INTERNATIONAL ENERGY AGENCY



Energy Policies of IEA Countries

Norway 2001 Review



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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 cooperation among twenty-five* 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 nonmember 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, 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).

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Figure 1 Map of Norway



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SUMMARY AND RECOMMENDATIONS

SUMMARY

General Energy Policy

Norway plays a central role in the IEA because it is a major producer and exporter of energy. Norway's successful integration into the European electricity and gas markets, and its continuing role in world energy supply, should be overriding considerations when decisions are made on Norwegian energy policy. It is important that Norwegian energy policy be coherent, and understood by consuming countries, particularly in Europe. Within Norway, transparent and independent regulation could play an important role in ensuring continued successful development of the energy sector.

Government involvement in the energy sector continues to be prominent in Norway. There are indications that government ownership and broad policy announcements, notably on environmental issues such as the future of hydro, may have affected, for example, the choice of technology for electricity generation. There is a need for clarification of government environmental objectives for the energy sector, and for greater separation of the roles of government as regulator and substantial owner of the sector. Closer attention should be given to defining the framework of environmental objectives and standards, as a means of ensuring consistent and predictable decisions.

Energy-Environment Policy

Energy-related greenhouse gas emissions are projected to increase significantly in Norway. The Kyoto flexible mechanisms are important for Norway because of the limited opportunities for achieving domestic reductions in greenhouse gas emissions. Emissions trading and carbon dioxide taxation raise issues of competitiveness and trade impacts.

The development of an emissions quota system may suggest a major change of approach in Norwegian energy-environment policy. A firm decision needs to be made soon on the future of the carbon dioxide tax regime, and on its relationship to the quota system, to avoid uncertainty about the impact of government environmental policy on investments in the energy sector. If the quota system is to be implemented, an early decision should also be made on the allocation of the quotas based on an analysis of the costs and benefits of the range of options already identified.

Attention also needs to be given to the impact of other aspects of environmental policy on energy supply. Decisions restricting the choice of electricity generation technologies – notably large-scale hydro and gas-fired power – should take into account their possible impact on investment in new electricity capacity. Environmental standards should be stated clearly, and should take into account the

cost of their achievement, to contribute to a stable and predictable investment climate in which companies can take decisions on the basis of relative economics, including the environmental costs.

Energy Efficiency and Renewable Energy

Growth in energy consumption has been limited by a number of policies, principally taxation. Consumption of energy in the industry, residential/commercial, and transport sectors has grown in Norway in recent years, driven by economic growth. Government policies should continue to promote changes in consumption habits.

The Norwegian government recognises that greater effort is necessary and has taken an important step by establishing a new energy efficiency agency for promoting energy efficiency and new renewables. This report recommends how the new agency might undertake its task.

Promotion policies for renewables should be fully compatible with the operation of the liberalised electricity market, and be developed in consultation with the electricity companies. Decisions on the level of support for the development of "new" renewables should take into account that large-scale hydro is also a renewable energy source and would generally be the most economic option for renewable electricity generation.

Electricity

Norwegian energy use per capita is similar to countries with similar climate and temperatures. The composition of energy consumption in Norway differs from other countries because of its large hydro power production. Norway has the highest electricity consumption per capita in the world, reflecting its large hydro power resource endowment, substantial energy-intensive industries, and its cold climate. Competition has developed in the electricity market, although public involvement is still strong.

Generation

Expansion of Nord Pool should provide more flexibility in responding to growing electricity demand. Nevertheless, there appears to be a consensus that Norway will need to consider substantial additions to its generating capacity over the next few years. International connections could also play an important role, but there is some concern about investment in international cables because of uncertainty about long-term contractual commitments to support their commercial viability.

The government has announced general limits to new large-scale hydro, and the future of gas-fired power continues to be uncertain. Wind generation is a supply option, but

there are environmental considerations associated with its development. As a result of these considerations, few medium-term supply options exist. Electricity prices are low at present, but most market participants expect prices to rise as the gap between supply and demand narrows. If the supply side is excessively constrained, the result could be increasing price instability, price spikes, or even failure of supply in a dry year.

Transmission and Distribution

Investment in transmission has been declining over the past decade as efficiency gains have improved the capability of the system to meet growing demand. Limits to efficiency gains are likely to be reached within the next few years and major investments in expanding the capability of the system may be required. This will test the adequacy of incentives for investment in transmission. Related to this issue is the question of security and reliability of the transmission grid. System reliability is becoming more important as the transmission system approaches its capacity. Mandatory reliability standards do not currently exist. Penalties for supply failures may be used to provide incentives to the grid owners and operators to maintain reliability.

Forecasting the outlook for electricity supply could play an important role in guiding the development of government policies and by informing the market. The government no longer prepares forecasts of electricity because it no longer has a direct role in investment. However, forecasts could usefully inform the market of the need for investment in new electricity generation and transmission capacity. The government need not prepare forecasts. The transmission system operator, for example, could be encouraged to take on this task.

The revenue cap provides an incentive to merge smaller distribution systems. Current hydro generation concessions may discourage private and foreign participation in the generation and distribution of electricity. Publicly-owned Norwegian companies may have an advantage in acquiring municipal systems and further limit competition from private companies.

Alternatives to new transmission lines may be found by, for example, developing distributed power and gas. Mechanisms need to be put in place to ensure that decisions on the grid take into account a range of alternative economically-efficient options.

Oil and Gas

Partial privatisation of Statoil and the restructuring of the State Direct Financial Interest (SDFI) are both positive developments that are likely to lead to further change. Experience with the changes currently proposed will be an important guide to the benefits of reducing government participation in the sector.

Norway's oil and gas supply industry is important internationally. Norway now has the opportunity to develop an oil and gas services industry that could help maintain economic activity as oil and gas reserves deplete. Norwegian policy must ensure an adequate level of investment in the petroleum sector, the optimisation of recovery, and the maintenance of an adequate level of research and development and of expertise. Wider participation by international players would help achieve these objectives. The fiscal regime has an important influence on the outlook for investment. Tax policy should be reviewed in a long-term perspective with this objective in mind.

Norway has on two occasions since 1998 reduced the level of oil production by government regulation with a view to stabilising oil prices at a higher level. The review team believes that Norway has an important role to play during periods of price volatility. Restricting oil production to influence oil prices is of concern to consuming countries. The review team believes that there are alternatives to production controls as a means of offsetting price volatility such as consumer-producer dialogue, where Norway has played a lead role for the benefit of all IEA Member countries. The Norwegian government considers that dialogue alone would have been an insufficient response when oil prices were at US\$ 10 per barrel. Nevertheless, the review team considers production to influence the market to be detrimental and suggests that every effort should be made to avoid its repetition.

The review team considers that obligations imposed by the European Union gas directive have been an important influence on recent changes in Norway's policy on gas marketing. Norway should consider taking a proactive approach to its policy on gas marketing, in view of the maturity of its industry and the importance of promoting the integration of its industry into European energy supply. Abolition of the Gas Negotiations Committee (GFU) is an important step. In implementing a new policy approach, Norway should accept private marketing of gas as a leading principle. Depletion policies that are consistent with this principle should be developed in consultation with industry. Concerns over the future of long-term commitments, benefiting some consumers as well as producers, also need to be addressed.

Domestic use of gas for electricity generation and direct end-use could be important in the future. The government could anticipate this development by preparing a policy framework, including regulation, for the sector.

Coal

Norway has subsidised the production of a very small quantity of coal to maintain a community in the dependency of Svalbard. A new, larger mine is to be developed. The government has paid a part of the capital cost of developing the mine, but the mine may make a surplus over operating costs.

Research and Development

Energy research and development funded through the Research Council is at present managed in three divisions: Energy and Industry, Science and Technology, and Environment and Development. Many of the programmes are directed at industry objectives, and in some cases are arguably more appropriate for full industry support. Clarification and better definition of energy research programmes are necessary to ensure that energy policy objectives are being achieved. Care is also necessary to ensure that *ad boc* industry proposals are evaluated consistently to ensure balance and coherence in the energy research programme.

RECOMMENDATIONS

The Government of Norway should:

Environment

- □ Review the impact of environmental policies on the development of energy projects.
- \Box Evaluate the efficiency and effectiveness of existing policies and measures, in particular the carbon dioxide tax.
- □ Base future policies and measures on market-based instruments, developed in consultation with industry and other energy market players, including neighbouring countries.
 - If an emissions quota system is adopted, make early decisions on the relationship of the quota system to the existing carbon dioxide tax, and on the mechanism for allocating quotas.
- □ In developing new policies and measures, give particular attention to the petroleum and transport sectors, which are both key emitters in Norway.
 - Ensure that policies and measures take into account the importance in Norway of greenhouse gas emissions other than carbon dioxide.

Energy Efficiency

- □ In establishing the new agency for promoting energy efficiency and new renewables:
 - Set clear objectives for the agency, along with clear time scales for achieving its objectives; require regular reports on the actions taken and progress towards the objectives; require the agency to develop a range of measures for improving energy efficiency, chosen according to their cost-effectiveness, with a particular focus on electricity consumption.
 - Consider the continuation of existing programmes directed at improving energy efficiency in the industry and domestic sectors.
- Undertake public awareness programmes to complement energy taxation.

□ Undertake an assessment of the effectiveness of the vehicle taxation regime to determine if it is contributing to improvement in the vehicle fleet as a whole; develop ways of improving overall fleet efficiency.

Electricity

Security of Supply

- □ Ensure that the market addresses security of supply by removing impediments to free operation of the market. In this context, consider using electricity forecasts to provide basic information on the outlook for electricity supply security in Norway as a guide for developing policy options, and to provide information for the market.
- □ Review the influence of the hydro concession on the level of private and foreign investment in hydro-based generation.
- □ Review the impact of small-scale and municipal ownership on efficiency and investment in the electricity sector.
- □ Allow the market to determine the choice of electricity generation technology within clear environmental regulations.

Regulation

- □ Review the electricity regulatory functions of the Water Resources and Energy Directorate with a view to improving the independence of the economic regulation function, including by giving consideration to:
 - Clarifying and simplifying the objectives of regulation, in consultation with electricity producers and consumers.
 - Establishing a separate division within the Water Resources and Energy Directorate (or a separate organisation) responsible solely for economic regulation of the electricity industry.
 - Establishing independent lines of reporting by the head of the economic regulation division to the minister.
- □ As part of its five-year review of its incentive regulations, the Water Resources and Energy Directorate should:
 - Seek market-based solutions to issues such as investment in transmission and system reliability.
 - Accommodate alternatives to new transmission capacity including distributed generation, direct use of natural gas, and gas-fired generation and co-generation.

Market Development

- □ In consultation with Sweden, Finland and Denmark, consider the merits of promoting the development of a single Transmission System Operator in the Nordic market.
- □ Continue to work towards harmonisation of taxation and other factors influencing the operation of the Nordic electricity market.

Oil and Gas

- \Box Maintain the momentum for privatising Statoil by early follow-up to the initial public offering.
- \Box Review the level of exploration in the Norwegian continental shelf, and give close consideration to the influence of taxation on the level of exploration.
- \Box In consultation with industry, develop a new policy approach to balancing the goals of optimising oil and gas depletion, and of ensuring competition in marketing.
- □ Proactively encourage the private marketing of gas as a means of assisting the closer integration of the Norwegian gas industry with the European market.
- □ Give priority to developing the proposed action plan for the domestic use of natural gas. Direct the Ministry of Petroleum and Energy to take responsibility for the promotion of gas in direct end-uses and in electricity generation. Specific tasks might include, for example:
 - Working in consultation with the Department for the Environment to analyse and report on the environmental and economic implications of any proposed domestic gas developments.
 - Anticipating the development of a domestic gas industry in Norway by developing proposals for economic regulation of the domestic gas industry. Consider expanding the role of the electricity regulator to include responsibility for regulating the domestic gas industry.

Coal

□ Ensure that the proposed new mine in Svalbard is genuinely economic. If economic viability cannot be achieved, seek alternative means to maintain the Norwegian community in Svalbard.

Research and Development

- □ Review the way in which priorities for energy research and development are established and individual projects selected. Consider:
 - Better definition of the energy programme within the Research Council.
 - Aligning energy research and development priorities more closely with current government energy policy priorities.
 - Commissioning projects in key policy areas.
 - Ensuring close co-ordination of the activities of the Research Council and the activities of the new agency responsible for energy efficiency and promoting "new" renewables.

2

CONDUCT OF THE REVIEW

REVIEW TEAM

The 2001 International Energy Agency (IEA) in-depth review of the energy policies of Norway was undertaken by a team of energy policy specialists drawn from the Member countries of the IEA. The team visited Norway 12 – 16 March 2001 for discussions with government officials, energy suppliers and energy consumers. Published sources and IEA statistical analysis of data provided by the Norwegian government have supplemented information provided during the visit.

Members of the team were:

Didier Houssin (team leader) Ministère de l'Economie, des Finances et de l'Industrie France

David Burpee Department of Natural Resources Canada

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John Cameron managed the review and drafted the report. Martina Bosi drafted Chapter 4. Monica Petit and Bertrand Sadin prepared the figures.

The team held discussions with the following:

EBL (Norwegian Electricity Federation) Water Resources and Energy Directorate Lyse Energi Ministry of Environment Ministry of Finance Ministry of Foreign Affairs Ministry of Petroleum and Energy Nord Pool Norsk Hydro Norwegian Petroleum Directorate PIL (a federation representing major industrial customers) Research Council of Norway Shell Statkraft Statnett (Norwegian Transmission System Operator). Statoil

The assistance and co-operation of all participants in the review are gratefully acknowledged.

REVIEW CRITERIA

The *Shared Goals* of the IEA, which were adopted by IEA Ministers at their 4 June 1993 meeting, held in Paris, provide the evaluation criteria for in-depth reviews conducted by the Agency. The *Shared Goals* are set out in Annex B.

Norway has the rights and obligations of a full IEA Member for non-emergency purposes. Norway's obligations for emergency purposes differ from those applying to full Members. The Agency's formal arrangements with Norway provide that, in case of a serious oil supply shortage, Norway will contribute, by decision of the government, to an emergency oil-sharing programme (see Chapter 7). Norway has explicitly endorsed the *Shared Goals* of the IEA.

3

GENERAL ENERGY POLICY

BACKGROUND

The Kingdom of Norway (Kongeriket Norge) occupies the western and northern portions of the Scandinavian Peninsula. Norway has an area of 323 877 sq km. It is an extremely mountainous land, nearly one-third of which lies north of the Arctic Circle. The coastline is, in proportion to the area, longer than that of any major country in the world. Forests cover slightly more than one-quarter of the land area.

The population is about 4.4 million, including several thousand Sami (Lapps) and people of Finnish origin in north Norway. Norway has the lowest population density in OECD Europe, with about 14 persons per sq km. The population is growing slowly, with an annual rate of increase of 0.5%. About half of the population lives in the south-east, and more than three-quarters of all Norwegians live within 16 km of the sea. Some 72% of the population is urban, about 25% lives in the vicinity of Oslo, the national capital, which is the largest city and the principal port and industrial centre. Other major centres are Bergen (population about 216 000), Trondheim (140 000), and Stavanger (100 000).

Norway is a constitutional and parliamentary monarchy. The constitution was enacted in 1814. Nominal executive power is vested in the king, but in practice is held by the cabinet of ministers, headed by the prime minister. Legislative authority is vested in the parliament, called the Storting. It consists of 165 members popularly elected every four years by all citizens over eighteen. The Storting elects one-quarter of its members to an upper house, the Lagting; the remainder constitute the lower house, the Odelsting. Norway is divided into 19 counties, and subdivided into rural and urban municipalities, each of which has a governing council, elected every four years.

The Labour Party has traditionally been the strongest party and has governed almost continuously since 1935, except for the periods when a coalition has held power. The Labour Party took government in 2000, following the resignation of a coalition of the Christian People's Party, the Centre Party and the Liberal Party over proposed emissions permits for gas-fired power plants. Energy issues have played an important part in Norwegian politics since exploitation of oil and gas resources began in the 1970s. Support for the Labour Party was reduced in the September 2001 election. The other major parties are the Conservative Party, the Centre Party, the Christian People's Party, and the Socialist Left Party. Minority parties include the Progress Party, the Liberal Party, and the Norwegian Communist Party.

Referendums in 1972 and 1994 rejected membership of the EU. Norway is a member of the European Free Trade Association (EFTA)¹. In 1992, Norway signed

^{1.} Other members are Iceland, Liechtenstein and Switzerland.

the Agreement on the European Economic Area (EEA). The agreement gives Norway access to the EU market and allows co-operation in a number of areas. The agreement does not extend to agriculture and fisheries, nor to commercial policy, but does provide for free trade. Most of the relevant legislation related to the internal market is covered by the agreement.

Norway has one of the highest standards of living in the world. Average annual growth in GDP over the last five years was 4.2%. Industrial development has benefited from extensive and inexpensive hydro-electricity, and from the exploitation of offshore mineral resources. Oil and gas account for about 40% of exports and up to 16% of GDP, depending on world oil prices. Over 50% of exports are raw or semi-processed materials from hydro power-based aluminium smelters and ferro-alloy industries. Before offshore drilling for petroleum began in the 1970s, mining was relatively unimportant in Norway. Other mineral products include iron ore, coal, zinc, iron pyrites, lead concentrates, and copper.

The composition and direction of exports changed dramatically with the development of oil and gas. Norway is now Europe's largest exporter of these two products. Other major exports include machinery, aluminium, iron and steel, chemicals, pulp and paper products, and food products consisting mostly of fish. The merchant marine is one of the largest in the world and an important source of foreign exchange earnings. Major trading partners are the United Kingdom, Sweden, Germany, Denmark and France.

GENERAL ENERGY POLICY

Government Energy Organisation

Petroleum, Water Resources and Energy

The Ministry of Petroleum and Energy advises the government on resources and energy matters. Responsibility for petroleum operations rests with the Oil and Gas Directorate. The Water Resources and Energy Directorate is responsible for landbased energy generation, water resources and energy consumption. The Ministry of Foreign Affairs handles certain international energy issues in co-operation with the Ministry of Petroleum and Energy. These include relations with the IEA. The government appoints a Foreign Ministry official as Norway's representative to the IEA Governing Board, the European Energy Charter, and to deal with energy issues within the framework of the European Economic Area.

The Storting determines the framework for petroleum operations in Norway. The Storting must approve major development projects and issues of principle. Authority has been delegated to the government to approve smaller development projects. Overall administrative responsibility for petroleum operations rests with the Ministry of Petroleum and Energy, which ensures that these operations follow the Storting's guidelines.

The Ministry of Local Government and Regional Development has overall responsibility for the working environment in the petroleum sector, as well as for emergency response and safety aspects of the industry.

The Norwegian Petroleum Directorate reports to the Ministry of Local Government and Regional Development on issues relating to the working environment, safety and emergency response. Primary functions of the directorate are to:

- Exercise administrative and financial control to ensure that exploration for and production of petroleum are carried out in accordance with legislation, regulations, decisions, licence terms, etc.
- Ensure that exploration for and production of petroleum are pursued at all times in accordance with the guidelines laid down by the Ministry of Petroleum and Energy.
- Advise the Ministry of Petroleum and Energy on issues relating to exploration for and production of submarine natural resources.

Environment

The Ministry of Environment takes the lead for the development of climate change policy in Norway. Other departments, including the Ministry of Petroleum and Energy, contribute. An interministerial group has been set up to address climate change and transboundary air pollutants issues.

Electricity

The Norwegian Water Resources and Energy Directorate is responsible for regulation and monitoring of the electricity industry. It also provides administrative support for licensing power plants. The directorate is currently responsible for the introduction and demonstration of new energy technologies, but this function will be transferred in July 2001 to a new agency responsible for energy efficiency and new renewables.

A Master Plan for Water Resources has been prepared by the Ministry of Petroleum and Energy and the Ministry of Environment to balance the cost-effectiveness of the remaining hydro power projects with environmental concerns.

Transport

The Ministry of Transport and Communications has overall responsibility for energy use for transport.

Research and Development

The Research Council of Norway is responsible for public funding of user-driven and long-term strategic energy research and development.

Energy Prices and Taxation

A general value-added tax applies at a level of 23%.

Fossil Fuels

A carbon dioxide tax on fossil fuels used for energy purposes was introduced in 1991. It is among the highest in OECD countries. Taxes on carbon dioxide, sulphur dioxide, and excise tax are shown in Table 1. Further details on the carbon dioxide tax are tabulated in Chapter 4 (Table 4).

Taxes on Carbon Dioxide and Sulphur Dioxide and Excise Tax, 2000 ²							
Product	Carbon Dioxide	Sulphur Dioxide	Excise Tax				
Coal and Coke	0.47 NOK/kg	3.00 NOK/per kg					
Fuel Oil	0.47 NOK/kg	0.07 NOK/litre					
Gasoline, leaded	0.94 NOK/litre		4.59 NOK/litre				
Gasoline, unleaded	0.94 NOK/litre		4.34 NOK/litre				
Oil, offshore	0.70 NOK/litre						
Gas, offshore	0.70 NOK/sm ³						

 Table 1

 Taxes on Carbon Dioxide and Sulphur Dioxide and Excise Tax, 2000²

Source: Country submission.

Electricity and Fuel Oil

The Storting increased the tax on electricity consumption to NOK 0.0856/KWh from 0.0594/KWh as from 1 January 2000. To avoid a switch from electricity to heating oil, a basic tax on fuel oil of NOK 0.19/litre was also introduced. The tax on electricity consumption was increased again, to NOK 0.113/KWh, from 1 January 2001. About half Norway's electricity consumption is exempt from this tax.

Households in Nordland, Troms and Finnmark and all manufacturing industries, mining and quarrying, and greenhouse nurseries, are exempt from value-added tax on electricity.

Taxes on electricity account for a large proportion of total revenue in many municipalities. Table 2 shows the taxes paid by power companies to the various levels of government in 1998.

Petroleum Tax Commission

In October 1999, the Ministry of Finance commissioned an expert group to evaluate the petroleum taxation system. The commission presented its report in June 2000.

^{2.} On average in 2000, NOK 1 = US\$ 0.113 or \notin 0.123518.

Corporate taxes	State	Municipalities	Counties	Total
Income	1 925			1 925
Natural Resources		1 233	224	1 457
Economic Rent	352			352
Wealth		1 216		1 216
Licence Power (estimate)		180		180
Investment Fee (estimate)	225			225
Licence Fee	107	420		527

Table 2Taxes Paid by Power Companies, 1998(Million NOK)

Source: Country submission.

An important finding of the commission was that the existing petroleum taxation system may discourage new entrants on the Norwegian Shelf. Companies with income from the Norwegian Shelf may receive higher after-tax returns than companies without current Norwegian Shelf income. In this respect, new entrants are at a disadvantage compared with established companies.

The commission proposed new measures to increase the attractiveness of the Norwegian Shelf for new companies. The objectives of the recommendations were to make the tax system more targeted towards Norwegian Shelf income, to diminish distortions in company-level investment decisions and to encourage exploration and development irrespective of the tax position of the individual company.

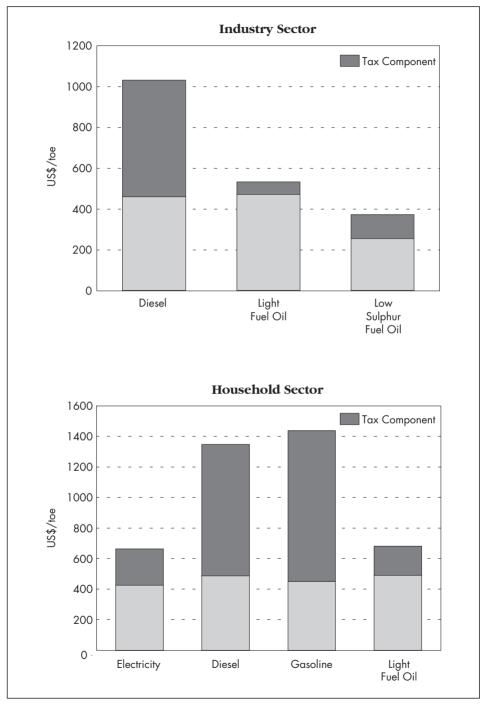
ENERGY SUPPLY AND DEMAND

Production

Annex A contains information on Norway's energy balances and key statistical data. Norway is the largest oil producer among the IEA Member countries and the third largest exporter in the world. It is also a major producer and exporter of natural gas, and is expected to become more important in the near future. In 1999, total energy production was 209.77 Mtoe, an increase of 1.5% from 1998. Most of the increase was attributable to an increase in gas production from 41.34 Mtoe to 44.13 Mtoe, or 6.75%. Oil production fell from 153.92 Mtoe in 1998 to 153.42 Mtoe in 1999, or 0.32%.

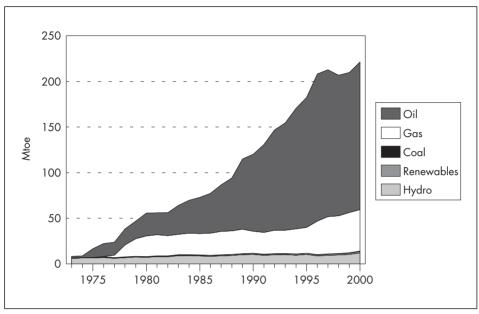
Hydro power production supplies nearly all electricity in Norway and for export. Hydro production increased from 9.92 Mtoe in 1998 to 10.40 Mtoe in 1999, or 4.84%. Norway also produces a small amount of energy from wastes, amounting to 1.49 Mtoe in 1999, and from coal, amounting to 0.33 Mtoe in 1999.

Figure 2 **Fuel Prices, 2000**



Source: Energy Prices and Taxes, IEA/OECD Paris, 2001.

