INTERNATIONAL ENERGY AGENCY

Energy Policies of IEA Countries

NORWAY

2005 Review

OECD

INTERNATIONAL ENERGY AGENCY

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

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

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

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

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The OECD is a unique forum where the governments of thirty democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

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

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Disclaimer

This report is based on the visit to Norway by the IEA review team that took place in April 2005. It was mainly drafted before the change of government became official, and the new government's policies were announced.

On 12 September 2005, the Norwegian general elections resulted in a change of government. The following list contains the main policy initiatives announced in the new Prime Minister's inaugural address to the Storting:

- The government will promote new, renewable energy sources and apply environmental standards to other energy production.
- The government will find solutions that reduce emissions of greenhouse gases.
- The government will seek to ensure that a larger share of the natural gas produced on the Norwegian Continental Shelf is used in the domestic industrial, energy and transport sectors in compliance with our international climate commitments.
- Norway aims to become a world leader in the environment-friendly use of gas.
- The State will participate in funding infrastructure for the transport of natural gas.
- The government will create conditions that encourage CO_2 capture, transport and storage.
- The government will ensure that the establishment of a full-scale CO_2 capture facility at Kårstø is started and will provide funding towards this.
- Petroleum activities will not be initiated in the Nordland VI area during this parliamentary period.
- Once the integrated management plan has been adopted, it will be decided which parts of the remaining areas off the Lofoten Islands and further north, including the Barents Sea, are to be opened up and which are to remain closed to petroleum activities.

Any mention of "government" in this review refers to the former Norwegian government. Initiatives and policies by the current government are indicated by using "new government".

ORGANISATION OF THE REVIEW

REVIEW TEAM

An IEA review team made up of energy specialists drawn from IEA member countries and the IEA Secretariat visited Norway from 17 to 22 April 2005 to review the country's energy policies. The team met with representatives from government, the energy industry, trade associations, consumers, and others. This report was drafted on the basis of information received during and prior to the visit, including views expressed by various parties during the visit.

The team greatly appreciated the co-operation and the transparency demonstrated by the participants during this policy review process, and wishes in particular to thank Eva Paaske and Espen Mehlum of the Ministry of Petroleum and Energy, without whose kind and generous help and extensive preparation the visit would not have been possible.

The members of the team were:

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ORGANISATIONS VISITED

The team held discussions with representatives from the following organisations:

- Confederation of Norwegian Business and Industry

- Electricity Users Association
- Energi & Strategi AS
- Enova
- Gassnova
- Ministry of the Environment
- Ministry of Foreign Affairs
- Ministry of Petroleum and Energy
- Ministry of Transport and Communications
- Nord Pool
- Norsk Hydro
- Norwegian Competition Authority
- Norwegian Electricity Industry Association
- Norwegian Petroleum Directorate
- NFR (Research Council of Norway)
- Norwegian Water Resources and Energy Directorate
- Petoro
- Statkraft
- Statnett
- Statoil
- Talisman

Andreas Biermann managed the review and drafted the report in consultation with the team, with the exception of the electricity chapter which was written by Doug Cooke from the IEA/EDD. Sandra Martin edited the text. Monica Petit prepared the figures and Bertrand Sadin prepared the maps.

REVIEW CRITERIA

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

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

Energy policy in Norway is receiving sizeable political attention and is conducted by highly respected professionals. The economically efficient development of its large oil and gas resources has made Norway Europe's largest exporter of petroleum (oil, oil products and natural gas), and it is contributing significantly to Europe's security of supply. Income from the oil and gas sectors represented 18% of GDP and 24% of government revenue in 2004. The development of the long-term scenario for the production of petroleum resources and the responsible management of wealth derived from natural resources through for instance the Petroleum Fund, are examples of a transparent and forward-looking way to manage the petroleum wealth of the country, and should be commended.

Norway enjoys extensive access to cheap and clean hydropower and has developed this resource extensively. Abundant offshore oil and gas resources and relatively cheap hydropower have enabled Norway to enjoy a high level of security of supply and one of the highest standards of living in the world.

In terms of economic efficiency, Norway is to be commended for its role as a pioneer in liberalising its electricity market and promoting the Nordic electricity market. In the oil and gas sector, Norway has made important progress in boosting efficiency by the partial privatisation of Statoil.

Despite its successes, Norway is facing important energy policy challenges. Since 1990, onshore energy consumption has grown slowly, but even this relatively slow growth has not been matched by an extension of onshore energy production. In spite of the government's authorisation in the 1990s, the construction of gas-fired power stations has been delayed owing to environmental concerns about carbon dioxide (CO_2) emissions, and the construction of a gas supply network onshore is delayed because of regulatory and economic uncertainties. The construction of additional hydropower stations and onshore wind farms has also been delayed by environmental concerns. Electricity grid operators face constraints on expanding their capacity. Little relief can be expected in the coming years unless these concerns are resolved. Initiatives to resolve these issues will not go ahead unless a better understanding by the general public of Norway's future challenges in terms of energy supply/demand is ensured. In this context, the publication of long-term energy forecasts could play a significant role.

Environmental sustainability has been very highly positioned in Norwegian energy policy. The Norwegian Continental Shelf and the Barents Sea have very high standards of environmental regulation for petroleum production. In carbon capture and storage (CCS) the Sleipner field is an important pioneering project. The country ratified the Kyoto Protocol, which dictates a tough target for greenhouse gas (GHG) emissions of 1% above 1990 levels. However, Norwegian CO_2 emissions are rising owing to an increased production of offshore petroleum and an increase of demand in all sectors of the economy even though energy intensity has decreased. The concentration of emission increases in the offshore and transport sectors, the predicted growth of offshore activities, together with the commissioning of gas-fired power generation, will make the achievement of Norway's Kyoto target difficult without the extensive use of the Kyoto mechanisms. Meeting its Kyoto target without compromising security of supply is Norway's biggest energy policy challenge. Micro-management of investment decisions for individual power projects may paralyse decision-making without contributing to the achievement of the Kyoto target. A comprehensive public and political debate looking at the entire portfolio of tools of climate change policy, including intensified use of flexible Kyoto mechanisms, is recommended.

Norway has been a pioneer in introducing a CO_2 tax system. However, the effectiveness of the tax has been limited owing to significant exemptions for major emitters. The government should clarify the role of the environmental taxation in climate change mitigation, evaluate their effectiveness and review their design if appropriate. Norway has introduced a quota-based emissions trading system (ETS), which it is aiming to link to the European Union's (EU) ETS. This will present a challenge to the future of CO_2 taxation in Norway because it is difficult to design the tax in a way that is compatible with emissions trading. The greatest challenge will be to decide whether to include the offshore sector in the ETS after 2008. The current trading system is restricted to a small part of emissions, and this may reduce its effectiveness. The government will make use of the Kyoto Protocol's project-based mechanisms to help achieve its targets, and it should be commended for its efforts to build up an understanding of these mechanisms.

Norway is expecting that CCS will play a significant role in reducing emissions from gas-fired power generation. Technological and economical realities of CCS need to be considered by the public and energy policy-makers, and every effort should be made to ensure that a realistic understanding of the possibilities of CCS in reducing emissions from power generation informs both the public debate and decision-making.

Norway's energy demand is unusual when compared with that of other IEA countries because it primarily consists of hydroelectricity in stationary use and oil for transport, with a very high share of the electricity being used for heat production. While Norway has increased energy consumption and production considerably since 1973, demand has now caught up with supply. Energy efficiency has the potential to increase security of supply in Norway, and the government has had conservation policies in place since 1993. Investment in energy efficiency appears to be very cost-effective.

Norway has set up Enova SF as a state-owned company tasked with achieving energy savings. The underlying structure of Enova as an independent body with its own long-term funding and clear objectives is exemplary. The 2002/03 programme of support for energy efficiency in the residential sector has shown that great success is possible. This is commendable, and Norway should consider expanding efforts to reduce building and transport energy use.

The Norwegian oil and gas industry on the Norwegian Continental Shelf (NCS) is most likely close to reaching the peak of production. The government should be commended for the transparent and forward-looking way in which it intends to manage the decline of the industry, and to extend production for as long as possible. The government has taken significant action to increase exploration and to open the industry further, while reducing state involvement. Altogether, Norway's management of its oil and gas resources is an example of best practice for the management of valuable natural resources in a small economy.

Norway reopened the southern part of the Barents Sea for petroleum activity in 2003, recognising environmental and fisheries interests. The first development in the Barents Sea is the Snøhvit field, which is planned to come on stream in 2006. With the first development in this area, the government is encouraged to investigate whether other currently closed areas further south can be opened, bearing environmental considerations in mind.

The high cost base of the petroleum industry in Norway presents a challenge for the achievement of the long-term scenario. Comparatively higher costs than in the United Kingdom (UK) sector of the North Sea are driven by a combination of high environmental standards, and significantly higher cost for labour. The government should take all possible steps to ensure that the economics of marginal assets on the NCS are improved, taking into account environmental and safety considerations.

The use of gas is very limited within Norway, even though it has increased slightly in recent years. Increasing domestic access to gas can make a significant contribution to security of supply in the power sector, as it contributes to the diversification of generation sources recommended before. Despite significant commercial interest in establishing an industry, this has been held back by uncertainties about the investment framework, and the failure to construct the licensed gas-fired power stations, which could become a major driver in creating demand pull for the industry.

Norwegian domestic production of electricity is almost exclusively based on hydropower. The government is encouraging the development of new renewables such as biomass and wind, and this is commendable. The goal of 3 TWh delivered wind energy for 2010 would still represent a small share of the forecast electricity consumption of Norway by that date. Norway has a good resource base of high wind speeds and a very long coastline, but the future integration of wind into the Nordic grid, and the transportation cost for wind-generated electricity from the north of the country should also be considered in expansion plans for renewable capacity. The planned introduction of a green certificates system replacing direct subsidy is a positive development. The liberalised electricity market provides a good framework for this, and it can lead to a more market-based and cost-efficient allocation of financial resources. Norway should continue to work closely with Sweden so that the integrated market can launch from 2007. The government should consider the introduction of support policies helping to overcome non-market barriers to renewable energy sources.

