**
% Renewables	*0.7%*	*0.4%*	*0.6%*	*0.6%*	*1.1%*	*1.1%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*

Total primary energy supply (TPES) in Korea increased from 17 Mtoe in 1971 to 195 Mtoe in 2001, an average annual growth of 7%. Over the period, energy supply outpaced GDP growth of 5.9% per year. TPES fell in 1998 in response to the 1997 Asian financial crisis. Energy demand rebounded in 1999, but has since grown more slowly. In 2001, oil, all of which is imported, constituted more than 50% of TPES. Oil was the dominate energy source in all sectors except for residential, which was dominated by liquefied natural gas (LNG). In 2001, the remaining mix of TPES was coal (22%), liquefied natural gas (10%) and nuclear (15%).

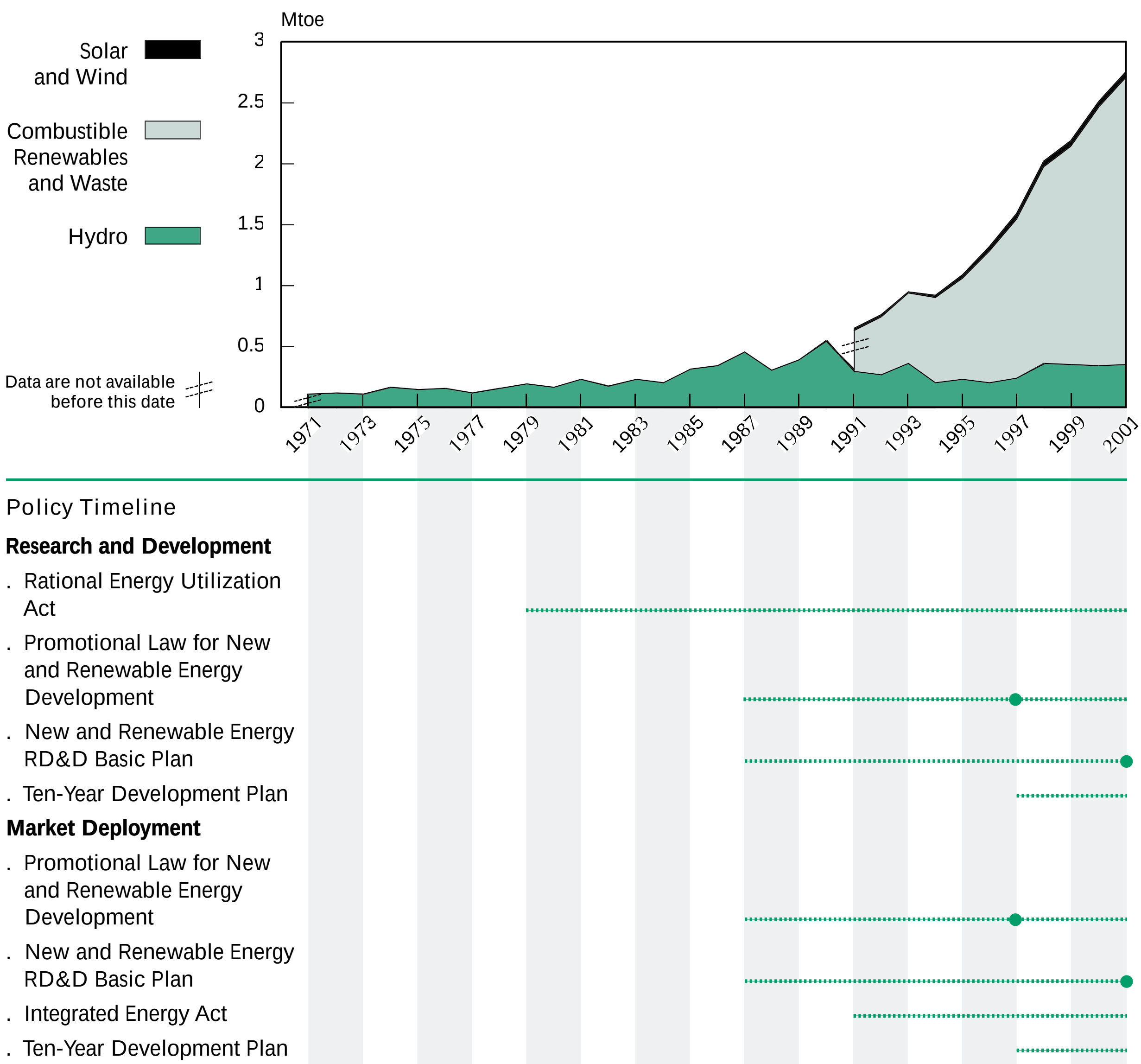
Renewables in total energy supply grew on average by 13.3% per year from 1990 to 2001, driven by a strong increase in biomass use. The share of renewable energy increased from 0.6% in 1990 to 1.1% in 2001. Biomass contributed 82% of total renewable energy supply in 2001, while hydropower accounted for 6%. In 2002, renewables supply was 2.9 Mtoe, accounting for 1.4% of TPES, according to data from the Korean Energy Economics Institute.

Total electricity generation grew much more quickly in Korea than the IEA average, in line with the country's higher economic growth, at an average of 9.3% per year between 1990 and 2001. The electricity generation mix was nuclear power at 41%, coal (37%), gas (11%), oil (10%) and hydropower (2%). As a consequence of a strong increase in fossil fuel-based electricity production in the 1990s, the share of renewables in total electricity generation decreased from 6% in 1990 to 1.6% in 2001.

The absence of significant domestic energy sources linked with rapid economic growth has rendered Korea especially vulnerable to fluctuations in energy import supply and prices. Following the oil price crises in the 1970s, energy policy has focussed on energy security, efficiency and conservation.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Figure 3 shows that biomass, waste and hydropower account for the largest shares in renewable energy supply in Korea.

Data for renewables from the Korean Energy Economics Institute is shown in Table 2. Combustible renewables and waste (CRW) represented almost 98% of total renewable energy supply in 2002. CRW has grown significantly since 1987 with the majority of the increase attributable to the 1987 Promotional Law of New and Renewable Energy Development. This Law promoted the installation of waste incineration facilities that generate heat and power in an effort to manage waste.

Table 2. **Supply of New and Renewable Energy in Korea** *(toe)*

	Solar Thermal	Solar PV	CRW*	Small Hydro	Wind Power	Geo-thermal	Total
1987	6 232	425	100 992	12 189	18	-	119 856
1988	7 275	568	142 345	16 933	18	-	167 139
1989	8 506	716	186 920	18 290	18	-	214 450
1990	9 940	887	306 544	18 540	25	-	335 936
1991	11 365	1 310	381 288	18 635	32	-	412 630
1992	12 614	1 766	518 456	19 465	123	-	552 424
1993	14 141	2 016	604 380	28 785	313	-	649 635
1994	16 839	2 153	736 071	22 538	303	-	777 904
1995	22 083	2 245	863 670	20 435	108	-	908 541
1996	32 016	2 560	1 106 861	20 349	87	-	1 161 873
1997	45 543	3 078	1 350 039	22 451	202	-	1 421 313
1998	43 957	3 747	1 640 372	27 228	369	-	1 715 673
1999	42 105	4 486	1 825 459	27 123	1 460	-	1 900 633
2000	41 689	5 051	2 059 666	20 456	4 171	-	2 131 033
2001	37 174	5 911	2 390 458	20 933	3 148	-	2 457 624
2002	34 777	6 735	2 849 305	27 645	3 720	122	2 922 304

Source: Korea Energy Economics Institute, 2004

** Korea is beginning to separate data for non-renewable and renewable waste in its statistics. At the time of publication, this information was not available, thus CRW includes non-renewable waste.*

Electricity generation from renewables was entirely from large hydropower in 1990. The composition of renewables in electricity generation changed in the latter half of the 1990s to include wind, solar PV and CRW. Hydropower continues to dominate the renewables share in electricity generation, but government incentives for wind and solar PV have increased their contribution to electricity generation in the past few years.

Research and Development Trends

The government has provided both financial and administrative support to research institutes and universities for renewable energy RD&D. Early programmes focussed on general RD&D efforts. More recent programmes have narrowed the RD&D focus to specific technologies, including market deployment strategies.

The Republic of Korea's first concerted attempt to reduce dependence on imported fossil fuels was the Promotional Law of New and Renewable Energy Development (1987) introduced by the Ministry of Commerce, Industry and Energy (MOCIE). It provided the initial framework for the development, through RD&D funding, of new and renewable energy technologies in Korea. The law encouraged the installation of waste-incineration facilities to generate heat and power, residential solar water heaters, small hydroelectric plants and facilities to use methane gas extracted from agricultural and livestock manure. A plan developed in the framework of the law established a target for new and renewable energy to contribute 3% to TPES by 2006. The target is to be achieved through government funded RD&D activities and demonstration and dissemination projects.

Between 1988 and 1998, KRW 255 billion was invested in RD&D and dissemination of new and renewable energy technologies under the 1987 New and Renewable Energy Act. Investments were made in 367 projects in eleven research areas, including PV, fuel cells, wind power, bioenergy and waste energy. As a result, the supply of new and renewable energy increased on average by about 15% per year over the period, according to the *Yearbook of New and Renewable Energy* in Korea. The majority of this growth was in the capture of waste heat produced from municipal and industrial waste. Energy production from municipal and industrial waste accounts for slightly more than 92% of total renewable energy. RD&D efforts continued to be promoted through the establishment of the New and Renewable Energy Development Centre (NREDC) in 1989 (renamed the R&D Supporting Centre for Energy Resources in 1992).

The financial crises of 1997 and 1998, combined with the devaluation of Korea's currency, led to a doubling of energy prices and exacerbated the country's dependence on imported energy sources. In order to develop domestic energy sources, the Korean government renewed its efforts in research and development and in dissemination activities for renewable energy technologies. A renewed framework gave rise to the New and Renewable Energy RD&D Basic Plan in 2001. Wind, PV power and fuel cells were selected as top-priority technologies for RD&D support. Other technologies targeted include solar thermal, waste and biomass. The Korean government projected to invest approximately US$ 800 million to help deploy renewable technologies. Preferential tax treatments were offered to encourage RD&D activities for specific technologies.

From 1988 to 2002, the Korean government invested KRW 248 billion in RD&D of new and renewable energy technology. In addition to government supported RD&D activities, Korea participates in international collaborative RD&D through the District Heating and Cooling and Photovoltaic Power Systems IEA Implementing Agreements.

Market Deployment Trends

Korea supports the deployment of renewable energy through demonstration projects, production and tax incentives, long-term low interest loans and public awareness campaigns. The 1987 Act defined technology and market priorities which provided the basis for market deployment activities in new and revised energy plans. The eleven technologies defined in the Act were narrowed down to three technologies: wind; solar PV; and fuel cells. The revised energy plan also introduced market deployment strategies.

Korea has developed two renewable energy development programmes: the New and Renewable Energy Development and Promotion Act of 1987, largely concentrating on RD&D activities and the 2001 New and Renewable Energy RD&D Basic Plan. The plan provides financial support for the dissemination of renewable energy technologies via the following mechanisms:

- Provides low-interest rate loans for companies that install renewable energy technologies.
- Requires utilities (only KEPCO) to purchase electricity from renewable energy sources at feed-in tariffs (per kWh): KRW 716.4 for PV, KRW 107.7 for wind, KRW 73.7 for small hydropower and KRW 61.8 for landfill gas electricity.
- Requires public institutions to buy renewable energy equipment with the aim of meeting 2% of energy demand in public institutions from renewable energy.
- Reduces local taxes imposed on new and renewable energy facilities.
- Plans to establish a net metering programme in which surplus renewable energy generated electricity will be sold to KEPCO at rates considered sufficiently high to make renewable energy projects viable.

The Ten-Year New and Renewable Energy Technology Development Plan (1997-2006) was revised as the Mid- and Long-Term Goal of New and Renewable Energy Supply with Detailed Action Plan (2003-2012). Its aim was the same as the plan in the 1987 Act, *i.e.*, to develop and deploy eleven new and renewable technologies with the overall target of supplying 2% of total energy consumption from solar, wind and biomass energy by 2006. It is to be achieved primarily through demonstration, evaluation, certification and dissemination programmes. Approximately KRW 77 billion of incentives and KRW 306 billion of low interest loans were invested in the application and dissemination of renewable energy technologies through the Ten-Year New and Renewable Energy Technology Development Plan.

Revisions of the Ten-Year Energy Development Plan came in response to the World Summit on Sustainable Development in 2002. The Mid- and Long-Term Goal of New and Renewable Energy Supply with Detailed Action Plan is scheduled for implementation in 2004 and has a budget of KRW 9.1 trillion (US$ 7.6 billion). The funding will be allocated between 2004 and 2011 in order to attain a revised target of 3% of renewable energy in total energy supply by 2006 and 5% by 2011. The primary means of support will be through financial and tax incentives such as low interest rate loans, investment tax credits of 10% and priority in receiving tax credits, as well as specified fixed prices for the mandatory purchase of electricity generated by renewable energy sources. To facilitate market deployment, renewable energy based business centres have been launched for wind power, PV and fuel cells with hydrogen. Other promotional measures such as green pricing programmes and funded RD&D activities to promote private sector involvement and funding are under review.

Public Awareness

Public awareness and acceptance of green pricing was deemed neither negative nor positive in a 2002 survey of utilities, large consumers and renewable energy industry. Given the early stages of renewable energy development in Korea, the government has been active in promoting renewable energy development and dissemination. In conjunction with efforts to improve waste management, the Korean government launched a public awareness campaign on the benefits of waste incinerators.

Intermittency

Intermittency of power generation for certain renewables such as wind and PV is a potential liability for closed small-scale grid systems. Several years ago, Korea experienced a problem with intermittency when a 600 kW wind turbine was installed to meet a significant portion of power demand on Ulneung-do, a remote island with about 3 000 households. The Korean government has worked to avoid the problem by limiting wind energy-based power supply to maximum allowance share, *i.e.*, 10%, though the share is not stipulated by law.

Distributed Generation

A research project conducted by Korea Electrotechnology Research Institute (KERI) is addressing the issue of grid connection for renewables. In a recent public hearing, relevant standards and codes related to grid connection were discussed. However, it is still not clear who will pay the costs incurred from connecting renewable power generation facilities to the national grid system.

Renewable Energy Markets

Hydropower

Figure 4. **Hydropower Capacity and Electricity Production**

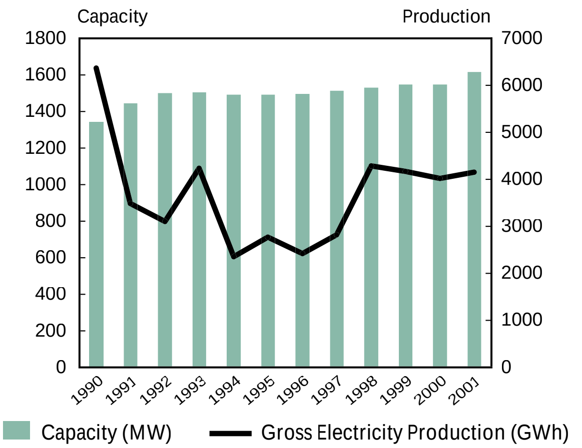
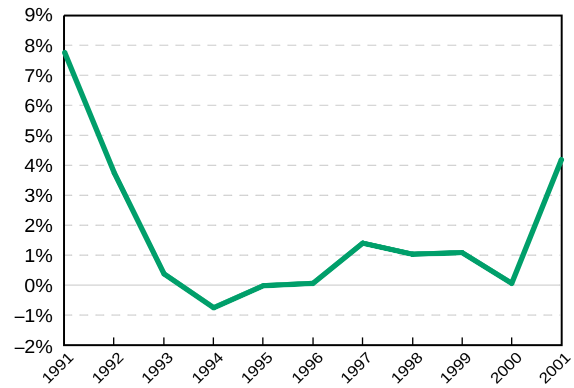
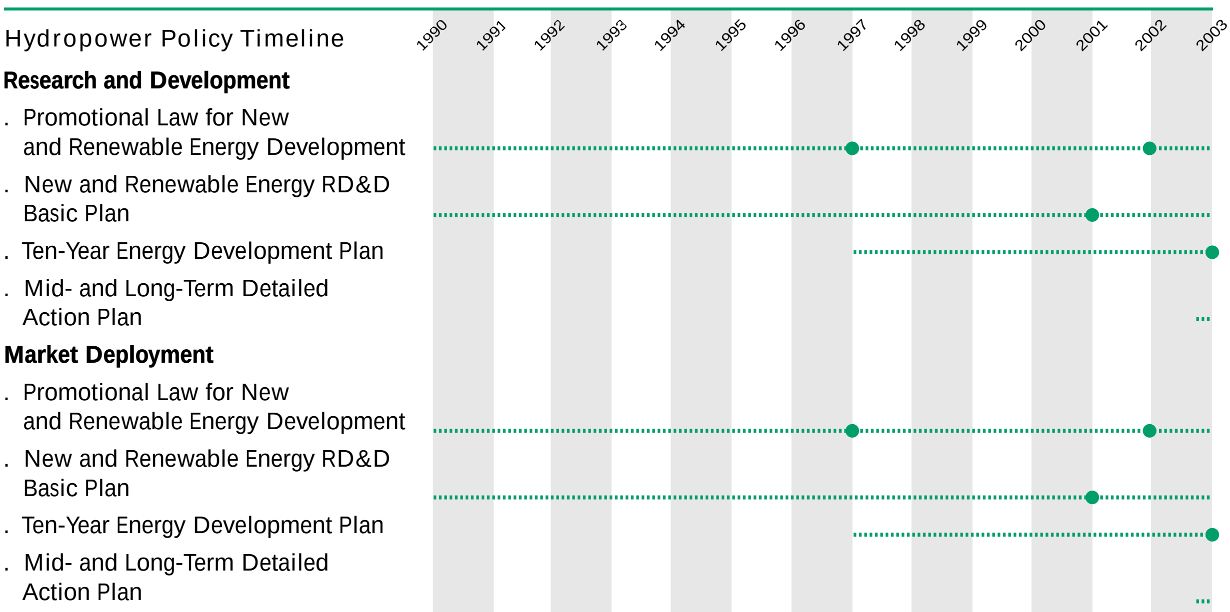


Figure 5. **Hydropower Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Hydropower contributed 16.4% to total renewable energy supply in 2001. Installed capacity increased from 1 340 MW in 1990 to 1 614 MW in 2001, an annual average rate of 1.7%. Integrated control and management of water resources stimulated the construction of multipurpose dams, primarily large hydro plants. More than 60% of the Korean Peninsula is mountainous with high precipitation levels. Hydropower capacity in Korea is dominated by large hydropower, although some effort has been made to encourage the construction of small hydro facilities.

Small hydropower plants have been classified as having capacity less than 3 MW. The classification changed in 2003, to hydropower plants with a capacity less than 10 MW. Since 1975, approximately one to three hydropower plants have been constructed each year, with an average capacity of 500 kW to 600 kW. As of 2001, the total installed capacity of small hydropower plants was 27 MW.

As one of the eleven major research areas in the 1987 Promotional Law, funds were allocated for investments in small hydropower plants. Small hydro is targeted in the 2003 Action Plan as a means of diversifying the energy supply mix. The construction of small hydro plants is also supported through low interest loans (approximately half the market or prime rate), a five-year grace period, and a ten-year repayment period. Small hydropower has encountered some opposition from local communities.

Biomass Production

Solid biomass production increased from 2 933 TJ in 1995 to 7 133 TJ in 2001. Data for biomass production are currently being revised by the Korean government, and official IEA data will reflect these revisions in the future.

According to data from the Korean Energy Economics Institute (Table 3), biomass production in Korea increased from 1 585 TJ in 1991 to 4 532 TJ in 2001, an annual average rate of 11.1%. There was a major revision to biomass statistics in 1996.

Table 3. **Biomass Production**

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
TJ	1 585	1 131	949	839	851	5 780	6 742	6 544	4 485	4 587	4 532

Source: Korean Energy Economics Institute.

The use of municipal solid waste and industrial waste for heat and power has increased substantially over the last decade. The growth is attributed to the Promotional Law of New and Renewable Energy Development (1987) which supported the installation of waste-incineration facilities that generate heat and power. Under the Integrated Energy Supply Act in 1991, tax incentives and long-term low interest loans totalling KRW 4 031.7 billion (approximately US$ 1 350 million between 1983 and 2001) were made available to suppliers and consumers. The first waste incineration plants were demonstration projects in Seoul. These plants were further expanded to include combined heat and power connected to a district heating scheme. The 1993 Waste Management Law encouraged industrial complexes to use waste for heat production. Steady financial support from the government combined with successful demonstration projects spurred growth in this market. Air pollution from waste incineration plants, however, is becoming an issue of concern and the government is addressing ways to reduce the negative impact.

Recently, landfill gas has emerged as an important renewable resource. In Korea, five landfill gas plants have been in operation since 2002. One of the plants supplies heat to an apartment complex. The government has set a feed-in tariff of KRW 61.80/kWh for plants under 50 MW, and KRW 65.20/kWh for plants under 20 MW.

Figure 6. **Solid Biomass Production**

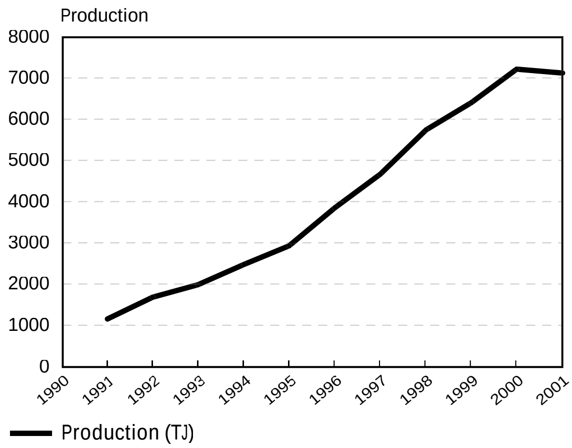
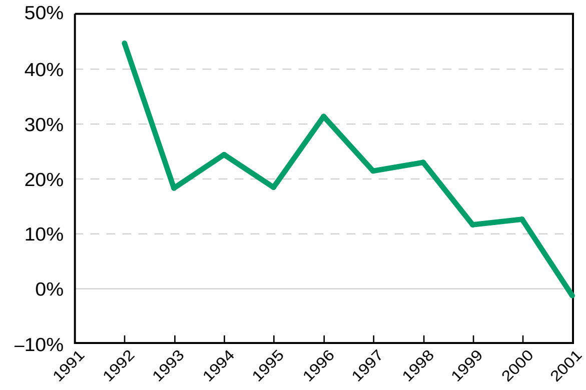
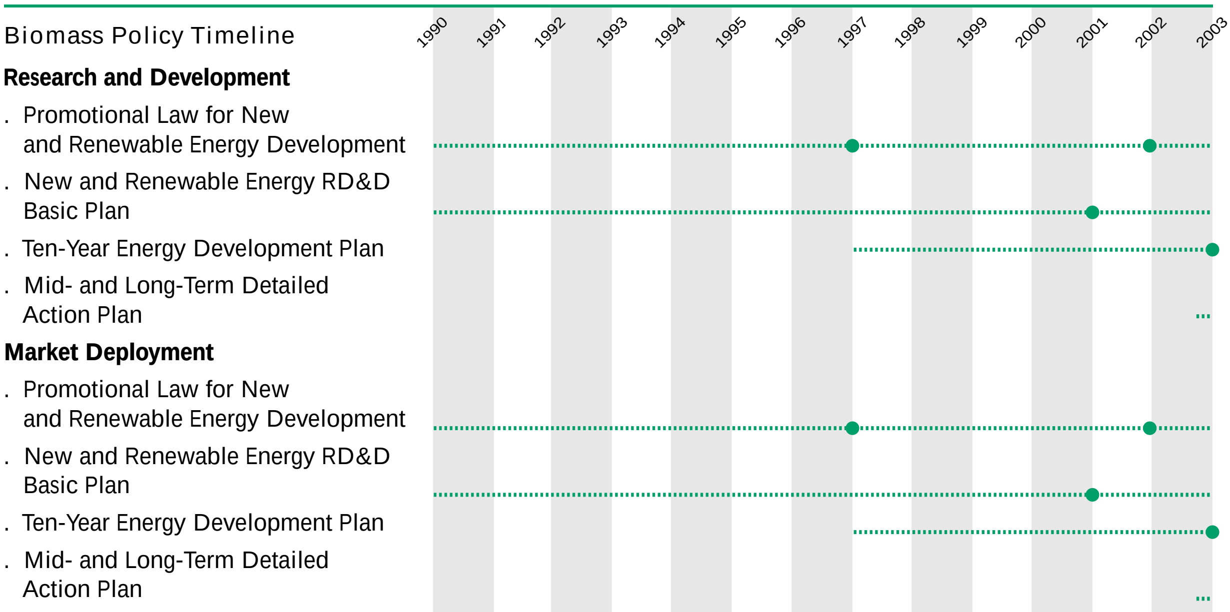


Figure 7. **Solid Biomass Production**
(Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

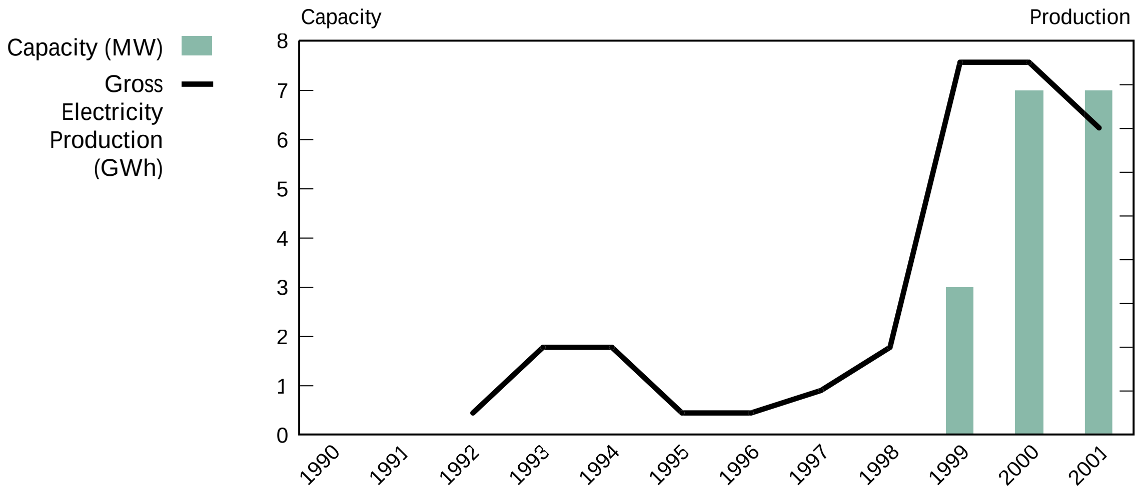
Wind Power

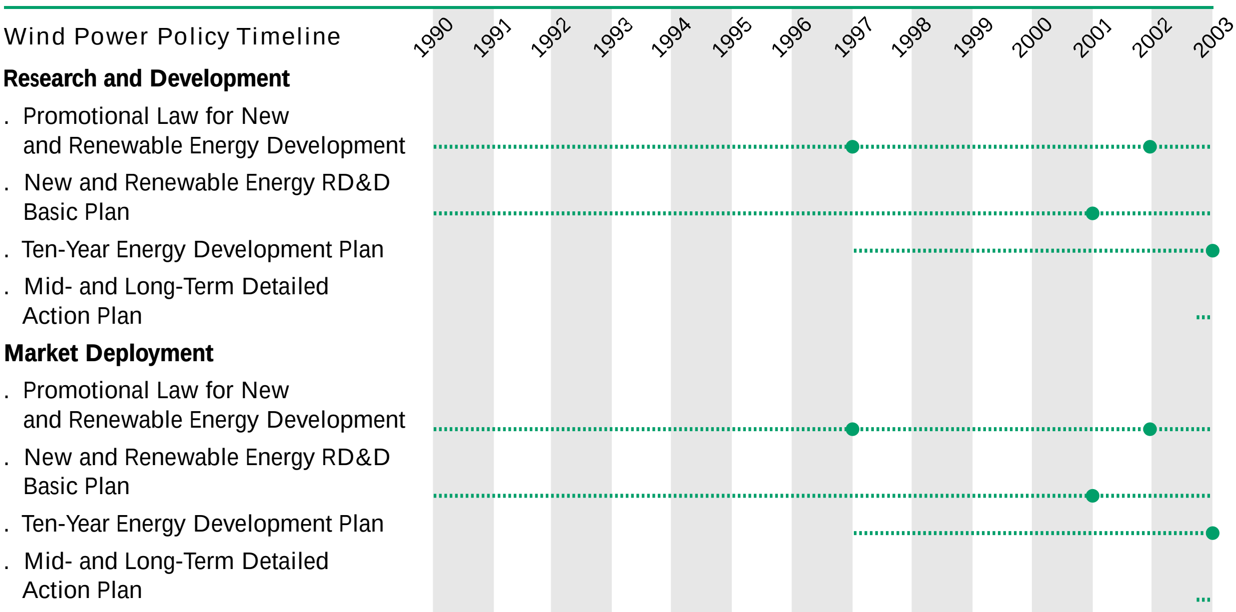
Official IEA statistics for wind capacity in Korea start in 1999. In 2001, Korea had 15 MW of installed capacity. Electricity generation was 26 GWh. Wind resources are found in the coastal, mountain and island areas.

According to Korean authorities, electricity generation from wind power was 16.9 GWh in 1999, 48.6 GWh in 2000 and 36.7 GWh in 2001.[1]

1. Data refer to electricity generation from auto and commercial plants.

Figure 8. **Wind Power Capacity and Electricity Production**





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

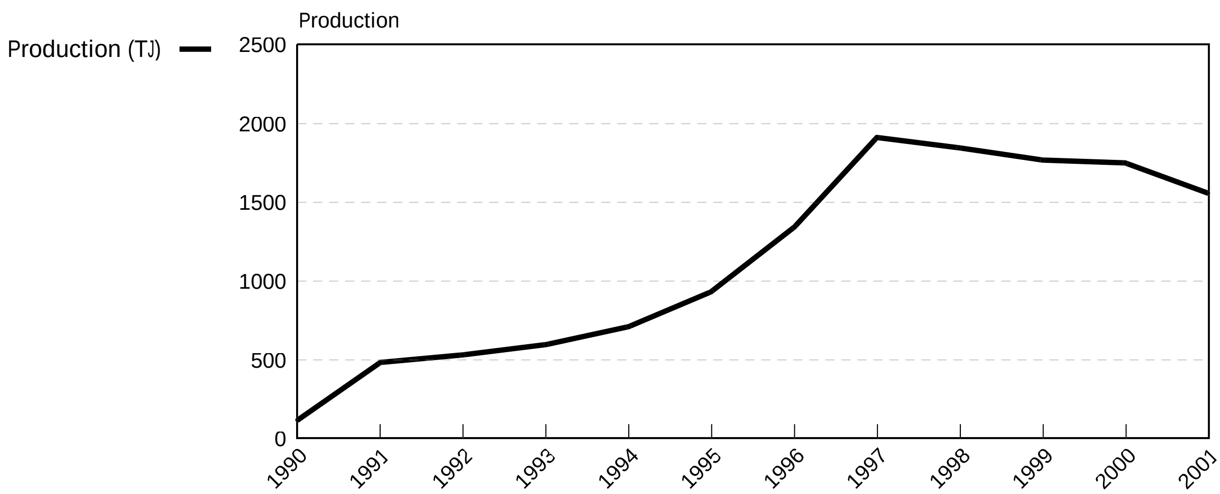
Prior to 1997, electricity generation from wind was entirely for research and development. In 1998, the Haengwon wind farm was built and operated commercially on Jeju Island. At the end of 2002, twelve units were in operation at Haengwon with a total installed capacity of about 7.8 MW. The Electricity Business Law of 2001 established a feed-in tariff for wind power at KRW 107.66/kWh. The feed-in tariff is believed to be the main driver behind the construction of new wind power plants over the last few years.

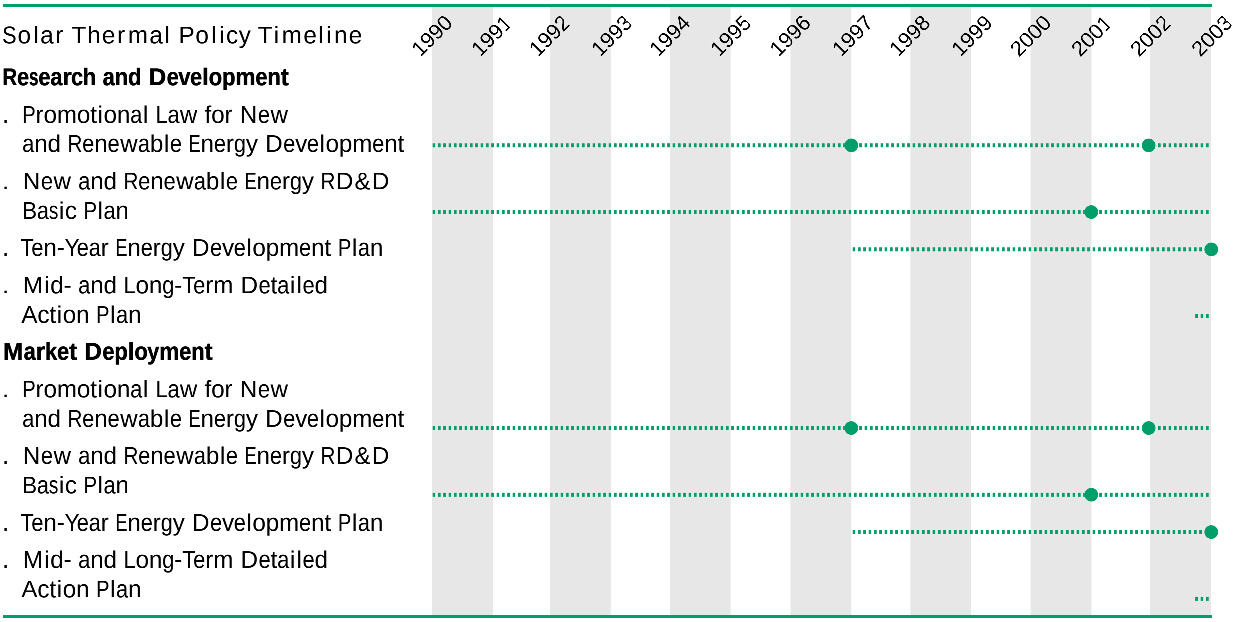
Through the Promotional Law of New and Renewable Energy Development (1987) and the Ten Year Energy Technology Development Plan, the Korean government has actively promoted the development and use of wind energy. KEMCO, the Korean Energy Management Corporation, invested KRW 23 billion between 1988 and 2002 in RD&D. Market growth has accelerated since 1997, following the establishment of the Ten-Year Energy Development Plan.

Local Energy Plans, instituted under the Ten-Year Energy Technology Development Plan, are comprised of an Infrastructure Build-up Program and a Demonstration Project. The Local Energy Plans are supported financially by KEMCO to allow local governments to facilitate the use of new and renewable energy through demonstration projects. These Plans have resulted in the development of numerous wind farms.

Solar Thermal Production

Figure 9. **Solar Thermal Production**





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Solar thermal production increased at an average annual rate of 27% from 1990 to 2001, from 116 TJ in 1990 to 1 556 TJ in 2001. Solar thermal accounted for 83% of new renewables in 2001. The solar thermal market peaked in 1997 and has declined steadily since then. This decrease was largely due to the Asian economic crisis which crippled government budgets. Recent financial support for the purchase of solar thermal systems is offered through agricultural agencies as subsidies to rural communities.

Solar thermal energy is a priority technology under the Ten-Year Energy Technology Development Plan. As such, the government has been promoting residential use of solar water heating systems in rural areas and in some cities. Low-temperature solar thermal systems are commercially available. The high cost of solar thermal water heating units has limited the market deployment of solar thermal technology in Korea.

Solar Photovoltaic

Figure 10. **Solar Photovoltaic Capacity and Electricity Production**

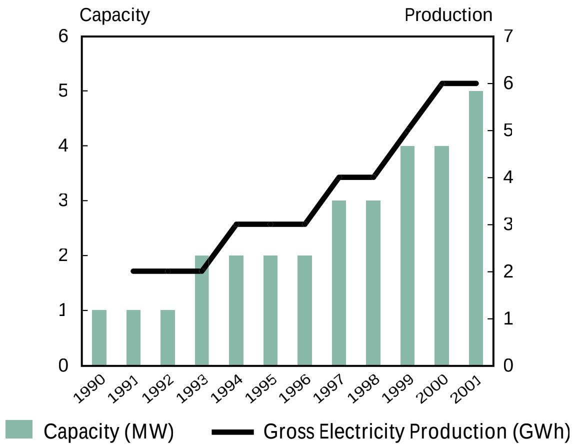
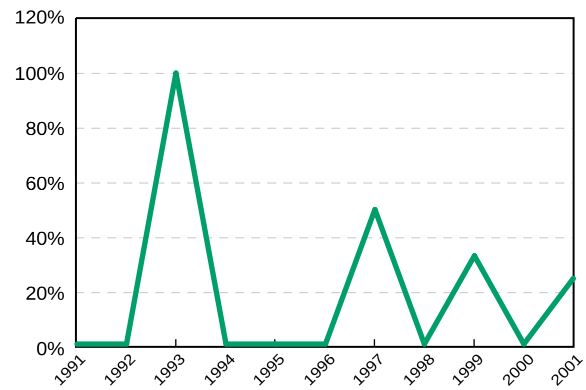
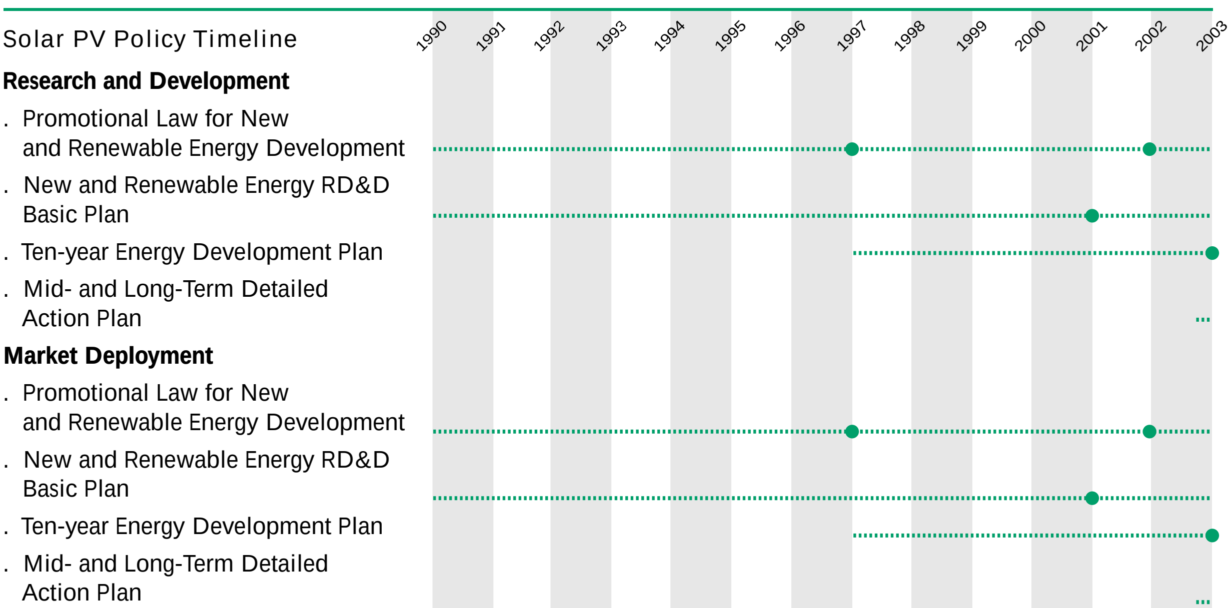


Figure 11. **Solar Photovoltaic Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Installed capacity of solar PV increased by 15.8% per year on average between 1990 and 2001. Solar PV accounted for 14% of new renewables in 2001.

The government estimates the potential for installed PV capacity to be 19 GW. The target under the national PV plan is to have PV systems installed on 30 000 roofs by 2010 and on 100 000 roofs and 70 000 buildings by 2012. The government recognises that an aggressive approach is needed to stimulate the market and expects to spend about US$ 2.3 billion during 2004-2012, mostly to promote PV systems for the residential and commercial sectors.

Steady growth in the PV market over the last decade is attributed to support under the 1987 Promotional Law, the Ten-Year Technology Development Plan and its replacement the 2003 Action Plan. About KRW 37.5 billion was invested between 1988 and 2002 for RD&D for PV technology (with KRW 22.8 billion from government and KRW 14.7 billion from industry).

It is too soon to see the effects in the market of recent production incentives which mandate the purchase of PV-generated electricity by government-owned utilities at fixed rates. These incentives are specified in the Electricity Business Law and the Promotional Law. Investors in PV installations are also eligible for long-term low interest loans.

Korea Policy Chronology

Rational Energy Utilization Act

Year
1979 - Present

Policy Description
This act formed the Republic of Korea's Energy Management Corporation (KEMCO) which functions as the national energy efficiency centre responsible for the implementation of the national energy efficiency and conservation programmes.

Article 35 instructs energy users to try to recover and use waste heat produced in their workplace or to help other third companies use it. The government may recommend this for the waste heat-generating users, when necessary.

Article 37 prescribes the National Energy Technology Research and Development Plan and its Annual Action Plan which the Minister of MOTIE is to establish to promote the development and dissemination of energy technologies. The government leads research and development activities in collaboration with industry, universities and research institutes. Priority projects are financed by the government budget and energy-related funds from the government and industry.

Policy Type
RD&D

RE Technology
All renewables

Special Accounts for Energy and Resources

Year
1985 - Present

Policy Description
Every fiscal year, loans are available to eligible applicants from the government fund "Special Accounts for Energy and Resources". Funding for Special Accounts originates mostly from the Business Petroleum Fund which is being collected as a certain percentage of crude oil import price. Loans are provided mainly for research and development, installation of energy conservation facilities and district heat and CHP projects. Terms of the loans depend on the type of project, but typically a three- to five-year grace period and a five-to-ten year repayment period are offered at a 5-10% interest rate — about half the market or prime rates.

Policy Type
RD&D / Third-party finance

RE Technology
All renewables

Promotion Law of New and Renewable Energy Development

Year
1987-2006

Policy Description
In an attempt to further reduce Korea's dependence on imported fossil fuels, especially oil, the New and Renewable Energy Development and Promotion

Act encouraged the installation of waste-incineration facilities that generate heat and power and residential solar heaters. It also promoted small hydro-electric plants and facilities to use methane gas. The act constituted the initial framework for the development of new and renewable technologies in Korea.

For the following periods, its goals were:

- 1988-1991 – To establish a research base through R&D projects partially funded by government. New and renewable energy was targeted to supply 0.5% of TPES by 1992.
- 1992-1996 – To establish a basis for using renewable technologies with demonstration and dissemination projects. New and renewable energy was targeted to supply 0.6% of TPES.
- 1997-2001 – To focus R&D efforts on priority technologies. New and renewable energy was targeted to supply 1.3% of TPES.
- 2002-2006 – To commercialise energy (new and renewable energy would represent 2% of TPES).

In 1988-1998, investments were made in 367 projects in eleven research areas, including PV power, fuel cells, bio energy and waste energy. As a result, the annual growth rate of new and renewable energy has been around 15% during the last ten years.

Policy Type RD&D

RE Technology All renewables

New and Renewable Energy RD&D Basic Plan

Year 1987-2006

Policy Description In 2001, the government announced a New and Renewable Energy RD&D Basic Plan, which updated the programme begun in 1987, as a renewed framework for further development of renewables. Wind and photovoltaic power are targeted as top-priority technology areas on which the government will focus its R&D support. Other areas targeted are solar thermal, waste and biomass.

From 2001 to 2006, the government plans to invest around US$ 800 million to disseminate renewable energy technology. It envisages the following measures:

- Providing financial support and preferential tax treatments for RD&D renewable technologies. Financial assistance includes low-interest loans (5.5% with a three-year grace period and five years to repay) for companies that install renewable energy technologies. A company can deduct up to 10% of its investment in R&D on renewables from its corporate tax.
- Introducing renewable portfolio standards (RPS) and making it mandatory for wholesale purchasers of electricity to buy at least 1% of their electricity from renewables. So far, this concerns only KEPCO. The government is also planning to require public institutions to buy renewable energy equipment. The aim is to meet 2% of the total energy demand from public institutes through renewable energy sources.

- Establishing a mechanism by which surplus electricity sold to KEPCO's grid from renewable energy facilities will be purchased at rates that provide sufficient incentives to make renewable energy projects viable.

Policy Type RD&D / Third-party finance / Investment tax credits / Obligations / Net metering

RE Technology All renewables

Integrated Energy Act

Year 1991 - Present

Policy Description As the first major step towards waste management, the Integrated Energy Supply Act of 1991 provided suppliers and users with tax incentives, less stringent environmental regulations and long-term low interest rate loans for the installation of waste incineration plants.

Policy Type Third-party finance / Investment tax credits

RE Technology Waste

Local Energy Plan as part of the Ten-Year Plan

Year 1997 - Present

Policy Description The Local Energy Plan is financed by KEMCO and is managed by local governments to facilitate the use of new and renewable energies. The Local Energy Plan consists of an Infrastructure Build-Up Program and a Demonstration Program.

Loans are available for the production and purchase of facilities using new and renewable energy at 4.75% interest with a three-year grace and five-year repayment period. Production incentives are available where renewables based electricity is purchased by a government-owned utility at the rate equivalent to the average retail price set by the Electricity Law. Electricity generated by hydro and wind power projects is paid at the same rate. PV is not yet commercially viable and not subject to the scheme. Tax incentives are offered in the form of income tax credits and compensate 10% of the total investment.

Policy Type RD&D / Third-party finance / Investment tax credits

RE Technology All renewables

Ten-Year Energy Technology Development Plan

Year 1997-2006

Policy Description This ten-year plan focuses on the following categories of energy technologies:

- Core technologies such as photovoltaic, solar thermal, fuel-cell and IGCC.
- General technologies such as waste, bio, wind power and coal utilization technology.
- Basic technologies such as small hydro, ocean, hydrogen and geothermal.

The plan seeks to meet the following targets by 2006:

- Reduce total expected energy consumption by 10%.
- Supply 2% of total energy consumption from new and renewable energy, including solar, wind and biomass energy.
- Secure clean technology for fossil fuels like coal and petroleum.

Policy Type Obligations

RE Technology All renewables

Electricity Business Law

Year 2001 - Present

Policy Description The Electricity Business Law mandates both the purchase and the fixed price of electricity generated from renewable sources. Any renewable energy generator that is connected to the grid is eligible to sell electricity to the grid at fixed prices. KEPCO is responsible for purchasing electricity from renewables.

Policy Type Guaranteed prices/feed-in tariff

RE Technology All renewables

The Promotional Law of New and Renewable Energy Development, Use and Dissemination (Revision of the 1987 Promotional Law of New and Renewable Energy Development)

Year 2002 - Present

Policy Description In 2002 Korea revised the 1987 Promotion Law of New and Renewable Energy Development. According to this revision, Korea will establish a centre for new and renewable energy development and dissemination, and introduce a certification system for new and renewable energy facilities.

Policy Type Public awareness / Tradable certificates

RE Technology All renewables

Clean Development Mechanism Co-ordination

Year 2002 - Present

Policy Description The Korean government earmarks approximately US$ 1 billion a year to finance energy savings and conservation projects. Technological and economic additionality with Clean Development Mechanism (CDM) projects can be achieved where the energy projects are considered as one of the major policy goals. A CDM National Authority will be established as soon as the CDM is officially launched. Some renewable energy projects, industry waste heat recovery projects, and energy efficiency projects are already being reviewed in this process with overseas investors. The enabling environment for the CDM projects will be ensured by the related programs.

Policy Type Capital grants

RE Technology All renewables

Renewable Power Generation Subsidy in the Electricity Business Law

Year 2002 - Present

Policy Description In 2002, the government set up a standard price for renewable energy power generation in order to support the use of new and renewable energy sources. The extra costs of power generators incurred by the use of renewables, instead of fossil fuels, are compensated for by the government.

Policy Type Guaranteed prices/feed-in tariff

RE Technology All renewables

Integrated Energy Policy

Year 2002 - Present

Policy Description The Integrated Energy Policy (IEP) is a system which combines the public energy auditing programme, the financial/technical support programme, the national registry system for the promotion of greenhouse gas reduction projects and protection of “early action” to reduce emissions. The main challenges are the identification of possible projects and the verification and recording of the results through a registry system. During the timeframe of the second comprehensive plan, most of the major industrial emitters will have public or detailed energy audits, and an auditing report will provide a new process for loans and ESCO (Energy Service Company) support. The Korean ESCOs are supported by public loans which cover 50% of the project finance and thus the identified potential projects will be guided by the new IEP system. The registry system will help to convert the past ”reduction” into an initial allocation when a domestic emission trading scheme is introduced.

Policy Type Third-party finance

RE Technology All renewables

Introduction of a Domestic Emissions Trading Scheme

Year 2002 - Present

Policy Description The emissions trading system is considered a cost-effective way of reducing greenhouse gases and currently Korea is examining the feasibility of implementing an emissions trading system as part of its efforts to reduce greenhouse gas emissions.

The emissions trading system is new to Korea and as such, the government is promoting seminars on emissions trading and various simulations of emissions trading, so that both the public and private sector will be better acquainted with the system.

Policy Type Public awareness

RE Technology All renewables

Research Funding for the Development of Renewable Energy Sources

Year 2002 - Present

Policy Description In 2002, the government invested more than KRW 71 billion in RD&D on new renewable energy sources, particularly solar thermal, solar photovoltaic, fuel cells and wind power.

Policy Type RD&D

RE Technology
Solar photovoltaic
Solar thermal
Hydrogen
Onshore wind
Offshore wind

Mid- and Long-Term Goal of New and Renewable Energy Supply with Detailed Plan

Year 2003-2012

Policy Description The goal of this Plan is to develop and deploy eleven new and renewable technologies with the overall aim of increasing the percentage contribution of renewable energy in the energy mix to 3% in 2006 and 5% in 2011.

This plan is comprised of RD&D and market deployment components. The RD&D component consists of a two-tiered strategy of selection and concentration. Technologies with comparative advantage will be selected and government support will be concentrated on the chosen technologies. Three technologies, wind, PV and fuel cells, have been chosen from eleven competing technologies, all of which received support under the 1987 Act. Solar thermal, biomass and waste to energy are included in the category of significant consideration for dissemination support.

A total of KRW 9.1 trillion (US$ 7.6 billion) is planned for investment through the government budget between 2004 and 2011.

Financial and tax support are offered as incentives through:

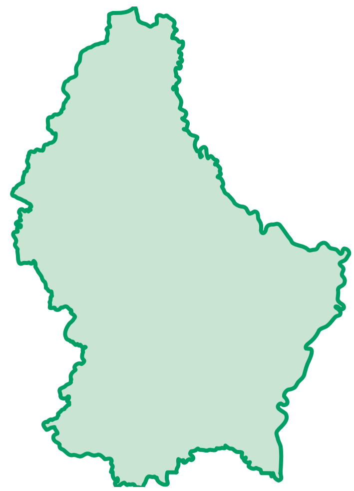
- Low-interest loans offered to companies that employ renewable energy technologies, processes and equipment.
- A 10% investment tax credit for companies investing in energy RD&D projects.
- Priority in receiving tax credits for companies reserving funds to invest in renewable energy RD&D.
- Plans to strengthen mandatory fixed-price purchases of renewables electricity.
- Plans to provide grants for RD&D of renewable technologies up to 75% of capital cost for PV and 25% for wind power.

In addition, a green pricing program is under review, more RD&D activities are supported and through project-based business centres and the private sector is encouraged to undertake RD&D activities by providing grants and credits.

Policy Type RD&D / Third-party finance / Investment tax credits / Obligations

RE Technology All renewables

Luxembourg



Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

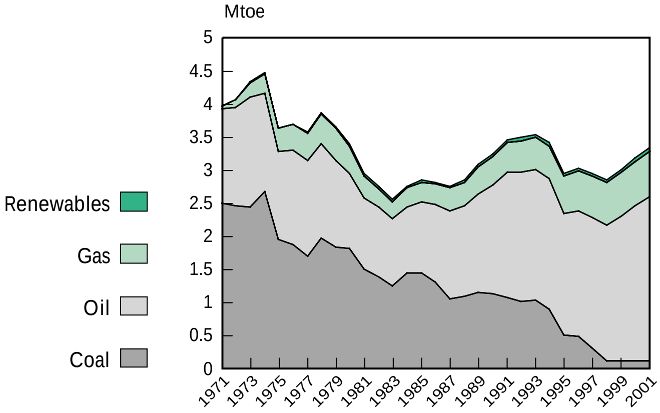
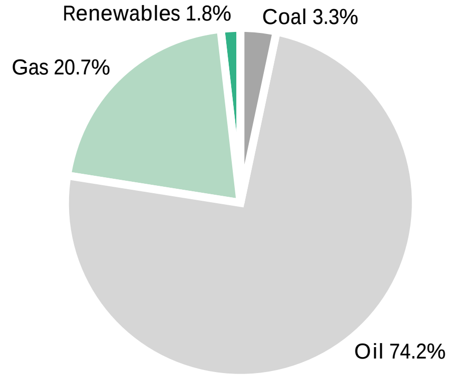


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1.
See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	**1970**	**1980**	**1990**	**1995**	**2000**	**2001**	**Imports**
Coal	2.6	1.8	1.1	0.5	0.1	0.1	100%
Oil	1.3	1.1	1.6	1.8	2.3	2.5	99.2%
Gas	0.0	0.4	0.4	0.6	0.7	0.7	100%
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	-
Renewables	0.0	0.0	0.0	0.0	0.1	0.1	-
Biomass	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Hydro	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Total	**4.1**	**3.6**	**3.6**	**3.4**	**3.7**	**3.8**	**97.9%**
% Renewables	*0.2%*	*0.9%*	*1.0%*	*1.6%*	*1.8%*	*1.8%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*

Luxembourg's total primary energy supply (TPES) exhibited a very low average growth rate of about 0.5% between 1990 and 2001. Looking back over the past three decades Luxembourg has experienced a negative growth rate averaging -0.2% per year. This is due to energy efficiency gains and restructuring of the iron and steel industry that reduced energy demand.

The energy supply mix in 2001 was dominated by oil (66%) and natural gas (187%) (Table 1), a substantial change from the beginning of the 1990s when coal played a much larger role. Oil supply almost doubled from 1.3 Mtoe in 1970 to 2.5 Mtoe in 2001. Natural gas was added to the supply mix in the 1980s replacing oil use in industry and the residential and commercial sectors.

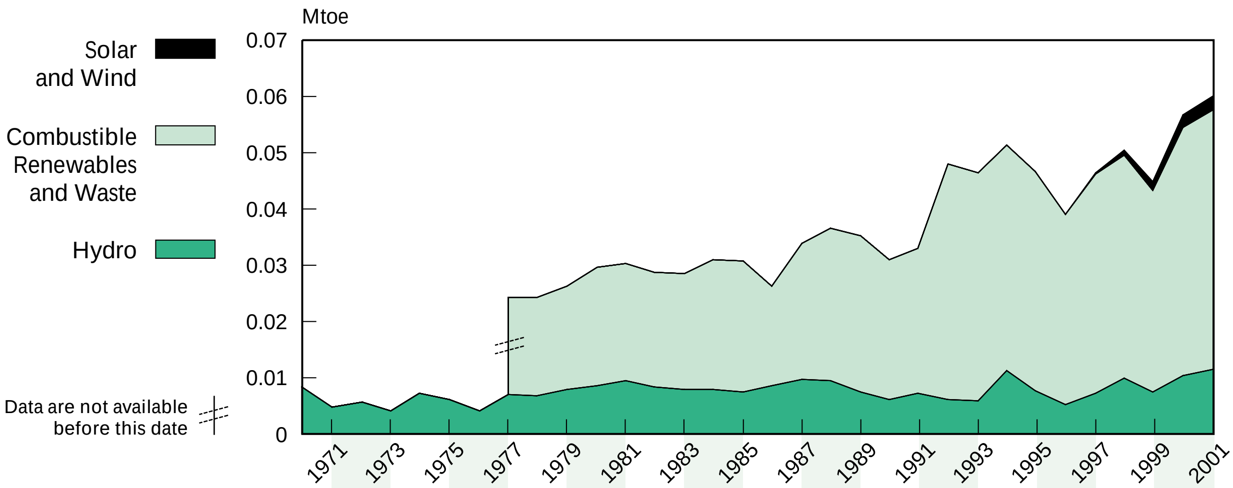
Renewable energy supply increased from 0.03 Mtoe in 1990 to 0.06 Mtoe in 2001, increasing as a share of TPES from 1% in 1990 to 1.8% in 2001. This was primarily due to increases in hydropower and biomass. In 2001, biomass accounted for 1.2% of TPES and hydropower for 0.3%. Renewable energy is used primarily in electricity generation in Luxembourg.

In 2001, electricity was generated primarily by natural gas (56%) and renewable energy (44%). Hydro power provided almost 27% of electricity generation, biomass and waste almost 12% and the remaining renewable energy technologies contributed some 5%.

1. The non-renewable portion of municipal solid waste is not included in Table 1. See Annex 2 for details.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



Policy Timeline

Research and Development

Market Deployment

. Règlement Grand-ducal du 30 mai 1994

. Règlement Grand-ducal du 17 juillet 2001

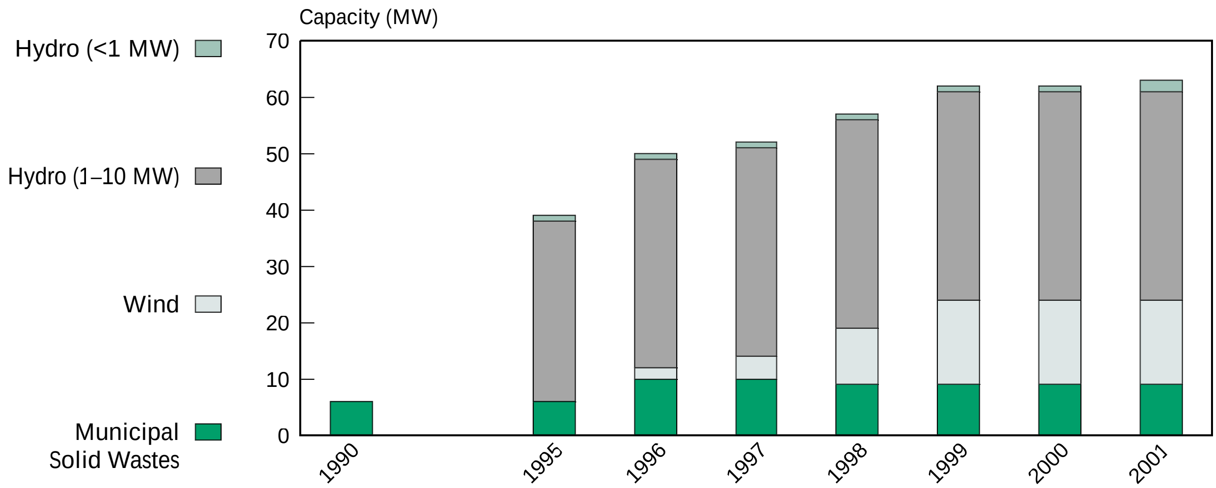
. Règlement Grand-ducal du 28 décembre 2001

● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Total renewable energy supply grew at an annual average rate of 6.2% between 1990 and 2001. The share of biomass and waste within the renewable energy share decreased slightly from 80.4% to 76.9% from 1990 to 2001. Hydropower production (excluding pumped storage) grew on average 6% per year between 1990 and 2001. Wind, solar, thermal, photovoltaics and biogas experienced growth in the latter half of the 1990s from 0% in 1996 to 4% of total renewable energy supply in 2001. Of the new renewable energy technologies, wind power comprises the majority and experienced the highest growth rate, from a very low base, at 71.6% per year between 1997 and 2001 profiting from advantageous feed-in tariffs and capital grants from 1994 to 2001. Neither PV nor solar thermal technologies contribute much to renewable energy supply, however, the PV market has started to grow in response to advantageous feed-in tariffs provided in the 2001 government regulations. The majority of renewable energy sources in Luxembourg are used for electricity generation.

Net generating capacity from municipal solid waste increased on average by 3.8% per year between 1990 and 2001. Capacity additions from wind started in 1996 with 2 MW and rose to 15 MW in 2001. Net generating capacity for small hydro plants increased by 6 MW between 1995 and 2001.

Figure 4. **Net Generating Capacity of Renewable and Waste Products**

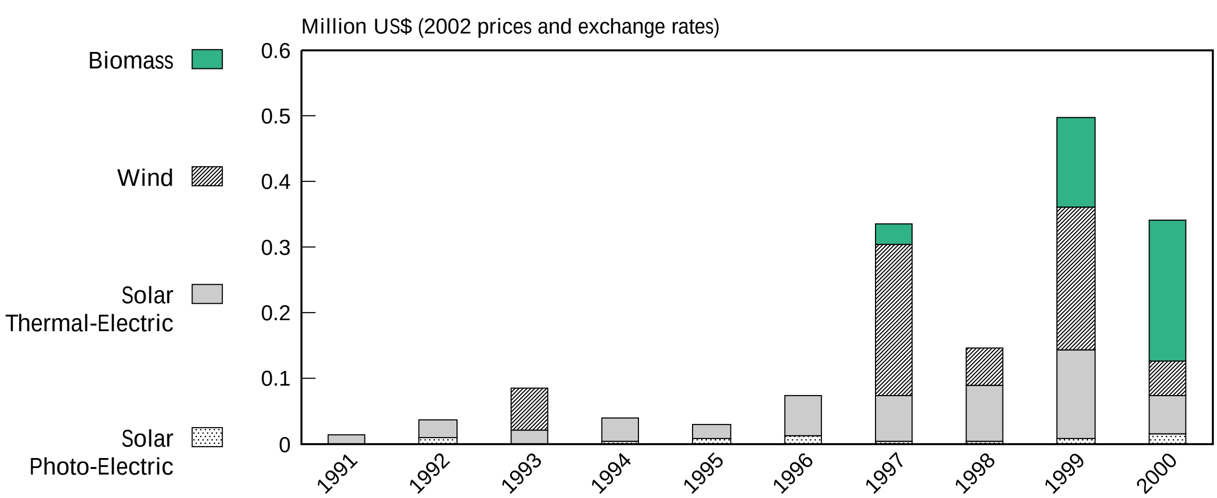


In 2001, 44% of total electricity generation (excluding pumped storage, non-renewable industrial waste and municipal solid waste) came from renewables. Renewables-generated electricity increased by 7% per year between 1990 and 2001. The main renewable source for electricity production in 2001 was small hydropower, which provided 26.7% of total electricity generation. The remainder was mostly from municipal waste and combined heat and power plants. Luxembourg's national target as an EU member country is 5.7% of electricity output from renewable sources by 2010.

Research and Development Trends

Luxembourg has devoted few financial resources to energy RD&D. The only R&D activity that has commanded funds consistently for the past twenty years is the European fusion research programme, which received some € 50 000 per year. The majority of government funds for renewable energy RD&D have been for demonstration projects at between € 50 000 and € 100 000 per year.

Figure 5. **Luxembourg – Government Renewable Energy RD&D Budgets**



Government budgets for renewable energy RD&D totalled US$ 1.6 million (in 2002 prices and exchange rates) between 1991 and 2000. The overall trend of government RD&D expenditures for renewables was minimal in the early 1990s, but with some increase in the latter half of the 1990s.

Among the renewable technologies, wind received the highest level of funding at US$ 0.62 million, 39% of the total renewable RD&D budget in the 1991 to 2000 period. Solar thermal-electric was funded at US$ 0.53 million (33%) and biomass at 24% of the renewable RD&D expenditures during the period.

Market Deployment Trends

A landlocked country with limited renewable energy potential, Luxembourg is almost entirely dependent on energy imports and its energy policy pursues energy security through diversification and energy efficiency gains. Luxembourg's market deployment strategies can be characterised by demonstration projects, advantageous feed-in tariffs and investment incentives.

In 1991, the Agence de l'Energie s.a., *i.e.*, the Luxembourg Energy Agency, was established to promote the rational use of energy and renewables. This marked the first step to accelerate renewable energy in Luxembourg. The major shareholders of the Energy Agency include the Luxembourg government (50%), "Compagnie Grand-Ducale d'Électricité de Luxembourg" (CEGEDEL) (40%) and the "Société Electrique de l'Our" (SEO) (10%). CEGEDEL is the main distributor of electrical energy in Luxembourg and SEO is the biggest energy producer. Measures to promote renewables include preliminary feasibility studies and demonstration projects, which were funded at € 70 000 per year between 1991 and 2000. The importance and scope of renewables objectives increased and in 2000 the amount of funding more than doubled to € 150 000 per year. The additional funding came primarily from the Ministry of the Environment, who joined the Ministry of Economy as the main funders of the Energy Agency.

The Energy Efficiency Law of 1993 provided the legal basis and identified the rational use of energy and increased use of renewables as key energy saving measures. This led to the 1994 Grand Ducal regulation of purchase price regulations for surplus electricity produced by CHP and renewable energy sources. The regulation established a government programme for new CHP projects and renewable energy sources that provided funding for a percentage of investment costs, primarily for non-industrial generators.

The funding for non-industrial generators was:

- CHP: 6 000 LUF/kWe (148.76 €/kWe), with a maximum of LUF 6 million (€ 148 736.7) per installation. Funding required that the system have a minimum efficiency of 80%, minimum load factor of 2 500 hours per year, and that the heat produced would be delivered to third parties.
- Wind: 3 000 LUF/kWe (74 €/kWe), with a maximum of LUF 6 million (€ 148 736) per project. Projects required a minimum capacity of 50 kWe. Wind turbines with a capacity less then 50 kWe received a direct grant of 25% of the investment cost.
- Solar thermal, PV, biomass and heat pumps: grants of 25% of the investment cost, with up to a maximum of LUF 60 000 (€ 1 487) per house, or a maximum of LUF 1.5 million (€ 36 785) in the non residential sector.

The Ministry of Energy additionally supported the production of electrical energy by granting bonuses through a separate 1994 ministerial regulation to benefit mainly co-generation systems, wind power and PV. Some renewable energy technologies, notably biomass, biogas, wind, and solar thermal, have shown small but noticeable market growth due to financial and regulatory support stemming from the 1993 and 1994 rules. However, these programmes had no impact on stimulating a PV market.

The regulations were revised in 2001 to raise the level of financial support and specify timeframes and price digression schemes for each renewable energy technology. The Règlement Grand-Ducal du 17 Juillet 2001 granted incentives to private owners for the installation of renewable systems and is supported by the Ministry of Environment. Renewable technologies targeted by the 2001 Règlement include wind energy and PV.

The Règlement Grand-Ducal du 28 Decembre 2001 stated that the Ministry of the Environment needed to augment support for the production of electrical energy. Increased support was based on the system used, with PV receiving the largest bonus. This bonus was complementary to the 1994 ministerial regulation concerning the promotion of co-generation systems, wind power and PV. The 2001 regulation stipulated that PV systems were to be supported for twenty years and limited support for other systems to ten years (hydropower, wind, biomass and biogas). It set a digression system in place for the bonuses, which were applied in 2001, 2003 and 2004. The remuneration scheme differentiates between normal- and peak- production of electrical energy for wind, hydro, biogas and biomass production plants with an electrical output greater than 500 kW. The feed-in tariff is supported in part by consumers and in part by the state budget through the environmental fund. A modification of the remuneration structure for wind, hydro, biogas, biomass and co-generation plants is under discussion, which may include a digressive remuneration scheme based on return on investment over the years.

Existing policies in Luxembourg aim to increase the use of renewable energy, particularly for electricity generation. Other issues related to renewables, such as intermittency and grid connection, have not been explicitly addressed in Luxembourg's energy policies. The Energy Agency carries out information dissemination and educational activities related to renewables to inform the public of the benefits of renewables in the energy supply mix.

Renewable Energy Markets

Hydropower

Figure 6. **Hydropower Capacity and Electricity Production**

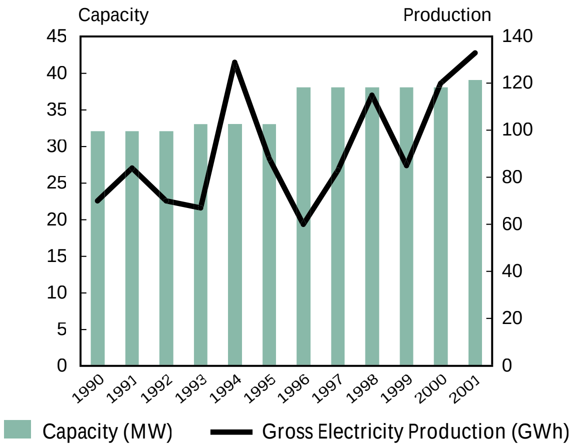
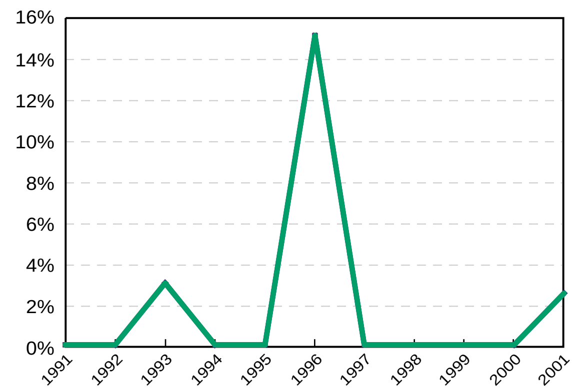
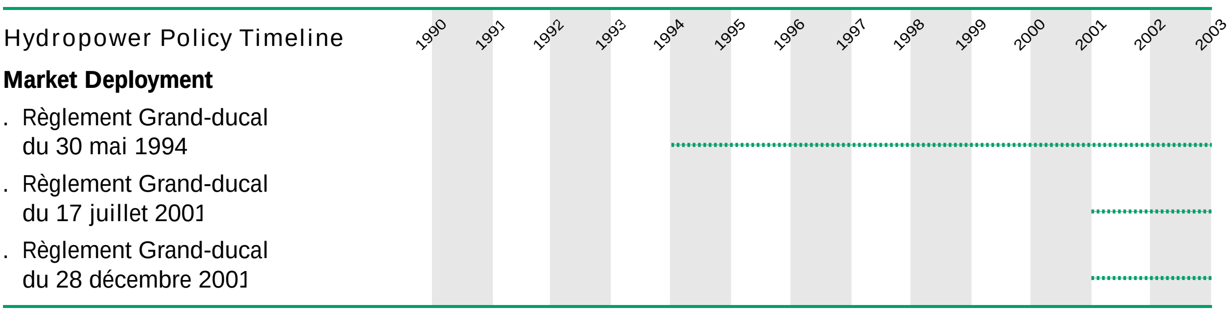


Figure 7. **Hydropower Capacity** (Year to Year Change)





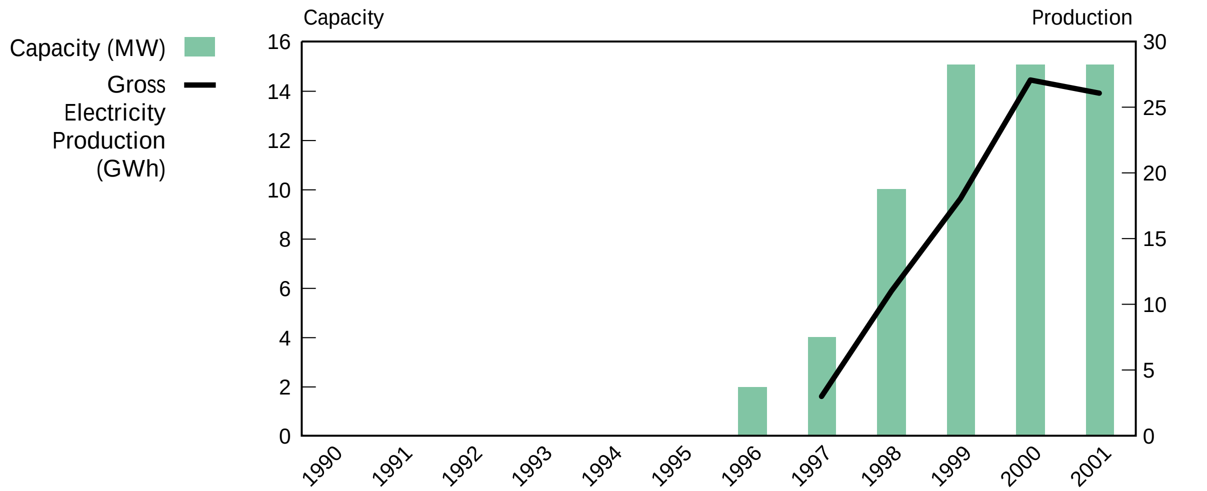
● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

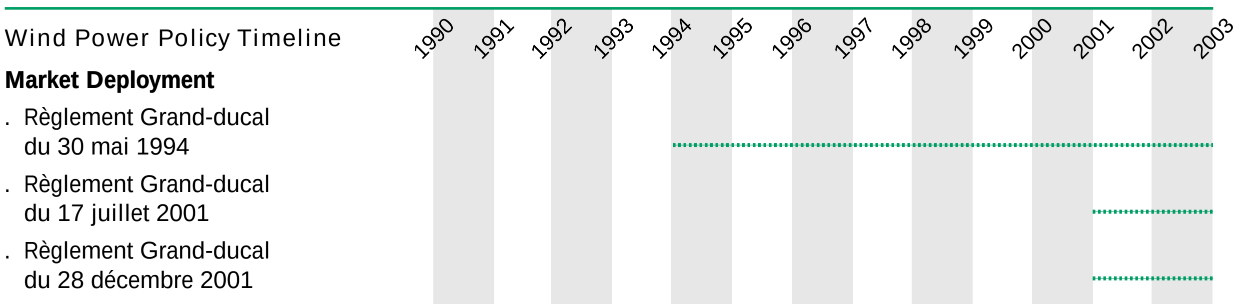
Hydropower is considered a mature technology in Luxembourg. Small hydropower (<1 MW) in Luxembourg represents about 10% of the total installed capacity and gross electricity generation from hydroelectricity. Very small hydro accounted for approximately 2 MW of total hydropower capacity in 2001.