Figure 3 **Energy Production by Source, 1973 to 2000**



Source: Energy Balances of OECD Countries, IEA/OECD Paris, 2001.

Primary Energy Supply

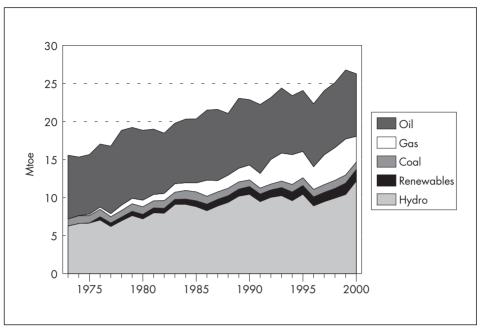
In 1999, hydro accounted for 39.1% of total primary energy supply, and oil 34%. The share of gas in energy supply rose from 16.9% in 1998 to 17.9% in 1999. Renewables, principally wastes, contributed 5.6% of energy supply in 1999, and coal 4%. Electricity trade was relatively small in 1999, with net exports of 0.16 Mtoe, but this understates the importance of electricity trade in balancing energy supply in Norway. Electricity trade fluctuates with the availability of hydro power.

Final Energy Consumption

Norway's energy use per capita is similar to countries with similar climate and temperatures. The composition of energy consumption in Norway differs from other countries because of its large hydro power production. Norway has the highest per capita electricity consumption in the world. In 1999, electricity accounted for 50.4% of energy consumed in industry and 71.1% of energy consumed in other sectors (excluding transport).

In 1999, industry accounted for 40.68% of final energy consumption; transport accounted for 25.18\%. Industrial demand for energy in Norway fell by 0.12% in the

Figure 4 Total Primary Energy Supply, 1973 to 2000



Source: Energy Balances of OECD Countries, IEA/OECD Paris, 2001.

period 1998 to 1999, probably reflecting lower growth in GDP of 0.9% in 1998-99 compared with 3.7% in 1997-98. Transport demand for energy rose by 5.79% in 1998-99. Energy demand in other sectors fell by 0.86% in 1998-99.

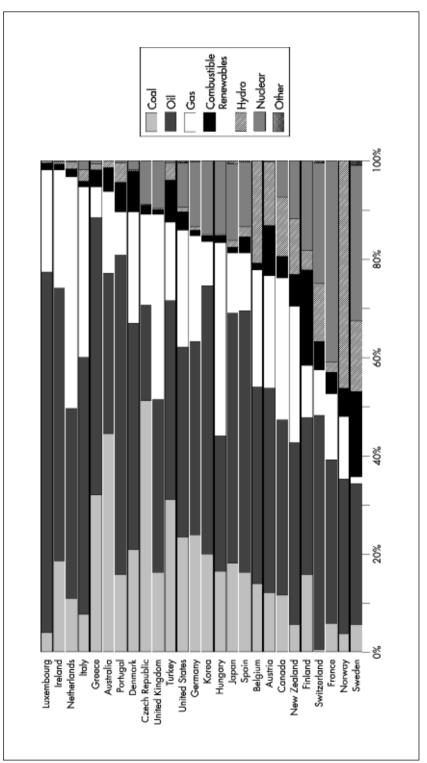
Outlook

Petroleum Production

Figure 9 shows expected production of crude oil from the Norwegian Continental Shelf. Output is estimated to have averaged about 3.1 million barrels per day during 2000. Crude oil output is expected to remain at about this level until 2005, when a gradual decline will start. In the longer term, the number and size of new discoveries and industry profitability are likely to influence the level of production.

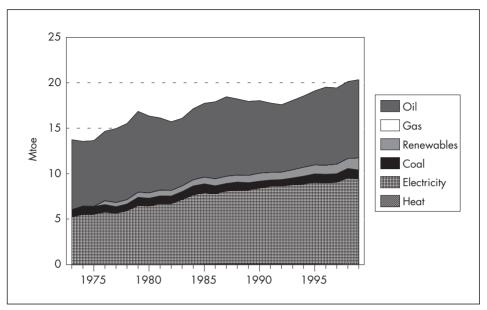
Annual Norwegian gas sales have been around 40 to 50 billion sm³ (standard cubic metres) in recent years. Under existing contracts, however, they should almost double over the next decade. For planning purposes, annual gas sales are put at about 85 billion sm³ from 2007-08. Figure 10 shows contractual delivery commitments for Norwegian natural gas, based on existing agreements.

Figure 5 Total Primary Energy Supply in IEA Countries, 2000



Source: Energy Balances of OECD Countries, IEA/OECD Paris, 2001.

Figure 6 **Total Final Consumption by Source, 1973 to 1999**



Source: Energy Balances of OECD Countries, IEA/OECD Paris, 2001.

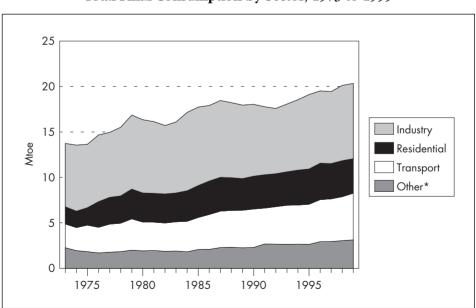
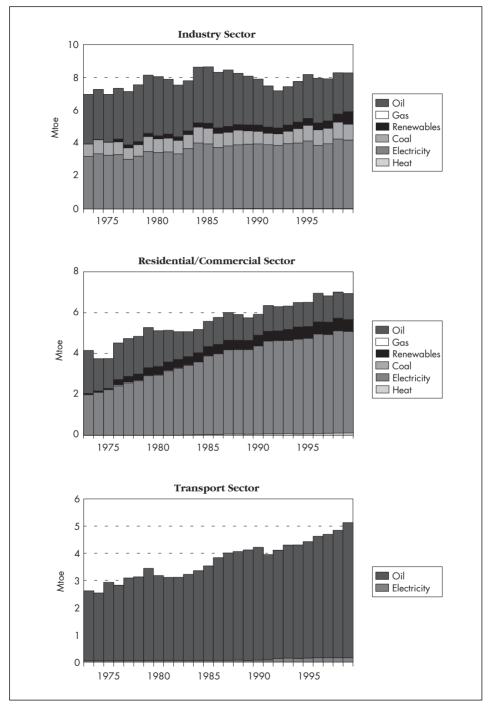


Figure 7 Total Final Consumption by Sector, 1973 to 1999

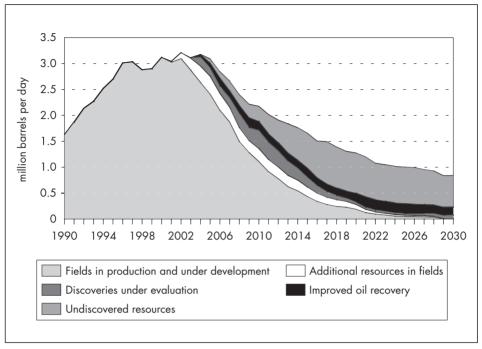
* includes commercial, public service and agricultural sectors. Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2001.

Figure 8 **Final Consumption by Sector and by Source, 1973 to 1999**

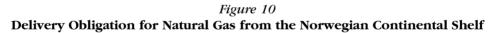


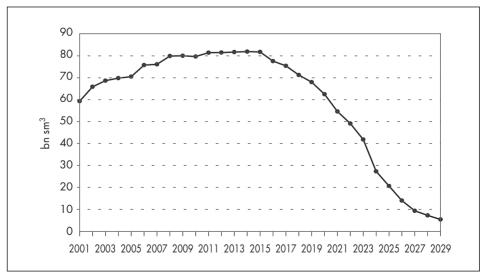
Source: Energy Balances of OECD Countries, IEA/OECD Paris, 2001.

Figure 9 Forecast Oil Production



Source: Ministry of Petroleum and Energy.





Source: Ministry of Petroleum and Energy.

CRITIQUE

The economic importance of oil and gas to Norway is a determining influence on Norway's approach to energy policy.

Production of oil and gas contributes a significant share of Norway's GDP and export earnings. The economic importance of oil and gas to Norway is a determining influence on Norway's approach to energy policy. The Storting plays a decisive role in formulating policy on oil and gas development and hence in much of energy policy generally. Norway has given only qualified support for the IEA's oil-sharing arrangements in the event of an oil supply emergency. Unlike other IEA countries, the decision for Norway to participate in oil-sharing arrangements will be taken by Norway in the event of a declared emergency, and not by the IEA Governing Board.

Recent movements in oil prices have affected overall economic performance and encouraged the government to use production controls as a means of influencing prices. Recovery in oil prices has contributed to economic recovery and may reverse the recent decline in investment in the offshore oil and gas industry.

Energy-environment issues have also been politically sensitive.

Energy-environment issues are also important. Debate on energy policy³ resulted in a change of government in 1999. In 1999, the three-party coalition government (consisting of the Christian People's Party, the Centre Party and the Liberals) resigned following a request from the Storting to set discharge permits for emissions of carbon dioxide and nitrogen oxides at the same levels as in other European countries.

The State continues to play an important role, but change is occurring in response to EU legislation.

The State plays an important role in the Norwegian economy, but change has been more marked in the energy sector than elsewhere in the economy⁴. Market mechanisms are used to achieve goals, notably in electricity, but achieving environmental protection, supply diversity, efficiency and flexibility within the energy sector are considered to require more pronounced government intervention than would be judged necessary in some other IEA countries. Market deficiencies and national circumstances are considered to require political solutions in some cases and may affect the pace of introducing further market reforms.

Nonetheless, a comprehensive policy assessment of state ownership in the offshore oil sector is currently under way. Statoil is being partially privatised, and the State

^{3.} White Paper no. 29, "The Energy Policy".

^{4.} The OECD Economic Survey of Norway (*OECD Economic Surveys – Norway*, February 2000) points out that some product markets remain heavily regulated, including in the agricultural sector; privatisation of Norway's telecommunications operator has started; and state ownership in the two largest commercial banks is considerable.

Direct Financial Interest restructured. The Gas Negotiations Committee terminated its activities as from 1 June 2001 with regard to the European Economic Area, and will be formally abolished from 1 January 2002, subject to discussion in the Storting. Changes in policy on oil and gas development, and on gas marketing, are driven in large measure by closer integration of the Norwegian oil and gas sector with the European market, and by the formal need to satisfy EU legislation. As a member of the European Economic Area, Norway is obliged to implement some EU directives, including the gas directive.

Closer integration into the European electricity and gas markets should be seen as an opportunity...

Closer integration with the European market is an important opportunity for Norway to benefit further from the development of its vast petroleum reserves. Norway should proactively take advantage of this opportunity. Norway's successful integration into the European electricity and gas markets, and its continuing role in global energy supply, should be overriding considerations when decisions are made on Norwegian energy policy. It is important that Norwegian energy policy be coherent and understood by consuming countries, particularly in Europe, while protecting the nation's own interests.

... along with some important opportunities in the domestic electricity and gas sectors.

Within Norway, transparent and independent regulation could play an important role in ensuring continued successful development of the energy sector. In the domestic and regional electricity market, improving the independence of regulation is identified in this report as the main area requiring consideration by the government. The report also recommends government action to promote development of the domestic use of gas.

4

ENERGY AND THE ENVIRONMENT

GREENHOUSE GAS EMISSIONS⁵

Kyoto Target

Norway ratified the United Nations Framework Convention on Climate Change in July 1993 and signed the Kyoto Protocol⁶ in April 1998. The Norwegian commitment under the Kyoto Protocol is to limit the increase in greenhouse gas emissions to 1% above 1990 levels in the first commitment period, 2008-2012.

For the first time since 1991, greenhouse gas emissions fell between 1999 and 2000 (by 1%), mainly because of unusually mild weather resulting in lower consumption of heating oil and heating kerosene and the shut-down of several air services, reducing sales of aviation fuel. This decline is not expected to continue in 2001.

Norway's greenhouse gas emissions could be more than 20% above target in 2010 if robust economic growth continues. The introduction of natural gas-fired power plants in Norway would further increase the gap with the Kyoto target, possibly by more than 30% above Norway's target.

Oil and gas production, and transport, are the main sources of Norwegian emissions. Carbon dioxide is the principal greenhouse gas, accounting for about 74% of all Norwegian greenhouse gas emissions (1998). Methane (CH₄) represents 13% and nitrous oxide (N₂O) 9%. Perflurocarbons (PFCs), sulphur hexafluoride (SF₆) and hydroflurocarbons (HFCs) together account for about 4% of national emissions, of which most are PFCs and some SF₆. Table 3 shows the trend for each gas. Figures 11 and 12 illustrate the trend in carbon dioxide emissions by fuel and by sector.

Mobile sources represent 27% of total emissions, petroleum activities account for approximately 16%, the metal industry emits 12.5%, other industry represents 18%, landfills 12.5% and agriculture 7.8%. In 1998, about 9.6 million tonnes of carbon dioxide emissions were attributable to petroleum activities. Combustion of diesel oil and gas on offshore petroleum installations accounted for 75% of these emissions.

^{5.} Gases which contribute to the warming of the Earth's surface. The Kyoto Protocol (December 1997) defines commitments to reduce emissions of the following six greenhouse gases: CO₂ (carbon dioxide), CH₄ (methane), N₂O (nitrous oxide), HFCs (hydrofluorocarbons), PFCs (perfluorocarbons), SF₆ (sulphur hexafluoride). On a global level, CO₂ is the single most important anthropogenic greenhouse gas. Fossil fuel production and use represent about three-quarters of CO₂ emissions from human activity. Other energy-related greenhouse gases include CH₄ from the production, transportation and use of natural gas and coal, and N₂O primarily from fuel wood use. The three other greenhouse gases covered by the Kyoto Protocol are not energy-related: HFCs (used as alternatives to ozone-depleting substances, such as coolants), PFCs (from aluminium smelters), and SF₆ (used in insulators for electrical transmission and distribution systems).

^{6.} The full text of the Kyoto Protocol can be found on the UNFCC web site, www.unfcc.de

Table 3
Greenhouse Gas Emissions (kt carbon dioxide equivalent)

PFC/SF ₆ /HFC	5 225	,	2 713	2 736	2 488	2 169	2 080	2 017	2 098	-60 +8
CH ₄ N ₂ O	6 610 5 161	6 717 5 000	6 858 4 324		7 143 4 789				7 265 5 092	+10
CO ₂	35 146	33 605					-			+19
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1990-1998 (%)

Source: Ministry of Environment, Norway.

Transport contributes about one-third of carbon dioxide emissions from fuel combustion. About one-quarter of emissions from the transport sector are from coastal navigation and the fishing fleet. The principal increase in transport sector emissions is from road transport, offset in part by more fuel-efficient cars.

Energy industries, such as oil refineries, oil and gas extraction and coal mines also contributed just over one-third of carbon dioxide emissions from fuel combustion in 1998. Emissions from these industries more than doubled from 1990 levels

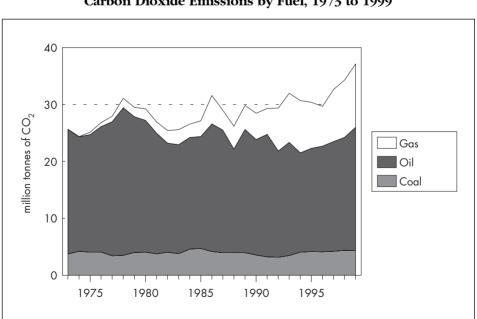
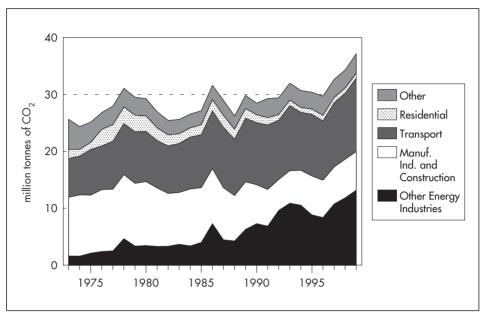


Figure 11 Carbon Dioxide Emissions by Fuel, 1973 to 1999

Source: CO2 Emissions from Fuel Combustion, IEA/OECD Paris, 2001.

Figure 12 Carbon Dioxide Emissions by Sector, 1973 to 1999



Source: CO2 Emissions from Fuel Combustion, IEA/OECD Paris, 2001.

owing to increased activity in this sector during the 1990s, particularly oil and gas extraction. The power requirements to produce oil and gas on offshore installations come mainly from natural gas-fired turbines, which can also run on diesel.

Power generation is not an important contributor to greenhouse gas emissions in Norway because electricity generation is almost entirely hydro power. Figure 13 compares the trend in carbon dioxide intensity in Norway with other IEA countries. It is lower than that of other IEA countries because of the domination of hydro in Norway's power sector.

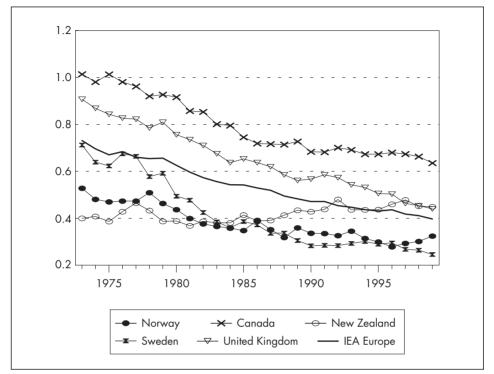
PFC and SF₆ emissions from aluminium and magnesium plants decreased during the 1990s. Although not included in the Kyoto target, emissions from international aviation and marine bunker fuels have increased significantly in Norway. International marine and aviation bunker fuels-related carbon dioxide emissions were more than 75% higher in 1998 than in 1990.

Outlook

Norwegian authorities estimate that emissions in 2010 according to the business-asusual scenario will be 63.6 million tonnes of carbon dioxide equivalents. This scenario includes planned reduction in emissions from landfills. Following the

Figure 13

Energy-related Carbon Dioxide Emissions per GDP in Norway and in Other Selected IEA Countries, 1973 to 1999 (CO₂ emissions/GDP using 1995 prices and purchasing power parities)



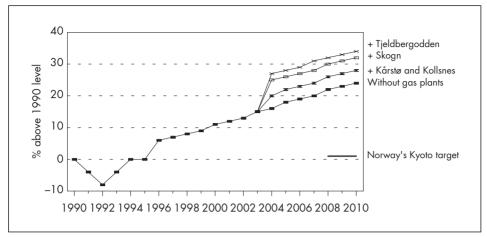
Source: Energy Balances of OECD Countries, IEA/OECD Paris, 2001.

Kyoto treaty, the cap on annual Norwegian greenhouse gas emissions in the period 2008 to 2012 is 52.5 million tonnes of carbon dioxide equivalents. Thus, in reference to the business-as-usual scenario (without gas-fired power plants), Norway must reduce annual emissions by nine million tonnes of carbon dioxide equivalents.

Up to and including 1996, carbon dioxide emissions increased less than the rise in oil and gas production on the Norwegian Shelf. From 1997, carbon dioxide emissions per unit of production began increasing faster than output. This trend is expected to continue as fields mature and activity moves northwards, unless technical solutions are found. Norway's greenhouse gas emissions grew by 8% between 1990 and 1998. Carbon dioxide emissions from the petroleum sector will probably peak in about 2005 and then fall, slightly reducing emission levels between 2010 and 2020.

Three licences have been allocated to install natural gas-fired power plants on the mainland at Kårstø, Kollsnes and Skogn. At present, gas-fired power is not considered commercially viable. The impact on emissions from developing the plants is illustrated in Figure 14.

Figure 14 **Projected Greenhouse Gas Emissions***, 1990 to 2010



^{*} projections reflect implemented and decided policies and measures.

Note: The diagram shows the impact on emissions of the proposed gas-fired power stations at Tjeldbergodden, Skogn, Kårstø and Kollsnes.

Source: Ministry of Environment, Norway.

Policies and Measures

Norwegian policy seeks to combine the country's role as a large energy exporter with leadership in the protection of the environment. Co-ordinated international effort, based on burden-sharing and cost-effectiveness, is a key principle underlying Norwegian policy. In June 2001, the government submitted its climate policy to the Storting. Carbon dioxide taxes, agreements with industry, emissions trading, and technology development are key measures by which the government proposes to meet Norway's Kyoto target.

The Pollution Control Act aims to achieve a level of environmental quality that is satisfactory on the basis of an overall evaluation of human health and welfare, the natural environment, the costs associated with any measures implemented and economic considerations. It seeks to apply the polluter-pays principle, whereby the owner of the source of pollution is accountable for any release of pollutants, for which a concession must be sought and certain conditions met.

Flexible Mechanisms⁷

In December 1999, a commission of inquiry appointed by the government outlined a system for domestic emissions trading in greenhouse gases to meet Norway's

^{7.} Articles 3.10, 3.11 and 3.12 of the Kyoto Protocol allow Annex I Parties to acquire and transfer any part of their emissions commitment through international emissions trading (Article 17), Joint Implementation (Article 6) and the Clean Development Mechanism (Article 12). The Kyoto Mechanisms implicitly recognise that countries have different circumstances. They offer a certain flexibility in choosing the location of emissions reductions where they are least costly.

Kyoto target. The commission recommended that a system covering as many sectors and sources as possible be in place in 2008. The system could include nearly 90% of Norway's total greenhouse gas emissions, and it should be part of an international market. The commission recommended that sources of emissions included in the trading system should not be subject to other regulations such as the carbon dioxide tax. The commission was divided on the allocation mechanism for permits. The majority stated that all participants should pay the market price for permits.

In its June 2001 climate strategy, the government accepted most of the commission's recommendations and proposed establishing a broad domestic greenhouse gas emissions trading system. Some details are to be elaborated later, taking into account developments in the EU and elsewhere.

Norway has made available funding for several AIJ (Activities Implemented Jointly) projects in different host countries since 1995 and has been actively involved in studies of possible regional co-operation regarding climate change policies.

For example, Norway has financed a project for the reduction of carbon dioxide emissions in Slovakia. Norway has contributed NOK 1.2 million to modernise two district heating systems in Slovakia through the replacement of coal and natural gas with bioenergy. The net reduction in carbon dioxide emissions is expected to be 50 000 tonnes over 30 years.

The Norwegian government is a participant (as well as Norwegian energy companies Norsk Hydro and Statoil) in the World Bank's Prototype Carbon Fund⁸, investing US\$ 10 million over the next ten years to gain experience in, and emission credits from, emissions-reducing projects consistent with the development of the Kyoto Protocol's project-based mechanisms (known as Joint Implementation and the Clean Development Mechanism).

Taxation and Regulation

Taxation is the main instrument to limit carbon dioxide emissions in Norway. The tax rates are high compared to similar taxes introduced or proposed in other countries. Since 1991 a carbon dioxide tax has applied in addition to excise taxes on fuels. The carbon dioxide tax covers approximately 64% of Norway's carbon dioxide emissions and 48% of its total greenhouse gas emissions. The tax rates vary between different emissions sources (see Table 4). Some energy-intensive industries are exempt from the tax for competitiveness reasons.

The carbon dioxide tax and other "green" taxes are treated as general revenue and earmarked for any specific purpose. Revenue from the carbon dioxide tax is expected to reach NOK 7 000 million in 2001.

^{8.} The PCF is worth US\$150 million and is financed by industrialised countries and companies which will receive emissions reduction certificates, consistent with the Kyoto Mechanisms.

Table 4 Carbon Dioxide Taxes, 2001 (NOK)

	Tax per litre oil and petrol, per kg coal and coke, or sm ³ gas	Tax per tonne carbon dioxide
Petrol	0.72	311
Mineral Oil		
Light oil	0.48	182
Heavy oil	0.48	154
Reduced tax	0.24	91/78
Pulp and paper industry	0.24	91/78
Fishmeal industry	0.27	104
Domestic shipping of goods	0.27	104
Continental Shelf supply fleet	0	0
Exemptions		
Foreign shipping	0	0
Fishing in Norway	0	0
Fishing in distant water	0	0
Coal and Coke		
For energy purposes		
Coal	0.48	
Coke	0.48	
Exemptions		
Cement and leca* production	0	
All processing purposes	0	
Oil and Gas in the North Sea		
Oil	0.72	272
Gas	0.72	309

* A clay-based building material.

Source: Ministry of Finance, Norway.

In 1999, a tax on waste disposal was introduced to encourage energy recovery and to reduce emissions of methane from landfills. The tax rate is reduced when waste is used as a source of energy. The tax rates are: landfills – NOK 314 per tonne; incinerators – NOK 79 per tonne, plus an additional charge of up to NOK 235 per tonne depending on the degree of energy recovery.

Emissions of greenhouse gases from large stationary sources are subject to licensing under the Pollution Control Act.

The Storting has also recommended that the government adopt the 1996 Green Tax Commission's proposal to exempt the building of wind turbines, biofuel plants, heat pumps, district heating systems and micro and mini hydro power plants from the 7% investment tax. In addition, these investments may be eligible for a direct state subsidy of 20% to 25% of the investment cost. The Storting has also recommended supporting production of electricity from wind plants by refunding half the tax on power.

Research

The 2001 budget for the Ministry of Petroleum and Energy proposed to increase its research and development funding by 3.2% to reach NOK 202.7 million. The budget increase will be used mainly to develop technologies for reducing greenhouse gas emissions from gas-fired power plants. A grant of NOK 20 million has been allocated for a research project on this subject, to be located in Bergen.

Research programmes run by the Research Council of Norway include KLIMATEK (climate-friendly technology), NYTEK (Efficient and Renewable Energy Technologies) and SAMRAM (Norwegian Energy and Environmental Policy; Constraints, Opportunities and Instruments). These programmes are described in Chapter 8.

Statoil and Canada's Methanex Corporation have agreed on a five-year programme to develop methanol as an alternative vehicle fuel. The companies plan to establish a pilot programme by 2002 to demonstrate how methanol could be used in fuel cells. The programme is to include all aspects of supply, distribution and marketing of methanol.