In the 1990s, Norway fundamentally reformed its electricity sector, leading to the development of the Nordic electricity market, which was more market-based, and increased cross-border trade. The effectiveness of these arrangements was demonstrated during the 2002/03 precipitation shortage when market prices encouraged efficient use of the electricity system. Yet this also highlighted some emerging challenges such as a tightening of the supply-demand balance, and some issues in the policy and regulatory framework. A critical factor in determining whether the Nordic electricity market can continue to deliver affordable and reliable outcomes for Norway is the degree to which it remains an integrated market. Congestion has become a more regular feature in the Nordic market and this could become an important issue in dry years. Nordel's proposal to increase transmission capacity has the potential to strengthen the ability of the market to provide reliable and affordable electricity services. This is a very welcome development. However, co-ordination to this end could perhaps be improved.

More integrated regulatory and planning arrangements supported by efficient, transparent and cost-reflective network pricing could help to remove uncertainty. Regulatory and institutional responsibilities should be further clarified and the co-ordination among and between regulators and system operators should be strengthened. NVE, the regulator for the Norwegian electricity industry and the country's hydro assets, is reviewing its income cap methodology in the context of preparing for the regulatory period starting in 2007. Getting the balance right between incentives for lowering costs and for efficient investment will be a challenge in this context.

The 2002/03 experience also highlighted the importance of wider trade to secure reliable electricity services. The recent announcement of a new transmission link between Norway and the Netherlands (the NorNed cable) is commended. Efficient domestic investment in generating capacity could also strengthen the reliability of Norwegian electricity supplies. It is important to ensure that investors have a clear path for the approval of their projects available to them. Removal of the asymmetry in the concession rules applying to private and public ownership of hydroelectric facilities could help to further stimulate private investment. Uncertainty about the regulatory arrangements for gas-fired power plants and related infrastructure projects risks discouraging potentially efficient generation investment.

Representatives of large energy users have suggested that the degree of flexibility shown in 2002/03 should not be taken for granted. Further investigation of a market-based means to stimulate efficient demand responsiveness, especially to broaden the potential group of responsive end-users, should be encouraged. Many energy-intensive users currently enjoy long-term supply contracts with favourable prices. Most of these contracts will expire within six years.

Government funding for energy research and development (R&D) has increased substantially over the past two years. The increase is commendable. Nevertheless, the current funding level still does not appear to fully reflect the importance of the energy sector in the Norwegian economy. In order to achieve the long-term scenario for oil and gas production, the government may need to consider further increases of the energy R&D budget to address the technological challenges of exploration and production in extreme climatic conditions and in deep water.

Norway's energy R&D is also closely aligned with its energy policy and presents good examples in terms of strong private-public co-operation, its monitoring and assessment efforts and collaboration among relevant institutions. Results from the Norwegian R&D programme will contribute to enhanced oil recovery (EOR) worldwide, and the government should be praised for its efforts.

Norway has set up Gassnova as an agency dedicated to develop technological solutions for CCS and reduced emissions from onshore gas use. It should be ensured that Gassnova has the resources to manage the technological and project co-ordination issues in this complex field, while participating in international information exchange. The set-up and work of the agency appears to be exemplary, and Norway should be commended on this comprehensive approach to technology development.

RECOMMENDATIONS

The government of Norway should:

GENERAL ENERGY POLICY

- *Facilitate further oil and gas exploration in the Barents Sea and other areas containing important undiscovered resources within a framework of sustainable development.*
- *Continue pursuing Norway´s active role in advancing the further integration of the Nordic electricity market.*
- *Facilitate the introduction of gas-fired power generation and associated network infrastructure by proactively clarifying under which regulatory framework commercial projects could materialise.*
- *Publish energy projections for Norway for the coming decades in order to establish a common information basis for public debate on the future choices facing Norway´s energy policy.*
- *Continue the co-operation in the European Economic Area to ensure rapid implementation of relevant EU directives.*

ENERGY AND THE ENVIRONMENT

- *Clarify how Norway's climate change policy is supposed to meet its Kyoto target by a national climate strategy to allow secure investment decisions in the energy sector.*
- *Continue to evaluate the effectiveness of environmental taxation, and act on results from these evaluations to ensure the efficient development of the taxation system.*
- *Consider making stronger use of Kyoto's flexible mechanisms by putting Norway's quota system as soon as possible on the same wide basis as the EU emissions trading scheme and pursue the integration of the EU and the Norwegian ETS.*
- *Widely and internationally disseminate Norwegian experience in CCS.*
- *Ensure that decisions about diversification of energy supply take into account the current technological realities of CCS.*
- *Pursue further cost-effective reductions of non-CO_2 GHG emissions.*

ENERGY EFFICIENCY

- *Evaluate whether Enova's objectives are delivering the expected improvements in all target areas of work, in particular energy efficiency.*
- *Closely monitor Enova's work and disseminate lessons learned internationally through publication of Enova's literature in other languages.*
- *Reconsider the need for direct investment aid to industrial energy efficiency.*
- *Consider measures to increase the household sector's ability to react to price increases by reducing and/or shifting load.*
- *Gather statistical data required for effective policy-making, in particular in the building sector.*
- *Pursue cost-effective technological solutions for public transport, such as ferries, buses and commercial vehicles as appropriate through, for example, further use of the public transport fund as an incentive to local authorities.*
- *Encourage congestion charging aiming to achieve modal shifts in city transport.*
- *Introduce a taxation link to vehicle labelling at the earliest opportunity.*
- *Evaluate the effectiveness of the CO_2 tax as a means of fulfilling Kyoto obligations cost-effectively.*

FOSSIL FUELS

- *Promote the innovative and proactive approach to acreage management and the award of exploration and production licences internationally as an example of best practice.*
- *Consider the opening of currently restricted acreage off the Lofoten taking into account environmental concerns to ensure that environmental restrictions on offshore petroleum activities are not unduly hindering further exploration.*
- *Consider making available smaller stakes from the State Direct Financial Interest for new entrants and small specialised operators.*
- *Take all possible steps to control cost increases for operations on the Norwegian Continental Shelf, as they might diminish value creation.*
- *Monitor closely the decision-making on upstream pipeline investments to promote the exploration and production from smaller or more remote fields.*

- *Support the market-driven development of onshore gas use by clarifying the legal and regulatory framework in order to give investors long-term security.*

- *Leave Store Norske Spitsbergen Kulkompani to operate on a commercial basis with no government support.*

RENEWABLES

- *Work to clarify as quickly as possible the regulatory framework for the green certificates system to be introduced together with Sweden from 2007, in order to provide the market with certainty and ensure timely implementation and smooth phasing-in.*

- *Further investigate the potential for heat production from renewable sources to make carbon-free hydroelectricity available for international trade.*

- *Examine the additional measures for wind generation management and smooth grid integration with a view to avoid creating problems in the grid owing to the introduction of new wind generation.*

- *Take into account the cost-effectiveness of further support for renewable energy on the integrated power system and compare it with other energy policy options, such as energy efficiency.*

ELECTRICITY

- *Continue to promote greater harmonisation within the Nordic market in relation to economic regulation, system operation, competition surveillance and co-ordinated planning and development of the Nordic transmission "backbone".*

- *Ensure that the income cap methodology adopted for the regulatory period commencing in 2007 provides sufficient incentive for efficient and timely network investments.*

- *Facilitate the development of efficient transmission links between Norway and other countries.*

- *Review regulatory arrangements with the potential to discourage or delay efficient investment in new generating capacity, or to hinder efficient diversification of ownership. In particular, opportunities may exist to: clarify regulatory requirements; streamline and accelerate licensing approval processes; and remove any inconsistencies in the treatment of public and private ownership.*

- *If introduced, ensure that the capacity reserve programme does not undermine the development of efficient, market-based demand responses or generation investment. Consider a transparent activation trigger linked to water reservoir levels. Ensure that any such programme is compatible with emerging Nordic-wide approaches.*
- *Further promote market-based methods to help broaden demand responsiveness. Consider pursuing this work in a Nordic context, as appropriate.*
- *Existing long-term supply contracts with terms set by the government for energy-intensive users should not be renewed.*

ENERGY TECHNOLOGY AND R&D

- *Examine the appropriateness of the current level of funding for energy R&D taking into account the importance of the energy sector for Norway.*
- *Continue to give the the Research Council of Norway the flexibility to manage the energy R&D programmes, in alignment with strategic guidance, to ensure the optimal mixture of top-down and bottom-up approaches to R&D management.*
- *Examine potential synergies between the PETROMAKS and RENERGI programmes with a view to realising any potential synergies in the underlying sciences.*
- *Continue and further deepen the commendable efforts in the area of international R&D collaboration through the IEA and the EU Research and Technology Development Framework Programmes, and through other bilateral initiatives such as Norway's recently adopted Strategy for Research and Technology Co-operation with North America.*

Figure 1
Map of Norway

GENERAL ENERGY POLICY

OVERVIEW

GEOGRAPHY AND CLIMATE

The Kingdom of Norway (Kongeriket Norge) occupies the western and northern parts of the Scandinavian peninsula. Norway covers an area of 385 155 square kilometres, and has the longest coastline in the world, with its 25 148 kilometres continental coastline or 83 281 kilometres coastline if all islands and bays are included. Norway is extremely rugged, with mountains dividing the country in both north-south and east-west directions. Almost one-third of the country is located north of the Arctic Circle, and forests cover up to one-quarter of its surface area. Norway shares a long land border with Sweden, and a shorter border with Finland and Russia. Maritime borders also exist with Denmark and the United Kingdom (UK).