According to the Ministry of Economic Affairs, electricity generation from hydropower increased from 68.1 GWh in 1989 to 97.4 GWh in 2002. Although electricity generation in Luxembourg from hydropower has increased steadily from 1990 to 2001, additional new hydro development is unlikely as all attractive sites have been exploited. Increased capacity has come primarily from modernization and retrofitting of existing hydropower plants that benefited from the investment incentives and feed-in tariffs (1994 and 2001 regulations). Between 1995 and 2001, small hydro was promoted by the EU Thermie programme, which has affected some thirty very small hydro plants.

Wind Power

Figure 8. **Wind Power Capacity and Electricity Production**





Denotes a significant change to a policy, such as an extension, repeal or revision.

According to the data provided by the Ministry of Economic Affairs, wind power in Luxembourg increased from 2 MW in 1996 to 21.5 MW in 2003, an annual average growth rate of 40%. Wind accounted for 94% of new renewable energy supply in 2001.

The incentives provided in the laws and regulations of 1993 and 1994 have been instrumental in getting the wind industry started in Luxembourg. They offer a guaranteed market with feed-in tariffs of € 0.10/kWh and capital grants amounting up to 10% of investment costs. Since the first wind installation in 1996, wind capacity has exhibited the steadiest increase among renewable energy technologies in Luxembourg, which achieved the highest wind capacity per capita in Europe in 1998.

Luxembourg Policy Chronology

Flexible Depreciation

Year 1989 - Present

Policy Description The objective of this policy is to stimulate the investment in the protection of the environment and energy savings in businesses. It provides accelerated depreciation for income taxes, up to 60% of the investment costs.

Policy Type Investment tax credits

RE Technology All renewables

Energy Efficiency Law

Year 1993 - Present

Policy Description The Energy Efficiency Law of 1993 provides the legal basis and sets out energy savings and renewable energy objectives and measures.

The feed-in tariffs for electricity produced by renewables derive from the Grand Ducal regulation of 1994. There are two classes of feed-in tariffs for producers, depending on their size and technology:

- Class 1 renewables (wind, biomass or PV) 1-500 kW: € 0.01/kWh.
- Class 1 CHP 1-150 kW and Class 2 CHP 150 – 1 500 KW: € 0.01/kWh - Class 2 renewables 501-1 500 kW: € 0.058/kWh (day tariff) and € 0.003/kWh (night tariff). CHP minimum average is 2 500 hours per year of operation and 80% all-over efficiency.

Tariff levels are indexed to cost-of-living indices. There is a bonus for wind and PV power. In addition, average peak load deliveries during the three principal annual peak load period's leads to an extra bonus.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology Biomass
Onshore wind
Solar photovoltaic

Règlement Grand-Ducal (30 mai 1994)

Year 1994 - Present

Policy Description The Ministry of Energy supports the production of electricity from renewables by bonuses defined in this regulation, mainly for co-generation systems, wind power and PV.

Policy Type Capital grants

RE Technology Onshore wind
Solar photovoltaic

Ministerial Regulation

Year 1994-1999

Policy Description This Ministerial regulation (1994) provided financial support for renewable and energy efficiency technologies, including: CHP, wind, solar, biomass and heat pumps.

The funding for non-industrial generators was:

- CHP: 6 000 LUF/kWe (148.76 €/kWe), with a maximum of LUF 6 million (€ 148 736.7) per installation. Funding required that the system have a minimum efficiency of 80%, minimum load factor of 2 500 hours per year, and that the heat produced would be delivered to third parties.
- Wind: 3 000 LUF/kWe (74 €/kWe), with a maximum of LUF 6 million (€ 148 736) per project. Projects required a minimum capacity of 50 kWe. Wind turbines with a capacity less then 50 kWe received a direct grant of 25% of the investment cost.
- Solar thermal, PV, biomass and heat pumps: grants of 25% of the investment cost, with up to a maximum of LUF 60 000 (€ 1 487) per house, or a maximum of LUF 1.5 million (€ 36 785) in the non residential sector.

Policy Type Consumer grants/rebates

RE Technology Onshore wind
Solar thermal
Solar photovoltaic
Biomass

Programme d'actions d'Economies d'Energie dans les Communes (PEEC)

Year 1996-2001

Policy Description The aim of the PEEC program was to launch initiatives and measures adopted by the municipalities to promote the rational use of energy and renewables. The Energy Agency:

- Consulted with municipalities to help them to benefit from PEEC at the stage of planning projects.
- Motivated municipalities in their energy strategies.
- Supported pre-feasibility studies.
- Provided information on available financial support, licensing and tariffs.

The programme funding was:
Wind: 6 000 LUF/kWe (148 €/kWe) with a maximum of LUF 6 million (€148 736.7) per project. The minimum capacity is 50 kW.
CHP: 6 000 LUF/kWe (148 €/kWe) with a maximum of LUF 6 million (€148 736.7) per installation. The minimum load factor is 2 500 hours/year and the minimum efficiency standard is 80%. Heat should be delivered to third parties.

PEEC ended in 2001 but the targets and financial support have since been taken over by the Ministry for Environment and renamed the “Fund for the Protection of Environment”.

Policy Type Capital grants / Consumer grants/rebates

RE Technology All renewables

Fund for the Protection of the Environment

Year 1999 - Present

Policy Description The Fund for the Protection of the Environment is also titled the « Loi du 31 mai 1999 portant institution d’un fond pour la protection de l’Environnement ». This law created a fund to support exemplary and innovative projects by municipalities that benefit the environment.

Policy Type Consumer grants/rebates

RE Technology All renewables

Electricity Consumption Tax

Year 2001 - Present

Policy Description On 1 January 2001, an electricity consumption tax was instituted.

Policy Type Taxes

RE Technology All renewables

Renewable Energy Guide

Year 2001 - Present

Policy Description The Ministry of Environment developed a new Renewable Energy Guide in 2001. This guide, created in collaboration with the Luxembourg Energy Agency, aims to inform people about renewable energy technologies, their possibilities and use. It also serves as an information source on methods to apply for and obtain subsides under the government scheme for the promotion of renewable energy sources.

Policy Type Public awareness

RE Technology All renewables

Règlement Grand-Ducal (28 Décembre 2001)

Year 2001 - Present

Policy Description

The Ministry of the Environment, through this regulation, increased its support for the production of electrical energy. This support takes the form of bonuses whose size is dependent upon the system used. For example, PV receives the largest bonus. This bonus complements the regulation passed in 1994 concerning the promotion of cogeneration systems, wind power and PVPV systems are supported for twenty years, while support for other systems is limited to ten years. A digression system is also in place for the bonuses.

Policy Type

Consumer grants/rebates

RE Technology

Biofuel
Biomass
Biogas
Hydro
Onshore wind
Solar photovoltaic

Règlement Grand-Ducal (17 juillet 2001)

Year

2001 - Present

Policy Description

This legislation provides incentives for the installation of renewable systems for private owners including among other technologies, wind energy, PV and low-energy houses.

Policy Type

Consumer grants/rebates

RE Technology

Onshore wind
Solar photovoltaic

The Netherlands

Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

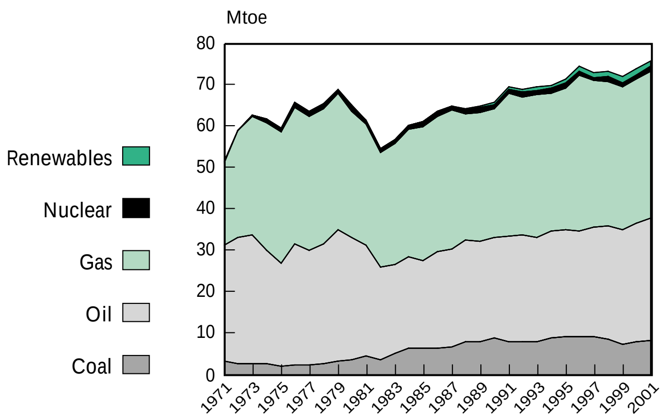
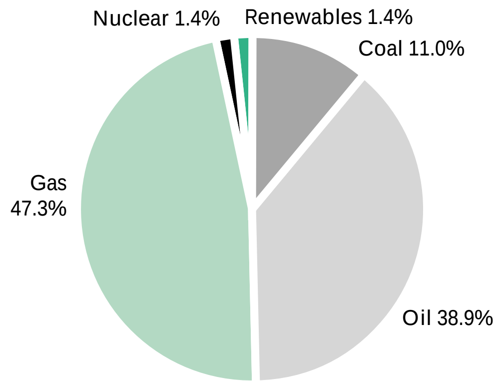


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1.
See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1970	1980	1990	1995	2000	2001	Imports
Coal	4.7	3.8	8.9	9.2	8.0	8.3	100%
Oil	29.1	29.5	24.3	26.0	28.6	29.5	100%
Gas	15.4	30.4	30.8	34.1	34.7	35.5	•
Nuclear	0.1	1.1	0.9	1.0	1.0	1.0	-
Renewables	0.0	0.2	0.6	0.7	1.0	1.1	-
Biomass	*0.0*	*0.2*	*0.6*	*0.7*	*0.9*	*1.0*	
Hydro	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.1*	*0.1*	*0.1*	
Total	**49.3**	**65.0**	**66.5**	**72.1**	**75.5**	**77.2**	**40.9%**
% Renewables	*0.0%*	*0.4%*	*1.0%*	*1.0%*	*1.4%*	*1.4%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*
• *Net Exporter*

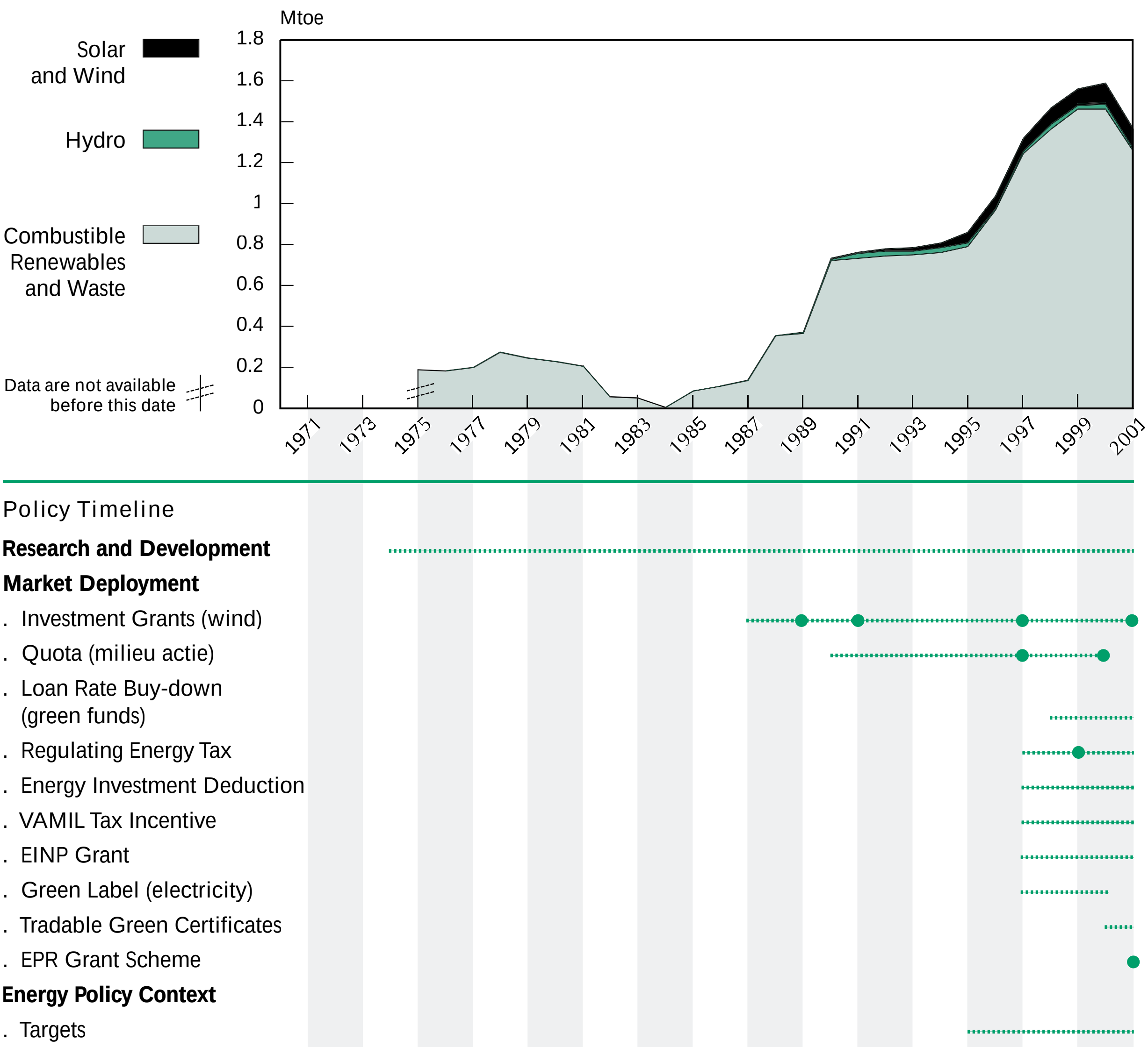
The energy sector of the Netherlands is dominated by fossil fuels. Total primary energy supply (TPES) increased from 49 Mtoe in 1970 to 77 Mtoe in 2001, with natural gas displacing oil in about 1980 as the main supplier of energy. This was largely due to the discovery and development of significant gas reserves. Natural gas use has more than doubled since 1970, while coal use has grown by 56%. By 2001, natural gas accounted for about 46% of TPES (Table 1), while oil and coal retained their relative positions (38% and 11% respectively), all of which is imported. It is of concern that domestic gas supplies may peak in 2011-2012, and the Netherlands will have to start importing gas. Renewables provided 1.4% of TPES in 2001, largely from biomass and combustible waste.

The electricity sector is characterised by growing shares of natural gas. Coal use peaked in 1995 and has declined slightly since. Almost all oil use is now concentrated in the transport and industry sectors. The

Netherlands has one nuclear plant (400 MW) which is scheduled for retirement in about 2013. It is unlikely that new nuclear plants will be built due to public concerns, economic feasibility and lack of political commitment. As a result of these constraints on domestic power generation, electricity imports have been rising gradually. From self-sufficiency in 1980, the Netherlands now imports more than 21 TWh per year. This is also a reflection of the liberalisation of the electricity market.

Renewable Energy Supply

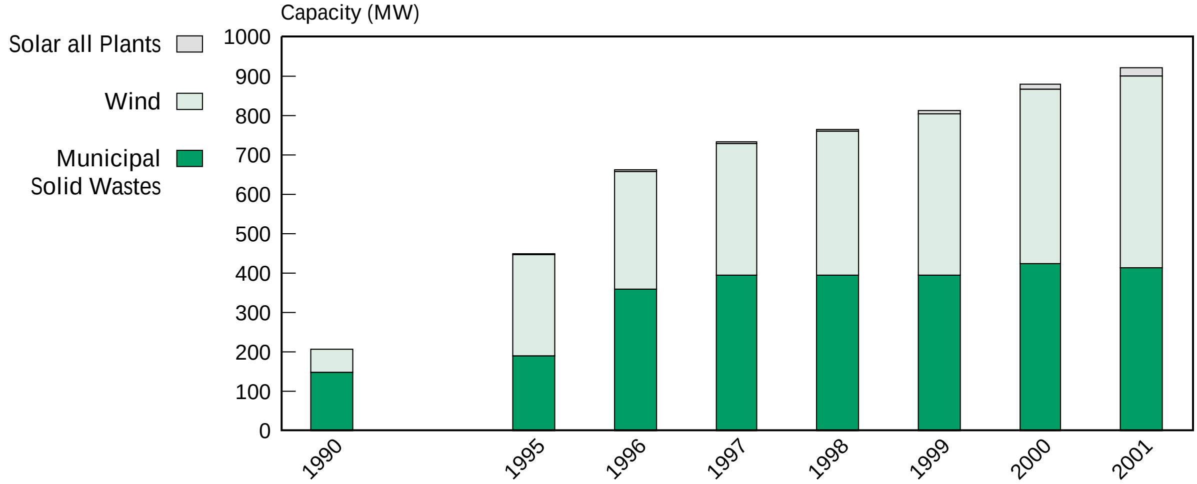
Figure 3. **Total Renewable Energy Supply and Policy Timeline**



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Biomass accounted for 90% of the renewable energy supply in the Netherlands in 2001. Biomass and waste sources are used in heat production and electricity generation. Electricity generation from renewables totalled 3.3 TWh and contributed 3.5% to total generation. At the end of 2001, total generation capacity from renewables was 953 MW of which 480 MW was wind, 414 MW municipal solid waste, 38 MW hydro and 21 MW photovoltaic. Installed wind capacity increased from 48 MW in 1990 to, 800 MW in 2002, according to national sources. Solar photovoltaic installed capacity was 2 MW in 1995 and reached 26 MW in 2002, according to Dutch statistics.

Figure 4. **Net Generating Capacity of Renewable and Waste Products**

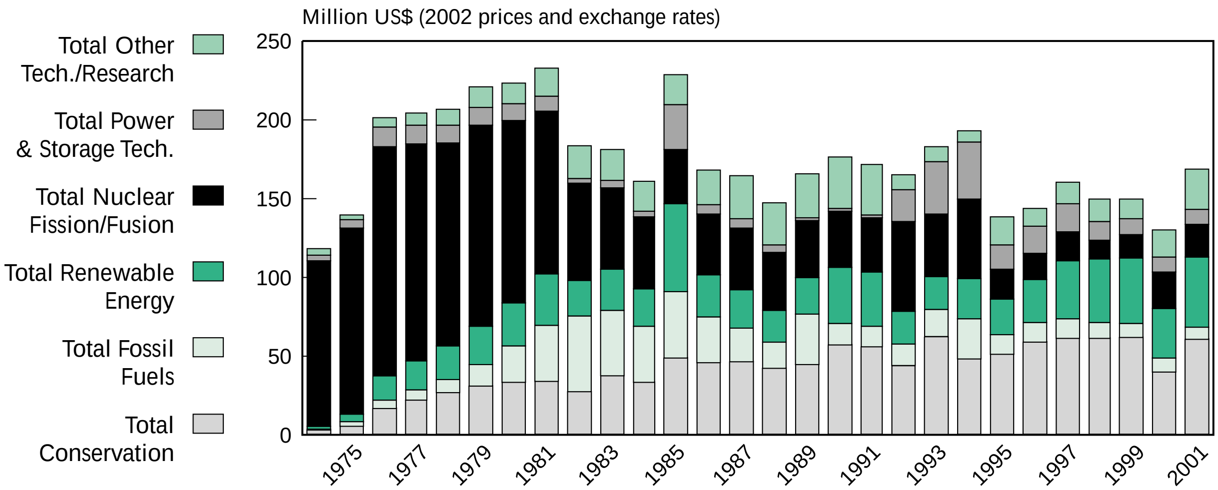


Note: A change in data collection methods at the IEA occurred in 1999 with the separation of net generating capacity between small and large hydro. Capacity data for small hydro are not available prior to 1999.

Research and Development Trends

The Netherlands spent a total of US$ 4.88 billion (in 2002 prices and exchange rates) on government energy RD&D between 1974 and 2001. In this period, 15.4% of the total energy RD&D budget was allocated to renewable energy RD&D.

Figure 5. **Netherlands - Government Energy RD&D Budgets**



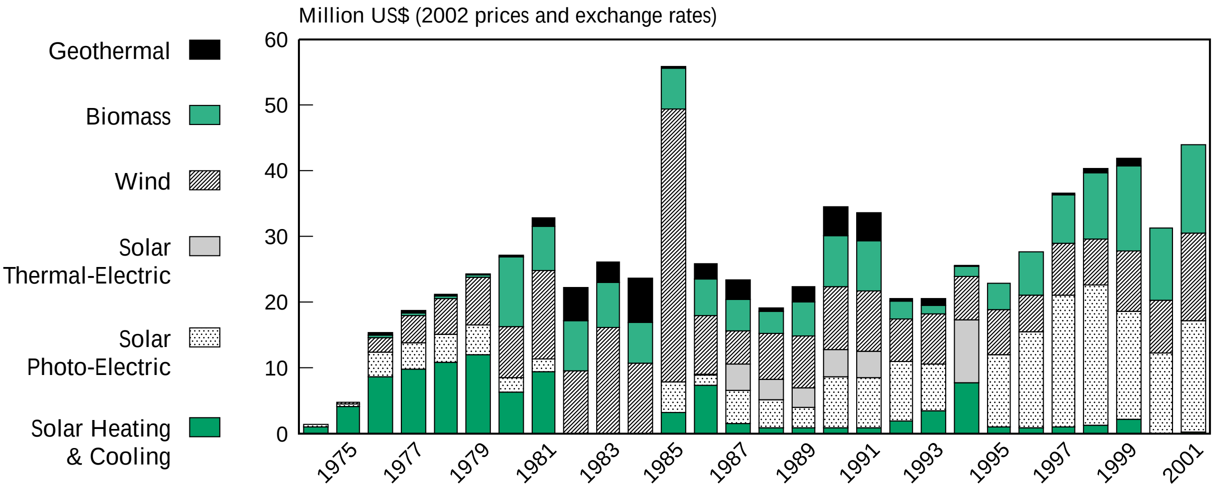
Among the renewable technologies, wind power received the highest level of funding at US$ 243.8 million, or 33%, in the 1974 to 2001 period. Solar photo-electric was funded at US$ 184 million, representing 25% of renewable energy RD&D. Biomass was the third largest recipient with 20% of the renewable RD&D expenditures from 1974 to 2001.

Prior to 2000, the Ministry of Economic Affairs managed 25 technology-specific multi-annual programmes covering short- and long-term research and development, as well as demonstration and market introduction. The programmes and the specific projects funded were determined by the Ministry and the Netherlands Agency for Energy and Environment (NOVEM). NOVEM reviewed the programmes annually, and an external evaluation was held upon programme completion. Such evaluations found that targets, *e.g.*, technology uptake, energy conservation, were often not met, leading to the continuation of programmes with larger budgets. The programmes were deliberately broad, covering an extensive range of energy technologies.

In 2001, the government decided that it should not be dictating specific technologies to achieve general energy goals, and the programmes were changed to two broad themes: EDI, the programme for energy efficiency through innovation; and DEN, the programme for renewable energy. In the same year the White Paper, called Energie Onderzoek Strategie (EOS), established a framework for clarifying which key technologies should form the focus of RD&D policy.

In 2002, the RD&D programme was reviewed and changed to better reflect this new framework. Short-term RD&D is generally left to the private sector or supported through innovation policy measures, and long-term (commercialisation after 2010) energy RD&D and demonstration projects are established by the Ministry of Economic Affairs in consultation with a range of stakeholders.

Figure 6**. Netherlands - Government Renewable Energy RD&D Budgets**



In addition, the Netherlands participates in international collaborative RD&D in Bioenergy, District Heating and Cooling, Photovoltaic Power Systems, Solar Heating and Cooling and Wind Turbine Systems through IEA Implementing Agreements. The Netherlands actively participates in the EU Framework Programmes for Research and Technological Development.

Market Deployment Trends

The first renewable energy to achieve any significant market share in the Netherlands was biomass, which began to be installed in the mid-1970s. These systems were mainly farm-based waste incinerators and digesters, installed due to the high fossil fuel prices of that period. This initial surge tapered off as fossil fuel prices came down, and by 1985 there were almost no renewables in the Netherlands' energy supply.

In the late 1980s, however, a second market surge started. The pace picked up in the early 1990s, due in large part to the Milieu Actie Plan (MAP), a voluntary programme between energy sector companies and the Ministry of Economic Affairs. This scheme included a levy on energy consumers of about 1.8% which was recycled into financial incentives. The market again tapered off in the mid 1990s, and then a third surge took place in the later part of the decade. This surge included some wind and solar in addition to biomass. This upswing was the result of a combination of policies, including a loan interest rate buy-down, a Regulatory Energy Tax (designed to raise the price of conventional energy so renewables would be more competitive), and the further development of voluntary programmes including green labelling and the offer of “green energy” by utilities. These “green” measures were premium priced products for consumers that were offered by seven of the country’s utilities.

Between July 2001 and July 2003, renewable energy consumption up to 10 MWh per year was exempt from the environmental tax on fuels (“ecotax”). This measure was successful in terms of increasing the number of green electricity buyers: the number of customers climbed from approximately 250 000 in July 2001 to more than 1.5 million in 2003 (20% of households).

This enormous increase in demand had some unanticipated negative consequences. The ecotax exemption led to very large electricity imports from renewable energy installations abroad resulting in considerable loss of tax revenues. At the same time, the scheme did not effectively stimulate additional investments in renewables in the Netherlands or elsewhere. The production of renewable electricity in the Netherlands has not risen enough to cover demand because the industry considered the regulatory and fiscal framework too unstable and because of the difficulties and delays in obtaining permits and licences, especially for wind turbines.

These consequences caused the government to review its renewables policy and subsequently led to an amendment to the 1998 Electricity Act. This amendment is called Environmental Quality of Electricity Production (*Milieukwaliteit Elektriciteitsproductie*, MEP) and came into force in July 2003. The MEP aims to increase certainty to investors and improve the cost-effectiveness of renewable electricity support. The MEP provides operating support through a combination of reduced ecotax exemptions and subsidised feed-in tariffs. In effect, the ecotax exemption was reduced to € 0.029/kWh for most forms of renewable electricity for consumption up to 10 MWh per year. It is planned that the ecotax exemption will be gradually decreased to be compensated by a subsequent increase in subsidies.

Under MEP, Dutch renewable electricity generators receive subsidies, which depend on the difference in costs (including investment, operation and maintenance cost) between their facilities and conventional (non-renewable) units. The maximum level of the subsidy is set at the difference between the production cost of offshore wind power and the average selling price of fossil-fuel powers, on average € 0.027/kWh. The renewables eligible for subsidies are wind energy, bio-energy (including waste incineration, landfill gas and digestion), hydropower, photovoltaics and wave and tidal energy. The producer must be connected to the national electricity grid and the installation must be maintained and exploited for at least ten years. For each installation the level of the MEP tariff is fixed for ten years at the level of the tariff in the first year that was requested by the producer. The ecotax exemption will be abolished at the beginning of 2005.

The feed-in tariff levels are reviewed annually, taking into account the decline in costs resulting from learning curves. In the annual reviews, tariffs are fixed for the next two to three years. The government prefers annual reviews over a pre-set reduction scheme to be able to use the latest market parameters to define the appropriate tariff level.

In addition to the feed-in tariffs, renewable electricity generators benefit from Energy Investment Tax Relief (EIA), which allows 55% of eligible costs to be deducted from the profits tax to promote investments in energy saving and renewable energy. In 2002, the total investments in renewable energy projects eligible amounted to € 803 million.

The Energy Premium Regulation (EPR) aims to increase demand for renewable energy in households. Subsidies are financed from the revenues of the Regulatory Energy Tax and can be given to both tenants and landlords. EPR was first implemented in 1999 by giving tax incentives but was converted into a subsidy scheme in January 2003. In 2002, it had a total budget of € 24 million for renewables of which some € 16 million was used for photovoltaics.

In addition to the MEP and feed-in tariffs, several other new policies have been established in recent years, such as replacing green certificates by guarantees of origin as part of the implementation of the European Union renewable electricity directive. There are not yet enough data to evaluate the impact of these recent schemes.

Energy Policy Context

In 1995 a target was established to increase the contribution of renewables to TPES from 1% in 1995 to 10% in 2020. The basic package of the CO_2 reduction plan and the Renewable Energy Action Programme 1997 to 2000 set an interim target of 5% by 2010, which requires an increase of 3.5 percentage points from the current level.

Following the EU Directive to promote electricity production from renewables (2001/77/EC), the Netherlands agreed to an indicative target of generating 9% of its electricity from renewables by 2010. Policy for renewable electricity generation mainly focuses on wind energy and biomass, which are expected to contribute the most to achieving the targets. Offshore wind power has an indicative target of 6 000 MW by 2020.

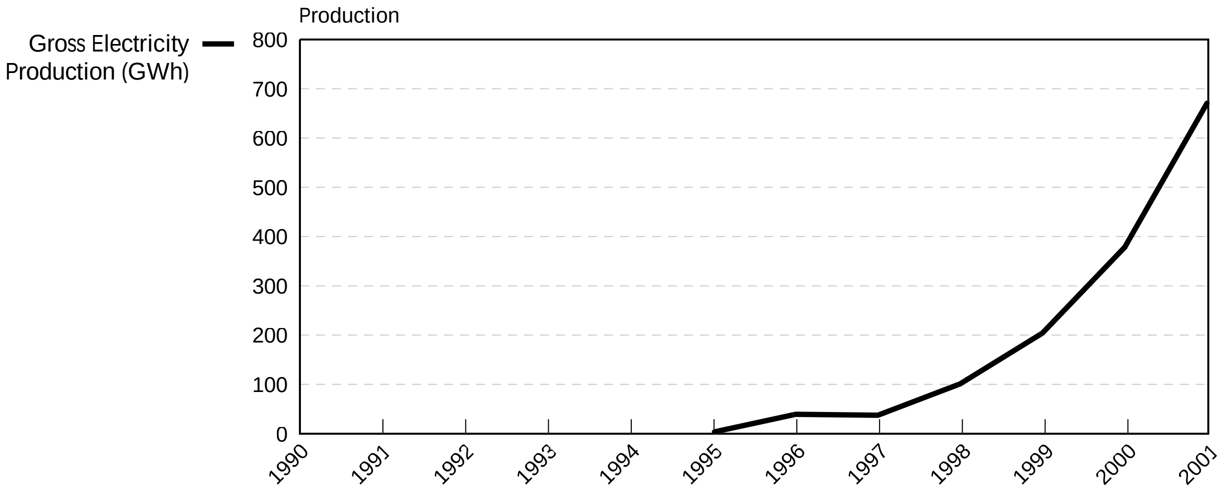
The Netherlands is taking both demand-side and supply-side measures to promote renewables. On the demand-side, consumers were given the freedom to choose their “green electricity” supplier in July 2001. Households also receive subsidies if they invest in equipment using renewable energy. On the supply-side, direct incentives are given to producers.

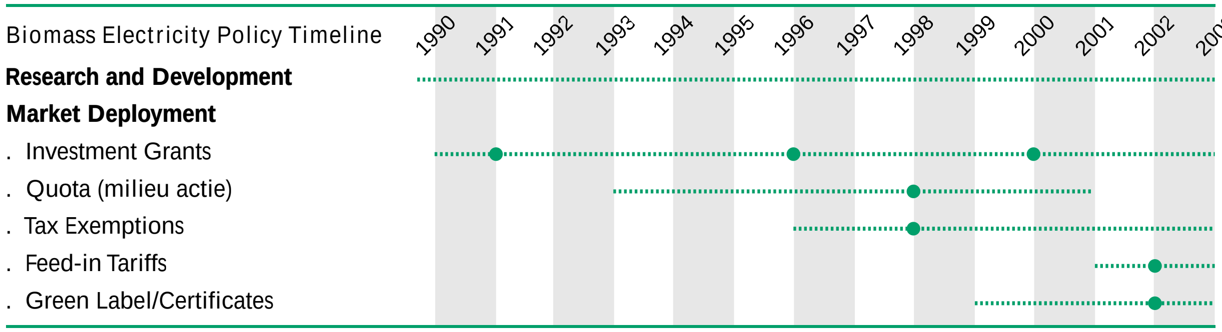
The lead times for investment in renewable energy systems tend to be long due to difficulties in licensing and permit procedures. At present, it can take four to five years to complete the process for wind systems. The government is making efforts to address the barriers formed by spatial planning by introducing harmonisation and acceleration of the planning procedures.

Renewable Energy Markets

Biomass Electricity Production

Figure 7. **Solid Biomass Electricity Production**





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Biomass electricity production has been growing slowly but steadily. It is primarily used in co-firing in coal plants (as a result of the "coal covenant" with the electricity production sector) and waste incineration. Landfill gas and digestion of organic wastes also contribute to electricity production.

Biomass projects qualify for the MAP feed-in tariff scheme, the EIA tax deduction, and the regulatory energy tax (REB). This combination of policies has driven growth, but the market seems to have levelled off in recent years. Biomass has the largest renewable energy potential in the Netherlands; however, public resistance towards the application of certain biomass types, *e.g.*, poultry dung, is a point of attention for policy-makers.

A Biomass Action Plan has been developed in co-operation with market parties and provided to the Parliament in late 2003. The Action Plan tackles various restrictions and problems that are present when starting up biomass projects in the areas of financing, licensing, public relations, the availability of fuel and biomass technology.

Wind Power

Figure 8. **Wind Power Capacity and Electricity Production**

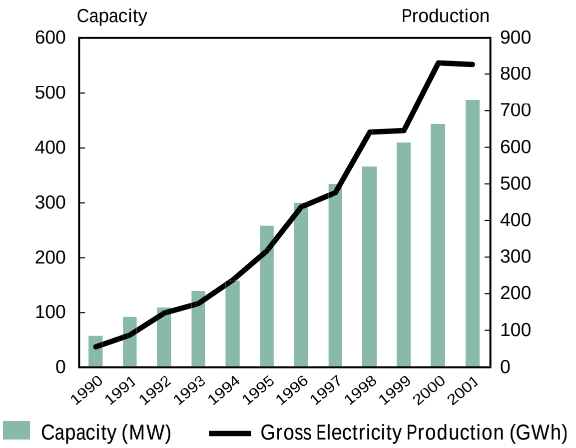
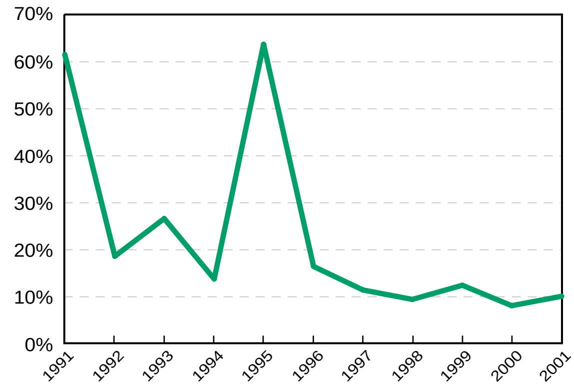
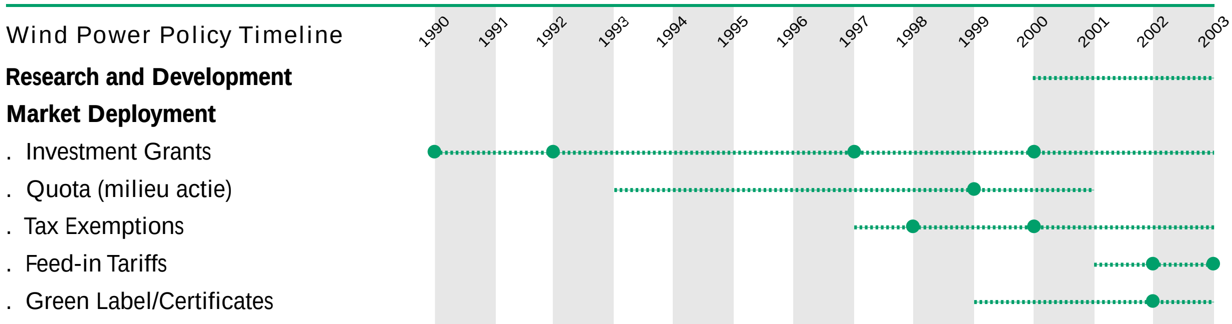


Figure 9. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Wind power was the beneficiary of one of the earliest investment incentives which began in 1989, and led to the opening of the market. The original scheme was supplemented in 1997 with a special incentive for non-profit groups, an energy investment deduction for private firms, and again in 2000 with a depreciation scheme. In July 2003 the MEP feed-in tariff scheme was started. Land use issues are limiting onshore installations, and new incentives and rules for offshore projects are being developed.

In 2001 the government's policy and targets for renewable energy were revised. Wind and biomass are expected to provide the greatest contributions to the 2020 target of 10% of TPES from renewables. The onshore wind target is 1500 MW by 2010; an offshore wind target of 6 000 MW of installed capacity is seen as possible. The government aims to create the conditions to reach these targets through various instruments such as fiscal incentives and financial instruments; spatial planning; research programmes; a competitive green market; administrative agreements; and research and demonstration programmes. The main challenge for onshore wind remains securing sufficient sites for wind turbines.

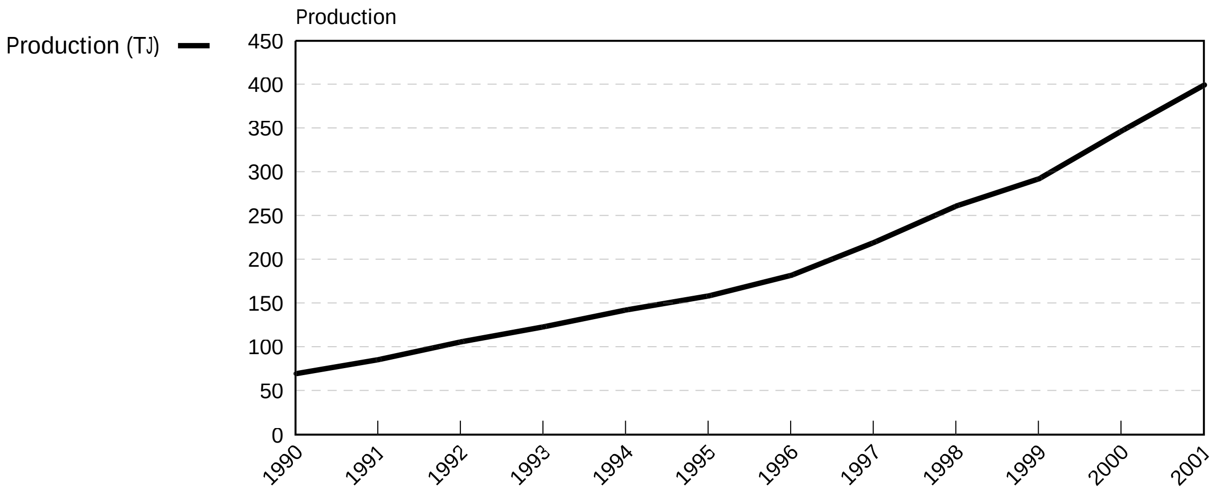
Inter-governmental efforts are underway to address siting and permitting matters for wind power development. In July 2001 an Administrative Agreement - National Development of Wind Energy (Dutch acronym BLOW) was signed by the Ministers of the Department of Housing, Spatial Planning and the

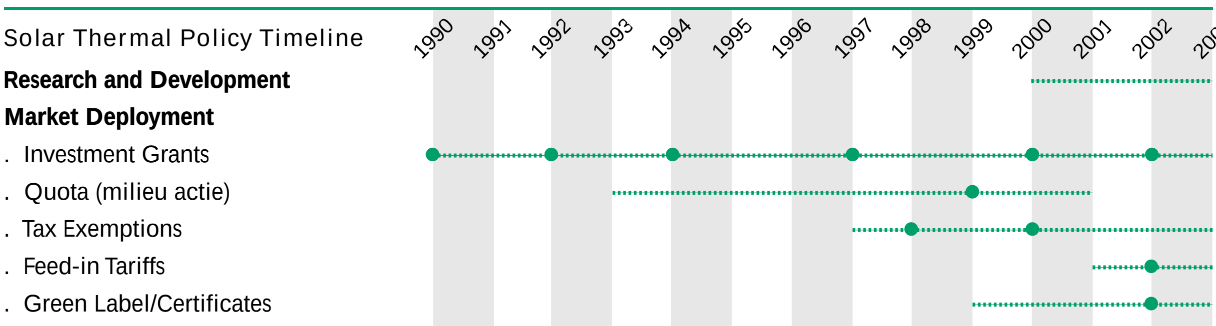
Environment, the Department of Economic Affairs, the sub-secretaries of state of the Department of Agriculture, Nature Management and Fishing, the Department of Traffic and Waterstate and of the Department of Defence. Co-signing were the provinces and the Association of Dutch Communities. Furthermore the government also aims to streamline and shorten the procedures for building permits. In 2002 the government carried out an investigation into the bottlenecks of wind projects. This was followed in 2003 with an operation (Better Policy for Citizens and Private Companies) that aims to evaluate the complex chain of laws and rules that apply to wind projects. The ambition is to shorten the process to two and a half to three years and to have one integrated permit.

A draft concession regime has been discussed with prospective offshore wind developers. It will be implemented in 2004. A survey of issues for the integration of 6 000 MW of offshore wind into the Netherlands grid system was carried out in 2002-2003. The first two offshore wind power facilities, with capacities of 100 MW and 120 MW, will be constructed in 2004 and 2005.

Solar Thermal Production

Figure 10. **Solar Thermal Production**





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Solar thermal hot water systems have increased steadily. About 66% of solar thermal production is used in residential systems, 14% in large collective systems and 20% for swimming pools. These have been primarily the result of various investment subsidy schemes, and the Regulatory Energy Tax that increased the rates on conventional consumer prices.

Since 2001 the EPR subsidy scheme for households has resulted in a fair boost of investments in solar thermal systems. The subsidies were part of a long-term agreement between the government, solar industry, installation sector and the utilities. This agreement was reached in 1994 and ended in 2002. It provided a subsidy, price reduction and funds for product development. It had an important role in the growth of the market, but not as big as expected. The government decided therefore not to renew the agreement and leave the market development to the solar industry.

For new buildings the energy performance standard (EPN) has had a positive effect on installed capacity. In new buildings the penetration of solar water heaters is about 10%, because they help to reach the energy performance standard set in building codes.

Solar Photovoltaic

Figure 11. **Solar Photovoltaic Capacity and Electricity Production**

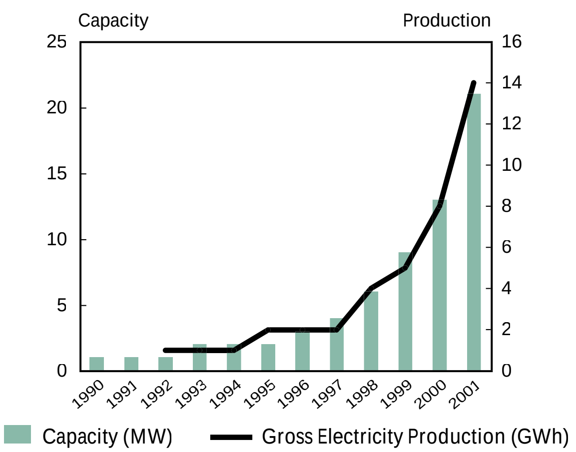
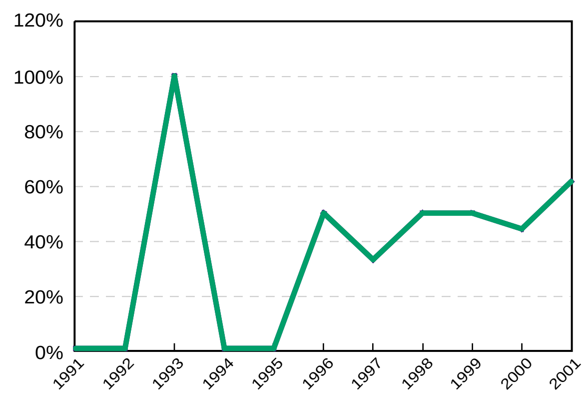
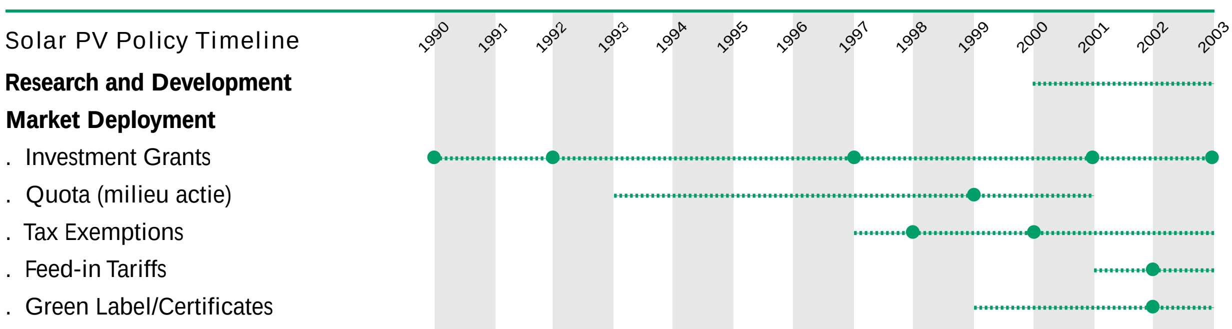


Figure 12. **Solar Photovoltaic Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

The PV market showed steady growth from 1989 due to the combination of policies in place, including successive RD&D, market development and generic market support. Starting in 2001, the subsidy scheme was changed from an option specific to renewable energy in general approach, with the contribution to the total installed power in 2020 as one of the main selection criteria. This resulted in a major reduction of support to PV R&D and demonstration projects. The investment credits (EPR scheme) implemented in 2001 led to strong growth in the PV market, in which home owners received an almost 100% investment subsidy. At the end of 2003, however, the government cut back the EPR subsidy scheme which is likely to result in considerably less investment by private house owners. Public funding for certain fields of solar PV R&D will be continued and even strengthened as a result of the 2003 energy strategy (EOS) report.

Netherlands Policy Chronology

Milieu Actie Plan (MAP): Environmental Action Plan

Year 1990-2000

Policy Description The objective of this plan is to promote energy efficiency and energy production from renewable sources. A specific target for renewable energies was set in 1997: to attain at least 3.2% of electricity distributed from renewable sources by the end of 2000. MAP was a voluntary agreement between the energy sector and the Ministry of Economic Affairs. A MAP levy was charged at about 1.8% on energy consumption. This levy was used to finance programmes to meet the objective and target, which were designed and implemented by utilities.

In 1997, a system of green labels was introduced by the utilities to distribute the cost burden of the renewable electricity target over the utilities in a more equal manner. This is effectively a quota system with tradable certificates.

Policy Type Obligations/tradable certificates

RE Technology All renewables

Green Funds

Year 1995 - Present

Policy Description Loans for green projects, which include virtually all renewable energy systems are available at rates 1-2% lower than the prevailing rate. In addition, investment income (such as interest or dividends) derived from green funds are exempt from income tax. To be eligible, a bank has to apply for a “green declaration” for a project. The “declaration” has a maximum duration of ten years.

Policy Type Third-party finance / Tax exemptions

RE Technology All renewables

Regulating Energy Tax

Year 1997 - Present

Policy Description The Regulating Energy Tax (REB) is an energy levy on electricity and gas consumption by small and medium-size customers. Since 1999, energy from renewable sources has been exempt from the tax. The proceeds from the tax can be used by suppliers as a premium tariff for renewable energy producers (not mandatory). In 2002, this combination totalled € 0.08/kWh (€ 0.06/kWh tax exemption + € 0.02/kWh production support).

Since 2001, a Green Certificate System has been used for the validation and monitoring of the production and sales of green electricity under the REB. In

2003 the energy tax on fossil electricity for small consumers (<10 000 kWh) was further raised to € 0.0639/kWh, with a partial exemption of € 0.029/kWh for renewables. With this tax level, green electricity is on average as expensive as regular electricity.

The energy tax exemption applies only to renewable electricity possessing a green certificate. Due to budgetary constraints, the REB facilities for renewables (the exemption) will be partially phased out in 2004 and totally in 2005. The MEP feed-in tariff scheme will replace the REB facilities. The production subsidy for renewables in the REB was phased out on the same date that the MEP scheme was started (1 July 2003).

Policy Type Fossil fuel taxes

RE Technology All renewables. As of 2002, small-scale hydro is no longer eligible.

Green Mortgages

Year 1996-1998

Policy Description For two years starting in November 1996, "sustainably built" houses could be financed in part with lower interest rate loans. Houses costing NLG 400 000 (US$ 188 000) or less could qualify for a green mortgage. A buyer could receive a loan of up to NLG 75 000 (US$ 35 000) for ten years at a rate roughly 20% below the prevailing market price (at about 4% instead of 5%). The so-called green mortgage let a buyer recoup roughly 75% of the additional costs of environmental extras. A total of 5 000 mortgages were allotted for the two years, after which the programme was suspended for evaluation.

Policy Type Third-party finance

RE Technology All renewables

Energy Investment Deduction

Year 1997 - Present

Policy Description This fiscal measure known as EIA aims to save energy by stimulating investment in energy efficient and renewable energy technologies. It allows investment in certain technologies (including wind) to be deducted from taxable profit up to a percentage of investment costs. Since 2001, this percentage has been 55%. With a taxation level of 35% for Dutch entrepreneurs, the EIA amounts to a discount of 19% of investment costs if the entrepreneur can use the full deduction. The maximum deduction is € 99 million per fiscal entity. The minimum investment (in the year of application) is € 1 900. The EIA can be viewed as a reduction in investment costs.

Policy Type Investment tax credit

RE Technology All renewables

Subsidy Regulations Energy Supply in Non-profit and Private Sectors

Year 1997-2002

Policy Description This measure known as EINP was a subsidy meant for stimulation of investment in renewable energy by non-profit organisations. This subsidy applied to the majority of farmers who invested in wind energy as private individuals. The subsidy amounted to 18.5% of investment for not-for profit organisations, and 20% for individuals. The subsidy only applied to investments larger than € 1 750. The EINP scheme was phased out in 2003, with the start of the MEP scheme.

Policy Type Consumer grants

RE Technology Onshore wind

VAMIL Depreciation Scheme

Year 1990's-2003

Policy Description The VAMIL depreciation scheme allowed enterprises to decide when they want to depreciate investments in specific environmentally benign equipment. This scheme may have reduced income and company taxes. An interest and liquidity advantage was gained by shifting the payment of taxes to the future. Accelerated depreciation was only applicable to equipment which was included in the yearly updated VAMIL list "Milieulijst". The equipment must have been new and should have been available in the Netherlands, *e.g.*, biomass preconditioning, biomass burning equipment, solar PV-systems. The incentive was applicable to all taxable Dutch enterprises. In 2000, tax expenditure under VAMIL amounted to NLG 250 million (€ 113.45 million); in 1999 47% of the investments were related to energy.

The objective of this policy was to stimulate investments in environmentally benign technologies, which included all renewable energy technologies. The VAMIL scheme allowed investors to decide when they offset their investments against taxable profits. Expenditures on the instrument including non-energy and energy efficiency measures grew from NLG 7.5 million (€ 3.4 million) in 1991 to NLG 70 million (€ 31 million) in 1999. Expenditures on renewable energy formed only a small part of this at approximately € 5 million per year.

From 2003 onwards, due in part to budget cuts from a new government, the VAMIL scheme no longer applies for energy (including renewable) investments. Therefore since 2003, the EIA scheme has been the only tax investment incentive for renewables.

Policy Type Investment tax credits

RE Technology Biomass
Solar photovoltaic

Energy Premium and Energy Performance Advice

Year 2001 - Present

Policy Description Energy Premium (EPR) is a subsidy scheme for households and social housing corporations investing in energy efficiency and renewable energy. The subsidy averages between 25% (energy efficiency) and 50% (renewable energy). Energy Performance Advice (EPA) is a consultation that can be requested by an association of owners, landlords and tenants, to improve the energy performance of their dwellings or offices. The consultation is performed by a certified company, and lists the possible measures to be taken. If the advice is neglected, a bill is presented. Should one or more of the measures be carried out, EPA pays the bill, and EPR will subsidise part of the cost. In addition, EPA adds a bonus of 10% (for individuals) to 25% (for housing co-operatives and landlords) to the EPR premium.

Both measures are financed by means related to the energy tax (REB). The mechanism thus encourages energy efficiency. One of the requirements for using EPA and EPR is that the consumer pays REB. Due to general government budget cut backs, energy efficient equipment will no longer be subsidised by the EPR from 2004. Renewable energy equipment (heat pumps, solar boilers and PV) and EPA energy consultations remain in the EPR scheme but with a lower budget (approximately € 20 million).

Policy Type Consumer grants/rebates

RE Technology All renewables

Renewables for Government Buildings

Year 2001

Policy Description By 2004, 50% of electricity consumption in all government buildings is to be derived from renewables sources. An important instrument is central purchasing of green electricity.

Policy Type Government purchases

RE Technology All renewables

RD&D Programme DEN (duurzame energie in Nederland)

Year 2001 - Present

Policy Description DEN is a tender programme for renewable energy projects. It is a follow-on programme from the former NOVEM programmes for specific renewable energy technologies.

Policy Type RD&D

RE Technology All renewables

MEP: Environmental Quality of Electricity Production (Milieukwaliteit van de Elektriciteitsproductie)

Year 2003 - Present

Policy Description The MEP is a kWh subsidy that is paid to domestic producers for electricity from renewable sources and CHP who feed-in to the national grid. It is guaranteed for a maximum of ten years (not for CHP). The level of producer support is differentiated for technologies. The highest support level (€ 0.068/kWh) is granted for offshore wind, PV, small (< 50 MW) stand-alone biomass installations, hydro, wave and tide energy. For onshore wind, the production support is € 0.049/kWh for a maximum of 18 000 full load hours in ten years. The subsidy is financed by a levy of € 34 (2003) on all connections to the electricity grid in the Netherlands. This levy is for 100%, compensated by means of a reduction of the REB on fossil energy consumption. The MEP producer support exists along with a partial REB exemption for renewable electricity consumption. The MEP support levels in 2004 (1 July) and 2005 (1 January) will be adapted in line with the phasing out (in two steps of € 0.015/kWh) of the REB renewable energy tax exemption.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology All renewables

New Zealand

Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

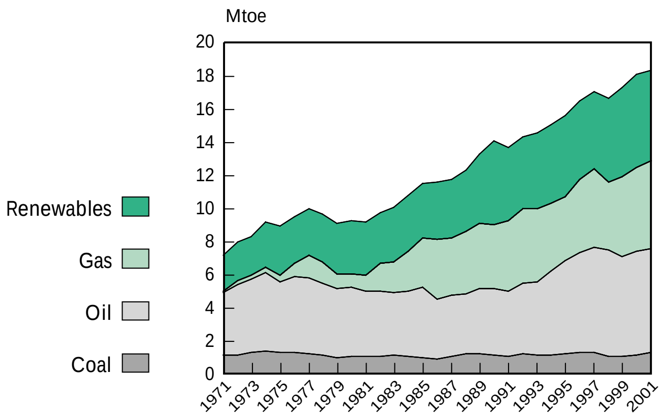
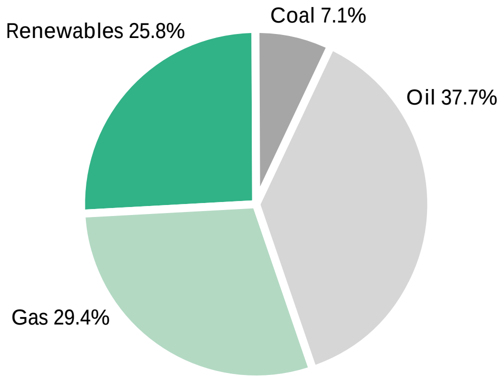


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1. See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1970	1980	1990	1995	2000	2001	Imports
Coal	1.2	1.0	1.1	1.2	1.1	1.3	•
Oil	3.9	4.2	4.0	5.7	6.3	6.4	73.5%
Gas	0.1	0.8	3.9	3.9	5.1	5.3	-
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	-
Renewables	2.1	3.2	4.8	5.2	5.1	4.7	-
Biomass	*0.0*	*0.5*	*0.6*	*0.7*	*0.9*	*0.8*	
Hydro	*1.0*	*1.6*	*2.0*	*2.3*	*2.1*	*1.8*	
Geothermal	*1.1*	*1.0*	*2.2*	*2.2*	*2.1*	*2.0*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.0*	*0.1*	*0.1*	
Total	**7.2**	**9.2**	**13.9**	**16.0**	**17.9**	**18.1**	**18.1%**
% Renewables	*28.7%*	*34.4%*	*34.7%*	*32.6%*	*28.0%*	*25.8%*	

** See Annex 2 for explanation of components in total and definition of biomass.*
• Net Exporter

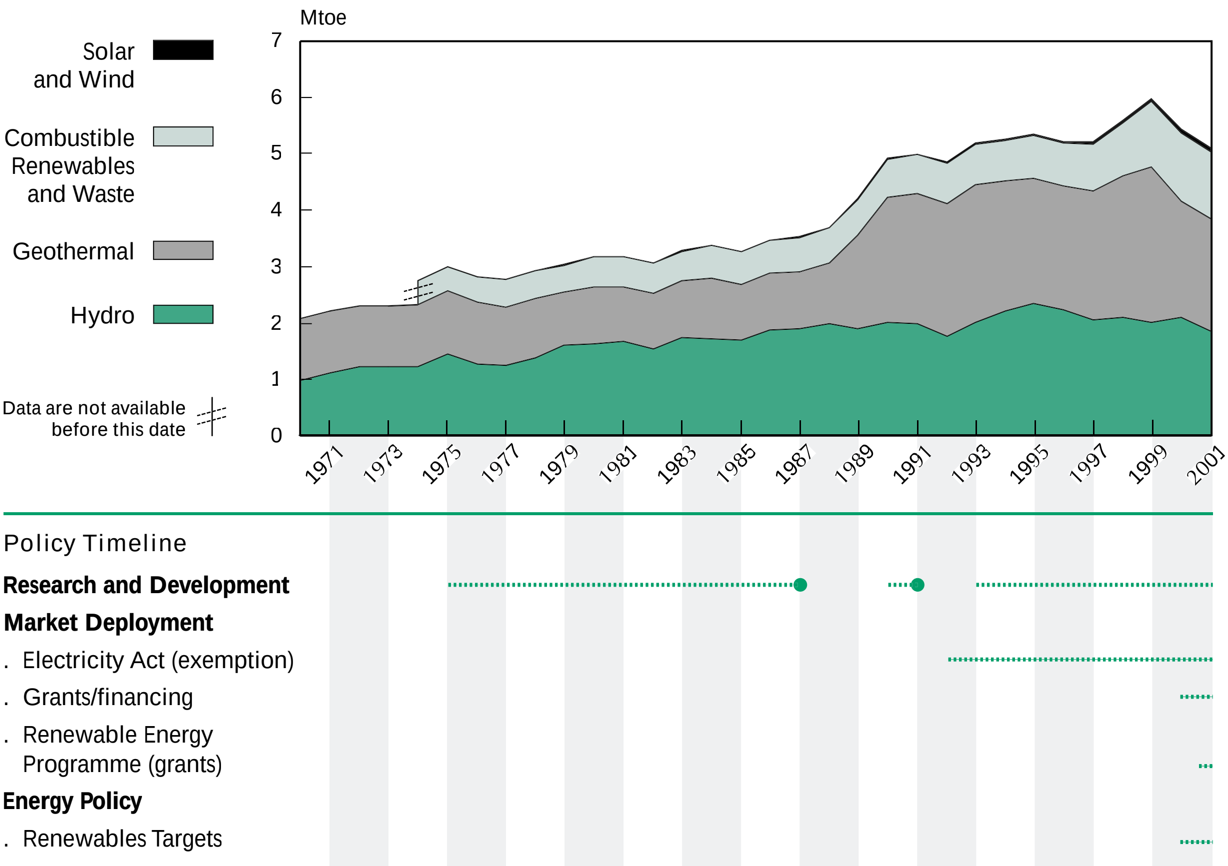
New Zealand is energy self-sufficient except for oil, which in 2001 accounted for 35% of total primary energy supply (TPES). Natural gas represented 29% and coal some 7%.

Renewable energy plays a major role in meeting energy demand in New Zealand, primarily hydro and geothermal electricity and biomass. Renewable energy sources accounted for almost 26% of TPES in 2001, but its share is steadily declining as total energy demand increases, particularly for transport fuels and natural gas-fired electricity generation. According to New Zealand statistics, renewables accounted for 27% of TPES in 2002.

Hydro and geothermal are the basis of electricity production, accounting for about 62% of total generation in 2001. Hydropower capacity was 5.3 GW; geothermal capacity represented another 417 MW. New Zealand had some 57 MW of biomass-electricity generation and 20 MW of generation from biogas in 2001. Generation from wind was 137 GWh in 2001, with 36 MW of installed capacity. The government's strategy is to structure the electricity market so as not to discriminate against new and emerging renewable energy sources.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Geothermal and hydropower account for the largest shares in renewable energy supply in New Zealand. In 2001, geothermal was 42% and hydropower was 38% of total renewable primary energy supply. Geothermal generation capacity in 2001 was 417 MW, an increase from 261 MW in 1990. Hydropower capacity increased from 4.6 GW in 1990 to 5.3 GW in 2001. After hydropower and geothermal, biomass is the next significant contributor to total renewable energy supply, accounting for 17% in 2001. Most of the biomass is consumed for direct heat in the final energy sector.

Research and Development Trends

New Zealand spent a total of US$ 182 million (2002 prices and exchange rates) on government energy RD&D between 1975 and 2002. In this period, 31% of its total RD&D budget was allocated to renewable energy.

The overall trend of government RD&D expenditures for renewables peaked in the early 1980s and declined notably after 1985. Government RD&D budgets for renewables increased somewhat in 2001 and 2002.

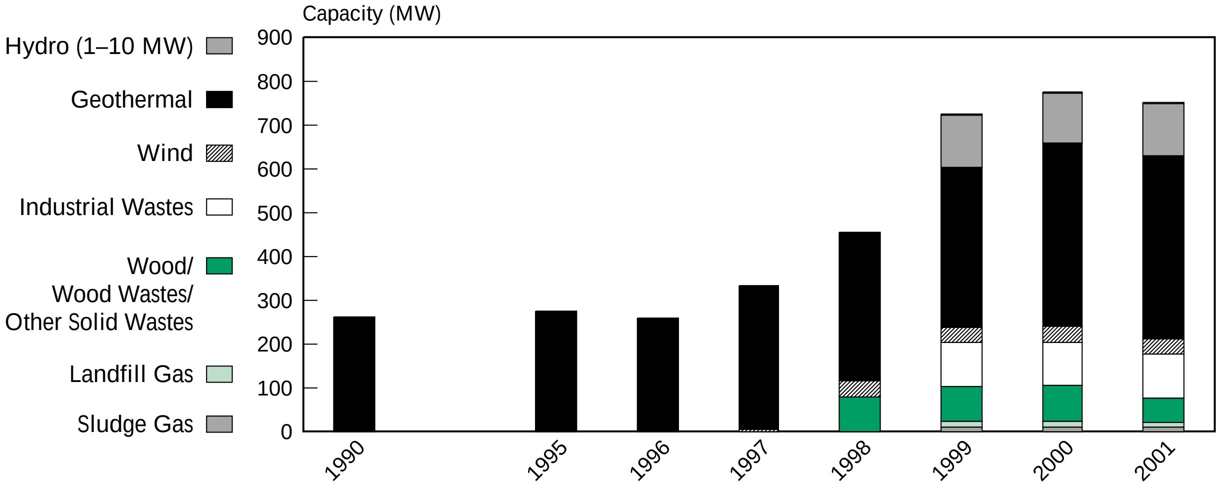
Among the renewable technologies, geothermal received the highest level of funding at US$ 34 million, or 60%, in the 1975 to 2002 period. Biomass was funded at US$ 16.3 million, representing 29% of renewable energy RD&D. Wind was the third largest recipient with 4.5%.

The oil price shocks in the 1970s resulted in higher public RD&D investment. However, once the crude oil price dropped in the early 1980s both funding agencies, the New Zealand Energy Research and Development Committee and Liquid Fuels Trust Board, were closed. The Ministry of Energy became part of the Ministry of Commerce soon after. In the 1990s, the Foundation of Research Science and Technology was established and funded a series of research programmes for renewable energy, particularly geothermal and biomass. Higher levels of investment in fossil fuels in recent years were made to support oil and gas exploration due to lower than expected natural gas reserves. This competed with investment in renewables.

Renewable energy RD&D is mostly applied research, though some support has been given to new solar capture systems based on poryphyrins. Hydropower is deemed a mature technology.

In addition, New Zealand participates in international collaborative RD&D in Bioenergy, Geothermal, Solar Heating and Cooling and Wind Turbine Systems, and more recently Hydrogen, through the IEA Implementing Agreements.

Figure 4. **Net Generating Capacity of Renewable and Waste Products**



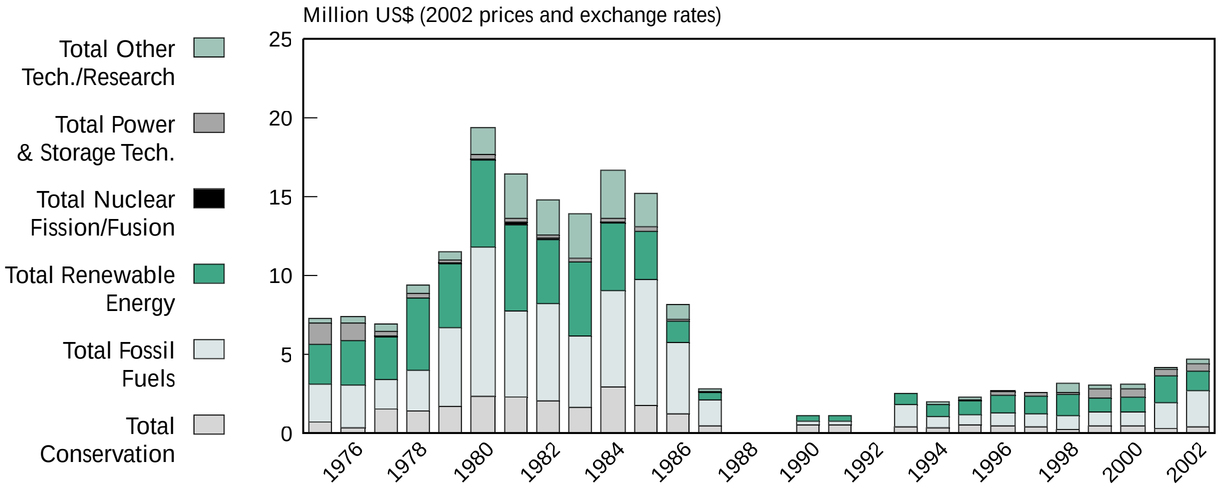
Note: A change in data collection methods at the IEA occurred in 1999 with the separation of net generating capacity between small and large hydro. Capacity data for small hydro are not available prior to 1999.

Market Deployment Trends

Before 2000, renewable energy programmes in New Zealand were largely aimed at informing and facilitating competitive markets in a deregulated economy. There were no quantitative targets or policies to promote renewable energy sources. These were not considered necessary since hydro and geothermal for electricity and biomass for heat had long been capturing a third of the market at competitive rates. The only support for new renewables such as solar PV, bioenergy and wind was an exemption from a cap on the construction of additional generating capacity by the dominant generator, ECNZ, in 1992 under the Electricity Act.

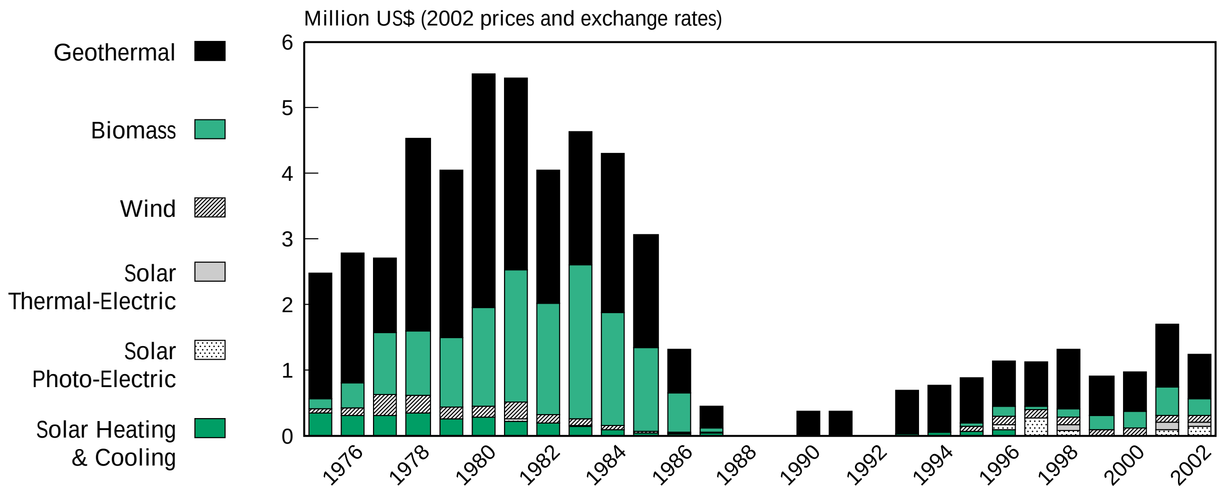
The National Energy Efficiency and Conservation Strategy, arising from an Act passed in May 2000, set out further measures to encourage greater uptake of renewable energy. It set a target to increase New Zealand's supply of renewable energy by 30 PJ in 2012. Measures to promote renewable energy are being implemented through the Renewable Energy Programme. Most of the initiatives to date aim to expand information and education about renewables and to support demonstration projects, rather than setting favourable prices for renewable energy sources. However, there is a financial support programme for the solar water heater industry and a new "projects mechanism" to encourage greenhouse gas mitigation projects with more than a 10 000 tonne carbon offset during the 2008-2012 period. In this mechanism, carbon credits, nationalised from the forest industry's "Kyoto forests", can be bid for by project developers and then sold on the international market to offset the project investment costs. This has resulted in several project developments including an 84 MW wind farm under construction and the doubling in capacity of an existing 32 MW wind farm.