Norway is involved in a project concerning carbon sequestration in the Sleipner Vest field on the Norwegian Continental Shelf. Carbon dioxide from gas produced from this field has been removed and injected into sub-sea reservoirs since 1996. This project has resulted in about one million tonnes per year of avoided carbon dioxide emissions.

Other Policies and Measures

The government has sought to develop voluntary agreements with industry. To date, only one agreement has been concluded, with the aluminium industry in 1997. By 2005, the industry has agreed to reduce its greenhouse gas emissions by 55% compared to its 1990 emissions. In 2000, a reduction in emissions of 52% per tonne was achieved, exceeding the target of 50% in that year.

In 2001, a new central agency was established to implement energy efficiency policy and programmes, as well as to support increased use of new renewables. Activities will include raising public awareness.

Activities by CICERO⁹ (Centre for International Climate and Environment Research, Oslo), an independent research centre founded by the Norwegian government in 1990, also informs Norwegians about climate change and possible ways to respond.

^{9.} CICERO has a twofold mandate: to undertake research and to provide information on climate change issues.

The Norwegian Government Environmental Fund is a loan scheme administered by the Norwegian Industrial and Regional Development Fund to provide funding for greenhouse gas mitigation projects and projects to limit emissions of gases, as well as to provide funding for energy efficiency investments.

Measures in the transport sector, in addition to the carbon dioxide tax, include subsidies for public transport, and road-user fees. Norway intends to implement all relevant EU regulations on transport-related emissions.

The government is seeking to encourage the development of non-hydro renewable sources of energy. It has set an objective of 4 TWh per year by 2010 for district heating systems based on new renewable energy sources. Norway has also set an objective for wind power of 3 TWh by 2010.

OTHER ENERGY-RELATED ENVIRONMENTAL REGULATIONS AND MEASURES

Sulphur Dioxide, Nitrogen Oxides and Volatile Organic Compounds

Norway has signed the 1999 Gothenburg Protocol to abate acidification, eutrophication and ground-level ozone¹⁰. The protocol includes quantified commitments for sulphur dioxide, nitrogen oxides and volatile organic compounds. Norway is committed to reducing its sulphur dioxide emissions by 58% from 1990 levels by 2010.

Energy-related sulphur dioxide emissions in Norway arise from the use of mineral oils, mainly in heavy industries such as aluminium, and from the refineries. A sulphur dioxide tax was introduced in 1970. In 2000, it was set at NOK 3 per kg of sulphur dioxide resulting from the use of coal and coke and at NOK 0.07 per litre for fuel oil. Regulations limit sulphur dioxide levels from large stationary sources, and EU directives on air pollution have been implemented. In 1998, sulphur dioxide emissions were 43% below 1990 levels.

Under the Gothenburg Protocol, Norway must reduce its total nitrogen oxides emissions by 28% compared with 1990 levels by 2010, bringing emissions to a level of 156 000 tonnes. In 1998, emissions of nitrogen oxides were estimated to be 4% above 1990 levels. Emissions are principally from transport (70% in 1998) and the oil and gas sector (15%). Decreasing emissions from transport, resulting from the use of catalytic converters, have been offset by rising emissions from offshore activities.

^{10.} Other European countries, the United States and Canada also signed the Gothenburg Protocol.

Under the Gothenburg Protocol, Norway must reduce emissions of non-methane volatile organic compounds by 37% below 1990 levels by 2010. Loading of crude oil offshore is the largest source of emissions of non-methane volatile organic compounds in Norway, accounting for about 55% of emissions in 1998. Oil and gas companies operating in Norway have since the mid-1990s been working on commercialisation of technologies to reduce these emissions. Pilot projects using two different approaches are now under way. In 2000, the Norwegian authorities informed the Implementation Committee under the Convention on Long-range Transboundary Air Pollution that Norway was not in compliance with its commitment. Higher emissions than initially projected are caused by an unexpected increase in offshore loading and shipment of crude oil and by the longer time required to develop commercially-available technology to reduce emissions from offshore loading of crude oil. Norway expects emissions of volatile organic compounds to be below the protocol's target by the end of 2005.

Environmental Issues Related to Electricity Generation

The Water Resources Act and the Watercourse Regulation Act make licences mandatory for the development of waterfalls and the construction of power plants on river systems. Public consultation is also required on proposed projects on river systems.

Protection Plans for Water Resources specify the protection of river systems against hydro power development. It is estimated that about 20% of the country's remaining hydro power potential, about 35 TWh, is in protected watercourses.

The Master Plan for Water Resources sets out an order of priority for considering individual hydro power projects, based on economic considerations and the degree of conflict with other interests, often environmental.

Norway's prime minister, in his 2001 New Year's speech, said that the era of building large waterfalls is now over in Norway. Most economically viable sites are considered to have been developed, and most of the remaining potential sites are located in protected environment areas and/or face opposition to its development by various civil society groups. A White Paper on the future of hydro power has been discussed by the Storting.

Licences have been granted to build three large gas-fired power plants. Any natural gas plants developed on the mainland are to meet the same emission regulations as European gas-fired power plants. The government is also considering guidelines for flexible mechanisms to address nitrogen oxides emissions from gas plants, taking into account the Gothenburg Protocol.

The Norwegian government is seeking to encourage the development of wind energy along the coast where there are many suitable sites with good wind speed, particularly along the coast from Lindsnes in the south to Kirkenes in the north. The development of large wind farms along the Norwegian coast is meeting strong opposition from various non-governmental organisations.

Environmental Policy on Petroleum Activities

Exploration

The most important environmental danger of exploration activities is oil spills. Environmental impact analyses are required under the Petroleum Act before exploration takes place. Specific requirements are laid down to protect fishing interests and the environment. These might include, for example, no-drilling periods and emergency procedures to limit damage from spills.

Development and Operation

The Petroleum Act calls for the preparation and approval of a development and operation plan, and possibly a plan for construction and operation. The developer is obliged to describe the effect of expected emissions and discharges, and the costs and benefits of possible mitigating measures. The carbon dioxide tax applies. Flaring is not permitted beyond a level required for safe operations. Permits are needed to discharge oil and chemicals into the sea, and the Pollution Control Act requires preparation of an emergency plan for acute discharges.

Closing Phase

In July 1998, the Commission for the Convention for Protection of the Marine Environment of the North East Atlantic (OSPAR) passed a general prohibition against the disposal of disused offshore installations. Exceptions are made for concrete installations, certain parts of large steel installations, and installations which can be more justifiably disposed of at sea than on land. The 1982 UN Convention on the Law of the Sea and guidelines from the International Marine Organisation also include rules. As a consequence of these rules, a major portion of Norwegian installations which are not reusable will be brought back to shore for recycling or disposal.

The installations on the Odin field and on several satellite fields have already been removed. Preparations are now being made to abandon most of the Ekofisk I installations. The OSPAR decision does not cover pipelines and cables. As a general rule, the Ministry of Petroleum and Energy proposes to give permission to leave pipelines and cables in place, assuming that they do not cause problems for other users of the seas or impose a heightened risk for fishing compared with the cost of trenching, burial or removal. This implies that pipelines and cables may be abandoned in place when there is no important fishery with bottom gear in the affected area, or that the pipelines are or will be properly trenched or buried. Hazardous substances must be removed from pipelines.

Applying these principles to the Ekofisk and Frigg areas, the ministry recommends trenching the Odin-Frigg gas pipeline and the western half of the water injection Frøy-Frigg pipeline. A free span on the Valhall-Ekofisk oil pipeline should be removed, and the rest of the disued pipelines and cables, which are mainly stable and covered by bottom sediments or buried, should be left in place.

CRITIQUE

Government actions, for example on renewables and energy efficiency, are important, but economic instruments continue to be the heart of Norwegian energy-environment policy.

The government's 1997-98 White Paper on the Norwegian Implementation of the Kyoto Protocol, the Parliamentary Bill on Green Taxes passed by the Storting in June 1998, and an earlier White Paper on Environmental Policies for Sustainable Development, all place a high priority on environmental policies. This is reflected both in enhanced efforts in the field of energy efficiency in order to increase energy conservation and in policies to increase energy production from renewable energy sources.

Economic instruments are nonetheless the chief means of carrying out environmental policy in Norway. On the basis of cost-effectiveness, Norway supports international emissions trading, joint implementation, and the Clean Development Mechanism in the Kyoto Protocol.

The carbon dioxide tax is the main instrument of Norwegian greenhouse gas policies. In the last ten to fifteen years, green taxes have been an increasingly important part of government revenue. Green taxes are levied on fossil fuels, beverage packaging, waste, and health- and environment-damaging chemicals and pesticides. Taxes on fossil fuels are the largest portion of government revenue from green taxes. Greater attention might be given to evaluating the cost-effectiveness of the environmental outcomes of the tax, particularly in light of the development of the emissions quota system discussed below. The impact on the emission level of the carbon dioxide tax has been evaluated several times for some sectors, but there is no systematic monitoring of its total impact. Monitoring and adjustment of the tax in light of experience could significantly improve its efficiency and effectiveness in balancing competitiveness, revenue and environmental objectives.

Compliance with the Gothenburg Protocol will require new policies and measures and the application of new technologies. Given the important contribution of the oil and gas sector not only to the country's carbon dioxide emissions, but also to emissions of nitrogen oxides and volatile organic compounds¹¹, Norway should ensure that policies and measures to regulate all polluting emissions continue to work effectively and efficiently.

^{11.} Sulphur dioxide is also emitted by the oil and gas sector, but sulphur dioxide emissions from the sector accounted for only about 1% of national emissions in 1998.

Attention needs to be given to the impact of environmental policy on energy supply.

Licences have been granted for the construction of three gas-fired power plants. The Norwegian Pollution Control Authority originally required the elimination of 90% of carbon dioxide emissions from the power plants. Available technology cannot meet this requirement. In March 2000, the Storting voted in favour of emission standards that would facilitate the construction of power stations using currently available technology. Despite this decision, the standards required for nitrogen oxide emissions still exceed those achievable by the best available technology. The Pollution Control Authority expects the standards to be achieved by an agreement to trade emissions in the region where the plant is developed. The details of this procedure are yet to be settled. It is thought that the plants could be commercially viable. Companies responsible for building the plants are working to realise the projects. The environmental requirements represent a cost not faced by developers of similar plants elsewhere in Europe.

Caution is necessary in evaluating the carbon dioxide emissions from gas-fired power in Norway. The original decision to reduce carbon dioxide emissions by 90% was based on the contribution gas-fired power would make to domestic emissions. Taking a regional approach may result in different conclusions. For example, Nordel has studied the impact of expanding gas-fired power in the region by two units in Norway and one in Finland. Nordel found that with a combined production of 6 TWh per year, one-half exported, the three units could raise carbon dioxide emissions in Scandinavia, but that total emissions could be reduced by around two million tonnes per year by replacing coal-based condensing production. Combined with an international emissions trading system, which Norway supports, gas-fired power in Norway could be environmentally beneficial.

Different types of energy sources and uses raise different environmental issues. There has been some form of public and/or political opposition against all forms of new power generation because of their potentially negative impact on the environment. As new power capacity is expected to be needed to meet demand within the next five years or so, the government should clarify environmental conditions as soon as possible, including those related to greenhouse gas emissions. A clearer signal on the government's intentions with respect to environmental obligations and regulations related to power generation would enable industry to evaluate options better and start planning. These issues are discussed further in relation to the electricity sector in Chapter 6.

An emissions quota system may replace the carbon dioxide tax.

Sectors covered by the carbon dioxide tax such as private transport and petroleum appear to have adapted well to the relatively high costs placed on emissions. The burden has not been shared by several energy-intensive and greenhouse gas-emitting sectors, such as refineries, metallurgical industries and chemical raw materials processes. The broad scope of the proposed quota system should give a more widespread price signal to reduce emissions and could lead to a more equitable distribution of the cost of reducing greenhouse gas emissions.

The development of an emissions quota system may suggest a major change of approach in Norwegian energy-environment policy, while still using economic instruments. The emissions quota system was proposed by the parliament as an alternative to expanding Norway's carbon dioxide tax regime. The 1999 report of the commission that developed parliament's proposal recommended that Norway replace the tax regime with a system of tradable emissions quotas to comply with the Kyoto Protocol. In June 2001, the government proposed to continue the carbon dioxide tax until it is replaced by a quota system, but some implementation details are to be considered further. A firm decision needs to be taken soon on the future of the tax regime, and on its relationship to the quota system, to avoid uncertainty about the impact of government environmental policy on investments in the energy sector.

The most efficient outcome may well be a combination of the two approaches – taxation and emissions trading – particularly if the approach could be harmonised on a regional or European basis. The decision should be based on an analysis of the impact of the carbon dioxide tax, and the relative cost-effectiveness of emissions trading, an extended tax, or a hybrid system. Either approach should be supported by other abatement measures to develop a coherent and efficient programme to reduce greenhouse gas emissions. Possible costs to industry of the entire climate programme should be evaluated.

An early decision should also be taken on the allocation of the quotas.

The majority in the commission recommended that the government sell the quotas in the market. A minority recommended a combined allocation system, with some being sold and some allocated free-of-charge. A second minority group saw the question of allocation as essentially political. Clearly, the quotas have a market value, but the means of allocation for existing and future emitters raise equity and efficiency issues. These issues could be resolved politically, provided the decisions are based on an analysis of the costs and benefits of the range of options.

The question of how emissions quotas are allocated will be one of the key decisions to be made in a quota system. The sooner this question is answered, the clearer the signal will be to future private sector participants and the greater the likelihood of a smooth transition towards a quota system. Competitiveness issues and risks of leakage will remain key concerns for the implementation of a quota system. Under a scenario where a greenhouse gas-intensive industry would simply move its operations from Norway to another country with less stringent emissions regulations, and thus where operating costs are lower, global emissions would remain unchanged, but Norway would have lost a potentially important economic activity. The system should thus be fully compatible with any international system and also allow for reductions obtained abroad. In this sense, it would also be particularly beneficial to have a dialogue with other countries, especially neighbouring Nordic countries, but also others considering domestic trading schemes. Compatibility between different countries' emissions trading schemes is desirable.

Norway should continue to take an active role in international negotiations on climate issues.

Given the possible limited potential for abating emissions at relatively low cost in Norway, it will be critical to take into account reductions achieved abroad and to develop a system that will not impose unacceptable costs on Norwegian industry. It will thus be important to continue examining possibilities for greenhouse emissions reductions abroad, whether this is through internationally-agreed arrangements or bilaterally with other countries, or by other means.

Emissions trading and carbon dioxide taxation raise issues of competitiveness and trade impacts. Ideally, both policy approaches would be part of an internationally-agreed approach to the use of economic instruments. In common with other IEA countries, Norway will need to determine its future approach to the Kyoto Protocol in light of the developing US policy. Following the Bonn negotiations in June 2001, the Norwegian government announced that it will start the ratification process, regardless of the US position.

Norway has been an important contributor to the development of efficient international market-based mechanisms proposed under the Kyoto Protocol, such as emissions trading, Joint Implementation and the Clean Development Mechanism. Norway should ideally continue this role, in the context of international negotiations.

RECOMMENDATIONS

The Government of Norway should:

- □ Review the impact of environmental policies on the development of energy projects.
- □ Evaluate the efficiency and effectiveness of existing policies and measures, in particular the carbon dioxide tax.
- □ Base future policies and measures on market-based instruments, developed in consultation with industry and other energy market players, including neighbouring countries.
 - If an emissions quota system is adopted, make early decisions on the relationship of the quota system to the existing carbon dioxide tax, and on the mechanism for allocating quotas.
- □ In developing new policies and measures, give particular attention to the petroleum and transport sectors, which are both key emitters in Norway.
 - Ensure that policies and measures take into account the importance in Norway of greenhouse gas emissions other than carbon dioxide.

5

ENERGY EFFICIENCY AND RENEWABLES

ADMINISTRATION

Energy efficiency measures are largely the responsibility of the Norwegian Water Resources and Energy Directorate. Activities focus on buildings, industry, information and education and the introduction of energy-efficient technology. The directorate also has responsibility for administration of support schemes for new renewables.

In 1999, Regional Energy Efficiency Centres were established in each of the 19 counties in Norway. The regional centres work primarily with local utilities, but are also open to participation through co-financing with others, such as oil companies, municipalities and manufactures of energy-efficient equipment. Local utilities can collect a supplementary charge of up to NOK 0.003 per kWh on transmission tariffs to finance energy efficiency activities. Activities financed by the levy are primarily carried out through the regional centres, but utilities may use the revenue from the surcharge to conduct their own efficiency activities.

Prior to the White Paper on Energy Policy submitted to the parliament in March 1999, a national energy committee reported to the government that the responsibility for energy efficiency measures in Norway is fragmented and should be more purposefully organised. A new agency has been established to take over the work in this area now undertaken by the Norwegian Water Resources and Energy Directorate. The agency, known as Enova, is organised as a public enterprise and located in Trondheim. Enova was established in June 2001, and will be fully operational by 1 January 2002.

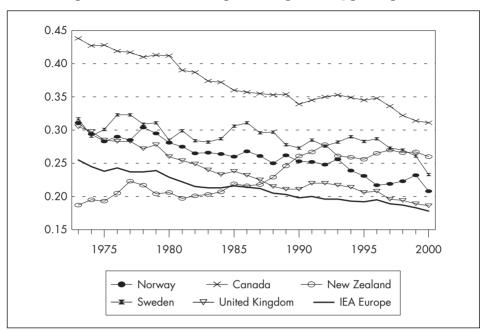
ENERGY CONSUMPTION TRENDS

Energy intensity (energy use per unit of output) is illustrated in Figure 15 in aggregate, and by sector in Figure 16. Overall, energy intensity has fallen steadily and consistently with trends in Europe. The industry sector shows the greatest fall, while in transport there has been very little movement since 1980. Changes in the ratio of energy consumption to GDP can be explained by shifts in energy intensities (related to energy efficiency improvements) and structural changes.

In Norway, increased electricity use has driven up total stationary energy use in manufacturing, services and residential uses. The share of raw materials (oil and gas) production in total value-added from manufacturing has increased. This has moved the sector towards a more energy-intensive structure, pushing up energy consumption per unit of GDP. Energy use in the commercial/service and residential sectors has been climbing steadily as private incomes and production of services have increased. As a result, the manufacturing share of total stationary energy use has fallen steadily.

Figure 15

Energy Intensity in Norway and in Other Selected IEA Countries, 1973 to 2000 (toe per thousand US\$ at 1995 prices and purchasing power parities)



Source: Energy Balances of OECD Countries, IEA/OECD Paris, 2001.

In the residential sector, increased use of electricity for space heating in bigger homes and greater use of electrical appliances and lighting have raised the consumption of energy. About 60% of residential energy use, principally electricity, is for heating. The size of Norwegian homes has risen with per capita income. Energy use has also risen with the steady decline in household sizes since space heating, and lighting to some extent, are independent of the number of people in a house. In the commercial sector, energy consumption has also risen with floor area and value-added, principally because of demand for heating.

ENERGY EFFICIENCY PROGRAMMES¹²

Residential/Commercial Sector

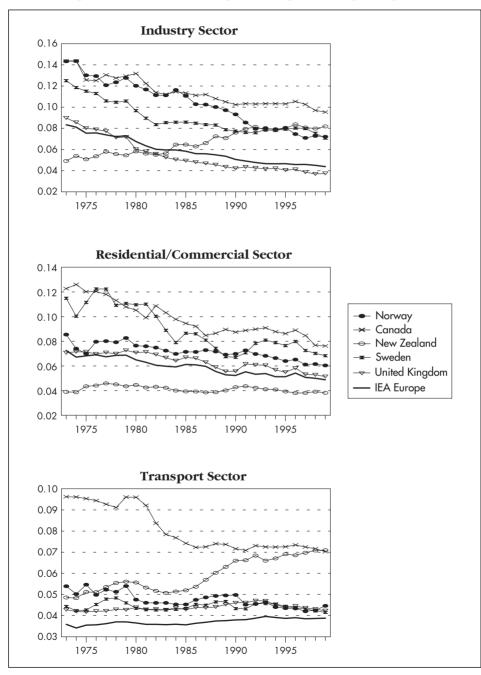
Building Codes

New building codes came into force on 1 July 1997. A 25% reduction of energy use is expected to be achieved in new buildings by more stringent insulation requirements for walls, windows, floors and roofs.

^{12.} The IEA publishes summaries of Member country energy programmes in IEA Energy Efficiency Update (www.iea.org/pubs/newslett/eneeff).

Figure 16

Energy Intensity by Sector in Norway and in Other Selected IEA Countries, 1973 to 1999 (toe per thousand US\$ at 1995 prices and purchasing power parities)



Source: Energy Balances of OECD Countries, IEA/OECD Paris, 2001.

Efficiency Standards and Labelling for Household Appliances

Energy labelling for refrigerators and freezers, washing machines and tumble dryers has been introduced following the EU directives on these items. Standards and labelling for lamps came into force in January 2001.

Energy Efficiency Network for Buildings

The Energy Efficiency Network for Buildings was established in 1996 to exchange information and experience on energy efficiency projects in buildings. The network is also used as a forum for developing strategies for energy administration in buildings. Participants are obliged to submit information on their use of energy in buildings for inclusion in a national statistics database on energy use in buildings. Reports on energy use in buildings were published in 1998, 1999 and July 2000.

Electricity Billing

In 1995, a pilot project involving four energy utilities in three regions sought to develop a simplified and more informative electricity bill for household consumers. The goal was to give customers a better understanding of both energy efficiency and the liberalised electricity market. Participating customers received frequent electricity bills based on actual electricity consumption. The bills included a graphical, temperaturerelated comparison of their use of energy over time. Information on energy efficiency measures, the possibility of changing suppliers and information on tariffs were also included in the bill. A similar project carried out by the Nordic Council suggested potential energy savings of 5% to 10%.

From 1 June 1999, all utilities have been required to issue simplified electricity bills. Bills are now sent quarterly, or even more frequently, and are based on actual consumption for each period.

The Norwegian Government Environmental Fund

The Norwegian Government Environmental Fund is a loan scheme administered by the Norwegian Industrial and Regional Development Fund. Loans are granted for projects that reduce emissions of greenhouse gases and other environmentally harmful gases, and for energy efficiency investments.

Other Financial Measures

"Øko-bygg" is a development programme that was started in 1998. The programme provides information, advice and grants to promote the use of eco-efficient technology, including more efficient and flexible energy use in the construction industry. The Norwegian State Housing Bank has various loan and grant schemes for residential energy efficiency measures.

Industry Sector

Industrial Energy Efficiency Analysis

In 1999, a government programme was introduced to increase energy efficiency in industry by reducing the cost of raw materials and energy used in core processes. Pilot projects have been carried out in companies producing nonferrous-alloys, pulp, paper and paperboard. These pilot projects have shown that certain materials have a significant impact on specific energy consumption and output of the process. Average consumption of electricity was reduced by between 5% and 10%, sometimes with little or no capital investment. The programme will be continued, with power-intensive industry as the main target.

Industrial Energy Statistics

Statistics Norway collects energy statistics from industry. Industrial plants receive individual feedback on their energy performance compared with others in their industry sub-sector. Benchmarking is expected to yield a reduction in energy intensity of 5% to 10%.

Industrial Energy Efficiency Network

The Industrial Energy Efficiency Network established in 1989 now has a membership of 650 enterprises from 13 industries. Participating enterprises are offered various forms of assistance, in two phases. In the first phase the enterprise has to establish an energy monitoring system. The government supports the company with training for key personnel and contributes to consultant fees. In the second phase, the company undergoes an energy audit. Performance benchmarking is also an important network activity.

Grants for Production of Energy-efficient Products

Grants are given to assist companies that manufacture and deliver energy-efficient products. The programme is focused on marketing products, with an emphasis on energy efficiency in the building industry.

Voluntary Agreements

As part of its climate change action plan, the government hopes to develop voluntary agreements with industry for improved energy efficiency and emissions reductions. Norway has only one voluntary agreement, with the aluminium industry. Voluntary agreements with industry have proved difficult to negotiate, possibly because of the discussion on quotas for a domestic emissions trading system.

Transport

Taxes

Transport pricing reflecting marginal social costs is a major element in Norwegian transport policy. The policy is based on the premise that correct pricing will affect the total transport volume, the distribution between different means of transport and the fuel efficiency within each group. Relatively high fuel taxes and a consumer purchase tax on private cars are considered by the government to be important measures to provide incentives to reduce external costs from transport.

Norway has a high purchase tax on private cars, set according to the weight and energy performance of different models. The purchase tax on cars was initially fixed according to the value and weight of different models. The weight component may be an incentive to purchase lighter, more energy-efficient cars. Since 1996, the tax has been differentiated to replace its value-base element with an energy performance component.

The duties on petrol and diesel, as well as the registration tax on vehicles, are also set high as an incentive to encourage energy efficiency.

The legal basis for introducing road pricing is now being developed. The road pricing system is intended to reduce congestion and to improve the local environment. Parking policy is also considered an essential measure for reducing congestion and environmental problems.

Consumer Information

The Ministry of Environment distributes consumer information on fuel economy and emissions from cars, buses and lorries. Norway has also implemented the European Union norms on emissions from vehicles, known as EURO I and II. EURO III came into effect on 1 October 2000. Norway will also implement all the relevant EU regulations on emissions from transport. Work has started on implementing the EU directive on availability of consumer information regarding fuel economy and carbon dioxide emissions in marketing of new passenger cars.