The population of Norway is increasing. In 2005 it reached 4.6 million, an increase of 9% since 1990, when it stood at 4.2 million. The population density is very low, at 12 inhabitants per square kilometre. Almost 17%, or 811 000 of Norway's inhabitants, live in the greater Oslo area, while up to 75% live in major towns and cities. Norway is also inhabitated by an ethnic minority of Sami, the majority of whom live in the northern parts of the country. Norway had almost 2 million inhabited dwellings at the time of the 2002 census.

The Norwegian climate is milder than is generally assumed, owing to the influence of the Gulf Stream and the predominating westerly winds. Average summer temperatures reach 16.4°C in Oslo, while average January temperatures fall to –4.3°C.

POLITICAL SYSTEM

Norway is a constitutional monarchy, with a full parliamentary democracy, and has existed in its current form since 1905. Executive power is vested formally in the King, but is exercised through the government headed by the prime minister. The government is referred to as "The King in Council". Legislative power is held by the Storting, the Norwegian parliament. There are general elections every four years for the 169 seats in the Storting. The 19 counties and 433 municipalities also have an extensive system of local government with elections every four years. The Norwegian government is committed to sustain the settlement in remote areas such as Finnmark in the far north, and the Svalbard archipelago in the Barents Sea, and subsidises communities in these areas through various forms of tax relief and direct subsidies. The monarchy holds a strong position in Norwegian society since the country regained its independence from Sweden in 1905. The present king is Harald V.

The Labour Party has traditionally been the strongest party and has governed Norway almost continuously from 1935 through to the 1990s, except for the periods when coalitions from centre/conservative parties held power. Other parties in the Storting are the Conservatives, who governed for most of the last decade in coalitions, the Centre Party, the Liberals, the Christian Democratic Party, the Socialist Left Party, the Progressive Party and the Coastal Peoples Party. Energy issues have played an important role in Norwegian politics since the discovery and exploitation of oil and gas resources below the Norwegian Continental Shelf (NCS) in the 1960s and 1970s. For example, in 2000, the first coalition government of previous Prime Minister Bondevik, formed in 1997, fell over the issue of the construction of gas-fired combined-cycle power stations without carbon capture, when it attempted to diversify Norway's electricity supply away from hydro. A second Bondevik government ruled from 2001 to September 2005, when it was defeated in a general election. The new government is formed of a coalition of Social Democrats, the Centre Party, and the Socialist Left Party.

NORWAY AND THE EUROPEAN UNION

Norway has twice held referendums to decide on the proposed membership in the EU. Both of these, in 1972 and 1994, rejected the membership. Norway is the largest member of the European Free Trade Association (EFTA)[1], and in 1992 signed the agreement on the European Economic Area (EEA), in preparation for the possibility of full membership in the EU following the 1994 referendum. Despite the rejection of the membership proposal by the voters, the EEA agreement is still in force, and has been important in shaping Norway's energy policy in recent years. The EEA excludes fisheries and agriculture, as well as commercial policy, among other policy areas, but

1. Other members are Iceland, Liechtenstein and Switzerland.

includes free trade. Most of the legislation relating to the internal market is covered by the agreement. As a consequence, Norway has implemented a number of EU directives relating to energy and environmental issues.

Norway is also subject to surveillance by the EFTA Surveillance Authority (ESA) with regard to legislation and regulation affecting internal market matters, although there is no automatic compliance requirement for the government if the ESA raises concerns or objections to Norwegian policies. In 2004, energy-related issues brought up by the ESA as regards Norway dealt with electricity tax exemption in remote areas, a proposed aid scheme for energy from waste, and CO_2 and heating oil tax exemptions for Norway's pulp and paper industry. Energy-related directives where the relevant annexes were implemented in Norway include the Hydrocarbon Licensing Directive (94/22), the directives governing the internal market in gas and electricity (96/92 and 98/30), as well as the original and amendment directives governing the transit of electricity and gas (98/75, 90/547 and 95/49, 91/296), among others. Norway is performing very well in the implementation of directives.

ECONOMIC SYSTEM

Norway has one of the highest standards of living in the world, partly owing to its wealth of natural resources and the sensible management of these. Norway has developed an important industrial base, relying on the availability of cheap and plentiful hydroelectricity for the production of energy-intensive goods, such as aluminium and ferro-alloys. These industries, together with fisheries, provide the bulk of Norwegian exports other than energy. They currently benefit from long-term electricity tariffs at low prices set by the Storting (see Chapter 8). The Norwegian merchant marine is also sizeable, and contributes to foreign currency earnings. Norway's major trading partners are the UK, Sweden, Denmark, Germany and France.

Annual gross domestic product (GDP) growth in Norway has slowed to an average of 1.8% from 2000 to 2003. The energy industry provides a significant contribution to Norwegian GDP, exports, capital investment, and government revenue, since the development of the NCS began in the 1970s. The industry contributes significantly to employment, with 75 000 workers directly employed by the industry. The government considers that natural resources are a strategic asset that should be held in public ownership or under public control. Additional to exports of petroleum products are exports of coal from a new mine in Svalbard. In recent years, Norway has changed from a net exporter of electricity to a more balanced position owing to an increase in electricity demand with no corresponding substantial increase in power generating capacity, and it is expected to become a net importer in a year with normal precipitation as from 2006.

Norwegian Government Petroleum Fund

The considerable surplus produced from petroleum activities is invested in an oil fund, established on the basis of an act of parliament from 1990, with the first investment made in 1996. The fund is managed by the Norwegian Central Bank on behalf of the Ministry of Finance, and receives income from the State Direct Financial Interest (SDFI) (see Chapter 6), petroleum taxation receipts, and dividends from Statoil and Norsk Hydro share ownership. Today the fund is one of the largest investment funds in the world.

Money from the fund is invested in foreign financial assets, and it is estimated that the fund now controls 0.2% of all shares traded worldwide. Investing the fund in international assets is also a mechanism for the management of the Norwegian kroner (NOK) exchange rate, and helps to avoid the symptoms of the so-called "Dutch Disease".

The fund is meant to be a means of inter-generational wealth transfer. Under the rules governing the fund, 4% of the fund's value at the beginning of every year can be used for current budget stabilisation. This restriction aims to achieve long-run stability in the fund. This rule has not been kept in the recent past, and there is no binding constraint on the government to follow it.

Table 1

Income Situation of the Petroleum Fund 2002–2004 (in billion NOK)

	2002	2003	2004
Net petroleum revenues	169.2	165.9	143.5
Share of revenues invested in fund	91%	89%	87%
Value of fund at start of the year	619.3	604.6	857.0
Estimated income with 4% rule	24.8	24.2	34
Real fund dividend income	22.6	29.5	30.2
Transfers to state budget	53.4	59.0	67.8
Transfers above 4% rule	28.6	34.8	33.8
		(in percentage)	
Real income as share of fund value	3.7	4.9	3.5
Transfers as share of fund value	8.6	9.8	7.9
Net transfer impact after income	-4.9	-4.9	-4.4

Source: *OECD Economic Survey of Norway 2004*, OECD Paris, 2004.

The most recent *OECD Economic Survey* is critical of the failure to comply with the rule, because the deviation from the 4% rule has been significant in most recent years, and there is concern that increased spending of fund revenues can lead to reduced growth in Norway.

The first years of the fund's operation coincided with worldwide equity crashes and a domestic recession in Norway, so the failure to adhere to the 4% rule during these years may not indicate that future years will also see higher contributions by the fund towards the government's budget than the 4% laid out by the rule. In the last three years, petroleum revenues were used to balance the Norwegian budget above the 4% limit, as set out in Table 1.

Despite the higher than expected withdrawal rate from the fund in recent years, it is expected that income generated from currently high oil and gas prices will to some extent redress this situation, and that the fund will therefore be able to play the role envisaged as a method to allow future generations of Norwegians access to petroleum wealth, even when the petroleum resources have been depleted.

ENERGY MARKETS

PRIMARY ENERGY SUPPLY

Detailed information on Norway's energy balances is contained in Annex A[2]. Norway is the largest petroleum exporter among the IEA members, both in terms of absolute volume and share of total primary energy supply (TPES). While oil production has most likely reached its peak, the government expects to increase gas production considerably in future years, and to slowly decrease production of both oil and gas over a period of 30 to 50 years from now. There are also large unexplored areas off the Norwegian coast, where additional discoveries of petroleum could potentially contribute substantially to this aim in the future.

Norway is a net exporter of energy. In 2002, its total production stood at 234 Mtoe, which was 95% above the 1990 level of 120 Mtoe; 86% of this production, or 205 Mtoe was exported. The increase in total production derived primarily from an increase in oil and gas production by 102%, from 109 Mtoe in 1990 to 220 Mtoe in 2002. In 2002, 206 Mtoe, or 88% of the production of oil and gas, were exported, after accounting for imports.

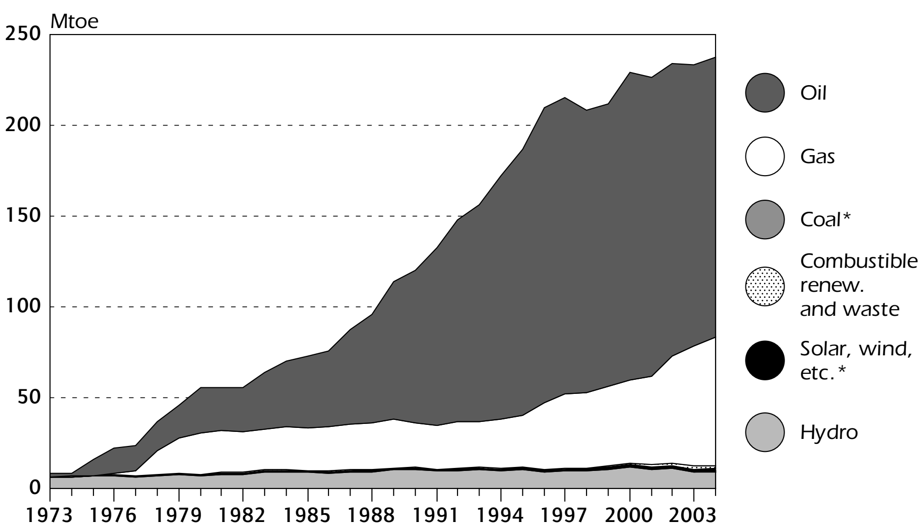
2. In this in-depth review, 2002 figures are used for comparison, because of statistical quality problems with the 2003 set of figures supplied to the IEA (see Figure 3).