Figure 5. **New Zealand - Government Energy RD&D Budgets***



** Data are not available for 1988, 1989 and 1992.*

Figure 6. **New Zealand - Government Renewable Energy RD&D Budgets***



** Data are not available for 1988, 1989 and 1992.*

The Renewable Energy Programme has helped to establish renewable energy industry associations and networks to support the uptake of renewable energy technologies. Direct assistance grants have been provided in the form of support for reduced interest payments for the installation of a small number of solar water heaters, particularly for low-income homes. The grants had a major impact on the solar water heating industry as the whole sector received a boost from the publicity that resulted from the grant money. The aim is to increase annual sales from 1 000 to 10 000 by 2010. Increased training of installers is part of the activity.

A forthcoming green pricing initiative is expected to test consumer interest in small-scale renewable energy at a small premium on current prices.

Energy Policy Context

A current barrier to further installation of renewable energy projects in New Zealand is the financial viability of the systems due to the low wholesale price of electricity in the liberalised electricity market. Renewable energy sources must compete directly with other sources of generation. Recent announcements confirming a 17% reduction in recoverable reserves of natural gas, together with a proposed small carbon charge (capped at around US$ 15 per tonne CO_2 equivalent) on fossil fuel consumption after 2007 will enable renewables to become more competitive in the future.

With regard to grid connection policy, small-scale electricity generation connected to local grid networks will be helped along by new regulations, which are currently under review. A discussion paper in October 2003 outlined proposals to regulate grid company charges and conditions for connecting generators to their networks.

Around 15 to 20% of New Zealand's electricity already comes from small plants connected to local networks. This distributed generation includes small hydro schemes, landfill gas, small geothermal, diesel, gas, wind, solar and co-generation including from wood processing residues.

The government sees benefits in distributed generation and wants to encourage its growth. There is considerable potential for more small-scale power projects and increasing interest from electricity companies and other investors.

It is anticipated that regulating line charges for distributed generation will help the expansion of renewable generation. Wind farms and micro hydro stations are frequently located away from the national grid and the ability to connect to local lines for a reasonable charge will help make such projects viable.

Some grid companies have actively encouraged distributed generation on their network by contracting for capacity to meet peak demands and hence offset the costly upgrading of lines that are nearing load carrying capacity. They have produced guidelines for distributed generation developers in their region including at the small domestic net metered scale <5 kW; as well as guidelines for medium 5-30 kW and large 30 kW to 1 MW projects.

Other grid companies have sought high charges from new generation developers which have constrained some renewable energy projects from proceeding, hence the government's proposed regulations. The regulations are expected to come into force in 2004 and are due to be refined and administered by the newly established Electricity Commission as regulator.

Renewable Energy Markets

Hydropower

Figure 7. **Hydropower Capacity and Electricity Production**

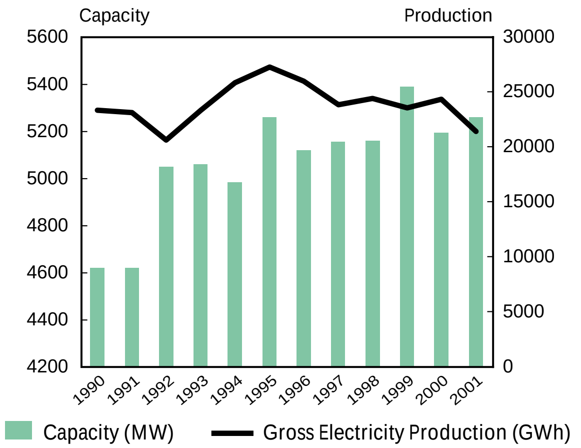
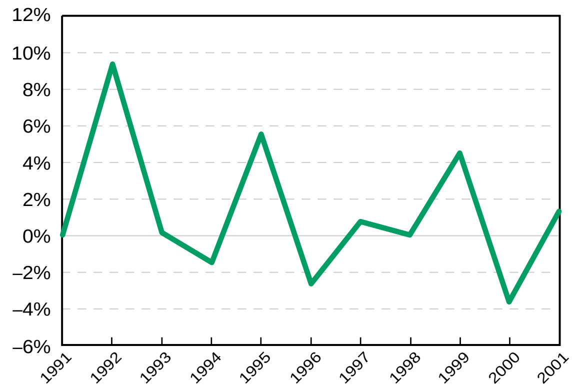


Figure 8. **Hydropower Capacity** (Year to Year Change)



Hydropower Policy Timeline

1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003

. No Major Policies

Hydropower accounted for 54% of total electricity generation and produced 21.5 TWh in 2001, which was a dry year.

Large hydropower is considered a mature technology and there have been no recent related policies. Government involvement is focused on small hydro projects in terms of easing the resource consent process by modifying the Resource Management Act to encourage authorities to take greater heed of greenhouse gas mitigation benefits.

Biomass

Overall the use of biomass increased from 24.2 PJ in 1990 to 32.9 PJ in 2001, with an average growth of 2.8% per year. Most of the biomass is consumed in the industrial and residential sectors. The forestry industry in New Zealand produces major quantities of wood residues that are used on-site for process heat such as kiln drying timber or for co-generation. Wood is also used in large quantities to provide residential space heating in both open fireplaces and modern wood burning devices.

Figure 9. **Solid Biomass Capacity and Electricity Production**

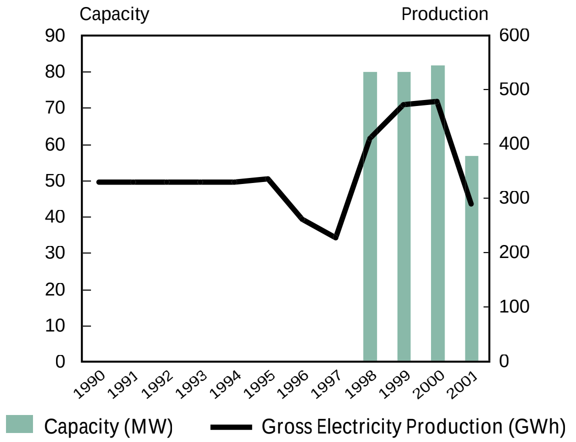
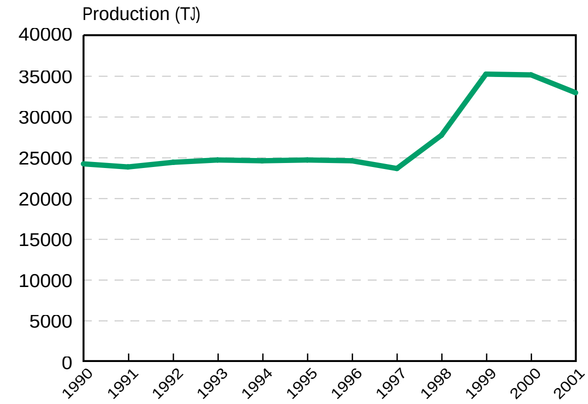
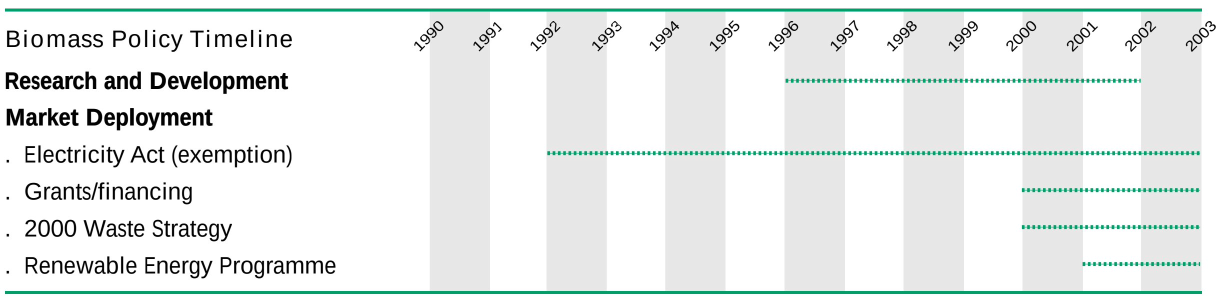


Figure 10. **Solid Biomass Production**





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Electricity generation from biomass decreased from 330 GWh in 1990 to 289 GWh in 2001. Some 13% of that biomass is used to produce electricity in just a few co-generation plants in the forest industry. Only a small proportion of the waste from wood processing is currently used directly for electricity production or for CHP as most is used to provide process and space heating.

RD&D funding for renewable energy sources rose in the mid 1990s and solid biomass increased in importance. This shift reflected the government's renewable energy priorities, which now also include wind and ocean energy sources.

The 2000 Waste Strategy is a research programme that covers liquid, solid and gaseous waste. The Strategy has three major goals: lowering the social costs and risks of waste, reducing damage to the environment from waste generation and disposal and increasing the efficiency of biomass use. The policies used to support these goals include new legislation, efficient pricing, environmental standards and information dissemination.

Geothermal Electricity Production

Geothermal capacity increased from 261 MW in 1990 to 417 MW in 2001, an average growth of 4.4% per year. Electricity generation from geothermal was 2 838 GWh in 2001, 12.5% of total electricity generation from renewable energy sources. Research priority is provided to increase the efficiency of geothermal power. The focus of the research is on low enthalpy systems.

Figure 11. **Geothermal Capacity and Electricity Production**

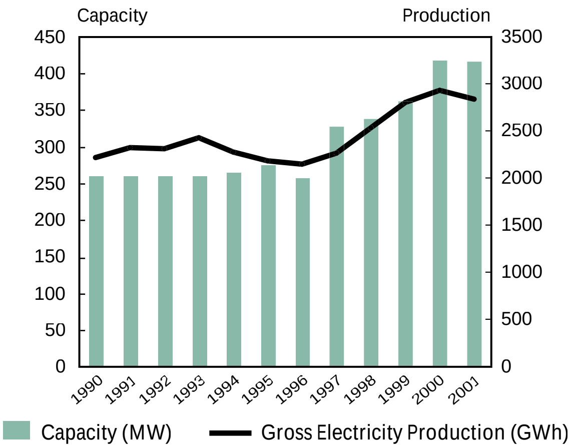
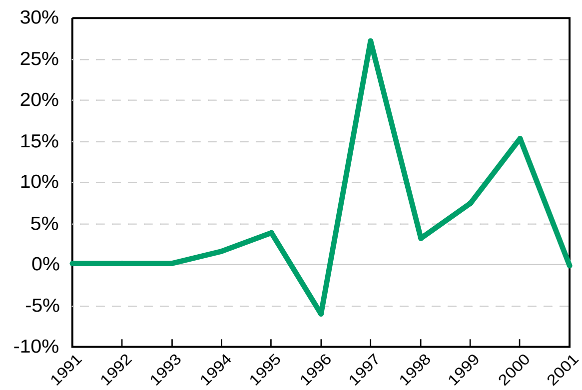
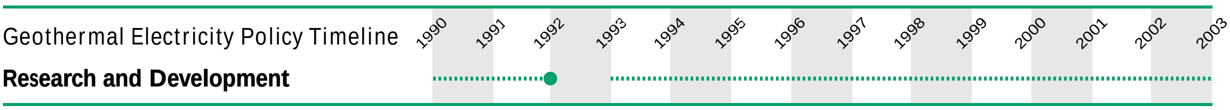


Figure 12. **Geothermal Capacity** (Year to Year Change)





Denotes a significant change to a policy, such as an extension, repeal or revision.

New Zealand is endowed with good geothermal resources. Development of these resources generated increasing interest by private land-owners and utilities following the deregulation of the electricity industry in the mid-1990s. In addition more efficient plant designs (including re-injection and binary heat transfer systems) have made power generation more viable. No direct government subsidies have been made available for geothermal development, but market liberalisation and the revelation of reduced volumes of cheap natural gas reserves have encouraged private development.

Wind Power

Two grid-connected wind farms of 32 MW and 3.5 MW have been developed in New Zealand. These are significant achievements given that wind power projects must compete directly with large hydro and gas-fired combined cycle power plants within the fully deregulated electricity market. There are also many small wind turbines used in remote areas to provide electricity to single residences.

Following successful resource consents and financial support under the government's "project mechanism" a new 84 MW wind farm is under construction and the existing 32 MW wind farm is being doubled in capacity. A 0.5 MW prototype machine is being tested by its local manufacturer.

One electricity generator launched a green pricing scheme aimed at residential consumers to assist the financing of its wind farm expansion. This was the first time this type of initiative has been tried in New Zealand, but it proved unsuccessful with only around 150 takers from a predicted 16 000.

Key research efforts include studies related to developing wind power generation systems suitable for New Zealand conditions, identifying optimum and environmentally appropriate sites for locating wind farms and merging wind power to electricity distribution systems.

Figure 13. **Wind Power Capacity and Electricity Production**

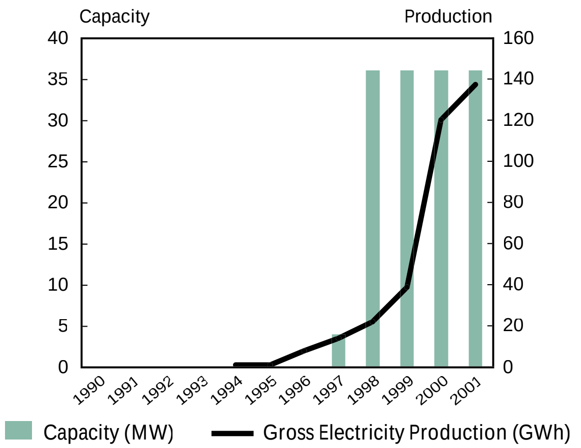
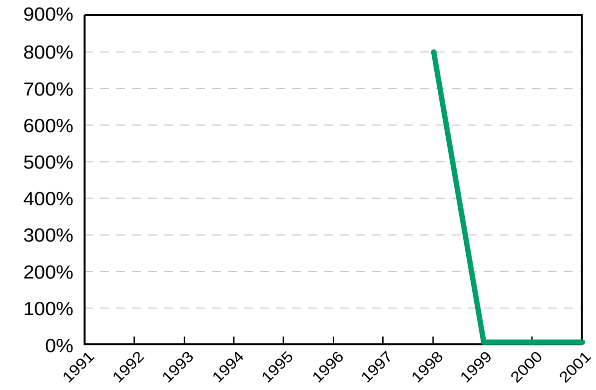
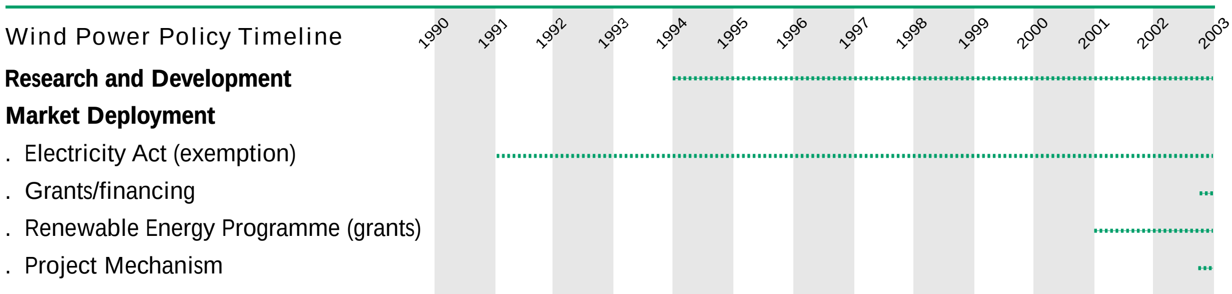


Figure 14. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

New Zealand Policy Chronology

Resource Management Act

Year 1991 - Present

Policy Description The general purpose of the Resource Management Act (RMA) is to promote sustainable management. The act is therefore favourable towards increased deployment of new renewable energy resources to meet community needs. However, areas that require protection can continue to constrain sites for wind power, hydro electric or other developments. Moreover, the RMA requires plans to identify specific resources for protection or preservation, which may be inconsistent with, for example, wind farms in economically attractive wind resource areas. An amendment is being debated to enable greenhouse gas mitigation projects to become more acceptable than under the current legislation.

Policy Type Regulatory and administrative rules

RE Technology All renewables

The Electricity Act and Energy Companies Act

Year 1992 - Present

Policy Description This act allows independent power producers to supply directly to a specific local market or customer and requires energy companies to disclose financial information to assist potential suppliers with grid and energy cost information. Electricity market reform has separated the bodies responsible for transmission and generation and has increased competition within generation. These changes play an important part in promoting the development of renewable energy sources for electricity generation, including new renewables, and interest in these sources of energy has been growing. New renewables were exempt from a cap on the construction of additional generating capacity by the dominant generator, ECNZ, but this organisation no longer exists.

Policy Type Regulatory and administrative rules

RE Technology All renewables

Renewable Energy Policy Statement

Year 1993 - Present

Policy Description In 1993, the Government released its Renewable Energy Policy Statement. Its key objective is to ensure "the continuing availability of energy services at the lowest cost to the economy as a whole consistent with sustainable development." At the time, there were no specific quantitative targets or plans for future renewable energy use in New Zealand. However, recent government forecasts, based on the target of 30 PJ in the National Energy Efficiency and Conservation Strategy, indicate that renewable energy supply will increase by around a fifth in 2010 compared with 1996, mainly due to increased electricity generation from wind, combustible renewables and wastes, and geothermal.

Policy Type General energy policy/Obligations

RE Technology All renewables

Renewable Energy R&D funding

Year 1995 - Present

Policy Description Publicly funded R&D expenditure for renewable energy.

Policy Type RD&D

RE Technology All renewables

Energy Efficiency and Conservation Act 2000

Year 2000 - Present

Policy Description New Zealand's House of Representatives passed the Energy Efficiency and Conservation Act 2000, which became effective in 2001. It placed emphasis on the importance of renewable energy sources with the development of biomass, wind, solar, small hydro and other technologies. The act also provided for the establishment of mandatory energy performance standards for energy-using products such as appliances, equipment and vehicles. The renewable energy target under the New Zealand Waste Strategy (see below) is 30 PJ of new capacity (including heat and transport fuels) by 2012.

Policy Type Obligations

RE Technology All renewables

New Zealand Waste Strategy

Year 2000 - Present

Policy Description The waste strategy sets a new direction for minimising the country's waste and for improving waste recovery and management. It sets out a practical programme of large and small actions for the medium term, as well as some far-reaching, longer-term commitments.

This strategy covers liquid, solid, and gaseous waste, and recognises that moving toward zero waste and sustainability is a long term challenge. It has three major goals:

- Lowering the social costs and risks of waste.
- Reducing the damage to the environment from waste generation and disposal.
- Increasing economic benefit by making more efficient use of materials.

Five core policies form the basis for action:
- A sound legislative basis for waste minimisation.
- Efficient pricing.
- High environmental standards.
- Adequate and accessible information.
- Efficient use of materials.

RE Technology Waste

Energy Efficiency and Conservation Authority

Year 2000

Policy Description The Energy Efficiency and Conservation Act 2000 established the Energy Efficiency and Conservation Authority (EECA) as a separate Crown entity. EECA has been funded to encourage, promote and support energy efficiency, energy conservation and the use of renewable energy.

Policy Type Regulatory and administrative rules

RE Technology All renewables

National Energy Efficiency and Conservation Strategy

Year 2001 - Present

Policy Description New Zealand's first National Energy Efficiency and Conservation Strategy (NEECS) was prepared as a requirement of the Energy Efficiency and Conservation Act 2000. The Strategy's purpose is to promote energy efficiency, conservation and renewable energy, and to move New Zealand towards a sustainable energy future. It promotes practical ways to make energy efficiency, conservation and renewable energy mainstream solutions and is organised around policies, objectives and targets, supported by a set of measures. The Strategy outlines five action plans for government, energy supply, industry, buildings, appliances, and transport to help achieve its targets.

The Strategy's overall plan is to improve New Zealand's energy efficiency by at least 20% by 2012 and to increase the supply of renewable energy by 30 PJ by 2012.

Policies within the NEECS will take effect through the renewable energy programme. This programme is designed to support renewable energy development by engaging with stakeholders and working to minimise the barriers that inhibit the realisation of the full potential of renewable energy. The expanded Renewable Energy Programme aims to cover the following:

- Planning and policy processes.
- Information and communication.
- Education and training in renewable energy.
- Identifying and prioritising research needs.
- Supporting pilot projects/demonstrations.
- Standards setting where appropriate.

- Market development, capacity enhancement and business development opportunities.
- Government leadership.

Policy Type Regulatory and administrative rules /Public awareness/RD&D

RE Technology All renewables

Energy Saving Scheme : Solar Heaters Support

Year 2001 - Present

Policy Description The Energy Saver Fund is a government-funded, residential energy efficiency grant programme administered by the Energy Efficiency and Conservation Authority (EECA). Funding is allocated by competitive tender to projects that are designed to achieve cost-effective improvements in residential energy efficiency.

The fund has, in part, provided direct assistance grants in the form of reduced interest payments for the installation of solar water heaters for low-income family homes. These grants have had a significant impact on the solar water heating industry.

Policy Type Consumer grants/rebates

RE Technology Solar thermal

Projects to Reduce Emissions (Project Mechanism)

Year 2003 - Present

Policy Description Projects to reduce carbon emissions are part of New Zealand's confirmed policy package on climate change. Projects are activities undertaken by businesses, other groups or individuals that deliver measurable reductions of greenhouse gas emissions. In return, the government awards them an incentive of emission units, or "carbon credits." Projects must result in a measurable reduction in greenhouse gases and not be merely business-as-usual.

While the process is open to all forms of renewable energy supply, it is anticipated that process heat and electricity projects will be the most favourably positioned renewable energy sources to benefit from this funding. Nine projects were allocated a total of 4 million tonnes of carbon dioxide credits in the first round in 2003.

Policy Type General energy policy

RE Technology All renewables

Negotiated Greenhouse Agreements

Year 2003

Policy Description Negotiated Greenhouse Agreements (NGAs) were established with at-risk businesses beginning in 2003, the first being the NZ Refinery Company Limited. Firms can qualify by being classified as "competitiveness-at-risk" based on the costs imposed by an emissions charge (during the first Kyoto Protocol commitment period 2008-2012). Such firms will be able to avoid the charge in part or in full, by entering into binding commitments to manage their greenhouse gas emissions. For some firms, adoption of renewable energy sources may be the favoured route to meet their NGA commitments.

Policy Type Third-party finance

RE Technology All renewables

Resource Management Act Amendment (Energy and Climate Change) 2004

Year 2004

Policy Description This legislation changed the original Management Act (1991) to require that all persons exercising powers under the Act have particular regard to the:

- Efficiency of the end-use of energy.
- Effects of climate change.
- Benefits to be derived from the use and development of renewable energy.

It also requires regional councils to give appropriate regard to the use and development of renewable energy.

Policy Type Regulatory and administrative rules

RE Technology All renewables

Carbon Emissions Charge

Year 2007

Policy Description From 2007, a carbon emissions charge will be levied on fossil fuels and industrial process emissions, *i.e.*, CO_2 and methane excluding agricultural sources. The charge will approximate the international emissions price, but be capped at NZ$ 25 (US$ 15) per tonne of CO_2 equivalent. It is expected that the levy will make renewable energy sources relatively more attractive.

Policy Type Fossil fuel taxes

RE Technology All renewables

Norway

Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

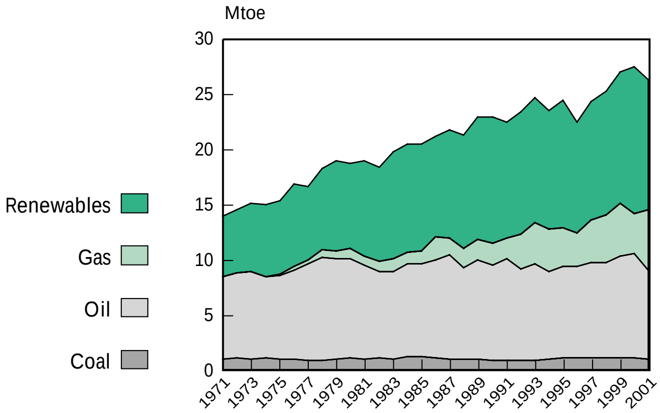
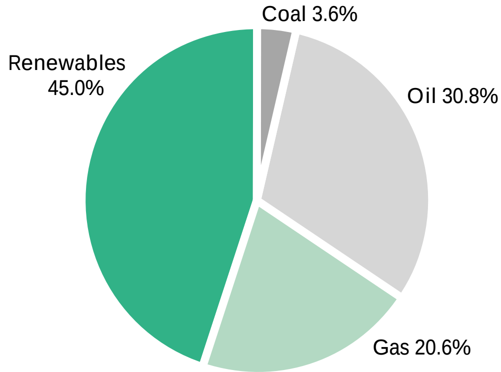


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1. See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1970	1980	1990	1995	2000	2001	Imports
Coal	1.1	1.0	0.9	1.0	1.1	0.9	-
Oil	7.6	9.0	8.6	8.4	9.4	8.1	•
Gas	0.0	0.9	2.0	3.5	3.6	5.4	•
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	-
Renewables	5.0	7.8	11.4	11.6	13.3	11.8	-
Biomass	*0.0*	*0.6*	*1.0*	*1.1*	*1.3*	*1.5*	
Hydro	*5.0*	*7.2*	*10.4*	*10.4*	*11.9*	*10.4*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Total	**13.6**	**18.7**	**21.5**	**23.9**	**25.8**	**26.6**	•
% Renewables	*36.5%*	*41.6%*	*50.1%*	*47.4%*	*48.5%*	*45.0%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*
• *Net Exporter*

Norway's total primary energy supply (TPES) almost doubled from 1970 to 2001. Norway is a major oil and natural gas producer and exporter. Energy demand in Norway is met principally by oil and natural gas for industry and transport and hydro for electricity generation. Demand for natural gas has grown considerably since 1980, on average by 9% a year. Oil demand has remained relatively stable, but its share in TPES has fallen. In 2001, the share of oil in TPES was 30%, and natural gas was 20% (Table 1).

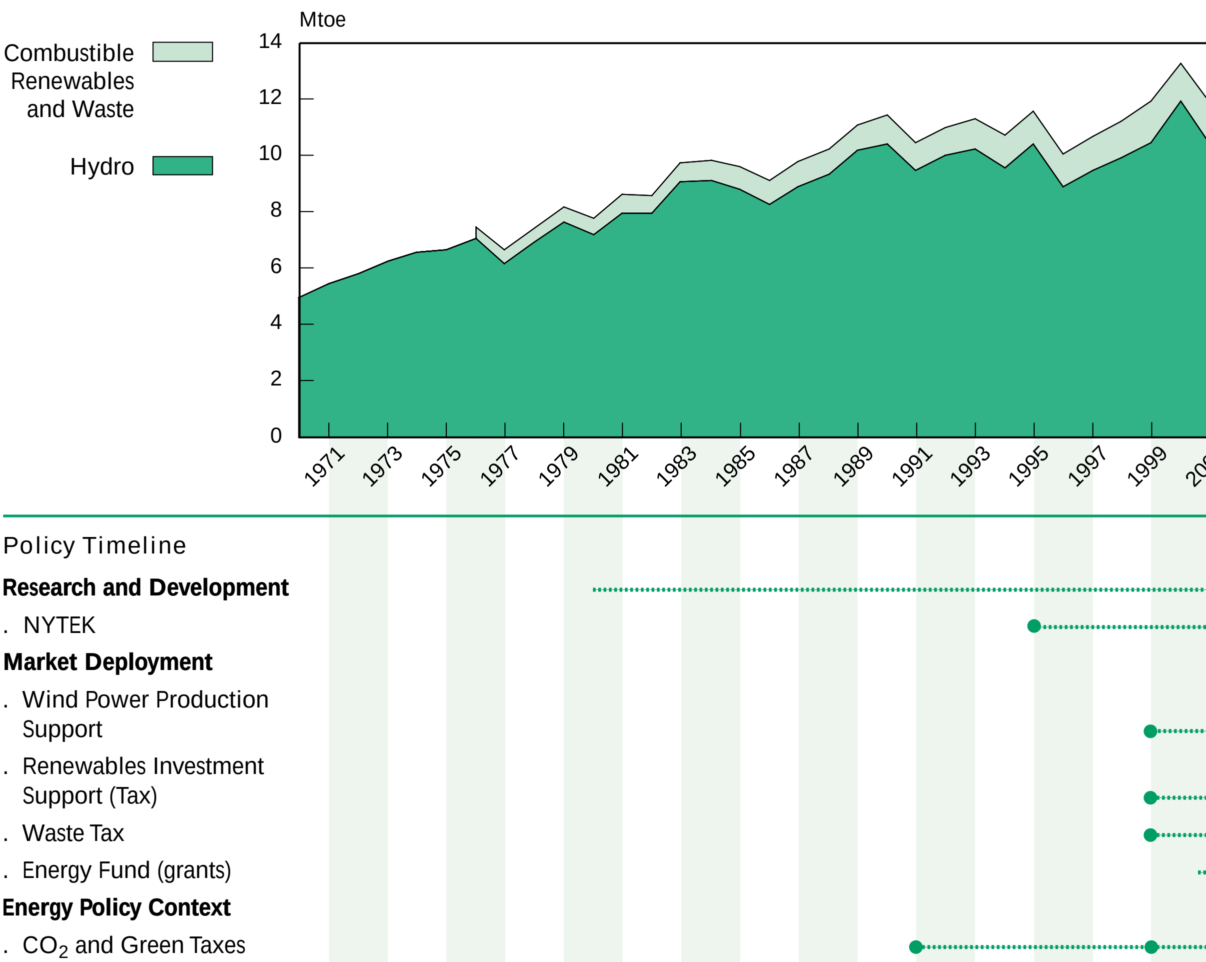
Norway is endowed with abundant hydropower resources that provide virtually all of its electricity generation. Consequently renewable resources account for a large share (45%) of TPES. In 2001, large hydropower accounted for 39% and biomass for 6% of TPES. Norway has the highest per capita electricity consumption in the world.

Hydropower accounts for more than 99% of electricity generation in Norway. During an average year the production is about 118 TWh. Hydropower capacity in 2001 was 26.8 GW. The electricity supply also has 13 MW of wind power capacity.

Due to the large amount of low-cost electricity from large-scale hydro, “new” renewable energy technologies have not been implemented to any significant degree. However, the government aims to increase wind power capacity and the use of district heating systems based on renewable energy sources, waste heat or heat pumps.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Large hydropower is the dominant source of renewable energy produced in Norway and provides basically all the electricity consumed, plus exports. Hydro capacity has been almost constant since the 1990s. Annual hydropower production fluctuates widely from year to year depending upon reservoir inflow. Bioenergy is the second most important renewable energy source. In 2001, biomass provided 1.5 Mtoe, about 6% of total supply. Most of the biomass is used for heating purposes.

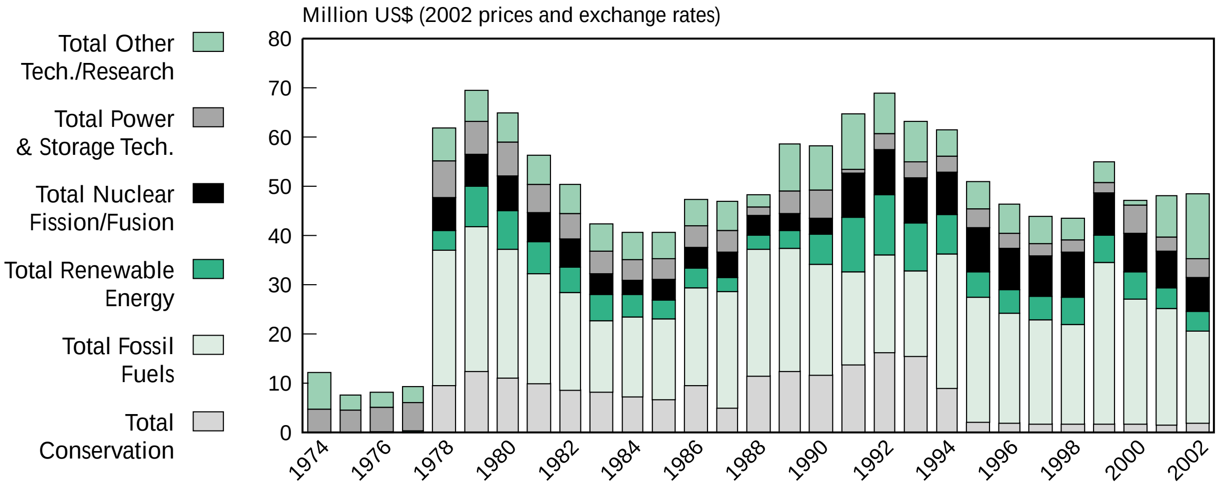
As all of Norway's electricity is already generated from renewable sources, its national targets focus more on the introduction of specific technologies, primarily wind power and heat production from biomass, than on a general increase of renewable energy sources as in the EU countries. The government aims to increase "new" renewable capacity (other than large-scale hydro) by 7 TWh (about 0.6 Mtoe) in 2010 by:

- Increased use of central heating based on "new" renewables by 4 TWh per year.
- Installation of wind generators with production capacity of 3 TWh per year.

Research and Development Trends

Norway spent a total of US$ 1.37 billion (2002 prices and exchange rates) on government energy RD&D between 1974 and 2002. In Norway, 10.7% of its total energy RD&D budget in the 1974 to 2002 period was allocated to renewable energy RD&D.

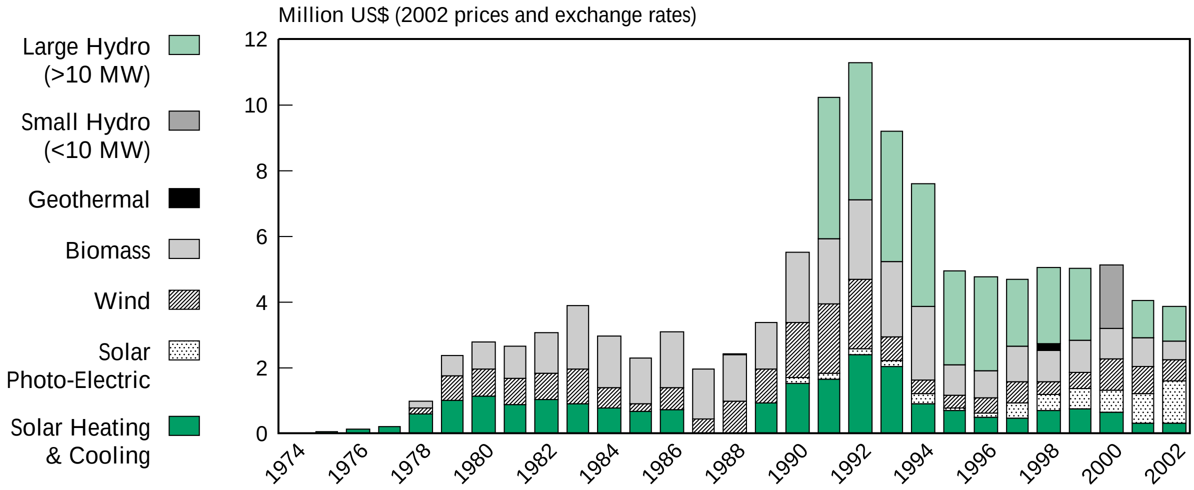
Figure 4. **Norway - Government Energy RD&D Budgets**



The overall trend of government RD&D expenditures for renewables peaked in the late 1980s to early 1990s followed by a notable decline in 1995 when renewables RD&D funding levelled out at about US$ 5 million annually until 2000. The trend shows a further decline in public investment in renewable energy RD&D in recent years.

Among the renewable technologies, ocean/wave energy received the highest level of funding as it was a priority in the 1980s and though it still receives a little support, it is not a priority. Biomass has received the most sustained funding levels over the last two decades, totalling US$ 33 million or 23% of the renewables RD&D expenditures between 1974 and 2002.

Figure 5. **Norway - Government Renewable Energy RD&D Budgets**



R&D Programmes

Efficient, renewable energy technologies (NYTEK, 1995-2001) is an industry-driven R&D programme administered by the Research Council of Norway to develop products and processes for efficient energy technologies and new renewable energy sources in Norwegian enterprises. The primary research areas are bioenergy, wind, photovoltaics, thermal solar, wave energy, heat pumps and hydrogen. The programme is intended to develop products and expertise that will make it profitable to use new forms of renewable energy in parts of the energy market within five years.

Research on large-scale hydropower still accounts for a considerable proportion of the expenditure on renewables, consistent with Norway's near-exclusive use of hydro for electricity generation. The increase in R&D budgets has been allocated to new renewables and to projects to increase flexibility in the energy system. Projects include the following:

Bioenergy: Small combustion systems with low emissions; electricity and heat production from biomass; biofuels for engines. Support for biomass research is strong, particularly in relation to wood wastes produced by Norway's substantial forest industry. Biomass-fired systems for medium-to-large buildings are a new priority area.

Solar: Solar energy systems integrated into buildings; photovoltaic cells, silicon metal, wafer production.

Wind: Focus on subcontractor market (turbine blades, controlling electronics, cast-iron hubs); methods for mapping wind resources.

Wave power: Small pre-manufactured modular installations; controlling of phase and amplitude; tapered channel concept. Wave power was a high priority in the 1980s and still receives some support, but is not expected to be a priority area in the future.

In addition, Norway participates in international collaborative R&D through the Bioenergy, District Heating and Cooling, Hydropower, Photovoltaic Power Systems, Solar Heating and Cooling and Wind Turbine Systems IEA Implementing Agreements.

Market Deployment Trends

Since the 1990s, Norway has employed fiscal measures and investment subsidies as its primary measures to accelerate the market deployment of renewables. Government support for investment in "new" renewables and energy efficiency has been increasing since 1995. In 1998, the budget was NOK 193 million; in 2000 it was NOK 340 million. With the establishment of the state enterprise Enova in 2001, the budget for renewable energy, about € 68 million, was transferred to the Energy Trust. Enova manages the trust, and has established several funding schemes for renewable energy production, primarily wind, bioenergy (heat) and waste, solar (heat) and tide/ocean energy. The fund also covers energy efficiency measures and technologies. The 2004 state budget for the Energy Trust is about € 66 million (NOK 565 million).

Heat production and distribution based on new renewables and waste heat, as well as wind power, are given priority. The aim is to establish markets for new technologies and for energy generated from new renewable sources.

Investment subsidies of 20-25% were available for projects based on bioenergy, waste heat, solar and heat pumps from 2000. This support level was reduced to 10% in 2003 in Enova's investment support programme. Investments in these types of projects were exempt from a 7% investment tax from 1999 until the investment tax was abolished in 2002. In 1999 a tax on waste disposal was introduced to encourage energy recovery and to reduce emissions of methane from landfills. District heating plants with capacity more than 10 MW require a concession and local authorities may impose a mandatory connection for new buildings.

The investment support and the imposed connection for district heating both have had an effect, according to Norwegian officials. Biomass used for energy purposes provides about 16 TWh, of which 5.4 TWh is used in the pulp and paper industry, 0.9 in the wood industry, 0.9 is municipal solid waste, 7.2 is direct heating with wood (mainly in households).

A support scheme for wind power also provided investment subsidies of 25% from 1999, which was reduced to 10% in 2003. Wind project investments were also exempt from the 7% investment tax until the tax was eliminated in 2002. Wind power benefits from production support through a feed-in tariff equal to half the consumer tax on electricity. In 2001 this provided a subsidy of NOK 0.0565/kWh produced. This incentive rate in 2002 was NOK 0.0465/kWh produced. This feed-in tariff incentive terminated in 2003. As detailed in the wind section, installed capacity of wind turbines increased from 13 MW in 2001 to 100 MW in 2003.

Energy Policy Context

Norwegian policy seeks to combine the country's role as a large energy exporter with leadership in the protection of the environment. Norway's energy policy, in the short and medium term, focuses on reduced energy consumption, a more flexible energy system, distributed power production, gas-fired power plants with reduced or no emissions and "new" renewable energy sources such as wind and bioenergy.

Following the restructuring of the electricity sector in 1991, grid access for renewable energy sources is on an equal basis with conventional sources, namely hydro, at all grid levels. Transmission and distribution tariffs are set to reflect the costs to the network. Small renewable energy generation plants that can feed power to local distribution utilities may exploit a competitive advantage from a reduced need for grid investments and reduction of line losses.

The national budget for the promotion of renewable energy sources has grown over the past decade and in 2001; it totalled about € 68 million. Since the establishment of the state enterprise Enova SF, the budget for renewable energy has been transferred to the Energy Trust. Enova manages the trust, and has established several funding schemes for renewable energy production, primarily wind, bioenergy (heat) and/or waste, solar (heat) and wave/water currents. The fund also covers energy efficiency measures and technologies. The 2004 state budget financing for the Energy Trust is about € 66 million (NOK 565 million).

Taxes

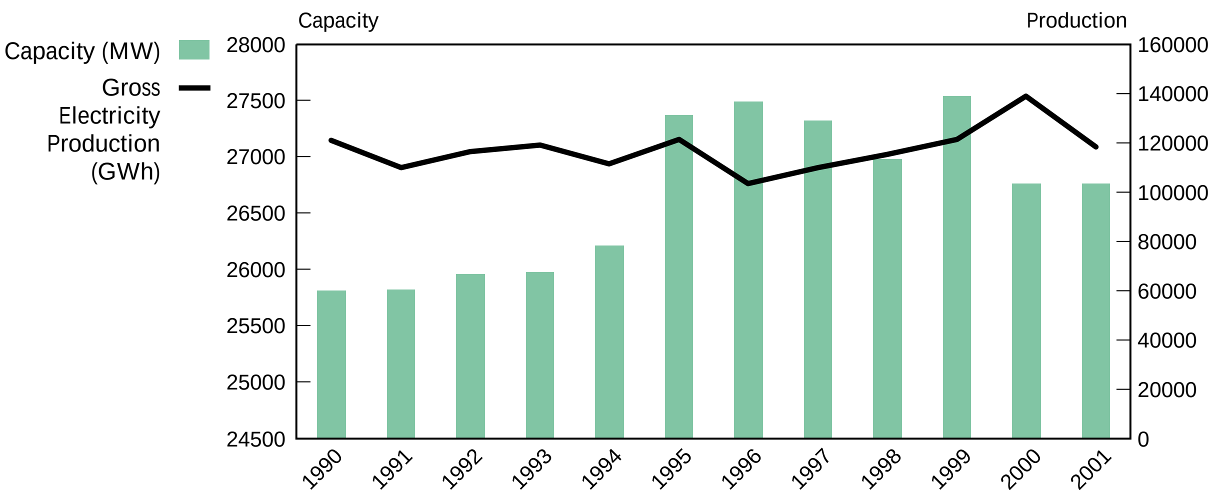
Investments in several renewable energy sources have been exempt from paying a general investment tax of 7%. This tax was abolished in October 2002 so renewable energy investments no longer benefit from the incentive.

Taxation is the main instrument to limit CO_2 emissions and the tax rates in Norway are high compared to other countries. Such taxes have been applied in addition to excise taxes on fuels since 1991. In addition to the CO_2 and other green taxes, electricity is taxed at the consumer level.

Renewable Energy Markets

Hydropower

Figure 6. **Hydropower Capacity and Electricity Production**



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Hydropower capacity in 2001 was 26.8 GW primarily in large-scale facilities. Total installed capacity of hydropower up to 1 MW was 50 MW, and hydro in the range of 1-10 MW was 1 025 MW, most of which has been installed since 1990.

In 2001, the then Prime Minister announced that the era of building large hydro facilities in Norway was over. Most economically viable sites are considered to have been developed, and most of the remaining potential sites are located in protected environmental areas and/or face opposition to development by various civil society groups. It is estimated that about 20% of the country's remaining hydropower potential, about 35 TWh, is in protected watercourses.

Within the current policy of the government, there is still some potential for further development of hydropower capacity although it is on a smaller scale than earlier developments. Production capacity of 350 GWh is being built, and a concession for an additional 1 TWh has been granted. Increased capacity is also foreseen from small-scale hydropower (estimated potential 10-15 TWh annually). A strategy for small-scale hydropower was launched in 2003 that exempts >5 MW plants from certain taxes and provides guidelines for constructing and operating such plants.

Wind Power

Figure 7. **Wind Power Capacity and Electricity Production**

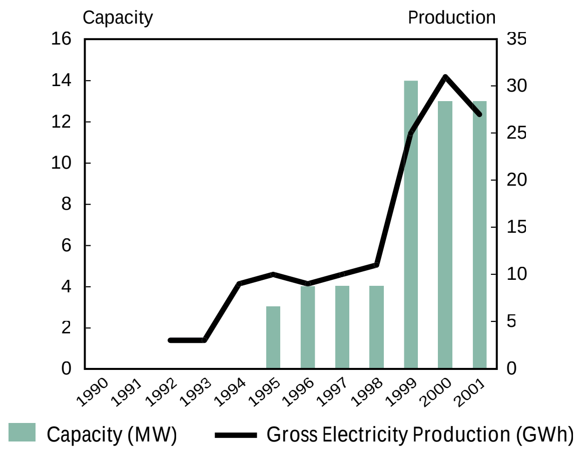
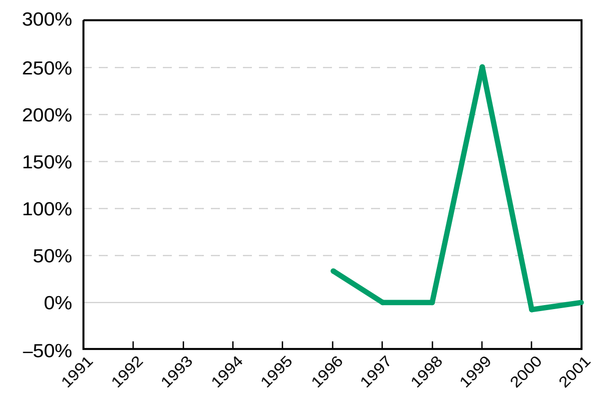
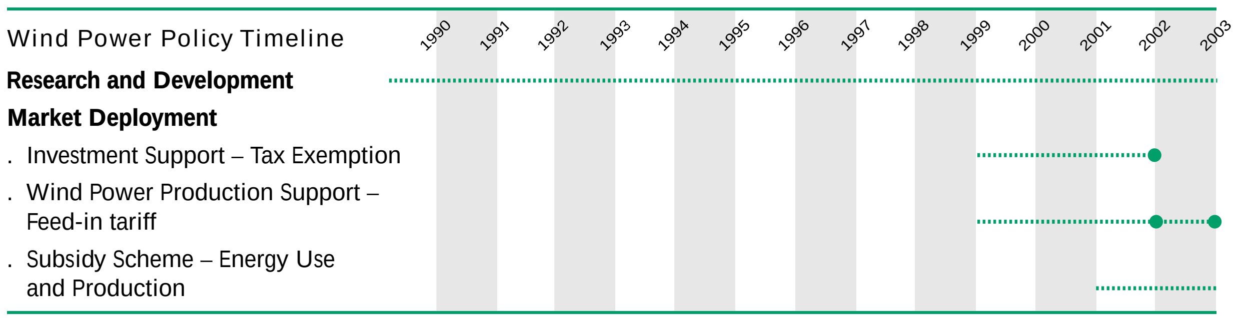


Figure 8. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

In 2001 there were twenty-three wind turbines (onshore) in Norway with an installed capacity of 13 MW. The government aims to increase wind power to 3 TWh per year (approximately 1 000 MW) by 2010. By the end of 2003 installed capacity was 100 MW.

Investments in "new" renewable energy, including wind, were excluded from the general 7% investment tax until it was abolished in 2002.

From 1999 to the end of 2003, the Norwegian government actively supported wind power production through a favourable feed-in tariff. In 2001, the subsidy was NOK 0.0565/KWh of wind power produced. This was lowered to NOK 0.0465/kWh in 2002. In January 2004 this support scheme was abolished.

Wind power projects were eligible for support of up to 25% from 2000 through the Energy Use and Production Subsidy Scheme. This support level was reduced to 10% in 2003 in Enova's investment support programme. Maximum support is NOK 0.20/kWh produced annually.

Wind power developments require a concession from the Norwegian Water Resources and Energy Directorate (NVE). As of January 2004, 565 MW of wind capacity had received a concession from NVE and applications for concessions for six projects (totalling about 590 MW) were under assessment.

Solar Photovoltaic

Figure 9. **Solar Photovoltaic Capacity***

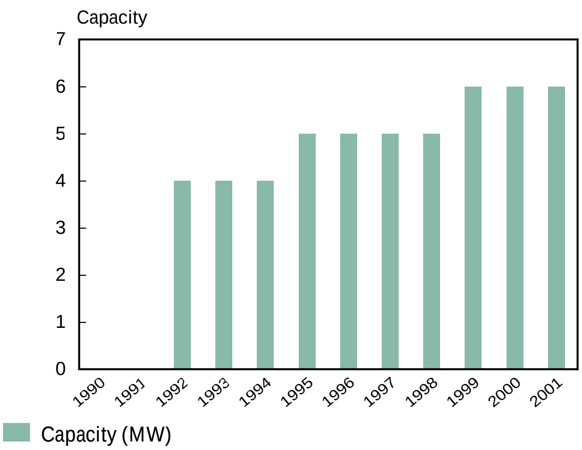
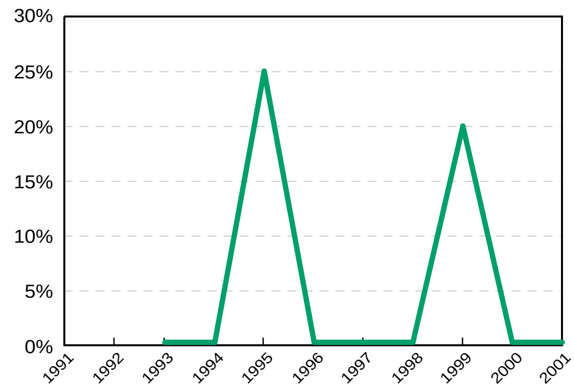
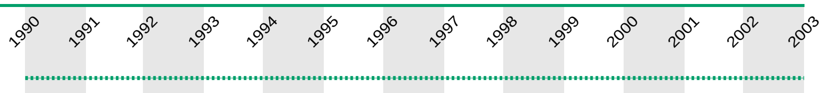


Figure 10. **Solar Photovoltaic Capacity**
(Year to Year Change)



Solar PV Policy Timeline

Research and Development



More than 90% of the photovoltaic (PV) installations in Norway are off-grid applications used for recreational homes, boats, etc. Norway supports RD&D for PV (23% of the renewable energy RD&D budget in 2002), but there are no subsidies for PV, the market is completely commercial.

The PV market in Norway is defined as all (terrestrial) PV applications with an installed power of 40 W or more. A PV system consists of modules, charge controller and energy storage (batteries) or power electronics for grid connection (inverters), and all installation and control components for modules, inverters and batteries. Table 2 shows the total cumulative installed PV power for each sub-market on the 31 December of each year since 1992.

Table 2. **Cumulative Installed PV Power in Four Sub-markets**

Sub-market/ application	**31 December**										
	1992 kW	**1993 kW**	**1994 kW**	**1995 kW**	**1996 kW**	**1997 kW**	**1998 kW**	**1999 kW**	**2000 kW**	**2001 kW**	**2002 kW**
Off-grid domestic	3 700	3 970	4 240	4 460	4 680	4 900	5 100	5 400	5 650	5 810	5 966
Off-grid non-domestic	100	130	160	190	220	250	300	320	330	335	350
Grid-connected distributed							4	6	50	65	68
Grid-connected centralized											
TOTAL	**3 800**	**4 100**	**4 400**	**4 650**	**4 900**	**5 150**	**5 400**	**5 730**	**6 030**	**6 210**	**6 384**

Source: Research Council of Norway.

Norway Policy Chronology

NYTEK R&D Programme

Year 1995-2001

Policy Description The Research Council of Norway administers this industry-driven R&D programme to develop products and processes for efficient energy technologies and new renewable energy sources in Norwegian enterprises. Its primary research areas are bioenergy, wind, photovoltaics, thermal solar, wave energy, heat pumps and hydrogen.

Policy Type RD&D

RE Technology All renewables

CO_2 Tax

Year 1999 - Present

Policy Description A CO_2 tax of NOK 104 per tonne of CO_2 emissions is applied to mineral oils used in air traffic, domestic shipping and supply ships and offshore petroleum installations. Major industrial sectors and gas used in the transport sector are exempt from the CO_2 tax.

Policy Type Fossil fuel taxes

RE Technology All renewables

White Paper on Energy Policy

Year 1999 - Present

Policy Description In 1999, the Norwegian Government submitted a White Paper on Energy Policy which included an increase in electricity taxation and provided approximately NOK 5 billion in investment support over ten years for new renewable energy.

Policy Type Capital grants

RE Technology All renewables

Green Taxes

Year 1999 - Present

Policy Description The Norwegian Parliament increased the tax on electricity consumption by NOK 0.025/kWh as part of the minority government's 2000 budget. At the same time, a tax on oil was raised NOK 0.19/litre to avoid a switch from electricity to heating oil (wood-processing industry exempt). Some (NOK

200 million) of the NOK 1.9 billion from the increased tax revenues was used to support energy efficiency and renewable energy programmes.

Policy Type Fossil fuel taxes

RE Technology All renewables

Renewable Energy Investment Support (RE Tax Treatment)

Year 1999-2002

Policy Description From January 1999, investments in new renewable energy, heat pumps, district heating, natural gas grids, small-scale hydropower plants (< 1 000 kW) and refurbishment of all hydropower plants were exempt from the 7% investment tax.

The general investment tax was abolished in April 2002.

Policy Type Investment tax credits

RE Technology All renewables

Imposed Connection to District Heating

Year 1999

Policy Description Under this legislation, district heating plants >10 MW require a concession. A concession is necessary for local authorities to impose mandatory connection for new buildings.

Policy Type Regulatory and administrative rules

RE Technology Biomass

Wind Power Production Support

Year 1999-2003

Policy Description This support scheme for wind power production corresponding to half of the consumer electricity tax was introduced in 1999. In 2001 the consumer tax on electricity was NOK 0.113/kWh, giving an incentive of NOK 0.0565/kWh of wind power produced. In 2002 the consumer tax on electricity was NOK 0.093/kWh, giving an incentive of NOK 0.0465/kWh of wind power produced. This scheme terminated at the end of 2003.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology Offshore wind
Onshore wind

Waste Incineration

Year 1999

Policy Description In order to reduce methane emissions, a tax on final disposal of waste, with tax rebates for energy utilisation, was introduced in 1999. In addition, it prohibited the disposal of wet organic waste in landfills and required that it be used for animal feed, composted or incinerated.

In 2004, the tax rates are:

- Fixed part of tax: NOK 82/tonne (€ 9.6/tonne).
- Part related to energy utilisation: NOK 245/tonne (€ 28.8/tonne).

Policy Type Fossil fuel taxes

RE Technology Waste

Subsidy Scheme - Energy Use and Production

Year 2000 - Present

Policy Description The government provided NOK 340 million in the 2001 budget to promote a shift in the use and production of energy. About NOK 60 million was to be used for work directly related to energy efficiency. The government stated its objective to increase "new renewable capacity" (*i.e.*, other than large-scale hydro) by 7 TWh.

Policy Type Obligations

RE Technology All renewables

New Central Agency - Energy Efficiency

Year 2000 - Present

Policy Description In 2000, the Ministry of Petroleum and Energy announced the establishment of a new central agency (Enova SF) that is responsible for implementing energy efficiency policy and programmes, and for increased use of new renewables. The new body was established in 2001, taking over from the Norwegian Water Resources and Energy Administration (NVE).

Policy Type Regulatory and administrative rules

RE Technology All renewables

Wind Farm Concessions

Year 2000 - Present

Policy Description The Norwegian Water Resources and Energy Directorate (NVE) announced in 2000 that it had given state-owned utility Statkraft three separate concessions to build wind farms. The project will produce a total of about 800 GWh of renewable energy per year. The largest of the three planned wind farms at Smoela would consist of 70 turbines with a total installed capacity of 144 MW of electricity.

Policy Type Bidding systems

RE Technology Onshore wind
Offshore wind

Enova SF - The Energy Fund

Year 2001 - Present

Policy Description Enova SF was established in 2001 and has been operating since January 2002. Enova is owned by the Government of Norway, represented by the Ministry of Petroleum and Energy (MPE). Enova aims to ensure the more cost-effective use of public funding for energy efficiency and new energy technology by creating a more target-oriented organisation.

The Energy Fund was established on 1 January 2002 to finance Enova's activities. The MPE is the legal owner of the Energy Fund. Enova is responsible for the Fund's implementation and administration.

The central task for Enova is to reach the energy policy objectives that were approved by the Storting (parliament) in 2000:

- To limit energy use considerably more than would be the case if developments were allowed to continue unchecked.
- To increase annual use of central heating based on new renewable energy sources, heat pumps and waste heat by 4 TWh per year by the year 2010.
- To increase wind power production capacity to 3 TWh per year by 2010.

To achieve these objectives, the Storting has indicated grants within a framework of up to € 680 million over a ten-year period. The funding comes from a levy on the electricity distribution tariffs and from ordinary grants from the national budget.

Within the framework of the Energy Fund, Enova provides investment support for energy saving systems and new energy technologies, initial investment for market introduction of new energy technologies, and support to energy efficiency information and education measures for the industry, commercial and household sectors.

Policy Type Obligations / Capital grants

RE Technology All renewables

Subsidies for Energy Efficiency and Renewables

Year 2001 - Present

Policy Description Within the framework of the Energy Fund, subsidies for energy efficiency and renewables come from a fee on transmission tariffs and from ordinary grants from the national budget. The government granted NOK 280 million in the 2002 budget and the income from the fee is stipulated at NOK 200 million. In 2003, Enova's funding totalled NOK 565 million (€ 66.5 million). The funds are managed through the Energy Fund trust that was established in 2002 and directed to the government objectives described above.

Policy Type Capital grants

RE Technology All renewables

Incentives for Non-electric Heating Technologies

Year 2002 - Present

Policy Description The Norwegian State Housing Bank offers financial incentives for new homes incorporating non-electric heating technologies. Loans are available for builders to incorporate technologies such as heat pumps, solar systems and biofuel boilers in new construction.

Policy Type Third-party finance

RE Technology Solar photovoltaic
Concentrating solar
Solar thermal
Biofuel

Electricity Consumption Tax

Year 2002 - Present

Policy Description The electricity consumption tax was NOK 0.093 in 2002. Industry is exempt from the tax.

Policy Type Fossil fuel taxes

RE Technology All renewables

Policy on Increased Domestic Use of Natural Gas

Year 2002 - Present

Policy Description This legislation includes a policy on increased efforts for hydrogen and green certificates.

Policy Type Tradable certificates

RE Technology Hydrogen

Green Certificates

Year 2003 - Present

Policy Description (White Paper no 9, 2002 – 03).
The government wants to establish a market for green certificates. Preparations for a certificate market are in progress. The green certificate market should preferably be integrated with the Swedish market and co-ordinated with an international market. A proposal is expected before mid-2004. To ensure continuous investments in renewable energy projects during the preparation and planning period, it was decided that all projects initiated after 1 January 2004 will be included in the certificate system.

Policy Type Tradable certificates

RE Technology All renewables

Electricity Consumption Tax

Year 2003 - Present

Policy Description The electricity consumption tax was NOK 0.0967 in 2003. Industry is exempt from the electricity consumption tax. To comply with EU-legislation, changes in the tax system are being considered and are expected to be implemented in 2004.

Policy Type Tax on electricity

RE Technology All renewables

Strategy for Small-scale Hydropower

Year 2003 - Present

Policy Description Hydropower plants < 5 MW are exempt from natural resource and ground rent taxes. Guidelines for building and running small scale hydropower plants have been published.

Policy Type Property tax exemptions

RE Technology Hydro

White Paper on Energy Supply

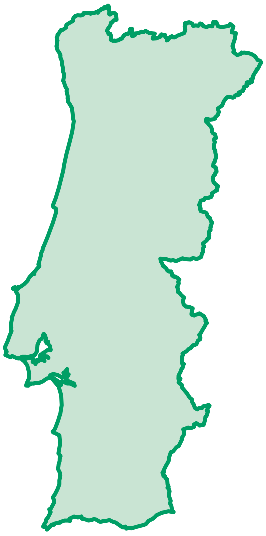
Year 2003 - Present

Policy Description The policy encourages increased efforts to prepare a more environmentally-friendly energy system, *e.g.,* stimulate investments in infrastructure for district heating and increased efforts to modernise and upgrade hydropower plants.

Policy Type Regulatory and administrative rules

RE Technology All renewables

Portugal



Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

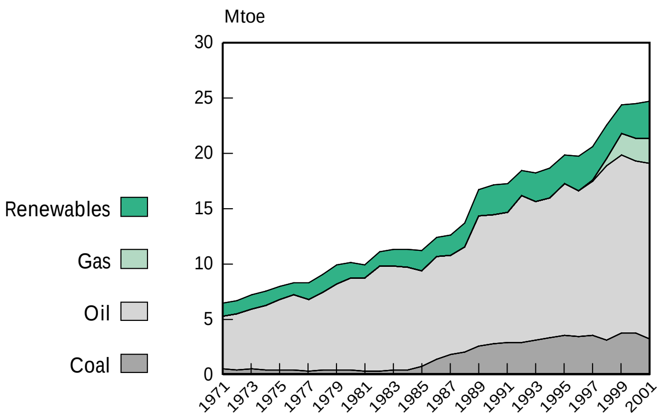
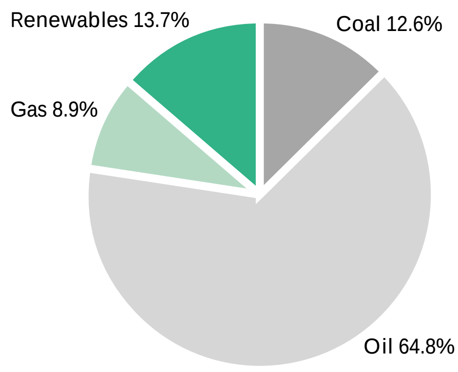


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1. See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	**1970**	**1980**	**1990**	**1995**	**2000**	**2001**	**Imports**
Coal	0.7	0.4	2.8	3.6	3.8	3.2	93.1%
Oil	4.0	8.3	11.7	13.7	15.6	15.9	100.0%
Gas	0.0	0.0	0.0	0.0	2.0	2.3	100.0%
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	-
Renewables	1.2	1.4	2.7	2.6	3.1	3.4	-
Biomass	*0.7*	*0.7*	*1.9*	*1.8*	*2.1*	*2.1*	
Hydro	*0.5*	*0.7*	*0.8*	*0.7*	*1.0*	*1.2*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.1*	*0.1*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Total	**6.0**	**10.3**	**17.2**	**20.0**	**24.6**	**24.7**	**89.1%**
% Renewables	*20.8%*	*13.9%*	*15.7%*	*13.1%*	*12.8%*	*13.7%*	

** See Annex 2 for explanation of components in total and definition of biomass.*

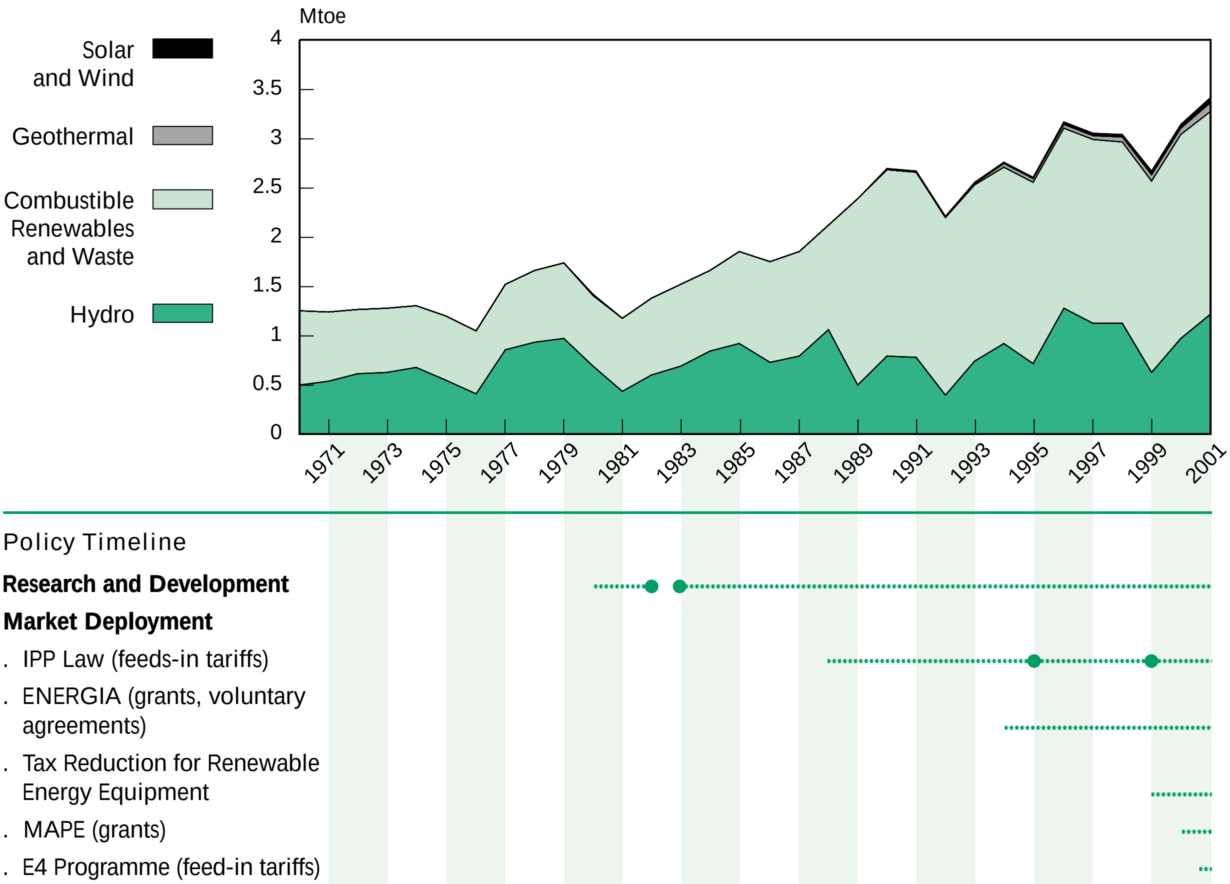
Total primary energy supply (TPES) in Portugal increased rapidly over the past three decades at an average annual rate of 5.6% in the 1970s, 5.3% in the 1980s and 3.3% from 1990 to 2001. These growth rates were among the highest in Europe although per capita energy consumption in Portugal remains lower than in most European countries. Net energy import dependence was 89% in 2001. Oil supply dominates TPES, but its share fell from 80.6% in 1980 to 64.4% in 2001. Natural gas was introduced as an energy source in the late 1990s, and its share in TPES was 9.3% in 2001. Although renewable energy supply increased from 2.7 Mtoe in 1990 to 3.4 Mtoe in 2001, the share of renewables fell to 13.7% in 2001 from 15.7% in 1990.

The Portuguese government supports renewable energy for diversity of supply and for reducing energy import dependence. Hydropower and biomass have been the primary contributors to renewable energy supply with more recent contributions from wind and solar. Geothermal resources are exploited for electricity generation but their contribution to renewable energy supply is less than 3%.

In 2001, coal accounted for 29% of electricity generation, oil for 20% and gas for 16%. The share of renewables in 2001 was 35%. Hydropower accounted for 30% of total electricity generation in 2001, but is estimated to have accounted for only 17% in 2002. Portugal does not use nuclear power.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

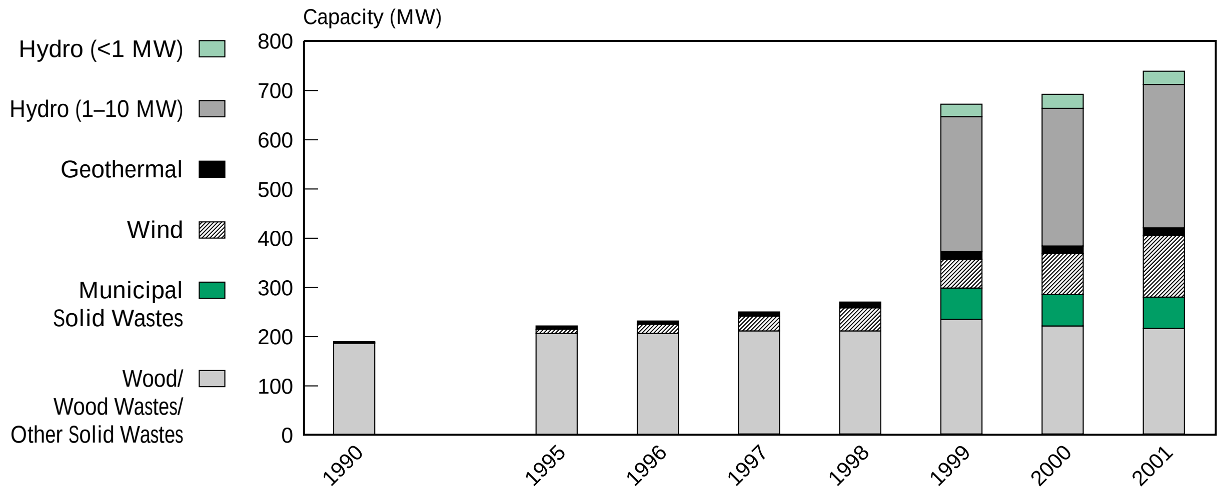
The bulk of renewable energy production is supplied by hydropower and biomass sources. In 2001, biomass represented 61% of renewable energy supply and hydropower 35%. Efforts to increase the market penetration of wind and solar PV have had limited success over the past decade, as the longevity of certain key policies such as feed-in tariffs was not specified. More recent emphasis on raising consumer awareness of the benefits of renewables and on adjusting feed-in tariffs is expected to boost market deployment over the next decade.

Net generating capacity of renewables and waste including large hydropower was 4 979 MW in 2001. Hydropower capacity was 4 GW and solid biomass 214 MW (Figure 4). Electricity generation from solid biomass has stagnated since 1995. Some 64 MW of electricity generation from municipal solid waste came on-line in 1999. Wind capacity increased from 1 MW in 1990 to 125 MW in 2001.

Research and Development Trends

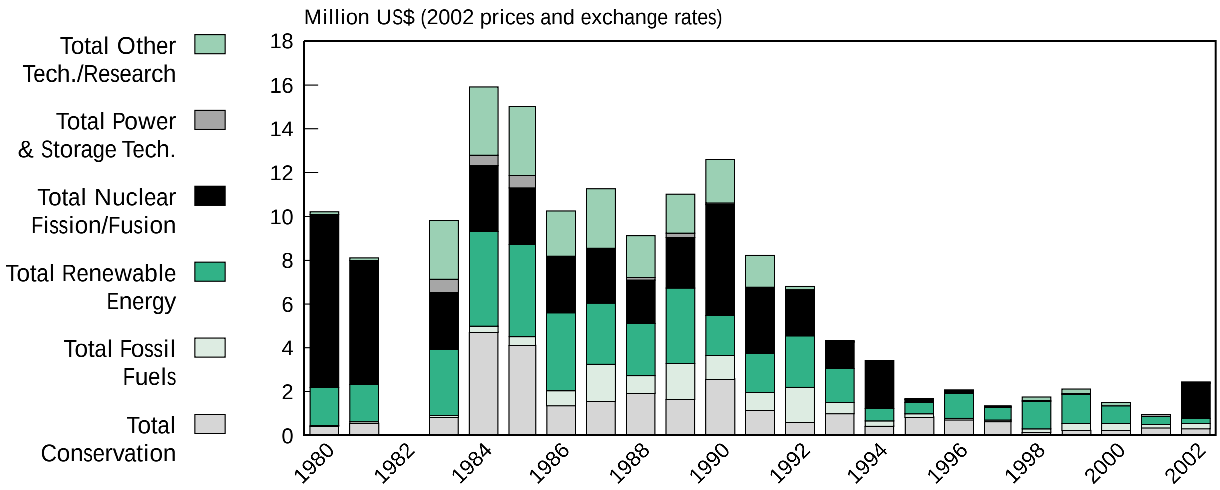
Expenditures on energy RD&D were US$ 150 million (2002 prices and exchange rates) from 1980 to 2002. Since the early 1990s, funding for energy RD&D has declined dramatically. The budget for renewable energy RD&D, however, has not exhibited as dramatic a decline as the overall energy budget; its share of total energy RD&D increased from 17% in 1980 to more than 40% in 2001.[1]

Figure 4. **Net Generating Capacity of Renewable and Waste Products**



Note: A change in data collection methods at the IEA occurred in 1999 with the separation of net generating capacity between small and large hydro. Capacity data for small hydro are not available prior to 1999.