RENEWABLES

Large-scale hydro accounts for almost all electricity production in Norway, and for more than 70% of non-transport energy use. Bioenergy is the second most important renewable energy source. In 1999, bioenergy supplied about 1 Mtoe, equivalent to about 10% of the energy supplied by hydro. The government plans to increase "new" renewable capacity (i.e., other than large-scale hydro) by 7 TWh (about 0.6 Mtoe). This will include increasing annual use of central heating based on "new" renewable energy sources by 4 TWh per year by 2010, and constructing wind generators with a production capacity of 3 TWh per year by 2010.

Wind

In May 2001, there were 23 wind turbines in Norway with an installed capacity of 13 MW. In the course of a year, the turbines can produce about 38 GWh. In December 1999, a licence was granted for a large wind power plant at Havøygavlen in Finnmark. The licence permits the construction of 26 wind turbines, each up to 1.5 MW, giving a total of 39 MW. This will make Havøygavlen Norway's largest wind farm. Wind conditions are very good at the site and production is expected to be up to 150 GWh per year. The wind farm will be able to meet the electricity needs of 6 000 households. Start of production is expected in 2002. Two smaller wind projects of 3 MW and 4 MW have also been granted licences. A further four applications for permission to establish wind parks are now under consideration. These are very large projects with a total capacity of about 470 MW, giving an annual production of about 1.4 TWh. There are many other suitable sites for the development of wind power along the coast and in the mountains of Norway, particularly along the coast from Lindesnes in the south to Kirkenes in the north.

Other Renewables

Three ferro-alloy plants generate electricity totalling 200 GWh per year from waste heat. Modest amounts of electricity are generated using gas turbines and gas engines. For example, gas from the Grønmo landfill in Oslo is used in electricity production. About 25 000 heat pumps are installed in Norway, giving an energy saving of about 0.2 Mtoe compared with the use of other sources to obtain the same amount of heat.

Government Support

Government support for energy efficiency measures and for investment in new renewables has been increasing since 1995. In 1998, the budget was NOK 193 million, in 1999 it was NOK 248.5 million, and in 2000 NOK 340 million. Heat production and distribution based on new renewables and waste heat, as well as wind energy, have been given priority. The aim is to establish markets for new technologies and for energy generated from new renewable sources. Partial funding of up to 25% of the investment cost is granted to investment projects.

In addition to grants for investments, a support scheme for the production of wind power, corresponding to half the consumer tax on electric power, has been introduced. In 2001, the consumer tax on electricity was NOK 0.113 per KWh, giving a subsidy of NOK 0.0565 per kWh of wind power produced. Investments in new renewable energy, heat pumps, district heating, natural gas grids, small-scale hydro power plants (less than 1 000 kW), and refurbishment of all hydro power plants are exempted from the 7% investment tax. Both the support scheme and the tax exemption have applied since January 1999.

Partial funding of 20% to 25% of the investment cost is granted to projects based on biofuels, solar energy and heat pumps. The programme also supports projects in

energy recovery from waste heat, and district heating. There is a similar programme for wind power to support investments in wind power plants that have a total capacity of over 1.5 MW.

The Water Resources and Energy Directorate is responsible for distributing information and advising on the use of new renewable energy sources.

CRITIQUE

Energy Efficiency¹³

Norway has achieved a marked transition from oil to electricity, but energy consumption continues to grow, particularly in the residential/commercial sector.

Over the last thirty years in Norway, there has been a marked transition from consumption of oil to relatively more use of electricity. In 1973, oil accounted for 55.9% of final energy consumption, compared with 42.2% in 1999. In the same period, electricity consumption rose from 38.1% to 45.7%. After a slight decrease in the late 1980s, energy consumption rose continuously in the 1990s.

In 1999, energy consumption in industries was 40.5% of final energy consumption. About two-thirds of this was consumed in the energy-intensive industries¹⁴. The residential/commercial sector accounted for 34.8% of final energy consumption, and transport for 24.7%.

From 1980 to 1999, the percentage increase in energy consumption was greatest in the residential/commercial sector, where energy consumption rose by about 45%. Electricity is the most important energy carrier in this sector, principally for space heating. About 41% of residential energy (electricity) use is for heating, 24% for water heating, 11% for lighting, and 8% for cooking.

Energy consumption in energy-intensive industries has increased by about 20% since 1980. Electricity is the most important energy carrier in energy-intensive industries, but consumption has remained relatively stable over the last ten years. In other industries, energy consumption has been fairly stable over the last 20 years.

Energy consumption has risen since 1973, contrary to the trend in other IEA countries.

Per capita stationary energy use (energy use in sectors other than transport) has increased in Norway since 1973, contrary to the trend in most other IEA countries. This is partly because the industrial structure has become more energy-intensive, homes have become larger, and the use of electrical appliances has increased.

^{13.} Much of this section is based on "Trends in Norwegian Stationary Energy Use – An International Perspective", a report by the International Energy Agency, published by the Norwegian Water Resources and Energy Directorate, October 2000.

^{14.} Manufacture of primary aluminium, ferro-alloys, iron and steel, other non-ferrous metals, and basic chemicals. The pulp and paper industry is also a major consumer of energy.

Energy savings lagged other countries in the 1970s and 1980s. Since 1990, savings in the stationary sector in Norway appear to have achieved a higher rate than in many other IEA countries.

Stationary energy use per capita is currently at about the level of Sweden and the United States. It is far lower than in Canada, a country with a similar climate and energy-intensive industry structure. Allowing for differences in outdoor temperature and industry structure, stationary energy use is just above the average of the IEA Member countries studied¹⁵.

Electricity use is particularly high. Limited supply options may direct greater attention to energy efficiency.

Electricity accounts for over 70% of stationary energy use in Norway. Electricity use per capita is far higher in Norway than in any other IEA country. This is explained by the high share of electricity-intensive industries in Norway, and by the use of electricity to heat homes and service buildings and to produce industrial process steam. The use of electricity for heating is not surprising given the early development of vast hydro resources for inexpensive electricity and the relatively recent exploitation of offshore gas resources. Limited options for future electricity supply may call for greater emphasis on measures to improve energy efficiency.

Low energy prices and rising incomes have encouraged growth in energy use.

Electricity prices and, to some extent, oil prices have been low over the period since 1973. It is reasonable to expect that energy savings in Norway have not been as great as in IEA countries where end-use prices have been higher. In the period to 1990, development of hydro resources allowed the development of electricity-intensive industries and offset the impact of rising oil prices. Incomes grew markedly following the development of oil exports. Indoor heating comfort levels and ownership of electrical appliances increased to the same levels as, for example, in Sweden and Denmark. Until 1990, energy savings in industry were equivalent to those in other IEA countries, but rising comfort levels offset improvements owing to house insulation in the residential sector.

Residential energy savings have occurred since 1990, but energy use is expected to grow.

Between 1990 and 1997, energy savings of about 10.5TWh were achieved in the stationary energy use sector in Norway. Since 1990, savings of about 4 TWh have occurred in residential energy use. However, income levels and expenditure on housing continue to rise and bigger houses can be expected to drive up energy service demand. New forms of energy use, such as heating driveways and vacation homes, are also expected to increase electricity use.

Energy intensity in the services sector fell until 1995, but has recovered since.

In the services sector, energy use per unit of value-added also fell more than in most other IEA countries between 1990 and 1995. Energy use grew rapidly to 1997. It

^{15.} Australia, Canada, Denmark, Finland, France, former West Germany, Italy, Japan, the Netherlands, Sweden, the United Kingdom and the United States.

is not yet clear if this growth indicates a longer-term trend in the sector. Savings of 2.5 TWh are estimated for the period 1990-1997.

Savings in industry occurred at a lower level in the 1990s compared with the 1980s.

Corrected for changes in the manufacturing structure, energy savings in manufacturing continued in the 1990s at a lower rate, but still greater than in most other IEA countries.

Energy use in transport may have been influenced by the carbon dioxide tax.

High fuel taxes, including the carbon dioxide tax, are the primary measure used to increase transport fuel efficiency. Fuel taxation in Norway is high compared to other countries and to other sectors in Norway using fossil fuels. The effect of the carbon dioxide tax has been evaluated by Statistics Norway. The evaluation suggests that a carbon dioxide tax on private transport increasing fuel prices by 6% to 7% will reduce the use of fuel by 2% to 3% each year. Most of the effect is achieved by reducing the transport volume by 1.5% to 1.9%. Although the analyses indicate that the tax has had an effect, the calculations are uncertain. The long-run effects on fuel efficiency have not been studied.

Some policy implications are to be addressed in establishing the new agency for promoting efficiency and new renewables.

Consumption of energy in the industry, residential/commercial, and transport sectors has grown in Norway in recent years, despite the objective of the government to limit the growth in the use of energy. The Norwegian government recognises that greater effort is necessary and has taken an important step by establishing a new agency for promoting energy efficiency and new renewables. The next step is to ensure that the new agency has a sound footing and that it works within the framework of the liberalised electricity market to improve efficiency of energy end-use and increase the production of new renewable energy.

Renewables

Promotion policies for renewables should be fully compatible with the operation of the liberalised electricity market, and should be developed in consultation with the market participants. Decisions on the level of support for the development of "new" renewables should take into account that large-scale hydro is also a renewable energy source and will generally be the most economic option for renewable electricity generation in Norway.

RECOMMENDATIONS

The Government of Norway should:

 $\hfill\square$ In establishing the new agency for promoting energy efficiency and new renewables:

- Set clear objectives for the agency, along with clear time scales for achieving its objectives; require regular reports on the actions taken and progress towards the objectives; require the agency to develop a range of measures for improving energy efficiency, chosen according to their cost-effectiveness, with a particular focus on electricity consumption.
- Consider the continuation of existing programmes directed at improving energy efficiency in the industry and domestic sectors.

□ Undertake public awareness programmes to complement energy taxation.

□ Undertake an assessment of the effectiveness of the vehicle taxation regime to determine if it is contributing to improvement in the vehicle fleet as a whole; develop ways of improving overall fleet efficiency.

ELECTRICITY

POLICY

Regulatory Reform

The Energy Act introduced a clear distinction between a market for power production, and the natural monopoly functions of the grid. The act allows customers at all levels to select their supplier. The aim of the restructuring was to:

- Level the price of power in various regions.
- Improve the efficiency of power production and grid operation.
- Give consumers correct signals to save energy.
- Provide incentives for the optimal selection of investments according to profitability.

Production and electricity prices became fully determined by market mechanisms, customers at all levels were allowed to choose their supplier, enterprises owning the national grid had to allow third party access, with transmission tariffs regulated by the Norwegian Water Resources and Energy Directorate. The state electricity authority was split into a production company (Statkraft) and a network company for the high-voltage grid (Statnett). Local government companies were also required to unbundle generation and distribution on an accounting basis.

In 1998, the fee for switching suppliers by small consumers was discontinued and load profiling introduced, *i.e.* the use of average consumption patterns to determine individual consumption in between metered measurements. Customers receive an invoice which specifies the electricity charge, the transmission charge and taxes, each making up about one-third of the total charge. For most consumers, electricity charges are based fully on actual spot market prices.

An electricity market for physical and financial contracts was created, but later merged with the Swedish market in the Nord Pool physical market. In 2000, more than one-quarter of total consumption of electricity in the Nordic countries was sold in the Nord Pool physical market.

Originally, the total revenues from the transmission tariffs set by the Water Resources and Energy Directorate were based on covering operating costs plus a rate of return, but this did not produce the desired cost efficiency improvement in distribution utilities. In 1997, price caps were introduced, with tariffs 2% to 3% per year below consumer price inflation in the period 1997 to 2001. To prevent excessive profits, a maximum return is set at 15%, while a minimum rate of return of 2% is guaranteed.

Expected Developments

In the ten years since the Energy Act was passed, the electricity supply sector has undergone a major readjustment. The experience so far indicates that certain regulations must be altered in order to comply more closely with the intentions of the law. Amendments proposed by the government include:

- Some adjustments to the licence agreements on electrical systems, trading of electrical energy and district heating.
- New regulations on system responsibility, rationing and requirements for quality delivery.
- Legalising some regulations currently authorised under licence arrangements.
- Eliminating the current legal requirements for energy efficiency; formation of a new government body responsible for energy efficiency

Electricity and the Environment

The 1991 Energy Act introduced specific requirements for local energy utilities to provide customers with information and advice on the efficient use of energy.

In a White Paper on Energy Policy submitted to the Storting in March 1999, the government stated that it intends to pursue an energy policy that supports an ambitious environmental policy. The government considers that Norway must prepare for a future in which energy, and electricity in particular, is in shorter supply and becomes a more valuable commodity. Changes in energy production and use must take place in a way that has an acceptable impact on public welfare. The government's objectives for limiting energy use and bringing about a shift in energy production and use have since been confirmed by the Storting. The objectives are:

- 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 by 2010.
- To construct wind generators with a production capacity of 3 TWh per year by 2010.

The Storting has approved measures to achieve these objectives, including a gradual increase in the electricity tax combined with investment grants totalling up to NOK 5 billion over a ten-year period. Natural gas projects are to be supported by the grants.

INDUSTRY STRUCTURE

Generation

Almost all Norway's electricity is produced by hydro generation. Variations in output are largely caused by fluctuations in the level of precipitation. The majority of hydro stations are located in western Norway and Nordland, while the principal markets are in south-eastern Norway. Consequently, transmission lines are long and have to cross wide fjords and mountains.

New hydro capacity is one option for expanding generation capacity, but is likely to be restricted to relatively small developments. On 1 January 2001, the prime minister announced that there would be no more new large-scale hydro power developments in Norway. Most of Norway's hydro power resources have been developed. A substantial part of the remaining resources is protected against development because of environmental considerations. Public and political opinion opposes new major hydro power developments, and thus there are very few new projects either in planning or under construction.

The Storting has given partial consent for the planned Upper Otta project, which will produce about 540 GWh per year, if developed. Other projects in planning or undergoing licensing are much smaller. Tax incentives for refurbishing and upgrading existing hydro power plants might also increase hydro power production, but on a limited scale.

Diversification of the generation mix remains a possibility. Licences for gas-fired plants have already been issued. Following the decision taken by the Storting in early 1999, the government has amended regulations to remove restrictions on carbon dioxide emissions from gas-fired power plants, and to ensure that Norwegian producers meet the same regulations as are required for other European producers. Emissions of nitrogen oxides remain higher, however, and could only be met by regional trading in emissions. The criteria for emissions from gas-fired plants are expected to apply until an international quota system for greenhouse gases is established.

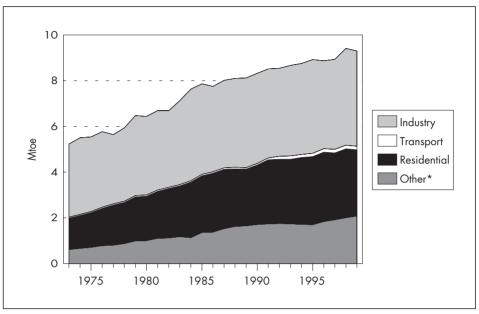
Electricity normally accounts for about 50% of energy consumption in industry, and about 70% of energy consumption in the residential/commercial sector.

Utilities

There are 344 electricity utilities in Norway. The Norwegian power industry is characterised by a fragmented owner structure and small units. There have been no major changes in the structure of the industry since market reform started.

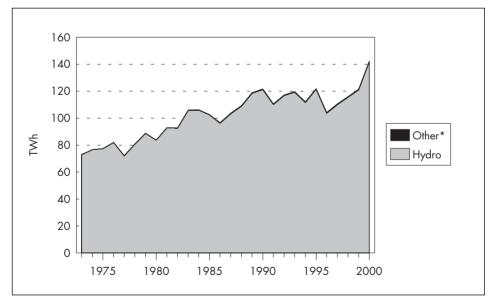
Almost half the utilities are involved in generation, grid management and operation, or trading only, while the rest are engaged in more than one sort of activity. There are 155 vertically-integrated utilities, *i.e.* companies engaged in both competitive

Figure 17 Electricity Consumption by Sector, 1973 to 1999



* includes commercial, public service and agricultural sectors. Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2001.

Figure 18 Electricity Generation by Source, 1973 to 2000



* includes negligible quantities of coal, gas, oil and combustible renewables. Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2001. (generation and/or trading) and monopoly (grid management and operation) activities. Of these companies, 81 are engaged in generation, trading and grid management and operation.

A total of 160 companies are engaged in electricity generation in Norway. Of these companies, 26 are confined to generation only, while 23 are engaged in generation and grid management and operation, and 30 are engaged in generation and trading.

There are 208 companies engaged in grid management and operation. Of these, 53 are involved in grid management and operation only. Twenty-three are engaged in grid management and operation, and electricity generation; 51 are engaged in grid management and operation and trading.

In all, 242 companies are engaged in trading, and 80 of them are not involved in any other activities.

Figure 19 summarises the different combinations of activities of the energy utilities. The overlapping circles indicate the extent to which the utilities are engaged in several types of activities.

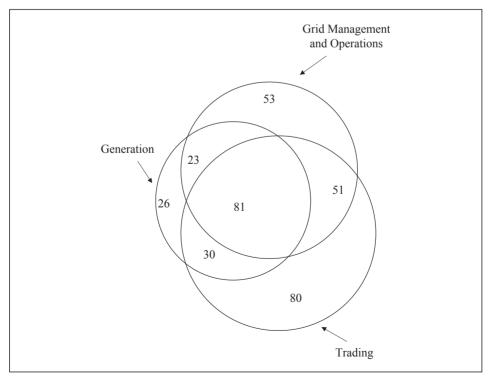


Figure 19 Overlapping Activities of Electricity Utilities in Norway

Source: Norwegian Water Resources and Energy Directorate.

Ownership

Privatisation of the power industry has not been a part of the market reform. Municipalities and county municipalities own about 57% of Norway's electricity generation capacity, the State about 30% and private companies about 13%. The State owns a large proportion of the central grid, and private companies, county municipalities and municipalities own the remainder. Municipalities and county municipalities own the majority of the regional and distribution grids.

State ownership of the central grid is managed through the state enterprise Statnett SF, and ownership of electricity production is managed through the state enterprise Statkraft SF. If a company is organised as a state enterprise, the State provides a guarantee for the company's liabilities and the company must be entirely state-owned.

Of the 344 energy utilities in Norway, municipalities and county municipalities wholly or partly own 250 and 43 utilities respectively. Of the total, only 69 utilities are entirely in private ownership.

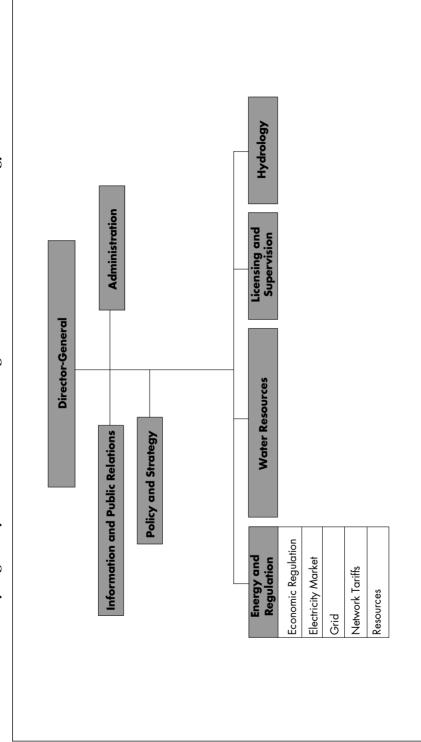
REGULATION

The Energy Act provides the legal basis for regulation of grid management and operation. The objectives are to control monopoly operations to safeguard consumer rights, and to ensure efficient development of the grid.

The Norwegian Water Resources and Energy Directorate defines the framework for control of monopoly operations. The directorate may issue any instructions necessary to ensure compliance with legislation and licensing conditions relating to control of monopoly operations. The directorate's decisions may be appealed to the Ministry of Petroleum and Energy. Regulation is only one of many functions of the directorate. The structure of the regulatory functions is illustrated in Figure 20.

The regulations require the grid owner to make transmission services available to all participants in the market on the same conditions. No discrimination between grid customers is permitted. Tariffs are set throughout the grid in a system known as point tariffs, discussed further below. To prevent cross-subsidisation, energy utilities involved in both monopoly operations and activities exposed to competition are required to keep separate accounts of monopoly operations.

The monopoly control involves two main activities. First, the directorate determines income caps to ensure efficient development of the grid and reasonable charges for customers. Second, the directorate determines the framework within which the point tariff structure must be developed.





Source: The Norwegian Water Resources and Energy Directorate.

From 1997, the grid companies have been regulated by income caps. The Water Resources and Energy Directorate determines an income cap for each grid company, based on factors that influence costs in the area served, such as climate, topography and settlement patterns. The company's income must not be higher than a figure determined by the directorate. This system is intended to ensure that grid companies do not make unreasonable profits on monopoly services and that cost reductions benefit customers.

Income caps are set for a minimum of five years. For the period 1997-2001, income caps are based on the grid companies' costs in 1994 and 1995. Income caps are reduced each year on the basis of a general efficiency requirement of 1.5% and an individual efficiency requirement of up to 3%. The individual efficiency requirements are determined by comparing analyses of the companies' costs and relative efficiency. The more efficient grid companies need only meet the general efficiency requirements. During the present regulation period, grid companies with an individual efficiency requirement need to improve efficiency by 38% compared with the most efficient grid companies. The weighted average efficiency requirement in 2000 was 2.6%.

The efficiency requirement is an incentive for companies to become more efficient because their rate of return rises if they can reduce their costs. On average, for the regulation period the grid companies are guaranteed a minimum rate of return of 2%, but are limited to a maximum rate of return of 15%.

The income cap is increased annually by a factor equivalent to half the percentage increase in energy supplied. The formula is intended to encourage grid companies to operate more efficiently, and to consider alternatives to investments in increased transmission capacity. A reduction in the quantity of energy supplied does not result in a reduction in the income cap. Income caps are corrected annually for inflation.

Income caps are not altered if grid companies merge. The income cap of the new company is determined by the sum of the income caps of the companies that have merged, so that any efficiency gains from mergers are retained in the company.

The regulation period from 2002 will be based on the same principles, but the Water Resources and Energy Directorate will give close attention to:

- Ensuring that both new investment and replacement investment are efficient.
- Ensuring that evaluation of investment is undertaken from a commercial and national perspective.

The sum of the income caps for all grid companies in 2000 was NOK 13.8 billion. Of the total revenues in grid management and operations, 15% accrued to the central grid, 22% to the regional grid, and 63% to the distribution grid.

PRICING

Domestic electricity prices are illustrated in Figure 21. Industry prices are not available. Domestic electricity prices in Norway are very low compared to other countries. Prices are lower than in New Zealand, where electricity generation is also hydro-based and where competition in a liberalised market has been similarly effective in reducing prices. Prices in Norway are very much lower than in Finland and Denmark, which compete with Norway in the Nordic market. After-tax prices are also low, in part because the high carbon dioxide tax does not affect hydro-based electricity.

Transmission Tariffs

All grid companies are required to use point tariffs when charging for transmission. Transmission tariffs are charged by the grid companies at the point of connection and are independent of power contracts. All customers who are connected to the central grid pay a point tariff for the electricity they feed into or tap from the central grid.

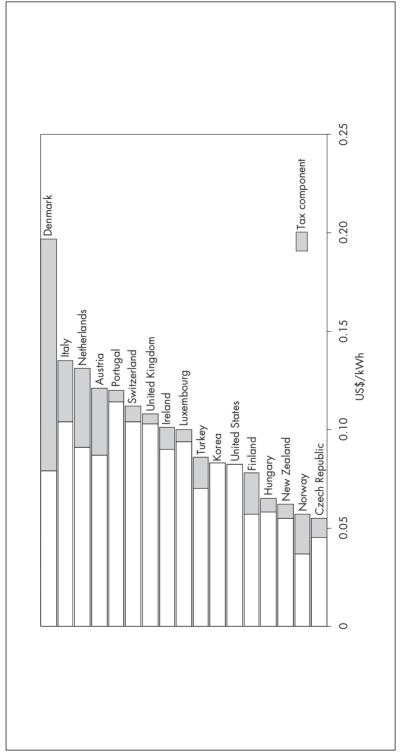
Customers connected to regional grids pay a proportion of the costs of the central grid as well as those of the regional grid. Similarly, all customers connected to the distribution grid pay the costs of the distribution grid and a proportion of the costs of the regional grid and the central grid. Point tariffs for the distribution grids are higher than for the regional and central grids.

Point tariffs have a variable component and one or two fixed components. There is also a capacity charge if there are bottlenecks in the transmission system.

Energy Charge

The variable component, the energy charge, is intended to reflect the marginal losses in transmission and distribution. The energy charge also depends on the amount of energy (kWh) that is fed into or tapped from the grid, and on the spot price.

From 1 January 1998, the energy charge in the central grid has been based on the percentage marginal loss in each node, and on the spot price. The percentage marginal loss is calculated eight times a year, and there are different daytime, night-time and weekend rates. The marginal loss varies with the load on the system and thus according to where the nodes are situated in relation to each other. In general, feeding into the grid in a surplus area will incur a positive energy charge, and tapping out in the same area will incur a negative energy charge. Through tapping and feeding in the same node, the marginal losses should be around zero. The marginal loss rate in the central grid varies by +/-10%.

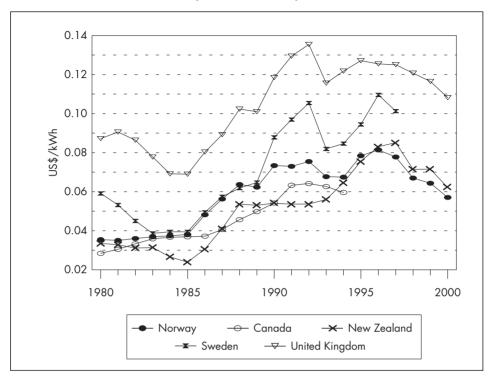


Domestic Electricity Prices in IEA Countries, 2000

Figure 21

Note: Ex-tax prices for the United States. Tax information not available for Korea. Data not available for Australia, Belgium, Canada, France, Germany, Greece, Japan, Spain and Sweden. Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2001.