TPES after deducting exports reached 29 Mtoe in 2002. Of this, fossil fuels supplied 17 Mtoe, or 59%. Oil accounted for 10 Mtoe, or 35% of TPES in 2002, while hydro accounted for 11 Mtoe, or 39%. Gas accounted for 21% of TPES in 2002, and most of it is being used offshore to power oil industry installations. Very little gas is used domestically in Norway, although the planned construction of a 400 MW combined-cycle gas turbine (CCGT) at Kårstø and the construction of the Melenkoya LNG export facility for gas from the Snøhvit field in the Barents Sea will increase its use significantly.

Electricity trade is highly dependent on annual precipitations, and can fluctuate substantially. Hydro production stayed relatively stable over the period 1990 to 2004, changing from 10.4 Mtoe in 1990 to 11.1 Mtoe in 2002, which was a "wet" year. In 2002 Norway exported 0.8 Mtoe of electricity, compared to an export of 1.4 Mtoe in 1990. In 2001, Norway imported 0.3 Mtoe, and in 2003 0.68 Mtoe. While trade stood at 14% of total electricity production in 1990, this had increased to 17% in 2002. Norway is also producing a small amount of energy from waste, and this has risen by 40% from 1 Mtoe in 1990 to 1.4 Mtoe in 2002. Coal production increased by 715% to 1.4 Mtoe from 0.2 Mtoe in 1990. Since the opening of the new mine in Svalbard (see Chapter 6) in 2001, Norway has become a net exporter of coal.

Figure 2

Energy Production by Source, 1973 to 2004

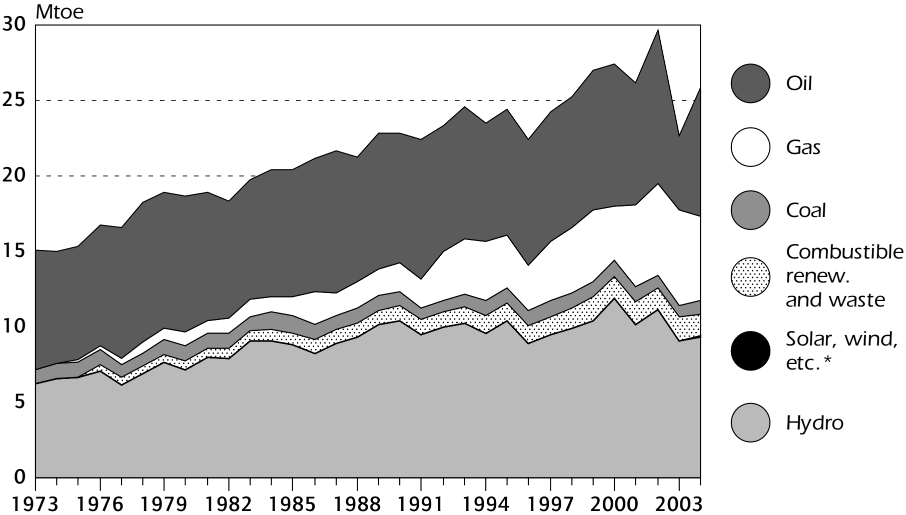


* negligible.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

Figure 3

Total Primary Energy Supply, 1973 to 2004



* negligible.
Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

FINAL ENERGY CONSUMPTION

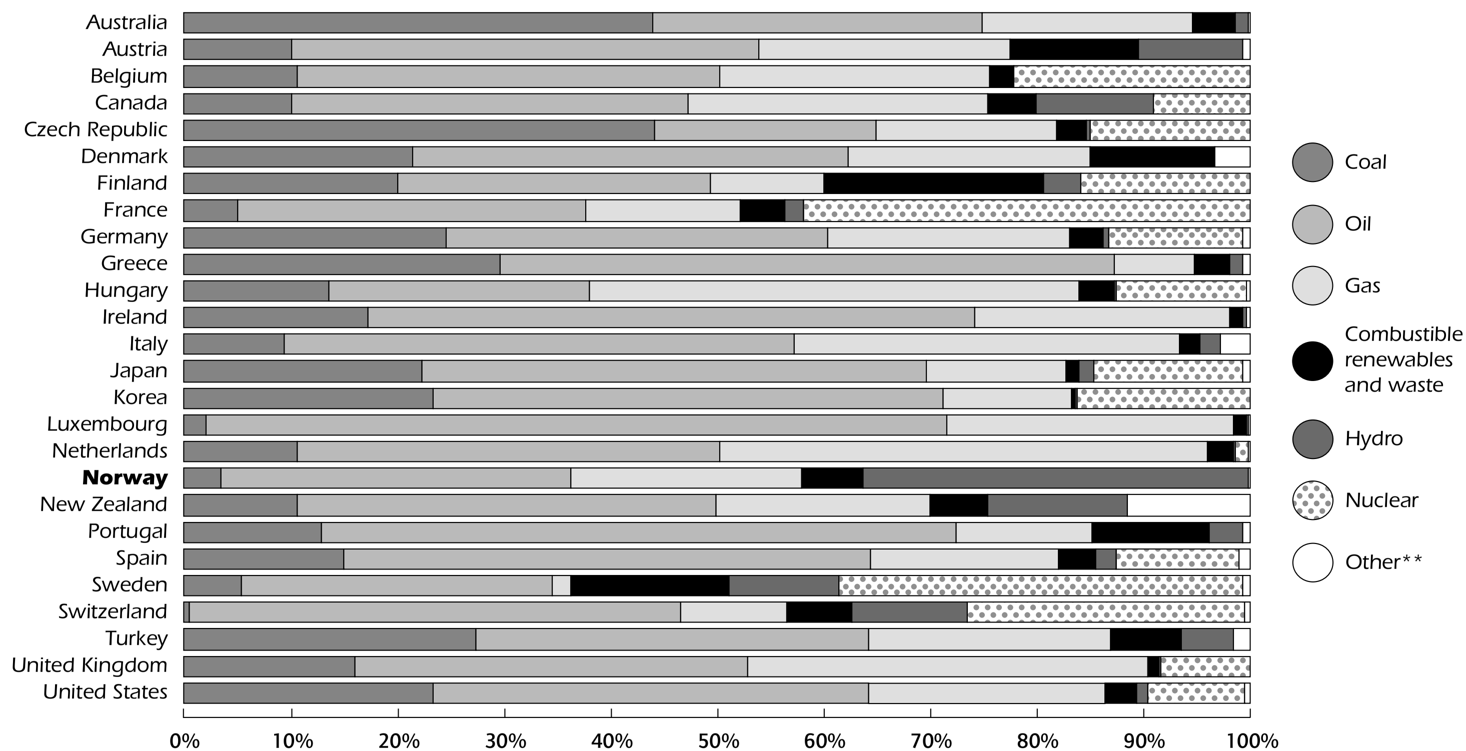
Norway's total final consumption of energy (TFC) increased from 18 Mtoe in 1990 to 21 Mtoe in 2003, by 16%. TFC increased from 7.9 Mtoe to 9.3 Mtoe in industry, by 17.2%; from 4.2 Mtoe to 4.8 Mtoe, by 13.3%, in transport; and from 5.9 Mtoe to 6.9 Mtoe, by 16.6%, in the other[3] sectors. The share of electricity in industry TFC fell from 50% (3.9 Mtoe) to 45% (4.2 Mtoe) between 1990 and 2003. In the other sectors, the share of electricity decreased from 73% (4.3 Mtoe) to 66% (4.5 Mtoe) in the same period.

Norway's energy use per capita is similar to that of other countries with a similar climate, but differs completely in its structure, because of the high share of hydro-generated electricity in Norway. This has led to Norway consuming the highest amount of electricity per capita in the world, with 25 MWh consumed in 2002. This has created a high demand for electricity for energy-intensive industries, and also for heating purposes in domestic dwellings, a demand normally supplied mainly by either oil or natural gas in other IEA member countries.

3. This includes public services, commercial, agriculture, and domestic sectors.

Figure 4

Total Primary Energy Supply in IEA Countries, 2004*



* preliminary data.

** includes geothermal, solar, wind, and ambient heat production.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

ENERGY FORECASTS

General Energy

Since 1992 the Ministry of Petroleum and Energy (MPE) no longer publishes forecasts concerning future energy supply and demand in the Norwegian economy, because it was felt that this would interfere with the newly liberalised markets. Other players in the energy markets do however provide forecasts at least for their own use, *e.g.* Statnett in the electricity sector, or the Norwegian Water Resources and Energy Directorate (NVE). There is no national level aggregation of these forecasts.

Petroleum Production

The Norwegian Petroleum Directorate (NPD) biannually estimates the future production from the Norwegian Continental Shelf (NCS). The main revision is in winter, and there is also a smaller adjustment in summer. Production data are reported by the operators and are the main source for these estimates. The NPD makes some adjustments to the data. To ensure the quality of the data, the authorities and companies have regular meetings within the Revised National Budget Advisory Board.