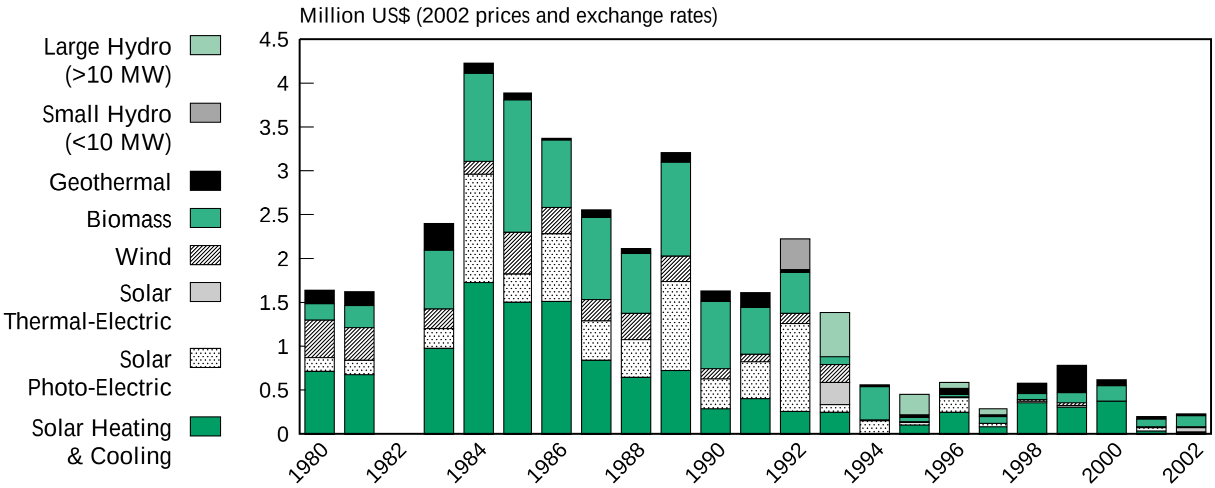
Figure 5. **Portugal - Government Energy RD&D Budgets**



Portugal's renewables RD&D budget has hovered around US$ 0.5 million since 1994. In the 1980s, the focus was on solar thermal, PV and biomass. For the past several years, the focus has primarily been on biomass. Funding for ocean technologies (not shown in Figure 6) was US$ 5.1 million from 1980 to 2002, averaging some US$ 220 000 per year over the period.

1. The share subsequently declined in 2002, as Portugal allocated some US$ 2 million to nuclear fission/fusion.

Figure 6. **Portugal - Government Renewable Energy RD&D Budgets**



Market Deployment Trends

In view of the country's very high dependence on imported fuels, Portugal established a number of policies to increase the market share of renewables. Support to renewable energy has been in the form of feed-in tariffs, grants and investment incentives.

The 1988 Independent Power Production (IPP) Law allowed public or private entities or private individuals to generate electricity from renewable energy sources and sell it to the grid, provided certain technical conditions for interconnection were met. The law also determined the principles and method for calculating the prices that would be paid for the renewable power generation, establishing a system of feed-in tariffs. The IPP Law was revised in 1995 and again in 1999.

The ENERGIA Programme was established in 1994 and provided incentives for investments in renewable energy projects. The programme of incentives was updated by the Measure for Supporting the Use of Energy Potential and Rational Use of Energy Programme (MAPE/POE) in 2000 which provided financial incentives of up to 40% of the project investment costs.

In 2001, the E4 (Energy Efficiency and Endogenous Energies) legislation was passed to streamline administrative procedures and promotional policies for renewables, including a revision to feed-in tariffs for renewable energy sources. The tariffs are now differentiated by renewable energy source, depending on their technical maturity.

In 2003, the Resolution of the Council of Ministries (RCM 63) suspended the E4 programme. According to RCM 63/2003, energy policy will focus on three main vectors: security of supply; sustainable development; and the promotion of national competitiveness. Portugal's target under the EU Directive for Electricity Produced from Renewable Energy Sources 2001 is to increase the share of renewables in electricity generation from 34.5% in 2001 to 39% in 2010. To reach the target, the government has established indicative targets for renewables supported under the RCM 63/2003 (Table 2).

Table 2. **Targets for Renewables Generating Capacity in 2010**

	Installed Capacity (MW) 2001	Installed Capacity (MW) 2010
Wind	101	3 750
Small hydro	215	400
Biomass	10	150
Biogas	1	50
Solid waste	66	130
Wave	0	50
Solar photovoltaics	1	150
Large hydro	4 209	5 000
Total	**4 603**	**9 680**

Source: *Departamento de Energias Renováveis.*

Potential for Biomass Electricity Generation

About 38% of Portugal is covered by forest. Forest management directly provides cellulosic materials as well as residues and wastes obtained from wood transformation. It is estimated that 6.5 million tonnes per year of forestry biomass is produced in Portugal. An additional 4.2 million tonnes per year is estimated to be available for energy production. Electricity generation from solid biomass in 2001 was 1 086 GWh, 11% of electricity generation from renewables.

Electricity generation from potential biomass is expected to supply more than 1.4 TWh per year into the national grid. This estimation is based on an efficiency of 30%, which could increase significantly with the employment of new advanced combustion technologies.

Renewable markets have not responded well to market deployment strategies for several reasons. For example, with the feed-in tariffs put in place to promote renewables, there is a level of uncertainty associated with the amount of time that the tariffs will be in force exacerbating investor risk and limiting investor confidence. The licensing process is complicated and lengthy, which has significantly increased the amount of time between start-up and implementation of a project. There is also a general lack of awareness regarding the benefits and economic competitiveness of some renewable technologies. For example, the government targeted 150 000 m^2 of solar thermal collectors to be installed in 2003, but only 7 000 m^2 were installed. Prospective customers have been unaware of the economic and environmental benefits of installations. To some extent, the E4 programme addressed this barrier by providing training in the design and installation of solar thermal systems. But there was no effort to disseminate information to consumers.

Renewable Energy Markets

Hydropower

Figure 7. **Hydropower Capacity and Electricity Production**

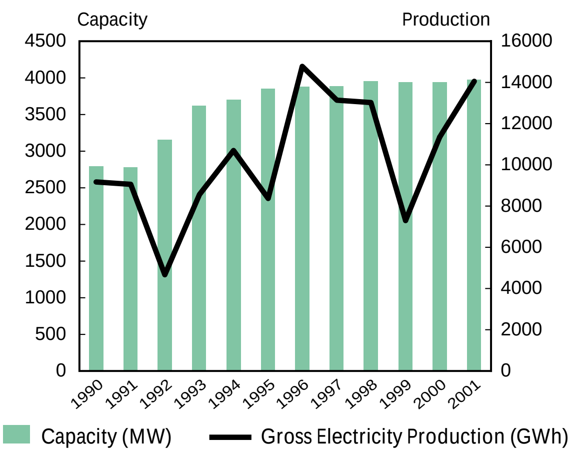
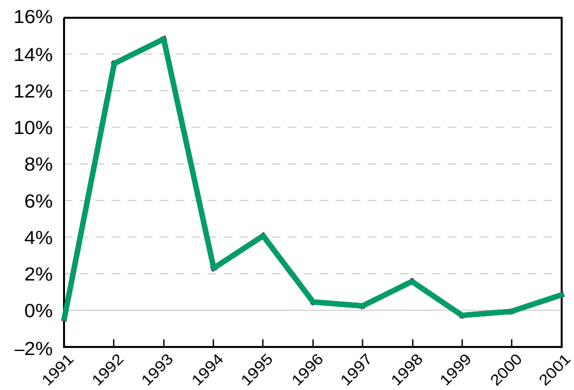
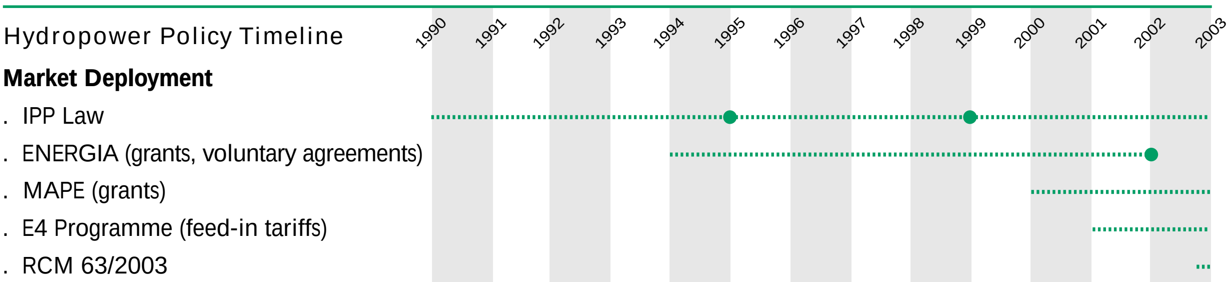


Figure 8. **Hydropower Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Hydropower capacity (excluding pumped storage) was 4 GW in 2001. Electricity generation from hydropower was 14 TWh or 87.7% of total generation from renewables, mostly because 2001 was a very good hydrological year. Hydropower generation grew by about 4% per year on average from 1990 to 2001. Installed capacity of small hydropower (< 10 MW) was 317 MW in 2001. Future growth in hydropower capacity is expected to come from additional small hydropower plants.

Portugal's target is to increase small hydropower capacity to 400 MW by 2010.

Wind Power

Wind capacity grew dramatically in the second half of the 1990s, from 8 MW in 1995 to 125 MW in 2001. Wind power accounted for 1.5% of electricity generation from renewables. According to Portuguese statistics, capacity in 2003 was 277 MW (Table 3) and electricity generation (based on the average capacity factor at different locations) was 691 GWh.

Figure 9. **Wind Power Capacity and Electricity Production**

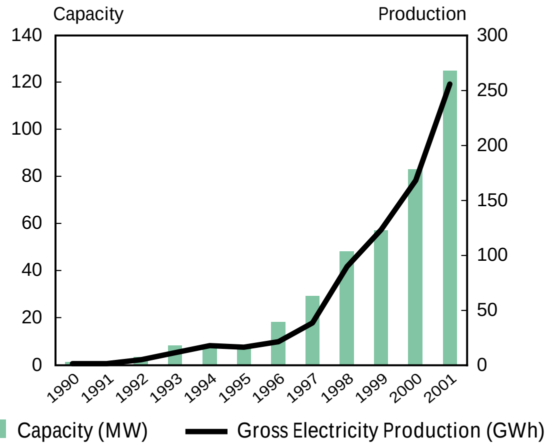
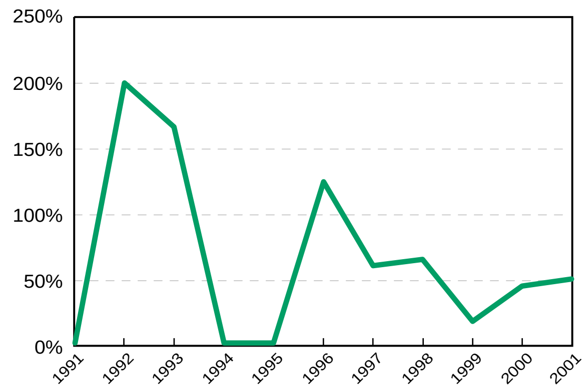
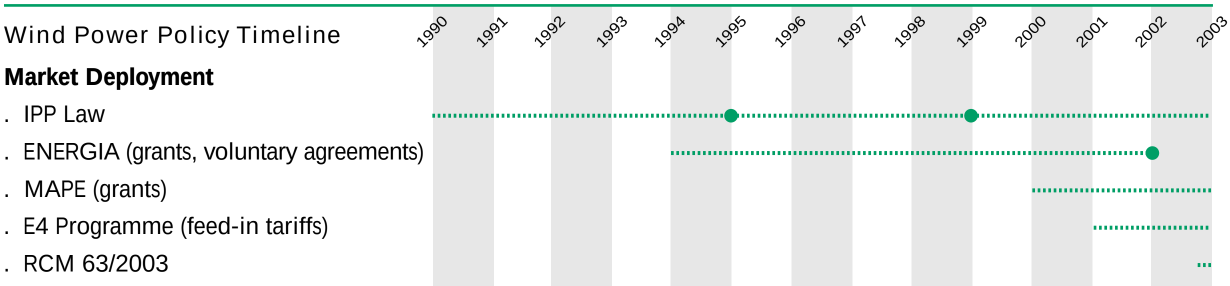


Figure 10. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

A series of national policies have stimulated the recent expansion in wind power, including financial incentives and feed-in tariffs. At the beginning of 2002, applications for 7 000 MW of new capacity were received. The Portuguese government currently has a target to increase wind capacity to 3 750 MW by 2010. The growth of the wind market is hampered, however, by the absence of a specified time period for feed-in tariffs and the complicated licensing procedures, which are considered the primary challenges in the years ahead.

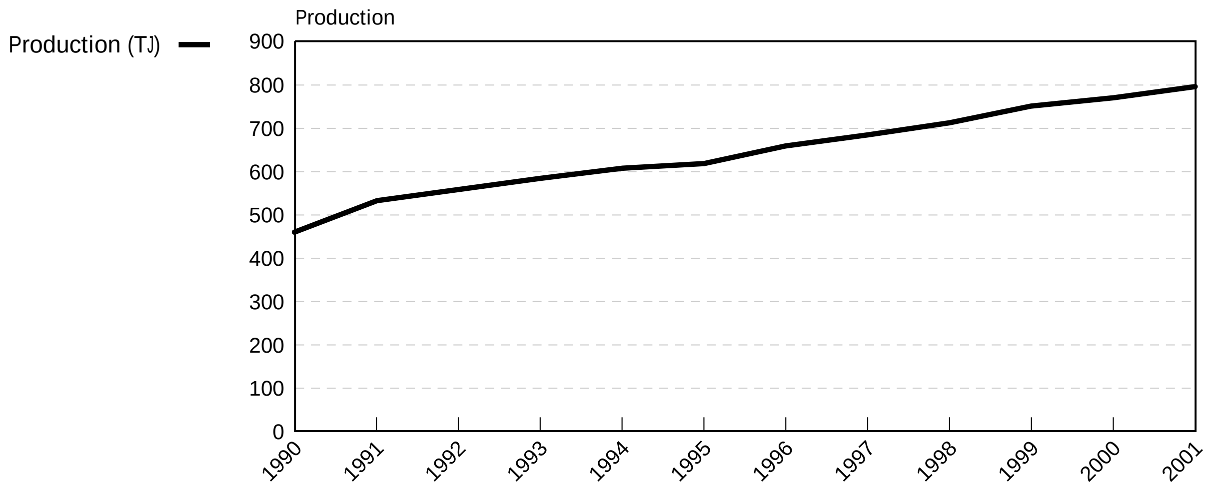
Table 3. **Wind Capacity in December 2003**

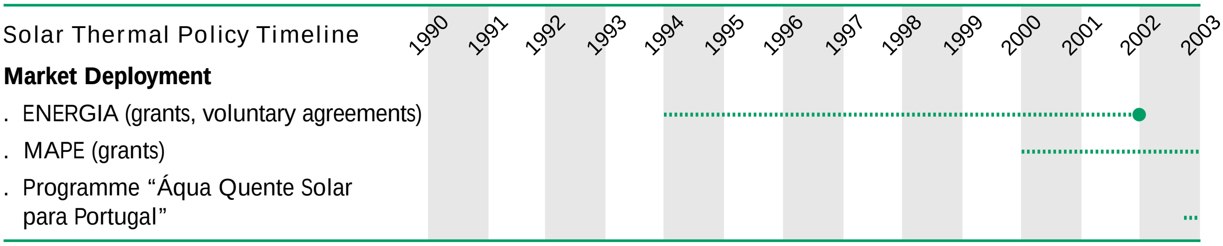
	Total Operating Capacity (MW)	Total Operating Capacity (number)
Continent	262	274
Azores	5	22
Madeira	10	43
Total	**277**	**339**

Source: *Departamento de Energias Renováveis.*

Solar Thermal Production

Figure 11. **Solar Thermal Production**





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Solar thermal production in Portugal increased from 458 TJ in 1990 to 796 TJ in 2001, an average annual growth of more than 5%.

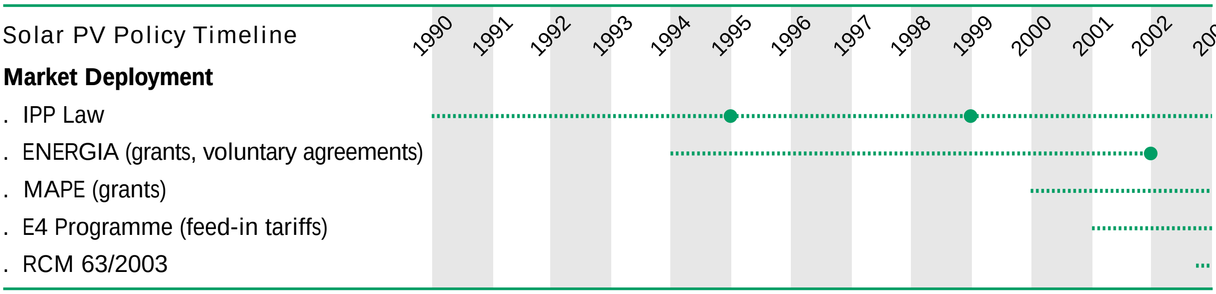
Recent support for solar water heaters in Portugal is through the "Água Quente Solar para Portugal". The aim of this programme is to install one million square metres of solar panels by 2010 (150 000 m^2 per year). The purpose of the programme is to decrease national greenhouse gas emissions by 1%, which is to be achieved via three strategies: promotion, quality certification and surveys.

To promote the programme, a media campaign was held in July 2003.[2] In 2003, the Portuguese Association of Solar Industry registered a small increase in sales of solar thermal systems for hot water from 6 000 m^2 per year to 7 000 m^2 per year, still far below the aim of 150 000 m^2. The general feeling is that this campaign was only a first step and that more work will be needed to increase consumer awareness of the programme. The "Certification of the Whole Scheme for Products" was implemented based on European standards. There was also an effort to provide training and certification to designers and installers of solar hot water systems.

2. More information on the campaign can be found at www.aguaquentesolar.com.

New Codes for Energy Efficiency in Buildings were designed and established to help promote the installation of solar water heaters in Portugal. The main objective is to increase energy efficiency in the building sector to reduce energy consumption and CO_2 emissions. These codes were carried out in the framework of the programme P3E and were intended to accomplish the *European Directive on Energy Performance of Buildings* and the Portuguese commitments under the Kyoto Protocol. The programme is expected to have a major impact on the building sector by increasing the quality of the projects and by creating jobs.

Solar Photovoltaic

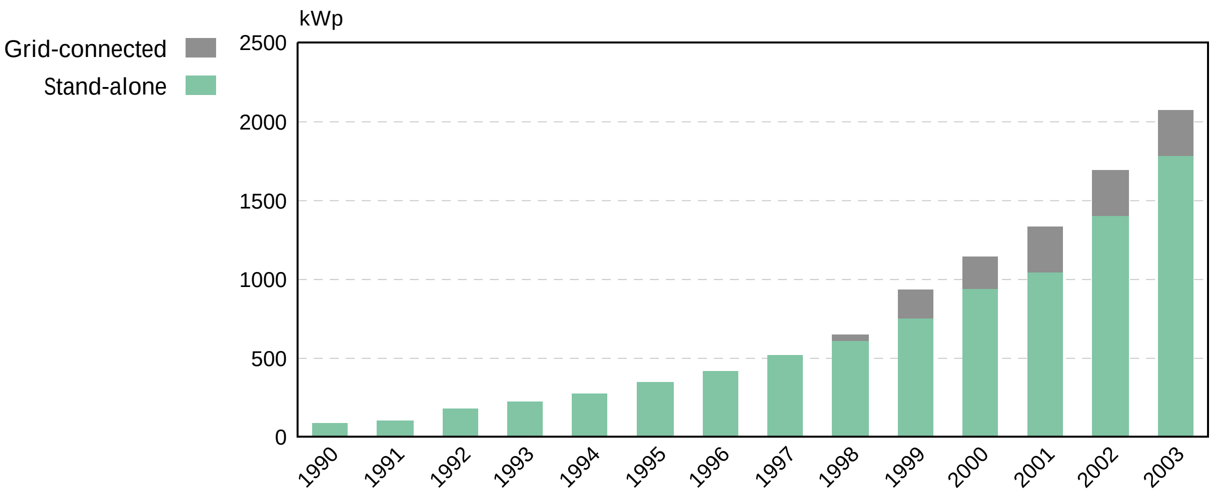


Denotes a significant change to a policy, such as an extension, repeal or revision.

In 2001, Portugal had 1 MW of on-grid installed solar photovoltaic (PV) capacity.

The most significant government initiatives regarding PV are the E4 Programme and the RCM 2003. The programmes have a target of installing 150 MW of PV by 2010, supported by feed-in tariffs of € 0.003/kWh (for systems over 5 kWp) and € 0.052/kWp (for systems under 5 kWp). The legislation only applies to independent power producers (IPPs) and rates are guaranteed for the lifetime of the plant and are embedded with automatic adjustments based on the inflation rate. IPPs are required to deliver all

Figure 12. **Cumulative Installed Photovoltaic Power in Portugal**



Source: *Departamento de Energias Renováveis.*

generated power to the grid, which the utility is obliged to buy. Financial incentives covering up to 40% of project costs are also available under the MAPE programme (2000-2006).

In spite of a favourable legal and policy framework for PV, especially in the grid connected market, many barriers to the deployment of PV in the built environment in Portugal still exist. These include a lack of regulations for grid interconnection of small systems at the low voltage level, lack of building codes for PV integration and complicated and lengthy licensing procedures for PV installations. As a result, only a few installations had been installed by 2003. The market is expected to grow in the coming years as IPP producers become more aware of the advantages of (and support for) PV systems. By early 2004, a number of requests had been made for grid interconnection points (mainly for systems up to 5 kWp).

The module assembly industry recently signed an agreement to expand the factory capacity from the current 10 MW to 17 MW per year. Portugal has two solar type and stationary battery manufacturers. In addition, a dozen companies are supplying and installing PV modules and BOS components imported from the EU, the United States and Japan. A few of these companies produce power electronics for stand-alone PV applications (*i.e.*, small charge regulators, ballasts, etc.).

Portugal Policy Chronology

Decree-Law no. 189/88 (IPP Law)

Year
1988 – Present

Policy Description
The Independent Power Production (IPP) Law was introduced in 1988, revised in 1995 and 1999, for consistency with the implementation of a new regulatory framework for the electricity sector. The IPP Law allows for public or private entities or private individuals to generate electricity from renewable energy sources (including small hydro) and sell it to the grid, provided certain technical conditions for interconnection are guaranteed.

Policy Type
Guaranteed prices/feed-in tariff

RE Technology
All renewables

Decree-Law no. 445/88

Year
1988 – Present

Policy Description
Following the publication of the Decree-Law no. 189/88 (IPP law), this law established the licensing procedures to use water for electricity generation (small-hydropower).

Policy Type
Regulatory and administrative rules

RE Technology
Hydro

Decree-Law no.87/90 and Decree-Law no.90/90

Year
1990 – Present

Policy Description
This law, passed in 1990, “establishes the procedures regulating the awarding and management of the exploration, assessment and exploitation licences related to the geothermal resources (natural resources of public domain)”.

Policy Type
RD&D

RE Technology
Geothermal

Decree-Law no.195/94 (ENERGIA Programme)

Year
1994-2002

Policy Description
This law created the ENERGIA Programme, within the Community Support Framework (CSF) 1994-99, aimed at increased energy diversification, energy efficiency and use of renewables. The programme established the beneficiaries and the general rules for the granting of subsidies within the programme.

The programme contained four measures:

1) Introduction of natural gas.
2) Renewables for electricity generation.
3) Improving energy efficiency, including non-electric uses of renewables.
4) Voluntary actions (government initiatives).

Policy Type Capital grants / Voluntary programmes

RE Technology All renewables

Despacho Normativo no.11-B/95

Year 1994-1999

Policy Description This law established the regulatory rules for the granting of financial support, in the form of non-recoverable grants not exceeding 50% of eligible costs, aiming to increase the rational use of energy, through the valorisation of renewables, within the ENERGIA Programme.

Policy Type Capital grants

RE Technology All renewables

Despacho Normativo no. 681/94

Year 1994-1999

Policy Description Within the ENERGIA Programme, this law established the regulatory rules for the granting of financial support to projects aiming to increase the use of renewable energy sources in electricity generation.

Its mechanism was a recoverable subvention at zero interest rate. Total public aid did not exceed 40% of eligible costs.

Policy Type Third-party finance

RE Technology Biomass
Geothermal
Hydro
Offshore wind
Onshore wind

Despacho Normativo no.11-E/95

Year 1994-1999

Policy Description This 1994 law established the regulatory rules for the granting of financial support to projects aimed at increasing the demonstration and dissemination of new energy technologies (generation, conservation and end-use), within the ENERGIA Programme.

Its mechanism was a non-recoverable grant, not exceeding 60% of the eligible costs.

Policy type Capital grants

RE Technology All renewables

PAM (Action Plan for Municipalities)

Year 1996-1999

Policy Description This Action plan promoted renewables use and energy management at the municipal level. These activities included training, technical assistance and financial advice targeted to local authorities and the creation of local energy teams or agencies.

Policy Type Public awareness

RE Technology All renewables

Tax Reduction for Renewable Energy Equipment

Year 1999 – Present

Policy Description New budget provisions allow purchasers of renewable energy equipment, such as solar panels for residential use, to benefit from a reduced VAT of 5%. Investment costs in renewable end-use technology were deductible from the income tax with a limit to the deduction set at PTE 50 000 in 2000. Beginning in 1999, investors in equipment using solar energy are entitled to claim a depreciation rate of 25% (previously set at 7.14%).

Policy Type Sales taxes

RE Technology All renewables

Electricity Generation Efficiency

Year 1999 – Present

Policy Description The government has implemented measures to encourage the development of more efficient or carbon free electricity production, including co-generation, small hydroelectric production and generation using other renewable energy sources. The formula for payments of capacity and energy supplied to the grid by new co-generators was set in 1999. Monthly payments are a function of performance and availability. An environment premium is added if thermal efficiency of the plant is at least equal to the most efficient combined-cycle. As with efficient electricity generation, the legislation approved for the payments of electricity from renewables is based on a market value associated to the environmental benefits (avoided carbon) obtained from renewable based electricity.

Policy Type Regulatory and administrative rules

RE Technology All renewables

Decree-Law no.254/99

Year 1999 – Present

Policy Description This law established the procedures to obtain licences to develop ocean energy projects, as well as the procedures regulating the awarding and management of the construction and use of equipment and infrastructure located in areas of marine public domain.

Policy Type Regulatory and administrative rules

RE Technology Ocean energy

Follow up of the Energy Programme and PEDIP

Year 2000 - Present

Policy Description In 2000, a new programme in support of economic development activities under the European Union's Community Support Framework (POE) was prepared. It set out new regulations related to incentives for energy efficiency and energy diversification (renewables) projects.

Policy Type Regulatory and administrative rules

RE Technology All renewables

Decree-Law no.69/2000 (05/05/00); Despacho no.11091/2001 (25/05/01); Despacho no.12006/2001 (06/06/01); Despacho Conjuncto no.583/2001 (03/07/01)

Year 2000 – Present

Policy Description This set of legislative measures concerns the promotion of investments in renewable energy projects (wind and hydro). They established the procedures to evaluate and obtain environmental permission to develop renewable energy projects.

Policy Type Regulatory and administrative rules

RE Technology Hydro
Offshore wind
Onshore wind

Portaria no. 383/2002 (MAPE/POE Programme)

Year 2000-2006

Policy Description This legislative measure created the Measure for Supporting the Use of Energy Potential and Rational Use of Energy Programme (MAPE/POE), which is considered to be the main tool of the Ministry of Economy to support projects in the energy sector under the III Community Support Framework (QCA III – 2006).

The programme grants subsidies to public and private organisations for investments projects in four categories:

- Renewables for electricity generation.
- Energy management measures and co-generation.
- Green fuels for transport fleets.
- Fuel switching to natural gas.

Subsidies vary according to renewable-type and project economic feasibility, but in general correspond to approximately 40% of the investment.

Policy Type Capital grants

RE Technology All renewables

New Tariffs for Renewables

Year 2001 – Present

Policy Description In 2001, the buy-back tariffs for renewables were increased (up to 25% for wind energy), in order to develop more electricity generation under the special regime for co-generation and renewables.

Policy Type Guaranteed prices/feed-in tariff

RE Technology All renewables

Energy Efficiency and Endogenous Energies (E4) Programme

Year 2001 - Present

Policy Description New legislation aimed at promoting investment in energy efficiency and renewable energy generation was approved in September 2001. The main changes relate to the simplification of the process involved in obtaining licences and substantially more attractive tariffs for the acquisition of electricity from renewable sources by the national grid.

Under the new programme, € 0.082/kWh will be paid for the first 2 000 hours of wind energy production each year and € 0.07/kWh for the following 2 000 hours, with prices decreasing slightly after that. Average payment is expected to be about € 0.08/kWh, compared with € 0.06/kWh under the previous legislation. The new tariffs for mini-hydro production are € 0.07/kWh and € 0.224/kWh for wave energy. Solar will be paid at € 0.284/kWh for plants bigger than 5kW and € 0.499/kWh for smaller plants. These prices compare with an estimated average of € 0.064/kWh paid to Portugal's renewable energy producers in 2001.

Policy Type Guaranteed prices/feed-in tariff

RE Technology Offshore wind
Onshore wind
Solar photovoltaic
Hydro

Decree-Law no. 339-C/2001

Year 2001 – Present

Policy Description This Decree-Law was adopted by the Council of Ministers within the framework of the E4 Programme package. Although the general principles of the IPP law remain in force, this new law changed the formula for calculating prices paid to special-regime producers.

The measure revises DL no.168/99 and led to the establishment of differentiated tariffs as a function of the technology and operating regime.

Policy Type Guaranteed prices/feed-in tariff

RE Technology All renewables

Decree-Law no. 312/2001

Year 2001 – Present

Policy Description This law concerns the independent producers of electricity from renewable energy sources and co-generation. It establishes the procedures regulating the awarding and management of the interconnection points with the Public-Service Electrical System (SEP) for the delivery of electricity received from new power plants, in the framework of the Independent Electrical System (SEI).

Policy Type Regulatory and administrative rules

RE Technology All renewables

Decree-Law no. 68/2002

Year 2002 – Present

Policy Description This law pertains to micro-power producers and is intended to speed up administrative and technical procedures associated with the interconnection of micro-generators to the low voltage grid.

Policy type Regulatory and administrative rules

RE Technology All renewables

Tax Incentives

Year 2002 – Present

Policy Description The Ministry of Finance is directing favourable taxation towards private investors who get tax credits for investing in renewable energy (personal income tax) to stimulate investment in renewable energy technologies.

The lower VAT rates of 5% (versus 12%) applied for renewables in Portugal are no longer in force due to the European fiscal harmonisation of 2002.

Policy Type Tax exemptions

RE Technology All renewables

Resolution of the Council of Ministries

Year 2003 – Present

Policy Description The Council of Ministries approved the main orientations of energy policy and defined objectives and measures to achieve them in Resolution RCM 63/2003. (This suspended Resolution 154/2001 that created the E4 programme.)

The resolution is based on three main vectors:

- Security of supply – new objectives for 2010 for electricity produced from renewable energy sources to reduce import dependency.
- Sustainable development – supports the use of renewable energy and promotes the rational use of energy to assure Portugal's commitment in the framework of the Kyoto Protocol.
- Promotion of national competitiveness – the main focus is the liberalisation of the electricity market and to decrease energy intensity.

Policy Type General energy policy

RE Technology All renewables

Spain

Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

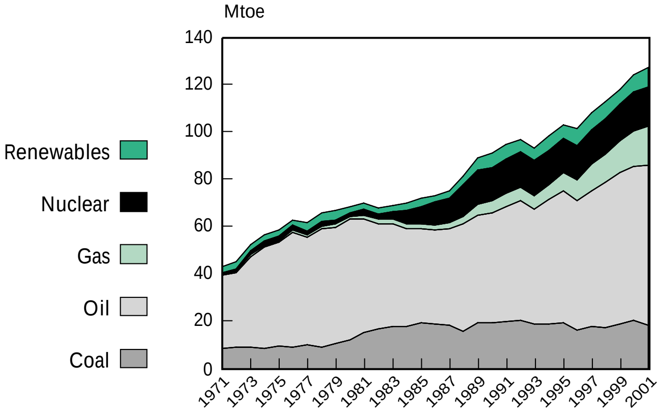
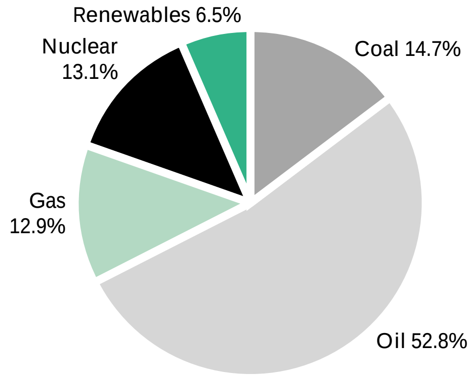


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1.
See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1970	1980	1990	1995	2000	2001	Imports
Coal	9.0	12.4	19.4	19.5	20.6	18.7	59.8%
Oil	26.7	50.7	46.5	55.5	64.8	67.1	100%
Gas	0.1	1.5	5.0	7.7	15.2	16.4	96.5%
Nuclear	0.2	1.4	14.1	14.5	16.2	16.6	-
Renewables	2.4	2.8	6.2	5.6	7.0	8.2	-
Biomass	*0.0*	*0.3*	*4.0*	*3.6*	*4.0*	*4.1*	
Hydro	*2.4*	*2.5*	*2.2*	*2.0*	*2.5*	*3.5*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.0*	*0.4*	*0.6*	
Total	**38.4**	**68.6**	**91.2**	**103.3**	**124.3**	**127.4**	**79.0%**
% Renewables	*6.2%*	*4.1%*	*6.8%*	*5.4%*	*5.7%*	*6.5%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*

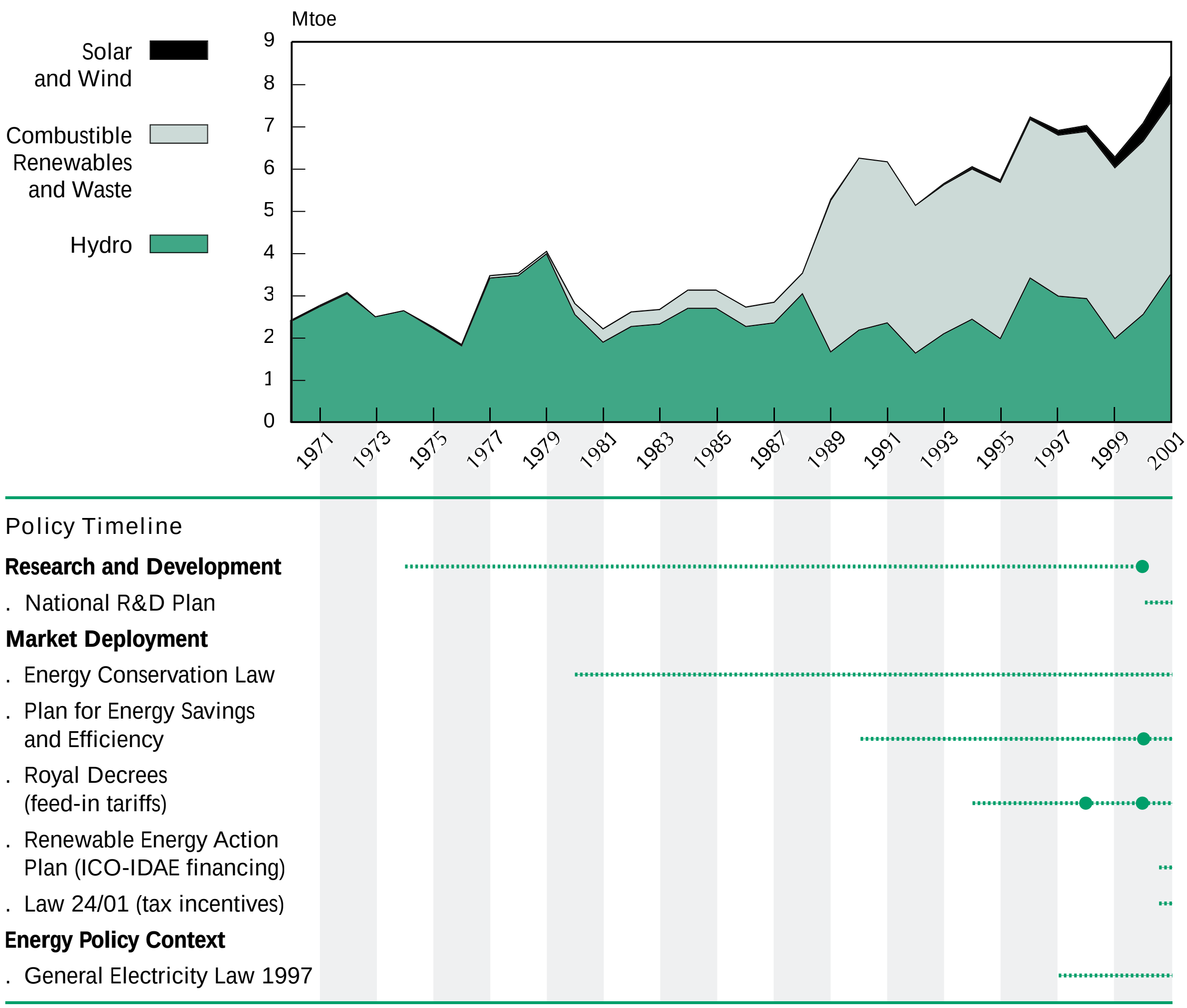
Total primary energy supply (TPES) in Spain grew by 3.1% per year from 1990 to 2001, considerably faster than in other IEA countries. In 2001, oil demand was 67 Mtoe, representing more than half of TPES. While oil still dominates energy demand, its share has fallen from 74% in 1980 (Table 1). The share of coal was about 15% in 2001, down from 21% in 1990. The share of natural gas in TPES, however, rose from 5% in 1990 to almost 13% in 2001. Gas demand increased by nearly 25% per year from 1990 to 2001. Nuclear power is an important energy source, accounting for 13% of TPES in 2001. Renewable energy supply grew from 6.2 Mtoe in 1990 to 8.2 Mtoe in 2001, but its share in TPES fell from nearly 7% to 6.5% over the same period. The decline in share was a result of the surge in gas demand and the levelling off of demand for biomass.

Renewable energy use is dominated by hydropower and biomass. In 2001, hydropower accounted for 43% of total renewable energy use and biomass for 49%. Wind power and solar energy accounted for some 7% of total renewable energy. Growth in wind power from 1995 to 2001 was rapid, more than 70% per year on average. Geothermal resources are not exploited for electricity generation in Spain.

In 2001, coal (31%), nuclear (27%) and hydropower (18%) comprised the bulk of fuels for electricity generation. The share of oil fell from 35% in 1980 to 11% in 2001. Gas-fired generation grew rapidly in the late 1990s, and its share in total electricity generation was 10% in 2001. The Spanish Ministry of Economy reports that the share of gas increased to 13% in 2002. The share of renewable energy in total electricity generation was 22% in 2001, compared with 17% in 1990. Most of the recent growth in renewables generation is from biomass, which increased from 0.5 TWh in 1990 to 2.3 TWh in 2001. Wind power represented 3% of total electricity generation in 2001. Spain's target under the *EU Directive for Electricity Produced from Renewable Energy Sources 2001* is to reach 29.4% of total electricity generation from renewables by 2010.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

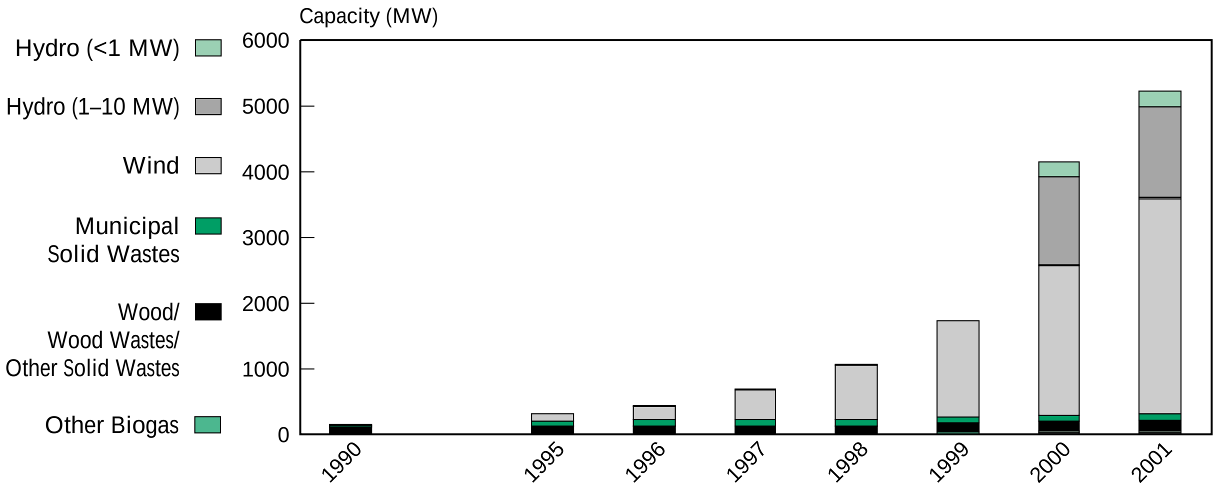
** Note: As part of the Renewable Energy Programme 1991-2000, wood consumption in the residential sector was revised upwards. This explains the large increase in CRW supply from 1989 to 1990 in Figure 3.*

Renewable energy use was 8.2 Mtoe in 2001, 4.1 Mtoe of biomass, 3.5 Mtoe of hydropower and 0.6 Mtoe of wind power and solar PV. The industry and residential sectors account for more than 90% of solid biomass use in Spain. The remaining share is used for electricity generation. The share of solid biomass that is used for electricity generation as opposed to final energy consumption increased from 1% in 1990 to nearly 10% in 2001. Hydropower's contribution has declined over the past decade.

The mix of policy support, including feed-in tariffs and favourable lending schemes, over the past decade has played a major role in the expansion of wind power. Installed wind capacity was 3.2 GW in 2001, up from 7 MW in the early 1990's (Figure 4). In order to meet its EU target for electricity generation from renewables, Spain plans to increase capacity to 13 GW by 2010. Solar PV only makes a minor contribution to total renewable energy supply.

Government support for renewable energy increased considerably after the electricity sector was liberalised in 1997. Electricity generation from renewable energy sources grew by 11.2% per year from 37.3 TWh in 1998 to 51.3 TWh in 2001.

Figure 4. **Net Generating Capacity of Renewable and Waste Products**

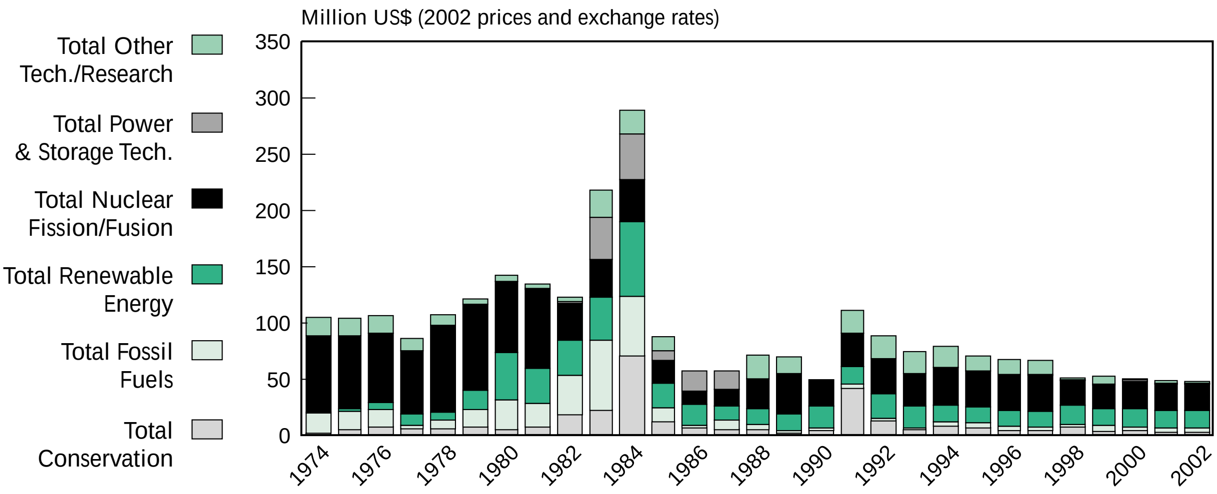


** Note: A change in data collection methods at the IEA occurred in 1999 with the separation of net generating capacity between small and large hydro. Capacity data for small hydro are not available prior to 1999.*

Research and Development Trends

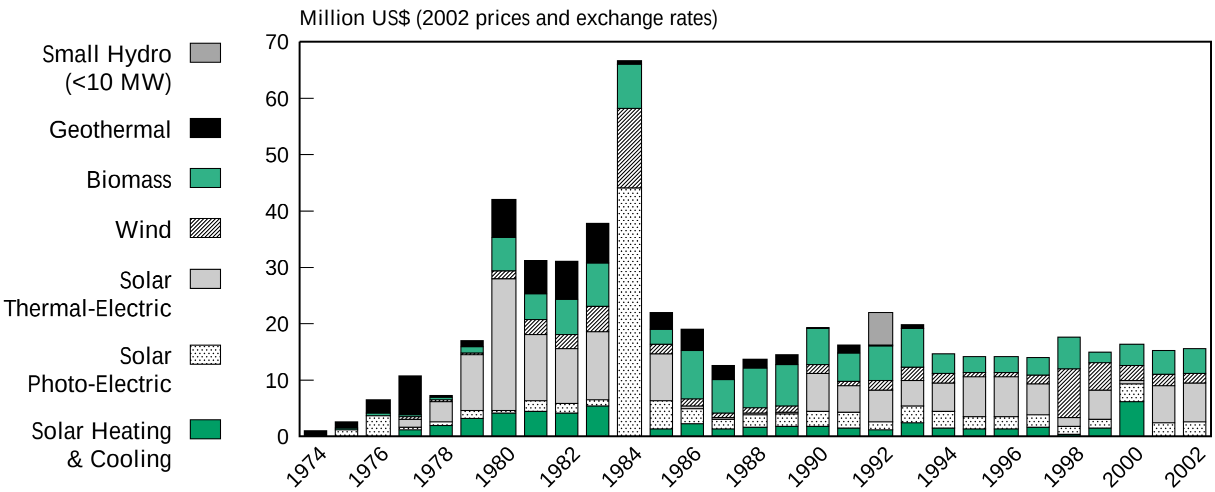
Spain spent a total of US$ 2.7 billion (in 2002 prices and exchange rates) on government energy RD&D between 1974 and 2002. Funding peaked in 1984 at US$ 288 million. Spain allocated US$ 47.9 million to energy RD&D in 2001.

Figure 5. **Spain - Government Energy RD&D Budgets**



The share of renewable energy expenditures in total energy RD&D was about 20% over the past two decades, averaging US$ 13.4 million per year from 1985 to 2002. Spain has spent considerable funds on researching concentrating solar power, over half the renewable energy RD&D budget since the early 1980s, although there is no commercial use of this technology. Some 27% of budget outlays for renewable energy RD&D went to solar-thermal electric technology from 1974 to 2002. The remainder of funding has been directed to biomass technologies (22.4%), with smaller shares going to solar PV (18.3%), wind (11.6%) and solar heating (9.5%) technologies. Funding for renewable energy was US$ 15.5 million in 2002.

Figure 6. **Spain - Government Renewable Energy RD&D Budgets**



The National RD&D Plan was in effect from 2000 to 2003. The budget for the programme was US$ 62 million (€ 51 million) over four years, and was used for the development of cleaner energy systems, including renewables.

Spain participates in international collaborative RD&D in Photovoltaic Power Systems, Solar Heating and Cooling, SolarPACES and Wind Turbine Systems through the IEA Implementing Agreements.

Market Deployment Trends

Spain has used the following market deployment strategies to support the uptake of renewable energy:

- Feed-in tariffs.
- Low-interest loans.
- Capital grants.

Support has been provided to wind, solar PV, biofuels, biomass-electric plants and small hydropower. The policies also apply to combined heat and power (CHP) plants.

The Energy Conservation Law of 1980 formed the first legal framework for the support of renewables. The law created a special economic regime, from which hydropower plants of less than 5 MW and other renewable energy generation could benefit. The law spurred the development of renewable energy by providing three major guarantees: network connection, purchase contracts with utilities and guaranteed prices. The prices were set annually by an order from the Ministry of Energy and Industry.

The 1991-2000 Plan for Energy Saving and Efficiency supported renewable energy through investment incentives and soft loans. The Renewable Energy Programme was set up under the Plan, resulting in an investment of € 2 billion and public aid of € 420 million for renewable energy projects over the ten year period. In 1994, the protection regime was strengthened by guaranteeing purchase contracts for a minimum period of five years. The feed-in tariffs established under this 1994 Royal Decree were insufficient, however, in stimulating the market for new renewable energy technologies, particularly PV.

The 1997 Electricity Law introduced competition at the generation and supply levels, with market entry based on administrative licence. Electricity generators using renewable energy sources could sell electricity to the grid under three different regimes:

• In the ordinary regime, electricity could be sold through a pool system in which all domestic generators with plants in the range of 50 MW were obliged to subscribe.

• In the independent system, electricity could be sold through bilateral contracts with a distributor, supplier or qualified consumer, but under this system there was no government guarantee for grid-connection, purchase contracts or price.

• In the special regime, electricity generation with capacity less than 50 MW using CHP or renewable energy could be sold through priority network connection, a standard five-year purchase contract with the electricity company owning the closest transport network and a certain adjustable price per kWh.

The special regime was regulated in the 1998 Royal Decree and the market-based special price was comprised of two components: the pool price and a technology-specific bonus. The law required that the bonus be sufficiently high so that, when combined with the estimated pool price, eligible generators would receive a final price within the range of 80% to 90% of the average electricity price for all consumers. The premiums under the special regime are modified annually according to the variation in the market price. Since the 1998 Royal Decree came into force, the development of wind has accelerated (Figure 4).

The 1999 Policy Plan for renewable energy set overall and technology-specific targets, identified obstacles to renewable energy development and set up incentives for market deployment of renewable energy technologies.

The Law 24/2001 on Fiscal, Administrative and Social Measures offered corporate tax deductions for investments in renewable energy. Eligible investments entitle firms to a 10% tax deduction on installations or equipment using solar power, biomass from agricultural or forestry waste, solid municipal waste and biofuels. The tax deductions do not apply to wind power.

The 2002 Royal Decree revised the regulations for installations producing electricity under the special system and changed the incentives. For installations with a generating capacity more than 50 MW using renewable energy sources, generators are now required to submit offers for the sale of electricity through the market operator.

Under the 2000-2010 Renewable Energy Plan, the Official Credit Institute (ICO) and the Institute have provided a financing line for Diversification and Energy Saving (IDAE) for the installation of renewable energy systems. The maximum that can be financed is 70% of investment costs. The line of financing is open to both public and private organisations. The maximum loan size per project is € 6.3 million. In 2000, € 9.98 million was provided, in 2001 nearly € 13.5 million. An estimated € 150.2 million was available in 2002.

Recent Support for Biofuels Production

Spain is the largest producer of fuel ethanol in the EU. Total biofuel production in 2001 was 80 000 tonnes and it is estimated to have increased to 187 000 tonnes in 2002. Spain plans to increase ethanol production and to expand biodiesel plant capacity. Both national and regional governments provide subsidies for plant construction and for promoting ethanol use. All ethanol and biodiesel producers are exempt from the hydrocarbon tax. The percentage of ETBE in gasoline is exempt from the tax. Public transport programmes in Spain have promoted the use of ethanol and biodiesel. Policy support for biofuels has been in the form of fiscal exemptions, funding for demonstration plants and research and development of processes to convert lignocellulose crops to ethanol. Under the 2000-2010 Renewable Energy Plan, Spain has set production targets for 2010 of 400 000 toe of ethanol and 100 000 toe of biodiesel.

Local authorities play an important role in the development of renewable energy in Spain. Legislation varies among regions, and several of them have their own renewable energy plans to promote the use of renewable energy through investment subsidies.

Renewable Energy Markets

Hydropower

Figure 7. **Hydropower Capacity and Electricity Production**

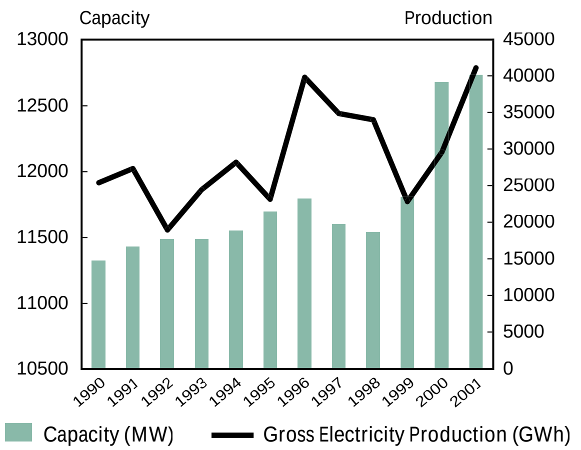
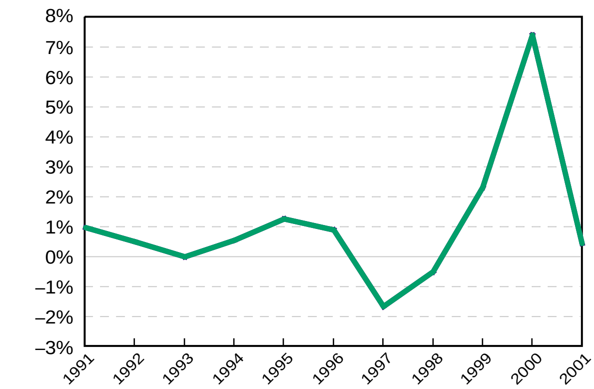
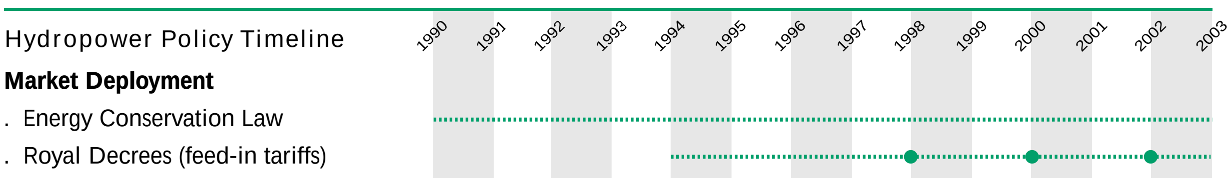


Figure 8. **Hydropower Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Hydropower plays an important role in total electricity generation (17.5% in 2001), and the major role in electricity generation from renewable energy sources (85.5% in 2001). The Spanish Ministry of Economy reports that the share in total electricity generation fell to less than 11% in 2002, due to a decline of 66% in hydropower generation.

Hydropower is generated throughout the country. The Spanish energy agency IDAE estimates that small hydro capacity (> 10 MW) was some 1.6 GW in 2001, 12.7% of total hydropower capacity. Generation from small hydropower was 4 873 GWh, 11% of total hydropower generation.

The Energy Conservation Law of 1980 created a special economic regime, targeting hydropower plants of less than 5 MW. These plants have also benefited from direct capital participation by the government and by third-party financing of plants. They are also included in the feed-in tariffs under the Royal Decrees. Small hydropower plants will likely represent the bulk of capacity additions in the future.

Despite the price support, investors in small hydro plants face several barriers. Licensing procedures are often complicated and lengthy. Potential developers are required to provide an environmental assessment plan, which often delays or inhibits construction of new plants.

Biomass Electricity Production

Figure 9. **Solid Biomass Capacity and Electricity Production**

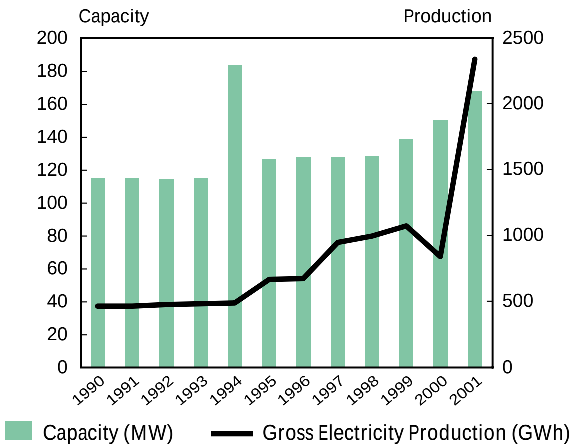
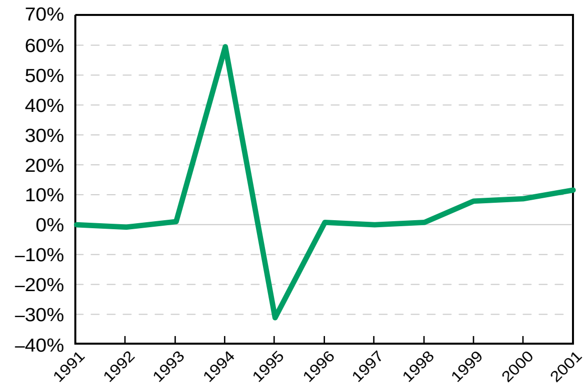
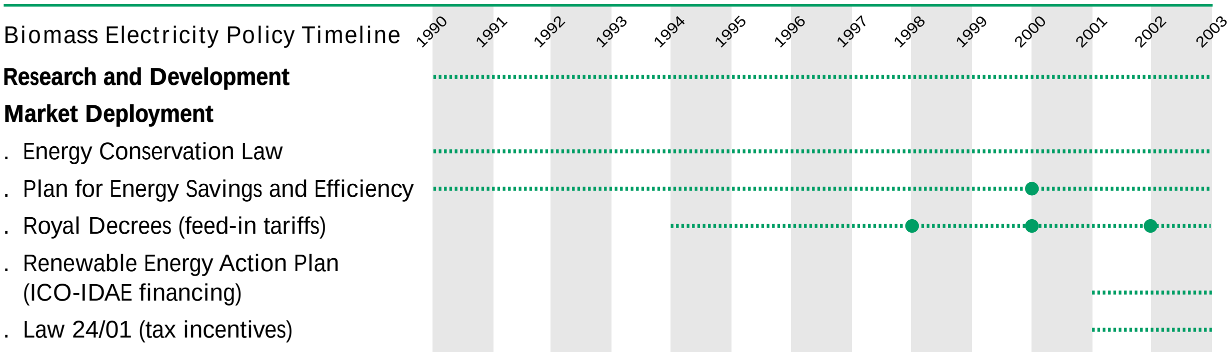


Figure 10. **Solid Biomass Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

In 2001, some 10% of solid biomass use was for electricity generation. Growth has been strong over the past decade. Solid biomass net generating capacity increased from 115 MW in 1990 to 167 MW in 2001. Electricity generation increased from an estimated 462 GWh to 2 331 GWh.

The substantial growth in electricity generation from solid biomass, about 16% per year from 1990 to 2001, was a result of policy support, including investment credits and RD&D. The government attributes more recent growth to revisions in feed-in tariffs, which took place in 1998, 2000 and 2002. The tariffs were increased from € 0.0279/kWh in 2002 to € 0.0332/kWh in 2003. Investors in biomass-electric technologies benefit from a guaranteed market for electricity produced at favourable rates and the availability of capital subsidies.

Under the 2000-2010 Renewable Energy Plan, the Official Credit Institute (ICO) and the Institute have provided a financing line for Diversification and Energy Saving (IDEA) for renewable energy. Aid to biomass technologies was € 6 million in 2000, supporting five projects.

The considerable uncertainty surrounding biomass supply in Spain has undermined the confidence of many potential investors. Policy support for bioenergy technologies should be linked to agricultural policies, in order to ensure a supply of either dedicated energy crops or agricultural residues.

Wind Power

Figure 11. **Wind Power Capacity and Electricity Production**

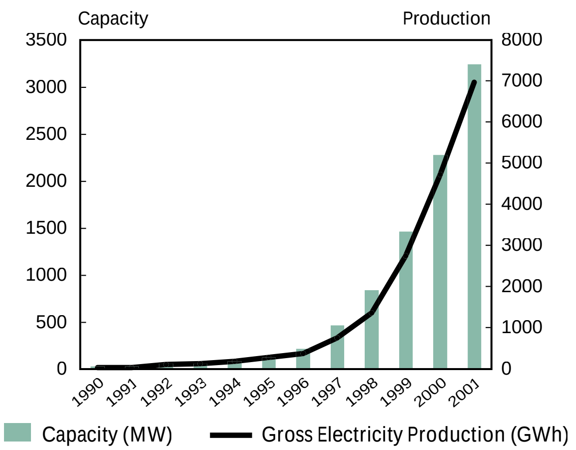
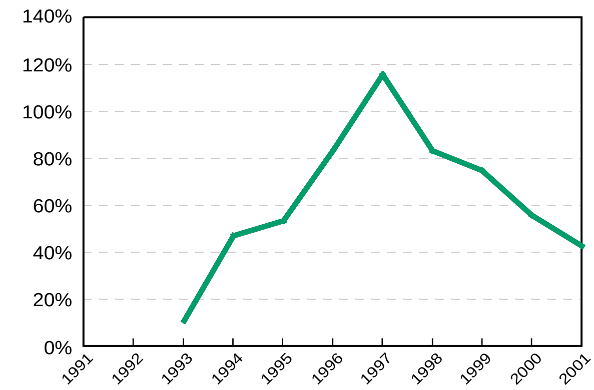
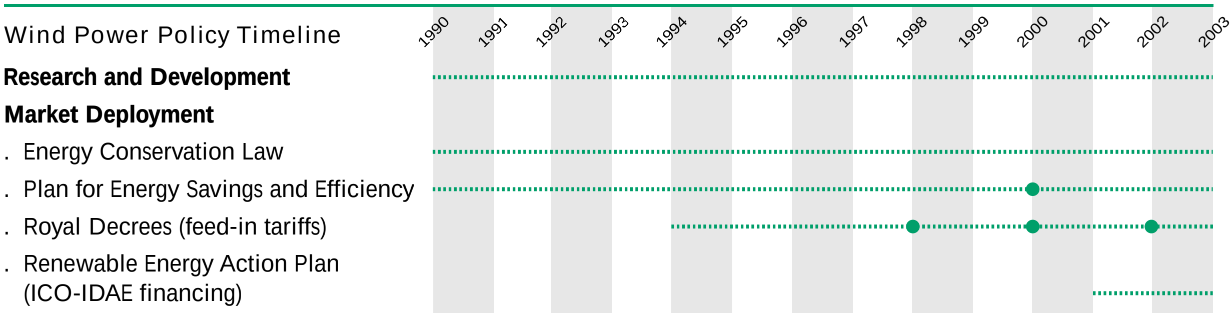


Figure 12. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Installed wind capacity has grown rapidly, from some 7 MW in 1990 to 3.2 GW in 2001, an average annual growth of 74.7%. The Spanish energy agency IDAE estimates that wind capacity was 5 GW in 2002. Spain has the third largest wind capacity in the world. The share of wind energy in electricity generation from renewables was 13.6% in 2001.

IDAE reports that the cost of installed capacity per kW has fallen from nearly € 1 700/kW in the late 1980s to € 860/kW in 2002. Wind technology is mature and three Spanish companies are among the world's ten largest manufacturers of wind turbines. Strong growth in wind capacity is attributed to local manufacturing of turbines and price support under the Royal Decrees. The premium for wind energy was € 0.029/kWh in 2002 and € 0.0266/kWh in 2003.

Wind power in Spain has received considerable government support over the past decade, with accumulated investment of € 4 206 million. Wind farms are mainly owned by consortia formed by utilities, regional institutions involved in local development, private investors and in some cases the manufacturers. Favourable lending schemes, in which banks guarantee the cash flow of the project thus reducing investor risk, have been very effective in increasing wind power capacity in Spain.

The Autonomous Communities play a vital role in the development of wind energy. The province of Galicia granted concessions to develop set quotas of capacity within 98 specified areas. The local government plans for at least 70% of the investment in the increased capacity to be made within its borders, creating some 2 000 to 3 000 jobs. Local factories make blades, components and turbines. At the end of 2001, almost 30% of Spain's total wind power capacity was in Galicia.

Potential barriers to further growth in wind capacity are dispatchability and grid connection. Spain is working to increase its ability to forecast wind speed. Grid connection has also become a barrier, as some of the wind farms are too large to use the existing transmission network. A potential constraint to further growth could be that the national law does not state the term of the price support system.

Solar Photovoltaic

Solar PV capacity increased from 5 MW in 1993 to 16 MW in 2001. Electricity generation was 24 GWh in 2001. Growth in the PV market has been strong over the past decade, due to cost reductions, a rising number of applications, and a significant RD&D effort especially for grid-connected PV installations. The primary impetus for new PV installations has been high guaranteed prices. The government has provided incentives for the installation of PV systems since 1991. Incentives are available at both the national and regional level.

The 1994 Royal Decree determined the fixed tariff for solar PV at € 0.06/kWh. This tariff was insufficient to stimulate the market and no additional capacity came on-line between 1995 and 1998. Under the 1998 Royal Decree, the tariff was raised to € 0.39/kWh. This tariff applies to installations with capacity less than 5 kW.

The target under the Renewable Energy Programme 1991-2000 (as part of the Plan for Energy Savings and Efficiency) was to increase the installed capacity of solar PV to 2.5 MW. In fact, photovoltaic capacity increased by 5 MW from 1993 to 2000. The following measures and incentives for the solar PV market were approved at the end of 1999:

- Public subsidies for RD&D projects whose objectives are the improvement of PV technologies and the improvement of production, commercialisation and installation processes.
- Public subsidies for the installation of PV systems, both off-grid and grid-connected systems.
- Establishment of a new regulation for the connection of PV systems to the grid.
- Tax benefits for PV installations.

The Royal Decree 1663/2000 established the technical conditions for the connection of photovoltaic systems to the low voltage grid. It applies to photovoltaic installations of nominal power not higher than 100 kVA and whose connection to the distribution grid is low voltage (*i.e.*, not more than 1 kV). If the nominal power of a PV installation is more than 5 kW, the connection to the grid will be through three-phase inverters. This connection can be made through one or various single-phase inverters at each phase, with power less than 5 kW.

Under the 2000-2010 Renewable Energy Plan, the Official Credit Institute (ICO) and the Institute have provided a financing line for Diversification and Energy Saving (IDAE) for renewable energy. As part of the Plan, € 10.8 million in grants were allocated to solar PV projects. The incentives were given to projects that started in March 2002 and were completed before October 2003.

Figure 13. **Solar Photovoltaic Capacity and Electricity Production**

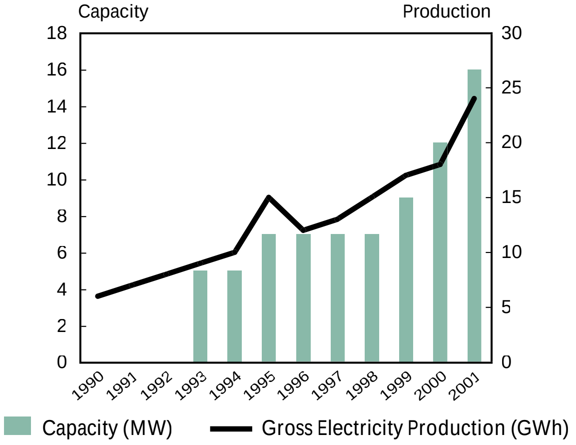
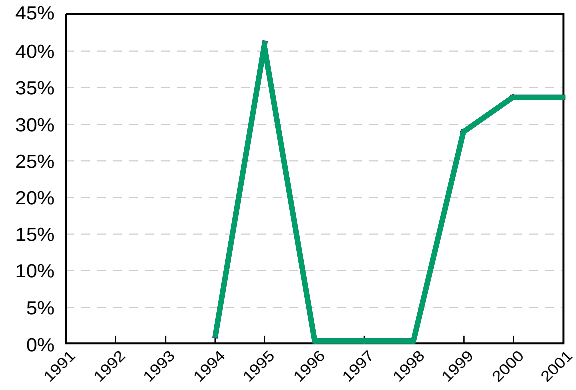
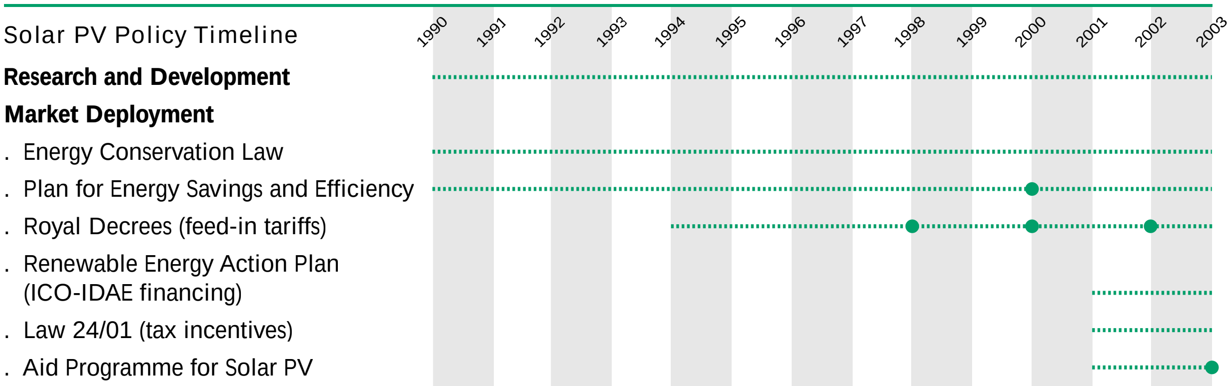


Figure 14. **Solar Photovoltaic Capacity** (Year to Year Change)



Solar PV Policy Timeline



Denotes a significant change to a policy, such as an extension, repeal or revision.

Spain Policy Chronology

Energy Conservation Law

Year 1980-1994

Policy Description This Energy Conservation Law (82/1980) formed the first legal framework for the support of the renewable energy, but did not offer a definition of renewable resources or technologies. The Law created a special economic regime, from which hydropower plants of less than 5 MW and other renewable energy generators could profit.

The development of renewable energy in Spain was promoted by three major guarantees: network connection, purchase contracts with utilities and a certain guaranteed price. The price was set annually by an Order from the Ministry of Energy and Industry.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology All renewables

Feed-in Tariffs

Year 1994 - Present

Policy Description A series of Royal Decrees provided support for electricity generation from renewable energy sources, waste and CHP, based on feed-in tariffs. The 1994 decree determined the fixed tariff for solar electricity at ESP 10.42/kWh (€ 0.06/kWh). The Royal Decree (2818/1998) increased the tariff for solar electricity to € 0.22 to € 0.39/kWh. In 2000, it was revised and a new price at which a utility or supplier has to purchase renewable electricity from private generators was fixed. It ranges from € 0.03/kWh (for secondary biomass) to € 0.39/kWh (for PV under 5 kW). From 1999, wind electricity producers could receive either a fixed tariff of € 0.06/kWh or the average hourly market price of electricity plus a bonus of € 0.03/kWh.