Figure 22 Electricity Prices in Norway and in Other Selected IEA Countries, 1980 to 2000 (Household sector)



Source: Energy Prices and Taxes, IEA/OECD Paris, 2001.

For feeding into the grid, the energy charge is always based on the percentage marginal loss for that specific node, regardless of central, regional or distribution grids.

In some regional grids, marginal loss rates for the energy component, for tapping out, are calculated in the same way as for the central grid. In other cases, the loss rate is calculated as the average annual percentage loss in that grid.

In distribution grids, the average annual loss for tapping out from the grid is calculated. The regulations also permit the grid company to take an energy charge that is higher than the real losses.

Capacity Charge

The system price (the Nord Pool spot price) is determined as if there were no bottlenecks in the transmission grid. Bottlenecks are managed by using zonal pricing on each side of the bottleneck. The price difference is the capacity charge, and is intended to reflect bottlenecks and differences in equilibrium prices.

Fixed Charges

The fixed components do not vary with the amount of electricity that is fed into, or tapped from, the grid. The fixed component of the tariff for the central grid has a connection element and a power element. Both elements are based on installed capacity, measured in MW in the power stations. In 2000, the connection element for feeding into the grid was NOK 11 000 per MW, and NOK 14 000 per MW for tapping out. The power charge for feeding into the grid was NOK 45 000 per MW, and NOK 63 000 for tapping out. All network companies normally charge the same fixed components in the input tariff as the central grid.

The fixed components for consumption tariffs in the regional grids vary among the companies. Normally they charge a power element, based on maximum power consumption, but they can also charge a fixed component of a set sum per year.

Small consumers connected to the lowest grid voltages in the distribution grids normally pay a fixed charge, while larger consumers connected to higher grid voltages pay one or more power charges. Charges for electricity consumption vary from one grid to another because of natural conditions, and thus the costs of distributing electricity to customers differ greatly in different parts of the country. Charges will also vary according to how efficiently the grid companies operate. The average tariff for a household customer in 2000 was NOK 0.23 per kWh, including value-added tax. The lowest tariff was NOK 0.17 per kWh and the highest tariff was NOK 0.39 per kWh.

Priority is currently being given to improving the short- and long-term efficiency of the point tariff system.

TRADE

Norway has connections with Sweden, Denmark, Finland and Russia. The transmission capacity to Finland and Russia is small, and the connection with Russia is used only for imports to Norway. The largest transmission capacity is between Norway and Sweden, and reaches a maximum of 2 500 MW. The transmission capacity between Norway and Denmark is 1 000 MW. It may be theoretically possible to transport almost 20 TWh per year of electricity between Norway and neighbouring countries. However, operating and market conditions restrict the amount that can be transmitted.

Power trade with Sweden, Finland and Denmark is based on Elspot, the physical spot market of Nord Pool, the Nordic Power Exchange. In addition, within its responsibility as the system operator for the Norwegian power system, Statnett administrates the regulatory market. These markets are described below.

Two new cables, one to Germany and one to the Netherlands, are planned to be operating in the course of 2005. They will increase the transmission capacity between Norway and Europe by 1 200 MW. The market is expanding as countries

in the region take steps to harmonise their policies. Thus, the cross-border tariff between Norway and Finland was eliminated in March 1999. This initiative was taken as a consequence of the positive deregulation process of the electricity market in Finland.

To further develop electricity trade within the Nordic electricity market, the Norwegian government has proposed a new regulation regime for the power trade between Norway and Denmark. The government has also proposed eliminating the priority tariff used when electricity is imported from Russia to Norway.

As a result of closer integration in the Nordic electricity market, the government has also facilitated enlarging ownership of the Nordic Power Exchange, Nord Pool. The Finnish system operator, Fingrid, will become a part-owner of Nord Pool's Elspot enterprise (see below).

MARKETS

The electricity power market in Norway is divided into the wholesale market, the end-user market and the regulatory market.

The Wholesale Market

The wholesale market is where producers, distribution companies, large industrial enterprises and other large units buy and sell electricity. Electricity is traded either bilaterally between market players or in the markets organised by the Nordic Power Exchange, known as Nord Pool. Bilateral contracts still have the largest market share, but a growing proportion of contracts is traded through Nord Pool.

Physical trade between Norway, Sweden and Finland, and between Norway and Denmark, takes place in the spot market. Financial contracts on the other hand may be arranged bilaterally between actors in the various countries or in Nord Pool's financial markets.

Nord Pool – The Nordic Power Exchange

Nord Pool determines the system price (spot price) in the physical market for Norway, Sweden and Finland on an hourly basis, as well as a separate market price (Elspot price area) for Jutland and Funen in Denmark. The system price is a reference price for other trade in the power market.

Currently, more than 270 participants trade in one or more of the Nord Pool markets. Apart from the Nordic countries, participants are from the United Kingdom, Germany and the Netherlands. Norwegian participants make up nearly 60% of Nord Pool's customers.

Nord Pool also offers clearing services for the power market. Nord Pool clears contracts that are traded over the power exchange and offers clearing of contracts traded bilaterally. Clearing means that Nord Pool acts as a middleman in contracts, in effect making the pool the legal counterpart to a contract between all the parties. Nord Pool requires security from the parties and guarantees settlement and delivery of contracts. Clearing reduces the risk of credit and settlement problems, for example the risk that the buyer will not be able to pay on the settlement day or may go bankrupt before settling. In 1999, Nord Pool cleared a total of 975 TWh, nearly 88% more than in 1998.

Nord Pool Markets

Nord Pool organises four markets: Elspot, Elbas, Eltermin and Eloptions.

Elspot is the market for physical trading of electricity for delivery the following day. The price is determined on the basis of the total quantity of electricity the participants announce that they will be buying and selling. Prices for sales and purchases are determined hourly throughout the day. The system price is the balance price for the aggregate supply and demand curves. Elspot determines the system price (reference price) both for the financial market and for the rest of the power market.

Elbas is a continuous physical market for balance purposes, *i.e.* trade in electricity up to two hours before delivery. This market is only available to Swedish and Finnish participants, and is not used by the Norwegian system operator. In Sweden and Finland, Elbas is a supplement to Elspot. The administration for the Elbas market is in Helsinki.

Eltermin is a financial market for price hedging and risk management when buying and selling electric power. The market currently consists of futures and forward contracts. Participants can hedge purchases and sales for up to three years. The difference between the two contract types lies in the form of settlement during the contract's trading period. For futures, the value of each participant's contract is calculated on a daily basis, based on the difference between the price set in the contract and the system price. Forward contracts do not have cash settlements prior to the beginning of the delivery period.

Eloptions is part of Nord Pool's financial market and is an important instrument for risk management and for forecasting future income and costs related to trade in power contracts. Trade in power options gives the right to buy and sell an underlying instrument for a specific underlying period. The power options offered by the power exchange are standardised and thus have clearly defined conditions. The market was established in October 1999.

The turnover in Nord Pool has risen considerably since the power exchange started in 1993. From 1997 to 1998, the turnover in the Elspot market rose by 30%, and in the financial market by about 70%. The turnover for the clearing service rose by almost 200%.

Managing Bottlenecks in the Grid

The system price (Nord Pool's spot price) is determined as though there were no constraints in the grid. However, such constraints may in fact arise between two geographical areas.

Constraints in the grid, often known as bottlenecks, are managed by determining price zones on each side of the bottleneck. This means that Nord Pool, on the basis of total demand and supply in a constrained area, determines a specific market price, the Elspot zone price. In areas with a production surplus, the zonal price is lower than the system price, whereas in areas with a production deficit, it is higher than the system price. Zonal prices help to balance supply and demand when bottlenecks are taken into account.

In Norway, price zones are the main tool for dealing with bottlenecks within the country's borders, and with bottlenecks across the borders to Sweden and Finland. Sweden and Finland also use price areas to deal with bottlenecks to other countries, but use counter-purchases to deal with internal bottlenecks. The latter means that the system operator pays producers to increase or reduce production to create balance in the market. The result is, for example, that every Swedish producer and consumer has the same Elspot price independent of internal constraints in Sweden.

The difference between the zonal price and the system price is called the capacity charge. The capacity charge for the volume of electricity transmitted through the bottleneck provides income for the grid companies. The system operators in Norway, Sweden and Finland share the income generated from bottlenecks in the Nordic power market.

The End-user Market

Anyone who buys electricity for his own use is defined as an end-user. Small endusers normally buy power via a trading company or a distribution utility. Larger end-users, for example industrial enterprises, often buy directly in the wholesale market.

An invoice for power is made up of several charges: the price of the electricity, transmission charges, the electricity tax and value-added tax. The price of electricity, transmission charges and taxes currently make up about one-third each of the invoice for an average household customer.

All end-users must pay transmission charges to the local distribution utility that serves their area. End-users who have changed supplier, or who live in an area where the distribution utility is separate from the trading company, receive two bills, one from the electricity supplier and one from the distribution utility. However, most end-users receive only one bill, which specifies how much of the total charge consists of transmission charges and how much is the price of the electricity. The grid owner is required to include information on trends in customers' consumption on invoices. The meter must be read at least four times a year. The quarterly invoice must show electricity consumption in the preceding three months and a comparison with consumption in earlier periods. The aim is to make consumers more aware of their own electricity consumption and to make sure that the effects of energy efficiency measures become apparent more quickly.

All end-users are free to choose their electricity supplier. They can choose a new supplier without any cost. Large customers, defined as customers using more than 400 000 kWh per year, must have a meter that measures electricity use by the hour, so that a precise settlement can be made. Smaller customers receive invoices based on a predetermined load profile, and can therefore change supplier without the need to meter consumption by the hour.

Household customers can choose between different types of contracts for electricity. The most common kind is based on a variable price, which means that the supplier can change the price after notifying the customer. In the third quarter of 1999, about 85% of all households had contracts based on variable prices. A fixed price, for example for one year, means that the supplier may not change the price during the contract period, even if there are large price changes in the wholesale market. A third type of contract is based on the Elspot price; for example, in some contracts the electricity price is NOK 0.01 per kWh higher than the spot price.

In the third quarter of 1999, about 7% of household customers had a different electricity supplier from the main one for their area. The main electricity supplier in an area generally has a market share of about 95%.

The Regulatory Market

The regulatory market is used by the system operator, Statnett SF, to maintain a stable frequency and a continuous balance between production and consumption of power in the country. Once prices and quantities have been fixed in the spot market, Statnett obtains Norwegian reports on the situation before adjusting the amount of power generated, or consumption, up or down. It must be possible to adjust power generation and consumption at short notice, for example in the event of the sudden failure of a power plant or transmission line, or sudden unexpected changes in demand. Traditionally, mostly producers participate in this market. Statnett can also exchange power on the regulatory market with the system operators in Sweden and Finland. In Sweden and Finland, Elbas is also used in short-term regulation of the market.

CRITIQUE

Electricity consumption in Norway is very high. Regulatory reform was introduced swiftly and has been beneficial.

Norway has the highest electricity consumption per capita in the world, reflecting its large hydro power resources, substantial energy-intensive industries, and its cold

climate. The electricity market is among the most market-driven in Europe, although public involvement is still strong through public ownership at the national and municipal level, and regulation.

Regulatory reform was introduced swiftly and in a single step. The move was motivated by concerns about over-investment in the sector leading to substantial efficiency losses. Reform was effective in absorbing excess capacity and there is now some concern about the level of investment.

Considerable progress has been made in developing competition in the electricity market, both domestically and between the Nordic countries. In the domestic market, the industry has adjusted well to the framework provided by the Energy Act. Competition has led to reorganisation and some mergers, but consolidation has been less than might have been expected. Regulation of monopoly functions has safeguarded consumers and ensured efficient development of the grid.

A common power market now functions between Norway, Sweden, Finland and Denmark. Since the last review, Finland became a member of Nord Pool in 1998, western Denmark in 1999, and eastern Denmark on 1 October 2000. Traded volume has also increased markedly along with participation. In 1995, trade on the physical market was 20 TWh, and in 2000, 97 TWh. In 1995, trade on the financial market was 15 TWh, and in 2000, 359 TWh. Trade on Nord Pool's physical delivery market exceeded 25% of the electricity consumed in Sweden, Denmark, Finland and Norway in 2000.

The international market continues to develop positively. Norway is working actively within the framework of the Nordic Energy Ministers Council to promote further integration within the Nordic electricity market, and between the Nordic and the Baltic Sea States' electricity markets.

Taking the Elspot price as a reference, Nord Pool prices generally reached a low point in 1995, rose sharply in 1996, but fell again in 1997 and 1998. Prices in 1998 fell further than in 1995. Seasonal fluctuations in 1999 were less pronounced than in 1998, but the generally low level was sustained. A sharp December peak has been noticeable in recent years (1997, 1998, 1999). Prices in Norway have been low, but are influenced strongly by the level of precipitation because of Norway's almost total dependence on hydroelectricity. It is difficult to differentiate between this effect and the effect of competition on prices.

Since the last IEA review there has been a marked improvement in market access. Prior to eliminating the hourly metering requirement, practically no residential customers changed supplier. In 1995 and 1996, the first two years following the abandonment of hourly metering, market mobility was very low. This was caused, in part, by a substitution fee of NOK 246 and a fee imposed on the suppliers of NOK 4 000 for each grid area they served. The removal of these fees in 1997 was followed by an increase in consumer mobility. As of 1998, consumers were able to change supplier weekly as opposed to the previous three-month limit. These changes have led to a significant increase in the number of supplier substitutions.

Security of Supply

The level of investment in the sector is now a concern for the government.

Challenges now facing Norway in electricity policy are judged by the government to be in the areas of supply security, energy efficiency and the environment. Reduced investments in energy installations and increased consumption have resulted in a higher degree of utilisation of the capacity of the electricity system. Accordingly, attention has been devoted to the security of energy supplies.

Work by Nordel¹⁶ illustrates the extent of the problem. The Nordic energy balance to 2005 is relatively strong, with an average net export from Scandinavia of around 5 TWh. In dry years, however, the balance is weak, resulting in considerable increases in forecast prices to ration available production. Of 13 TWh of forecast imports in dry years, only about 9 TWh could be sourced from Scandinavian countries. The remainder must be sourced from elsewhere in Europe. Without cables between Norway and the continent, Nordel estimates that Norwegian prices in dry years would rise around four times the average annual price. Nordel's study also shows the importance of backup capacity in the Nordic market. Nordel concludes that the risk of loss of load in the Nordic system can no longer be regarded as negligible.

Power cables connecting Norway to other markets (cables to Germany and the Netherlands are in planning, and a cable to the UK is being investigated) pose similar access problems as gas interconnectors discussed in Chapter 7. Development of interconnecting cables would allow the hydro, thermal and nuclear generating capacity in the region to be used to best advantage, enhance security of supply, and could contribute to competition. However, cables up to 600 kilometres long require large investments at substantial risk. The companies depend on longterm contracts, typically involving firm power deliveries over 25 years, to secure finance for the investment. Statkraft and its partners have guaranteed the cable owners (on the Norwegian side, Statnett) that they will pay all the costs for the cable, independent of power flow. There is a risk that the long-term contracts that would allow such a guarantee to be given may at some time in the future be ruled anti-competitive. In principle, it should not matter if cables are used by the companies which invested in the cables or by third parties who negotiate a price for their use, provided there is open access and competition between users of the cables, and the cables are used to an acceptable capacity. In practice, financial institutions may consider third party access involves excessive risk. Markets can provide sufficient investment, but a balance may need to be struck between the interests of competition and third-party access to transmission on the one hand, and the need for investment in interconnecting cables on the other.

A final particular issue concerning reliability of the system is the expected growth in the number of wind turbines and small combined heat and power (CHP) plants in the Nordic market. These types of plant are encouraged on environmental

^{16.} Nordel Production Group, reported in Nordel's Annual Report 1999.

grounds but make demands on the technical regulatory capacity of the system because they are non-despatchable, *i.e.* electricity production cannot be ordered by the system operator but is taken when it is available – when the wind is blowing in the case of wind turbines or heat is being produced in the case of small CHP plants.

Electricity forecasts could help by guiding government policies and by informing the market of the need for investment in new electricity generation and transmission capacity. The government no longer prepares electricity forecasts because it no longer has a direct role in investment. Forecasts need not be prepared by the government directly. The transmission system operator, for example, could be encouraged to take on this task.

Policy-makers in other IEA countries that have reformed their electricity markets also need to ensure that liberalised markets deliver the required level and type of investment in new generation and transmission capacity that will meet consumer security requirements and government environmental standards. Analysis of problems that have arisen to date suggests that the level of investment in new capacity is not a general problem arising from liberalisation itself. It is clear, however, that details relating to the particular market have to be addressed to make sure the market operates properly. In particular, adequate price signals and regulatory incentives should exist to ensure that investment in generation and transmission capacity is timely and that issues such as diversification and reliability of the supply are addressed by the market with minimal government oversight.

Ensuring sufficient generation and transmission capacity poses different issues. As in other countries that have undertaken electricity market reform, generation is a competitive activity in Norway. Attention should be directed to the way in which the market works while transmission remains a regulated monopoly, and to the way investment in transmission capacity is influenced by the regulatory system.

In the Norwegian market a number of factors could be influencing the level of investment in generation. In the first instance, the government should ensure that the market functions freely so that market solutions are found for concerns about generation capacity, as well as for other concerns such as environmental performance of the sector. An overriding consideration should be to treat the domestic electricity market as a component of the regional international market. It may not be possible to retain the "Norwegian" character of the electricity sector and also have the benefits of competition. Intervention designed to limit foreign participation, for example, may be counterproductive. Limits on the type of generating technologies may also need to be addressed. Hydro and gas face limitations in Norway and nuclear is excluded as an option.

Strengthening public ownership of the electricity sector is a government policy goal that may affect the level of investment.

The Norwegian government considers the maintenance of a high degree of public ownership in the energy supply sector to be of crucial importance. The policy of ensuring public ownership has been strengthened over time and is currently being reviewed to ensure its continuation. Public ownership is considered to give government authorities greater freedom of action in the management of hydro power resources than might be possible through licensing alone.

Although ownership is not a concern in itself, difficulties can arise in energy markets where mixed public/private ownership exists if public and private sector (including foreign) companies do not compete on an equal footing. Where public companies are small and municipally-owned, as is sometimes the case in Norway, concerns can also arise over the quality of management and the possibility of non-commercial objectives influencing company decisions. A similar concern may arise if larger state-owned companies take on policy roles on behalf of the government. The overriding concern should be to ensure that full and fair competition exists, regardless of the form of ownership.

The main basis for public ownership of the power supply sector is to be found in the water resources legislation. The most important instruments for ensuring that public ownership continues are the provisions relating to the right of pre-emption, mandatory licensing procedures, and the right of reversion. For private companies concessions are granted for a period of up to 60 years. Hydro resources developed by private companies revert to the State when the concession expires, without compensation. State-owned companies can hold hydro resources indefinitely. Hence, private companies, including foreign companies, are discouraged from investing in hydro. Since many Norwegian distribution companies are also generators, the market for mergers and acquisitions of such companies may also be affected. The value to a private company of acquiring a hydro generator/distributor is lower than the value to a state-owned company such as Statkraft. The reversion principle achieves the government's policy of maintaining and increasing public ownership, but may be restricting the level of new investment. In principle, it would be preferable to have open competition for mergers and acquisitions to encourage private, including foreign private, investment in the Norwegian electricity sector.

Municipal ownership may still adversely affect efficiency of management, and should be kept under review.

Municipalities and county municipalities wholly or partly own the majority of the energy utilities in Norway. Most of the publicly-owned utilities engage only in energy-related activities. The majority of the energy utilities owned by municipalities and county municipalities are organised as limited companies, *i.e.* the companies are managed independently from municipal and county municipal activities and also have separate accounts.

The Water Resources and Energy Directorate has commented¹⁷ that studies and interviews with the management and boards of directors of transmission companies conducted before the introduction of income caps show that a variety of goals exist for the mostly publicly-owned network companies, which are often also generators. The Water Resources and Energy Directorate noted that unclear goals may in themselves lead to inefficiencies, but did not question the legitimacy of the goals

^{17.} Incentive-based regulation of electricity monopolies in Norway, Ketil Grasto, Norges Vassdrags-og Energiverk.

provided that the companies met the efficiency criteria set by the regulator. It should be noted that the goals are important. An "efficient" company directed to achieving, say, lower local prices and maintaining employment, may achieve the income caps, but is not necessarily behaving like a rational firm. How the available profit is spent should be a matter of concern if only because it is one source of funds for investment in the system.

The most recent OECD Economic Survey of Norway¹⁸ has drawn attention to a number of deficiencies in the Norwegian electricity market arising from municipal ownership of energy utilities. These deficiencies are important since they could impact on investment in the sector.

- Some municipal energy utilities attempt to keep prices for customers in their region below the market price.
- Some high-cost production enterprises still have above-average rates of return.
- Capital market discipline may be too soft for municipal utilities, leading to suboptimal decisions.
- Municipalities may not act in a sufficiently professional way in a rapidly internationalising electricity market.
- Municipalities are entitled to 10% of the production at cost when a new hydro plant is constructed on their territory.

The report also notes that stronger unbundling requirements than accounting separation might lead to efficiency improvements. It also points out that Statkraft is increasing its share of the market by partnerships with local electricity companies, possibly inhibiting competition.

Decisions on matters such as the choice of technology should be left to the market operating under clear environmental regulations.

Investors in the electricity supply industry in Norway face a number of restrictions on the choice of generating technology. Continuing stringent environmental restrictions on gas-fired power are discussed in Chapter 4. The impact of these restrictions is uncertain because gas-fired power is currently judged to be uneconomic. New hydro development is limited to a few remaining areas and the prime minister has discouraged investment by stating the government's general view that new hydro is unlikely to be developed. There are also environmental objections to the development of wind power.

Options for investment in new generating technology are therefore very limited. Because "new" renewables are uncompetitive at prevailing electricity prices, imports of electricity are likely to increase in the immediate future.

^{18. 2000-2001} Annual Review - Norway, OECD (15 December 2000).

Environmental standards are, of course, necessary, but they need to be realistic concerning the ability of technology to meet them at acceptable cost. Standards should be stated clearly to contribute to a stable and predictable investment climate in which companies can take decisions on the basis of relative economics, including the environmental cost.

Regulation

Economic regulation of the electricity sector could be more independent and focused.

Economic regulation of the electricity market is the responsibility of the Energy and Regulation Division of the Water Resources and Energy Directorate (NVE). The division has a number of responsibilities for monitoring the technical and economic framework of Norway's energy system, as well as more conventional economic regulation functions. The division prepares the Master Plan for Water Resources, conducts surveys of production and consumption of electricity, co-ordinates regional and national grid planning, and assesses and licenses plans for electricity production plants and district heating. Economic regulation functions include studying pricing and margins, regulating metering and reconciling accounts, and regulating transmission and distribution tariffs and access conditions.

The division thus combines many functions undertaken by separate bodies in some other IEA countries. The advantage of having them being undertaken in a single body is to widen the viewpoint of regulatory decisions, by taking a resource planning approach to decisions concerning economic regulation. But the complex considerations potentially to be taken into account may reduce the capacity of the division to focus on promoting competition by introducing potentially conflicting goals at an early stage.

The division reports, along with several other divisions, to the director-general of NVE. The director-general, in turn, is subordinate to the Ministry of Petroleum and Energy. The minister is both owner of a substantial part of the electricity sector, and the final arbiter of the regulatory decisions that are appealed. In most IEA countries, the regulator is independent of both industry and government to avoid conflicts of interest.

Review of the present income cap should focus on strengthening economic incentives signals for appropriate and timely investment in transmission.

The regulation of grid companies through income caps was implemented in 1997. NVE will review the system to determine the income caps for the next regulation period from 2002.

Statnett, the owner of 80% of the main grid and owner of the Rana regional grid in Nordland, has criticised the present income caps. In 1999, income caps did not cover actual costs borne by Statnett for its main grid or regional grid operations. Statnett also has a special income cap set on physical energy losses from the grid.

If the costs of physical losses fall below the income cap, the loss is divided among the owners. As the largest owner, most of any loss is borne by Statnett.

Issues discussed earlier concerning security of supply will be important subjects for consideration by NVE when the present incentive regulation system is reviewed. Deficiencies that will inevitably be found should be addressed by enhancing the market-based incentives currently used, rather than by intervention. Concerns about the level of the cap – possibly influencing the level of investment – should, however, be distinguished from discussion of the use of the cap. In principle, continuing financial pressure to improve efficiency is appropriate. Some fine-tuning, for example, of the formula for sharing losses or having differential caps for different companies or regions may be necessary, but, in general, transmission companies should be encouraged to act more like private profit-maximising firms. The cap provides a surrogate for competition in pressing managements to reduce costs. Consistent with this view, mergers and acquisitions should be encouraged where efficiency gains are achievable, and new entrants, including foreign companies, should be encouraged.

The revamped regulatory system should be sufficiently flexible to encourage companies to consider investing in alternatives to conventional transmission lines, such as distributed generation and gas, where they are economic. Distributed power is already used to some extent: there are at present more than 50 000 photovoltaic-powered vacation homes in Norway, and more than 8 000 new installations are completed every year.

Market Development

A single Transmission System Operator for the Nordic market could have benefits for the international electricity market.

Supervising the overall operation of the system is of crucial importance to the security of supply in any power system. In Norway, Statnett SF has this responsibility, while in Sweden Svenska Kraftnett is responsible. A bilateral agreement between the two companies defines the responsibility arrangements for the interconnected Norwegian-Swedish system. System supervision is basically restricted to co-ordination of the technical operation of the transmission network and production units of importance to the operation of the main grid system. In addition to defining reliability and quality requirements, the supervisor performs load flow analysis to determine network configuration, detect bottlenecks and analyse other technical issues.