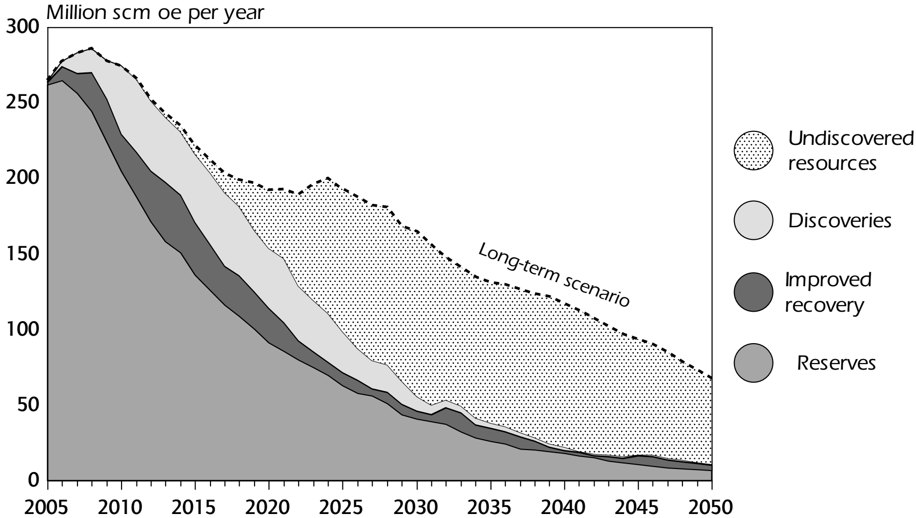
The government's goal is to provide for profitable production of oil and gas in the long term. The parliamentary debate on the Report to the Storting on Petroleum Activities (Report No. 38 to the Storting [2003-2004]) revealed widespread support to work on the realisation of the long-term scenario for the petroleum industry (see Figure 5). The realisation of the long-term scenario requires that all economic petroleum resources on the NCS are produced. This is an ambitious goal, which will result in oil production from the NCS for more than 50 years despite its decline, and in gas production over an even longer period.

Norway's production of crude oil, including natural gas liquids (NGL), was 3.2 million barrels per day (b/d) on average during 2004. The production is expected to stay at this level for the next two years and then to fall gradually. Gas sales from the NCS in 2004 were approximately 75 million standard cubic metres (scm). The annual sales are expected to increase to a plateau level of 120 million scm per year in 2010, and to decline slowly thereafter.

The long-term scenario is based on the NPD's estimate for all recoverable petroleum resources on the NCS. The remaining petroleum resources include proven reserves and expected, undiscovered resources. The long-term scenario represents a production path of these resources, and is treated in more detail in Chapter 6.

Figure 5

The Long-term Scenario, 2005 to 2050



Source: Ministry of Petroleum and Energy.

ENERGY POLICY OBJECTIVES

Norway's energy objectives are in line with the 3E's as outlined by the IEA: economic efficiency, energy security, and environmental sustainability. The government's main energy policy objectives are the creation of wealth in a framework of sustainable development. To sustainably create wealth, the government has developed the long-term scenario for the production of petroleum resources from Norway's territories, and is investing in the Petroleum Fund.

To achieve environmental sustainability, the government's aim is to limit energy use in Norway through its policies to a level below that which would occur without an active government policy, and to produce petroleum assets with a minimum impact on the environment and safety. Consequently, the NCS and the Barents Sea are areas with very high standards of environmental regulation for petroleum production.

A final objective of Norwegian energy policy is to achieve a secure supply of power in Norway through international interconnections and diversification of power sources.

ENERGY POLICY INSTITUTIONS

STORTING

The Storting (parliament) determines the legislative framework for petroleum operations and for the energy sector and water resource management in Norway. Major development projects or issues of principle must be considered and approved by the Storting. Authority has been delegated by the Storting to the King in Council (the government) to approve petroleum development projects with an estimated cost of less than NOK 10 billion.

Unlike parliaments in other countries, the Storting is considerably involved in energy policy-making, thereby reflecting the importance of energy resources to the Norwegian economy, and the high concern about the environmental impact of energy use.

MINISTRY OF PETROLEUM AND ENERGY

The Ministry of Petroleum and Energy (MPE) has overall responsibility for resources and energy matters. The MPE is organised into the following four departments:

- Oil and Gas Department.
- Energy and Water Resources Department.
- Technology and Industry Department.
- Department for Administrative and Economic Affairs.

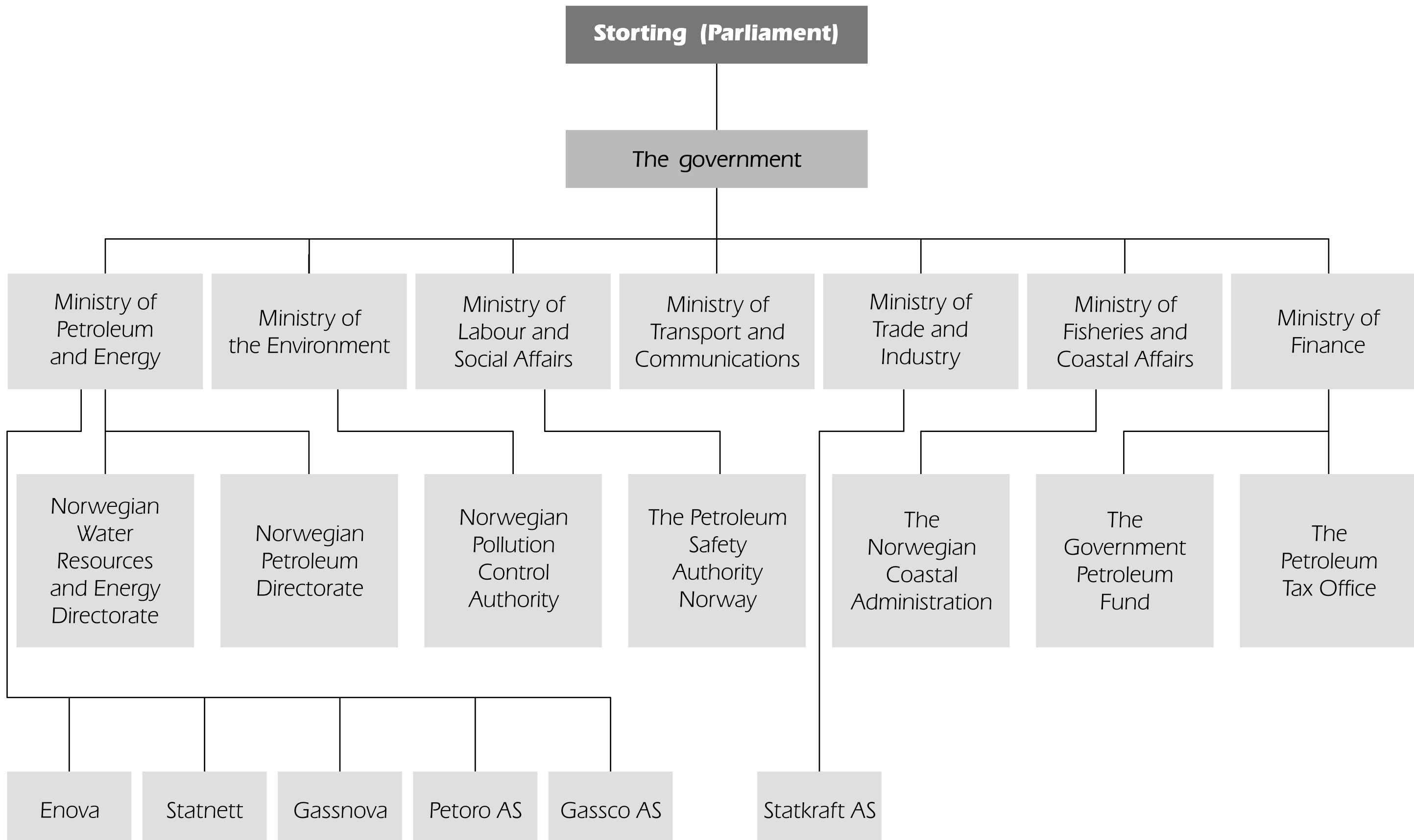
The MPE also carries out the Norwegian state's ownership function for Statoil.

Responsibility for petroleum operations on the Norwegian Continental Shelf (NCS) rests with the Oil and Gas Department. Its task is to ensure that these operations are pursued in accordance with the guidelines laid down by the Storting. This department oversees the Norwegian Petroleum Directorate (NPD), and the state-owned companies Petoro and Gassco. It is also in charge of the overall licence award process. The MPE is also responsible for the State Direct Financial Interest (SDFI), the government share in oil licences awarded, although the day-to-day management of the ownership function is carried out by Petoro, and investment decisions for the Government Petroleum Fund are made by Norges Bank (the Norwegian central bank.)

The MPE oversees or owns subordinate agencies and companies, which are active in the petroleum sector, as illustrated in Figure 6:

Figure 6

Norwegian State Energy Policy Administration



Source: Ministry of Petroleum and Energy.

Norwegian Petroleum Directorate (NPD)

The Storting decided on 2 June 1972 to establish a Norwegian Petroleum Directorate (NPD). The NPD’s headquarters are in Stavanger and there is a branch office in the north Norwegian port of Harstad. This agency is administratively subordinate to the MPE. On 1 January 2004, the NPD was divided into two independent agencies, the NPD and the Petroleum Safety Authority Norway (PSA). See the section on the PSA below.

The primary functions of the NPD are as follows:

- To exercise administrative and financial control to ensure that exploration for and production of petroleum are carried out in accordance with legislation, regulations, decisions, licensing terms, etc.
- To ensure that exploration for and production of petroleum are pursued at all times in accordance with the guidelines set by the MPE.
- To advise the MPE on issues relating to exploration for and production of submarine natural resources.