Rates are specified for both capacity and output credits. Output credits are the highest for wind and solar plants: € 0.07/kWh over a five-year period. Capacity credits are the highest for waste incineration plants; output credits for these plants vary depending on the size of the plant and on the relative importance of any co-fired fossil fuel. They also decrease annually. Buy-back rates for these plants are about € 0.06/kWh in the first year. Buy-back rates also depend on continuity of supply to avoid surges in power sold to the grid. The legislation also provides for guaranteed access to the electricity grid, with agreed rates for connection.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology All renewables

Renewable Energy Programme

Year 1991-2000

Policy Description The Renewable Energy Programme (PER) was part of the Energy Saving and Efficiency Plan (PAEE), which is, in turn, an annex of the National Energy Plan (Plan). The Renewable Energy Programme promoted energy security and diversification.

In order to attain the objective set in the PER, *i.e.*, to introduce 1 171 ktoe from renewables from 1991 to 2000, total investments costs were an estimated amount of PTA 334 000 million and total public aid (coming from all public administrations) was PTA 70 118 million.

Policy Type Regulatory and administrative rules

RE Technology All renewables

Electricity Law

Year 1994-1997

Policy Description The Electricity Law (40/1994) passed in 1994 reorganised Spain's electricity industry. This law strengthened the special protection regime for renewable energy. The guarantee on purchase contracts was five years. The new law also envisaged that prices would be set by means of governmental Royal Decree instead of an Order by the Ministry of Industry and Energy. Like its predecessor (Law 82/1980), this law did not define renewable energy.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology All renewables

Royal Decree

Year 1994-1997

Policy Description This Royal Decree (2366/1994) further specified the new special economic regime. The decree also distinguished between six eligible technological groups, which were differentiated in the special regime by tariff levels. Except for hydropower, the maximum size for a plant's eligibility was 25 MW, or 100 MW with special governmental approval.

This legislation mandated the purchase by the utilities of all the electricity generated with renewable energy sources. It also established electricity rates and quality standards.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology All renewables

General Electricity Law

Year 1997 to Present

Policy Description This regulation (Law 54/1997) of the electric sector liberalised the electricity sector and guaranteed electricity supply at lowest possible cost. It elaborated the plan for the promotion of renewable energy and the plan for achieving the goal of 12% of primary energy consumption from renewable sources by 2010. The law also established a special regime for producers, which are not allowed to surpass a maximum of 50 MW power. This law is implemented through royal decrees, most notably Decree 2818/1998, which specified the feed-in tariffs from which the generating plants under the “special regime” may benefit. The law established the guarantee of access to the grid for producers under the special regime. The law also established a premium, so that the price of electricity sold under the special regime is 80-90% of the mean price of electricity charged to final consumers.

Policy Type Guaranteed prices/feed-in tariffs / Obligations

RE Technology All renewables

Royal Decree: “ Special Regime”

Year 1998 - Present

Policy Description The Royal Decree (2818/1998) increased the tariff for solar electricity from € 0.22 to € 0.39/kWh. In 2000 it was revised and a new price was fixed, at which a utility or supplier has to purchase renewable electricity from private generators. It ranges from € 0.03/kWh (for secondary biomass) to € 0.39/kWh (for PV less than 5 kW). From 1999, wind electricity producers could receive either a fixed tariff of € 0.06/kWh or the average hourly market price of electricity plus a bonus of € 0.03/kWh.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology All renewables

Renewable Energy Promotion Plan

Year 1999-2010

Policy Description The Renewable Energy Promotion Plan was approved in 1999 and aims to supply at least 12% of Spain’s total energy demand with energy generated from renewable sources by 2010.

Policy Type Obligations

RE Technology All renewables

R&D Priorities

Year 1999-2003

Policy Description In 1999, the Spanish government approved the National Plan on Scientific Research and Technology Development and Innovation, which was effective from 2000 to 2003. Priorities included: more efficient and less polluting energy systems (with a special focus on renewables and fuel cells); more economic and efficient energy transmission, sorting, distribution, and use; and alternative systems for propulsion as well as new fuels for the transport sector, with special attention to the reduction of carbon dioxide emissions.

Policy Type RD&D

RE Technology All renewables

Feed-in tariffs for Small Scale Co-generation/Renewable Electricity Production

Year 1999-Present

Policy Description Generators with an installed capacity of less than 50 MW using co-generation systems or renewable resource systems (biomass, wind, mini-hydroelectric or photovoltaic solar), or any type of biofuel or non-renewable waste have the right to sell the electricity they generate or their surpluses to the grid at a pre-set price, the value of which is the market price plus a premium according to the type of plant. The premiums are established and decreased on a yearly basis in order to maintain market competition.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology All renewables

Plan on Renewables

Year 2000 - Present

Policy Description The Promotion Plan of Renewable Energies ("Plan de Fomento de las Energías Renovables en España"), adopted by the Spanish government in 1999, became effective in 2000. It calls for doubling the renewable energy share in the primary energy supply quota from 6 to 12%. The main areas that are considered by the plan are biomass, wind, hydropower, solar and urban solid waste.

Policy Type Obligations

RE Technology Biomass
Onshore wind
Offshore wind
Hydro
Solar photovoltaic
Concentrating solar
Solar thermal
Waste

R&D Energy Programme

Year 2000-2003

Policy Description The National RD&D Plan (2000-2003), promulgated by the government in 1999, became effective in 2000. The plan integrates many horizontal and specific programmes such as the National Energy Programme (PROFIT-Energía). It focuses on four key actions: cleaner energy systems, including renewable energy sources and fuel cells; technologies for the transmission, storage, distribution, and rational and efficient use of energy; new propelling systems and fuels for the road transport sector; and complementary actions (fossil fuels, renewable energy integration, nuclear safety, environmental impact, etc.).

Policy Type RD&D

RE Technology All renewables

Royal Decree

Year 2000 – Present

Policy Description The Directorate General for Energy Policy and Mines drafted a standard contract and invoice for solar PV installations connected to low voltage grids. The Royal Decree (1663/2000) applies to photovoltaic installations of nominal power not more than 100 kVA and whose connection to the distribution grid is carried out in low voltage, *i.e.*, not higher than 1 kV. If the nominal power of a photovoltaic installation to be connected to the distribution grid is more than 5 kW, the connection to the distribution grid will be triphasic, through three-phase inverters. This connection could be made through one or various single-phase inverters at each phase, with power less than 5 kW.

Policy Type Feed-in tariff

RE Technology Solar photovoltaic

National Energy Programme of the Promotion of Technical Research

Year 2000-2001

Policy Description The goal of this law was to facilitate the integration of renewable energy and the environmental and socio-economic aspects of energy. The program offered grants/aids for industrial research and technology demonstration programmes. In 2000, a total of 105 projects received grants, while in 2001, a total of 54 projects received grants. The grants were mainly non-refundable loans and, in some cases, subsidies.

Policy Type Capital grants
RD&D

RE Technology All renewables

Law on Fiscal, Administrative and Social Measures

Year 2001

Policy Description This Law (24/2001) offers corporate tax deductions for investments in renewable energy sources. Those investments that were originally for Royal Decree 1663/2000 have been incorporated into this Law. Eligible investments entitle firms to a 10% tax deduction in the case of investments in installations or equipment using solar power, biomass from agricultural or forestry waste, solid municipal waste and biofuels. These tax deductions are not applicable to wind power equipment or installations.

Policy Type Investment tax credits

RE Technology All renewables

Inter-ministerial Commission for Biomass

Year 2001-2010

Policy Description An inter-ministerial commission was created to promote a package of measures and to remove barriers to the development of biomass.

Policy Type Regulatory and administrative rules

RE Technology Biomass

Aid Programme for Solar PV and Solar Thermal

Year 2001-2003

Policy Description As part of the Renewable Energy Action Plan 2000-2010, subsidies for both solar thermal (€ 10.8 million) and solar photovoltaic (€ 10.8 million) were provided in 2002. The subsidy was given to projects that started in 2002 and were completed before October 2003.

Policy Type Capital grants

RE Technology Solar photovoltaic
Solar thermal

Low Interest Loans

Year 2001 - Present

Policy Description This programme provides investment assistance to renewables through low interest loans at discounts of 2-5 points. The programme's total budget for 2001 was € 9.62 million.

Policy Type Third-party finance

RE Technology All renewables

Planning and Development of the Electric and Gas Transport Networks

Year 2002-2011

Policy Description The "Planning of Electricity and Gas Sectors: Development of the Transport Networks 2002-2011" was approved by the Government and ratified by Parliament in 2002. Under the plan, priority is given to the installation of power lines coming from renewable energy facilities and for combined cycle power plants; and also for the building of natural gas pipelines to serve co-generation and combined cycle plants.

The structure of electrical generation is to be modified through fuel substitution and technical change. The plan is to increase the installed capacity of wind power facilities to 13 000 MW in 2011 and of combined cycle plants to at least 14 800 MW by 2011.

The forecast for energy demand used in this new plan is higher than that used in the Renewable Energy Plan. In order to reach the target of 12% of energy produced by renewables, the plan updates the objectives for wind energy and biomass electricity production in the 2000 Renewable Energy Plan.

Policy Type Regulatory and administrative rules

RE Technology All renewables

Modification to the Biomass, Waste and Wind Energy Premiums

Year 2001-2010

Policy Description Within the Renewable Action Plan 2000-2010, an inter-ministerial commission was created in 2001 to promote a package of measures and remove barriers in the deployment of renewable energy sources. Modification of renewable energy premiums has been introduced in the legislation that set the yearly electric tariffs. The premium for energy from biomass has been increased from €0.0279/kWh in 2002 to €0.0332/kWh in 2003, and also for the livestock manure management from €0.0271/kWh to €0.0294/kWh. Conversely, the premium for wind energy has been reduced from €0.0290/kWh to €0.0266/kWh.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology Biomass
Offshore wind
Onshore wind
Waste

Royal Decree

Year 2002 - Present

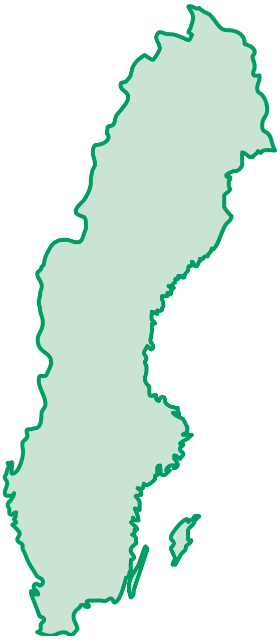
Policy Description Royal Decree (841/2002) specified changes to the special regime, regulating installations producing electricity from renewables and the incentives for them to participate in the energy market. It included a series of obligations concerning disclosure of their production forecasts and other information, as well as rules for the purchase of the electricity generated by energy traders.

Installations with a generating capacity > 50 MW using renewable/non-consumable energy sources are required to submit offers for the sale of electricity via the market operator. Generators covered by the system are guaranteed a price equal to that offered by the market plus € 0.009015/kWh as a power guarantee, in addition to the premium due under the legislation.

Policy Type Guaranteed prices/feed-in tariffs

RE Technology All renewables

Sweden



Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

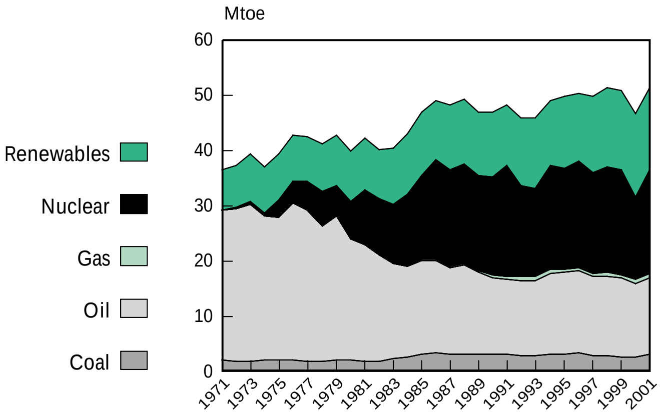
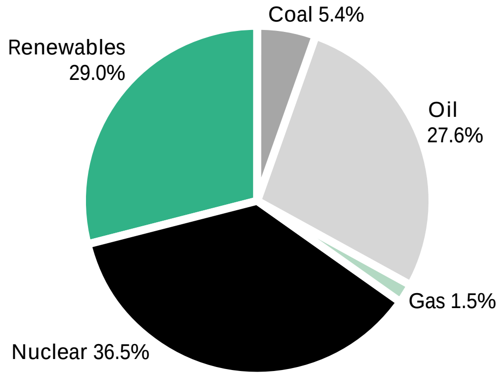


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1. See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1970	1980	1990	1995	2000	2001	Imports
Coal	1.9	1.7	3.0	2.9	2.4	2.8	85.9%
Oil	29.2	22.1	13.8	14.9	13.4	14.3	100.0%
Gas	0.0	0.0	0.5	0.7	0.7	0.8	100.0%
Nuclear	0.0	6.9	17.8	18.2	14.9	18.8	-
Renewables	6.5	9.2	11.7	13.1	15.3	15.0	-
Biomass	*2.9*	*4.1*	*5.5*	*7.3*	*8.5*	*8.2*	
Hydro	*3.6*	*5.1*	*6.2*	*5.9*	*6.8*	*6.8*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Total	**37.9**	**39.9**	**46.7**	**50.0**	**47.5**	**51.1**	**35.0%**
% Renewables	*17.2%*	*23.1%*	*25.1%*	*26.2%*	*32.4%*	*29.1%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*

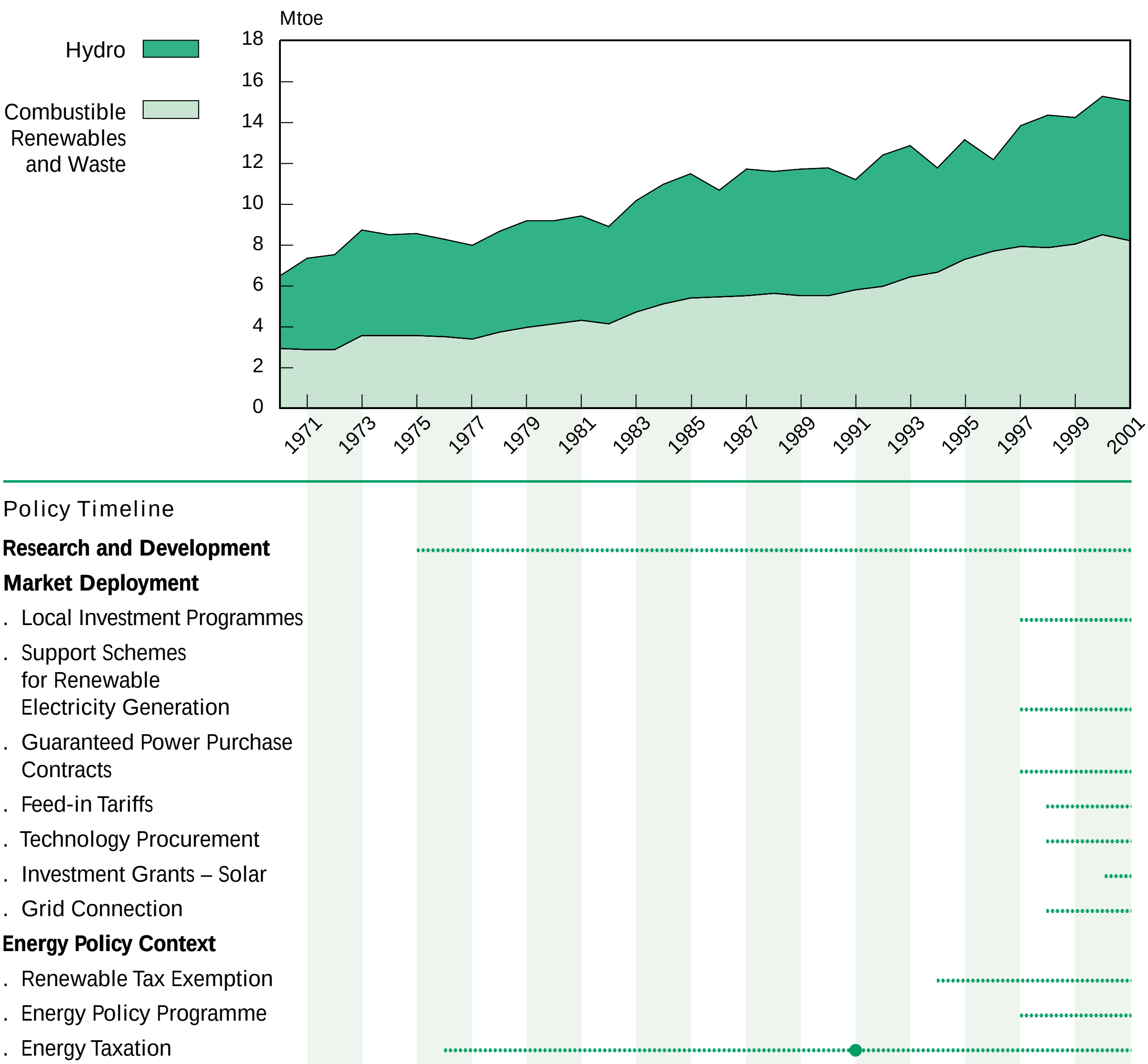
Total primary energy supply (TPES) in Sweden increased 10% from 47 Mtoe in 1990 to 51 Mtoe in 2001. Between 1970 and 2001, TPES increased by 35% and the components of supply changed considerably: oil accounted for 77% of TPES in 1970 compared to 28% in 2001(Table 1), while nuclear grew from zero in 1970 to 18.8 Mtoe in 2001. In 1970 most of the oil supply was used in the residential and service sectors, while today about 55% is used for transport. Much of the energy previously supplied by oil has been replaced over the decades by nuclear power and biomass. Biomass has increased its share of supply from 7.7% in 1970 to 16% in 2001. Biomass is used mainly in the industrial sector and district heat production.

Renewables have increased from 11.7 Mtoe in 1990 to 15 Mtoe in 2001, largely due to growth in biomass use. Sweden's renewable energy supply is primarily hydro and biomass. Biomass grew from 5.5 Mtoe in 1990 to 8.2 Mtoe in 2001, while hydropower grew more slowly in the same period. Sweden's share of renewables in total energy supply at 29% in 2001 compares favourably to the average of 5.5% for all IEA countries.

There has been considerable change in the production mix of Sweden's electricity sector over the last three decades. The oil price crises of the 1970s spurred the construction of nuclear power plants to reduce dependence on oil. Large hydro was already a significant contributor and by 2001, hydro and nuclear together accounted for 94% of electricity production. In addition to nuclear and hydro and a very modest amount of wind, Sweden operates combustion-based power production, of which 35% of the fuel is supplied by coal, 35% by biomass and 26% by oil.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**

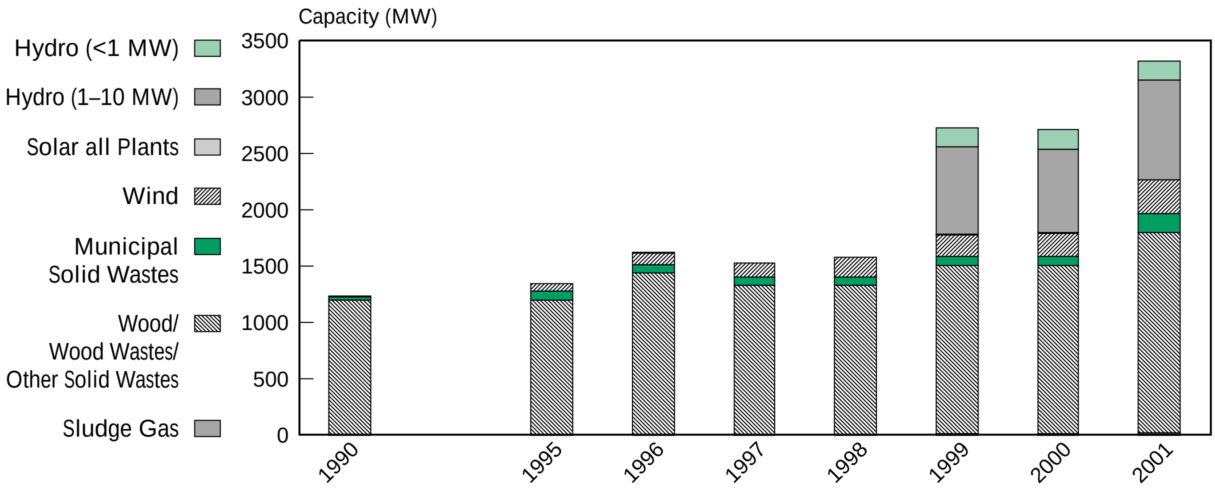


● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Biomass and hydropower dominate renewable energy production in Sweden. In 2001, biomass accounted for 55% of all renewable production, hydropower accounted for 45% and solar and wind power accounted for 0.3%. Hydro production fluctuates year-to-year depending on precipitation patterns.

The two most significant changes in Sweden's energy supply over the last decade were the decrease in nuclear power, as part of a phase-out process, and an increase in biomass. In 1990 biomass accounted for 12% of TPES and by 2000 it reached 18%, falling slightly to 16% in 2001. Increased biomass use resulted from a concerted government effort in the early 1990s to support biomass through taxation and other means. Taxes as a tool to increase biomass use are expected to continue to play an important role in the future.

Figure 4. **Net Generating Capacity of Renewable and Waste Products**



Note: A change in data collection methods at the IEA occurred in 1999 with the separation of net generating capacity between small and large hydro. Capacity data for small hydro are not available prior to 1999.

Research and Development Trends

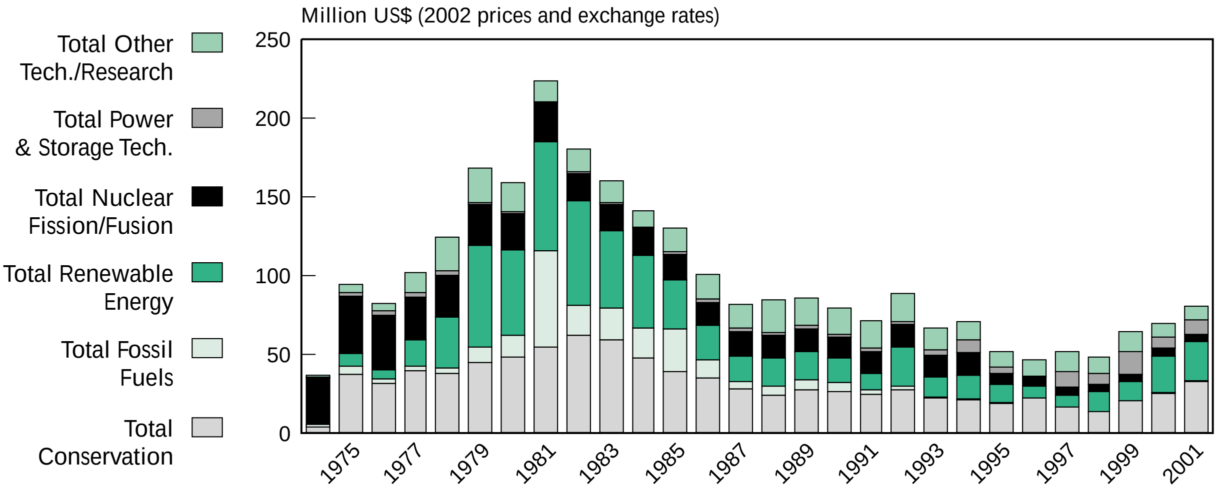
Sweden spent a total of US$ 2.73 billion (2002 prices and exchange rates) on government energy RD&D between 1974 and 2001. In that period, 25% of its total RD&D budget was allocated to renewable energy R&D.

The overall trend of government RD&D expenditures for renewables peaked in the early 1980s and declined notably after 1984 except for a boost in 1992. Government RD&D budgets for renewables increased considerably in 2000 and 2001.

Among the renewable technologies, biomass received the highest level of funding at US$ 323 million, or 47%, in the 1974 to 2001 period. Solar heating and cooling was funded at US$ 186.6 million, representing 27% of renewable energy RD&D. Wind was the third largest recipient with 20% of the renewable RD&D expenditures from 1974 to 2001.

Government-funded energy research and development programmes date back to 1975. Sweden uses RD&D to promote commercial applications where possible, particularly for new technology with higher efficiency and lower environmental effects. Among the areas that the parliament has highlighted are combined heat and power production using biomass and waste, biofuel production, new processes for the production of ethanol from woody biomass, large-scale use of onshore and offshore wind, photovoltaics, as well as efficient use of energy in buildings, industry and transport.

Figure 5. **Sweden - Government Energy RD&D Budgets**



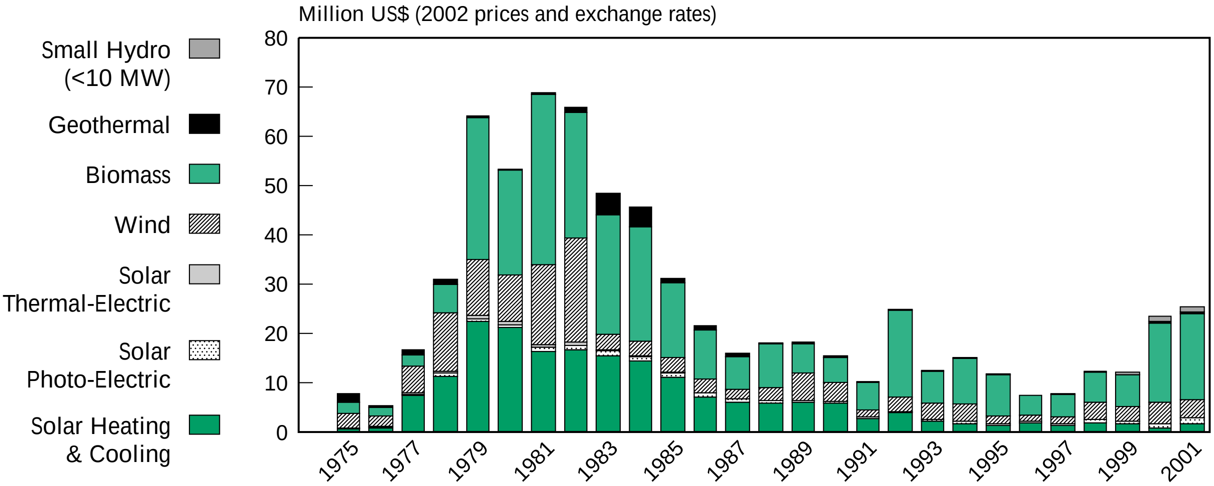
Swedish government RD&D activity takes place mainly in the following renewable energy technologies:

- Hydropower: Two major programmes whose aim is to create general improvements in hydropower technology and in the water environment used for hydropower generation.
- Photovoltaic Cells: One major programme seeks to develop thin film solar cells, Grätzel solar cells and smart windows. Another programme focuses on user-oriented development of complete solar cell systems.
- Wind Power: A number of research programmes focus on how to integrate wind plants into the Swedish energy system without negatively impacting the environment.
- Biomass: The government spends about 16% of its annual total energy R&D funds in the field of biomass. Various programmes look at fuels from agricultural lands, carbon balances, biomass and the environment, and refined solid biomass.
- Solid Waste (including biogas): There is one research programme that focuses on energy production with minimal environmental consequences.
- Geothermal: One programme examines possibilities for geothermal energy in southern Sweden (Skåne) and another is looking at deep drilling for geothermal energy in Lund.

There are many programmes related to renewable energy in the Swedish RD&D programme. Apart from the ones listed above, there are efforts on biofuel-fired CHP (bio-IGCC), large-scale biofuel-fired heat plants, renewable based production of hydrogen, gasification of black liquor from the pulp and paper industry for power generation or transport fuel production and small-scale heating using wood or pellets.

In addition, Sweden participates in international collaborative RD&D in the Bioenergy, District Heating and Cooling, Hydropower, Photovoltaic Power Systems, Pulp and Paper, Solar Heating and Cooling and Wind Turbine IEA Implementing Agreements.

Figure 6. **Sweden - Government Renewable Energy RD&D Budgets**



Market Deployment Trends

Sweden has set a target of increasing its annual electricity generation from renewable resources by 10 TWh from 2002 to 2010. Reaching this target will require a quadrupling of the rate of renewables development seen under the renewable support programmes that were in effect from 1997 to 2002. Half of the 10 TWh increase is expected to come from greater production at existing plants, and the other half from production at new plants.

Taxes are expected to remain a primary policy approach and to have an important role in reaching the target. The other main tool is an electricity (green) certificate system, which came into force in May 2003. The target serves as the basis for allocating quotas in the electricity certificate trading system. The certificate quota obligation began at 7.3% of total electricity supplied in 2003 and will increase to 16.9% in 2010 according to a set schedule.

Under the system, all electricity generators receive a certificate for each MWh of electricity produced from eligible technologies, including:

- Wind power
- Solar power
- Geothermal energy
- Biomass
- Tidal energy
- Hydro power (= or < 1.5 MW).

Suppliers may obtain the needed certificates through generation from their own eligible plants, or they can purchase certificates from other companies which generate with eligible technologies. Such suppliers need not enter into a contract with the renewable generator for the purchase of the electricity itself, only the certificates. In this way, they are free to purchase all their electricity from a non-renewable generator as long as they acquire sufficient certificates from other companies using eligible technologies. Suppliers can pass the cost of certificates onto their customers, although they are required to list it as an explicit component of the bill.

Investment Incentives

In addition to the certificate system, Sweden will continue to offer subsidies for selected renewable technologies. There is investment support for the market introduction of wind. The environmental bonus for wind power, which provides for a deduction of the energy tax due on electricity production, will continue until 2009. A subsidy to support solar heating has been in place since June 2000 with no established end date.

Taxation

Energy taxation in Sweden is used as a tool to raise revenue and reach certain policy goals. Sweden has three different levies on energy products: energy tax, carbon dioxide tax, and sulphur tax. There is also an environmental levy on emissions of nitrogen oxides for boilers, gas turbines and stationary combustion plants producing an annual energy output of at least 25 GWh.

In connection with the tax reforms of 1990/1991, Sweden began a process of green tax exchange. Under this system, energy taxes were increased while other taxes (such as income and payroll taxes) were decreased by similar amounts. The green tax shift affects domestic consumers and the service and energy sectors.

Since January 2004, households and the service sector pay an electricity tax of SKr 241/MWh. Consumers in manufacturing, agriculture, forestry and fishing pay no electricity tax until 1 July 2004, when an electricity tax of SKr 5/MWh will be introduced.

The carbon dioxide tax, introduced in 1991, is levied on the emitted quantities (kg) of carbon dioxide from all fuels except biomass and peat. It does not differentiate between the uses of fuels for heating or as motor fuels. It was increased on 1 January 2001 from SKr 370 per tonne to SKr 530 per tonne, from 1 January 2002 to SKr 630 per tonne and from 1 January 2003 to SKr 760 per tonne. Since 1 January 2004, the CO_2 tax has been SKr 910 per tonne.

Also introduced in 1991, the sulphur tax amounts to SKr 30 per kg of sulphur emissions from coal and peat and to SKr 27 per cubic metre for each tenth of a percent by weight of sulphur content in oil. However, if the sulphur content of liquid or gaseous fuels does not exceed 0.1% by weight, no sulphur tax is charged.

Fuels used for electricity production are exempt from the energy and CO_2 taxes, although they are subject to the NO_x levy and sulphur tax in certain cases. Fuels used for heat production are subject to energy and CO_2 taxes and, in certain cases, to the sulphur tax and NO_x levy. In principle, biofuels, refuse and peat are free of tax for all energy uses, although peat is subject to the sulphur tax.

Special taxation rules apply for combined heat and power (CHP) plants. Since 1 January 2004, no energy tax and only 21% of the CO_2 tax are levied for fuels used for heat production in CHP plants. This same taxation is applied in manufacturing, industry, agriculture, forestry and fishing. The reason for lowering the tax is to promote production in existing CHP plants and investments in new plants.

All transport fuels are taxed, generally at higher rates than those used for heating. Under the terms of the EU Directive 92/81/EEC (1992) on excise duties on mineral oils, governments can reduce or waive taxation on certain volumes of alternative fuels to promote the development of more environmentally benign fuels. Such tax reductions in Sweden have led to the introduction of biofuels like bioethanol, biodiesel (RME) and biogas.

Energy Policy Context

The basic line of Swedish energy policy comes from a 1997 energy policy agreement. Its main goals are to:

- Secure access to electricity and other sources of energy on internationally competitive terms.
- Facilitate the transition to an ecologically sustainable society.
- Contribute to the creation of stable conditions for a competitive business sector and the renewal and development of Swedish industry.
- Co-operate in the Baltic region in the field of energy, environment and climate change.

Energy policy guidelines set out in 2002 are consistent with those of the 1997 bill in that they continue to pledge support for renewable energy and activities to reduce electricity consumption. However, an evaluation indicated the need for a somewhat different approach in certain areas. As a result, the energy policy agreement of 2002 constitutes a shift in the direction of the policy instruments that are to influence development in the short term. For renewables, it set out the new quota system with tradable certificates to promote environmentally friendly and renewable electricity production. Energy and environment taxation remains the primary policy measure.

Renewable Energy Markets

Hydropower

Figure 7. **Hydropower Capacity and Electricity Production**

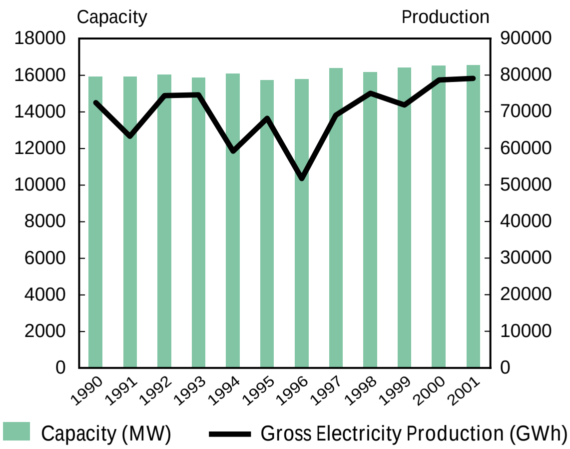
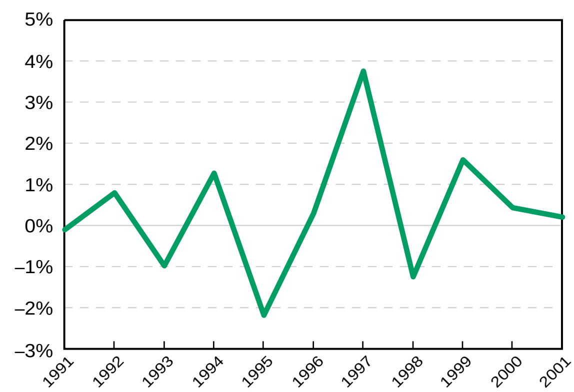
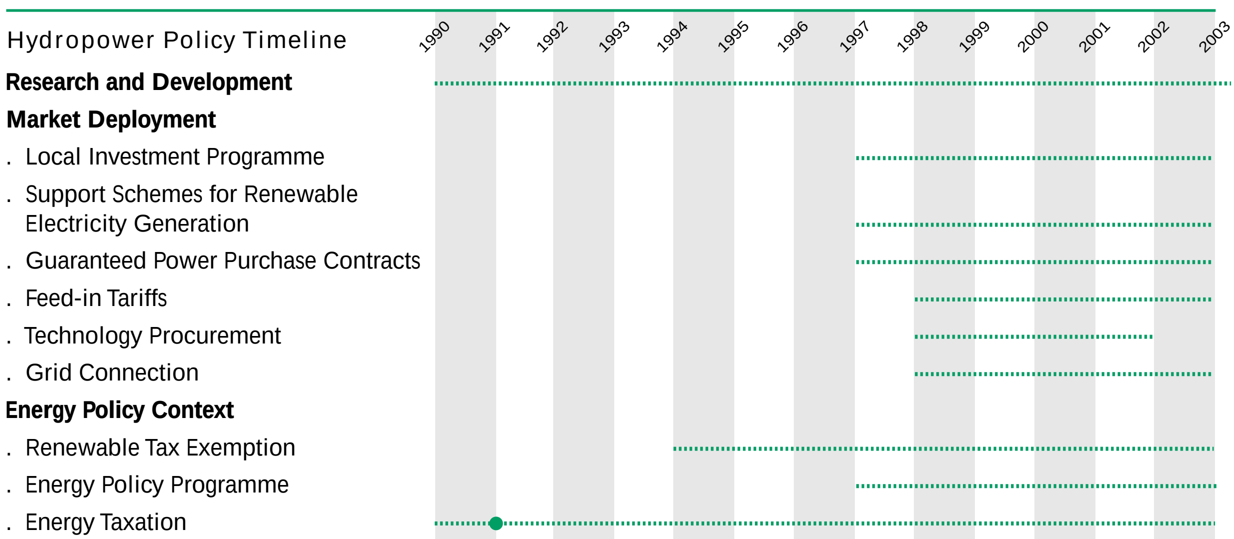


Figure 8. **Hydropower Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Installed hydropower capacity has not changed much in recent years. Production fluctuates depending upon precipitation levels.

Other than research and development for technology and resource management, hydropower is not a major policy focus as it is considered a mature technology. Small-scale hydro was promoted by an investment subsidy, but this aid is currently frozen and new directives for its use are being considered.

Biomass Production

Figure 9. **Solid Biomass Production**

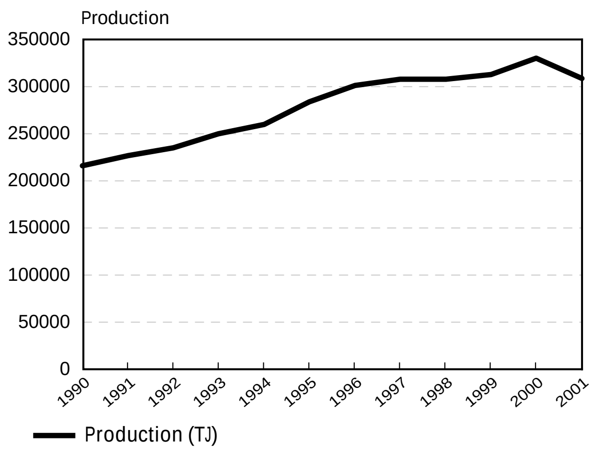
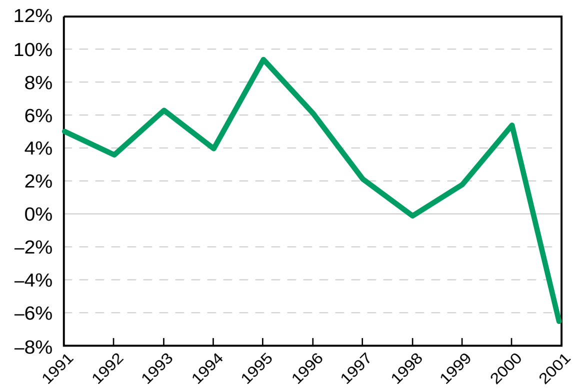
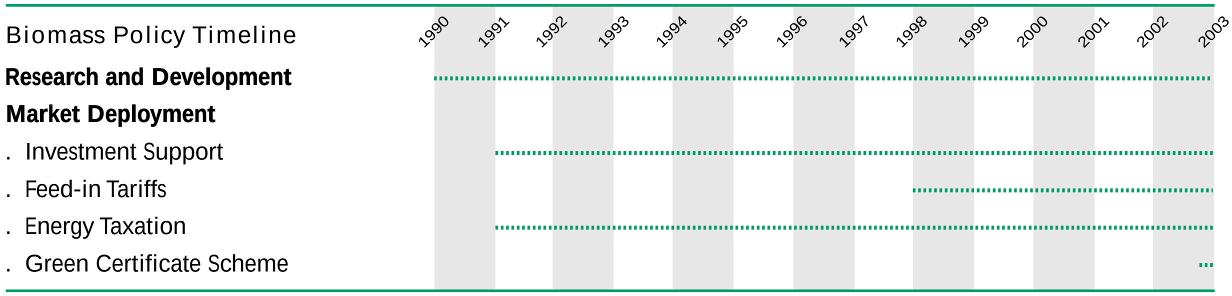


Figure 10. **Solid Biomass Production**
(Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

In 2001, 16% of Sweden's total primary energy supply was from biomass and waste, usually known as biofuels in Sweden. These fuels are mainly indigenous and consist of wood fuels, black liquors in pulp mills, peat, waste, straw and energy grasses. They are used mainly in the forest products industry, district heating plants, detached houses and for electricity production.

The availability of raw materials for transportation biofuels is good. Some are indigenously produced and there is a relatively extensive commercial importation of biofuels.

Sweden's strong biomass programme includes participation in IEA research networks on bioenergy and alternative fuels.

In terms of transport biofuels, there has been an increase in ethanol use in recent years. A 5% mixture of ethanol in unleaded petrol has been sold at gas stations in the Stockholm area for a couple of years and has now spread to other parts of Sweden. Tax incentives and R&D subsidies have been provided for the development of liquid biofuels for transport. In 2002, 74 million litres of bioethanol were sold and used for transport, most of which was produced in Sweden and a small amount was imported.[1]

1. As a rough approximation, this is about 1% by volume of the total automotive fuels consumed in Sweden.

Biomass Electricity Production

Figure 11. **Solid Biomass Capacity and Electricity Production**

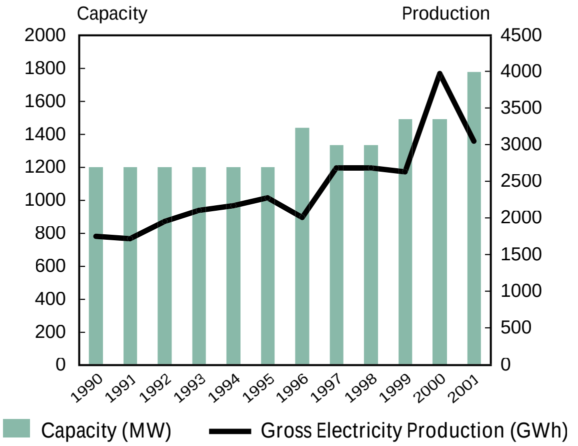
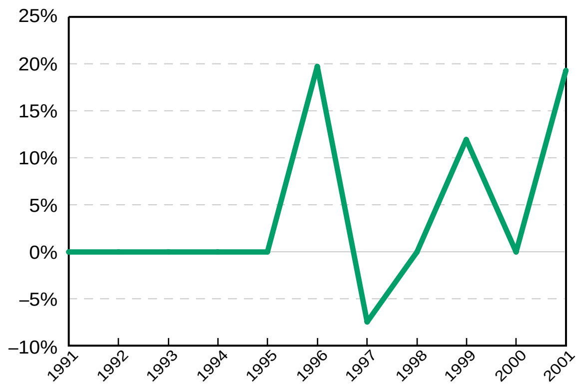
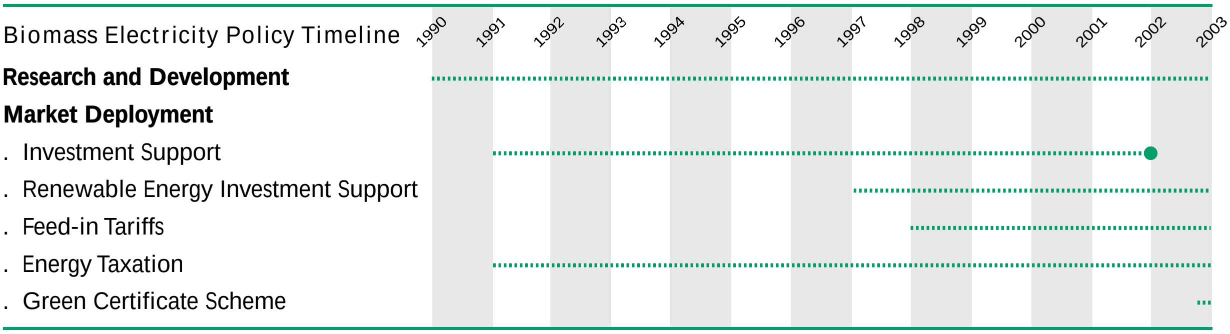


Figure 12. **Solid Biomass Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Solid biomass for electricity generation has increased steadily from 1 200 MW in 1990 to about 1 800 MW by 2001. Black liquor and wood fuels account for virtually the entire production, but with a small amount used in co-generation facilities that supply district heating plants.

In the 1990s, biomass started to receive government support in the form of favourable tax treatment. Largely as a result, its share of national TPES rose from 12% in 1990 to 16% in 2001. Government policies will become increasingly favourable towards biomass as the "green tax shift" continues and the introduced certificate system provides another revenue source for biomass-fired electricity. Investment support for biomass-based CHP was available from 1991 until it was discontinued in 2002 and replaced by the certificate scheme.

Biomass Heat Production

Biomass now meets more than 50% of the supply for district heating grids. This is an increase by a factor of five since 1990. Wastes and by-products from the forest products industry are the main forms. However, processed fuels such as briquettes and pellets have been increasingly used in recent years.

Figure 13. **Solid Biomass Capacity and Heat Production**

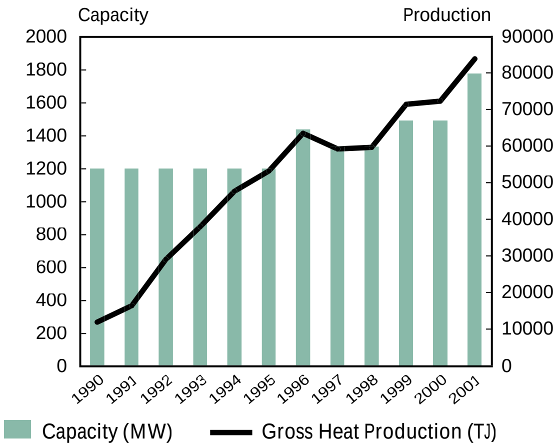
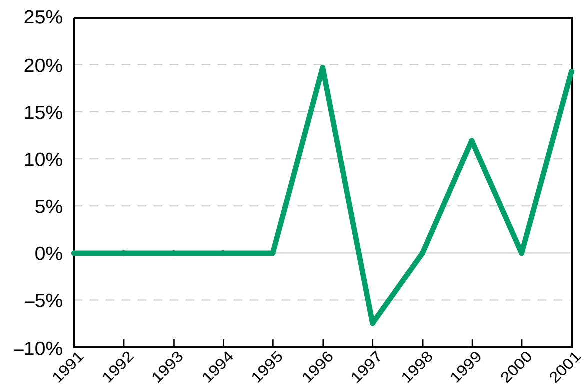
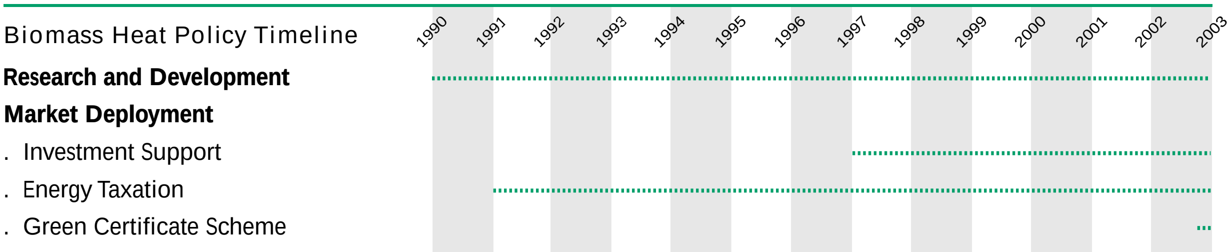


Figure 14. **Solid Biomass Capacity** (Year to Year Change)





Denotes a significant change to a policy, such as an extension, repeal or revision.

Reducing the costs of using biomass was established explicitly as an important objective in the 1997 energy policy legislation. Energy policy has favoured district heating through various forms of state support, *e.g.*, grants for the extension of existing district heating systems and connection of group and individual heating systems.

The 1997 energy policy programme introduced grants for investment in district heating systems. However, the take-up was poor, due to the fact that the costs for extension for main and conversions of electrically-heated buildings were too high and the grants were withdrawn in 1999. They were reinstated in a modified form and then terminated at the end of 2002 before being replaced by the certificate scheme.

District heating supplies more than 40% of Sweden’s total residential and commercial building heating requirements. It supplies heat to about 75% of the heated floor area in apartments and more than 50% of commercial heated space. The fuel mix in district heating plants has changed considerably over the last twenty years. In 1980 more than 90% of the fuel input was oil. Now the fuel mix is more varied with biofuels being the main energy source. This change has been induced by the carbon dioxide tax, which has reduced the use of fossil fuels and the good availability of electricity for several years which favoured the use of heat pumps and electric boilers.

Wind Power

Figure 15. **Wind Power Capacity and Electricity Production**

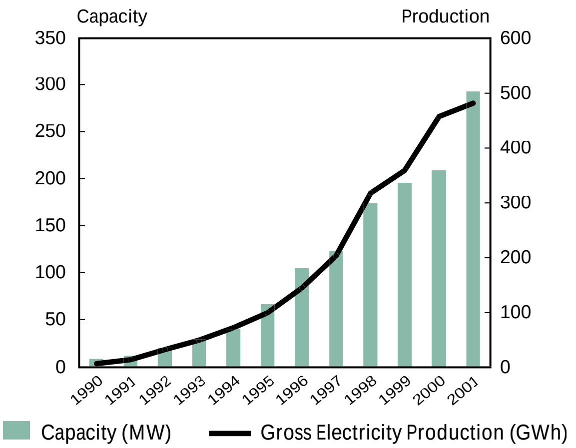
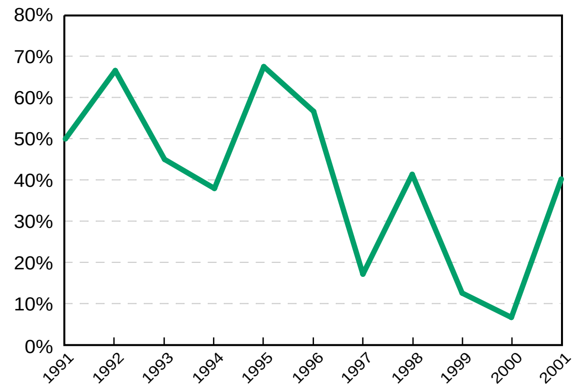
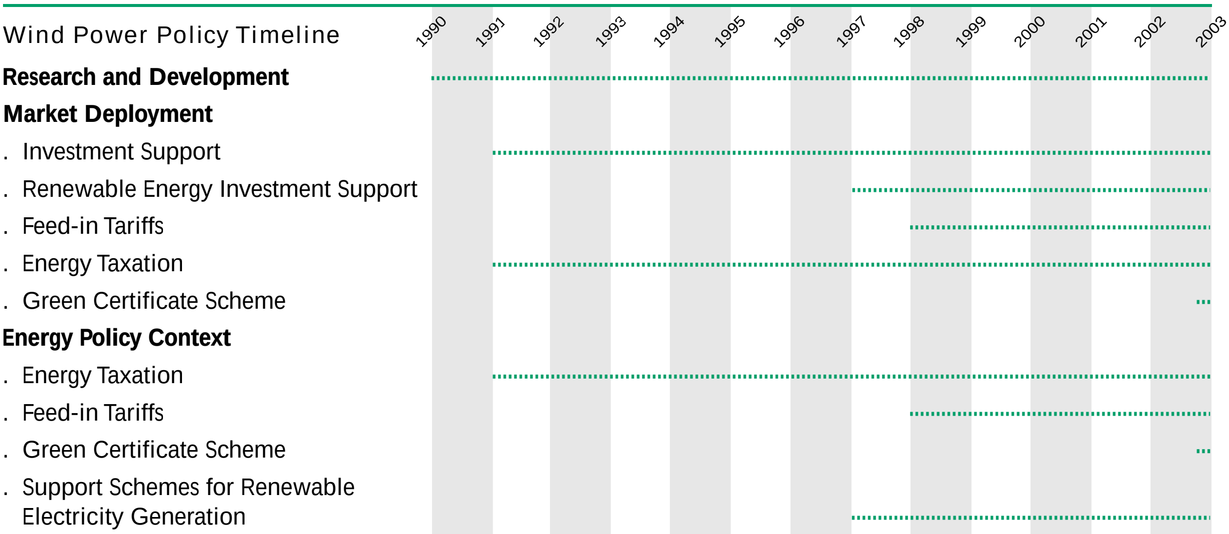


Figure 16. **Wind Power Total Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Currently wind power is a negligible contributor to energy supply in Sweden. In 2001 it produced 481 GWh of electricity as a result of investment subsidies included in the programme for a sustainable energy supply. Wind power has been demonstrated offshore and will also be demonstrated in arctic and mountainous locations. The preconditions for further expansion were found to be the need for criteria for permission to establish wind power, both onshore and offshore, as well as the need to reinforce local electricity grids and related economic considerations.

Investment support for wind power developments has been available since 1991. Wind power is included in the green certificate instrument that came into effect in 2003.

Sweden Policy Chronology

Energy Research and Development

Year 1975 - Present

Policy Description There have been long-term energy RD&D programmes in Sweden since 1975. This section covers the relevant portions of the 1997 Long-term Energy Policy Programme. The RD&D programme was divided into a five-year short-term programme (with a new programme from 2003 and a seven-year programme to be put into action in 2005).

The Energy Policy Programme adopted in 1997 included a seven-year RD&D programme of SKr 5.6 billion (€ 93 million per year) for renewable energy sources and new energy technology. The main target of the programme was to reduce the cost of renewables to make them more viable alternatives to nuclear power and fossil fuels.

Biomass RD&D received total funding of about SKr 400 million (€ 36 million) per year from the government. Electricity companies and other industries also provided funds. The main areas of support were combustion and conversion technologies, demonstration of pre-competitive technologies, fuel production, harvesting supply programmes and ashes recycling.

Policy Type RD&D

RE Technology Biomass

Renewables Tax Exemption: Act 1776

Year 1994 - Present

Policy Description Small-scaled renewable energy based electricity production is partially or totally exempt from the energy tax levied on households and the service sector; this gives a tax benefit of € 0.1-2/kWh.

Furthermore, producers and consumers of biomass-based electricity are exempt from various environmental taxes, such as the CO_2 tax, sulphur tax and NO_x levy.

Policy Type Tax exemptions

RE Technology All renewables

Guaranteed Power Purchase Contracts

Year 1997

Policy Description The guaranteed power purchase contract with local utilities supports small renewable energy projects within the liberalised Swedish electricity market.

Local distribution companies must purchase all electricity generated by projects of less than 1 500 kW within their service territories.

Policy Type Guaranteed prices/feed-in tariff

RE Technology All renewables

Local Investment Programmes

Year 1997-2002-2005

Policy Description A support initiative for Local Investment Programmes (LIP) was established in 1997 with a budget of SKr 5 400 million (later increased to SKr 7 200 million) for the period 1998-2003. The programme was designed to support local governments' investments in technology to achieve lower environmental impacts, more efficient use of energy and resources and to promote the use of renewable resources. The Swedish government granted support amounting to SKr 1 200 million to local governments for 56 local investment programmes in 2000. Up to 1 July 2001, the government granted a total of SKr 5 600 million to 136 local governments. The supported programmes are expected to lead to decreases in energy use of 2.2 TWh per year. Conversions to renewable energy sources will contribute 2.6 TWh per year. Carbon dioxide emissions are expected to decrease by 1.7 million tonnes per year.

The 2002 Budget bill set out a support programme for Local Climate Investment Programmes as a replacement for the Local Investment Programmes and allocated a budget of SKr 900 million for a three-year period beginning 2002. The measure is designed to support local governments' investments to reduce greenhouse gas emissions in Sweden.

Policy Type Government purchases

RE Technology All renewables

Energy Policy Programme

Year 1997 - Present

Policy Description This programme was established in 1997 to compensate for the closure of nuclear power stations by promoting the production of electricity from renewable energy sources. It includes measures aimed at reducing the consumption of electricity for heating purposes, to make more efficient use of the existing power system and to increase the supply of electricity and heating from renewable energy sources. It consists of a short-term programme, which focuses on ways to increase the supply of renewable electricity and to reduce electricity consumption, and a programme of a more research-directed and long-term nature.

Policy Type RD&D

RE Technology All renewables

Renewable Energy Investment Support Programme

Year 1997-2002

Policy Description The Swedish government set up a programme to increase the use of renewable energy sources in 1997. The programme supported renewable energy investments, particularly in biomass and wind. It included grants of:

- 25% for investments in CHP plants based on biomass (up to SKr 3 000/kWh, or € 330/kWh) with a five-year budget of SKr 450 million (€ 48.67 million).
- 15% for wind turbines over 200 kW, with a five-year budget of SKr 300 million (€ 32.45 million).
- 15% for environment-friendly small-scale (<1.5 MW) hydro plants, with a five-year budget of SKr 150 million.

The annual budget for this programme was € 21 million.

Policy Type Capital grants

RE Technology Biomass
Offshore wind
Onshore wind

Technology Procurement Programme

Year 1998-2002

Policy Description The government set up a five-year technology procurement programme specifically for renewable electricity production from January 1998 in addition to the 1997 Investment Support Programme. Total funds for this programme were SKr 100 million (€ 11 million) for the five- year period. This procurement programme ended in 2002 and was replaced by the Energy Bill which came into effect in 2003.

Policy Type Government purchases

RE Technology All renewables

Feed-in Tariffs

Year 1998 - Present

Policy Description The liberalisation of the Swedish electricity market provides straightforward access for small independent generators to be connected to the grid. Swedish utilities were obliged to purchase electricity from small generators at agreed prices. Since the end of 1998, biomass and wind power has been sold at the market price plus a temporary support of SKr 0.09/kWh (€ 0.009/kWh) provided by the state.

Policy Type Guaranteed prices/feed-in tariff

RE Technology Biomass
Offshore wind
Onshore wind

Energy Taxation

Year 2000 - Present

Policy Description Sweden levies three different taxes on energy products: an energy tax, a CO_2 tax and a sulphur tax (introduced in 1991).

In 2000, a budget proposal was approved to increase energy taxation by SKr 3 billion in 2001; in the form of green tax exchange (the bulk of the money was to replace lost tax revenue). The carbon dioxide tax rate was raised from SKr 370 to SKr 530 per tonne. The tax on diesel increased by SKr 0.117/litre and taxes on electricity by SKr 0.019/kWh.

Biomass is exempt from the three levies.

Policy Type Fossil fuel taxes

RE Technology Biomass

Investment Grant for Solar Heating

Year 2000 - Present

Policy Description In 2000, the Swedish government introduced an investment support scheme for solar heating. Home owners can apply for an investment grant corresponding to SKr 2.50/kWh of calculated yearly supply for investments in solar heating installations.

Policy Type Consumers grants/rebates

RE Technology Solar thermal

Support for Small-Scale Electricity Production

Year 2000-2002

Policy Description In 2000, an interim support scheme for small-scale electricity production (production plants < 1.5 MW) was established. Its aim was to ensure the conditions that will allow small-scale renewable electricity production to achieve further market penetration. The support amounted to SKr 0.09/kWh. The support measure was approved by the European Commission and was established in July 2000 in "Economic Conditions for the Production of Electricity from Renewable Energy Sources" (Government Bill 1999/2000:134).

Policy Type Guaranteed prices/feed-in tariff

RE Technology All renewables

Tax Reduction for Wind Power Prolongation

Year 2000-2009

Policy Description Tax exemptions for electricity generated from wind power were prolonged to 2009. This "environmental bonus," introduced in 1994, provided the opportunity for deduction of the energy tax due on electricity produced from wind power. In 2004 the incentive is SKr 0.181/kWh.

Policy Type Investment tax credits

RE Technology Offshore wind
Onshore wind

Measures to Support Wind Power

Year 2000

Policy Description The 2001 budget bill included additional funding of SKr 40 million per year to support wind power installations under the Swedish Energy Policy Programme initiated in 1998.

Policy Type Capital grants

RE Technology Offshore wind
Onshore wind

Eco-Energy Municipality Programme

Year 2001

Policy Description The Eco-energy municipality programme was started in March 2001. Seventy municipalities applied for participation and ten were selected for the first year of the programme. The responsibility of the municipalities is to decide an energy policy, engage in a continuous improvement process and carry out measures to improve energy efficiency and introduce renewable energy sources. The municipalities are also offered seven educational packages.

Policy Type Public awareness

RE Technology All renewables

Energy Policy

Year 2002

Policy Description In 2002, the Swedish government presented its Energy Policy Bill “Co-operation for a Secure, Efficient and Environmentally-Friendly Energy Supply” (2001/02:143). This report, approved by Parliament, re-affirmed the country’s established energy policy objectives.

The energy policy decision contained measures designed to encourage more efficient energy consumption through the rationalisation of existing policy measures and the dissemination of knowledge at the national and regional levels. The decision also announced a new method to promote environmentally-friendly and renewable electricity production through a quota-based trading programme for green electricity certificates.

Policy Type Tradable certificates

RE Technology All renewables

Transitional Regulation for Wind Power

Year 2003 - Present

Policy Description As part of the green certificates plan, a transitional regulation was introduced in 2003 for wind power plants that had been in operation before 1 January 2003. These plants, until they achieve 25 000 equivalent full-load hours, are granted support for each MWh produced during the initial five-year period: SKr 150/MWh in 2003, SKr 120/MWh in 2004, SKr 90/MWh in 2005, SKr 60/MWh in 2006 and SKr 30/MWh in 2007.

Policy Type Guaranteed prices/feed-in tariff

RE Technology Offshore wind
Onshore wind

Green Certificate Scheme

Year 2003 - Present

Policy Description A law instituting a green certificate system in Sweden came into force on 1 May 2003. Under the scheme, generators using solar, wind, biomass geothermal, wave or small hydro (< 1.5MW) are awarded one certificate for each 1 MWh produced, and all consumers are obliged to buy these certificates to cover a set proportion of their use. This requirement started at 7.4% in 2003, and will rise to 16.9% in 2010. Energy-intensive industry is exempt from the requirement. There is a floor and a ceiling set on certificate prices. Should generators find no buyers for their certificates; the government is obliged to buy then. The price was SKr 60/MWh (€ 6.6/MWh) in 2003, with the price falling in future years. For consumers who fail to buy enough certificates, there is a penalty of SKr 175/MWh (€ 19.3/MWh) in 2003 and SKr 240/MWh (€ 26.5/MWh) in 2004.

Policy Type Tradable certificates

RE Technology All renewables

Investment Subsidy for Plants in Difficult Locations

Year 2003-2008

Policy Description The Swedish government intends to work together with industry to gaining experience building wind farms in "difficult areas" such as offshore or mountain locations. An amount of SKr 350 million (about € 38.6 million) is planned for this measure.

Policy Type RD&D

RE Technology Offshore wind
Onshore wind

Tax Reduction for Installation Costs of Biomass Heating Systems

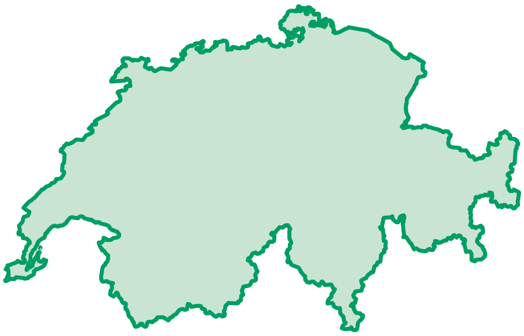
Year 2004-2006

Policy Description Through this legislation, home owners may get tax reductions of 30% of the costs of the installation of heating system based on biomass (*i.e.*, pellet or wood burners/furnaces) in new houses or energy-efficient windows in existing houses. The upper limit is set at SKr 15 000 for heating systems and SKr 10 000 for windows. The reduction may be first applied for in the 2005 income tax return (2004 income).

Policy Type Tax exemptions

RE Technology Biomass heaters

Switzerland



Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

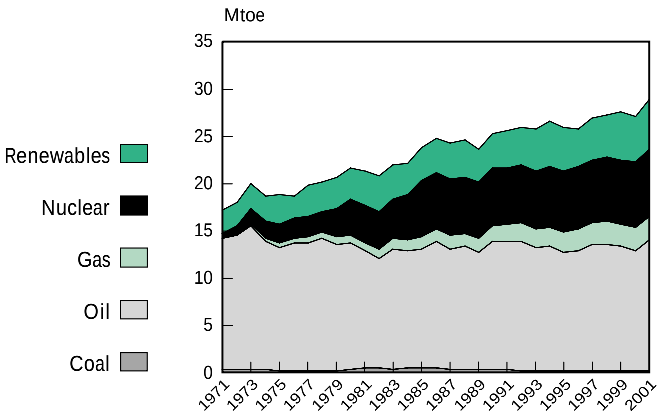
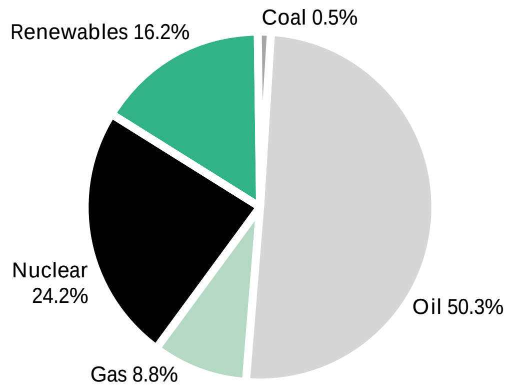


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1.
See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1970	1980	1990	1995	2000	2001	Imports
Coal	0.6	0.3	0.4	0.2	0.1	0.1	86.7%
Oil	13.0	13.3	13.5	12.5	12.7	13.9	98.9%
Gas	0.0	0.9	1.6	2.2	2.4	2.5	100.0%
Nuclear	0.5	3.7	6.2	6.5	6.9	7.0	-
Renewables	2.9	3.3	3.3	4.0	4.2	4.7	-
Biomass	*0.2*	*0.5*	*0.7*	*0.9*	*0.9*	*1.0*	
Hydro	*2.7*	*2.8*	*2.6*	*3.0*	*3.2*	*3.6*	
Geothermal	*0.0*	*0.0*	*0.1*	*0.1*	*0.1*	*0.1*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Total	**16.5**	**20.9**	**25.1**	**25.3**	**26.5**	**28.0**	**55.2%**
% Renewables	*17.1%*	*15.3%*	*13.1%*	*15.6%*	*15.6%*	*16.2%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*

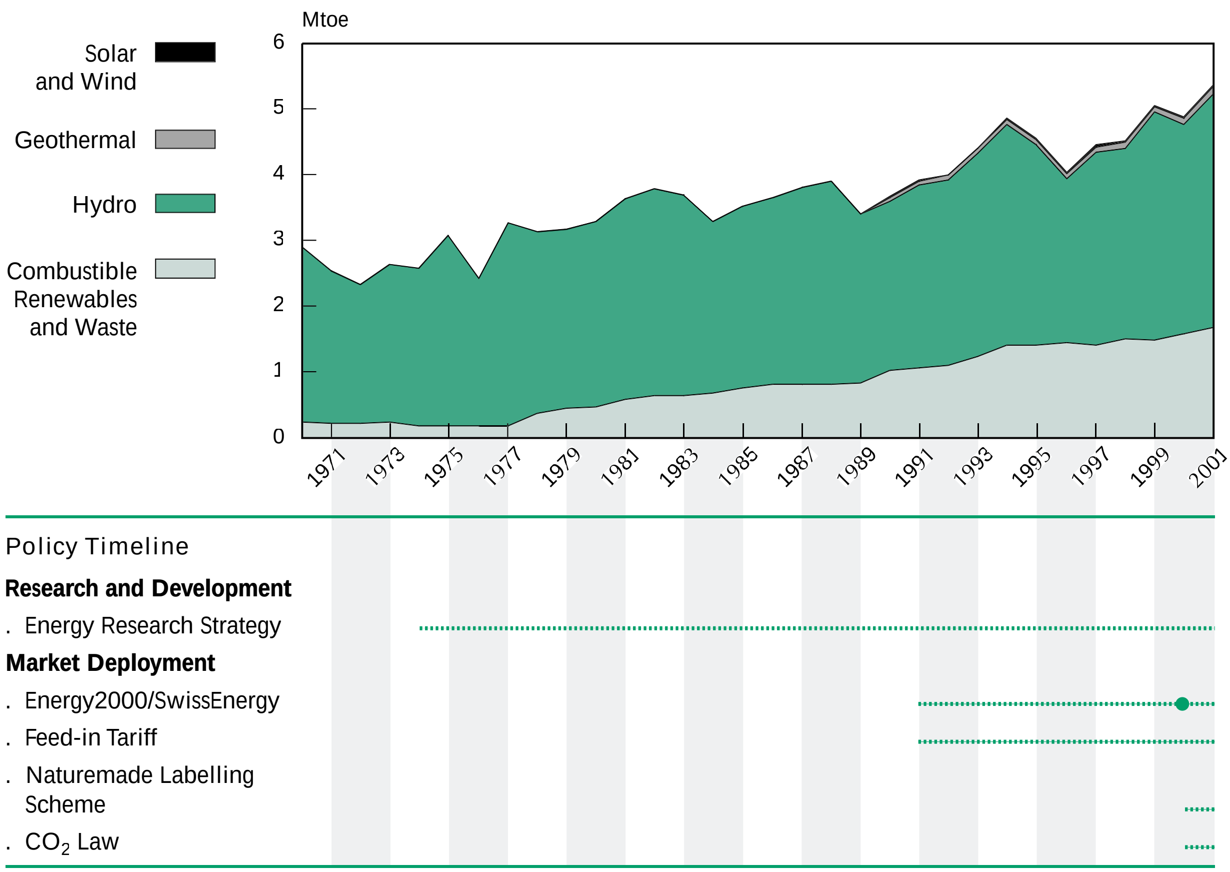
In 2001, total primary energy supply (TPES) in Switzerland was 28 Mtoe, having increased by 1% on average per year between 1990 and 2001. Switzerland's energy intensity (TPES per unit of GDP) is among the lowest of all IEA member countries, and remained relatively unchanged through the 1990s. Energy intensity actually decreased slightly during the second part of the 1990s as a result of economic stagnation, the effects of which were cancelled out by a substantial increase in energy demand in 2001. As shown in Table 1, energy composition, however, has changed quite significantly over time with a substantial decrease in coal use, a reduction of oil share in TPES (from 78.8% in 1970 to 49.6% in 2001) and the increased use of nuclear energy (from 3% in 1970 to 25% in 2001). Renewables accounted for a 16.2% share of TPES in 2001. Hydropower accounted for the largest share of renewable energy supply in 2001, some 12.7%.

Renewables supply grew on average by 3.3% per year between 1990 and 2001, more than three times faster than TPES, mainly due to strong increases in hydropower and in biomass production. Renewables supply grew 42.4% in absolute terms over the period. The share of biomass did rise slightly to a little more than 21% in 2001. New renewables entered the market in the late 1980s and early 1990s but their share remains very small.

Electricity generation, excluding pumped storage, was 70.5 TWh in 2001. Electricity generation experienced an annual average growth rate of 2.4% between 1990 and 2001. Hydropower was the most important source of electricity generation with a contribution of 58.6%. From 1990 to 2001, its share varied between 51% and 61% of total electricity generation, thus having a large impact on the share of other fuels in the generating mix. Nuclear power was the second most important source of electricity, accounting for 38% of electricity generation in 2001, a decline from 43.3% in 1990. Natural gas increased its share from 0.6% in 1990 to 1.2% in 2001. The share of oil was 0.1% in 2001. The share of autoproducers in Swiss electricity generation is about 6% whereas 94% of electricity comes from public utilities. Liberalisation of the electricity market is expected to occur when Switzerland is fully integrated in the European electricity market, with partial liberalisation to be achieved by 2007.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Switzerland has a significant amount of large-scale hydropower. At the end of 2001, the installed capacity of hydropower was 13.24 GW (excluding 1.63 GW of pumped storage), municipal solid waste was 262 MW and solar PV was 18 MW. Significant investments in renewables, excluding hydro or biomass, led to large increases in new renewables with average annual growth rates of 28.2% for PV (from 1991 to 2001), 32% for wind power (from 1996 to 2001) and 11.4% for solar thermal (from 1990 to 2001). In absolute terms, the use of new renewables increased only by about 18.6 ktoe between 1990 and 2001. The most important unexploited potential is in biomass, ambient/geothermal heat (with heat pumps), solar thermal energy and waste heat.