The supervisor has an obligation to monitor the operation of the system. The supervisor has the right to intervene and co-ordinate any such interventions deemed necessary to maintain a proper reliability and quality of supply and/or reduce the costs occurring from reduced quality or interruption of supply. Such interventions may affect the commercial actors in the system, for example through changed operation of production units. The supervision function thus has an important interface with competition.

In principle, the number of system operators need not impact on the way the market functions provided there is sufficient communication and co-operation between the different operators. In practice, however, national system operators may be discouraging the development of a truly unified market. At present, for example, there are three price zones in Norway, all defined by Norwegian national borders. Similarly, there is a single zone for Sweden. Limited interconnections may have this result, but over time it would be reasonable to expect price zones to overlap national borders. Merging national system operators could further improve system security and reliability and enhance the economic performance of the market ¹⁹.

Zonal pricing continues to be used, although some modifications have been made. Full nodal pricing for transmission may still be a desirable goal.

The last in-depth review recommended that Norway consider using real-time nodal pricing to reflect accurately the costs of losses and constraints on the transmission system.

Some modifications to the system have been made that Norway considers are alternatives to nodal pricing. From 1 January 1998, the energy charge in the central grid has been based on the percentage marginal loss at a number of points, and on the spot price. The percentage marginal loss is currently calculated eight times a year, and there are different daytime, night-time and weekend rates. Calculation of marginal loss is used in other national systems and is not an alternative to real-time nodal pricing. Similarly, constraints in the transmission system are managed by using zonal pricing on each side of the constraint. Norway recognises that this is also not real-time nodal pricing, but does consider it to be a practical modification.

Zonal pricing may have practical advantages in a small system. However, as the system becomes larger and operations more sophisticated, the benefits of full nodal pricing may be achievable. Ideally, prices should be set wherever there are real cost differences. Zonal pricing averages out cost differences. As a result, it is difficult to define zones on economic criteria, and price signals for investment and competition are weakened.

International barmonisation of taxation and other regulations affecting the market are recognised as important steps in further improving the operation of the market.

Whether or not a single system operator develops, there is general agreement on several areas where the Nordic market could be improved by international harmonisation of transmission and system operation. These include the following:

^{19.} The benefits of co-operation are recognised by the system operators. On 1 July 1999, a new organisation, the Association of European Transmission Operators (ETSO) was formed by Nordel (the body responsible for co-operation between system operators in the Nordic countries), the Union for the Co-ordination of Electricity Transmission (UCTE), the United Kingdom Transmission System Operators Association (UKTSOA) and the Association of Transmission System Operators in Ireland (ATSOI). Since the formation of ETSO, Nordel has played an active part in promoting the development of the electricity market in Europe.

- Harmonisation of domestic transmission and distribution tariffs on a cost-reflective basis to avoid distorting competition.
- In the EU context, the development of international transmission tariffs.
- A single Nordic market approach to the management of congestion.

RECOMMENDATIONS

The Government of Norway should:

Security of Supply

- □ Ensure that the market addresses security of supply by removing impediments to free operation of the market. In this context, consider using electricity forecasts to provide basic information on the outlook for electricity supply security in Norway as a guide for developing policy options, and to provide information for the market.
- □ Review the influence of the hydro concession on the level of private and foreign investment in hydro-based generation.
- \Box Review the impact of small-scale and municipal ownership on efficiency and investment in the electricity sector.
- \Box Allow the market to determine the choice of electricity generation technology within clear environmental regulations.

Regulation

- □ Review the electricity regulatory functions of the Water Resources and Energy Directorate with a view to improving the independence of the economic regulation function, including by giving consideration to:
 - Clarifying and simplifying the objectives of regulation, in consultation with electricity producers and consumers.
 - Establishing a separate division within the Water Resources and Energy Directorate (or a separate organisation) responsible solely for economic regulation of the electricity industry.
 - Establishing independent lines of reporting by the head of the economic regulation division to the minister.

- □ As part of its five-year review of its incentive regulations, the Water Resources and Energy Directorate should:
 - Seek market-based solutions to issues such as investment in transmission and system reliability.
 - Accommodate alternatives to new transmission capacity including distributed generation, direct use of natural gas, and gas-fired generation and co-generation.

Market Development

- □ In consultation with Sweden, Finland and Denmark, consider the merits of promoting the development of a single Transmission System Operator in the Nordic market.
- □ Continue to work towards harmonisation of taxation and other factors influencing the operation of the Nordic electricity market.

7

OIL, GAS AND COAL

OIL

Petroleum Reserves and Production

In 1999, Norway was the third-largest oil producer in the OECD after the United States and Mexico and the largest exporter in the OECD. It was the seventh-largest producer in the world and the third-largest exporter after Saudi Arabia and Russia.

Total petroleum reserves of the Norwegian Continental Shelf amount to 10.8 billion toe²⁰. Petroleum reserves corresponding to 10 billion toe have been discovered on the Shelf, including the potential for enhanced oil recovery and resources already produced. Most of the discovered resources are in the North Sea. Of the total petroleum resources discovered on the Norwegian Continental Shelf, 75% are in the North Sea, 22% in the Norwegian Sea, and 3% in the Barents Sea.

In recent years oil production on the Norwegian Continental Shelf has been fairly constant at about 150 Mtoe. In 1999, Norwegian petroleum production totalled 197.55 Mtoe, comprising 153.42 Mtoe of oil and 44.13 Mtoe of gas. Some 148.75 Mtoe (about 2.9 million barrels per day) were exported. In 1999, oil and gas production was roughly on a par with 1998, while production of natural gas liquids and condensate rose by 19%. At present rates of production, Norway's remaining discovered oil resources, including improved recovery measures, will last for about 17 years. The equivalent figure for gas is roughly 93 years.

Undiscovered Resources

Undiscovered resources of oil and gas are estimated to amount to 27% of the total resources on the Norwegian Continental Shelf. Of these resources, 31% are estimated to be in the North Sea, 43% in the Norwegian Sea, and 26% in the Barents Sea. There is a high degree of uncertainty about undiscovered resources and a very wide range of estimates. It is expected that 64% of undiscovered resources is gas.

North Sea

A total of five exploration wells (wildcat and appraisal wells) were drilled in the North Sea in 1999 and 2000, resulting in five discoveries. Expected, undiscovered resources in the North Sea are smaller than the estimate made in 1996, but the range between the maximum and minimum is wider because the uncertainty has increased.

^{20.} Reserves are estimated to fall within a range from 8.9 to 14.5 billion toe.

Norwegian Sea

A total of 20 exploration wells were drilled in 1999 and 2000 and eight discoveries were made. There has been a small increase in the estimates for undiscovered resources in the Norwegian Sea. Expectations of further discoveries are greater in the Norwegian Sea than in the North Sea.

Barents Sea

There was little exploration activity in the Barents Sea during the 1990s in part because it has not been profitable to develop any of the discoveries made so far. In 2000, four exploration wells were drilled resulting in two discoveries. The Norwegian Petroleum Directorate considers that the area has a substantial hydrocarbons potential. The expectation of the total oil and gas potential has not been raised since the last resource calculations made in 1998. It is expected that more gas than oil will be discovered. The greatest uncertainty concerns the area north of 74° 30' N, which has not been opened up for exploration.

Recovery

The average recovery factor for all fields on the Norwegian Shelf has been 44% in the last three years after a steady annual increase during the 1980s and 1990s. The high average recovery factor depends on recovery from the largest oil fields, many of which are now in a depletion phase. The Norwegian Petroleum Directorate believes that there is still potential to increase recovery through technological advances, but that this would require a considerable effort by the companies as well as the government. The goal is to achieve an average recovery factor of 50% for oil and 75% for gas. This would represent additional reserves of close to one billion cubic metres of oil equivalent.

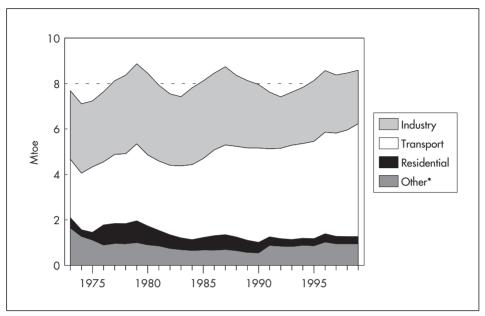
Trade

Petroleum, including products, has represented about 40% of the total value of Norwegian exports in recent years. Norway's oil trade is mainly with the OECD region, but lately cargoes have also moved into the non-OECD region, especially the Asia-Pacific region. The petroleum sector contributed about 16% of GDP in 1996 and 1997, and about 12% in 1999. The share rose again in 2000 with higher oil prices.

Consumption

Norway's domestic consumption of petroleum products is only about 8.7 Mtoe (1999), or 5.8% of annual production. Figure 23 illustrates oil consumption in Norway. Oil accounts for about 42% of final energy consumption in Norway. The growth in consumption by the transport sector is clearly illustrated, as is the steady reduction in consumption by the industry sector as electricity has replaced oil.

Figure 23 Total Final Consumption of Oil by Sector, 1973 to 1999



* Includes commercial, public service and agricultural sectors. Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2001.

In 1999, total refinery production was 14.31 Mt; domestic consumption of products was 8.06 Mt; imports of products amounted to 2.4 Mt.

Industry Structure

Some 20 major international oil companies participate in upstream activities on the Norwegian Continental Shelf, together with two Norwegian oil companies. Of the Norwegian oil companies, Statoil is a joint stock company incorporated under the laws of Norway, and the stock is state-owned. The State also has a 44% interest in Norsk Hydro. Hydro also has significant foreign ownership. The state interest in Norsk Hydro was reduced from 51% to 44% by the take-over of Saga in 1999.

Following the closure of Shell's refinery at Sola in 2000, two refineries remain: the Mongstad refinery, owned 79% by Statoil and 21% by Shell, with a capacity of 10 million tonnes a year; and the Esso refinery at Slagen, which has a capacity of 4.5 million tonnes a year.

Statoil had the largest retailing market share with 31.9% of retail sales of petroleum products in 1999. Shell had a 27.7% share, and Esso 22.2%. Norsk Hydro and Texaco market their products jointly. In 1999, they had a 12.1% market share. Several other smaller retailers made up the remaining 6.1%.

Initial Public Offering of Statoil

On 18 June 2001, 18.2% of Statoil was floated on the Oslo and New York stock exchanges. The government intends for Statoil to remain a Norwegian-based company with its head office and top management in Norway.

New shares were issued in the parent company, Den norske stats oljeselskap a.s., in combination with the sale of part of the State's shareholdings. The addition of assets previously held as part of the State Direct Financial Interest (see below) has boosted Statoil's petroleum reserves by 45%, making it the eleventh-largest among listed oil companies.

The government plans to reduce its holding in Statoil to two-thirds by allowing the company to enter into equity-based strategic alliances with other companies.

The State Direct Financial Interest

The State Direct Financial Interest (SDFI) in petroleum operations was established in 1985 by dividing Statoil's interests in most offshore fields into an equity share for Statoil, and a direct interest for the State. The SDFI is included in most licences awarded after 1985. As a result, the State now has a direct interest in most offshore petroleum fields and transport systems.

Under the SDFI arrangement, the State pays a share of all investment and operating costs in a project corresponding to its direct interest. It also receives a corresponding proportion of production and other revenues on the same terms as other licensees. Statoil is responsible for the operation and financial management of the SDFI.

The government has proposed that SDFI assets corresponding to 20% of the asset value of the SDFI be included in a restructuring of the State's participation in petroleum activities. The State will retain SDFI assets corresponding to 80% of the SDFI asset value. The government has sold about 15% of the SDFI asset value to Statoil, and intends to sell a further 6.5% to Norsk Hydro and other companies.

Assets in future licensing rounds will continue to be reserved for the SDFI.

A new state-owned company known as Petoro has been established to manage the SDFI portfolio of assets retained by the State in production licences, pipelines and land-based plants. New SDFI assets will also be managed by Petoro. The company will not be an oil company and will not apply for new licences or be given operatorships. Costs and revenues related to the SDFI will continue to be channelled through the state budget.

Exploration and Production Policies Licensing

Title to petroleum resources on the Norwegian Continental Shelf is vested in the State. Assessments are made of the environmental, economic and social impact of

opening new areas on other industries and adjacent regions before an area is opened for exploitation and a licence for exploration and production is issued.

Licences are normally awarded through licensing rounds. The government invites applications for a certain number of blocks, and companies must usually apply individually. Since 1994, several applicants may submit a joint (group) application. This approach was used in the Barents Sea project in 1997 and in the North Sea rounds of 1999 and 2000. All future licensing rounds will allow for joint (group) applications. The announcement of the round gives details of the terms and the objective and non-discriminatory criteria that will form the basis for awards.

The Ministry of Petroleum and Energy generally considers a group of companies as partners for each licence. The ministry appoints an operator for the partnership who is responsible for the daily management of operations in accordance with the licence.

From the award of the Statfjord field in 1973 until the 13th offshore licensing round in 1991, state participation via Statoil was set at a minimum of 50% in each partnership. This interest could be increased on a sliding scale for the development and production phases. The sliding scale was abolished in 1993 for all new licences and was subsequently also abolished for existing licences.

The 15th licensing round in 1996 was the first round completed within the framework of the licensing directive. Statoil did not participate in all licences and competed for participation on equal terms with all other companies.

In the 16th licensing round, the government extended and developed the principle applied in the 14th and 15th rounds for the size of the State's interest. The average size of the State Direct Financial Interest was reduced from approximately 50% in the 13th round to around 15% in the 16th round. Foreign companies were awarded the major part of the increased participating interest. In the 15th and 16th rounds, the government reduced the number of companies in each production licence, thus giving them larger interests. The average participating interest for operators increased from about 25% in the 14th round to around 35% in the 15th round and 42% in the 16th round.

Production Regulation

Section 4-4 of the Petroleum Act authorises the government to regulate petroleum production. Production regulations have been imposed twice, first in 1986-90 when oil production was reduced initially by 7.5%, and later by 5%. The second regulation was imposed from May 1998, when oil production was reduced initially by 100 000 barrels per day. From 1 April 1999, a reduction of 200 000 barrels per day was imposed. From 1 April 2000, the reduction reverted to 100 000 barrels per day, and the regulation was abolished on 1 July 2000.

Production was regulated because of the collapse in oil prices. The regulations are considered by the government as an element in the long-term management

of the country's petroleum resources and of the petroleum sector's impact on the economy.

Apart from production regulation, the government does not seek to influence the import and export of oil.

Government Take

Securing high and stable government revenues from petroleum operations is an important objective in shaping Norwegian policies for the sector. The most important instruments for generating such revenues in the petroleum sector, both in the immediate future and in the long term, are the tax system and the State Direct Financial Interest, as well as dividends and capital gains from the State's holdings in Statoil and Norsk Hydro.

Petroleum taxation is based on the Norwegian rules for ordinary corporate tax, which is charged at the rate of 28% both on land and offshore. A special tax of 50% is also levied to capture economic rent. A deduction for straight-line depreciation over six years is allowed. Companies can also deduct the proportion of their net financial costs that corresponds to the share of their commercial income derived from offshore operations. An uplift of 5% of investment is deductible from the income base for determining special tax over a six-year period from the date of the investment.

Royalty on oil production, an area fee and a carbon dioxide tax also apply to petroleum operations. Royalty is payable on production from some fields approved for development before 1 January 1986, and has amounted to 8% to 16% of gross production value. No royalty is charged on gas production. In 1999, the government decided to phase out the royalty either within three or six years for the few fields that are still paying this duty.

All production licensees must pay an area fee after the exploration period has expired. The annual fee for most licences increases from NOK 7 000 to a maximum of NOK 70 000 per square kilometre over the subsequent decade. Special rules apply for older licences, and for licences in the Barents Sea.

Carbon tax is levied at a rate per sm³ of gas burnt or directly released and per litre of oil burnt. The rate for 2000 was NOK 0.70.

Petroleum Fund

The Petroleum Fund was established in 1990 and received its first transfers in 1996. Its income represents the government's net cash flow from petroleum activities and the return on fund investments. The fund finances the government's non-oil budget deficit. Capital in the fund offsets oil price volatility and fluctuations in economic activity. It also serves as an instrument for coping

with the financial challenges presented by an ageing population and declining oil revenues.

At 31 December 1999, the fund had accumulated NOK 222.4 billion, equivalent to 18.7% of GDP. The value of the fund increased by NOK 50.6 billion during 1999.

Emergency Response Measures

Policy

In case of a serious oil supply shortage, Norway has agreed to "contribute, by decision of the Government, to a sharing program by adding to normal supplies to Participating Countries of the Agency such additional deliveries as may be obtained from appropriate demand restraint measures and from the activation of any stand-by production capacity that may exist."²¹ Norway is obliged to enter into consultation with a view to specifying its contribution whenever the Agency considers the activation of emergency measures.

Norway advises that if the Cabinet agrees to participate in IEA response measures, Norway's contribution would be tailored to the actual situation, and in co-operation with the oil industry. An emergency organisation would be established with representatives from the Ministry of Petroleum and Energy and the oil companies. Should the need arise, the organisation would be enlarged with representatives from other relevant bodies and entities.

Emergency Reserves

Normal production is expected to provide sufficient supplies during an emergency. Norway does not have any stockholding commitments nor any legal basis to require oil companies to acquire or hold stocks. For IEA purposes, no stocks are held, but Norway does have a certain amount of product stocks owned by the government for emergency purposes. These stocks could be used as a Norwegian contribution, solely or in combination with other emergency measures, in IEA co-ordinated actions, if the Cabinet decides on Norwegian participation. Release of government stocks, generally held by the companies, is governed by agreements with the Ministry of Petroleum and Energy. Emergency and commercial stocks are reported to the ministry each month and physical checks are undertaken regularly. The Supply and Contingency Measures Act can be used to authorise stockholding for defence purposes.

There is considered to be no scope for increasing production in the event of an emergency.

Demand Restraint Measures

Regulations on demand restraint were established in 1983. Revised regulations were put into effect in 1999. Voluntary restraint and stockdraw rather than restrictions

^{21.} Agreement between Norway and the International Energy Agency [IEA/GB(75)9].

and rationing are considered the most likely response in the event of an emergency. Demand restraint measures include:

- Voluntary restraint on consumption and fuel switching in response to a government information campaign and higher prices.
- Restrictions on sales of fuel for motor vehicles and recreation craft and on their use, restrictions on deliveries by oil companies to dealers and large consumers.
- As a last resort, rationing by coupons, when a shortage is expected to last for six months or more, when restrictions have been in place for three to four months, and when consumption must be cut by 20% or more.

Pricing

Retail prices for oil products are relatively high in Norway (see Figure 24). The government nevertheless considers that the distribution and retailing of oil products is a well-functioning market. Contingency powers exist in the Petroleum Act and in the general provisions of the Competition Law, should anti-competitive behaviour be found.

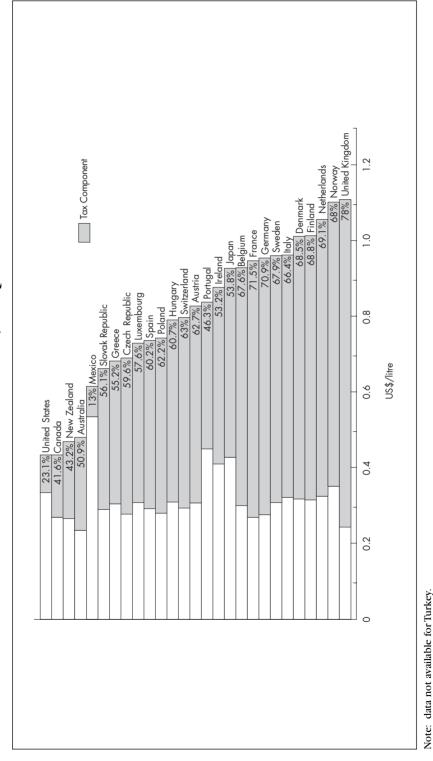
The last IEA in-depth review questioned the level of prices and suggested that the causes be investigated. Discussions with producers support the view that the above-average Norwegian prices are probably explained by high distribution costs because of the small and dispersed population in a country with a large surface and difficult topography and climate conditions.

NATURAL GAS

Management of the Gas Resource

The Norwegian Petroleum Directorate estimates recoverable gas resources at 7.032 tcm (2001). Norway has three main basins: the North Sea (3.356 tcm), the Norwegian Sea (2.286 tcm) and the Barrents Sea (0.891 tcm). Proven reserves are estimated to be 4.132 tcm. The North Sea has been well explored and is considered a mature area. Exploration in the Norwegian Sea, and especially the Barrents Sea, has been relatively limited to date.

Gas will play an increasingly important role in Norwegian petroleum activities. Around 2020, it is expected that more gas than oil will be sold, measured in oil equivalents. Norwegian policy aims to maximise the value of the resource by maintaining a government role in establishing the means for developing and producing the gas, and ensuring that the highest possible share of the economically recoverable petroleum resources can be produced.





Source: Energy Prices and Taxes, IEA/OECD Paris, 2001.

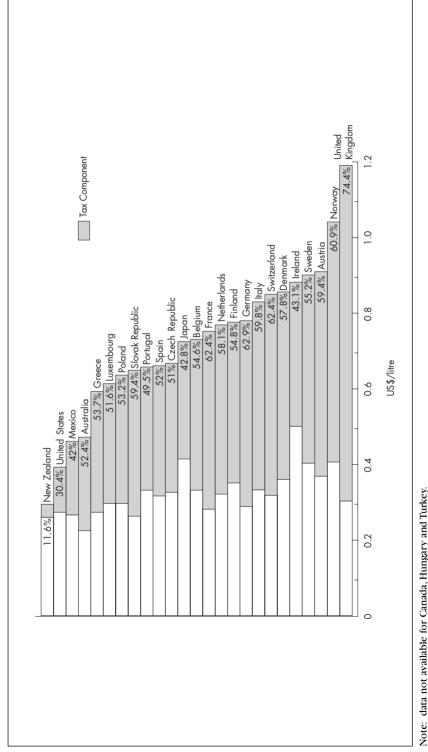


Figure 25 OECD Automotive Diesel Prices and Taxes, First Quarter 2001

Source: Energy Prices and Taxes, IEA/OECD Paris, 2001.

Oil production increased greatly in the 1980s relative to gas production, but the latter has risen sharply since 1996 with the coming onstream of the giant Troll gas field. Current obligations for selling gas will amount to between 40% and 45% of total petroleum production in 2005.

Production Policies

Development of production and transportation capacity has been co-ordinated by the government. All gas sales contracts that are not linked to specific fields have been negotiated by the Gas Negotiations Committee (GFU) under the leadership of Statoil, and with representatives from Norsk Hydro and Saga. The Gas Supply Committee (GSC) was established in 1993 to advise on the development and exploitation of gas resources and transport. The committee consists of representatives of the thirteen largest gas resource owners on the Norwegian Continental Shelf. The GSC, the Norwegian Petroleum Directorate and the Ministry of Petroleum and Energy advise the government on which fields are capable of fulfilling non-committed contracts in the best possible way, on the best way of utilising existing capacity in fields and pipelines, and on the need for new capacity. The advice takes into account the balance of small and larger fields, and the use of gas for re-injection. The government has the final decision on which fields are developed and which pipelines are built.

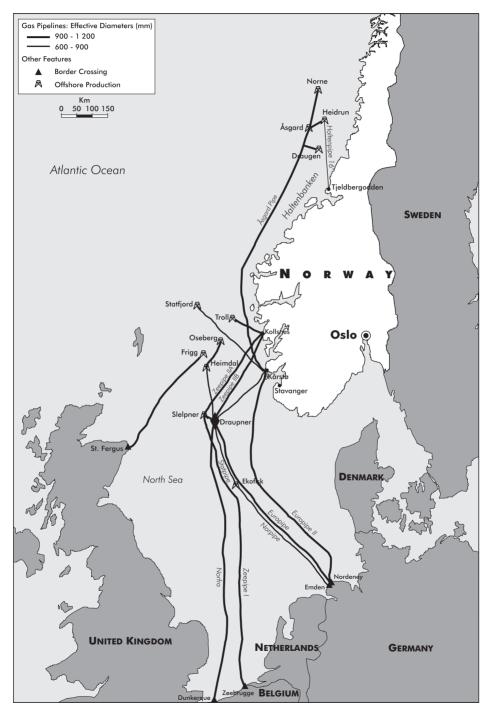
In May 2001, the government announced that co-ordinated marketing of gas in the European Economic Area would cease from 1 June 2001, and that the GFU would be abolished from 1 January 2002²². The government announced that: "Necessary changes in the legal framework will be prepared prior to the abolishment of the GFU. The government will instruct the companies on the Norwegian Continental Shelf to initiate the adaptation of contracts and other agreements between themselves, in order for the companies to be able to market their gas on an individual basis from now on." In connection with the partial privatisation of Statoil, a new state company has been established to take over as operator of offshore pipelines. Statoil will still be responsible for two-thirds of Norway's gas exports.

Gas has increasingly been used for injection into reservoirs to increase recovery of oil and condensate. From the end of the 1980s, two-thirds of gas production has been exported and one-third has been used for injection. The proportion used for injection is expected to rise. It is expected that 60% to 90% of injected gas will be recovered for sale.

During 1998, a new model was developed for co-ordination of production among gas fields. The purpose is, in part, to allow fluids-rich gas fields to produce independently of seasonal fluctuations in gas contracts to optimise recovery of

^{22.} The EU gas directive does not permit cartel structures in the market and prohibits joint selling of gas.