Petoro

The partial privatisation and listing of Statoil required changes to the management system for the State Direct Financial Interest (SDFI) in petroleum activities, which was managed by Statoil prior to privatisation. The SDFI is built up of the direct share that the Norwegian State reserves in licences awarded. Petoro was founded in May 2001 as a state-owned limited company to serve as the new manager for the SDFI, and is based in Stavanger. The company's main responsibilities are the management of the SDFI assets held by the Norwegian State in joint ventures, the monitoring of Statoil’s marketing and sales of the petroleum produced from the SDFI, in line with the instruction issued to Statoil by the MPE, and the financial management of the SDFI, including the keeping of accounts. Petoro aims to work as an ordinary non-operator investor in the licences in which it administers an ownership stake.

Gassco

The independent operating company Gassco, established on 1 January 2002, operates most of the upstream gas pipeline network, and co-ordinates the process for its further development. Based at Bygnes in Karmøy, north of Stavanger, Gassco is a wholly state-owned limited company.

Responsibilities for the natural energy resources on the mainland rest with the Energy and Water Resources Department. The main objective of the MPE is to ensure sound management, in both economic and environmental terms, of water and hydropower resources and other domestic energy sources.

In the sector of energy and water resources, the following agencies and companies are overseen by the MPE:

Norwegian Water Resources and Energy Directorate (NVE)

The NVE is the regulator for the Norwegian electricity industry and the country's hydro assets. It is a subordinate agency of the MPE responsible for the administration of Norway's water and energy resources. NVE's tasks are to ensure coherent and environmentally-sound management of river systems and to promote efficient electricity trading, cost-effective energy systems and effective energy use. It also plays a central role in emergency responses to flooding and dam failure, and heads contingency planning for power supply. Other duties relate to research and development (R&D) work and to international co-operation within its sphere of responsibility. In addition, it serves as Norway's national hydrological institution.

Statnett SF

Statnett SF was founded in 1992. The MPE acts as its owner on behalf of the government, as specified in the act of 30 August 1991 relating to state enterprises. Statnett SF is responsible for the construction and operation of the central electricity grid. It owns about 87% of the central grid, and operates the entire system. Statnett also has short- and long-term system responsibility. This means that it co-ordinates the operation of the entire Norwegian electricity supply system, and ensures that the amount of electricity generated is always equal to the amount consumed. Statnett's revenues are regulated by the NVE as part of its regulation of monopoly operations.

Enova SF

On 27 March 2001, the Storting approved the establishment of a new autonomous public enterprise responsible for promoting energy savings, new renewables, and environment-friendly natural gas solutions. The name of the new enterprise is Enova and it is situated in the city of Trondheim in central Norway. Enova has been operating since 1 January 2002. Enova is owned by the government and is represented by the MPE. The MPE also defines Enova's tasks and goals (see Chapter 5).

Gassnova

Gassnova has been active since January 2005. Its task is to support the R&D of technologies for gas use that do not emit CO_2. Gassnova is financed from a dedicated fund and is located in Porsgrunn. It co-operates closely with the Norwegian Research Council on R&D matters.

MINISTRY OF TRADE AND INDUSTRY

The ministry is exercising the State's ownership functions for Statkraft SF (the state-owned generation company) since 1 January 2002, when responsibility for exercising the government's ownership function for Statkraft SF was transferred from the MPE. The ministry is also exercising ownership functions for Norsk Hydro ASA in which the State holds a minority stake and for the coal company Store Norske Spitsbergen Kulkompani AS.

MINISTRY OF LABOUR AND SOCIAL AFFAIRS

This ministry has overall responsibility for the working environment in the petroleum sector, as well as for the emergency response and safety aspects of the industry. It oversees the Petroleum Safety Authority.

Petroleum Safety Authority Norway (PSA)

As a consequence of parliamentary consideration of Report No. 17 to the Storting (2002-2003) on government regulatory agencies, the Petroleum Safety Authority Norway (PSA) was established on 1 January 2004 through a division of the NPD. The PSA shares premises with the NPD in Stavanger.

The PSA is responsible for safety, emergency response and the working environment in the petroleum sector. It has taken over responsibility for regulating and supervising land-based facilities relating to the petroleum industry from the Directorate for Civil Protection and Emergency Planning and the Directorate of Labour.

MINISTRY OF THE ENVIRONMENT

The Ministry of the Environment is responsible for climate change issues, and the enactment of legislation to fulfil international treaty obligations such as the Gothenburg Protocol. It co-operates closely with the MPE on energy and environment issues. The ministry oversees the Pollution Control Authority (SFT).

Pollution Control Authority (SFT)

The SFT has the following tasks with a direct relation to energy:

- Monitoring and providing information about environmental development.
- Providing the Ministry of the Environment with advice, assessments and expert support.

- Exercising authority through regulations and control measures.
- Promoting Norwegian objectives in international environmental co-operation.

The SFT considers work on climate change and the effects of energy consumption as a priority area.

MINISTRY OF TRANSPORT AND COMMUNICATIONS

The Ministry of Transport and Communications has overall responsibility for energy use for transport purposes. It is responsible for the promotion of environment-friendly transport, financial support to local authorities and the development of biofuels.

MINISTRY OF FISHERIES AND COASTAL AFFAIRS

The Ministry of Fisheries and Coastal Affairs is responsible for overall shipping safety, including the shipping related to oil installations and seaworthiness of the installations themselves. It is also in charge of oil spill prevention and emergency oil spill response.

MINISTRY OF FINANCE

The Ministry of Finance has overall responsibility for all taxes and duties.

THE RESEARCH COUNCIL OF NORWAY (NFR)

The Research Council of Norway (NFR) is responsible for public funding of user-driven and long-term strategic energy R&D. The NFR works closely with other actors in the field of energy R&D.

ENERGY MARKET STRUCTURE

ONSHORE

Since 1991, Norway has been a pioneer in liberalising its energy markets and pursuing international interconnection of the electricity market. Consequently, Norway has become a central element of the Nordic electricity market. Norwegian energy markets are at the same time competitive and dominated by publicly-owned enterprises. The dominance by publicly-owned enterprises is mitigated to some extent by the international interconnection of the power market (which serves also to meet a significant part of heating demand), and by the ability to freely enter into the transport fuel market. In the power sector, account separation is used to prevent cross-subsidisation between monopoly and competitive functions. Partial privatisation of some state-owned companies such as Statoil is also providing a valuable indicator for these companies to compare them to their private competitors.

Natural monopoly functions such as the operation of the high-voltage power grid or the offshore gas pipeline network are carried out by state-owned enterprises under regulatory oversight by state-owned institutions. Electricity distribution networks are often owned by the municipalities they serve. Regulation in the form of a periodic income cap arrangement is aimed at achieving an efficient functioning of these companies. Regulation also encourages the merger of small network companies to achieve higher efficiencies (see Chapter 8). A new income regulation, which will be put in force in 2007 is now under preparation.

There is no comprehensive onshore gas distribution network, and regulatory arrangements for the small networks are almost non-existent at this stage, apart from a licensing process. It is uncertain whether there is a sufficient market for privately-financed onshore gas supply in Norway.

Electricity generation is dominated by publicly-owned utilities, with the largest majority privately-owned company being Norsk Hydro. Ownership restrictions on private ownership of hydropower assets exist in the form of a reversion of ownership rights to the State after 60 years for privately-owned enterprises. This legislation is currently being considered by the MPE.

Electricity supply is a highly competitive business in Norway, with a number of players active in the market, and a high number of consumers switching suppliers. In the case of transport fuel supply, there are indications that competition is weak in Norway, with pre-tax prices for gasoline being among the highest in OECD member countries.

Market oversight is provided by specialised regulatory authorities, such as the NVE and the relevant departments of the MPE, as well as by the general competition regulator, the Competition Commission. All development and operations are subject to governmental licences.

Norway's power supply sector is subject to governmental legislation, which includes licensing, supervision, control and other regulations. A Master Plan for Water Resources has been established to balance the cost-effectiveness of the remaining hydropower projects with environmental concerns. This plan is the result of co-operation between the Ministry of Petroleum and Energy and the Ministry of the Environment.

OFFSHORE

Norway's main energy resource consists of the offshore reservoirs of oil and gas, and these are under government control. Access to these resources is on the basis of regular licensing rounds for acreage for exploration in Norwegian waters, in which companies bid for the right to explore in a specific sector of the Norwegian economic zone. Any petroleum resources produced are then owned by the company (or group of companies) holding the licence. The government recovers wealth through taxation, and the reservation of direct stakes in a licence for the State Direct Financial Interest (SDFI), managed by Petoro AS.

ENERGY SECURITY OF SUPPLY

OIL

Norway became a member of the IEA on 7 February 1975[4]. Norway is a net oil exporter that has neither peacetime stockholding commitments nor the legal basis to procure and hold stocks of oil or to instruct companies to release their stocks in a peacetime supply crisis. The production of the Norwegian Continental Shelf (NCS) is expected to provide sufficient emergency stocks to meet national needs in a peacetime emergency. Norway does however have certain amounts of government-owned stocks of oil products, which can be used as a limited crisis management measure in situations ranging from disturbances caused by uncertainties in the oil market up to an emergency/war situation.

In terms of long-term security of supply for Norway, the government's policy of encouraging increased exploration activity both in the mature areas of the NCS and in frontier areas such as the Barents Sea will contribute to long-term security of supply not just for Norway, but also for other industrialised nations.

GAS

Norway is using little to no gas onshore for domestic consumption, while exporting almost all its production. Norway is therefore not experiencing any risks to its security of supply.

4. Agreement between the International Energy Agency and the Government of the Kingdom of Norway Concerning the Participation of the Government of the Kingdom of Norway in the Work of the Agency.