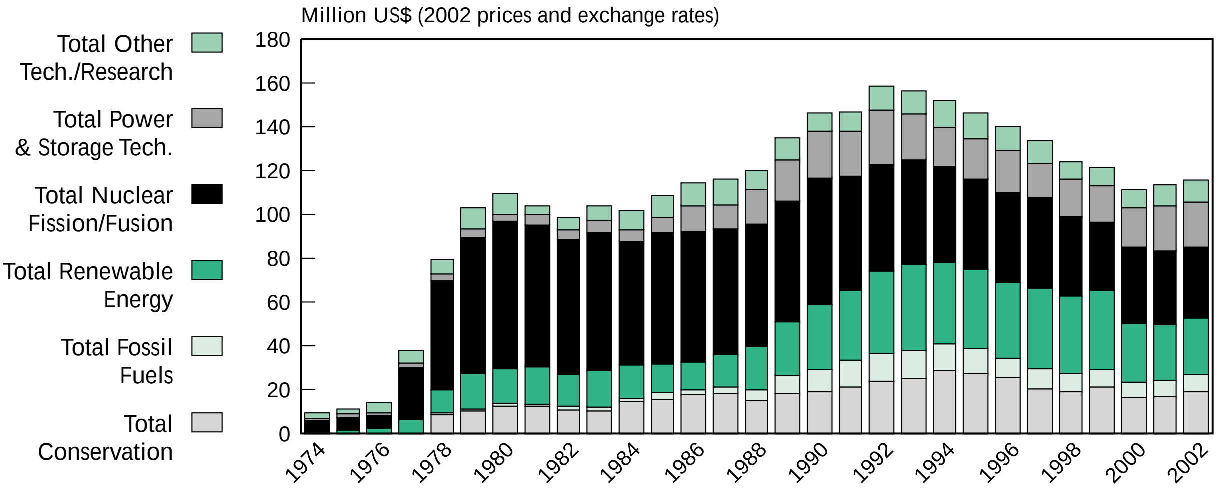
In 2001, renewables (excluding pumped storage) comprised 59.8% of total electricity generation. Renewables generated electricity grew at an annual average rate of 3.1% between 1990 and 2001. Municipal solid waste from renewable sources and solid biomass grew 8.3% and 8% per year on average, respectively. Within the renewables share, hydropower contributed 96.5% in 2001, municipal solid waste from renewables 1.6% and other renewables approximately 0.5%.

Switzerland is a landlocked country lacking fossil fuel resources, and security of supply is an important concern. The government principally envisages using actions implemented in the energy sector to achieve its Kyoto target of a reduction of greenhouse gas (GHG) emissions by 8% below 1990 levels in the period 2008 to 2012. Within the SwissEnergy Action Programme, these targets are to be met primarily through voluntary actions, complemented if necessary by certain regulatory measures as stipulated in the Energy Law and the CO_2 Law. A legal framework was established to monitor voluntary actions.

Research and Development Trends

Switzerland spent a total of US$ 3.1 billion (in 2002 prices and exchanges rates) on government energy RD&D between 1974 and 2002. In this period, 20% of the total energy RD&D budget (US$ 633.39 million) was allocated to renewable energy RD&D.

Figure 4. **Switzerland - Government Energy RD&D Budgets**



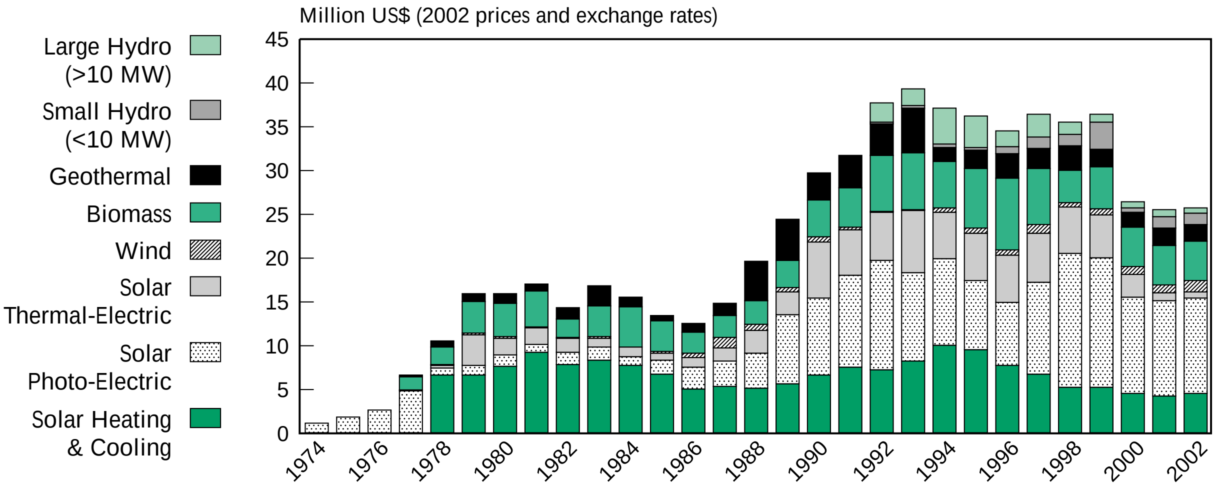
Government RD&D expenditures for renewables peaked in 1993. Expenditures declined after 1999, when renewables RD&D funding levelled out at about US$ 25 million annually until 2002.

Among renewables, solar heating and cooling and solar photo-electric technologies received the highest level of funding. Solar photo-electric received the most sustained funding, totalling US$ 177.216 million or 28% of the renewables R&D expenditures between 1974 and 2002. Most of the remaining renewable technologies, apart from hydropower, began receiving funding in 1977 and 1978. Hydropower has received the least amount of funding at 4.9% of the total government renewables R&D expenditure.

The Swiss Energy Research Strategy is responsible for both the funding and the formulation of overall energy research and development. Approximately 15-20% of funding for RD&D originates from the government, which influences the direction of energy research and co-ordinates and formulates overall energy strategies. The general decrease in funding for RD&D is a result of general federal budget cuts.

Government RD&D funding increased in the 1990s as a result of Switzerland's Energy2000 Programme. More than half of the Energy2000 budget was targeted at RD&D activities and at pilot and demonstration projects related to renewables. SwissEnergy (2001-2010) has a smaller budget, which is reflected in the decrease in government renewable energy RD&D expenditures since 2000.

Figure 5. **Switzerland - Government Renewable Energy RD&D Budgets**



Market Deployment Trends

Switzerland's market deployment activities can be characterised by two major programmes: the Energy2000 programme (1991-2000) and its successor SwissEnergy (2001-2010). These national energy programmes establish objectives and targets for renewables through action programmes, including direct incentives and grants to the renewable energy industry and developers, certification systems and indirect incentives through voluntary measures. The programmes were established in the wake of the Energy Decree of 1991 and the Energy Law of 1998 respectively. Their aim is to implement a constitutional mandate calling for safe, environmentally sound and economic energy supply, and the rational and efficient use of energy through the promotion of domestic and renewable energy sources.

Energy2000 established two objectives for renewables, to increase hydroelectric generation by 5% between 1990 and 2000 and to increase the contribution of non-hydro renewables in electricity generation by half a percentage point and in heat production by three percentage points. To this end, renewables received CHF 287 million in financial support from the Swiss Federal Office of Energy (SFOE), which represented approximately half of the total budget for Energy2000. In the last three years of Energy2000, expenditures on renewables totalled CHF 35.2 million to CHF 37.5 million per year whereas between 1990 and 1997 the average budget for renewables was CHF 22.5 million per year. The bulk of the budget was used for promotional activities (46.5%). A substantial amount was also used for R&D (37.5%) and pilot and demonstration projects (16%). Promotional activities included SFOE incentives for the purchase of solar collectors and automatic wood heating systems (> 100 kW), but also more indirect measures, such as information dissemination, training, consulting, and quality assurance and control.

Heat production from renewables, as a result of the Energy2000 programme increased by 2.1 percentage points (missing its target by 0.9 percentage points). The objective for hydroelectric generation was almost met (4.7%). The objective for non-hydro electricity generation was exceeded; its proportion in power generation increased to 0.7%, principally through municipal waste incineration.

The SwissEnergy Action Plan, introduced in 2001, eliminated all direct incentives for renewable energies. Voluntary measures are expected to achieve the two established objectives for renewables by 2010, namely to generate 0.5 TWh (equivalent to 1 percentage point) of additional electricity and 3 TWh (equivalent to 3 percentage points) of additional heat from non-hydro renewables compared to 2000 levels. This is equivalent to a 60% increase in electricity generation and a 40% increase in heat production from renewables. These targets are to be achieved through the following measures, as specified by the SwissEnergy Action Plan:

- Co-operation with private organisations in implementing voluntary measures based on performance contracts and agreements.
- Promotional programmes through lump sum payments to the cantons (*i.e.*, Lothar wood promotion programme).
- Measures to trigger voluntary action and supervision of promotional programmes, *e.g.*, marketing, public relations, consulting, education and training, quality assurance, R&D and pilot and demonstration projects.
- Regulations with regard to goods declarations and target and guide-line values for the energy consumption of motor vehicles, appliances and buildings.
- Incentives primarily in the transportation sector.
- A possible CO_2 tax.

There are no fixed targets for individual renewable energy sources but the government has made some estimates on the possible future use (Table 2). Furthermore, SwissEnergy calls for hydropower production to remain stable despite the partial energy market liberalisation expected to occur in the second half of the decade.

Table 2. **Potential Increases in Renewable Energy Use**

	Potential Increases in Renewables Use by 2010 Compared to 2000
Solar thermal	By 15% per annum (similar to the last 10 years)
Photovoltaics	By at least 1.5 MW per annum
Wood	To the level of 4 million cubic meters (mcm) per annum (compared to 2.5 mcm per annum today)
Other biomass	To the level of 0.5 TWh per annum (total for heat and electricity)
Ambient heat (heat pumps)	To the level of 0.5 TWh per annum
Geothermal	To the levels of 5 MWe and 10 MWth
Wind power	To the level of 50-100 GWh per annum
Waste (renewable fraction)	By 30% in electricity generation

Source: SFOE.

Voluntary measures are the primary method by which Switzerland promotes "green electricity". Today, some 400 utilities (out of 700) offer green electricity. Approximately 50% of all consumers have access to these offers of green electricity and some 3% are covering a part of their demand with green electricity. The starting point for the promotion of green electricity was the creation of the Solar Stock Exchange by the Zurich Electric Company (Elektrizitätswerk der Stadt Zürich/EWZ). The Solar Stock Exchange acts as a broker between producers and consumers. Electricity generated by privately-owned grid-connected PV systems is purchased by utilities at prices that cover costs and then resold by the utility at the same price to its customers. The contract duration between the electricity producer and the utility is twenty years but customers are free to unsubscribe annually. The kWh price in the exchange City of Zurich, for example, was CHF 0.85 at the end of 2001.

The Naturemade labelling scheme, launched in 2000, is a privately-owned and managed certificate system with two levels and includes special measures to promote non-hydro renewables:

- The first level, Naturemade Basic, is a declaration of the source (plants using renewables) and origin (owned plants or purchased energy) of renewable electricity. Large hydropower plants (>10 MW) are required to establish an environmental management system within five years of receiving the Naturemade Basic certificate.
- The second level, Naturemade Star, is defined for environmentally preferable electricity. Power plants can be granted the Naturemade Star label if they fulfil Naturemade Basic criteria as well as additional criteria for lifecycle characteristics.

Switzerland's primarily regulatory measure to promote renewables was the institution of feed-in tariffs in 1991. Originally set to expire in July 2003, the SFOE, in November 2002, extended these feed-in tariffs for another five years to 2008. Grid owners are obliged to purchase electricity from any private producer at the feed-in tariff of € 0.10/kWh. This mechanism has produced some discontent on the part of grid owners as no limit has been placed on the amount of electricity they have to purchase with the exception of hydropower, which is limited to 1 MW. A clause was introduced in the Nuclear Energy Law to amend the Energy Law (1999) so as to allow for electricity labelling and improved feed-in mechanisms. The extension and amendment of this Energy Law in 2005 will require a declaration of the source of electricity and production technology, as well as the creation of a national grid operator whose main task will be to equitably distribute the cost of this feed-in tariff across all grid owners in Switzerland.

The Swiss government foresees introducing renewable-friendly clauses in a draft law, targeted at the partial electricity market opening in 2007. An energy tax reform is currently under review, calling for lowering the tax level on biogas, ethanol and natural gas. The aim is to replace 3% of transport fuels with biofuels.

The issue of intermittency is not currently a problem as the contribution of energy from intermittent energy sources is limited, although with the potential rise in new renewable energy sources in Switzerland, it may become more of a concern.

Federal/Regional Policies

In addition to federal regulations, each canton has its own policies for renewables. For example, the Canton of Zurich emphasises measures in the building sector. In 1995, it established a target to meet up to 20% of the heating and hot water demand in new buildings with renewable energy sources or waste heat. This programme was such a success that eleven other cantons adopted the same target. The Canton of Geneva gives priority to the local production of hydropower but also promotes other renewables. The small Canton of Zug subsidises wood energy projects and the City of Zug, solar energy. Eighteen cantons promote the use of solar for heating purposes and ten cantons promote electricity generation from renewables.

The federal government provides CHF 14 million every year for these cantonal programmes. No overlap exists between federal and cantonal programmes as the federal government provides frequent evaluations on the effectiveness and success of cantonal programmes, presenting guidance and management of cantonal activities. Inter-cantonal policies, on the other hand, may be subject to conflict in the future, as definitions, management and exploitation of renewable energy sources are canton specific. When renewable energy policies and measures reach an inter-cantonal level, through the trading of green certificates for example, a harmonisation of definitions and incentives may be required.

Table 3. **Cantonal Renewable Energy Programmes, 2003**

Renewable Sources	Canton[1]
All renewables	AG, BS, GE, JU
Wood energy	ZH, UR, ZG, FR, SO, BL, SH, AR, GR, AG, TG, TI, VD, VS, NE, GE, JU, BE, GL, AI
Solar thermal	UR, NW, FR, SO, BS, BL, SH, AR, GR, TG, VS, NE, GE, JU, GL, AI, VD
Photovoltaics	FR, SO, BS, BL, SH, AR, AG, VD, VS, GE, LU, UR, TG, TI, NE
Heat pumps	UR, BS, BL, SH, VD, NE, LU, NW
Small hydropower schemes	UR
Heat recovery	BS, BL
Geothermal energy	BS
Waste heat	AG, BL, AG
Biogas	TG

Source: SFOE 2004.

[1] AG = Aargau, AI = Inner-Rhoden, AR = Ausser-Rhoden, BE = Bern, BL = Basel-Landschaft, BS = Basel-Stadt, FR = Fribourg, GE = Geneva, GL = Glarus, GR = Graubünden, JU = Jura, LU = Luzern, NE = Neuchâtel, NW = Nidwalden, OW = Obwalden, SG = St. Gallen, SH = Schaffhausen, SO = Solothurn, SZ = Schwyz, TG = Thurgau, TI = Ticino, UR = Uri, VD = Vaud, VS = Valais, ZG = Zug, ZH = Zurich.

Energy Policy Context

Switzerland's CO_2 Law entered into force on 1 May 2000. The Law stipulates that CO_2 emissions in 2010 must be 10% below the 1990 level. To achieve this target, the government set an 8% reduction target for motor fuels and 15% reduction target for heating fuels. The SwissEnergy Action Plan was established to achieve these goals, although reduced funding is jeopardising them. The CO_2 Law states that, should it become apparent that the targets will not be reached through voluntary measures instituted by the SwissEnergy Action Plan, a CO_2 tax may be introduced in 2004. The introduction of such a tax is currently under review, as is a voluntary proposal by the Swiss Oil Industry Association for a voluntary € 0.01 per litre levy on gasoline. As the renewable energy market in Switzerland is not mature and the electricity market is not open and competitive, it will be difficult for renewable energies to achieve the targets established by the SwissEnergy programme without additional regulatory efforts.

Renewable Energy Markets

Hydropower

Figure 6. **Hydropower Capacity and Electricity Production**

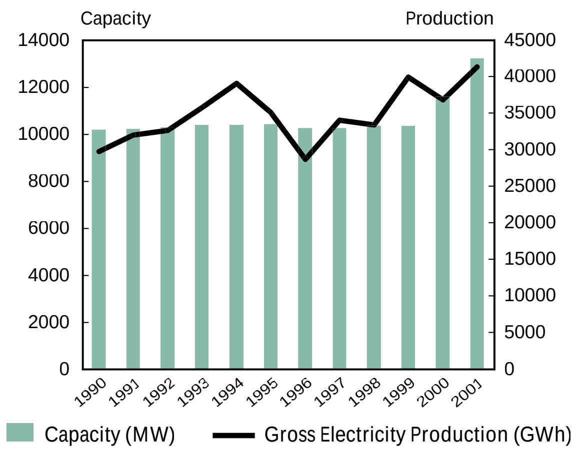
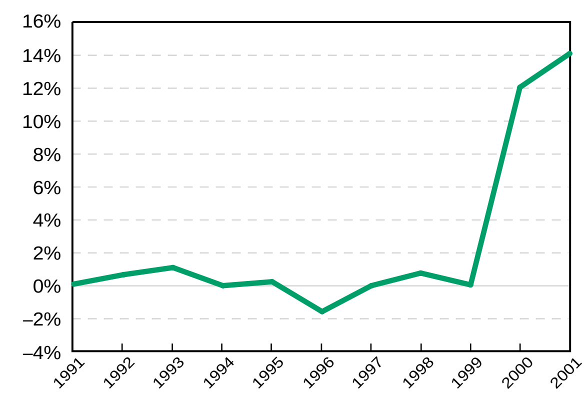


Figure 7. **Hydropower Capacity** (Year to Year Change)



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Hydropower represented 12.9% of TPES in 2001. Generation grew by 3% from 1990 to 2001. Hydropower accounted for 76.6% in total renewable energy supply. Hydropower capacity remained at about 10 GW from 1990 to 1999 but increased by 2.8 GW over the next two years. Under the SwissEnergy Action Plan, hydropower production is expected to remain stable over the 2001-2010 period.

Few remaining sites are suitable for the development of new large hydropower installations. One large hydropower plant, commissioned in 1998, was built in Bieudron and increased installed capacity by 1 200 MW. About 200 MW of additional capacity has come on-line through the retrofitting and maintenance of old plants, as a requirement of more stringent water quality requirements for rivers that contain dams.

The development of small-scale hydropower plants has been an outgrowth of the Energy2000 programme between 1991 and 2000. The construction of twelve small units with less than 3 MW of capacity was partly attributable to the DIANE programme, part of the Energy2000 programme, which provided grants to promote small hydropower plants. The majority of these plants were developed around small installations capturing the pressure caused by the transportation of both drinking water and waste water from high mountainous to lower areas. The existing feed-in tariff support system has also shown positive results for small hydropower plants since 2000. Potential for rapid growth in this sector, however, is negligible as hydropower is a relatively mature market in Switzerland.

Biomass Production

Figure 8. **Solid Biomass Production**

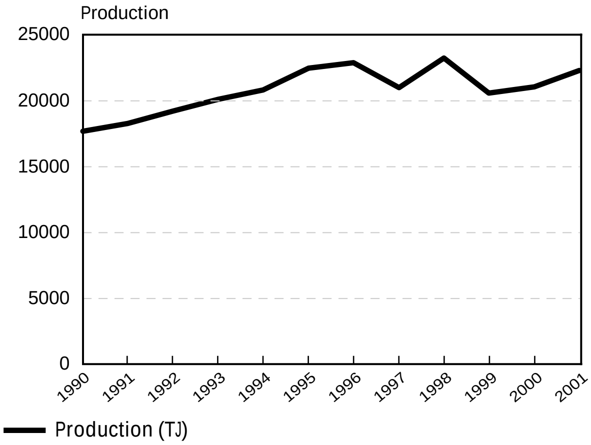
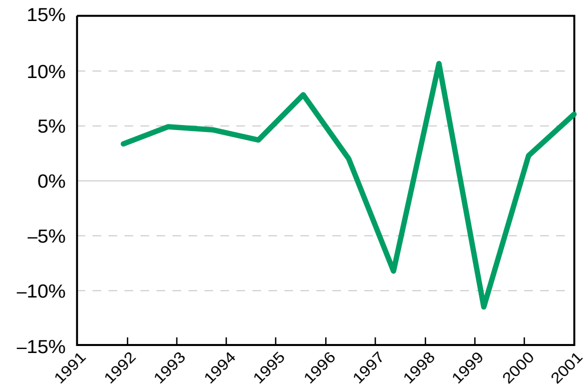
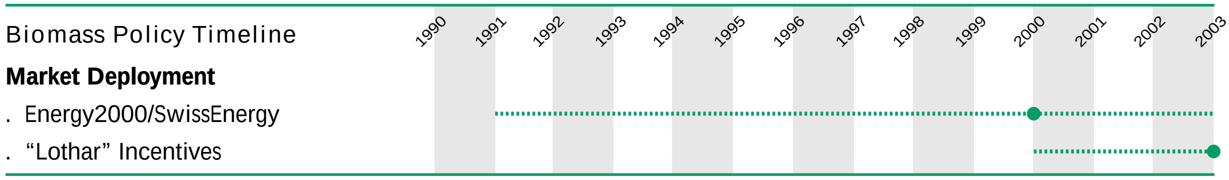


Figure 9. **Solid Biomass Production**
(Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Biomass production increased by 2.1% on average between 1990 and 2001. Wood energy is Switzerland's second most important indigenous renewable energy source after hydropower, but its potential is not being fully exploited. The Swiss government believes that it is both economically feasible and environmentally acceptable to double the use of wood-based biomass from 2.5 million cubic metres (mcm) to around 5 mcm without over-exploiting Switzerland's forest resources, a goal which is expected to be achieved over the next fifteen years.

The slight but steady growth in biomass production over the past decade has been influenced primarily through government activities, through grants to the renewable energy industry via the DIANE programme and other voluntary measures of Energy2000 and SwissEnergy, and through promotional marketing activities conducted by the Swiss Association for Wood Energy. The Swiss Association for Wood Energy is supported by the government and by its contributing members, which include manufacturers of wood burning stoves, district heating systems and installers of stoves and heating systems.

Data seem to indicate that growth in biomass production can also be attributed to a programme established in 2000 by the Swiss Parliament, in response to the "Lothar" storm in Switzerland. The parliament set aside CHF 45 million for a programme on wood energy systems during a three-year period. The goal of this programme was to increase the use of wood for energy, which would also aid in improving forest management. This money has resulted in an increase in the use of wood for energy by an additional 100 000 cubic metres annually.

Wind Power

Figure 10. **Wind Power Capacity and Electricity Production**

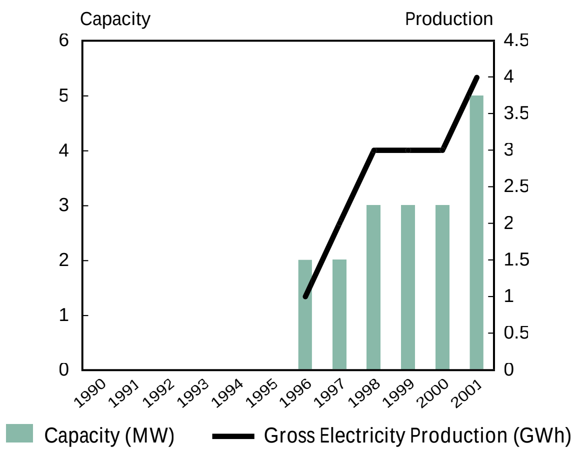
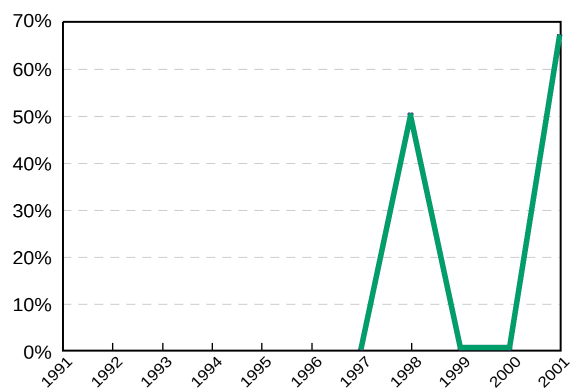
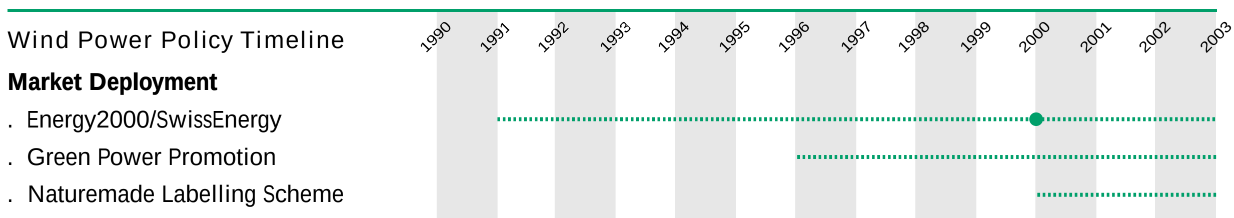


Figure 11. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

The first wind farm was constructed in 1996 with 2 MW of installed capacity. In 2001, electricity generation from wind power was 4 MWh and capacity was 5 MW. The contribution of wind to total renewable energy supply is less than 1%.

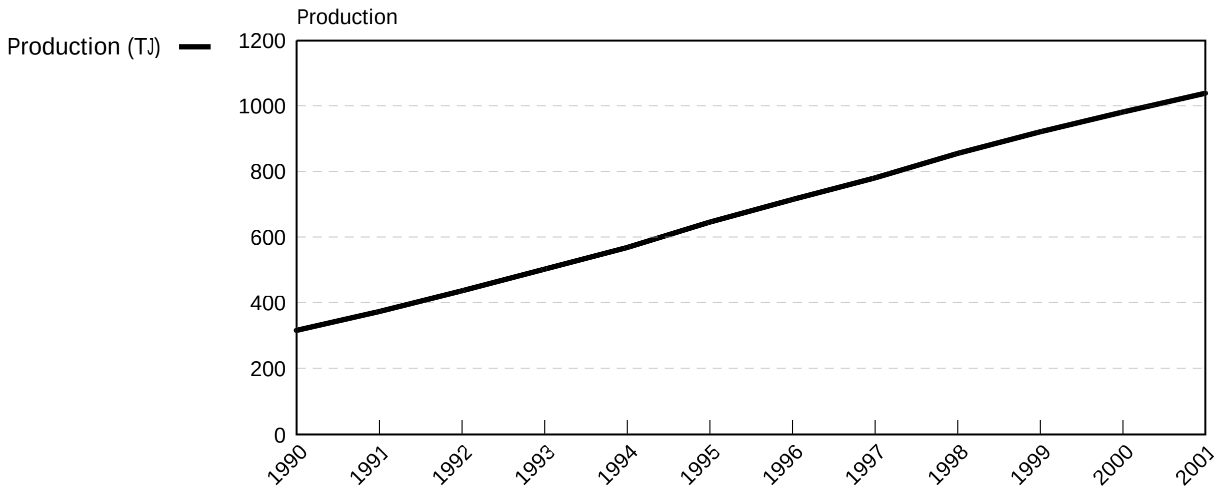
The first wind farm was constructed by the electric utility company, Bernese Electric Utility, with aid from the federal government which provided some funds to conduct wind measurements. The Bernese Electric Utility is responsible for the majority of the installed wind capacity in Switzerland. In 2002, a demonstration wind farm was constructed as part of an IEA project, to examine the behaviour of wind turbines in harsh climatic conditions.

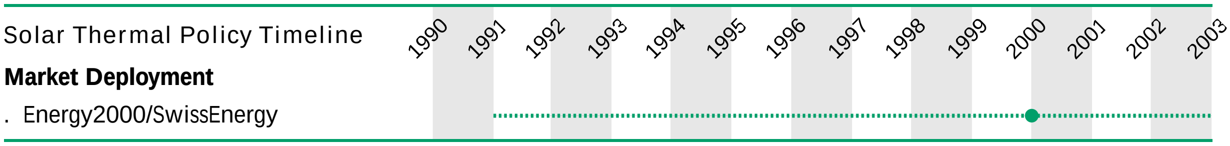
The technical wind power potential at environmentally acceptable sites in Switzerland is estimated to be 1 500 MW or 1.6 TWh per year. Although wind farms have been built over the past few years and several projects for new wind power plants are under way, wind power development is facing increasing public opposition. Good wind power locations in Switzerland are situated at altitudes starting at 800 m above sea level in hilly or mountainous country with difficult climatic conditions (ice, cold), turbulent wind, difficult access and landscape protection problems. Many of these technical problems have been solved but the economic competitiveness of wind power has been reduced as a consequence. The Swiss wind trade associations have adopted a target of some 3% of total electricity demand from wind power.

A government funded study, *Concept of Wind Energy,* is under way in 2004. This study is focused on identifying the potential installation sites to persuade electric utilities in regions and communities to participate in the planning and development of wind farms.

Solar Thermal Production

Figure 12. **Solar Thermal Production**





Denotes a significant change to a policy, such as an extension, repeal or revision.

Solar thermal production in Switzerland increased from 316 TJ in 1990 to 1 038 TJ in 2001, an average annual growth of 11.4%. Solar thermal production contributed 94.7% to the total renewable energy supply from new renewables in 2001, but this represents half a percent of total renewable energy supply (including hydropower and biomass).

With respect to the Energy2000 programme, growth in solar thermal has been slow, achieving less than 30% of the goal specified. The main barrier was limited funding. The SwissEnergy Action Plan is believed to provide a better framework for the market deployment of solar thermal technology. The increase in solar collector surface has been steady and reached 1.3 million square metres (m^2) in 2000. Approximately 90% of solar thermal installations are used for hot water heating while the remaining 10% are associated with “solar houses”. In the built environment, approximately 30 000 m^2 are covered each year which indicates an annual increase of 15%.

The solar thermal industry has greatly benefited from continuous public awareness campaigns for solar energy. This positive image, along with marketing schemes and indirect incentives under the Energy2000 programme, has kept growth fairly steady. In addition to the federal programme, which provided the bulk of the incentives, a few cantons also provided incentives in the form of investment grants. The federal and cantonal incentives can be used simultaneously, but the incentive cannot exceed 50% of the total investment cost. Direct incentives are no longer available from the federal government, but some direct incentives are still available from certain cantons.

Solar Photovoltaic

Figure 13. **Solar Photovoltaic Capacity and Electricity Production**

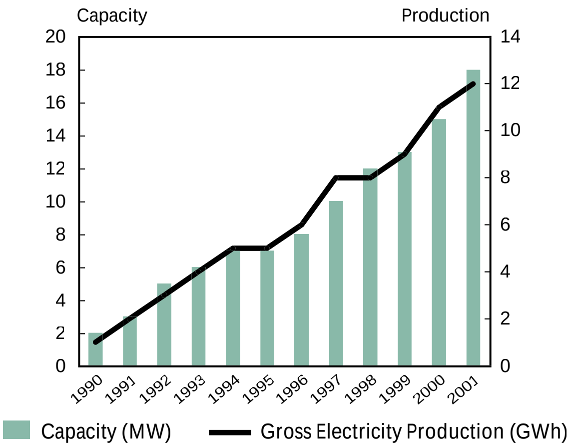
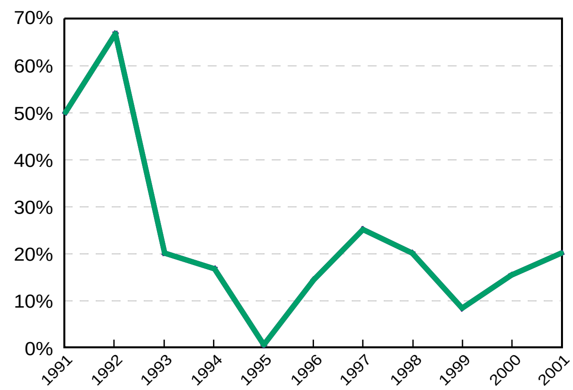
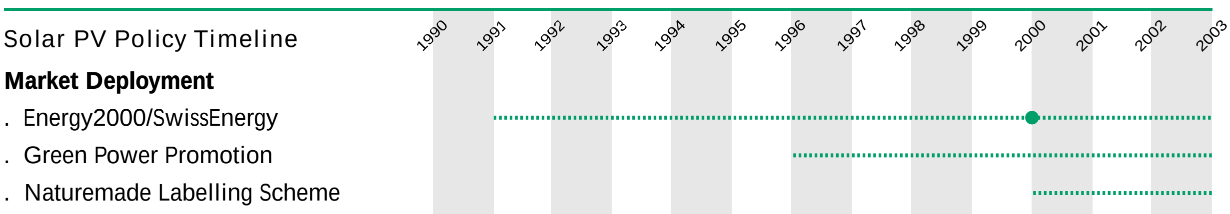


Figure 14. **Solar Photovoltaic Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Installed PV power in Switzerland was 18 MW in 2001, 85% was grid-connected. Installed capacity for solar PV grew by 22.1% per year from 1990 to 2001. Gross electricity generation from solar PV grew by 25.4% over the same period.

Although the feed-in tariff is only CHF 0.15 per kWh and the price of photovoltaic systems (CHF 0.85/kWh) is high, the PV industry has exhibited a steady growth. According to Swiss energy experts, this is in part attributed to the positive image of solar energy in Switzerland. As PV installations are expensive, this social acceptance has helped to spur market growth.

A large proportion of the recent increase in capacity is attributed to the "Solar Stock Exchanges", which provided a considerable promotional effect by buying PV power from independent producers at rates that covered production costs. Apart from incentives for PV in certain Swiss cantons, the main funding and market incentives for PV installations occurred within the framework of pilot and demonstration projects. In 2001, the funding for these projects was reduced by 50%.

Switzerland Policy Chronology

Energy Decree/Energy Law

Year

1991-1998 Energy Decree
1999 Energy Law

Policy Description

The goals of the Energy Law, which replaced the Energy Decree, are, among others, to ensure safe energy supply that is environmentally compatible and economically feasible, to contribute to the rational and efficient use of energy, and to encourage the use of domestic and renewable energy sources. The law calls for co-operation with the cantons and the private sector and gives priority to voluntary measures over regulations.

Policy Type

Voluntary programmes

RE Technology

All renewables

CO_2 Law

Year

1990-2010

Policy Description

The CO_2 Law entered into force on 1 May 2000. The Law stipulates that by 2010, the emissions of CO_2 must be reduced by 10% below the 1990 level. For motor fuels, the objective is a reduction of 8%, while for heating fuels, 15% is envisaged.

Measures to reduce CO_2 emissions include consumption-dependent heavy vehicle tax, the Energy Law and the SwissEnergy Programme. If Switzerland is not on course to meet its Kyoto targets via the voluntary measures within the SwissEnergy Programme, then a CO_2 tax may be instituted in 2004 at the earliest. The maximum rate of tax on CO_2 is set at 210 CHF per tonne CO_2, which will need to be approved by Parliament. The revenue from the tax is to be refunded in full to the public and industry. To avoid incurring a disadvantage over their foreign competitors, companies may be exempt from the CO_2 tax if they undertake measures to reasonably reduce their CO_2 emissions.

Policy Type

Fossil fuel taxes

RE Technology

All renewables

Energy2000

Year

1991-2000

Policy Description

On the legal basis of the Energy Decree, the action programme Energy2000 aimed to stabilise total fossil fuel consumption and CO_2 emissions at 1990 levels by 2000. Increased use of renewable energy featured prominently in different parts of the Energy2000 programme.

The federal Energy2000 programme rested on three main pillars: voluntary measures to promote energy efficiency and renewables, a favourable legal environment and dialogue between parties.

The implementation of Energy2000 rested with "marketing departments," one of which dealt specifically with renewable energy. The work of this department concentrated in three areas with associated Action Networks: Swissolar is a grouping of five utility and private solar energy associations, and its main purpose is the promotion and marketing of solar energy technologies. The Swiss Wood Energy Association aimed to increase wood's share of the heating market to 6% by 2000. There is also a Swiss Heat Pump Promotion Group which leads promotional efforts such as training, quality assurance and after-sales service.

The budget allocated was: promotional activities (46.5%), R&D (37.5%) and pilot and demonstration projects (16%).

Policy Type Voluntary programmes / RD&D

RE Technology All Renewables

SwissEnergy Action Plan

Year 2001-2010

Policy Description The Swiss Energy Action Plan started in 2001, following the Energy2000 programme. The objectives of SwissEnergy are to reduce the consumption of fossil fuels, to slow the growing electricity demand and to increase the contribution of renewables to energy supply. Specifically the targets of the SwissEnergy Action Plan are:

- +3000 GWh of heat (+3 percentage points).
- +500 GWh of electricity (+1 percentage point).

The targets are to be reached in extensive co-operation with the cantons and the private sector. Voluntary agreements; funding measures favouring energy savings; promotion of renewables; dissemination of research information; and energy consumption standards for buildings, equipment and vehicles are the main elements of SwissEnergy. Their aim is to achieve a 10% reduction in the consumption of fossil fuels, to cap electricity demand growth at 5% and increase the share of renewable energy.

Additional promotion of renewable energy is being undertaken by RD&D activities as well as with the programmes Energy2000 and SwissEnergy: Energy from biomass other than wood, deep geothermal energy, ambient heat for heat pumps. The promotion activities are similar to those described below.

Policy Type Voluntary programmes / RD&D

RE Technology All renewables

Some Examples of Actions within Energy2000 and SwissEnergy: Feed-in Tariff

Year 1991-2008

Policy Description Set up by the Swiss Federal Office for Energy based on the Energy Law, the feed-in tariff obliges electricity companies to purchase electricity from renewable energy sources at a fixed rate according to the following principles:

- The feed-in tariff is on average CHF 0.15/kWh for renewables. The tariff is adjusted to be higher during daily peak periods and lower in summer but the annual average must be met.
- The feed-in tariff is applied to all renewables except hydropower with capacity < 1 MW and (renewable) waste.
- Cantonal authorities can reduce the tariff where production costs by small hydropower plants (< 1 MW) are much lower than the fixed feed-in tariff.
- The cantons can also establish higher feed-in tariffs. For example, in Geneva the feed-in tariff for photovoltaics is CHF 0.60 to CHF 0.90/kWh.
- The cantons can establish, individually or in co-operation with other cantons, a compensatory fund in favour of electricity companies which are obliged to buy electricity from renewables generators when the purchase share is “over-proportional” to their turnover (determined on a case-by-case basis by the cantons’ authorities). These funds would be financed by all electricity suppliers inside the canton, but no such funds have yet been established.
- The obligation for utilities to purchase electricity from companies producing electricity from renewables only applies to electricity that exceeds the generator's consumption (the generators cannot sell their electricity at a higher price and at the same time purchase electricity at a lower price).

Policy Type Guaranteed prices/feed-in tariffs

RE Technology Biomass
Geothermal
Small hydro
Concentrating solar
Solar photovoltaic
Solar thermal
Wind

Naturemade Labelling Scheme

Year 2000

Policy Description Naturemade is a green electricity labelling scheme. The certificate system has two levels and includes special measures to promote non-hydro renewables:

- The first level, Naturemade Basic, is a declaration of the source (plants using renewables) and origin (own plants or purchased energy) of renewable electricity. Large hydropower plants (>10 MW) have to establish an environmental management system within five years of receiving the Naturemade Basic certificate.
- The second level, Naturemade Star, was defined for environmentally preferable electricity. Power plants can be granted the Naturemade Star label if they fulfil Naturemade Basic criteria as well as additional criteria for lifecycle characteristics. For example, the generator must establish an ecoassessment ("eco-indicator 99"); the minimum efficiency for wood-fired plants is set at 60% and environmental protection requirements are set for hydropower, photovoltaics and wind power generation. Hydropower plants can also achieve this level if they comply with certain criteria. Principally, they must have a lower environmental impact than traditional hydropower plants. For example, they have to leave sufficient water in streams and rivers (*i.e.* respect residual flow limits) or allow fish to pass through weirs.
- Hydropower units with more than 0.1 MW capacity must establish a fund to improve the ecological situation in the power plant site. The funds are financed from a levy on certified electricity; Naturemade Star producers pay CHF 0.009/kWh whereas Naturemade Basic producers pay only CHF 0.001/kWh.
- Specific provisions were developed to protect other renewables from competition with large hydropower plants and to create an incentive to develop non-hydro renewables. The marketers of all Naturemade certified electricity must guarantee that at least 5% of their certified electricity sales have the Naturemade Star certificate.

Policy Type Voluntary programmes

RE Technology Biomass
Geothermal
Wind
Small hydro
Solar photovoltaic
Concentrating solar
Solar thermal
Hydrogen

Start Programme (Energy2000 Action)

Year 1992-1995

Policy Description This programme targeted the promotion of a particular renewable energy application/technology over a short period of time (*e.g.*, PV systems in school buildings).

Policy Type Consumer grants / rebates

RE Technology All renewables

DIANE (Energy2000 Action)

Year 1992-1997

Policy Description The DIANE programme, under the Energy2000 programme, primarily encouraged wood energy and small scale hydropower.

Policy Type Consumer grants/rebates

RE Technology Biomass
Hydro

Lothar Wood Energy Promotion Programme

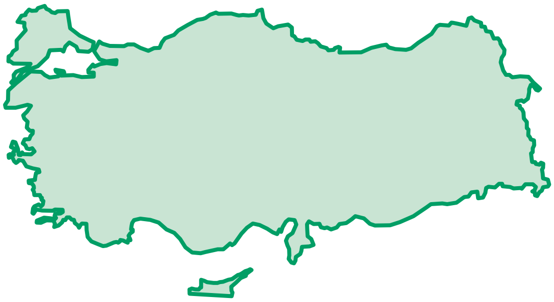
Year 2000-2003

Policy Description Wood heating systems benefited from special promotional measures financed by credit granted after Hurricane Lothar. The main beneficiary was automated boilers fuelled by wood pellets, with 537 new units commissioned (+70.2%). New capacity included 193 other automated boilers (+4.1%). The gross consumption of wood energy rose by 2.5%, compared to the previous year (+3.0%).

Policy Type Consumer grants/rebates

RE Technology Biomass

Turkey



Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

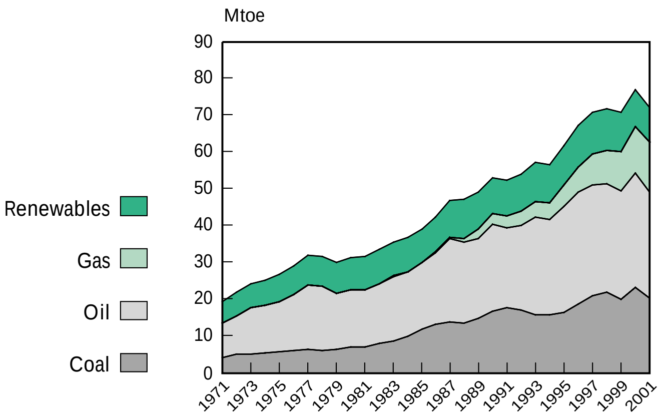
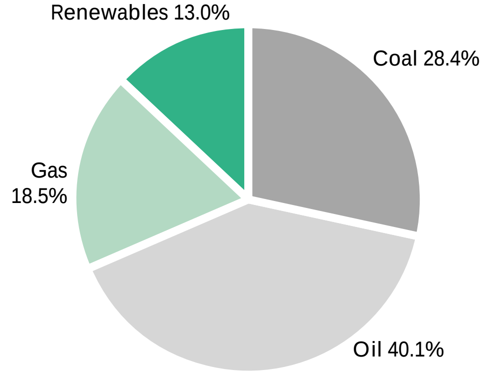


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1. See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	**1970**	**1980**	**1990**	**1995**	**2000**	**2001**	**Imports**
Coal	4.2	7.0	16.9	16.6	23.3	20.5	27.5%
Oil	7.7	15.7	23.6	28.7	31.1	28.9	92.6%
Gas	0.0	0.0	2.9	5.8	12.6	13.4	98.8%
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	-
Renewables	6.3	8.7	9.7	10.8	10.1	9.4	-
Biomass	*6.0*	*7.7*	*7.2*	*7.1*	*6.5*	*6.3*	
Hydro	*0.3*	*1.0*	*2.0*	*3.1*	*2.7*	*2.1*	
Geothermal	*0.0*	*0.1*	*0.4*	*0.5*	*0.7*	*0.7*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.1*	*0.3*	*0.3*	
Total	**18.2**	**31.5**	**53.0**	**61.9**	**77.5**	**72.5**	**63.4%**
% Renewables	*34.3%*	*27.8%*	*18.2%*	*17.4%*	*13.2%*	*13.0%*	

** See Annex 2 for explanation of components in total and definition of biomass.*

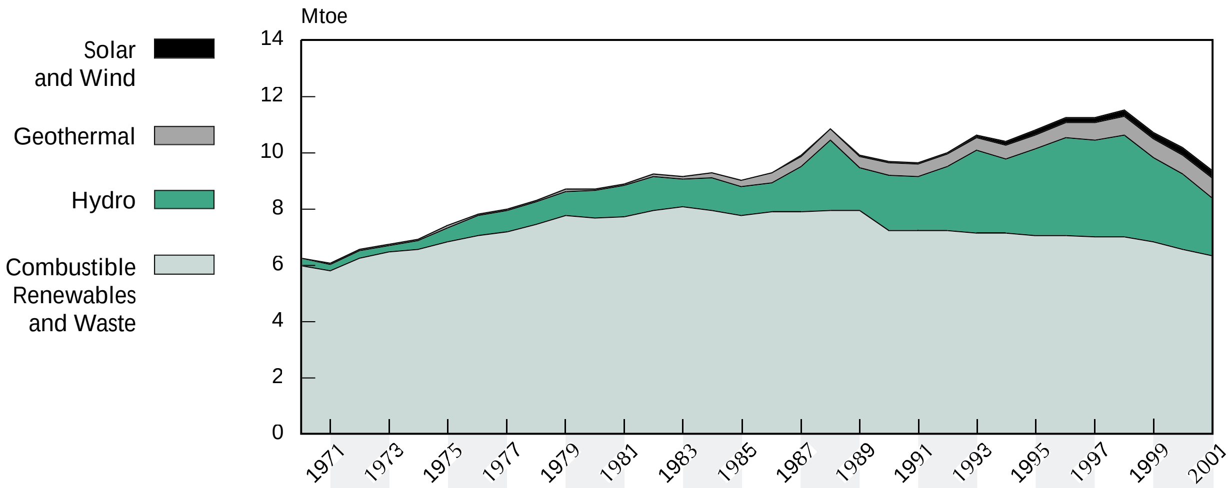
Total primary energy supply (TPES) in Turkey grew by 2.9% per year between 1990 and 2001, the fastest growth rate among IEA Member countries. Oil is the dominant fuel, accounting for 40% of TPES in 2001. Coal (28%) and gas (19%) also contributed significantly (Table 1). Renewable energy, mostly biomass, waste and hydropower, accounted for 13%. Hydropower represented 3% of TPES in 2001. Biomass, primarily fuel wood consumed by households, represented almost 9%. The economic downturn in Turkey in 2000/2001 caused TPES to decline by 6.5%. But energy demand is expected to more than double by 2010, according to Turkish government sources.

The share of renewables in TPES decreased from 18% in 1990 to 13% in 2001. The fall in share was the result of a considerable decline in biomass supply and a levelling off of hydropower. Renewables represent the second-largest domestic energy source after coal. But the share of renewables, particularly biomass, is expected to continue to decrease as oil and gas penetrate the residential sector and biomass becomes scarcer.

Gas accounted for 40% of total electricity generation in 2001, coal 31% and oil at about 9%. Hydropower is the main indigenous source for electricity production and represented 20% of total generation in 2001. Hydropower declined significantly relative to 2000 due to lower electricity demand and to take-or-pay contracts in the natural gas market. According to Turkish statistics, the share of hydropower in electricity generation increased to 26% in 2002.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



Policy Timeline

Research and Development

Market Deployment

. Build Operate Transfer

. Electricity Market Licensing Regulation

● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

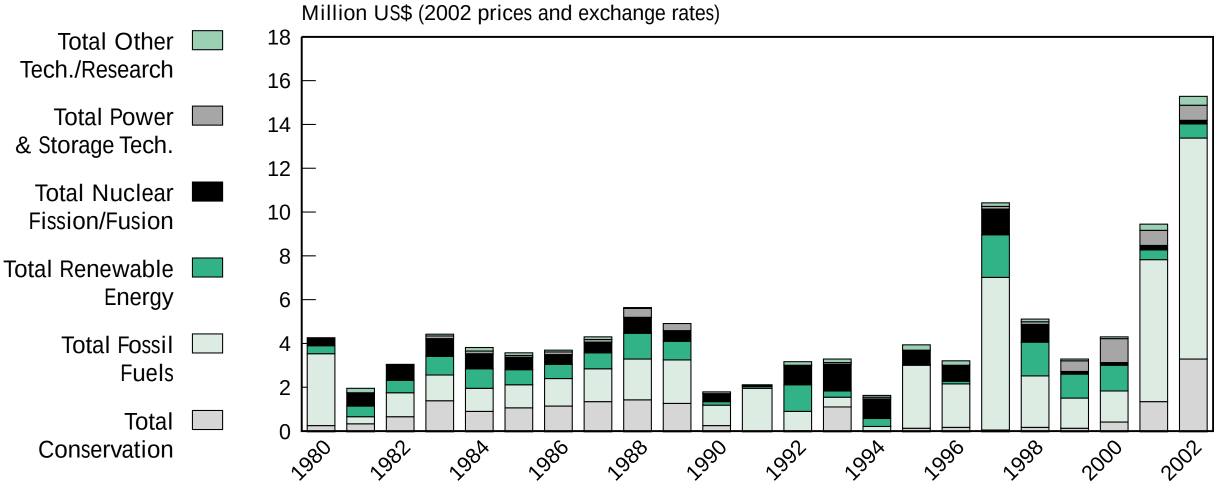
Renewable energy supply in Turkey is dominated by hydropower and biomass, but environmental and scarcity-of-supply concerns have led to a decline in biomass use, mainly for residential heating. Total renewable energy supply declined from 1990 to 2001, due to a decrease in biomass supply. As a result, the composition of renewable energy supply has changed and wind power is beginning to claim market share. As a contributor of air pollution and deforestation, the share of biomass in the renewable energy share is expected to decrease with the expansion of other renewables. On the whole, Turkey has substantial reserves of renewable energy sources, including approximately 1% of the total world hydropower potential. There is also significant potential for wind power development. Turkey's geothermal potential ranks seventh worldwide, but only a small portion is considered to be economically feasible.

Natural gas and coal are currently the primary fuels for electricity generation. Hydro accounted for 26% of total electricity generation in 2002. The government is pursuing hydropower expansion, particularly in the south-east where less than 40% of hydropower potential currently is being used. The government expects that in 2020 hydropower generation will reach 97.5 TWh (or 8.4 Mtoe).

Research and Development Trends

Turkey spent a total of US$ 107.2 million (2002 prices and exchange rates) on government energy RD&D between 1980 and 2002. In this period, 15.3% of its total energy RD&D budget (US$ 16.4 million) was allocated to renewable energy.

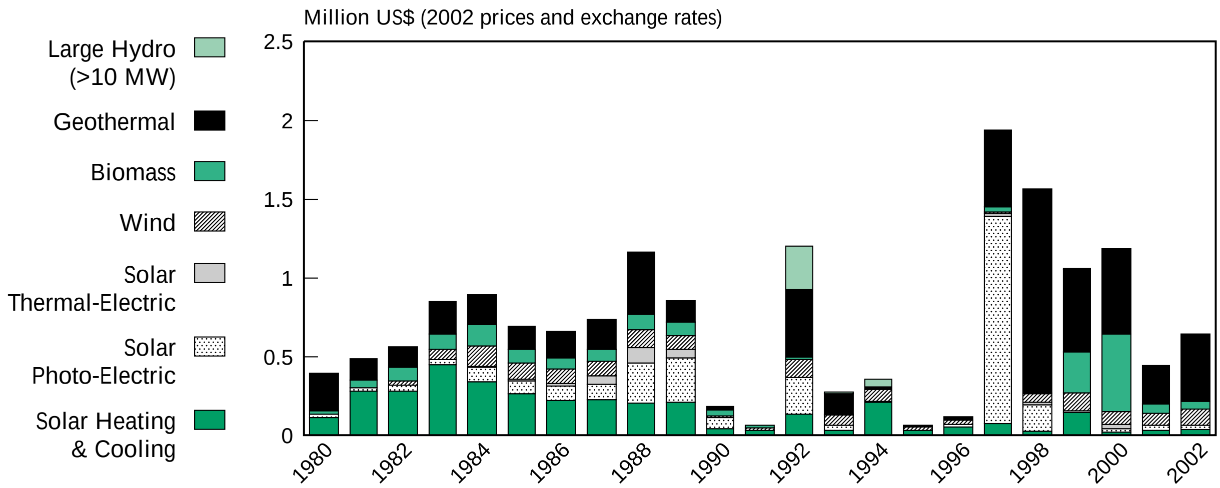
Figure 4. **Turkey - Government Energy RD&D Budgets**



Government RD&D expenditures for renewables followed the general trend in overall energy RD&D expenditures, rising in the late 1980s and then falling in the early 1990s. Public funding increased substantially in 1997.

Among the renewable technologies, geothermal received the most sustained funding over the past two decades and the highest level of funding, equivalent to US$ 6.1 million or 37% of the renewables RD&D expenditures between 1980 and 2002. In addition, Turkey participates in international collaborative RD&D in Photovoltaic Power Systems through the IEA Implementing Agreements.

Figure 5. **Turkey - Government Renewable Energy RD&D Budgets**



Market Deployment Trends

Market deployment policies for renewables started in 1984 with third-party financing, excise and sales tax exemptions. Capital grants were offered in 2001. The Turkish government's approach to the deployment of renewables reflects its priorities to develop indigenous and renewable resources in conjunction with the expansion of privately-owned and operated power generation from renewable sources.

The BOT (build-own-transfer) and the BOO (build-own-operate) schemes were put in place in 1984 and financed major power projects (not limited to renewables) with the main objective of attracting private investors. BOT projects were granted a treasury guarantee. Although BOT and BOO approaches attracted significant investment, they also created large contingent public obligations with the government covering the market risk through take-or-pay contracts. Security of term contracts and arbitration were two other major issues for private investors, which were partly addressed by the International Arbitration Law (No. 4501) which was applied for the first time in 2000 to settle disputes between the state and the private sector on public-service contracts. It facilitated the financing of energy sector projects. The economic crisis of 2000 and pressure from the International Monetary Fund, however, brought an end to the treasury guarantees, except for the twenty-nine BOT projects whose contracts were already in place (seventeen wind power projects, seven hydro and one geothermal project). The BOT and BOO financing schemes ended in 2000 and were replaced in 2001 by financial incentives within the framework of the Electricity Market Law.

The Electricity Market Licensing Regulation of the Electricity Market Law (Law Number 4628) contains two regulations pertaining to the promotion of the use of renewable energy:

- Entities applying for construction licences for renewable energy facilities only pay 1% of the total licence fee. In addition, renewable energy generation facilities do not pay annual licence fees for the first eight years after the facility completion date specified in the licences.
- The Turkish Electricity Transmission Company (TEIAS) and/or distribution companies are required to assign priority status for grid connection of renewable generating facilities.

The real beginning for renewable energy policy was the definition of renewable energy sources in the decree of the Modification of the Licence Regulation in the Electricity Market in 2003. Before then, there was no national renewable energy policy and few government incentives existed to promote market deployment of renewable energy. However, the Electricity Market Licensing Regulation, in itself, is not expected to be sufficient to overcome the high investment cost, risk and lack of security associated with the entrance of renewable power plants into the electricity market.

Turkey is to be the recipient of a US$ 202 million renewable energy loan provided by the World Bank to be disbursed as loans via financial intermediaries to interested investors in building renewable energy sourced electricity generation. These loans are expected to finance 30-40% of associated capital costs. The aim of the Renewable Energy Program is to increase privately-owned and operated power generation from renewables sources within a market-based framework, which is being implemented in accordance with the Electricity Market Law and the Electricity Sector Reform Strategy. This programme will assist the Directorate of the Ministry of Energy and Natural Resources (MENR) in the preparation of a renewable energy law, as well as to define the required changes and modifications related to legislation such as the Electricity Market Law to better accommodate greater private sector involvement.

The MENR, together with the Electrical Power Resources Survey and Development Administration (EIEI), currently are engaged in the preparation of renewable energy and energy efficiency laws. The renewable energy law is expected to be adopted by the second quarter of 2004. It is anticipated that the law will institute measures such as feed-in tariffs and investment incentives.

There is significant renewable energy opportunity in Turkey, but few measures have been employed to tap into that potential. Since the 1980s, Turkey's energy policy has concentrated on efforts to stimulate private investment to meet the increasing internal energy demand. Fossil fuels projects helped to meet the demand. CO_2 emissions from the energy sector increased by 58% between 1990 and 2000. As an Annex I Party to the United Nations Framework Convention on Climate Change, Turkey has an obligation to implement policies and measures for emissions reductions, but does not have an emissions target. In recent years, Turkey has begun to promote renewable energy sourced power generation.

Renewable Energy Markets

Hydropower

Figure 6. **Hydropower Capacity and Electricity Production**

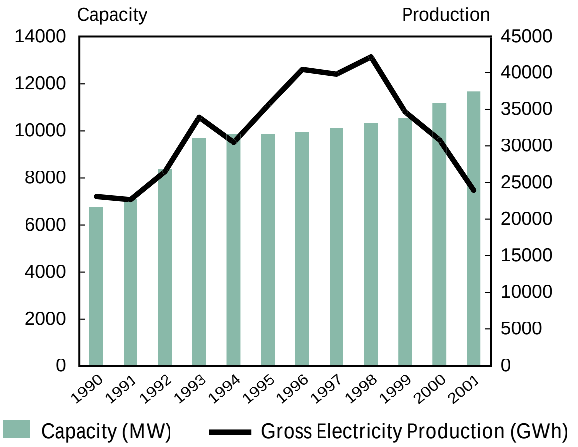
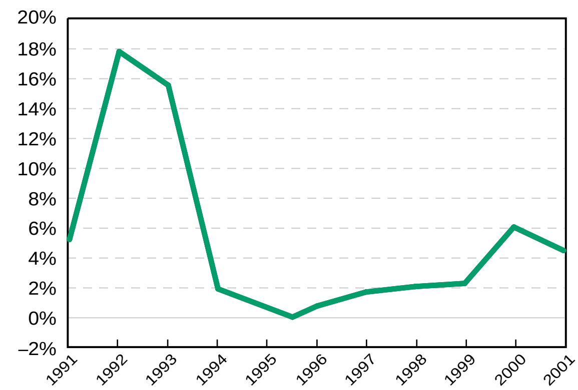
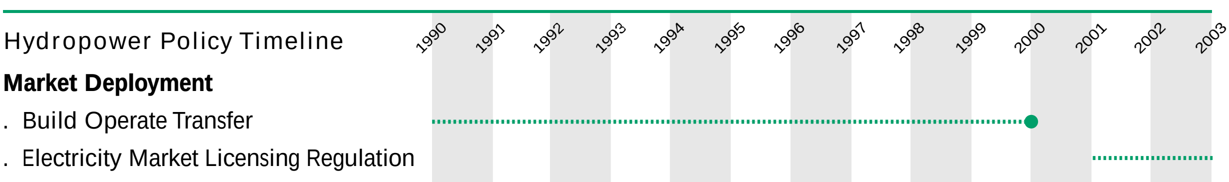


Figure 7. **Hydropower Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Hydropower installed capacity increased by 5.1% per year from 1990 to 2001. Hydropower contributed 22.1% of total renewable energy supply and 2.8% of TPES in 2001. According to Turkish statistics, there were 130 hydroelectric power plants, with capacity of 12 500 MW, operating in 2002.

Currently, some thirty hydro plants are under construction. Hydropower has to some extent been stimulated by the BOT financing scheme.

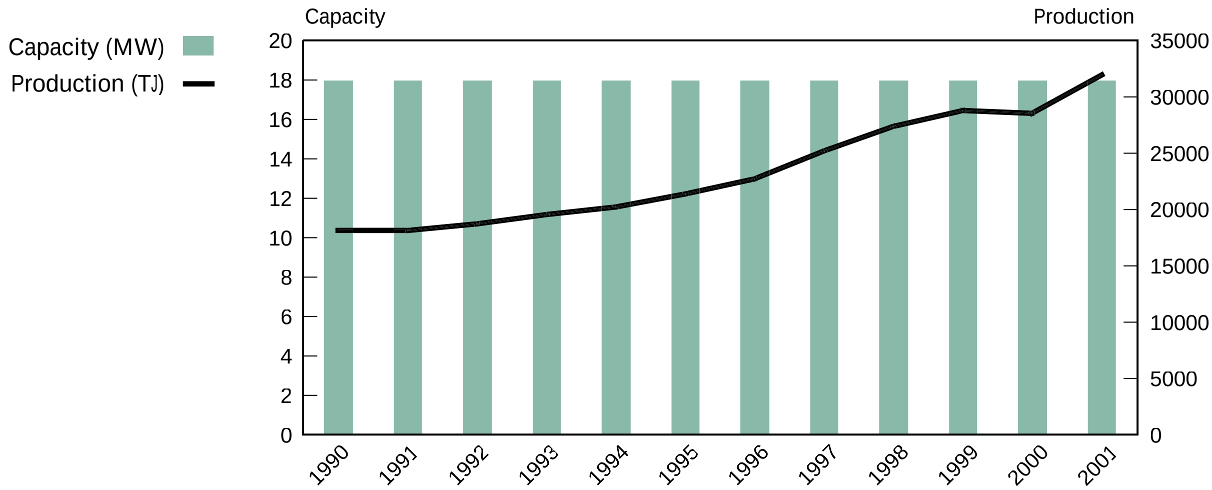
DSI and EIEI estimate that only 35% of the economic potential for hydropower has been exploited. The Turkish government has a strategy for developing this potential and expects that 332 additional hydro plants will be constructed over the long term, adding more than 19 GW of capacity. Construction costs would be on the order of US$ 30 billion.

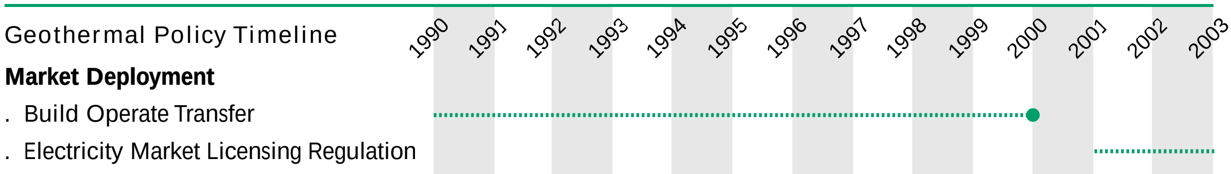
The Turkish government would like to expand hydropower capacity to 35 000 MW by 2020, and plans to encourage this outcome through favourable licensing conditions established by the Electricity Market Licensing Regulation. Hydropower is included in the loans available through the Renewable Energy Program.

1. Devlet Su Isleri (DSI), the General Directorate of State Hydraulic Works; Electrical Power Resources Survey and Development Administration (EIEI).

Geothermal Production

Figure 8. **Geothermal Capacity and Production**





Denotes a significant change to a policy, such as an extension, repeal or revision.

Geothermal production was 7.4% of total renewable energy supply in 2001. Installed capacity has remained unchanged but production increased by 4.4% per year on average between 1990 and 2001. Estimated potential of geothermal electricity generation capacity is 35 GW. There is one geothermal plant for electricity production with an installed capacity of 17.5 MW at the Denizli-Kizildere field. Another geothermal power station and five heat plants (73 MWth) are under construction. Two geothermal electricity generation projects with a capacity of 13.45 MW are currently in the licensing process.

Long-term planning studies forecast that geothermal energy capacity will total 500 MW in 2010 and 1 000 MW in 2020. The cost of electricity generated from geothermal resources is between € 0.03 and € 0.10/KWh. The bottom end of this range is competitive with conventional systems. Geothermal direct use is expected to increase to 6.3 Mtoe by 2020, especially for direct heating.

The Turkish government started a geothermal construction programme in 1972 that predicted an installed capacity level of nearly 710 MW by 2004. However, the programme was not fully implemented and the geothermal potential remains largely unexploited. The geothermal market has seen no growth in installed capacity between 1990 and 2001. The geothermal market has received some stimulation from the BOT financing scheme, where at least one geothermal project contract was put in place, although it may still be too early to see the effects on the geothermal market due to rather long lead times for geothermal power developments.

Wind Power

Figure 9. **Wind Power Capacity and Electricity Production**

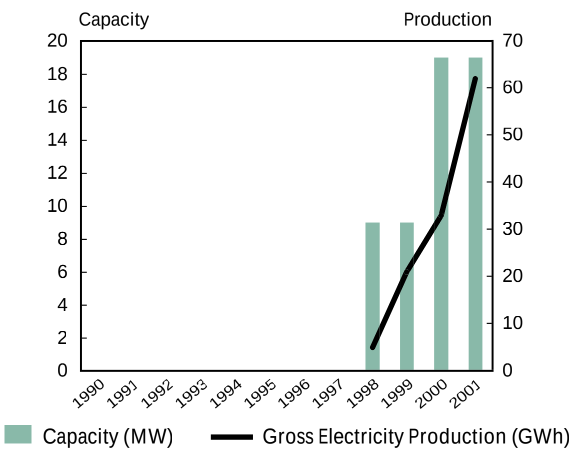
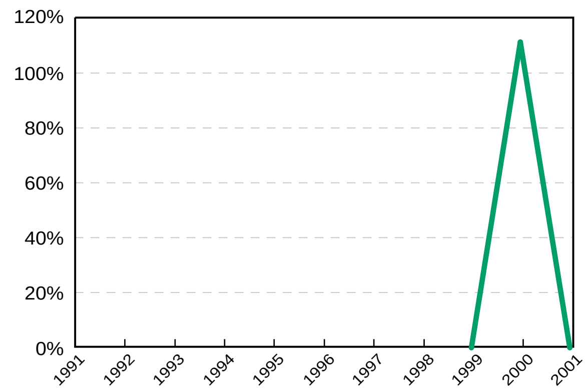
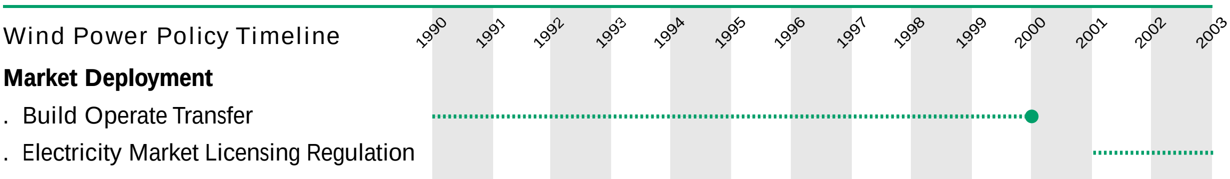


Figure 10. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Wind capacity was 19 MW in 2001 and its contribution to total renewable energy supply was a mere 0.06%. The first wind turbine was installed in 1986 at Çesme Altın Yunus with a nominal capacity of 55 kW. In 1998, two wind power plants were constructed through the BOT financing scheme, the first in Germiyan Village in Çesme in Turkey, with an installed capacity of 1.7 MW, and the second, the ARES wind farm in Alaçati, with twelve wind turbines and an installed capacity of 7.2 MW. ARES is to be transferred to the state after investment costs have been recovered and some profits have been made. ARES is expected to repay its investment cost in two and a half years. BORES, the newest and largest wind development, is 10.2 MW capacity and will be sold after investment costs of US$ 13 million have been recovered, which is expected to take six years.

The western coast and south-eastern Anatolia have been identified as very favourable locations for wind power generation, with annual average wind speeds of around 2.5 m per s and annual wind power densities of 2.4 W per m^2. Progress in wind energy technology in recent years has drawn much private-sector attention. Three plants have been commissioned. There are contracts in place for wind power projects through the BOT financing approach. In response to both the BOT approach and the advantages put in place by the Electricity Market Law, numerous companies have submitted applications to the authorities for the construction of new wind turbines. In 2001, 72 new projects totalling about 2 000 MW were under evaluation. Total capacity of all wind projects underway in Turkey was about 800 MW in early 2004. The goal is for wind power to represent about 2% of installed power capacity in 2005. Long-term planning studies project that wind energy capacity could reach 2 100 MW by 2010 and 5 000 MW by 2020. Given Turkey’s wind potential and private investor interest, these goals could be achieved given the market incentives in place.

Turkey Policy Chronology

Build-Operate-Transfer

Year 1984-2000

Policy Description Under the BOT model, private investors built and operated power plants. After remaining in private ownership for a number of years corresponding to the economic lifetime of the investment (typically fifteen to twenty years), these power plants were transferred to state ownership, *i.e.*, to the Turkish Electricity Transmission Company (TEIAS).

The BOT Law contained a number of provisions designed to encourage investment. These included exemptions from customs duties and deferral of VAT payments on certain types of imported equipment. Most importantly, the law provided that the Turkish Treasury could back up the power purchases contracted between the BOT investor and TEAS or TEDAS (the two state-owned electricity suppliers) with a treasury guarantee.

All types of BOT projects listed in the 1994 BOT Law were automatically defined as concessions. Following construction and start-up of the plant, generation costs varied because of changes in fuel prices, labour costs, tax law, etc. These were passed on to consumers through the electricity price, and could also be compensated through an electricity fund, which was financed through a tax on electricity consumers. The main purpose of the fund and the tax was to ensure security in electricity prices by providing an additional state guarantee to BOT schemes and by moderating sudden changes in electricity prices paid by TEAS by averaging this price on a yearly basis.

Policy Type Excise tax exemption/Sales taxes/Third-party finance

RE Technology All renewables

Electricity Market Licensing Regulation

Year 2001 - Present

Policy Description The Electricity Market Licensing Regulation of the Electricity Market Law (Law Number 4628) contains two regulations pertaining to the promotion of the use of renewable energy:

- The legal entities applying for licences for construction of renewable energy facilities are required to pay only 1% of the total licence fee. Also renewables based generation facilities are exempt from paying the annual licence fees for the first eight years following the facility completion date as specified in the licence.
- The Turkish Electricity Transmission Company (TEIAS) and/or distribution companies are required to give priority status for systems connection of generating facilities based on renewables.