Figure 26 Natural Gas Production and Transmission



resources. To make such co-ordination feasible, Troll and possibly other large gas fields, will need to vary daily gas production to allow smooth production from gas and liquids fields independently of how much gas customers actually take.

Production taxes applying to oil also apply to gas production. Royalties on gas production were abolished from 1 January 1992.

Consumption

Since the mid-1980s, Statkraft, Statoil and Norsk Hydro have evaluated several different alternatives for gas-fired power generation in Norway, but none has been developed. In 1994, Statkraft, Statoil and Norsk Hydro set up a joint company, Naturkraft. The objective of Naturkraft is to use natural gas from the Continental Shelf for generation of electric power for the Nordic market. Both Kårstø and Kollsnes are proposed as production sites.

Exports

In 1999, Norway exported gas to the United Kingdom, Germany, the Netherlands, Belgium, France, Spain, Austria and the Czech Republic. Up to 1990, the United Kingdom was the largest buyer. Germany is now the largest customer.

In 1999, exports from Norway constituted 45.5 bcm of natural gas, an increase of about 1.9 bcm compared with the previous year.

During 1999, negotiations and discussions were conducted with possible buyers in a number of countries. Discussions have also been held with countries in Central Europe. New sales opportunities for Norwegian gas would appear to be greatest in Central Europe and the United Kingdom. Norway's total gas sales may reach 85-90 bcm per year in the longer term. By 2005, Norway's exports are expected to amount to 14% of total European gas consumption.

COAL

Coal accounted for 4% of TPES in Norway in 1999. Coal is mined in Spitsbergen, the main island in the dependency of Svalbard, some 960 km from the Norwegian and Russian mainlands. Norway has sovereignty over the island, but other countries enjoy the right to pursue economic activities, including coal mining.

The state-owned Norwegian company, Store Norske Spitsbergen Kullkompani (SNSK), operates two mines. Production levels rose from 0.3 Mt in 1990 to 0.4 Mt in 1999. The SNSK coal operation was subsidised at the rate of about US\$ 24 per tonne in 1999. Most of the coal is exported (288 000 tonnes in 1999), primarily to Germany (239 000 tonnes).

The government is expected to take a decision on the development of a new mine on Spitsbergen during 2001. Production is likely to be higher than from the present mine, possibly up to 0.7 Mt per year. The government is expected to meet a part of the capital costs of developing the new mine, but a surplus will probably be made over the mine's operating costs.

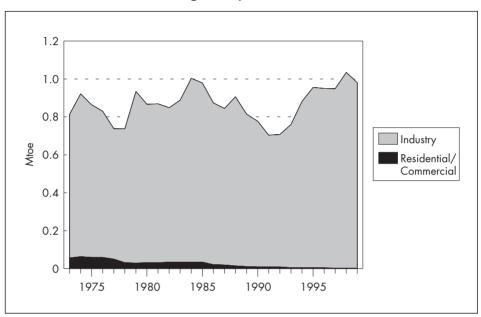


Figure 27 Coal Consumption by Sector, 1973 to 1999

Source: Energy Balances of OECD Countries, IEA/OECD Paris, 2001.

CRITIQUE

Regulation of oil production is of concern to consumer countries.

Norway is the third-largest exporter of oil in the world and the third-largest oil producer among the OECD countries. In the event of a supply emergency, Norway could play a major role in protecting the collective interests of IEA consumer countries through agreeing to participate in the IEA's oil-sharing arrangements. Unlike other IEA countries which have agreed to participate in advance, this decision would be taken at the time by Norway.

Norway has on two occasions reduced the level of oil production by government regulation, with a view to contributing to the efforts of some other oil-producing countries to stabilise prices at a higher level. The Norwegian production regulation measures were unilateral and decided on the basis of Norway's own evaluation of the market. They were not part of any formalised collaboration or agreement with other producing countries. Nevertheless, no other IEA oil-producing country has ever taken such action.

In announcing that production controls would cease from 1 July 2000, the minister also stated that "Norway continuously evaluates the developments in the oil market, and keeps in contact with other major producing countries. The Government will consider regulating the oil production again, if this is necessitated by the market situation"²³.

Norway considers that its actions are consistent with the IEA *Shared Goals* (see Annex B), and further considers that no IEA Member country objected to its actions. The review team has chosen not to state a firm view, but suggests that it is a matter that may call for further discussion in the IEA in anticipation of a recurrence of similar market circumstances.

Managed markets are not stable or efficient markets. Oil production controls involve some risk that demand will be further depressed. Had this occurred when Norway restricted oil production, and low prices continued, Norway's oil revenues would have been even further depressed. In other energy commodity markets such as coal where low prices are the norm in the long term, producers respond to falling prices by increasing production to maintain company revenue and, indirectly, government revenue. Government intervention could also contribute to uncertainty about the freedom of market players to decide the level of production and could discourage investment, particularly international investment, in Norway's oil industry.

Restricting oil production to influence oil prices is of concern to consuming countries. The review team considers that there are alternatives to production controls as a means of offsetting price volatility such as consumer-producer dialogue, where Norway has played a lead role for the benefit of all IEA Member countries. The Norwegian government considers that dialogue alone would have been an insufficient response when oil prices were at US\$ 10 per barrel. The Petroleum Fund is also intended, in part, to offset the impact of price volatility. The review team considers that production regulation to influence the market is detrimental and suggests that every effort should be made to avoid its repetition.

Privatising part of Statoil is an important step that will allow the government to assess the benefits of reducing its participation in the petroleum industry.

The initial public offering of Statoil poses no challenge to the existing structure or management of the Norwegian petroleum industry. Expanded ownership should provide new expertise, partners and capital, but Statoil will remain a majority stateowned Norwegian company. Partial privatisation will allow an assessment to be made of the benefits of private participation without compromising state control.

The benefits of privatisation relate principally to the government's objective of retaining a competitive and profitable oil and gas industry that contributes to

^{23.} IEA Press release No. 40/00, 29 June 2000, Regulation of Norwegian oil production.

employment and increased value creation, and that can compete at home and abroad. The major oil and gas companies are international in their structure and activities and compete in petroleum provinces throughout the world. Statoil has established good positions in other countries. It is important to its future success that it is structured to compete on equal terms for capital and expertise to develop its Norwegian Continental Shelf resources efficiently, and for access to petroleum resources in other provinces.

The EU electricity and gas directives are likely to lead to a truly competitive European energy market. The directives are also likely to lead to change in the way the Norwegian Continental Shelf is developed and managed in the future as changes are made in the transmission and marketing of gas, in particular. Competition for capital will be important to secure business opportunities that may in the past have been seen as the prerogative of the Norwegian government to distribute. The most effective way of maintaining a strong Norwegian presence will be to build on the Statoil foundation to create a major international integrated oil and gas company.

The success of the initial public offering may be affected by the relatively small change that is currently proposed. A share of up to one-third (which appears to be the ultimate goal of Norwegian policy) does not offer much opportunity for new participants to influence the company. Investors are likely to be either looking for income, or anticipate further change in Statoil's structure. The success of the initial offering would be helped if the government were willing to acknowledge that further privatisation may be possible depending on the success of the initial offering. Taking this course would not commit the government to take any further action, but would help clarify its intentions and its expectations concerning private participants.

Measures have been introduced to maintain strong interest in exploration and development of oil and gas resources. Consideration should be given to the influence of taxation on the level of activity.

The first licensing round on the Norwegian Shelf was in 1965. After the first ten years, licensing rounds have become more frequent and the area allocated, the number of blocks and the number of production licences granted in each round have increased significantly. Moreover, small areas have been allocated between the rounds, particularly to clarify the resource potential of specific areas. The price of oil and the market for drilling installations are important influences on the level of exploration activity. The number of wildcat wells varies largely with the price of oil. The high exploration activity in the early 1980s took place during a period when the price of oil was very high. By contrast, about 45% of the exploration wells drilled in the last five years were in areas where production licences were granted before 1985. Initially, growth in resources exceeded production, but for the last ten years, total production has mostly exceeded the growth in resources.

The scope and profitability of future exploration are uncertain. The largest fields were found during the first 20 years of exploration. Discoveries made in the last 15 years have, on the whole, been smaller and more demanding to develop. The current level of oil and condensate production is expected to be sustained until

after 2007. In the next ten-year period, three-quarters of the production is expected to come from fields that are already in production or that have been approved for development. Less than 10% of the production up to 2008 is expected to come from discoveries that have not yet been approved for development. About half current production is from fields in decline. Investments in the larger fields that are in decline is essential to maintain production targets.

Profitability will be a major influence on the level of exploration and development. Profitability will depend largely on prospectivity, price and cost levels, and on government take.

Promising opportunities continue to be offered on the Norwegian Continental Shelf. So far, roughly 20% of known oil and gas reserves have been recovered. Proven reserves could support oil production for 20 to 25 years, and gas production for close to a century. In addition, new discoveries are likely. The potential still exists for significant new finds. Technology has reduced costs, and this trend is likely to continue.

Since the 1997 in-depth review, several measures have been introduced to maintain the attractiveness of the Norwegian Shelf. These measures include:

- Reducing the share awarded to the SDFI.
- Increasing the participation share awarded to each licensee.
- Increasing the frequency of licence awards by aiming for a licensing round every year. In special cases acreage might also be awarded outside licensing rounds.
- Allowing the oil companies to form partnerships and submit group applications.

Government take through taxation and other means is obviously an important factor influencing the level of exploration and development in any petroleum province. In the case of Norway, the government's Commission on the Petroleum Tax System found that the existing petroleum taxation system may discourage new entrants on the Norwegian Continental Shelf. Debate continues on the reforms that are required. The need for change is not surprising, given the maturing of the area and the needs to be addressed.

A proactive approach to gas marketing would allow Norway to gain the benefits of closer integration with the European gas market, and to anticipate and respond to transitional issues that may arise, such as investment in pipelines and other infrastructure, and sequencing of development.

Norway is a member of the European Economic Area and must abide by EU rules, although it is not a member State of the EU. These obligations include compliance with the gas directive and EU competition law. Norway intends to remain an efficient, stable and long-term supplier of natural gas to the European market by including the gas directive in the European Economic Area Agreement, and by implementing it in national legislation. However, Norway has expressed concern

about the impact of the gas directive on its policy of allocating gas sold on a non-field-specific basis to individual fields.

The allocation policy was justified by the government on the grounds of satisfactory resource management. Other IEA countries leave gas marketing to the private sector on an openly competitive basis. In such cases, efficient depletion is enforced by restrictions on licences or other means used to encourage development of small fields and avoid duplication of field infrastructure. The means by which these goals are achieved can involve varying levels of government intervention, for example by requiring third party access to offshore pipelines. Norway will need to look to means such as these to ensure satisfactory resource management now that the GFU is to be abolished.

Gas marketing and depletion policy are closely related in Norway. Government direction is considered necessary for both to a greater extent than would be required in other countries. At the time of preparing this report, it is not clear how the government intends to reconcile abolition of the GFU with its views on depletion. In principle, the announcement that companies will be able to market their gas on an individual basis in the European Economic Area from 1 June 2001 is an important change in the right direction. Much will depend, however, on any other changes proposed that might replace some functions of the GFU, and on the government's intentions in relation to the Gas Supply Committee.

The review team considers that obligations imposed by the EU gas directive have been an important influence on recent changes in Norway's policy on gas marketing. Norway should consider a more proactive policy on gas marketing, in view of the maturity of its industry and the importance of promoting the integration of its industry into European energy supply. Private marketing of gas should be a leading principle, so that greater weight is given to the potential benefits of competition among producers than at present. Depletion policies that are consistent with this principle should be developed in consultation with industry. Concerns over the future of longterm commitments that benefit some consumers as well as producers also need to be addressed.

Investment in sub-sea pipelines requires a policy framework that balances long-term commitments to underwrite development and measures to avoid restrictions on competition.

The Norwegian gas management strategy has led to the growth of an integrated infrastructure for transporting gas on the Norwegian Shelf, and large landing systems of trunk pipelines, rather than smaller pipelines for specific fields. Transporting gas to markets is often extremely capital-intensive, and has relied on long-term contracts to justify the scale of investment involved. This might take the form of a purchasing contract with a producer or group of producers, or a sales contract with one or several buyers such as a distributor, a power plant or a large industrial consumer. The Norwegian gas transmission model might be viewed as a natural monopoly, in which development and management of transmission are closely related to physically optimal depletion of the resource. This approach requires that exclusive rights be recognised and not open to challenge once they are settled.

This approach understates the benefits that may arise from competition among gas producers and between gas and other energy forms. By giving too much priority to technical considerations, the natural monopoly approach carries the potential for some market players to acquire excessive influence in the market. In a competitive framework, there should be equal opportunity for new entrants to the market, either as producers or buyers, to gain access to the transmission infrastructure or build their own. Such a legal framework can be found in the United States, Germany and the Netherlands. The EU gas directive introduces the same principle for all EU member States.

In a sufficiently large market, the freedom to build and operate pipelines, even as parallel transmission pipelines, is not economically inefficient. The gas directive will eventually integrate national markets and enhance the opportunity for new pipeline projects.

Norway argues that consideration needs to be given to the impact on possible pipeline developments if long-term commitments are open to challenge. It also thinks that the policy framework must consider the impact of competitive transmission on field development. These considerations have merit as transitional issues in the development of the European gas market.

Domestic use of gas could be important in the future. Work might usefully commence now to develop an orderly policy framework for the sector.

The Norwegian government is developing an action plan for the domestic use of natural gas. Opportunities exist for the direct use of natural gas in industry, transport, district heating, space heating and cooking, and in other applications. Gas-electricity competition could allow the substitution of gas for electricity in some applications and gas transmission might effectively replace the need for expanding the electricity grid in some instances.

Debate on gas-fired power suggests that information on the environmental impact of gas-fired power generation is not well understood. For example, taking into account the substitution of gas-fired power in Norway for coal-based power elsewhere, emissions of carbon dioxide might well be lower on a regional basis if gas-fired power were developed in Norway. Objective analysis of possible projects would help improve understanding of the environmental impact and provide a more certain basis for political and commercial decisions.

In some circumstances, development of gas might be a viable substitute for further investment in electricity supply. For example, Lyse Energi is investigating if the introduction of gas in the Stavanger area could lead to savings in transmission and distribution networks. In a study funded by NVE, Lyse is reviewing the infrastructure needs and options for gas use. The study is expected to identify what constraints, if any, need to be removed to make the introduction of gas a feasible alternative. Studies of this nature should be undertaken nationally. The potential for gas-electricity competition may suggest that a regulatory regime for gas should be developed as a priority. Electricity and gas regulation should possibly be undertaken by a single body or, at least, regulatory activities in both sectors should be co-ordinated.

Production of subsidised coal appears likely to continue for essentially regional policy objectives.

Coal mining makes it possible to retain a Norwegian community on Spitsbergen in the dependency of Svalbard during the winter months. At other times, tourism and scientific work also contribute to maintaining the community. There is no doubt that the present mine, the last of seven on the island, has been subsidised at a level approximating the prevailing world price in 1999. The proposal for the new mine has been described as potentially profitable. The government is expected to meet part of the capital cost of developing the mine, and only the operating costs would be covered by the mine itself. It is a basic principle of the IEA to oppose subsidisation of energy production, and subsidisation of even low levels of coal production in other IEA countries has been criticised.

RECOMMENDATIONS

The Government of Norway should:

Oil and Gas

- □ Maintain the momentum for privatising Statoil by early follow-up to the initial public offering.
- □ Review the level of exploration in the Norwegian continental shelf, and give close consideration to the influence of taxation on the level of exploration.
- □ In consultation with industry, develop a new policy approach to balancing the goals of optimising oil and gas depletion, and of ensuring competition in marketing.
- □ Proactively encourage the private marketing of gas as a means of assisting the closer integration of the Norwegian gas industry with the European market.
- □ Give priority to developing the proposed action plan for the domestic use of natural gas. Direct the Ministry of Petroleum and Energy to take responsibility for the promotion of gas in direct end-uses and in electricity generation. Specific tasks might include, for example:
 - Working in consultation with the Department for the Environment to analyse and report on the environmental and economic implications of any proposed domestic gas developments.

• Anticipating the development of a domestic gas industry in Norway by developing proposals for economic regulation of the domestic gas industry. Consider expanding the role of the electricity regulator to include responsibility for regulating the domestic gas industry.

Coal

□ Ensure that the proposed new mine in Svalbard is genuinely economic. If economic viability cannot be achieved, seek alternative means to maintain the Norwegian community in Svalbard.

8

ENERGY RESEARCH AND DEVELOPMENT

GOVERNMENT PRIORITIES FOR ENERGY RESEARCH

In 1999, the Storting approved a White Paper on research ²⁴ that recommended that Norwegian research be increased substantially. The paper recommended that Norway, in the course of five years, reach a level of research funding equivalent to the OECD average, measured as a proportion of GDP. The paper recommended that priority be given to "research in the area of intersection between energy and the environment", and to strengthening long-term and fundamental research. This increased focus on environmental and fundamental research is in line with the strategy followed by the Ministry of Petroleum and Energy and the Research Council of Norway in recent years. The strategy aims to place more emphasis on long-term energy research and development and the building up of expertise in the science system. Higher priority will be given to efficient and renewable energy technologies at the expense of petroleum research and development.

Research Council of Norway

The Ministry of Petroleum and Energy has the primary responsibility for setting objectives for energy research and development in Norway. Funds are directed by the ministry to the Research Council of Norway. The Research Council has the primary responsibility for implementing government research objectives, ranging from support for higher education institutions to near-market applied research. The council acts as:

- Government adviser, identifying present and future needs for knowledge and research.
- Funding agency for independent research programmes and projects, strategic programmes at research institutes, and Norwegian participation in international research programmes.
- Co-ordinator to promote co-operation between research institutions, government and industry, other sources of funding, and users of research.

Six research boards submit annual strategic plans and budgets to an executive board responsible for national policy. In 2000, the Research Council had a budget of NOK 3.026 billion.

^{24.} Ministry of Research, Report to the Storting No. 39, 1998-99, Research at the Beginning of a New Era.

The major divisions were (in million NOK):	
Science and Technology	643
Industry and Energy	683
Bioproduction and Processing	479
Culture and Society	421
Environment and Development	296
Medicine and Health	198

Energy and energy-related research and development is funded primarily through the Industry and Energy Division, the Science and Technology Division, and the Environment and Development Division.

Industry and Energy Division

The division is responsible for 16 research programmes in the following areas:

Maritime activities and manufacturing industry.

■ Information technology, building, construction, and services.

■ The energy processing industries.

Corporate development and the management of technology.

Emphasis is placed on ensuring that research programmes and projects have a strong potential for creating added value, generate benefits to society over and above the profits generated for participating companies, and contribute to a more knowledge-based industrial structure that will generate long-term returns and rewards.

User-driven research is the cornerstone of the Research Council's collaboration with Norwegian business and industry. Industrial enterprises set their priorities and provide an average of 60% to 65% of the funding required. Among the council's partners are employer and employee organisations, government authorities, research institutions, and bodies such as the Norwegian Industrial and Regional Development Fund.

Science and Technology Division

Target areas and priorities of the Science and Technology Division are:

- Strategic programmes to facilitate growth in industry and enhance co-operation among research communities and between research communities, industry and government agencies. The activities include Norwegian participation in the OECD Halden nuclear reactor project (see below).
- Basic research programmes based on Norway's natural resources, areas in which the country possesses special natural advantages, and areas in which it is possible for Norway to be at the forefront of international research.

- An extensive scholarship/fellowship programme, including the exchange of personnel with foreign research communities.
- Independent researcher-initiated science projects in target areas such as biotechnology, information technology, materials technology and petroleum-related research.

Half the division's budget is spent on basic funding for 14 technical-industrial contract research institutes and allocations for advanced scientific equipment for universities.

Environment and Development Division

Target areas and priorities of the Environment and Development Division are:

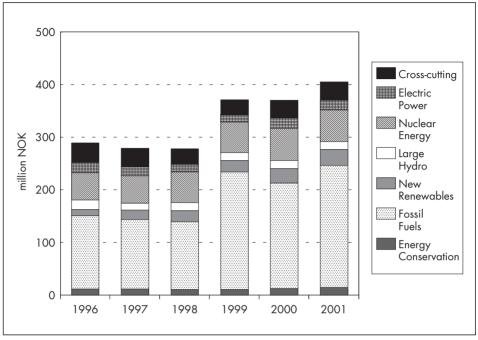
- Natural processes and man-made changes.
- The international framework.
- Changes in climate and the ozone layer.
- Loss of biodiversity.
- Pollution.
- Management and use of natural resources and the cultural environment.
- Environmentally sound production and consumption.
- Social change, economics and systems of governance.
- Population, health and quality of life.
- Values for sustainable development.

The division is responsible for a variety of independent, researcher-initiated projects and provides basic funding for some institutions. High priority areas include human resources development, the recruitment of new researchers, and the facilitation of co-operation among research institutions at the national and international levels.

Government Funding

The total government budget for energy research and development was NOK 370 million in 2000, compared with NOK 371 million in 1999 (see Figure 28). The level of government funding fell sharply in the mid-1990s from the levels seen in the early 1990s. Funding has increased considerably in recent years, but largely as a result of the DEMO 2000 programme (see below). There has also been some increase in expenditure for energy conservation and new renewable energy technologies.

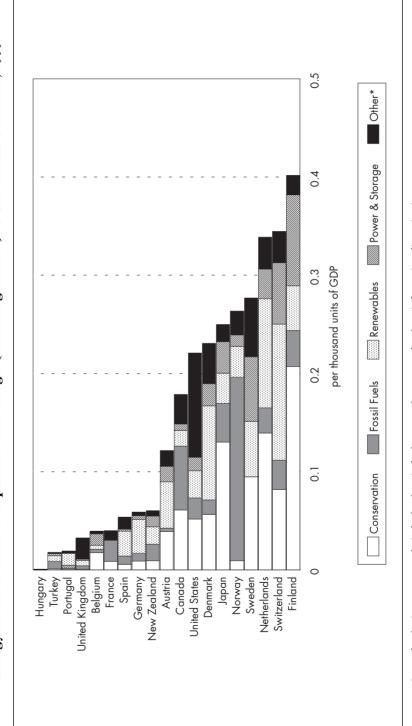
Figure 28 Government Funding for Energy Research and Development, 1996 to 2001



Source: Country submission.

About one-third of the funds the Research Council receives from the Ministry of Petroleum and Energy is spent on long-term basic and strategic research, and the development of expertise at research institutes and universities. This is intended to provide a basis for other, commercially promising, energy projects in co-operation with industrial and other users. The Research Council is responsible for the allocation of these funds to specific projects and programmes in the petroleum and energy sectors.

The remaining two-thirds of the energy research and development budget supports user-driven programmes where industry is heavily involved. There are two general groups of programmes: in the oil and gas sector, and in the energy sector covering energy conservation and renewables. The broad programme areas are determined in consultation with the Ministry of Petroleum and Energy. The programmes are developed by the Research Council, following advice from its own advisory boards. The Industry and Energy Board and the Environment and Development Board are composed of representatives of research users, such as oil and gas companies, energy companies, technology suppliers, etc., including foreign companies operating in Norway. The Research Council is responsible for determining the goals of the individual user-oriented programmes and the exact balance of priorities between the programmes. However, there is an understanding that these programmes should be consistent with the needs and policy objectives of the Ministry of Petroleum and Energy.



Energy Research and Development Public Budget (excluding nuclear) us GDP in IEA Countries, 1999 Figure 29

Sources: IEA Energy Technology R&D Statistics, IEA/OECD Paris, and National Accounts of OECD Countries, OECD Paris, 2001. * cross-cutting technologies, system analysis, hydroelectric, hydrogen and energy technology information dissemination. Note: data not available for Australia, the Czech Republic, Greece, Ireland, Italy and Luxembourg

Major Research Programmes and Priorities Energy Efficiency

Efficient Energy Systems (EFFEKT, 1996-2001) is an industry-driven programme administered by the Research Council of Norway. The programme is mainly concerned with electricity, but also includes other forms of energy if these are relevant in relation to electricity supplies. The main objective of the programme is to increase wealth creation by Norwegian business and industry in the electricity sector, within the framework of sustainable development.

The programme's targets are to find new, environmentally-acceptable systems and technical solutions that:

- Improve the returns on power exchange between Norway and other countries.
- Improve the efficiency of domestic grid monopolies.
- Promote wealth creation in the power supply sector by improving its competitiveness.

The programme is intended to result in innovative solutions and products whose investment and/or operating costs are 10% lower per kW than with currently available technology. The programme also aims to increase exports of products and services from the power supply sector. The budget for this programme has increased steadily in recent years.

Oil and Gas Development

Through the Research Council, the Ministry of Petroleum and Energy has launched a strategy-building process involving oil companies, technology suppliers and research communities. The process is intended to strengthen the interplay between these groups, and to help in setting priorities for research, development and demonstration in the oil and gas sector. The process aims to streamline public and private planning and collaboration, to identify future needs for new technology deployment and fundamental research, and to assess the level of public and private expenditure. The strategy process is managed by a panel of industry and academic representatives.

Research related to oil and gas remains a central priority. The overall goal is to capitalise on the benefits of using the most efficient technologies more aggressively, for example to achieve further cost reductions and productivity gains in exploration, development and production. Emphasis is placed on shortening lead times to large-scale market introduction of key technologies, and financial payback from research and development. The Research Council provides funding and administrative services for three related programmes:

- PETROFORSK a basic petroleum research programme.
- OFFSHORE 2010 a user-driven research programme.

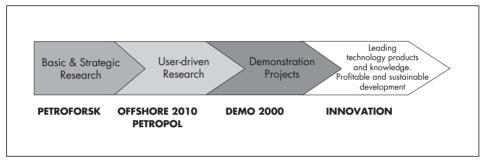
■ PETROPOL – a social science research programme focusing on petroleum-related issues.