ELECTRICITY

Policy

Norwegian electricity generation, almost all of which is accounted for by hydropower, has remained stable since 1990, with annual variations owing to levels of precipitation. Norway has a high consumption of electricity compared to other Nordic countries. Demand has increased since the 1990s, and this has led to the annual reserve capacity decreasing over this time. These factors make the Norwegian consumption more vulnerable to shortfalls in precipitation than the other Nordic countries.

To alleviate this situation, the government authorised the construction of gas-fired combined cycle power stations in the late 1990s. None of these have been built yet, owing to environmental concerns relating to their CO_2 emissions and developer concerns about the economic viability of these plants (see Chapter 4). As an additional measure for electricity source diversification, the government is supporting the construction of wind farms and fuel switching for heat through subsidy schemes (see Chapter 7 on Renewable Energy). Further development of hydropower is subject to stringent environmental regulations.

Following the precipitation shortfall of the winter 2002/03, a clarification of the transmission system operator's (TSO) responsibilities when power is in very short supply was provided by the Report to the Storting 18/2003 "On security of electricity supply". The TSO Statnett is now also responsible on a continuous basis for identifying and developing the instruments required for maintaining a moment-to-moment balance between supply and demand at times when electricity supply is very strained. Its duties include continuously evaluating the extent to which new measures are required in order to ensure that such a moment-to-moment balance is maintained in a better way than at present.

To achieve the objective of security of power supply in Norway, Report No. 18 emphasises that the energy strategy is based on a well-functioning power market and an active exchange of power between countries. The power exchange market has led to efficiency improvements in the power industry and to a better utilisation of available resources. An action list with ten policy measures was presented, and these are listed below. The initiatives are directed partly towards a more robust power supply in the longer term, and partly towards an improved management of future situations with precipitation shortfalls.

- Increased efforts to effect environment-friendly changes in energy consumption and energy production. A system for stimulating the construction of infrastructure for district heating.

- Improved rules and regulations for effecting changes in energy consumption and production.
- A strengthened basis for increased hydropower production.
- Development of a common Norwegian–Swedish market for green certificates to increase electricity production from renewables.
- Support for an environmentally sound use of natural gas in Norway.
- Strengthened Nordic co-operation on electricity, and facilitation of new interconnectors to other countries.
- Continuous efforts towards effective competition in the power market.
- Specification of the responsibility of the rationing authority and the TSO. Reserve production capacity might be established.
- Increased consumer flexibility.
- Strengthening of the consumers' position in the power market.

International Interconnection to Achieve Security of Supply

Norway has transmission connections with Sweden, Denmark, Finland and Russia. Transmission capacity to Finland and Russia is small, and the connection with Russia is used only for imports to Norway. Transmission capacity is largest between Norway and Sweden, with 3 600 MW. Capacity between Norway and Denmark is approximately 1 000 MW. A 700 MW connection to the Netherlands has been agreed upon, and construction should be finished by 2007/08.

Development of Spare Capacity in the Power System

Statnett SF is responsible for construction and operation of the transmission grid, and operates the whole of this facility. As the TSO in Norway, it is also responsible for short- and long-term system co-ordination. This means that it co-ordinates the operation of the entire Norwegian power supply system so that the amount of electricity generated equals consumption at all times.

ENERGY TAXES AND PRICES

TAXES

Energy taxation in Norway is driven to a large extent by environmental concerns, with special taxes on CO_2 and sulphur dioxide (SO_2) emissions. A consumption tax of 24% is also applied to energy consumption, after special taxes have been applied.

Fossil Fuels

Taxes on fossil fuels are the most important part of governmental revenue from energy taxes. The CO_2 tax on fossil fuels for energy purposes was introduced in 1991. It is among the highest CO_2 taxes in the OECD. Table 2 gives an overview of green taxes levied on fossil fuels in 2004.

CO_2 taxation is also applied to the production of oil and gas offshore. This has had beneficial effects in pushing the industry to seek technological solutions in order to avoid the release of surplus CO_2 from gas production and to investigate storage solutions, *e.g.* in the Sleipner field. It has also helped in the introduction of more efficient solutions for power supply of offshore installations.

As a response to new guidelines from the EFTA Surveillance Authority (ESA) regarding environmental support, all use of coal and coke is exempt from CO_2 and SO_2 taxes from 1 January 2003, to comply with EU internal market rules.

Electricity Tax

The tax on electricity consumption is NOK 0.0967 per kWh as of 1 January 2004. To avoid a switch from electricity to heating oil, a basic tax on fuel oil of NOK 0.398 per litre was introduced as of 1 January 2000 following an increase in the electricity tax the same day. The basic tax on fuel oil is NOK 0.405 per litre as of 1 January 2004. The tax on electricity was modified from 1 July 2004 in accordance with the Directive 2003/96/EC. Electricity used in certain production processes is totally exempt from this tax. Electricity used for the purpose of chemical reduction, as well as electricity used in electrolytic, metallurgical and mineralogical processes, is thus exempt. These exemptions will mainly benefit the metal industry, the cement industry and, partially, producers of basic chemicals. In addition to the total tax exemptions, a new reduced electricity tax rate of NOK 0.0045 per kWh was introduced, limited to certain industries. A programme for energy efficiency in the wood products industry is being designed. Wood products companies that participate in this programme will be exempt from the reduced tax rate. Households and remaining business activities pay the full tax rate on their electricity consumption.

The value-added tax (VAT) rate on electricity is 24%, as it is for all other goods and services that are subject to VAT. However, households in the remote regions of Nordland, Troms and Finnmark are exempt from VAT on electricity. Manufacturing industries, mining and quarrying, and greenhouse nurseries are also exempt from VAT.

Table 2

Energy Taxes in Norway in 2004

Tax	*Tax rate (NOK)*	*Estimated 2004 revenue (million NOK)*	*Introduced in*
Autodiesel tax, per litre	2.88/3.23[a]	4 535	1993
Petrol tax, per litre	3.96	9 070	1931
CO_2 tax		7 808	1991
• CO_2 tax - mineral oil, per litre	0.51	*2 468*	
• CO_2 tax - production of oil and natural gas, per litre/Sm3	0.76	*3 600*	
• CO_2 tax petrol, per litre	0.76	*1 740*	
SO_2 tax	0.07	103	1970
• mineral oil, per 0.25% weight share sulphur and litre of oil	0.07		
• SO_2 tax reduced rate per 0.25% weight share sulphur and litre of oil	0.029		
Total 2004 revenue from direct taxation (est.)		29 324	
Additional 2004 revenue from VAT (est.)[b]		7 038	
Total 2004 tax revenue from energy taxation (est.)		36 362	

a. Lower level of tax applies to low-sulphur diesel.

b. VAT in 2004 = 24%.

Sources: *Energy Prices and Taxes*, IEA/OECD Paris, 2004; Country submission.

PRICES

Energy prices in Norway are formulated by the market. Components of final prices are subject to government legislation, where they fund the operation of monopoly elements of the value chain.

CRITIQUE

Traditionally, energy policy in Norway has been receiving sizeable political attention and has been conducted by highly respected professionals at the different layers of government. This has enabled Norway to achieve remarkable success in terms of energy security, environmental protection and economic efficiency.

The economically efficient development of Norway's large oil and gas resources located offshore has made the country Europe's largest exporter of petroleum products and natural gas. Through its oil and gas export, Norway is significantly contributing to security of supply in Europe.

Government income from Norway's oil and gas sectors in 2004 represents 10% of the country's gross domestic product (GDP) and 24% of the government's revenue. The resource base is seen to be the property of the State and the income from oil and gas is invested to maximise the wealth of the national economy. The government has been actively pushing the frontiers of exploration areas and developing oil and gas technologies (*e.g.* enhanced oil recovery), which can be commended as an example of best practice of management of domestic resources. Development of the long-term scenario for the production of petroleum resources and responsible management of wealth derived from natural resources through the Norwegian Petroleum Fund are such examples. The Petroleum Fund shares this wealth over generations without distorting the economic situation of the country. The government should be commended for the transparent and forward-looking way in which it has chosen to manage the petroleum wealth of the country.

Norway also enjoys extensive access to cheap and clean hydropower and has developed this resource extensively. Based on this resource, a significant energy-intensive industry (for example aluminium, ferro-alloys, pulp and paper) has developed and domestic energy consumption is now heavily dependent on electricity.

Abundant offshore oil and gas resources and cheap hydropower have enabled Norway to enjoy a high level of security of supply and one of the highest standards of living in the world.

Environmental sustainability has been very highly positioned in Norwegian energy policy. Offshore oil and gas has been developed in an environmentally sustainable manner. The NCS and the Barents Sea have very high standards of environmental regulation for petroleum production. Norway is also playing a leadership role in carbon capture and storage (CCS) through its pioneer project in the Sleipner field.

In terms of economic efficiency, Norway is to be commended for its role as a pioneer in liberalising its electricity market and promoting the Nordic electricity market. The Nordic market is one of the most advanced and best functioning electricity markets in the world. In the oil and gas sectors, Norway has made important progress in boosting efficiency by the partial privatisation of Statoil, which increased market discipline in the company´s performance. In addition, the government completed positive steps to allocate different roles to separate institutions (Petoro, Gassco).

Despite its successes in many aspects, Norway is facing important energy policy challenges. Since the last review in 2001, Norwegian onshore energy production has remained stable, while demand has increased. Norwegian onshore energy consumption has grown slowly in recent years, but even this relatively slow growth has not been matched by an extension of onshore energy production. In particular, the precipitation shortages in the winter 2002/03 showed the country's vulnerability to a fuel mix for power generation that almost completely depends on hydropower. The demand/supply balance in Norway´s electricity market has become tight after a decade of growing demand and stagnating supply. These trends will lead to an increasing need for electricity imports and a possibility to divert some gas produced offshore for power generation as a diversification of the fuel mix.