Policy Type Capital grants

RE Technology All renewables

The United Kingdom

Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

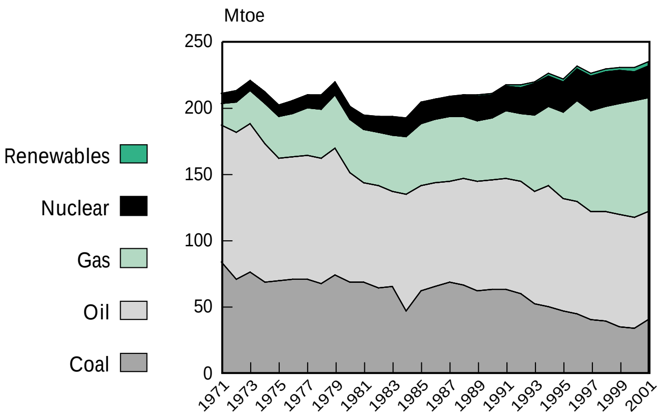
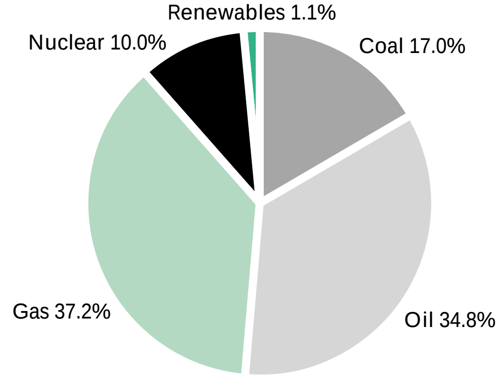


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1. See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	**1970**	**1980**	**1990**	**1995**	**2000**	**2001**	**Imports**
Coal	88.6	68.8	63.1	46.9	34.2	39.8	55.8%
Oil	101.3	82.2	82.6	84.6	83.7	81.5	•
Gas	10.2	40.3	47.2	65.1	87.3	86.8	•
Nuclear	6.8	9.6	17.1	23.2	22.2	23.5	-
Renewables	0.4	0.3	1.0	1.8	2.4	2.5	-
Biomass	*0.0*	*0.0*	*0.6*	*1.4*	*1.9*	*2.1*	
Hydro	*0.4*	*0.3*	*0.4*	*0.4*	*0.4*	*0.3*	
Geothermal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Wind/Solar	*0.0*	*0.0*	*0.0*	*0.0*	*0.1*	*0.1*	
Total	**207.3**	**201.3**	**212.2**	**223.2**	**231.2**	**235.2**	•
% Renewables	*0.2%*	*0.2%*	*0.5%*	*0.8%*	*1.0%*	*1.1%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*

• *Net Exporter*

The last three decades have seen a substantial shift in the energy supply mix of the United Kingdom. Figure 1 shows how the supply of coal and oil declined over time while the supply of natural gas and nuclear power increased. Overall, TPES was 235 Mtoe in 2001. In 1970, oil accounted for 48.9% of TPES, coal for 42.8% (Table 1). By 2001, oil had declined to 34.6% and coal to 16.9%. Over the thirty years, natural gas increased from 4.9% to 36.9% and nuclear power rose from 3.3% to 10%. The growth in natural gas use since 1991 has been largely for electricity generation and is reflective of changes in the electricity sector as it was restructured, the coal industry was reformed, and advances were made in combined-cycle gas turbine technology. Figure 1 also shows that the shortfall from the coalminer's strike was essentially compensated for by fuel oil.

Renewable energy has grown considerably in real terms since 1973, but from a very low base. Renewable energy's contribution to TPES increased from 0.4 Mtoe in 1970, to 0.6 Mtoe in 1990, and further to 2.5 Mtoe in 2001. Renewable energy sources accounted for 1.1% of total primary energy supply (TPES) in 2001, primarily from biomass, up from 0.5% in 1990.

In 2001, natural gas was the largest generation source for electricity accounting for 37% of the power produced. Coal was second at 35% and nuclear third at 23%. Generation from natural gas has increased explosively since 1990 and nuclear generation has also increased, primarily between 1990 and 1995, as coal and oil use for power generation have declined. Renewable sources for electricity generation increased from 1.8% in 1990 to 2.5% in 2001, primarily from biomass.

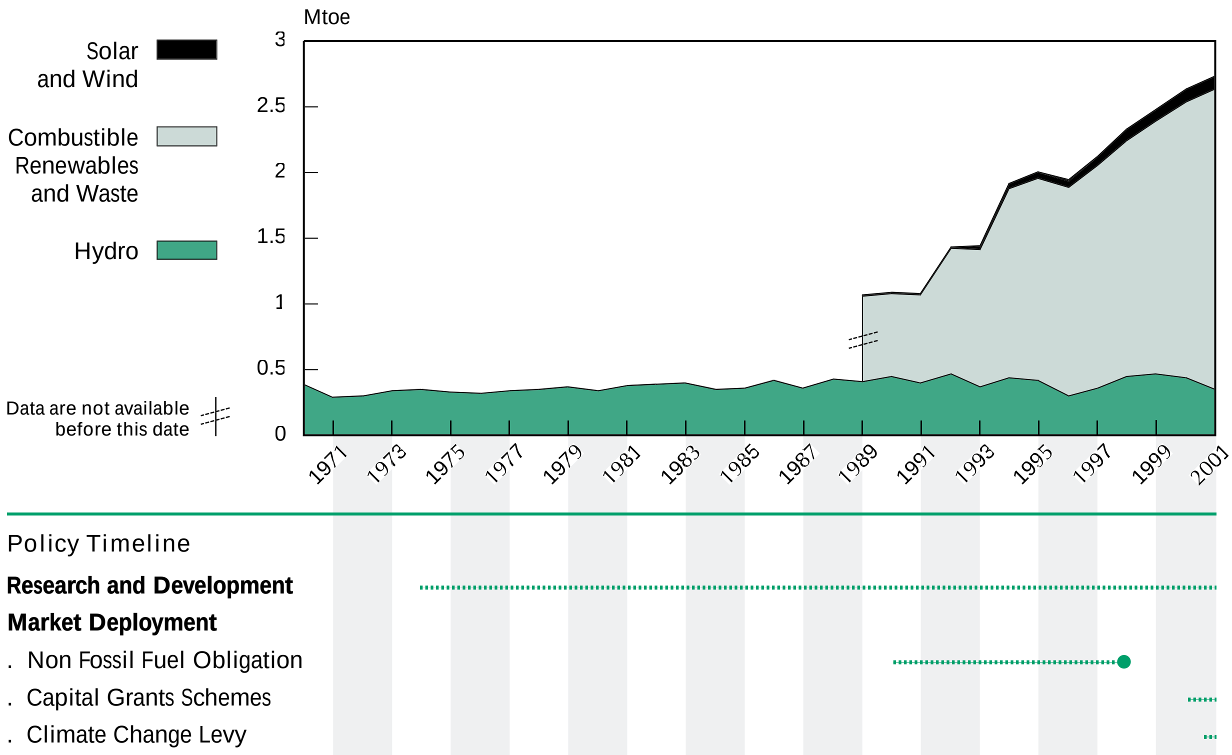
The UK energy industries contribute significantly to the country's wealth. In 2002, they were responsible for 4.3% of GDP, 7.2% of total investment, 35% of industrial investment and 3% of business expenditure on research and development. In addition, they employed about 165 000 people and indirectly employed an estimated 360 000 people in support of the oil and gas production from the UK continental shelf.

The United Kingdom is self-sufficient in energy and has been a net energy exporter since 1980. These exports generated a trade surplus in fuels of £6 billion in 2002. Oil and gas production are both expected to decline in the next few years. The UK government and significant parts of the oil industry believe that UK oil production passed its peak in 1999, and that production is set to fall by about 60% over the next ten years. The United Kingdom will rely increasingly on imports and revert to being a net importer of gas within the next five years.

Offshore renewable energy is an emerging market. In the United Kingdom there is a pool of skills and experience working in the demanding and difficult offshore environment. Both operating experience and skills in design, management and construction could help foster a viable offshore renewable market.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

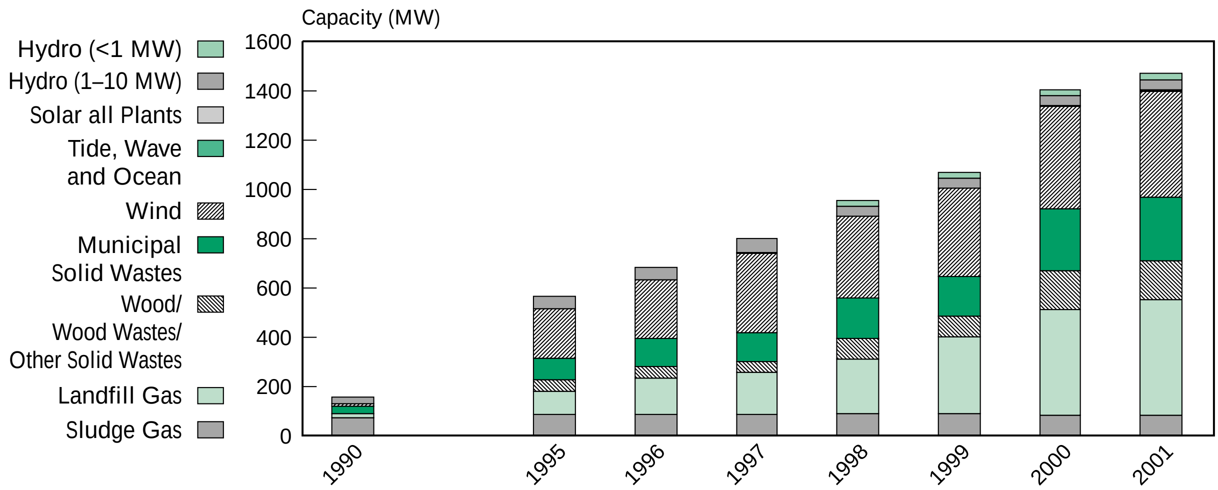
Renewable energy sources accounted for 1.1% of the UK's TPES and 2.5% of electricity production in 2001. Most of this is from biomass and waste. The rest is from hydro and a small contribution from wind. According to UK data, about 78% of the renewable energy produced in 2002 was transformed into electricity. Generation from renewables other than large-scale hydro in 2002 was 10% higher than the previous year and double the level in 1997. Figure 4 shows the progression in net generating capacity from 1990 with the most significant growth in landfill gas, municipal solid waste and wind power.

Research and Development Trends

The United Kingdom spent a total of US$ 14.6 billion (2002 prices and exchange rates) on government energy RD&D between 1974 and 2002. In this period, 4.7% of its total energy RD&D budget (US$ 688 million) was allocated to renewable energy R&D.

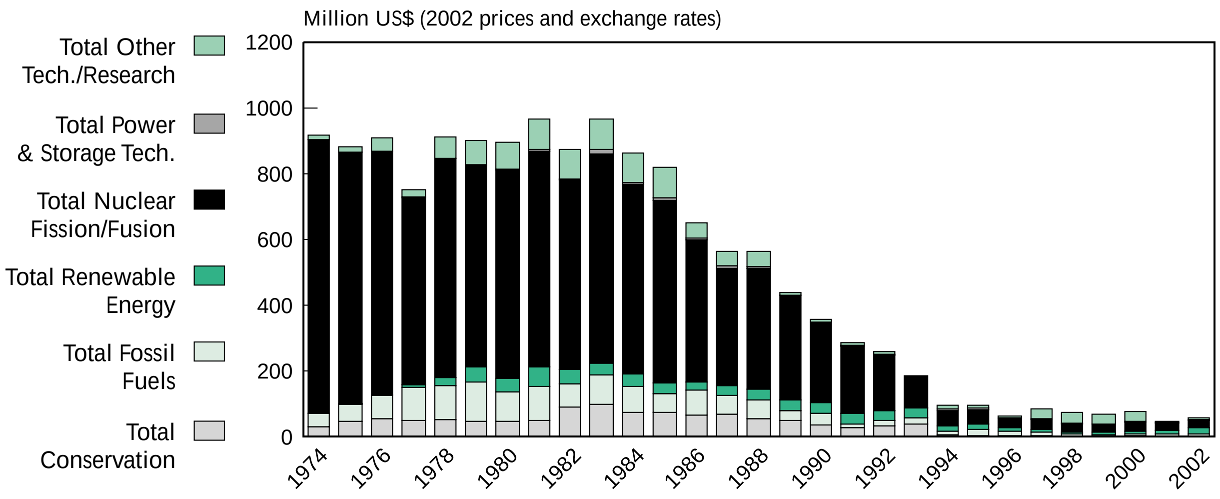
The overall trend of government RD&D expenditures for renewables peaked in 1981. There was a notable decline through the mid- and late-1990s. From this lowered level, the renewables RD&D budget doubled from 2001 to 2002 with increased RD&D focus on solar photo-electric.

Figure 4. **Net Generating Capacity of Renewable and Waste Products**



Note: A change in data collection methods at the IEA occurred in 1999 with the separation of net generating capacity between small and large hydro. Capacity data for small hydro are not available prior to 1999.

Figure 5. **United Kingdom - Government Energy RD&D Budgets**



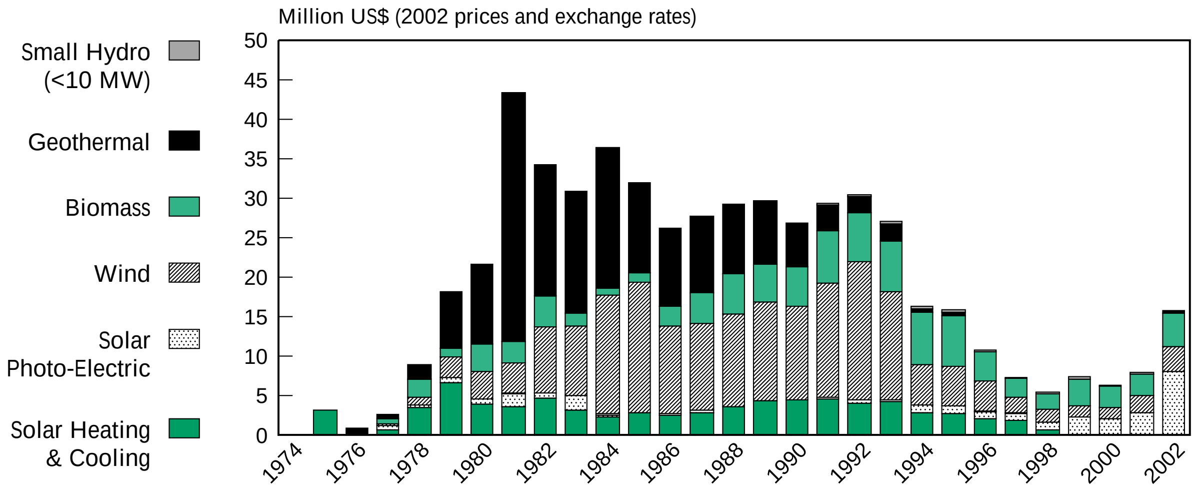
Among the renewable technologies, wind power received the highest level of funding (US$ 189 million) equalling 27% of renewables RD&D budget over the 1974 to 2002 period. Geothermal R&D was funded at US$ 164 million, 24% of overall RD&D spending, and was a focus in the 1980s, but support declined to zero in the 1990s. Ocean energy received about 20% of the renewable RD&D spending, concentrated in the late 1970s and early 1980s with minimal support until the early 1990s.

The government's policy is to stimulate the development of renewable and sustainable energy technologies where they have the prospect of being economically beneficial and environmentally attractive. The Sustainable Energy Programme, which supports the promotion of appropriate technology, was funded at £ 14 million for 2000/2001. Its principal role is to support and encourage innovation by industry of those technologies that have the prospect of becoming competitive.

The process for defining priorities is overseen by an advisory group. The Department of Trade and Industry (DTI) is responsible for the programme. In consultation with the main players, the DTI is preparing a series of route maps covering the time frame up until 2020 to help determine R&D priorities.

In addition, the United Kingdom participates in international collaborative R&D in Bioenergy, District Heating and Cooling, Geothermal, Hydropower, Ocean Energy Systems, Photovoltaic Power Systems, Solar Heating and Cooling, Solar PACES and Wind Turbine Systems through the IEA Implementing Agreements.

Figure 6. **United Kingdom - Government Renewable Energy RD&D Budgets**



Market Deployment Trends

The UK government takes the view that renewable sources of energy must be an essential ingredient of its Climate Change Programme and that renewables are set to make an increasingly important contribution to the provision of secure, diverse, competitive and sustainable energy supplies. From 1990 to 1998, the main instrument for the support of renewables was the Non-Fossil Fuel Obligation (NFFO). Since the privatisation of the electricity supply industry in 1990, public electricity suppliers have been obliged to secure a set capacity from specified renewables through competitive bidding procedures for government support under the NFFO. In the electricity supply restructuring, nuclear power was excluded from competition. A Non-fossil Fuel Levy was placed on electricity consumers to subsidise nuclear power and for the premium paid for renewables. The bulk of the subsidy supported nuclear: the renewables share went from 0% in 1990/91 to about 8.6% in 1995/96. The principal mechanism of the NFFO for renewables was a guaranteed price, with the rate set as a function of the power pool wholesale price plus a technology-specific premium that came from the Non-Fossil Fuel Levy funds.

Under the five rounds of the NFFO, renewable technologies were separated into different technology categories and competitive bidding rounds were organised for each category separately. This mechanism was successful in bringing down the cost of the support of renewables in each technology tranche, but less so in boosting the overall use of renewables in the energy market.

By 2003 the NFFO had spurred the development of 440 renewable projects with 1 104 MW of capacity. The largest contributions were from landfill gas (471 MW), municipal and industrial waste (236 MW), and wind power (219 MW). Other forms of bioenergy (biomass (107 MW) and sewage gas (25 MW) and small hydropower (47 MW) were also developed. Electricity generation from NFFO sites grew from 275 GWh in 1991 to 3 778 in 2001. However, the total installed capacity of 1 104 MW was only a small portion of the more than 3 600 MW of projects that had been contracted.

As a result, in 1998 the government began to overhaul the support scheme, as it was re-shaping the rules for electricity trading, deepening its commitment to climate change mitigation and seeking solutions to off-set the impending reduction in North Sea supplies. After consultation and extensive consideration within the government, it was decided to move away from the existing NFFO arrangements and adopt a supply obligation. The Renewables Obligation came into force in April 2002. It requires electricity suppliers in England and Wales to provide specified portions of their wholesale electricity from renewable sources, or to fulfil all or part of their obligation by paying the buy-out price. (The Renewables Obligation Scotland is the equivalent instrument in Scotland.)

The Renewables Obligation is the primary policy instrument for the United Kingdom to achieve its objective of raising the contribution of renewables to electricity supply to 10% by 2010. This is an ambitious target and the government appears determined to make up for delays of the past in the development of renewables. In addition to the Renewables Obligation, the Climate Change Levy, an emissions trading scheme, a market for green certificates and other support programmes are the main policy measures in support of the objective. In total, the UK Government has committed itself to support of £1 billion per year up to 2010 for the development of renewables.

Energy Policy Context

The Government of the United Kingdom is committed to increasing the use of renewable energy to help reduce greenhouse gas emissions, contribute to greater diversity of energy supply and to provide economic benefits for the UK economy. A target of 10% of electricity supply from renewables in 2010 has been established. In 2002 the government defined its strategic vision for energy policy combining environmental, security of supply, competitiveness and social goals in a white paper, *Our Energy Future – creating a low carbon economy*.[1]

In order to provide a stable and long-term market for renewable energy the Renewables Obligation will remain in place until 2027. Under the Obligation, electricity suppliers must provide an increasing proportion of their electricity sales from UK generated renewables or pay a financial penalty. The year-on-year proportion that must be supplied, together with an estimate of what this should mean in terms of the specific amount of renewable electricity supplied to the grid in a year, is set out in Table 2.[2]

1. *www.dti.gov.uk/energy/renewables/policy*
2. *www.dti.gov/energy*

Table 2. **Renewables Obligation Requirement to Supply**

Period	Obligation as % of Sales	Estimation of Obligation in MWh
2003-2004	4.3	13.5 million
2004-2005	4.9	15.6 million
2005-2006	5.5	17.7 million
2006-2007	6.7	21.5 million
2007-2008	7.9	25.4 million
2008-2009	9.1	29.4 million
2009-2010	9.7	31.5 million
2010-2011	10.4	33.6 million

The government estimates that infrastructure that has the capacity to provide a maximum of 10 000 MW of electricity will need to be installed by 2010. Capacity to provide 1 200 MW is already installed. This equates to a build rate of more than 1 250 MW a year. So meeting the target will require a large number of new renewable developments, both large and small, and utilising a range of technologies.

The other key strands in support of the United Kingdom's renewable objectives, and underpinning the Renewable Obligation, are:

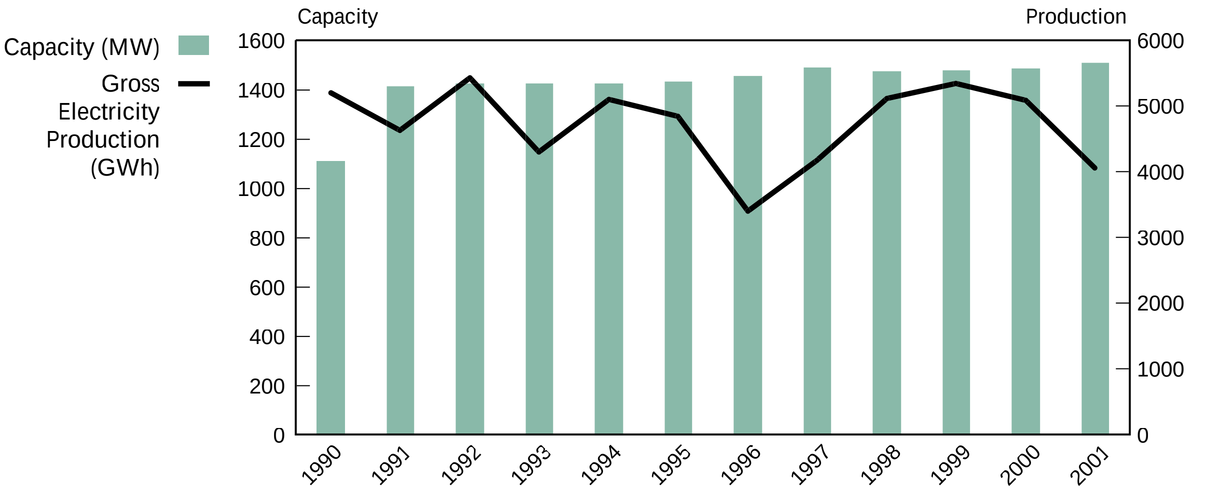
- Capital grants for biomass and offshore wind.
- Climate change levy (a tax on energy use from which renewable energy sources are exempt).
- New and renewable energy RD&D programme (£18 million per year for industry led R&D).
- Development of a regional strategic approach to planning and renewable targets.

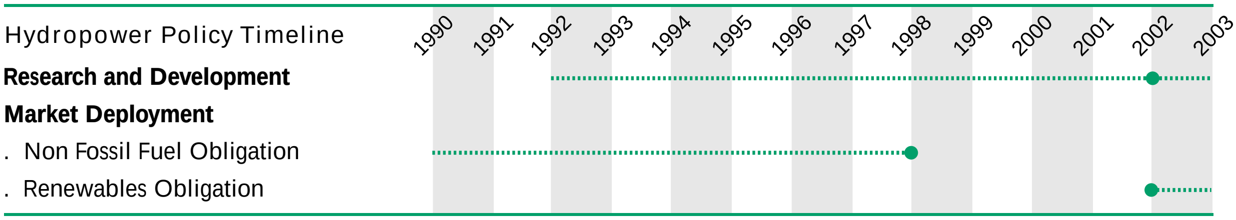
The Non-Fossil Fuel Obligation (NFFO) was the government's previous major instrument to encourage growth within the renewable energy industry. It required the electricity supply companies to secure specified amounts of new generating capacity from non-fossil sources by providing premium payments over a fixed period. More than 400 NFFO projects were operational in early 2004; about half are landfill gas plants.

Renewable Energy Markets

Hydropower

Figure 7. **Hydropower Capacity and Electricity Production**





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Hydro is a small contributor to the UK electricity generating mix: it provided 1% of electricity supply in 2002. Of the more than 1.5 GW of installed hydro capacity, most is located in Scotland and Wales and mainly draw their water from high-level reservoirs within their own natural catchment areas. Large-scale hydro capacity fell by 4% in 2002, as some stations were adapted to fall within the capacity limits set by the Renewables Obligation.

Small-scale hydro facilities (>5MW) have historically been part of water management schemes. The NFFO awarded contracts for 146 small hydro projects with a declared net capacity of 95 MW, however, less than half of the projects have been commissioned, providing just 47 MW of capacity.

Biomass Electricity Production

The use of solid biomass for electricity generation has grown substantially: capacity increased from 13 MW in 1992 to 157 MW in 2001. A substantial portion of the increase is a result of the NFFO rounds, which brought nine projects on-line with 106 MW of capacity. Most of this capacity uses poultry litter, one is a straw-fired plant that can also be fuelled by energy crops and some are relatively small “captive power” plants at forestry and farm sites. While incorporating innovative features, these plants rely on proven steam technology and have a reliable and predictable fuel supply. Reviewers suggest that the NFFO rules limited biomass electricity projects because wood-fired plants were required to use unproven advanced conversion technology and that the fuel supply was not reliable or predictable.

Figure 8. **Solid Biomass Capacity and Electricity Production**

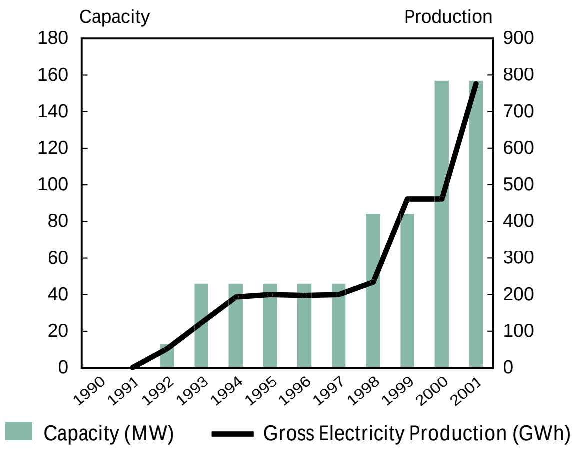
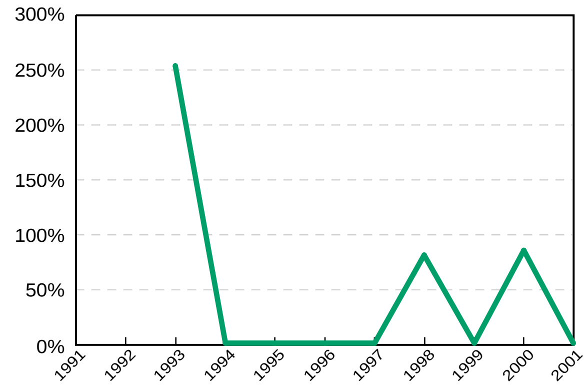
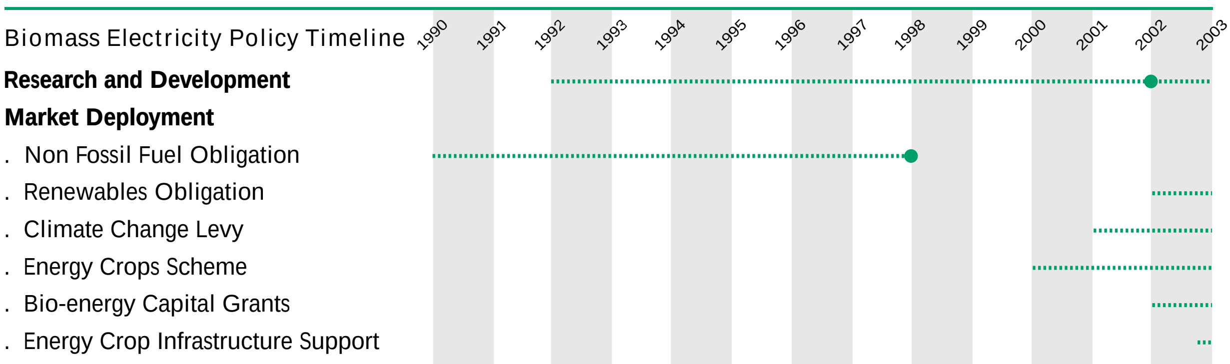


Figure 9. **Solid Biomass Capacity** (Year to Year Change)





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Solid biomass sources eligible under the Renewables Obligation include energy crops, agricultural waste and forestry materials and waste that are purely biomass. It allows co-firing until 2011, but 75% of the fuel must be from energy crops by 2006. (Though this technical requirement is proposed for modification in 2004 to lessen the amount in the early years.) The Bio-energy Capital Grants Scheme was launched in 2002 to stimulate the deployment of both biomass fuelled heat and electricity generation projects by awarding capital grants for the cost of equipment. The Energy Crops Scheme was introduced in 2000 to stimulate crop growth for power generation, combined heat and power or heat production. In 2003 an Energy Crops Infrastructure Support Scheme became operational with a budget of £3.5 million to help with the development of infrastructure to harvest, store and supply biomass to energy end-users. These support measures have not been in place long enough to determine their impact on the biomass electricity generation or heat production data.

Biomass Heat Production

As mentioned for biomass electricity generation, the UK government in 2002 made £30 million available to encourage the efficient use of biomass (particularly energy crops) for energy production for both heat production and electricity generation projects. In addition, the New Opportunities Fund is providing at least £ 3 million for energy crop power generation and at least £3 million for small-scale biomass/CHP projects.

Figure 10. **Solid Biomass Capacity and Heat Production**

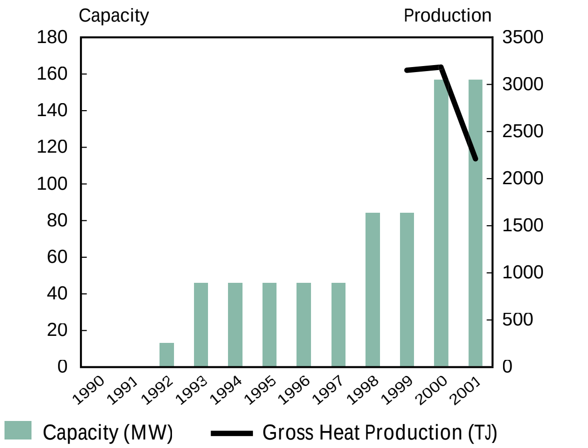
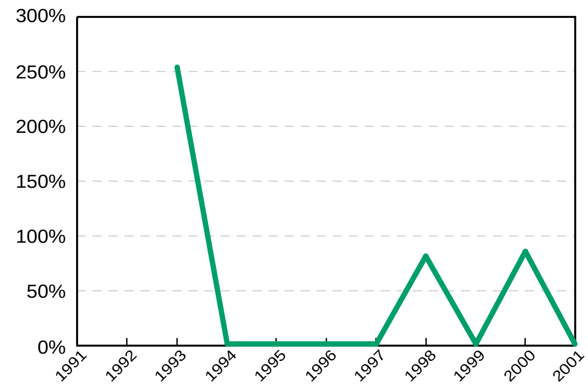
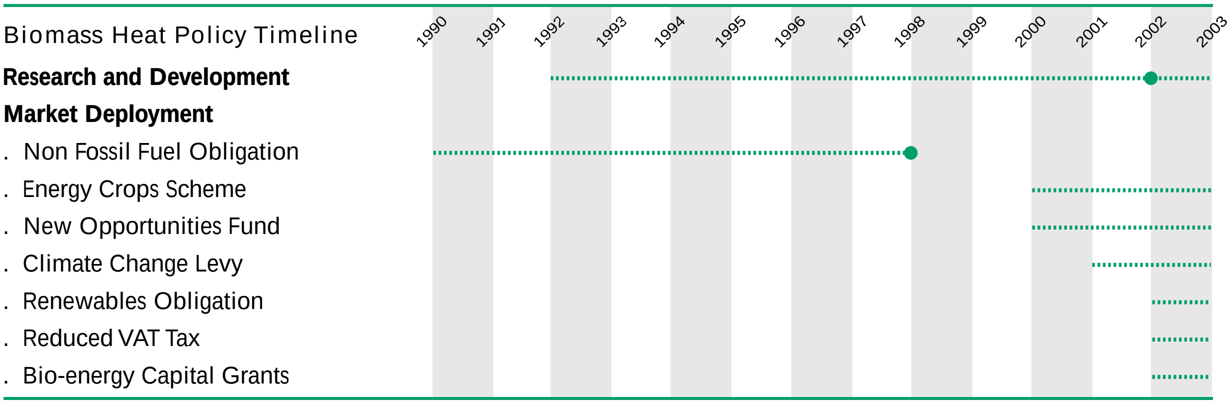


Figure 11. **Solid Biomass Capacity**
(Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

The energy crops scheme was launched in 2000. Grants are available to landowners to grow crops such as short rotation coppice and miscanthus for heat, CHP and electricity generation. Landowners must have an agreement with local energy producers to supply harvested crops to qualify. The scheme, which has £29 million available, will run until 2006.

Biogas Electricity Production

Biogas plants were one of the main success stories of the NFFO, growing from 90 MW in 1990 to 510 MW ten years later. The plants use a variety of technologies, including landfill gas, sewage gas, pyrolysis, and anaerobic digestion. During the transition to the Renewables Obligation scheme, capacity continued to grow, reaching 550 MW in 2001. Growth has been about 17.9% per year in the 1990-2001 period. The large growth of biogas electricity is expected to continue as several programmes targeting biomass have come into operation since 2000. These include the Bio-energy Capital Grant Scheme and the New Opportunities Fund financing for renewable energy in the UK programme.

Figure 12. **Biogas Capacity and Electricity Production**

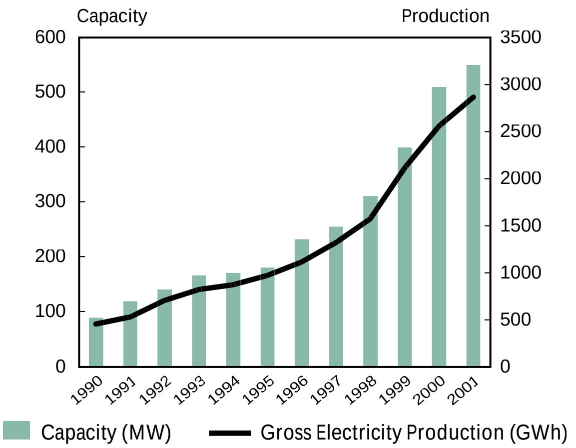
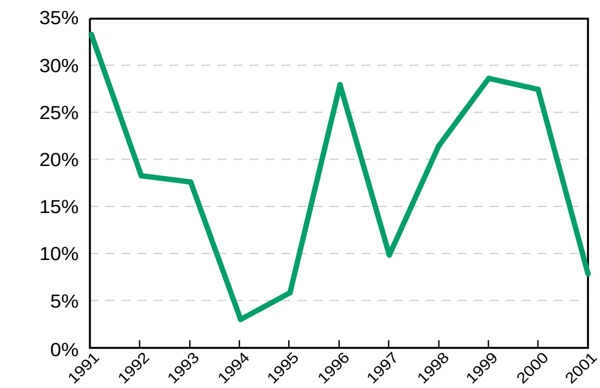
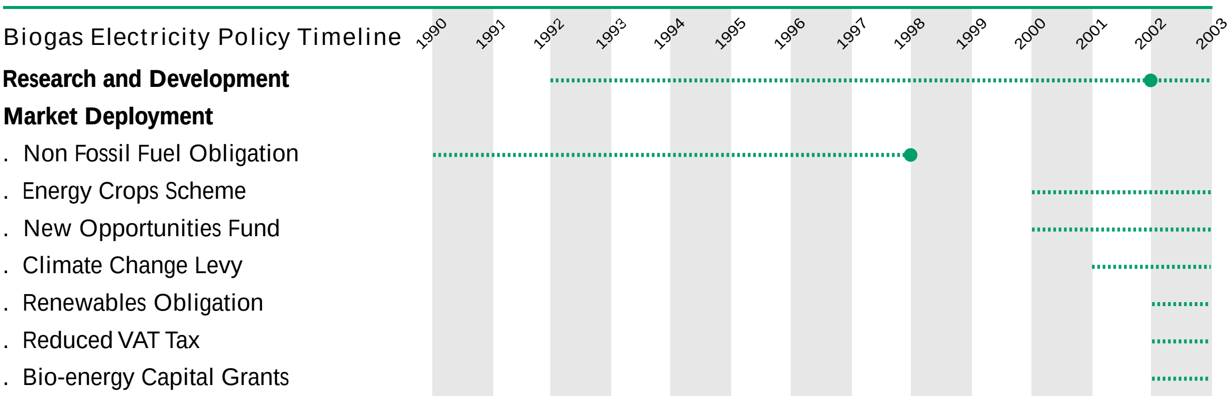


Figure 13. **Biogas Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Wind Power

Wind power grew steadily during the NFFO period, but from a very low base. Prior to 1992, only a few demonstration turbines were in place. Installed capacity of wind power was 427 MW in 2001.

More than 1 150 MW of wind power projects were approved and contracted in the NFFO rounds up to 2000. However, only 151 MW of these, or 13%, were actually installed, generally due to siting constraints. This low level of installed capacity in the country with the highest wind potential in Europe was a disappointment to government authorities. One lesson from the NFFO experience indicated to authorities that as a result of the difficulty of siting wind projects onshore, more attention should be given to encouraging the development of offshore projects. To that end, capital grants (£89 million and subsequently increased) to help develop offshore wind were introduced in 2000 under the Financing Renewable Energy in the UK programme. In addition, wind power benefits from the Climate Change Levy.

Introduced in 2002, the Offshore Wind Capital Grant Scheme seeks to stimulate early development of a significant number of offshore wind farms to provide learning experience, which will increase confidence

Figure 14. **Wind Power Capacity and Electricity Production**

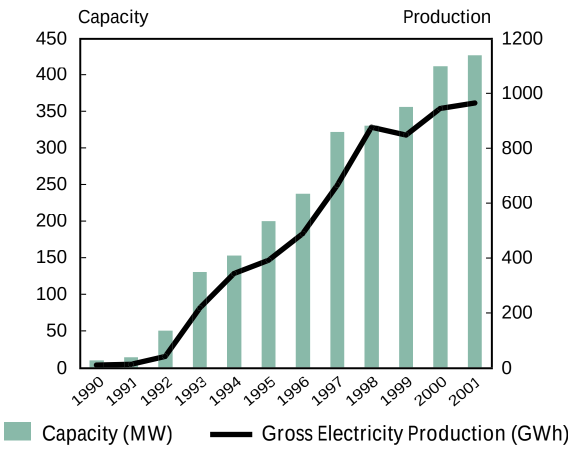
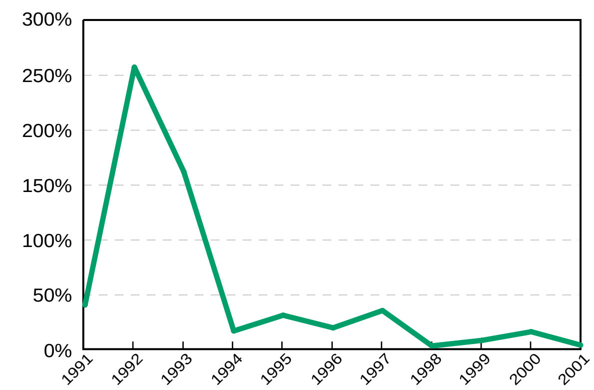
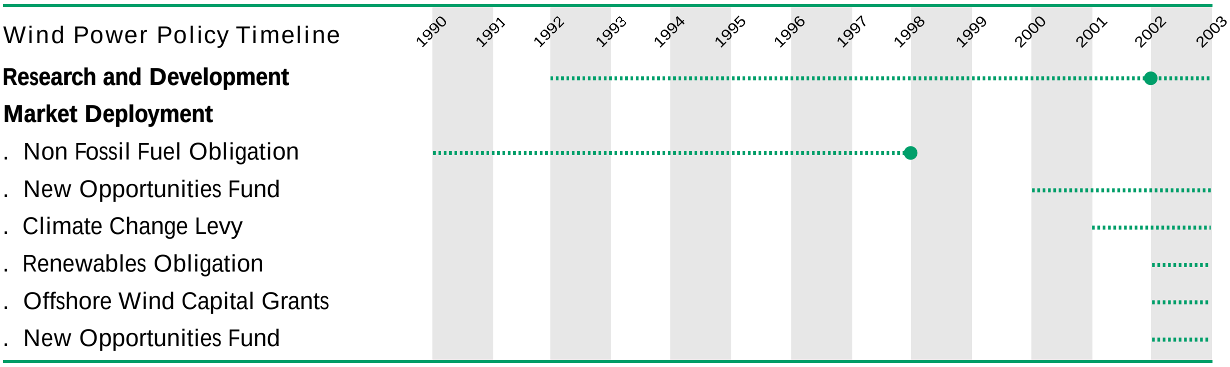


Figure 15. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

and reduce future costs. Round 1 was completed in September 2002 and resulted in two projects being awarded £20 million, which are to be commissioned in 2004. Round 2 in April 2003 supported five projects with a total of £42 million, which are to be commissioned in 2004-2005. Following completion of Rounds 1 and 2, the total budget for the scheme has increased from £64 million to £92 million. Some £40 million was available for Round 3, which was completed in December 2003. These grants provide capital support for up to 40% of eligible costs.

Both on and offshore wind projects qualify for premium payments under the Renewables Obligation (2002).The Obligation attempts to correct for a perceived bias against intermittent renewables in the New Electricity Trading Arrangements (NETA), which superseded the 1989 Electricity Act. The NETA required that intermittent suppliers contract for “firming” power to maintain a certain level of dispatch, which placed the full responsibility on the supplier. The Renewables Obligation requires the electricity distribution company to derive a certain portion of its generation from renewables, thus shifting the responsibility for integration balancing of intermittent wind to the electric company.

It should be noted that for offshore wind to grow rapidly, investments in the transmission system to deliver the energy to urban centres would be needed. This is being addressed in several programmes currently under development.

Solar Photovoltaic

Figure 16. **Solar Photovoltaic Capacity and Electricity Production**

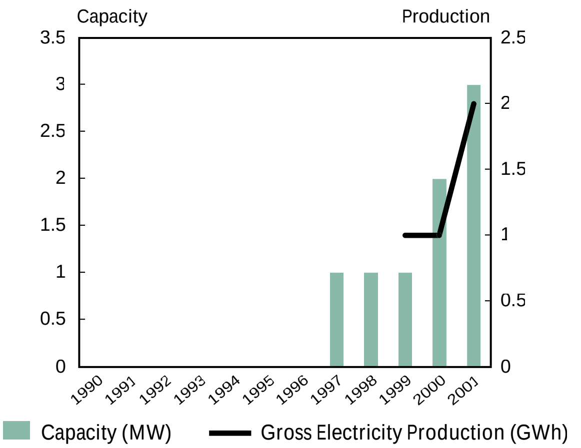
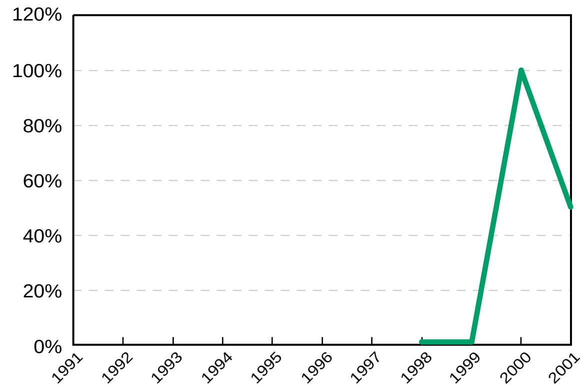
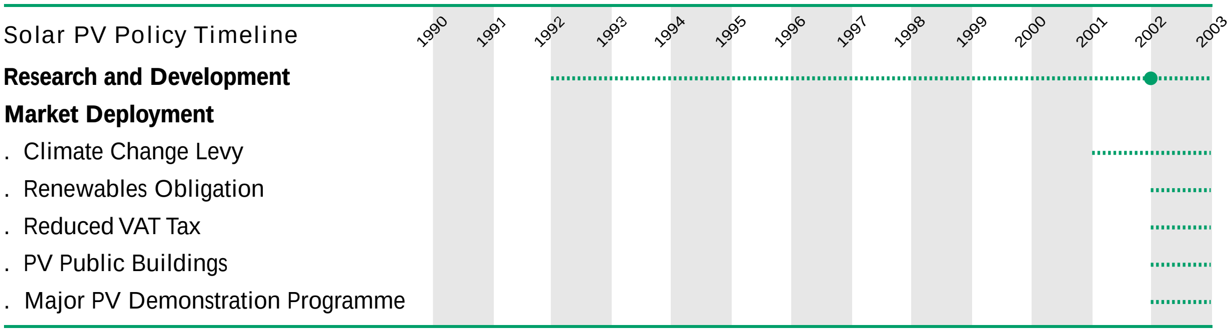


Figure 17. **Solar Photovoltaic Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

The first photovoltaic (PV) projects in the United Kingdom were demonstration installations, financed by EU and RD&D funds with an industry cost-share in 1997. In 2000 and 2001, new projects were installed bringing the total to just over 3 MW.

The focus of solar PV RD&D is building-integrated rooftop systems. These systems are believed to hold promise for the future despite the lack of a good solar regime, if costs can be brought down. In addition, the government is working towards increasing manufacturing capacity in view of the expectation of overseas sales.

The government has put in place a suite of policies to support PV, including a target and incentive tariff under the Renewables Obligation, a reduction in the value-added tax and a capital grants programme. In 2001 the government established a special programme for field trials, first for groups of residential dwellings and later for larger installations on public buildings to provide learning experience and to raise awareness. Launched in 2002 with a budget of £20 million, the Major PV Demonstration Programme (MDP) offers capital grants which are expected to decline from an average of 50% for two target areas: one for households, schools, community groups and small businesses and a second for housing groups, public organisations and large companies. In February 2004, the budget for the MDP was increased by £5 million to £25 million.

United Kingdom Policy Chronology

Non-Fossil Fuel Obligation

Year 1990-1998

Policy Description The Non-Fossil Fuel Obligation (NFFO) was the government's previous major instrument for encouraging growth within the renewable energy industry. The institutional framework was established as part of the 1989 Electricity Act. The NFFO in England and Wales and similar obligations in Scotland and Northern Ireland required electricity supply companies to secure specified amounts of new generating capacity from non-fossil sources, including renewables.

The NFFO process began with the government's announcement of proposals for an order covering specific technology bands. Five orders were carried out during the programme's span. The Non-Fossil Purchasing Agency (NFPA), an agent through which the electricity suppliers contracted collectively with renewable generators, issued bids for prospective schemes for specific technologies. Renewable energy generators competed in a tender process. Each scheme that passed a “will-secure” test submitted a final bid and the government then selected the cheapest schemes to secure the required capacity within each technology band. The renewables capacity was secured through contracts with generators at premium prices.

The guaranteed contractual price was made up of the pool price and a technology-specific premium. Additional costs incurred by the electricity suppliers under these contracts were financed through the Non-Fossil Fuel Levy. It was funded by all final electricity consumers as a levy on electricity consumption. The levy is also used to support nuclear power. The levy rate was set by the regulatory body each year, and in 2003 stood at 0.3% of the cost of fossil-fuel sources of electricity.

www.dti.gov.uk/energy/renewables/policy/nffo

Policy Type Bidding systems

RE Technology All renewables

UK Climate Programme

Year 2000 - Present

Policy Description The Climate Change Programme is the United Kingdom's central policy document setting out how the country intends to address the challenge of climate change and meet its twofold target. Under the Kyoto Protocol and EU's burden-sharing agreement, the United Kingdom is committed to reducing greenhouse gas emissions by 12.5% below 1990 levels by 2008-2010. But the government believes that the United Kingdom can and should go further and that there will be benefits from taking early action to cut emissions. Therefore, it has set a domestic target to cut the UK's emissions of carbon dioxide by 20% below 1990 levels by 2010.

The Climate Change Programme sets out a package of policies and measures in which all sectors of the UK economy play their part. Measures that impact renewable energy include:

- Climate change levy (described below).
- Establishment of the Carbon Trust to recycle approximately £100 million of climate change levy receipts to accelerate the take-up of cost-effective, low-carbon technologies and other measures by businesses and other levy payers.
- Exemption of "good quality" combined heat and power production and of renewables from the climate change levy.
- The Renewables Obligation (described below) requiring electricity suppliers to increase the proportion of electricity provided by renewables to 10% by 2010.

Policy Type Obligations

RE Technology All renewables

Energy Crops Scheme

Year 2000 - Present

Policy Description The Energy Crops Scheme is run by the Department for Environment, Food and Rural Affairs in partnership with the Forestry Commission, as part of the England Rural Development Programme. The scheme provides:

- Grants of: £1 600 or £1 000 per hectare for establishing short rotation coppice of either willow or poplar; and £920 per hectare for establishing miscanthus.
- Grants of up to 50% of the costs of establishing producer groups for short rotation coppice. Activities that may be eligible for assistance are: legal costs, office accommodation, office equipment purchase, IT equipment, recruitment costs and the purchase of harvesting machinery.

To be eligible, the crops must be grown for power generation, combined heat and power, or heat production. There must be evidence of an end use or market within a reasonable radius of the crop land. Applications are subject to environmental evaluations to ensure the environmental impacts are minimised.

www.dti.gov.uk/renew.eoi.htm

Policy Type Capital grants

RE Technology Biofuels

New Opportunities Fund - Financing Renewable Energy in the UK

Year

2000-2004

Policy Description

In 2000, the UK government announced a £260 million package for measures over 2001-2004 to stimulate renewable energy, comprising: £89 million towards capital grants to help develop offshore wind, energy crop power generation projects and small-scale biomass heating projects, through the New Opportunities Fund; grants for energy crops (short rotation coppice and miscanthus) of £ 2 million; an initial funding of £10 million to kick-start a major solar PV demonstration scheme; a further £100 million for new generation renewable energy technologies; and an expanded renewable energy research and development programme of £55.5 million. These measures are additional to the substantial boost for renewable energy coming from the Renewables Obligation and exemption from the Climate Change Levy.

Policy Type

Capital grants / RD&D

RE Technology

Offshore wind
Biomass
Biofuels
Solar photovoltaic

The Green Fuels Challenge

Year

2001 - Present

Policy Description

The Green Fuels Challenge aims to stimulate industry to develop practical proposals for alternative fuels. The budget in 2001 announced reductions on the duty on biodiesel and further reductions on the duty on road fuel gases. It also included duty reductions or exemptions for pilot studies for vehicles running on alternative fuels, in particular fuels for use in fuel cells, such as hydrogen and methanol.

Policy Type

RD&D

RE Technology

Hydrogen
Biofuels

Climate Change Levy

Year

2001 - Present

Policy Description

The Climate Change Levy is designed to promote energy efficiency and stimulate investment in new energy technologies. The levy is a tax on energy use in industry, commerce, agriculture and the public sector. It applies to gas, electricity, LPG and coal.

The levy is based on the primary energy content of the various fuels, not the carbon content. Levy rates are: £0.43/kWh for electricity; £0.15/kWh for gas; £1.17/kg for coal; and £0.96/kg for LPG.

Electricity generated from “new” forms of renewable energy, such as solar and wind power, and “good quality” combined heat and power plants are exempt. In addition to these, several other categories are exempt or have discounts related to the levy:

- Up to 80% discounts for businesses and energy-intensive industries that have Climate Change Agreements (negotiated agreements with the government to deliver specified energy savings).
- 50% discount for horticultural producers.

The levy package as a whole is designed to be broadly neutral for the manufacturing and service sectors. Revenues from the levy are recycled back to businesses via a 0.3 percentage point cut in the main rate of employers' National Insurance Contribution and additional support for energy efficiency measures. In 2001-2002, £50 million was available from the levy to support energy efficiency advice, promote the take-up of low-carbon technologies and to promote renewable energy projects. Some £200 million was expected to be available from the scheme in the 2001-2003 period.

www.dti.gov.uk/energy

Policy Type Fossil fuel taxes / Tax exemptions

RE Technology All renewables

Renewables Obligation

Year 2002-2027

Policy Description The Renewables Obligation Order came into force in 2002 and will remain in place until 2027.

The Renewables Obligation on electricity supply is the primary policy in support of the UK government's commitment to achieving the 10% target for electricity to be supplied from renewable sources by 2010. It is an obligation on all licenced electricity suppliers in England and Wales to supply a specified and growing proportion of their electricity sales from a choice of eligible renewable sources – with the ultimate aim of achieving 10% by 2010. (The Renewables Obligation Scotland is the equivalent instrument in Scotland.)

The Office of Gas and Electricity Markets (Ofgem) is responsible for monitoring and enforcing compliance with the Obligation. Their functions include accrediting renewable generators and issuing Renewables Obligation Certificates (ROCs).

As an alternative to supplying renewable energy, electricity suppliers may fulfil all or part of their obligation by paying the buyout price to Ofgem, which was set at £ 30/MWh to 31 March 2003 and is thereafter adjusted in line with the retail price index. Proceeds from the buyout fund are recycled and returned to the suppliers by Ofgem in proportion to the number of ROCs that each supplier presents to discharge its obligation.

A statutory consultation paper was issued in 2003 announcing a number of proposed changes to the Renewables Obligation that will be put before Parliament in 2004. The majority of the changes are technical adjustments to ensure the Obligation works as originally intended. Two of the more substantial changes include a relaxation of the rules on small generators and adjustments to the rules on the co-firing of biomass with fossil fuels.

A full review of the Renewables Obligation Order 2002 is planned for 2005/6.

The Renewables Obligations refers to the following technologies:

Landfill gas
Sewage gas
Energy from waste
- Only non-fossil derived energy is eligible.
- Energy from incinerating mixed waste is not eligible.
- Energy from the non-fossil derived element of mixed waste using advanced technologies is eligible.

Hydro <20MW
Onshore wind
Offshore wind
Co-firing of biomass with fossil fuels (revised proposals as detailed in The Renewables Obligation Amendment Order 2003)
- Any biomass can be co-fired until 31 March 2009 with no minimum percentage of energy crops.
- 25% of co-fired biomass must be energy crops from 1 April 2009 until 31 March 2010.
- 50% of co-fired biomass must be energy crops from 1 April 2010 until 31 March 2011.
- 75% of co-fired biomass must be energy crops from 1 April 2011 until 31 March 2016. Co-firing ceases to eligible for ROCs after this date.

Other biomass
Geothermal power
Wave and tidal power
Solar photovoltaics
Energy crops

www.dti.gov.uk/energy/renewables/policy

Policy Type Obligations / Tradable certificates

RE Technology All renewables

Demonstration and Testing of Wave and Tidal Technologies

Year 2002-Present

Policy Description The demonstration and testing programme for wave and tidal technologies makes £5 million available for grid-connected pre-commercial wave and tidal stream projects. The aim of this programme is to create a small niche market for marine renewables. This money is administered as part of the Department of Trade and Industry's New and Renewable Programme.

www.dti.gov.uk/renewables

Policy Type RD&D

RE Technology Ocean energy

New and Renewable Research and Development Energy Programme

Year 2002 - Present

Policy Description The New and Renewable Energy Programme supports pre-competitive research and development to help improve the understanding of the prospects for renewable energies and to improve their economic attractiveness. The current budget is about £18 million per year, awarded through a call and evaluation process. The programme presently supports industry-led R&D projects in the areas of: biofuels, fuel cells, photovoltaics, wind energy (primarily offshore) distributed generation (including energy storage), wave and tidal energy, and small-scale hydro.

Policy Type RD&D

RE Technology Biofuels
Hydrogen
Solar photovoltaic
Offshore wind
Onshore wind
Hydro
Ocean energy

Bio-energy Capital Grants Scheme

Year 2002 - Present

Policy Description The Bio-energy Capital Grants Scheme promotes the efficient use of biomass for energy, and in particular the use of energy crops by stimulating the early deployment of biomass-fuelled heat and electricity generation projects. It awards capital grants towards the cost of equipment and has a budget of £66 million.

Of this amount, £10 million will go to electricity generation and production from energy crops/wood fuel (focus on CHP): £18 million to demonstrate advanced energy crop technologies and £2 million for industrial heat produced by energy crops and forestry wood fuel. These funds are co-ordinated by the Department of Trade and Industry.

By 2006, £36 million is to be committed from the National Lottery New Opportunities Fund. Of this, £33 million will be allocated to energy crop power generation projects and £3 million will be allocated for heat and CHP projects using energy crops/biomass.

www.dti.gov.uk/renew/eoi.htm

Policy Type Capital grants

RE Technology Biofuels

Offshore Wind Capital Grants

Year 2002 - Present

Policy Description The key objective of this capital grants programme is to stimulate early deployment of a significant capacity of offshore wind. Support for these projects is targeted so as to help reduce both the costs and risks involved in offshore wind developments, and hence to maximise the contribution to the government's targets for renewable electricity supply. As such, the government will seek to ensure swift completion, making output from these projects available for electricity suppliers to respect their renewable obligation.

The Department of Trade and Industry's original funding of £64 million has been increased by £28 million and an additional £10 million has been provided through the National Lottery New Opportunities Fund.

The first round of the competition in 2002 granted two awards for a total of £2 million. The second round, later in 2002, awarded five grants for £42 million. The third round awards were announced in December 2003 and were expected to total close to £ 40 million. The grants cover up to 40% of eligible costs. Individual companies and consortia are eligible. Proposed projects must have an installed capacity of not less than 20 MW.

http://www.dti.gov.uk/energy/renewables/support

Policy Type Capital grants

RE Technology Offshore wind

Large-scale Field Trial: Building Integrated PV for Public Buildings

Year 2002 - Present

Policy Description This field trial was initiated to raise awareness and build confidence in PV applications, increase UK capacity to apply the technology, provide opportunities for local industry and assess the near-term potential for building-integrated PV. Projects were chosen through a tendering process to represent a wide range of technologies and applications. Projects providing the highest value through publicity, visits, information dissemination and marketing by the suppliers and installers were selected. The qualification criteria stipulated that: both project proposers and buildings must be public, the purpose must primarily be non-residential, arrays must be truly integrated and large scale (minimum 20 kWp).

The maximum grant for capital costs is £300 000, plus up to £20 000 for design and £40 000 for monitoring. The 18 successful projects with an increased budget of £4.2 million were announced on 18 March 2002.

Policy Type RD&D / Public awareness

RE Technology Solar photovoltaic

Reduced Value-added Tax

Year 2002 - Present

Policy Description Through this legislation, passed in 2002, VAT rates on the installation of solar panels have been reduced from 17.5% to 5% to correspond to the rate for domestic fuels. A similar reduced VAT rate is available for biofuels.

Policy Type Sales taxes

RE Technology Biofuels
Solar photovoltaic

Major PV Demonstration Programme

Year 2002 - Present

Policy Description A £20 million budget was allocated in 2002 to provide grants for the Major PV Demonstration Programme with the objective of preparing a secure platform for long-term and sustained growth of PV. In 2004 the funding level was increased by £5 million to a total of £25 million. Average capital grants of 50% were made available, though the level is expected to be reduced over the three years of the first phase.

Two types of grants are available:

- Stream 1 Grants – Small-scale individual applications (between 0.5 kWp and 5 kWp) that target households, small and medium-sized businesses and public and community groups such as schools.

Different grant amounts apply to bolt-on PV systems and integrated PV systems: bolt-on caps equals the lesser of £3 000/kWp or 50% of total eligible costs; integrated systems cap equals the lesser of £4 250/kWp or 50% of total eligible costs. The programme operates on a rolling basis with funds being allocated almost automatically provided the proposed installation meets certain basic criteria.

- Stream 2 Grants attract applications from housing groups, private developers, local authorities, large companies, etc. and are operated through a quarterly competitive call where criteria such as cost, level of integration, innovation and geographical location are taken into account. The grants are for medium to large scale applications (between 5 kWp and 100 kWp). Grants cover:

- up to 60% of eligible costs for public bodies.
- up to 50% of eligible costs for small to medium sized enterprises.
- up to 40% of eligible costs for large companies.

www.est.org.uk/solar

Policy Type RD&D / Capital grants / Consumer grants/rebates

RE Technology Solar photovoltaic

Renewable Energy Guarantee of Origin

Year 2003 - Present

Policy Description Implemented in 2003, the Renewable Energy Guarantee of Origin (REGO) electronic certificate system enables producers of renewable-sourced electricity that is eligible under the EU Renewables Directive to be issued with evidence (guarantees) that their electricity is indeed renewable.[3] Generators will be able to prove their green credentials at home and abroad as the scheme is based around mutual recognition between EU Member States. Although the certificates have no actual monetary value in and of themselves, they will prove useful for smaller generators and those who wish to conduct trade across national boundaries.

www.dti.gov.uk/energy/renewables/policy/directive

Policy Type Tradable certificates

RE Technology Onshore wind
Offshore wind
Solar photovoltaic
Geothermal
Ocean energy
Hydro
Biomass
Waste

Clear Skies Initiative

Year 2003 - Present

Policy Description Launched in 2003, Clear Skies provides grants and access to advice for household and community renewable energy projects.

Household grants can range between £500 and £5 000. Not-for-profit community organisations can receive up to £100 000 for grants and up to £10 000 for feasibility studies.

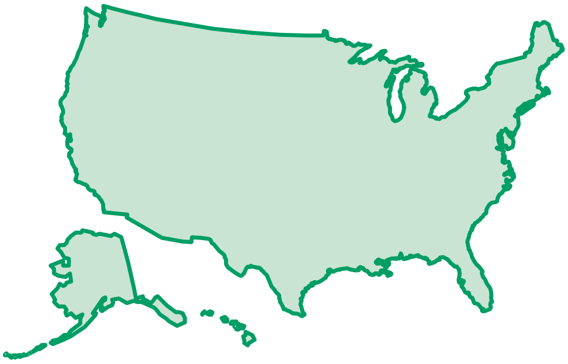
3. The EU Renewables Directive aims to promote a substantial increase in the proportion of electricity generated from renewable energy sources across the European Union by 2010. Individual Member States have all been required to take appropriate steps to encourage consumption of electricity from renewables, in order that the overall EU target of 12% energy (22.1% of electricity) by 2010 can be met.

	Clear Skies vets installers to ensure good quality of service. Applicants need to use registered installers and products that are listed by Clear Skies.
	www.Clear-Skies.org
Policy Type	Consumer grants/rebates
RE Technology	Solar thermal, Onshore wind Offshore wind Hydro Biomass

Industry Promotion and Information Development

Year	2003 - Present
Policy Description	This programme aims to strengthen the renewables industry and the use of renewable energy sources in the United Kingdom. It is currently seeking shared-cost proposals for effective industry promotion and information development projects that will support UK renewable industry development in domestic and international markets. Proposals are due in May 2004.
	www.dti.gov.uk/energy/renewables
Policy Type	Public awareness
RE Technology	All renewables

The United States



Total Primary Energy Supply

Figure 1. **Total Primary Energy Supply by Source**

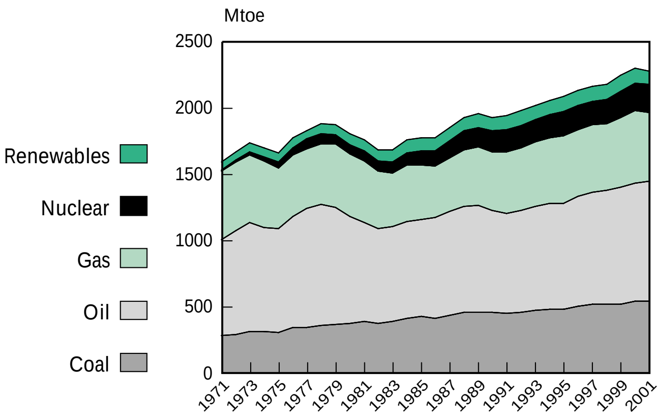
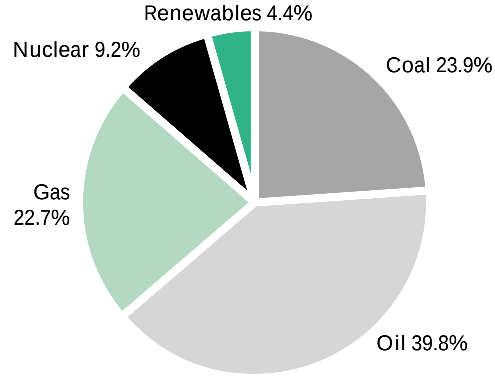


Figure 2. **Shares of TPES 2001**



Shares in Figure 2 may differ from Table 1.
See Annex 2 for more detail.

Table 1. **Total Primary Energy Supply by Source (Mtoe)***

Source	1970	1980	1990	1995	2000	2001	Imports
Coal	291.4	376.2	458.3	478.1	541.7	544.7	•
Oil	703.6	803.9	770.2	801.5	892.5	903.7	63.4%
Gas	499.0	476.8	439.4	508.5	548.8	517.4	16.2%
Nuclear	6.1	69.4	159.4	186.0	207.9	210.6	—
Renewables	57.1	83.1	100.5	108.2	105.9	99.1	—
Biomass	*35.1*	*54.5*	*62.3*	*67.5*	*69.1*	*67.0*	
Hydro	*21.5*	*24.0*	*23.5*	*27.0*	*21.8*	*17.3*	
Geothermal	*0.5*	*4.6*	*14.1*	*13.3*	*13.1*	*12.9*	
Wind/Solar	*0.0*	*0.0*	*0.3*	*0.3*	*2.0*	*1.9*	
Total	**1 557.4**	**1 811.6**	**1 927.6**	**2 088.5**	**2 303.8**	**2 281.4**	**26%**
% Renewables	*3.7%*	*4.6%*	*5.2%*	*5.2%*	*4.6%*	*4.4%*	

* *See Annex 2 for explanation of components in total and definition of biomass.*
• *Net Exporter*

Total primary energy supply (TPES) in the United States increased from 1 557 Mtoe in 1970 to 2 281 Mtoe in 2001, an average annual growth of 1.2%. Oil is the dominant fuel in primary energy supply. In 2001, the share of oil in TPES was 40%. Coal, at 24% of TPES in 2001, is the principle resource for electricity generation. Coal demand grew by an annual average of 2% from 1970 to 2001. Natural gas use fell by more than 23% from 1970 to 1986, but increased by 43% from 1986 to 2000 because of increased use in industry and for electricity generation. The overall share of natural gas in TPES was 23% in 2001. Nuclear power represented 9% of TPES in 2001. Renewable energy sources accounted for about 4.4% of total energy supply in 2001, after peaking in the early 1990s at about 5.2%.

Total renewable energy supply increased from 57 Mtoe in 1970 to 100 Mtoe in 1990, corresponding to an annual average growth of 3.8% in the 1970s and 1.9% in the 1980s. Renewable supply increased to

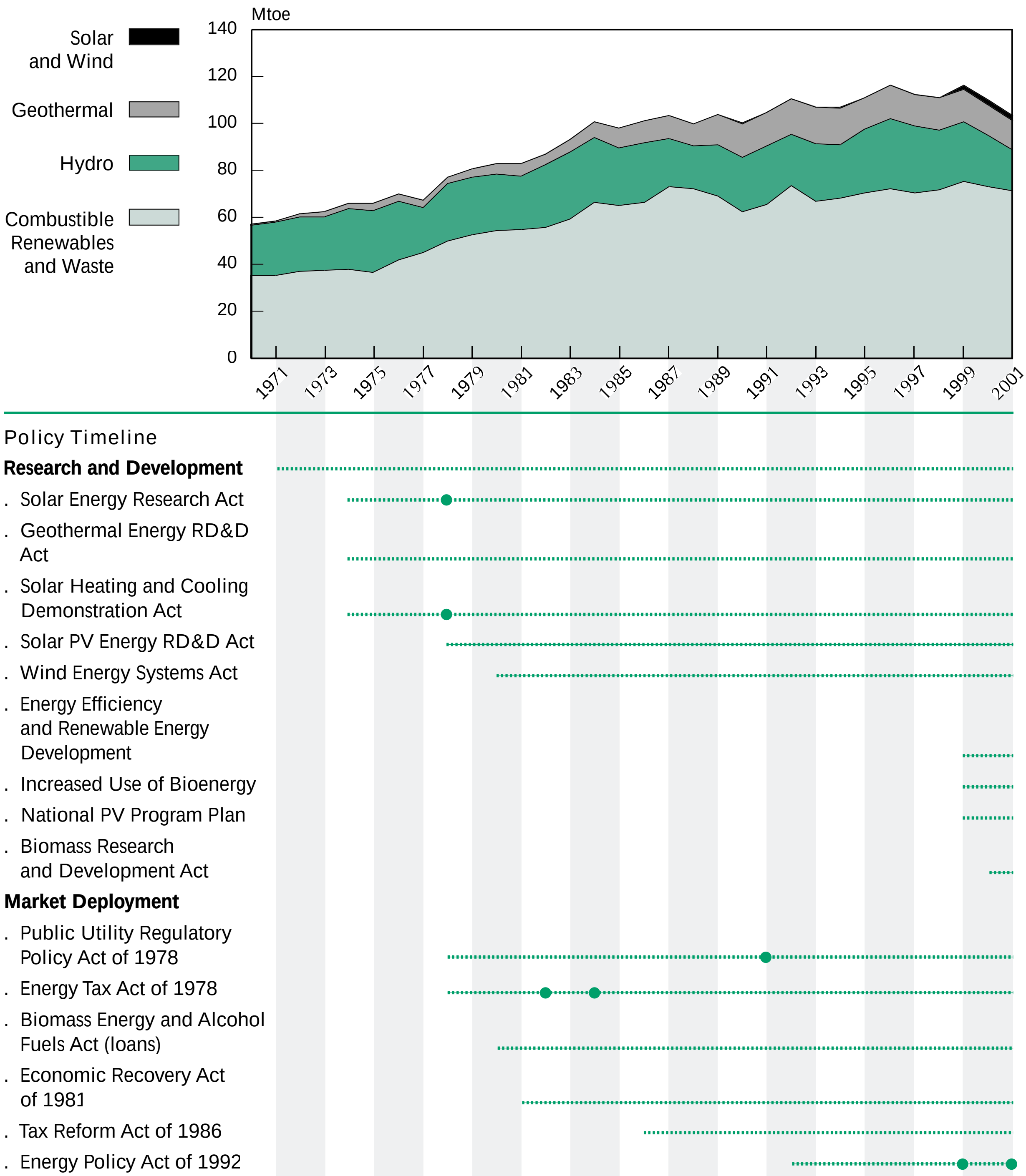
108 Mtoe in 1995, but subsequently decreased to 99 Mtoe in 2001. The decline in renewables was mostly due to a significant reduction in hydropower generation. Hydropower production declined for multiple reasons, including climate variability, environmental regulations, its exclusion from renewable energy policy incentives and lack of investment. Biomass and hydropower accounted for about 85% of the total renewables supply in 2001. Biomass use grew significantly from 1975 through the mid-1980s as the pulp and paper industry substituted the use of waste fuels for fossil fuels during the “energy crisis” period, but has levelled off and even declined in recent years. Of notable exception is the use of fuel ethanol derived primarily from corn, which increased to 2.8 billion gallons in 2003 from 0.9 billion gallons in 1990. Energy production from geothermal resources accounted for 13% of renewable energy supply in 2001.

Coal dominates electricity generation in the United States, accounting for more than half of total generation in 2001. Nuclear energy accounted for about 20%. Gas is rising in importance and accounted for 16.7% of electricity generation in 2001. Renewables accounted for about 7% of electricity generation. Hydropower has been an important component of domestic electricity supply, but its share in the generation mix has declined. Hydropower lost more than one-third of its production between 1995 and 2001. Because hydropower capacity is no longer expanding, annual production trends are more susceptible to year-to-year climatic changes. Hydropower represented 69% of electricity generation from renewables in 2001, and biomass accounted for about 16%. Geothermal, wind and solar energy contributed the remainder.

More than one-fourth of the energy used in the United States comes from imported sources. The United States imports more than 60% of its petroleum needs and net imports of natural gas have been rising.

Renewable Energy Supply

Figure 3. **Total Renewable Energy Supply and Policy Timeline**



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Biomass and hydropower accounted for most of renewable energy use prior to 1970, although there were a few commercial geothermal plants in operation. Hydropower became an important electricity source in the first half of the century as the federal government constructed dams for water supply and control and power generation. Many large-scale sites were developed by 1970, although capacity has continued to increase due to the installation of many small hydropower facilities.

Biomass use prior to 1970 was dominated by wood burning for heat. However, from 1970 to 2000, wood burning declined and other uses increased. By 2001, nearly two-thirds of the biomass contribution was black liquor and wood wastes used in the pulp and paper industry to produce steam and electricity. Additional important uses of biomass include electricity generation from wood, waste fuels, and biogas, and ethanol derived from corn. Geothermal energy grew rapidly in the 1970s and 1980s due to the development of several sites in California. Other renewables began to see commercial development in the 1990s including wind power and solar energy. These market patterns were the result of volatility in the costs of fossil energy, combined with policy actions to develop and deploy renewable energy technologies. The interaction between federal and state policies is particularly important in the United States.