The Ministry of Petroleum and Energy funds a fourth related programme:

■ DEMO 2000 - a technology demonstration programme.

The relationship between the programmes is illustrated in Figure 30.

Figure 30 **Relationship between Petroleum Research Programmes**



Source: The Research Council of Norway, Norwegian R&D Activities in the Petroleum Sector.

The PETROFORSK programme is part of the Research Council's long-term efforts to help optimise Norwegian oil and gas resources. The purpose of the programme is to develop technology and expertise to increase industry's opportunities to add value to products and processes.

The programme supports research that contributes to developing technology that renders exploration wells superfluous, and maximises petroleum recovery in existing and future fields. Research is being undertaken in many fields, including geology, geophysics, mathematics, chemistry and physics to:

- Develop quantitative methods for improving understanding of geological and reservoir-related problems.
- Develop a modelling tool to identify potentially commercial prospects on the Norwegian Continental Shelf and to improve understanding of fundamental geological processes involved in petroleum production.
- Improve understanding and methods for predicting and monitoring petroleum recovery processes.

The programme will run from 1998 to the end of 2003 and has a total budget of NOK 77 million. The main source of funding is the Ministry of Petroleum and Energy.

The OFFSHORE 2010 programme is exploring the challenges of sub-sea production in waters 3 000 metres deep, multiphase transport over 300 kilometres, down-hole separation and re-injection, and reducing discharges of carbon dioxide and nitrogen oxides by 50%. The main objectives are to:

Promote the development of new technology and expertise in sub-sea and downhole processing, and multiphase transport.

■ Facilitate innovation and commercialisation in small and medium-sized enterprises.

The vision is to develop technologies to ensure that as much of the wellstream processing as possible takes place close to the reservoir, and that end treatment can take place where it will be most cost-efficient, onshore if possible.

Priorities for work focus are on advanced seismic mapping, innovative solutions for increased oil recovery, and platform-free field development to allow oil and gas production to be monitored remotely from onshore control stations.

DEMO 2000 is a focused deployment programme for project-related technology demonstration. It is intended to reduce development costs and to bring new Norwegian products to the global offshore market. The programme involves national and international oil companies, technology suppliers and research institutions, working in collaboration with the Ministry of Petroleum and Energy. More than 50 pilot projects totalling approximately NOK 900 million have been selected by end-users in the oil industry on the basis of their expected contribution to cost-efficiency and introduction in the market. The programme has created novel approaches to gaining support for deployment of new technologies, and to reducing risk and lead times for successfully implementing results of research and development.

Natural Gas Use

The research programme on natural gas technologies (NATURGASS, 1996-2001) is an industry-driven programme administered by the Research Council of Norway. The Research Council's contribution was NOK 95 million. The goals are to:

- Promote the development of profitable products and services based on the use of natural gas. This goal refers primarily to projects that use natural gas directly in a distributed system featuring numerous, relatively small-scale users. This form of activity is most common on the export market and is a continuation of an earlier programme entitled "Gas research goods and services" (GAVOT).
- Promote the development of new and existing gas-related processes and new applications for natural gas. This goal refers primarily to the process industry and related activities and the promotion of wealth creation based on the application of natural gas in processes in Norway.

The prime target group for the first goal is equipment suppliers, as well as companies which help promote the use of natural gas in Norway in other ways.

Activities under the second goal target major Norwegian petrochemical companies such as Statoil and Norsk Hydro. The development of processes to convert natural gas could boost Norway's domestic consumption of natural gas appreciably and result in considerable wealth creation in Norway based on this resource.

Environment

KLIMATEK

The Ministry of Environment, the Ministry of Petroleum and Energy and the Ministry of Trade initiated KLIMATEK to test relevant technologies which could reduce emissions of all greenhouse gases. The Research Council launched KLIMATEK in mid-1997 with funding of NOK 650 million over five years. Projects ranging from carbon dioxide separation to direct biological fixation of carbon dioxide have been initiated. The programme focuses on demonstration of technology, with roughly 80% of the funds allocated for this purpose. The remaining funds will cover long-term research with a view to introducing a technology shift in the mitigation of greenhouse gas emissions. All projects in KLIMATEK have industry funding and involve a pilot study or full-scale technology demonstration. Government funding varies from 25% to 40%.

The petroleum and process industries are the key sectors in KLIMATEK but projects in other sectors are also included. A key project evaluation parameter in KLIMATEK is the potential emissions reduction for a specific project. Only projects aiming to reduce national emissions by at least 100 000 tonnes of carbon dioxide equivalents receive funding. The following success criteria have been defined for the programme as a whole:

- The overall potential national reduction in emissions shall be at least 10 million tonnes of carbon dioxide equivalents, provided technology and measures developed by KLIMATEK projects are implemented by 2010.
- For at least 50% of the national reduction potential, implementation issues shall be addressed in the KLIMATEK projects.
- Technology and measures tested and developed in KLIMATEK shall be characterised by global reduction of greenhouse gas emissions in an environment-friendly way at a cost which allows implementation.

Key areas addressed in the programme are: technology for utilising fossil energy which at the same time allows cost-effective mitigation of emissions; technology for carbon dioxide separation and disposal; technology for efficient use and recovery of energy; new processes in the industry and agricultural sectors and for use of waste, resulting in substantial reduction of greenhouse gas emissions; technology and measures allowing carbon dioxide emissions from the transport sector to be reduced; system analyses. Projects include the following:

Oil and gas: Separation of carbon dioxide using membrane gas/liquid contactors; measures for reducing carbon dioxide emissions from the Gullfaks field; system for optimum fuel consumption during dynamic positioning; second-generation automatic flare ignition system; air bottoming cycle gas turbine; wellstream turbine; saline aquifer carbon dioxide storage.

Metal industry: Biocarbon in the ferro-alloy industry.

Other process industry: Enhanced energy recovery in cement production; co-firing of condensate and biomass gas; production of charcoal (briquettes) for ferro- and cement industry; recovery and use of carbon dioxide as feedstock.

Landfills and waste: Oxidation of gas from landfills.

Buildings: Future energy systems in existing and new buildings.

Transport: Reduced carbon dioxide emissions through environmentally efficient transport technology

Other: Biological carbon dioxide removal plant; algal culture technology; consequences of ocean storage of carbon dioxide for the marine environment; modelling of carbon dioxide injection in the ocean.

SAMSTEMT

Social Science Research in Energy, Environment and Technology (SAMSTEMT, 2001-2010) is a user-driven programme administered by the Research Council of Norway. Its main objective is to build up and maintain the knowledge base for a Norwegian policy for sustainable development related to the production and use of energy, in Norway as well as globally and regionally. One of the goals of the programme is to improve knowledge of conditions and instruments needed for an effective policy relating to energy and the environment. The programme intends to build up and further develop expertise in these fields at Norwegian research and educational institutions, so that these institutions can provide well-qualified candidates who can help users make use of research-based knowledge. SAMSTEMT covers three main topics:

- Energy markets and energy use.
- Technological choices, energy planning and infrastructure.
- International environmental agreements and climate policies.

Renewable Energy

Efficient, renewable energy technologies (NYTEK, 1995-2001) is an industry-driven programme administered by the Research Council of Norway. Its objective is to develop products and processes for efficient energy technologies and new

renewable energy sources in Norwegian enterprises. The most important research areas are bioenergy, wind, photovoltaics, thermal solar energy, wave energy, heat pumps, energy efficiency technologies and hydrogen as an energy carrier. 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. Projects that can provide a basis for new forms of commercial activity will also be given priority.

Research on large-scale hydroelectric power still accounts for a considerable amount of the expenditure on renewables, consistent with Norway's near-exclusive use of hydro for electricity generation. The increase in research and demonstration 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; biofuel for engines. Support for biomass research is strong, particularly in relation to wood wastes produced by Norway's substantial forestry industry. Biomass-fired systems for medium-to-large buildings are a new priority area.

Solar energy: Solar energy systems integrated into buildings; photovoltaic cells, silicon metal, wafer production.

Wind power: 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, which was a high priority in the 1980s, receives some support but is not expected to be a priority area in the future.

Nuclear

Nuclear energy still accounts for a large element of the energy research budget. This expenditure is entirely devoted to an international collaborative research project located in Norway, the OECD Halden reactor. The Ministry of Trade and Industry is responsible for this programme.

Fundamental Energy Research

The Energy for the Future Programme (2000-2006) is a strategic programme administered by the Research Council of Norway. The main goal is to develop competence of value to education, research and industry, which can encourage the development of a sustainable system, characterised by, among other things, energy flexibility, diversity, efficiency and the "right quality for the right purpose". Interaction between different energy resources is important, and there is a particular focus on renewable energy sources and natural gas. Hydrogen as an energy carrier has gained increased attention, including decarbonisation and production of hydrogen from natural gas.

Applied Research in Watercourse Management

The Norwegian Water Resources and Energy Directorate administers applied research in watercourse management. The objective is to provide support for the directorate in carrying out its tasks. These activities are co-ordinated with the activities of the Research Council of Norway. The main programmes are:

- The Competence Programme for Energy and the Environment, which focuses on social frame conditions, priorities and means, how the market works and how the market participants behave and learn, in relation to the directorate's responsibility for economic management of Norway's water and energy resources.
- The Watercourse Environment Programme, which is intended to improve knowledge of the watercourse environment and environmental processes in watercourses, and of the environmental impact of hydro power and other developments in watercourses.
- The Museum Project, which is intended to provide the general public with information on the history of water resource management and its cultural heritage.

CRITIQUE

Total funding for energy research and development has been raised substantially and work is being undertaken across many fields, from basic research to the more aggressive application of mature technologies.

Norway is conscious of the important role played by energy research and development. Total funding has been raised substantially and work is being undertaken across many fields, from basic research to the more aggressive application of mature technologies. Apart from seeking to develop and apply new technologies, Norway is also giving priority to the development and improvement of its knowledge base. All public expenditure on energy research and development is monitored centrally by the Research Council of Norway.

Much of the petroleum demonstration programme and the natural gas programme would arguably be more appropriately conducted solely by industry.

Since the last IEA review there has been an annual increase in public funding for research on energy conservation, and on renewables. The focus of work has been mainly in the residential and commercial sector and in the area of renewables, mainly solar energy, wind and biomass. Most of the increase in government expenditure has, however, been in the petroleum area, and principally on demonstration of new technologies. These demonstration projects aim to cut costs in exploration and production and to develop technologies for global use. Much of the petroleum demonstration programme and the natural gas programme would arguably be more appropriately conducted solely by industry, since the pay-back periods are expected to be fairly short. The same might be said for those parts of the natural gas programme where established technologies are being evaluated in the Norwegian context. The counter-argument, proposed by Norway, is that low returns and long lead-times discourage the introduction of more cost-efficient

technology. Government involvement is therefore necessary to overcome aversion to new concepts, and uncertainty in a commercially volatile industry.

Expenditure on projects in areas other than nuclear energy and petroleum has, at best, remained fairly constant.

Nuclear research currently absorbs about 15% of the current total budget, and was over 20% in 1998. Allowing for the substantial proportion of expenditure on petroleum technology demonstration and nuclear, expenditure on projects in other areas has, at best, remained fairly constant. Attention might usefully be given to a better definition of the energy programme of the Research Council of Norway, to separate industrial development objectives from energy policy objectives, and to ensure that energy research and development projects proper are closely aligned with energy policy objectives.

Norway has a commendable range of research activities from basic research to implementation of innovative technologies.

An important link is the role played by user-driven research. There has been close interaction between the government and industry in setting objectives, but definition of individual projects appears to have been left largely to industry. In some other IEA countries, governments have defined the scope of projects they wish to see undertaken and called for projects by tender. Commissioned projects may play a useful role in Norway by ensuring projects retain the original objectives set in government energy policy.

It will be important to involve the new agency for promoting energy efficiency and new renewables in setting objectives for research on renewables and in selecting individual projects.

Research on "new" renewables is an important part of Norway's programme, and an important area of government policy. A new energy efficiency and renewables agency has been established to promote government policy objectives in these areas. It will be important to involve the new agency in setting objectives for research on renewables and in selecting individual projects.

RECOMMENDATIONS

The Government of Norway should:

- □ Review the way in which priorities for energy research and development are established and individual projects selected. Consider
 - Better definition of the energy programme within the Research Council.
 - Aligning energy research and development priorities more closely with current government energy policy priorities.
 - Commissioning projects in key policy areas.
 - Ensuring close co-ordination of the activities of the Research Council and the activities of the new agency responsible for energy efficiency and promoting "new" renewables.

ANNEX

ENERGY BALANCES AND KEY STATISTICAL DATA

							U	nit: Mtoe
SUPPLY								
		1973	1990	1998	1999	2005	2010	2020
TOTAL PRO	DUCTION	8.19	120.14	206.67	209.77			
Coal		0.29	0.20	0.22	0.33			
Oil		1.64	84.35	153.92	153.42			
Gas		-	24.14	41.34	44.13			
Comb. Ren	newables & Wastes ¹	-	1.03	1.26	1.49			
Nuclear		-	-	-	-			
Hydro		6.27	10.42	9.92	10.40			
Geothermo		-	-	-	-			
Solar/Win	d/Other ²	-	0.00	0.00	0.01			
TOTAL NET		6.48	-96.80	-181.64	-183.16	••	••	
Coal	Exports	0.09	0.17	0.20	0.20			
	Imports	0.67	0.84	1.04	0.91			
	Net Imports	0.58	0.67	0.84	0.71			
Oil	Exports	3.69	77.95	150.15	148.75			
	Imports	10.68	4.47	5.29	5.26			
	Bunkers	0.64	0.45	0.90	0.86			
	Net Imports	6.35	-73.93	-145.76	-144.36			
Gas	Exports	-	22.17	37.04	39.37			
	Imports	-	-	-	-			
	Net Imports	-	-22.17	-37.04	-39.37			
Electricity	Exports	0.45	1.40	0.38	0.71			
	Imports	0.01	0.03	0.69	0.56			
	Net Imports	-0.45	-1.37	0.31	-0.16			
TOTAL STO	OCK CHANGES	0.44	-1.87	0.38	-0.00		••	
TOTAL SUP	PPLY (TPES)	15.11	21.48	25.41	26.61	••	••	••
Coal		0.91	0.86	1.07	1.06			
Oil		8.38	8.56	8.53	9.05			
Gas		-	1.98	4.31	4.76			
Comb. Ren	newables & Wastes ¹	-	1.03	1.27	1.50			
Nuclear		-	-	-	-			
Hydro		6.27	10.42	9.92	10.40			
Geothermo	l	-	-	-	-			
Solar/Win	d/Other ²	-	0.00	0.00	0.01			
Electricity 1	Frade⁴	-0.45	-1.37	0.31	-0.16			
Shares (%)								
Coal		6.0	4.0	4.2	4.0			
Oil		55.5	39.9	33.6	34.0			
Gas			9.2	16.9	17.9			
	newables & Wastes	_	4.8	5.0	5.6			
Nuclear		-	-	-	-			
Hydro		41.5	48.5	39.1	39.1			
Geotherma	al		-	-	-			
Solar/Win		-	-	-	-			
Electricity 1		-3.0	-6.4	1.2	-0.6			
/					-			

0 is negligible. – is nil, .. is not available.

Unit: Mtoe

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FINAL CONSUMPTION BY SE	CTOR						
	1973	1990	1998	1999	2005	2010	2020
TFC	13.73	18.03	20.13	20.33			
Coal	0.81	0.78	1.04	0.98			
Oil Gas	7.68 0.01	7.96	8.46	8.59			
Comb. Renewables & Wastes ¹	- 0.01	0.90	1.10	1.33			
Geothermal	-	-	-	-			
Solar/Wind/Other	5.23	8.33	- 9.41	9.30			
Electricity Heat	5.25	0.33 0.07	9.41 0.12	9.30 0.13			
Shares (%)							
Coal	5.9	4.3	5.1	4.8			
Oil	55.9	44.1	42.0	42.2			
Gas	0.1	50		-			
Comb. Renewables & Wastes Geothermal	_	5.0	5.5	6.5			••
Solar/Wind/Other	-	_	_	-			
Electricity	38.1	46.2	46.8	45.7			
Heat	-	0.4	0.6	0.7			
TOTAL INDUSTRY ⁵	6.96	7.90	8.28	8.27			
Coal	0.76	0.77	1.03	0.98			
Oil Gas	3.01 0.00	2.79	2.50	2.35			
Comb. Renewables & Wastes ¹	- 0.00	0.38	0.49	0.76			
Geothermal	-	-	-	-			
Solar/Wind/Other	3.20	3.94	4.23	-			
Electricity Heat	3.20	0.02	4.23 0.02	4.17 0.02			
Shares (%)							
Coal	10.9	9.7	12.5	11.8			
Oil	43.2	35.3	30.2	28.4			
Gas Comb. Renewables & Wastes	_	4.8	6.0	9.1			
Geothermal	_	4.0	0.0	7.1			
Solar/Wind/Other	-	-	-	-			
Electricity	45.9	49.9	51.1	50.4			
Heat	-	0.2	0.2	0.2			
	2.62	4.22	4.84	5.12	••	••	
TOTAL OTHER SECTORS ⁷	4.15	5.92	7.00	6.94			
Coal Oil	0.06	0.01	0.00	0.00			
Gas	2.10 0.01	1.02	1.27	1.27			
Comb. Renewables & Wastes ¹	- 0.01	0.52	0.61	0.57			
Geothermal	-	-	-	-			
Solar/Wind/Other	1.98	4.31	5.02	4.98			
Electricity Heat	1.90	0.06	0.10	4.90 0.11			
Shares (%)		0.00	0110	••••			
Coal	1.3	0.2	_	_			
Oil	50.6	17.2	18.1	18.3			
Gas	0.2						
Comb. Renewables & Wastes Geothermal	-	8.7	8.7	8.3			
Solar/Wind/Other	_	_	_	_			
Electricity	47.8	72.9	71.7	71.7		••	
Heat	-	1.0	1.4	1.6			

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ENERGY TRANSFORMATION AND LOSSES							
ENERGY TRANSFORMATION	1973	1990	1998	1999	2005	2010	2020
ELECTRICITY GENERATION [®] INPUT (Mtoe) OUTPUT (Mtoe) (TWh gross)	6.31 6.28 73.03	10.59 10.46 121.61	10.18 9.99 116.12	10.68 10.47 121.72	•• ••	•• •• ••	••
Output Shares (%) Coal Oil Gas Comb. Renewables & Wastes Nuclear Hydro	0.0 0.2 - - - 99.8	0.2 0.0 - 0.2 - 99.6	0.2 0.0 0.2 0.3 - 99.4	0.2 0.0 0.2 0.2 - 99.3	 		
Geothermal Solar/Wind/Other	_	_	0.0	0.0			
TOTAL LOSSES of which:	1.34	3.65	6.12	6.57			
Electricity and Heat Generation ⁹ Other Transformation Own Use and Losses ¹⁰	0.03 0.57 0.73	0.04 -0.05 3.66	0.05 -0.18 6.24	0.04 -0.26 6.79			
Statistical Differences	0.05	-0.20	-0.83	-0.30		••	
INDICATORS							
	1973	1990	1998	1999	2005	2010	2020
GDP (billion 1995 US\$) Population (millions) TPES/GDP ¹¹ Energy Production/TPES Per Capita TPES ¹² Oil Supply/GDP ¹¹ TFC/GDP ¹¹ Per Capita TFC ¹²	70.07 3.96 0.22 0.54 3.82 0.12 0.20 3.47	122.33 4.24 0.18 5.59 5.06 0.07 0.15 4.25	164.22 4.43 0.15 8.13 5.73 0.05 0.12 4.54	165.65 4.46 0.16 7.88 5.96 0.05 0.12 4.56	 	 	
Energy-related CO ₂ Emissions (Mt CO ₂) ¹³ CO ₂ Emissions from Bunkers (Mt CO ²)	25.6 2.8	28.5 2.7	34.3 4.4	37.1 4.4			
		2.7	4.4	4.4			
GROWTH RATES (% per yea	73-79	79-90	90–98	98-99	99-05	05–10	10-20
TPES Coal Oil Gas Comb. Renewables & Wastes Nuclear Hydro Geothermal Solar/Wind/Other	3.7 1.4 1.8 - - 3.3 -	1.2 -1.3 -0.8 9.8 5.6 - 2.9 -	2.1 2.7 -0.1 10.2 2.7 -0.6 -	4.7 -1.1 6.1 10.5 18.2 4.8	 	··· ·· ·· ·· ·· ··	······································
	3.5	0.6	1.4	1.0			
Electricity Consumption Energy Production Net Oil Imports GDP Growth in the TPES/GDP Ratio Growth in the TFC/GDP Ratio	3.6 33.7 4.6 -0.9 -1.1	2.3 8.9 19.9 2.6 -1.4 -2.0	1.4 1.5 7.0 8.9 3.7 -1.6 -2.3	-1.2 1.5 -1.0 0.9 3.8 0.1	 	 	··· ·· ·· ··
Growth in the IFC/GDP Ratio	-1.1	-2.0	-2.3	0.1	••	••	

Please note: Rounding may cause totals to differ from the sum of the elements.

Footnotes to Energy Balances and Key Statistical Data

- 1. Comprises solid biomass, biogas, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.
- 2. Other includes ambient heat used in heat pumps.
- 3. Total net imports include combustible renewables and waste.
- 4. Total supply of electricity represents net trade. A negative number indicates that exports are greater than imports.
- 5. Includes non-energy use.
- 6. Includes less than 1% non-oil fuels.
- 7. Includes residential, commercial, public service and agricultural sectors.
- 8. Inputs to electricity generation include inputs to electricity, CHP and heat plants. Output refers only to electricity generation.
- 9. Losses arising in the production of electricity and heat at public utilities and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiency of 100% for hydro.
- 10. Data on "losses" for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.
- 11. Toe per thousand US dollars at 1995 prices and exchange rates.
- 12. Toe per person.
- 13. "Energy-related CO_2 emissions" specifically means CO_2 from the combustion of the fossil fuel components of TPES (*i.e.* coal and coal products, peat, crude oil and derived products and natural gas), while CO_2 emissions from the remaining components of TPES (*i.e.* electricity from hydro, other renewables and nuclear) are zero. Emissions from the combustion of biomass-derived fuels are not included, in accordance with the IPCC greenhouse gas inventory methodology. Also in accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 1999 and applying this factor to forecast energy supply. Future coal emissions are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.

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ANNEX

INTERNATIONAL ENERGY AGENCY "SHARED GOALS"

The Member countries* of the International Energy Agency (IEA) seek to create the conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments. IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants.

In order to secure their objectives they therefore aim to create a policy framework consistent with the following goals:

1 Diversity, efficiency and flexibility within the energy sector are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydro power, make a substantial contribution to the energy supply diversity of IEA countries as a group.

2 Energy systems should have **the ability to respond promptly and flexibly to energy emergencies.** In some cases this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies. 3 The environmentally sustainable provision and use of energy is central to the achievement of these shared goals. Decision-makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should where practicable have regard to the Polluter Pays Principle.

4 More environmentally acceptable energy sources need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development of economic non-fossil sources is also a priority. A number of

^{*} Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States.

IEA Members wish to retain and improve the nuclear option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.

5 Improved energy efficiency can promote both environmental protection and energy security in a costeffective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle from production to consumption. Strong efforts by governments and all energy users are needed to realise these opportunities.

6 Continued research, development and market deployment of new and improved energy technologies make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. co-operation International in the development and dissemination of energy technologies, including industry participation and co-operation with non-member countries, should be encouraged.

7 **Undistorted energy prices** enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.

8 **Free and open trade** and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.

9 **Co-operation among all energy market participants** helps to improve information and understanding, and encourage the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

(The Shared Goals were adopted by IEA Ministers at their 4 June 1993 meeting in Paris.)



GLOSSARY AND LIST OF ABBREVIATIONS

In this report, abbreviations are substituted for a number of terms.

bcm	billion cubic metres.
EEA	European Economic Area.
EU	European Union.
EFTA	European Free Trade Association.
GDP	gross domestic product.
GFU	Gas Negotiations Committee.
GHG	greenhouse gases (see footnote 5).
GW	gigawatt, or one watt $\times 10^9$.
kg	kilogramme.
kt	kilotonne.
kW	kilowatt, or one watt \times 10 ³ .
kWh	kilowatt-hour = one kilowatt × one hour, or one watt × one hour × 10^3 .
mcm	million cubic metres.
Mt	million tonnes.
Mtoe	million tonnes of oil equivalent; see toe.
MW	megawatt of electricity, or one watt $\times 10^6$.
MWh	megawatt-hour = one megawatt × one hour, or one watt × one hour $\times 10^{6}$.
NOK	Norwegian kroner.
Nord Pool	Nordic power exchange.
NO _x	oxides of nitrogen.
NVE	Norwegian Water Resources and Energy Directorate.
OECD	Organisation for Economic Co-operation and Development.
РРР	purchasing power parity: the rate of currency conversion that equalises the purchasing power of different currencies, <i>i.e.</i> estimates the differences in price levels between different countries.

R&D	research and development, especially in energy technology; may include the demonstration and dissemination phases as well.
SDFI	State Direct Financial Interest.
sm ³	standard cubic metre.
tcm	trillion cubic metres.
TFC	Total Final Consumption of energy; the difference between TPES and TFC consists of net energy losses in the production of electricity and synthetic gas, refinery use and other energy sector uses and losses.
toe	tonne of oil equivalent, defined as 107 kcal.
TPES	Total Primary Energy Supply.
TW	terawatt, or one watt $\times 10^{12}$.
TWh	terawatt × one hour, or one watt × one hour × 10^{12} .
UNFCCC	United Nations Framework Convention on Climate Change.

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