Table 2 shows net generating capacity of renewables in the United States from 1990 to 2002. The data are from the Energy Information Administration of the US Department of Energy. Wind capacity exhibited the fastest growth over the period. Preliminary estimates of the breakdown of biomass capacity in 2002 are 5 886 MW of wood and wood waste, 3 308 MW of MSW and landfill gas and 539 MW of other biomass.[1]

Table 2. **Net Generating Capacity of Renewables (MW)**

	1990	1995	1998	1999	2000	2001	2002
Hydroelectric	73 964	78 563	79 151	79 393	79 359	79 484	79 842
Geothermal	2 669	2 968	2 893	2 846	2 793	2 216	2 216
Biomass	8 796	10 280	10 495	10 454	10 024	9 709	9 733
Solar PV	339	333	335	389	386	392	392
Wind	1 911	1 731	1 720	2 252	2 377	3 864	3 982
Total	**87 679**	**93 874**	**94 595**	**95 335**	**94 939**	**95 664**	**96 165**

Source: Data refer to US net summer capacity in the power sector. Capacity for 1990 and 1995 is from Renewable Energy 2000: Issues and Trends (DOE/EIA). Capacity for 1998 to 2002 is from Renewable Energy Annual 2002 (DOE/EIA). 2002 data are preliminary.

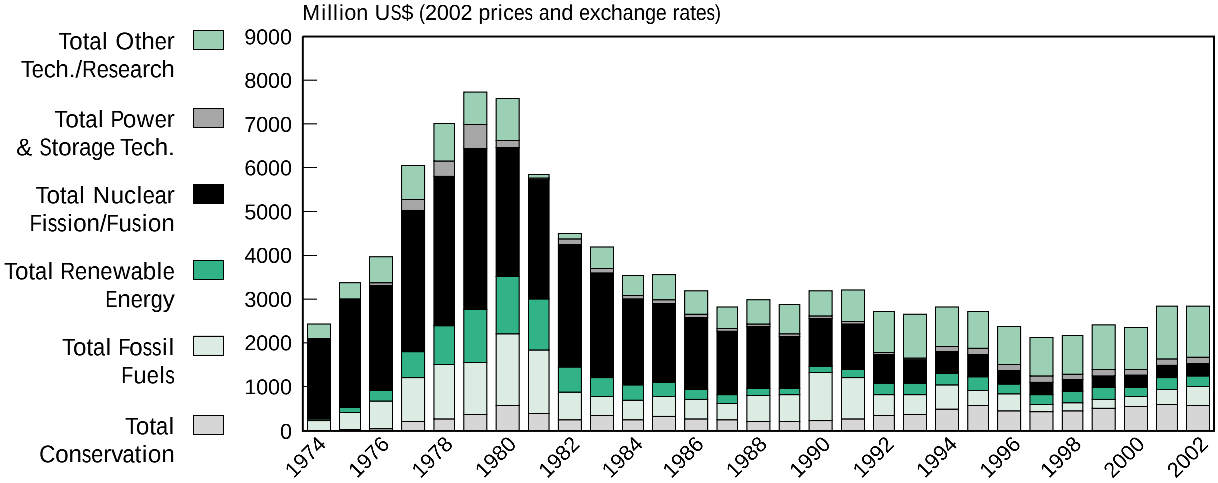
Research and Development Trends

The United States spent a total of $106 billion on government energy RD&D between 1974 and 2002. In this period, 10.4% of the total RD&D budget was allocated to renewable energy RD&D.

Energy RD&D has been dominated since 1974 by funding for nuclear energy, followed by funding for fossil fuels. Funding for energy technologies peaked in 1979, when the budget reached more than $7.7 billion, of which just over $1.2 billion went to renewables. The share of renewable energy RD&D has varied considerably since 1974, but has been in the 20% range since 1992.

1. *Other biomass includes agricultural residues, sludge waste, tires, and other biomass solids, liquids and gases.*

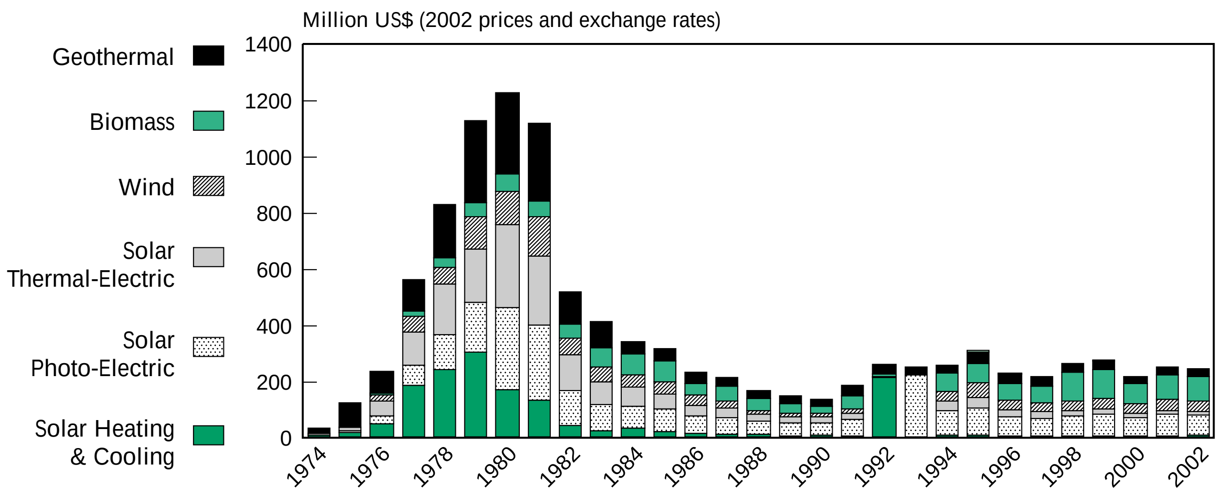
Figure 4. **United States - Government Energy RD&D Budgets**



Among the renewable technologies, solar photo-electric received the highest level of funding at $2.6 billion, or 23%, in the 1974 to 2002 period. Geothermal was funded at $2.2 billion, representing 20% of renewable energy RD&D. Solar heating and cooling and biomass were the next largest recipients with approximately 13% each of the renewable RD&D expenditures from 1974 to 2002.

In response to the oil price crises, the United States instituted aggressive RD&D programmes for renewables in 1974, including the Solar Energy Research Act, which authorised funding for solar and wind research and development, the Geothermal Energy Research, Development and Demonstration Act and the Solar Heating and Cooling Demonstration Act. In 1978, the solar programme was re-organised and funding was increased for solar technologies. The Wind Energy Systems Act of 1980 provided funding for wind RD&D. The re-authorisation also included funding to support demonstration projects, which was a key factor in promoting the early wind power projects in California.

Figure 5. **United States - Government Renewable Energy RD&D Budgets**



After the peak in 1980, funding for renewable energy technologies dropped significantly from about $1.3 billion in 1980 to $560 million in 1981 and to just under $140 million in 1990. Since then, funding has stabilised at more than $200 million, although there have been shifts in priorities between the different technologies.

Market Deployment Trends

The primary instrument for market deployment of renewables at the federal level has been tax policy. In 1978, the Energy Tax Act (ETA) created a programme of tax credits for households and businesses purchasing alternative energy equipment. Residential energy income tax credits for the purchase of solar and wind energy equipment were set at 30% for the first $2 000 invested and 20% for the next $8 000. The most important electricity sector incentive was the creation of a 10% business energy tax credit for investments in solar, wind and geothermal. This credit was in addition to the standard 10% investment tax credit, which was available for all types of equipment. Public utility property was specifically excluded from eligibility for the tax credits. These credits were originally set to expire at the end of 1982, but were extended several times. The tax credit for wind energy projects did expire in 1985. The 10% business energy tax credit for solar and biomass was eventually made permanent in the Energy Policy Act of 1992. However, the uncertainty of the continued availability of these incentives throughout the late 1980s proved devastating for the only United States developer of solar thermal electric projects.

The ETA also established an excise tax exemption of $0.04 per gallon of blended gasoline for alcohol fuels (ethanol and methanol), equivalent to the full value of the excise tax at that time. The credit was set to expire in 1984 but has been extended several times at different levels.

In 1980, the Biomass Energy and Alcohol Fuels Act provided loan guarantees for biomass and alcohol fuels projects, and the Crude Oil Windfall Profits Tax Act expanded the residential and business tax credits. Projects based on wind, solar PV and geothermal were also eligible for accelerated tax depreciation under the Economic Recovery Act of 1981. In 1986, the Tax Reform Act repealed some of these provisions, and scaled back others, as lower fossil prices reduced the perceived need for alternative energy sources.

In 1992, the Energy Policy Act (EPACT) supported renewables in three ways:

- Permanent extension of the 10% business investment tax credit for solar and geothermal;
- New Federal Renewables Production Tax Credit (PTC) for wind and closed-loop biomass was available to investor-owned utilities and non-utility generators for up to ten years for electricity produced in plants brought on-line before 1 July 1999. The programme was extended twice, but expired at the end of 2003.
- New Renewable Energy Production Incentive (REPI) payment was available to publicly-owned utilities that were not eligible for the production tax credit. The REPI applied to solar, wind, biomass (excluding MSW) and geothermal (excluding dry steam) and was subject to annual appropriations by the US Congress. Annual appropriations fluctuated but totalled more than $26.5 million from fiscal year (FY) 1994 to FY2002. The programme was administered by the US Department of Energy. It expired in September 2003.

While the PTC was successful when in place, the “on and off” nature of its availability was disruptive to the steady pace of market development, as industry rushed to complete projects before the incentive expired, and then waited to see if it would be re-authorised.

In addition to the basic tax strategy, the Farm Security and Rural Investment Act of 2002 provided grants, loans, and loan guarantees. Funding of $115 million is being allocated over a five-year period to support renewable energy development in rural areas. The funds can be used by farmers, ranchers and rural small businesses to purchase and install renewable energy systems and make energy efficiency improvements. The grants cannot exceed 25% of a project's cost with a combined grant and loan (or loan guarantee) not to exceed 50%. The funding programme is managed by the US Department of Agriculture. The effect of this programme has not yet been seen in the market.

In addition to tax measures, renewable energy developers in the United States have benefited from administrative interventions. The most important federal intervention in support of renewables is the Public Utility Regulatory Policies Act of 1978 (PURPA), which established a system of guaranteed pricing for qualifying renewable energy facilities. In the early years of implementation, the prices paid for the renewable power were pegged to high oil prices, which stimulated new renewables development. The law also required electric utilities to interconnect with and provide non-discriminatory backup power to qualifying facilities and provided exemptions from certain federal and state utility regulatory requirements. As a result of PURPA, more than 12 000 MW of renewable energy projects were interconnected to the electricity grid by the end of 1998. Although the law remains in effect, the guaranteed prices currently offered by utilities are generally too low to support new project development as a stand-alone policy.

State-Specific Policies

State policies have been important in supporting or augmenting federal policies. For instance, implementation of the federal PURPA law was left to the states with some, such as California, pursuing a more aggressive implementation than others. And a number of states and local administrations provided industrial development support to manufacturers in the form of tax benefits, grants, loans and loan guarantees.[2]

In many cases, states have acted independently of the federal government to encourage renewable energy development. For smaller-scale generators, an important administrative intervention has been net metering. These policies, which started in the late 1990s, have been entirely state-driven. At least 37 states allow some type of net metering, which allows small customer generators to "bank" any excess electricity generated from qualifying systems for later use. The customer pays only for the electricity used "net" of the electricity generated over the entire billing cycle. Net metering also allows customer-generators to maximise the value of their production because it is valued at retail prices. Net metering has been very important for encouraging PV systems. In California, for example, 50 MW of PV have been installed using net metering in combination with other policies. Net metering programmes have also been important for the development of small wind systems and for producers of biogas from anaerobic digesters.

Thirteen states have adopted a renewables portfolio standard (RPS), which is a statutory requirement on retail electricity suppliers to supply a minimum percentage or amount of their retail load from eligible renewable energy sources. Fifteen states have established renewable energy funds, which are financed through a system benefits charge (SBC) collected from all customers, with the funds used to support renewable energy development.

2. See www.dsireusa.org for a comprehensive and searchable list of state incentives for renewables.

Renewable Energy Markets

Hydropower

Figure 6. **Hydropower Capacity and Electricity Production**

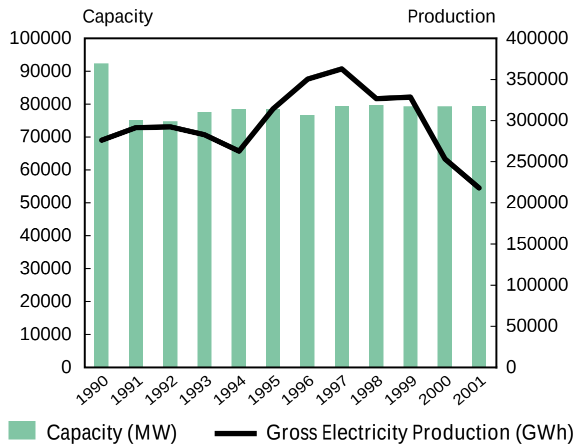
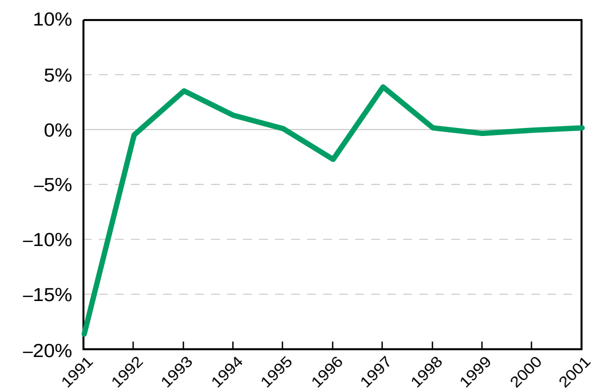
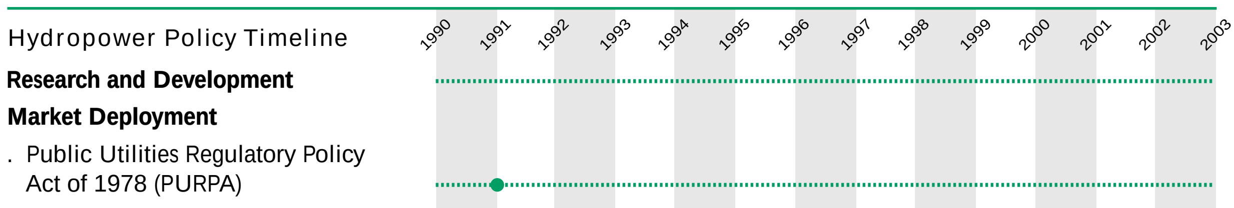


Figure 7. **Hydropower Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Hydropower capacity, excluding pumped storage, hovered at 80 GW from 1991 to 2001. Electricity production, however, has fallen considerably from 363 TWh in 1995 to 218 TWh in 2001. Electricity production declined partly due to climate variability and environmental regulations. But its decline has also been attributed to the exclusion of hydropower from most renewable energy policy incentives. This exclusion has resulted in a lack of investment in new hydropower developments. The Energy Information Administration of the US Department of Energy (USDOE) estimates that hydropower generation was 264 TWh in 2002.

Hydropower is the most mature renewable electricity generation source in the United States. Large hydropower plants were developed in the first half of the twentieth century, with substantial grants and low-interest loans provided by the federal government. Many were public works projects, and were developed as much for flood control and water resource management as for energy. Federal and state policies have not focused on stimulating additional growth in hydropower development, although the Public Utility Regulatory Policies Act did provide some stimulus for development of small-scale hydro sites. Hydropower capacity in the Unites States is split evenly between federal and state projects.

The US hydro programme is currently focussed on increasing existing capacity. This requires dealing with the re-licensing of many plants that have reached the limit of their permits, as well as optimising existing hydropower operations. There remains considerable resource availability in small-scale systems. USDOE estimates that as much as 30 GW could be developed in run-of-river facilities, by re-powering current plants with improved technology, and by installing generation equipment on dams that do not currently produce power.

RD&D funding has been modest, and is now focussed on the development of environmentally improved turbines for large hydro installations, and on alleviating the problem of dissolved oxygen downstream from the plants. Another technical issue that is gaining attention is the use of hydropower in conjunction with wind power to overcome wind intermittency. The Bonneville Power Administration, a federal power marketing authority in the Pacific Northwest, has recently announced new programmes that adjust hydropower operations to better integrate with wind power plants. The marginal cost of this service is under $0.005/kWh, considerably less than was anticipated.

Bioenergy Production

Biomass use, including bioelectricity, biofuels and bio-heat use, grew by about 7.5% from 1990 to 2001, from 62.3 Mtoe to 67 Mtoe. Biomass represented 62% of renewables in 1990, rising to about 68% in 2001.

Biogas production was 137 350 TJ in 2001, up from 28 136 TJ in 1992 (Figure 8). Electricity generation from solid biomass increased from an estimated 34.7 TWh in 1990 to 36.8 TWh in 2001 (Figure 9). Most of the growth took place in the early 1990s and electricity production from solid biomass has stagnated since 1995. The US Energy Information Administration reports that electricity generation from solid biomass was 35.2 TWh in 2001 and 36.5 TWh in 2002.

Electricity generation from biogas sources, particularly landfill methane, has been stimulated by a combination of PURPA, a federal tax credit for gas produced from non-conventional sources, known as the "Section 29" tax credit, and more recent environmental regulations requiring landfill operators to control methane emissions. Landfill methane-based electricity generation also benefits from the voluntary market for green power. The Section 29 credit, which was set at $ 0.52 per mmBtu in 1980 and adjusted for inflation, had reached a value of more than $ 1.00 per mmBtu of gas produced by the time it expired in 1998. Since the expiration of the credit, growth in new landfill methane facilities has slowed.

The majority of biomass electricity capacity is in the paper and forest products industry, which has a ready supply of biomass fuels available such as waste by-products including spent pulping liquors, wood chips, sawdust and other residues. PURPA allowed many companies to sell excess electricity to utilities but also stimulated new biomass capacity growth during the 1980s and early-1990s by non-utility companies using a number of different biomass feedstock materials. New capacity growth has slowed since this time because the prices that utilities are required to pay for alternative power generation have fallen. Although new "closed-loop" biomass facilities are eligible to receive a federal production tax credit, no facilities of this kind have been developed since the incentive was established in 1992.

Several new policies, at both the federal and state levels, are directed at re-kindling biomass growth. At the federal level, the Farm Bill of 2002 contained an energy title (Title 9) that includes grants and loan guarantees to growers and small businesses in rural areas. Also, the Healthy Forests Reconstruction Act of 2003 is expected to make available a substantial amount of biomass resources to be culled from forests for fire protection. Some amount of this resource might be economically used for energy production. Many states have qualified bioelectricity under their RPS or SBC programmes.

Figure 8. **Biogas Capacity and Production**

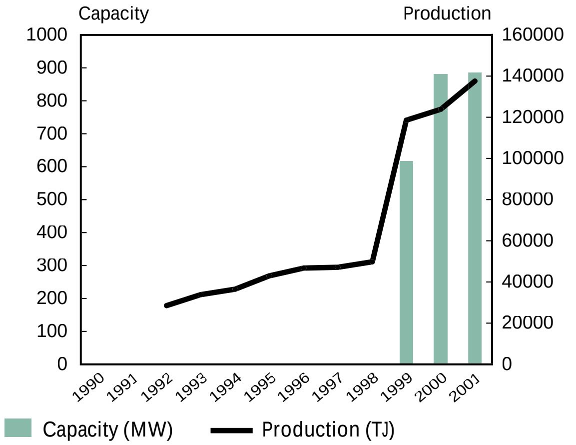
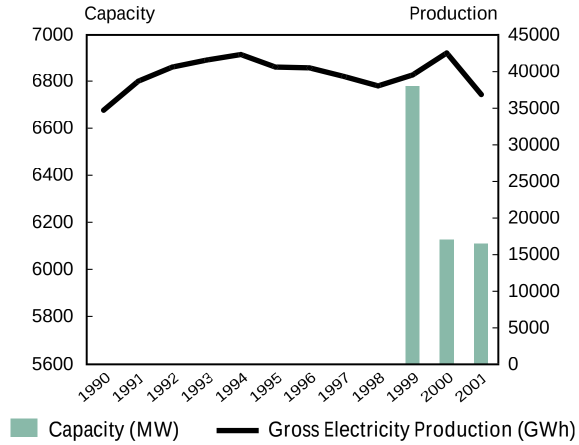
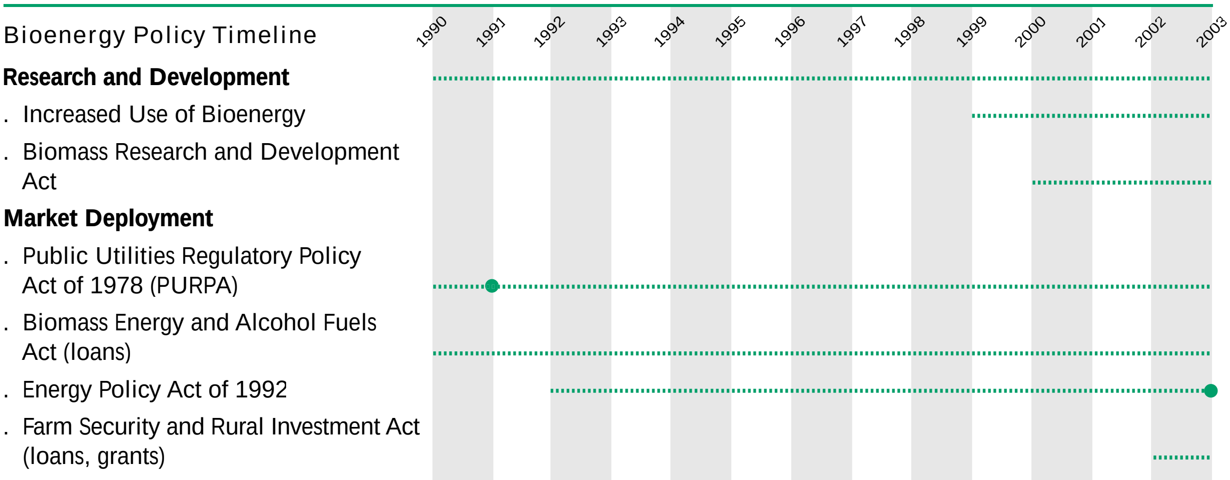


Figure 9. **Solid Biomass Capacity and Electricity Production**





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

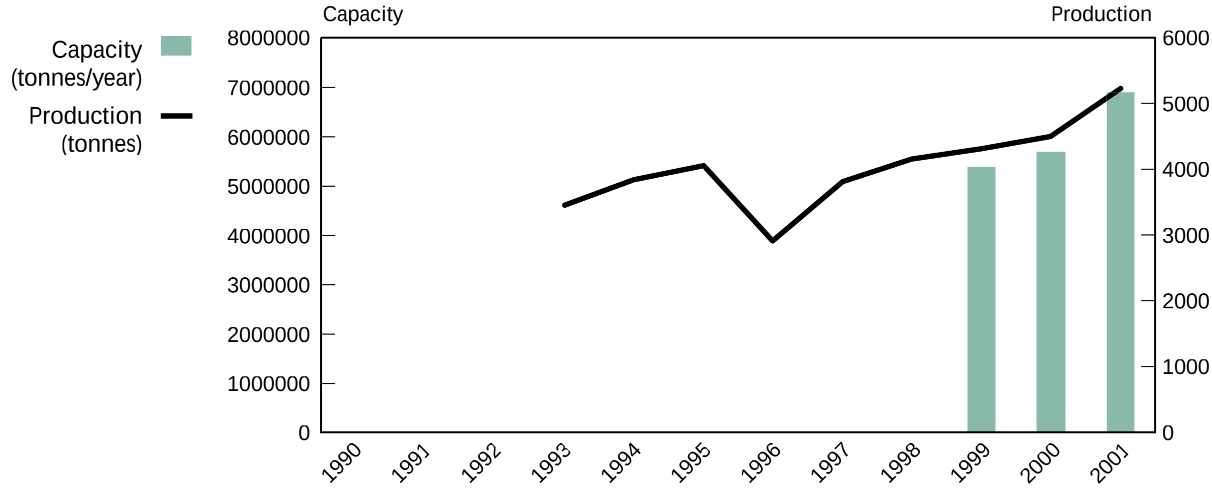
Note: Capacity data are not available for bioresources before 1999.

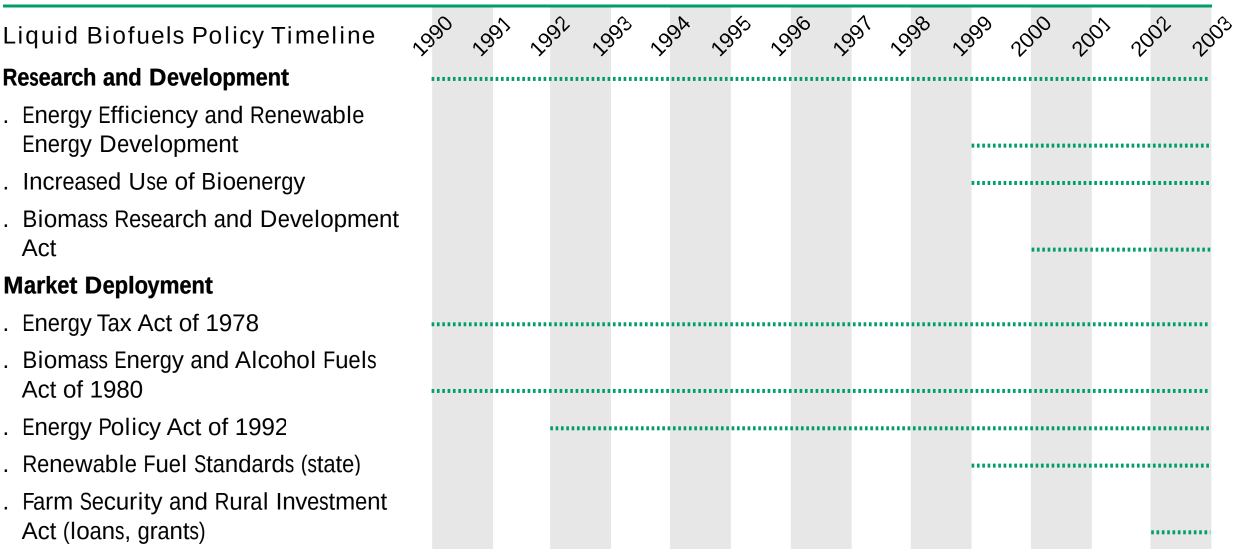
Liquid Biofuels Production

The main liquid fuel derived from biomass is ethanol, produced primarily from corn feedstock. Ethanol production has increased considerably over the past couple of years and is a significant contributor to US transportation fuels, particularly in the Midwest.[3] The US Renewables Fuels Association reports that ethanol production increased from 900 million gallons in 1990 to 2 130 million gallons in 2002. Production in 2003 is estimated to be 2 810 million gallons.

3. Further information about recent trends in ethanol production in the United States is available at www.ethanolrfa.org.

Figure 10. **Liquid Biofuels Capacity and Production**





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

In response to energy security and environmental concerns, US energy policy has strongly encouraged the market for biofuels. Since 1978, bio-ethanol production has benefited from a partial exemption from the federal excise tax on gasoline blended in prescribed portions with ethanol. A small number of ethanol production projects also received federal loan guarantees in the 1980s.

In the early 1990s, a combination of mandates and tax exemptions supported the biofuels market in the United States. The 1990 Clean Air Act Amendments required gasoline sold in "carbon monoxide (CO) non-attainment areas" to contain 2.7% oxygen. Further, the 1992 Energy Policy Act (EPACT) encouraged the use of "alternative fuels". EPACT requires that, for federal and state fleets, at least 75% of new vehicles purchased annually be alternative fuel vehicles. Within the EPACT, the voluntary Clean Cities Program created local markets for alternative fuel vehicles through the development of fleets of low blend and ethanol E85 vehicles, primarily in mid-western cities close to ethanol production plants. In addition, the reformulated gasoline (RFG) programme in 1995 required cleaner-burning reformulated gasoline to be sold in the nine worst ozone non-attainment areas in the United States. About forty more cities have voluntarily adopted the RFG programme.

Requirements for RFG will continue to increase demand for ethanol as an oxygenate, mainly because methyl tertiary butyl ether (MTBE), a previous oxygenate, is being phased out in several states. In California, New York and Connecticut, MTBE bans are already in effect. Largely due to the phase-out of MTBE, ethanol production increased by 32% in 2003.

A proposal has been made for a national Renewable Fuel Standard (RFS). Minnesota is currently the only state with a requirement for 10% ethanol.

Taxation of motor fuels in the United States is applied both by the federal and state governments. For ethanol there is a federal excise tax exemption of $0.052 per gallon of 10% ethanol blended gasoline (which equates to $0.52 per gallon of ethanol). This excise tax exemption applies pro-rata to gasoline blends of 10%, 7.7% and 5.7% ethanol (the lower concentrations correspond to 2.7% and 2% weight oxygen, required by the 1990 Clean Air Act amendments). Some states have partial tax exemptions, particularly in ethanol-producing areas. As of 2002, Idaho had a $0.025 credit for a 10% gasoline/ethanol blend, ($0.25 per gallon of ethanol). Some states have a discount sales tax on ethanol sales and some provide direct support to ethanol producers. Unlike the excise tax exemption, the income tax credit of $0.52 per gallon of ethanol does not depend on the blend percentage. The income tax credit has a number of restrictions and must be reported as gross income. The excise tax exemption and the income tax credit are set to expire in 2007.

Geothermal Electricity Production

Electricity generation from geothermal resources was 14.3 TWh in 2001, accounting for some 5% of total renewables generation. Geothermal capacity was 2.2 GW in 2001. Both capacity and electricity generation from geothermal resources have declined since the early 1990s. Most of the decline is due to a drop in pressure at The Geysers, the largest geothermal reservoir in the United States. The Energy Information Administration reports that electricity generation from geothermal resources was 13.4 TWh in 2002.

The earliest use of geothermal energy in the United States was a district heating plant in Boise, Idaho, in 1891, followed by other direct use applications in many western states. The earliest geothermal electric plant in the United States was only a few kilowatts in size, used by a small resort in 1924 in the region of northern California called The Geysers. In the 1950s, further drilling located the main steam reservoir of The Geysers, and planning for a larger plant commenced. In 1960, the first production well of 12 MW came on-line, and by 1970, the total had reached 70 MW. During the next two decades, growth took off, by 1980 the total installed capacity had reached 943 MW, and by 1990 more than 2 000 MW were installed, based on high-temperature, dry steam resources. The Geysers remains the largest geothermal development in the world. Development of The Geysers in the 1970s was supported by the Geothermal Steam Act (Public Law 91-581) that authorised the Secretary of Interior to issue leases for the development and use of geothermal steam and associated geothermal resources on federal land. Further support came from the Geothermal Energy Research, Development and Demonstration Act of 1974, which included a loan guarantee programme to assist in the commercial development of geothermal resources.

Figure 11. **Geothermal Capacity and Electricity Production**

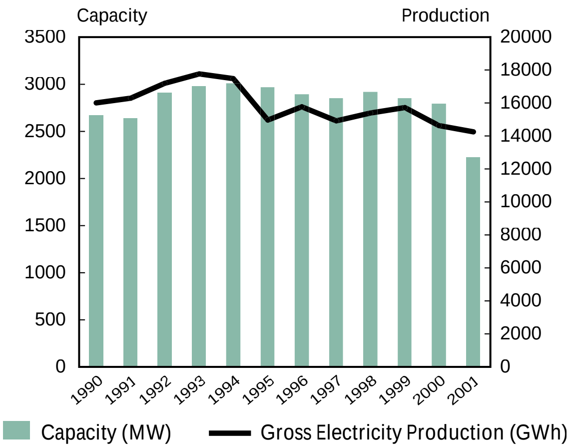
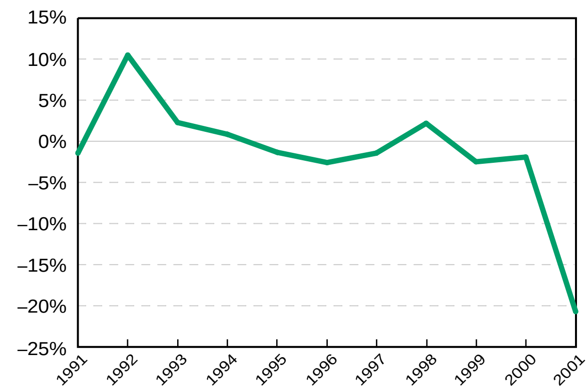
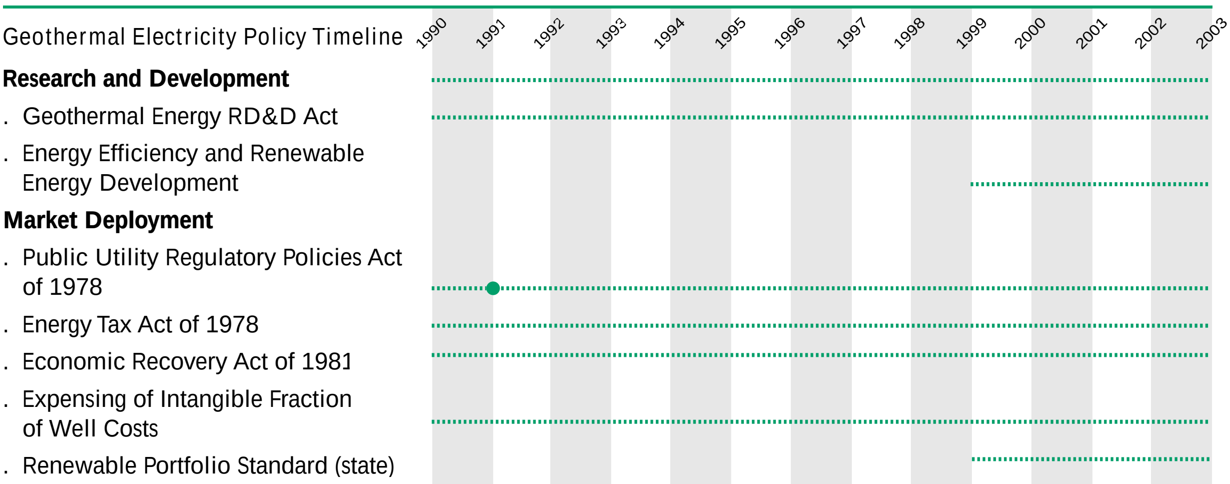


Figure 12. **Geothermal Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

With the advent of PURPA in 1978, which provided for guaranteed long-term power purchase contracts at favourable rates, and the Energy Tax Act of 1992, which provided federal investment tax credits, non-utility companies began to develop high-temperature, hydrothermal resources in other areas of California as well as in other western states. The first of these was a 10 MW plant at Brawley, California in 1980, followed by the Puna project in Hawaii in 1981 and later other power plant projects in Nevada, Utah, and California. A permanent 10% energy tax credit for businesses installing new geothermal projects was established in The Energy Policy Act of 1992, but this credit cannot be used by public utilities. Geothermal power plants also qualify for accelerated tax depreciation. In combination, these policies have resulted in more than 2 400 MW of electric generation capacity in California, 400 MW in Nevada, 40 MW in Utah, and 35 MW in Hawaii.

In the late 1990s, generation from The Geysers began to decline due to a drop in pressure in the steam reservoir. To overcome this, a partnership of government and private sector agencies designed and built a pipeline to deliver and inject eight million gallons of treated wastewater per day into the reservoir to increase the pressure. This project was successful and production rose again. A second pipeline was built and began delivering treated wastewater to The Geysers in late 2003.

More recently, state efforts to re-kindle growth in geothermal has focused on RPS programmes in Arizona (2001), California (2003), Nevada (2003) and New Mexico (2004). Arizona qualified a proposed project through a variance requested by a utility. These programmes have led to the planning of about 400 MW of new projects, but none of these had come on-line by the end of 2003.

In addition to power generation, more than 600 MWt of geothermal heat capacity is used for industrial and agricultural purposes, such as for district heating, food processing, greenhouses, space heating and aquaculture (not shown in Figure 11). Most of these direct use applications are in the western United States.

There do not appear to be major issues with public or utility acceptance of geothermal energy, except in some areas where indigenous people consider geothermal drilling to violate local cultural norms.

Wind Power

Figure 13. **Wind Power Capacity and Electricity Production**

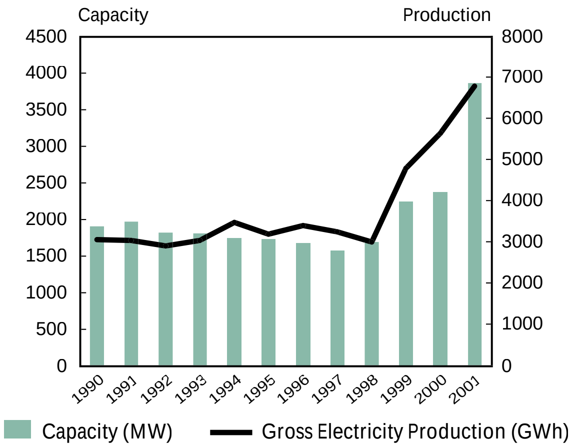
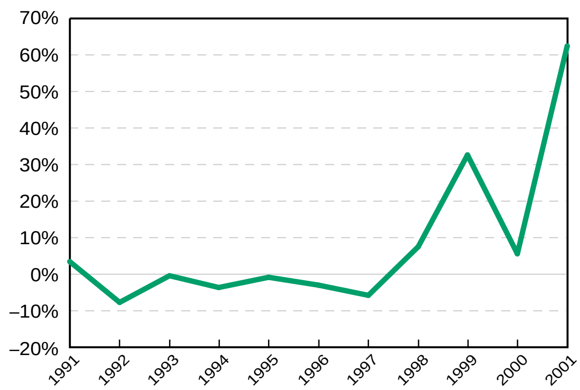
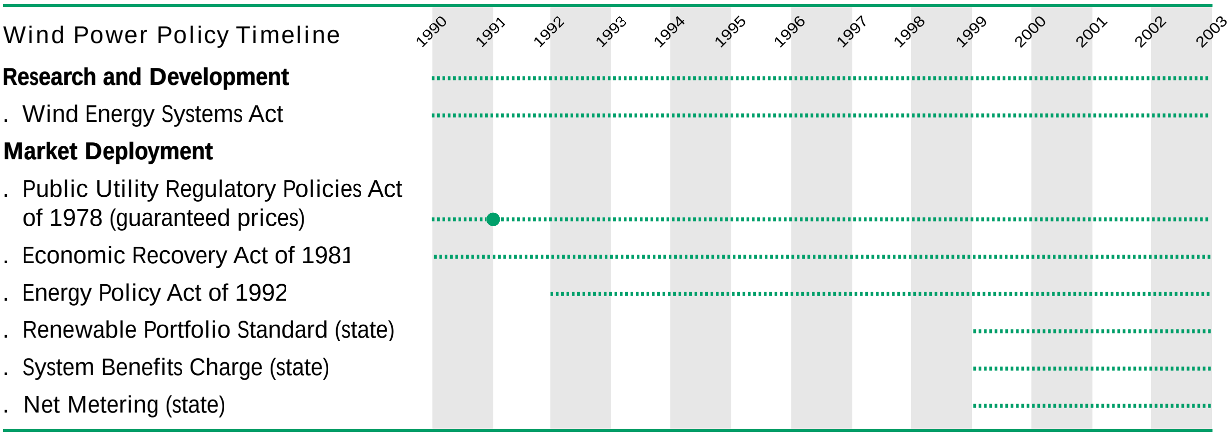


Figure 14. **Wind Power Capacity** (Year to Year Change)





● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Electricity generation from wind power accounted for 2.3% of renewables generation in 2001. Generation increased from 3.1 TWh in 1990 to 6.8 TWh in 2001. Capacity also increased, from 1 911 MW in 1990 to 3 864 MW in 2001. The US Energy Information Administration reports that wind power capacity was 4 685 MW in 2002 and 6 374 MW in 2003 and that generation from wind power was 10.5 TWh in 2002. Federal funding for RD&D began in the 1970s, and still continues today.

The wind energy market experienced two distinct periods of rapid growth. In 1978, PURPA was established, requiring utilities to offer long-term power purchase contracts to private power developers that were based on the utilities' avoided generation costs. Federal incentives included a 10% business investment tax credit, a 15% business energy tax credit and a five-year accelerated depreciation schedule. Most of the early development occurred in California, where utility payments were set at higher levels than in most other states due to higher marginal costs. The business energy tax credit for wind energy expired at the end of 1985 and subsequently new wind energy installations stalled.

Beginning in the late-1990s, wind energy experienced a second period of more widespread growth spurred by a combination of the federal production tax credit (PTC), established in 1992, the continuing availability of accelerated depreciation, and policies adopted in particular states, such as renewables portfolio standards (RPS). For example, in 2001, nearly 1 000 MW of wind energy development was developed in Texas, in part to provide power to meet the state's RPS requirement. The advent of markets for voluntary green power purchases has spurred wind energy developments. Wind power supplies more than 90% of the green power sold nationwide.

To date, intermittency is not a serious obstacle to wind projects in the United States. As new projects have been developed, the variable output has been absorbed by the grid without major difficulty. The wind energy and electric power industries, along with the federal government, are working collaboratively to address issues associated with integrating larger amounts of wind energy in the future, including co-joining wind plants with hydropower plants.

At current natural gas prices, wind energy generation costs are approaching parity with the costs of traditional fossil-fuel power plants for new construction in regions with high quality wind regimes. The US DOE estimates the current cost of wind energy produced by utility-scale systems is $0.04 to $0.06/kWh in Class 6 resource areas (*i.e.*, annual average wind speed of 6.7 metres per second at a height of 10 metres). The goal of the US DOE Wind Program is to reduce the cost of electricity from large wind systems in Class 4 resource areas (*i.e.*, 5.8 metres per second) to $0.03/kWh for onshore systems and $0.05/kWh for offshore systems by 2012.

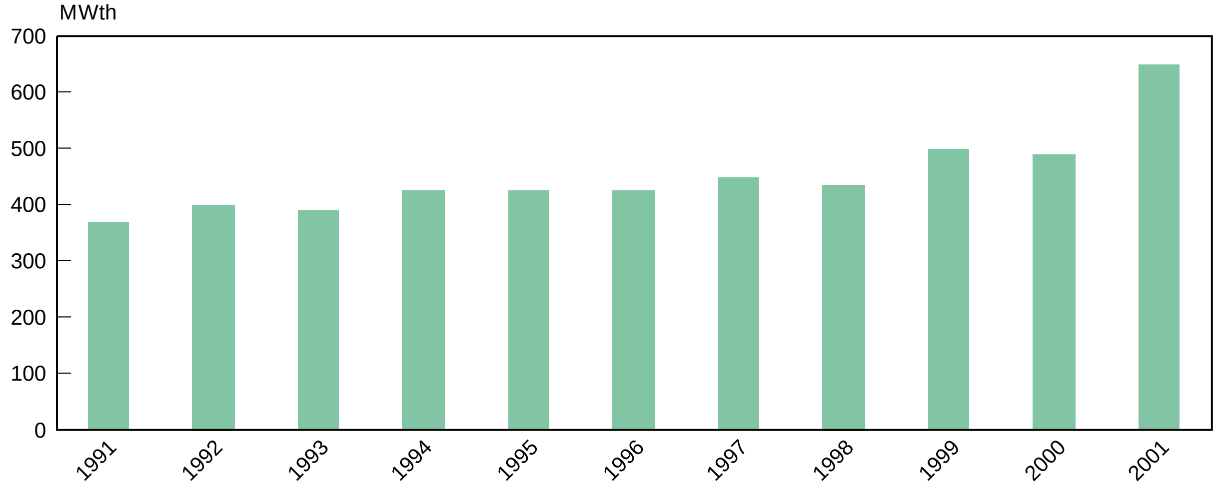
Public acceptance has been an issue in some areas. In the northeast where population density is high and where land values are at a premium, opposition has been more vocal, especially for offshore projects within sight of land. However, in the midwest, wind projects have generally been welcomed, as the plants provide new revenues to landowners and communities.

Solar Thermal Production

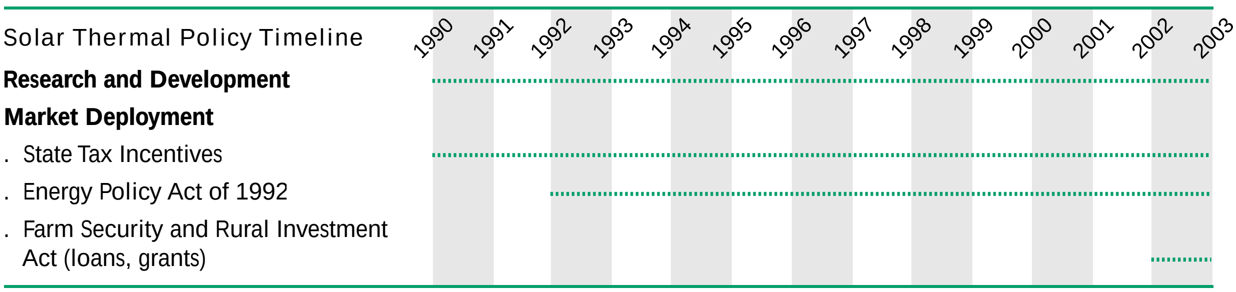
Solar thermal production in the United States exhibited rapid growth over the last decade from 2 387 TJ in 1990 to 58 872 TJ in 2001, an average annual growth of nearly 34%. The US DOE reports that heat generation capacity of solar thermal was some 650 MWt in 2001 (Figure 15).

Solar water heating in the United States is a mature technology that gained interest during the energy crises of the 1970s. During that time, a combination of federal and state incentives spurred consumers and businesses to install solar thermal systems, resulting in the installation of more than a million solar water-heating systems. When fossil fuel costs declined, the incentives were discontinued and annual sales fell dramatically in most states. Today, about 6 000 water heating units are sold each year, mostly in Hawaii where state and utility incentives remain. Solar heaters for swimming pools, on the other hand, have captured a much larger market (Table 3).

Figure 15. **Solar Thermal Capacity**



Source: United States Department of Energy and Paul Maycock.



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

The US DOE has supported solar water heating RD&D for the past thirty years but many challenges remain ahead for solar technologies to be accepted by the mainstream water heating markets. One obstacle is the high initial cost of solar water heaters compared to alternatives. Part of the DOE programme supports the development of low-cost solar heaters using polymer materials to bring down costs.

The only federal incentives remaining for solar thermal installations are the 10% business investment tax credit, which was made permanent in the Energy Policy Act of 1992, and the Accelerated Cost Recovery System (part of the Economic Recovery Act of 1981), which provides for a five-year accelerated depreciation schedule for business investments in solar, wind and geothermal property. The allowable tax credit for any given year is limited to $25 000. In addition, several states and utilities offer solar incentive programmes.

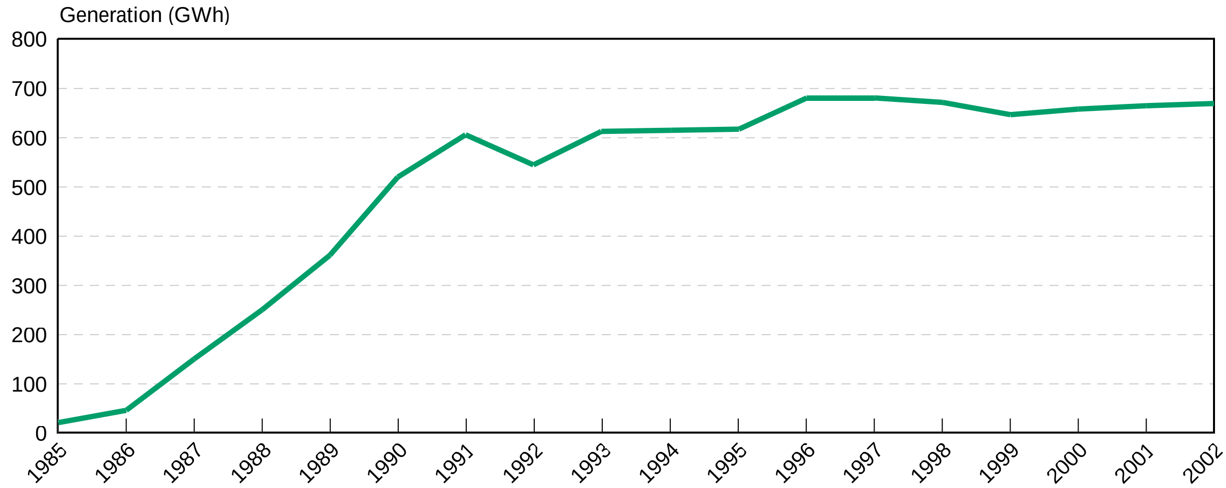
Table 3. **Solar Water Heating Systems (1 000 ft^2)**

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Pool Heating	5 585	6 187	6 025	6 823	6 813	6 821	7 524	7 292	8 152	7 948	10 797
Hot Water	989	897	931	803	840	785	606	443	427	400	390
Total	**6 574**	**7 084**	**6 956**	**7 626**	**7 653**	**7 606**	**8 130**	**7 735**	**8 579**	**8 348**	**11 187**

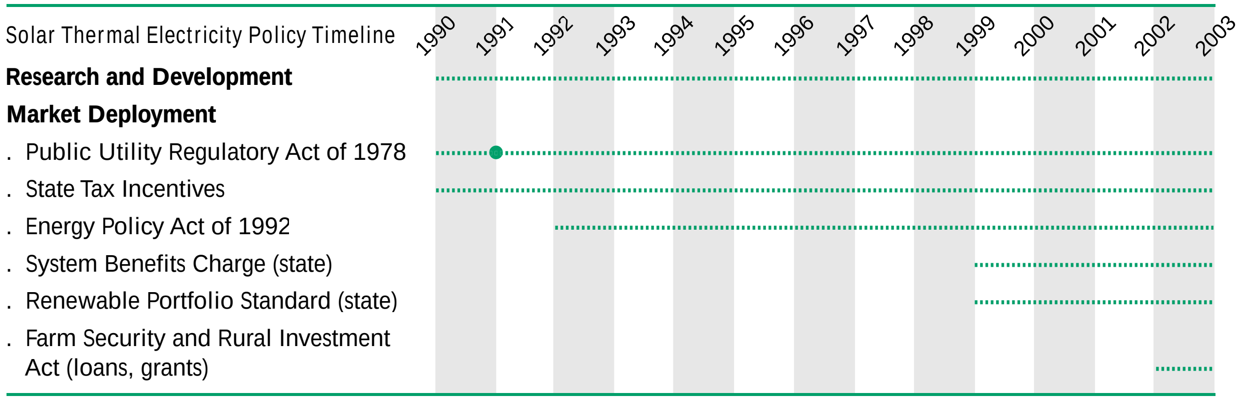
Source: US Energy Information Administration.

Solar Thermal Electricity Production

Figure 16. **Solar Thermal Electricity Production**



Source: US DOE.



● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

The only commercial-scale solar thermal electric projects in the world were installed in California between 1984 and 1990, employing parabolic trough technology. In total, 354 MW of solar trough plants were constructed by a single company taking advantage of the favourable PURPA implementation regulations in California as well as federal and state tax incentives. Ultimately, both the company and the technology became casualties of the unpredictability and decline of these incentives during the late 1980s and early 1990s as well as falling prices for conventional fuels. A permanent 10% energy tax credit for businesses installing new solar electric projects was established in the Energy Policy Act of 1992, excluding public utility property. The plants that were installed in California during the 1980s continue to operate and generate electricity as illustrated in Figure 16.

Solar Photovoltaic

Photovoltaic (PV) systems grew at an average annual rate of nearly 20% from 1990 to 2001, reaching 213 MW in 2001.

Figure 17. **Solar Photovoltaic Capacity**

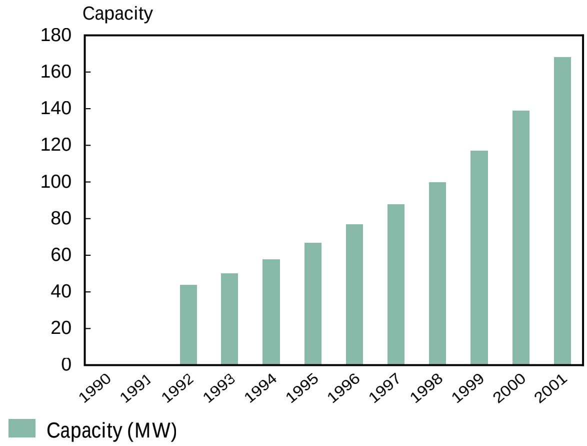
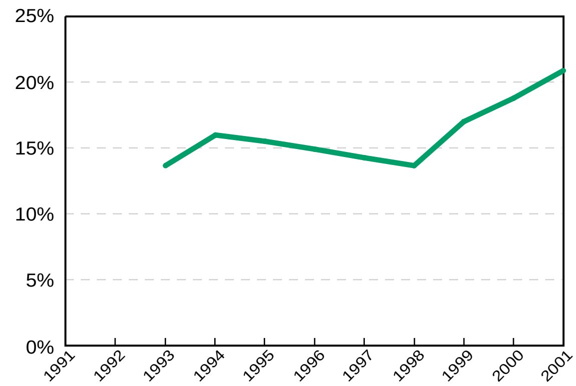
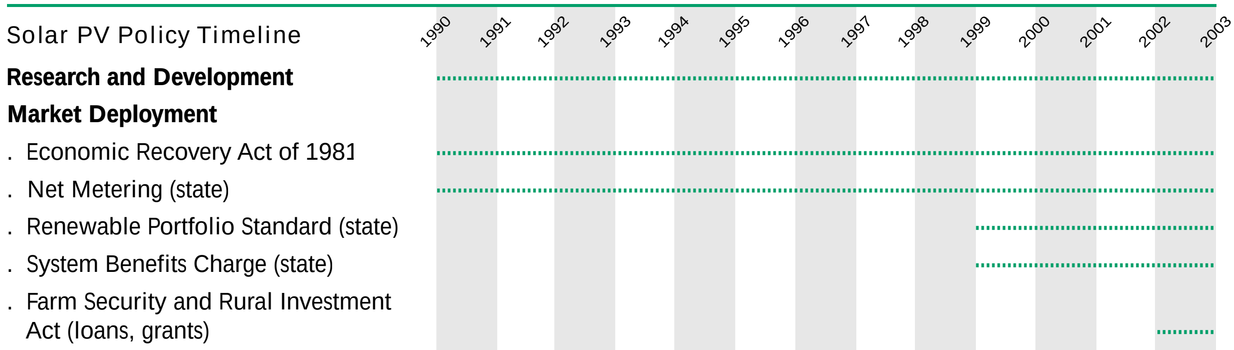


Figure 18. **Solar Photovoltaic Capacity**
(Year to Year Change)





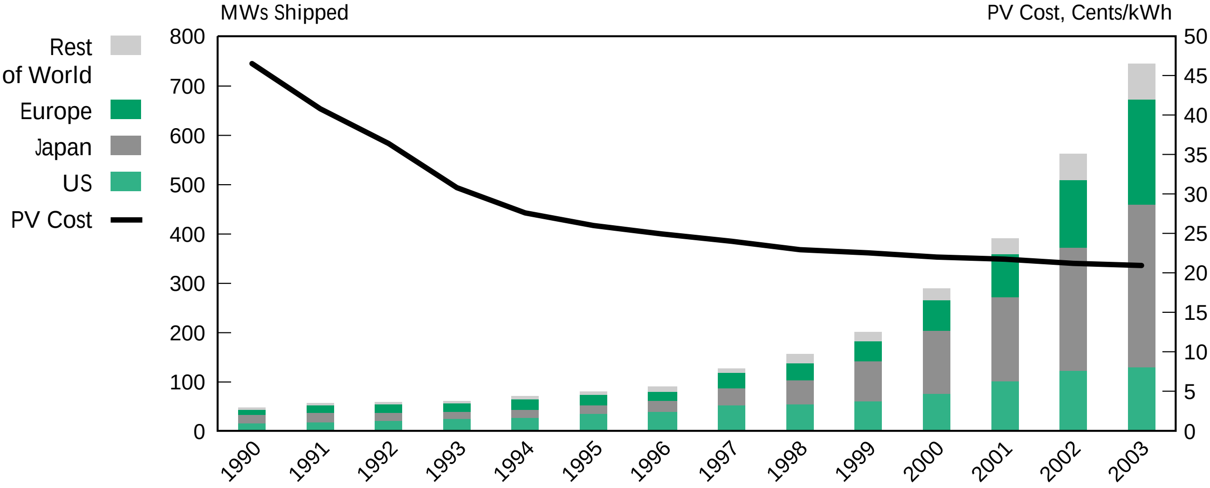
● *Denotes a significant change to a policy, such as an extension, repeal or revision.*

Federal policies that have encouraged market deployment of photovoltaics include RD&D expenditures to help reduce the long-term cost of the technology and the 10% investment tax credit and accelerated depreciation available to businesses. These two financial incentives together can provide up to a 42% capital tax benefit over the first five years of system operation.

Specific state policies have had an additional impact on PV market adoption by individual consumers in the United States. For example in California, a portion of the system benefits charge is dedicated to support the development of emerging renewable energy technologies including PV. Since 1998, the state has provided cash rebates to reduce (buy-down) the initial cost of customer-owned PV systems, resulting in the installation of 24 MW through October 2003. In Arizona, 60% of the state's renewable portfolio standard (RPS) must be met from solar resources, which has resulted in the installation of 6 MW of PV projects to date. In addition, the availability of net metering provides important regulatory support for PV deployment. Net metering allows a small PV electricity producer to receive the full retail value for the electricity produced and provides a remedy for the time mismatch between when the electricity is produced and when the consumer uses the electricity. The first net metering rules were implemented in 1980 in Idaho and in 1981 in Arizona. Thirty-seven states have now established some type of net metering policy.

The combination of federal and state RD&D activities has had a positive effect on PV in terms of technology performance, market acceptance and hardware prices. Figure 19 shows cumulative international shipments and the cost per kWh of PV systems from 1990 to 2003.

Figure 19. **International Shipments and Cost per kWh of PV Systems**

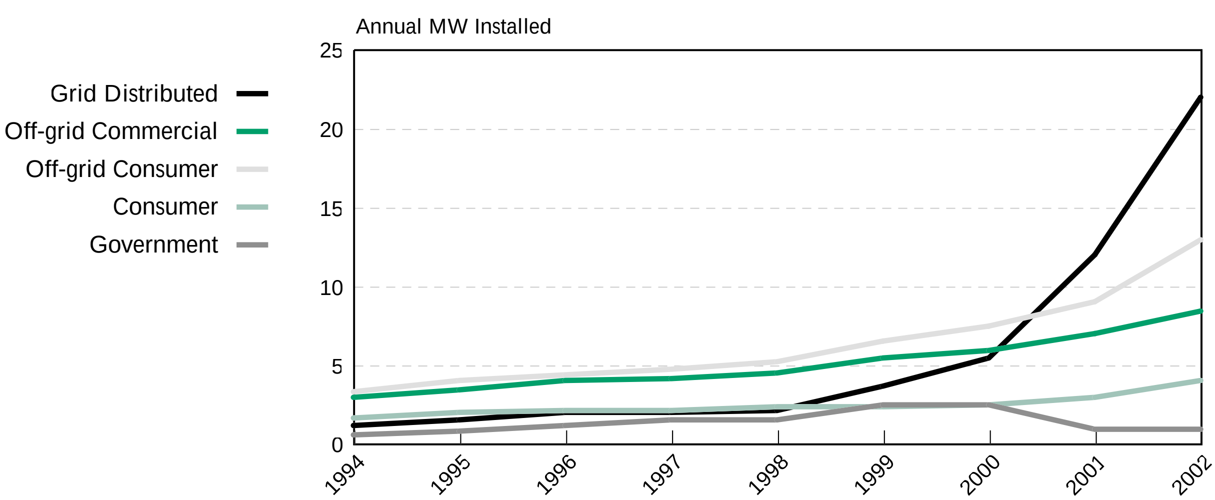


Source: US DOE and Paul Maycock.

The fastest growing segment in the United States, similar to international markets, is the grid-connected market. Although market growth was strong in some states, overall production growth in the United States in 2002 was only 20%. The rest of the world's production grew at an average of 57% in 2002. Of the 121 MW produced in the United States in 2002, only 48 MW was actually installed there.

Figure 20 shows trends in the major PV market segment in the United States. Sales of grid-connected systems showed remarkable growth in 2001 and 2002. Sales of off-grid commercial and consumer PV systems showed steady growth since the mid-1990s.

Figure 20. **Growth in PV Markets in the United States**



Source : US DOE.

United States Policy Chronology

Solar Energy Research Act

Year 1974 - Present

RE Description This Act, passed in 1974, authorises and funds research and development to assure the utilisation of solar energy as a major source for energy needs. It provides for the development of suitable incentives for rapid commercial use of solar technology and established an Office of Solar Energy Research in the US government.

Policy Type RD&D

RE Technology Solar photovoltaic
Solar thermal
Concentrating solar

Geothermal Energy Research, Development and Demonstration Act

Year 1974 - Present

RE Description This Act established RD&D programmes in geothermal energy technologies, a geothermal energy co-ordination and management project, and provided funding for RD&D projects in geothermal energy technologies.

Policy Type RD&D

RE Technology Geothermal

Solar Heating and Cooling Demonstration Act

Year 1974 - Present

RE Description This Act, enacted in 1974, provided for the commercial demonstration of solar heating and cooling technologies.

Policy Type RD&D

RE Technology Solar thermal

Solar Photovoltaic Energy Research, Development and Demonstration Act

Year 1978 - Present

RE Description This Act re-establishes and funds programmes for RD&D for solar photovoltaic energy systems.

Policy Type RD&D

RE Technology Solar photovoltaic

Public Utility Regulatory Policies Act (PURPA)

Year 1978 - Present

RE Description PURPA requires utilities to purchase power from certain "qualifying" non-utility producers, especially small (below 80 MW) renewables-based electricity production at avoided cost rates. The qualifying facilities were also exempt from some of the state and federal regulations that applied to utility generators. PURPA encouragement of non-utility generation has contributed to increased electricity production from geothermal, biomass, waste, solar, and wind. Biomass and waste-to-energy qualify as long as they meet a 5% of useful steam threshold. The impact of PURPA waned over time as states sharpened the definition of avoided costs and turned to competitive bidding to meet resource needs.

Policy Type Guaranteed prices/feed–in tariff

RE Technology Geothermal
Biomass
Waste
Solar photovoltaic
Offshore wind
Onshore wind
Hydro
Solar thermal

Energy Tax Act of 1978

Year 1978 - Present

RE Description The Energy Tax Act constitutes a programme of tax credits for households and businesses purchasing alternative energy equipment. Residential energy (income) tax credits for solar and wind energy equipment expenditures were set at 30% of the first $2 000 invested and 20% of the next $8 000. The most important electricity sector incentive was the creation of a 10% business energy tax credit for investments in various renewable energy options including solar, wind, and geothermal. This credit was in addition to the standard 10% investment tax credit, which was available on all types of equipment. The residential and business credits were extended and improved in 1980. Public utility property was specifically excluded from eligibility for the tax credits that were to expire at the end of 1982.

The bill also created an excise tax exemption of $0.04 per gallon of blended gasoline for alcohol fuels (ethanol and methanol), which was equivalent to the full value of the excise tax at that time. The ethanol excise tax exemption was extended in 1980. The credit was set to expire in 1984 but has been extended several times since at different levels of exemptions.

Policy Type Investment tax credits / Tax exemptions

RE Technology All renewables

Wind Energy Systems Act of 1980

Year 1980 - Present

RE Description This Act provided for an accelerated programme of wind energy research, development and demonstration.

Policy Type RD&D

RE Technology Offshore wind
Onshore wind

Biomass Energy and Alcohol Fuels Act of 1980

Year 1980 - Present

RE Description This 1980 act provides for a programme of loan guarantees for biomass and alcohol fuels projects.

Policy Type Third-party finance

RE Technology Biomass
Biofuel

Crude Oil Windfall Profits Tax Act

Year 1980-1992

RE Description This bill, passed in 1980, increased the ETA residential energy tax credits for solar and wind energy equipment from 30% to 40% of the first $10 000 in expenditures with the termination dates set at the end of 1985. The business energy tax credit for solar, wind, and geothermal was increased from 10% to 15% and the termination date was extended through 1985 for most renewables. Biomass combustion equipment was added to the definition of eligible equipment.

The bill also established an alternative fuels production tax credit, which provided a tax credit for synthetic fuels produced from non-conventional sources, including biomass, such as production from landfills. The availability of this credit, originally scheduled to expire in 1992, was later extended until 1998.

In addition, the Act extended the excise tax exemption for alcohol fuels through 1992 and introduced an alternative fuels production tax credit and an alcohol fuel blenders tax credit.

Policy Type Tax exemptions / Investment tax credits / Excise tax exemption

RE Technology Solar photovoltaic

Offshore wind
Onshore wind
Geothermal
Biomass
Waste
Biofuel

Economic Recovery Act of 1981

Year 1981 - Present

Policy Description This Act allowed for an Accelerated Cost Recovery System (ACRS) by which businesses can recover investments in solar, wind and geothermal property through depreciation deductions. The ACRS establishes the time over which various types of property may be depreciated (5-50 years). The current ACRS allows wind, solar and geothermal property placed in service after 1986 to be depreciated over five years.

Policy Type Investment tax credits

RE Technology Offshore wind
Onshore wind
Solar photovoltaic
Geothermal

Tax Reform Act of 1986

Year 1986 - Present

RE Description Under this legislation, the business energy tax credit was eliminated for wind energy systems, phased out for biomass, and extended to 10% (for two years) for solar and geothermal. The 10% credit for solar and geothermal was periodically extended until 1992. The standard 10% business investment tax credit was also phased out. On the other hand, the five-year accelerated depreciation for alternative energy property was further liberalised (from a 150% to 200% declining balance method), although co-generation equipment depreciation was lengthened to fifteen to twenty years depending on the type of equipment. Public utility property also became eligible for the accelerated depreciation. This Act also instituted the alternative minimum tax (AMT), which significantly reduced the pool of investors who could take advantage of the tax credits.

Policy Type Investment tax credits

RE Technology All renewables

Energy Policy Act

Year 1992 - Present

RE Description This Act provided three types of incentives to support the development of renewable energy resources:

- Permanent extension of the investment credit (Section 1916), provides a 10% investment credit for most solar technologies and geothermal;
- Establishment of a production tax credit (PTC) of $0.015/kWh (to be inflation-adjusted) for wind and closed-loop biomass, which is available to investor-owned utilities and non-utility generators for up to ten years for electricity produced in stations brought on-line before 1 July 1999. The programme was subsequently extended twice, and expired again at the end of 2003.
- Establishment of a production incentive payment of $0.015/kWh (Section 1212, Renewable Energy Production Incentive) for publicly-owned utilities (that cannot avail themselves of the PTC because they pay no federal income taxes). The payment is available for solar, wind, biomass (excluding MSW) and geothermal (excluding dry steam). The programme expired at the end of September 2003 for new projects.

Policy Type Investment tax credits

RE Technology All renewables

Climate Change Action Plan (CCAP)

Year 1993 - Present

RE Description The United States plans to stabilise emissions of greenhouse gases to 1990 levels by 2000. A renewables component of the plan aimed to lower the cost of renewable energy development through facilitation of aggregated buyer purchasing and to increase the penetration of renewable energy through application of integrated resource planning. The actions outlined in the CCAP were coordinated by the Department of Energy, the Environmental Protection Agency, the Department of Transportation, US Department of Agriculture, and the Department of State.

The Climate Challenge Programme (CCP) is part of the CCAP and is a voluntary programme between utilities and the DOE. The programme pursues cost-effective actions to reduce, avoid, or sequester greenhouse gases.

Policy Type Voluntary programmes

RE Technology All renewables

Energy Efficiency & Renewable Energy Development

Year 1999 - Present

Policy Description This legislation provides for increased funding for research, development and demonstration of renewable energy technologies. In addition, it included an investment package of nearly $ 1.4 billion to research, develop, and deploy clean energy technologies. The programme augments existing initiatives such as the Bioenergy Initiative to develop advanced bioenergy technologies: $ 13 million in financial assistance to promote the growth of the biomass industry was announced under this initiative.

Policy Type RD&D

RE Technology All renewables

Increased Use of Bioenergy

Year 1999 - Present

Policy Description In 1999, Executive Order 13134 accelerated the development of bio-based industries, which set a goal of tripling US use of bioenergy and bioproducts by 2010. This would reduce annual greenhouse gas emissions by an amount equal to as much as 100 million metric tonnes of carbon.

Additionally, this order established a permanent council consisting of the Secretaries of Energy and Agriculture, the Environmental Protection Agency Administrator, the Director of the National Science Foundation, and other agency heads to develop a detailed research programme to be presented as part of the annual federal budget. This council is also responsible for reviewing major agency regulations, incentives, and programmes to ensure that they are effective in promoting the use of bioproducts and bioenergy.

Policy Type RD&D

RE Technology Biomass
Biofuel

Tax Relief Extension Act of 1999

Year 1999-2001

Policy Description This Act extended the expiration date of the production tax credit (created in the Energy Policy Act of 1992) to 31 December 2001. It also expanded the tax credit eligibility to include poultry waste facilities.

Policy Type Investment tax credits / Consumer grants/rebates

RE Technology Offshore wind
Onshore wind
Biomass
Waste

Energy for the New Millennium: National Photovoltaics Program Plan

Year 1999 - Present

Policy Description This bill, passed in 1999, provides funding for research and development of thin film, high-performance devices, silicon materials, characterisation techniques, and other innovative concepts.

Policy Type RD&D

RE Technology Solar photovoltaic

Funding to Accelerate the Use of Wind Energy - Information Campaigns

Year 2000 - Present

Policy Description In 2000, the US Department of Energy granted $ 2.7 million to help promote the development of wind energy across the United States with projects targeting wind energy information campaigns.

Policy Type Public awareness

RE Technology Offshore wind
Onshore wind

Biomass Research and Development Act

Year 2000-2005

Policy Description The Biomass Research and Development Act of 2000, complements the Executive Order on Bioproducts and Bioenergy issued by the federal government in 1999. The act authorises $49 million in funding over a five-year period and establishes a technical advisory committee and agency board to co-ordinate activities related to bio-based products and bioenergy.

Policy Type RD&D

RE Technology Biofuel
Biomass

Funding to Develop Clean Burning Fuels

Year 2000-2003

Policy Description In 2000, the US Department of Energy announced it would grant $8 million until 2003 for research that could lead to the development of cleaner burning fuels for use in large-scale utility and industrial boilers. The fuels were used in "co-firing", a process that combines traditional fossil fuels with biomass.

Policy Type RD&D

RE Technology Biomass

Funding for the Development of Ethanol

Year 2000 - Present

Policy Description In 2000, the US Department of Energy awarded a one year $7 million grant for developing enzymes to convert wood chips, corn stalks and other biomass waste to ethanol.

Policy Type RD&D

RE Technology Biofuel
Biomass

The Economic Security and Recovery Act of 2001

Year 2002-2003

Policy Description Extended retroactively the expiration date of the production tax credit (created in the Energy Policy Act of 1992) to 31 December 2003.

Policy Type Investment tax credits / Consumer grants/rebates

RE Technology Offshore wind
Onshore wind
Biomass
Waste

Farm Security and Rural Investment Act

Year 2002 - Present

RE Description This Act provides $115 million in funding for a five-year period to support renewable energy development in rural areas. The funds can be used to make low-interest loans, loan guarantees and grants to farmers, ranchers, and rural small businesses to purchase and install renewable energy systems and make energy efficiency improvements. The grants cannot exceed 25% of project cost with a combined grant and loan (or loan guarantee) not to exceed 50%. The funding programme is managed by the US Department of Agriculture.

Policy Type Third-party finance / Capital grants

RE Technology All renewables

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