To create certainty for the investment in the onshore gas sector, the establishment of a long-term regulatory market framework is very important. Also, certainty with regard to the establishment of large-scale customers would help to support the establishment of a gas network.

Despite the government's authorisation during the 1990s, the construction of gas-fired power stations has been delayed owing to environmental concerns about CO_2 emissions, and the construction of a gas supply network onshore is delayed owing to regulatory and cost uncertainties, even though licences have been given to companies. During summer 2005, the holders of two licences have decided to exercise them.

The construction of additional hydropower stations and onshore wind farms is also delayed by environmental concerns. Electricity grid operators also face constraints on expanding their capacity. Little relief can be expected in the coming years unless these concerns are resolved. Private initiatives to introduce gas-fired power plants and additional investment in the grid to support new generation should therefore be welcomed both as an addition to generating capacity and as a diversification of the fuel mix for power generation.

However, these initiatives would not go ahead unless a better understanding by the general public on Norway's future challenges in terms of energy supply/demand is ensured. In this context, publication of a long-term energy supply and demand forecast could play a significant role. Development of energy forecasts and their timely updating are basic energy policy tools employed in many other IEA member countries. They could serve as a basis for a national debate on the future of onshore energy use and supply. Such, forecasts are also an essential tool in meeting Norway's Kyoto targets and a basis of the projections indicating that GHG emissions in Norway may be around 20% higher by 2010. The government should reconsider its decision to no longer supply demand forecasts for energy.

Norway is the largest member State of the agreement on the European Economic Area (EEA), and has been leading among EEA member States in adopting the EU directives that form part of the EEA agreement. This is laudable.

RECOMMENDATIONS

The government of Norway should:

- *Facilitate further oil and gas exploration in the Barents Sea and other areas containing important undiscovered resources within a framework of sustainable development.*
- *Continue pursuing Norway´s active role in advancing the further integration of the Nordic electricity market.*
- *Facilitate the introduction of gas-fired power generation and associated network infrastructure by proactively clarifying under which regulatory framework commercial projects could materialise.*
- *Publish energy projections for Norway for the coming decades in order to establish a common information basis for public debate on the future choices facing Norway´s energy policy.*
- *Continue the co-operation in the EEA to ensure rapid implementation of relevant EU directives.*

ENERGY AND THE ENVIRONMENT

OVERVIEW

Environmental issues are important in Norwegian society, and they affect both onshore and offshore energy production in Norway. Environmental issues that are considered important range from climate change to air and sea pollution and the conflicts between energy production and competing uses of areas of landscape. The main challenge for Norway's energy policy is to combine the role of a large energy exporter with the role of leader in the protection of the environment. Ambitious targets, policies and measures are key elements in achieving these goals.

There is close co-operation between different ministries in environmental policy-making. For example, questions related to climate change and transboundary air pollutants have for several years been consulted on by an interministerial group, while overall responsibility rests with the Ministry of the Environment. The Ministry of the Environment is responsible for dealing with climate change negotiations, and for the national registry of GHGs. It is also responsible for the Pollution Control Authority (SFT). The Ministry of the Environment also co-operates closely with the MPE, the Ministry of Transport and the Ministry of Finance in developing Norwegian climate policy. The Ministry of Fisheries is co-operating with the MPE and the Ministry of the Environment on questions such as the limitation of oil exploration in areas seen as important for Norwegian fisheries and on oil spill prevention and environmental emergency preparedness in case of oil spills.

CLIMATE CHANGE

NORWAY'S COMMITMENTS

Norway is a signatory to the Kyoto Treaty, but as a non-EU member country it is currently neither a party to the EU burden-sharing agreement nor a party to the EU Emissions Trading Scheme. Norway is considering the use of a mix of instruments to achieve its target. A particular challenge for the achievement of Norway's target is the increase of emissions from petroleum activities on the NCS.

An expert commission has been established to properly assess the options for long-term reductions of greenhouse gas (GHG) emissions by 50-80% by 2050, and is expected to report in late 2006 after extensive consultation.

Norway's commitment under the Kyoto Protocol is to restrict the increase of GHGs to 1% above the 1990 level by the commitment period 2008-2012. In 2003, total emissions were 9% above the 1990 level[5]. CO_2 emissions reached 43.2 Mt CO_2 in 2003, compared to 34.4 Mt CO_2 in 1990, an increase of 8.8 Mt CO_2, or 26%. Non-CO_2 GHG emissions had fallen by 26% in the same period, with most of the decrease coming from a reduction in the emission of sulphur hexafluoride (SF_6) and perfluorocarbons (PFCs). They contributed 31% of all GHG emissions in 1990, and 21% in 2003. The Norwegian government projects that by 2010, total GHG emission levels will be 23% above the 1990 level under the business-as-usual scenario.

Norway's CO_2 emissions per TPES and CO_2 emissions per GDP are low compared to the IEA average and IEA Europe thanks to the production of 99% of Norway's electricity from CO_2-free hydropower. The increase of CO_2 emissions between 1990 and 2003 is coming from two major sources. Oil and gas extraction activities (activities on the NCS, gas terminals onshore excluding transport) contributed 5.9 Mt CO_2 or 74% to the total increase of CO_2 in the period 1990-2003. Emissions from mobile emission sources increased by 3.3 Mt CO_2 in the same period.

Table 3

GHG Emissions by Sector in Mt CO_2–equivalents, 1990 to 2010

	1990	*2003*	*2010*[a]
Total energy	29.3	39.2	44.3
Oil and gas production[b]	*7.6*	*13.5*	*14.2*
Petroleum refining	*1.7*	*2.1*	*1.9*
Public electricity and heat production	*0.3*	*0.6*	*1.3*
Manufacturing industry and construction	*3.6*	*4.0*	*5.0*
Transport	*11.3*	*14.6*	*17.6*
Other sectors[c]	*4.8*	*4.4*	*4.4*
Industrial processes	13.7	8.9	11.2
Agriculture	4.6	4.5	4.4
Waste	2.6	2.2	1.9
Total	**50.1**	**54.8**	**61.8**

a. Projections from the white paper: Macroeconomic Perspectives for the Norwegian Economy – Challenges and Options (St.meld. nr. 8 2004-2005 Perspektivmeldingen). The total projections are divided into source categories by the Norwegian Pollution Control Authority.

b. Includes emissions from coal mining.

c. Includes fishing and military transport.

Sources: Ministry of Finance, Statistics Norway and Pollution Control Authority.

5. Preliminary data for 2004 shows 11% higher GHG emissions in CO_2-equivalents than in 1990.

Table 4

Norwegian GHG Emissions Inventory, 1990 to 2010

(in Mt CO_2–equivalents)

	1990	*2003*	*2010(est.)*
CO_2	34.4	43.2	49.9
CH_4	5.2	5.1	4.7[a]
N_2O	5.1	5.3	5.4
PFCs	3.3	0.7	1.1
HFCs	0.0	0.2	0.5
SF_6	2.2	0.2	0.2
Total	**50.1**	**54.8**	**61.8**

a. Corrected for new CH_4 model.

Sources: Ministry of Finance, Statistics Norway and Pollution Control Authority.

Table 5

2010 Predicted Norwegian GHG Emissions Inventory by Sector

(in Mt CO_2–equivalents)

	CO_2	*CH_4*	*N_2O*	*PFCs*	*HFCs*	*SF_6*
Total energy	42.3	1.0	1.0			
Oil and gas production[a]	*13.4*	*0.7*	*0.0*			
Petroleum refining	*1.9*	*0.0*	*0.0*			
Public electricity and heat production	*1.2*	*0.0*	*0.0*			
Manufacturing industry and construction	*4.9*	*0.0*	*0.1*			
Transport	*16.6*	*0.1*	*0.9*			
Other sectors[b]	*4.2*	*0.2*	*0.0*			
Industrial processes	7.5	0.0	1.8	1.1	0.5	0.2
Agriculture	0.0	2.0	2.5			
Waste	0.1	1.7	0.1			
Total	**49.9**	**4.7**	**5.4**	**1.1**	**0.5**	**0.2**

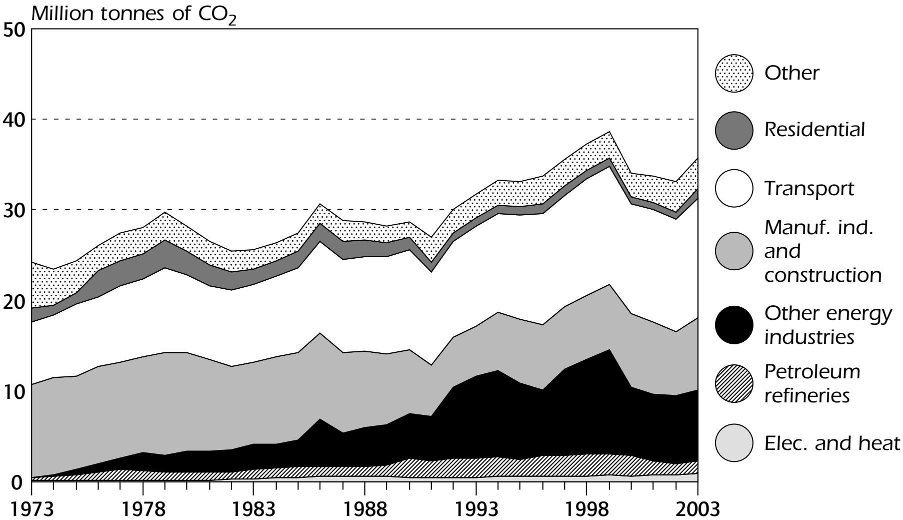
a. Includes fugitive emissions from coal mining.

b. Includes fishing and military transport.

Sources: Ministry of Finance, Statistics Norway and Pollution Control Authority.

Figure 7

CO_2 Emissions by Sector*, 1973 to 2003



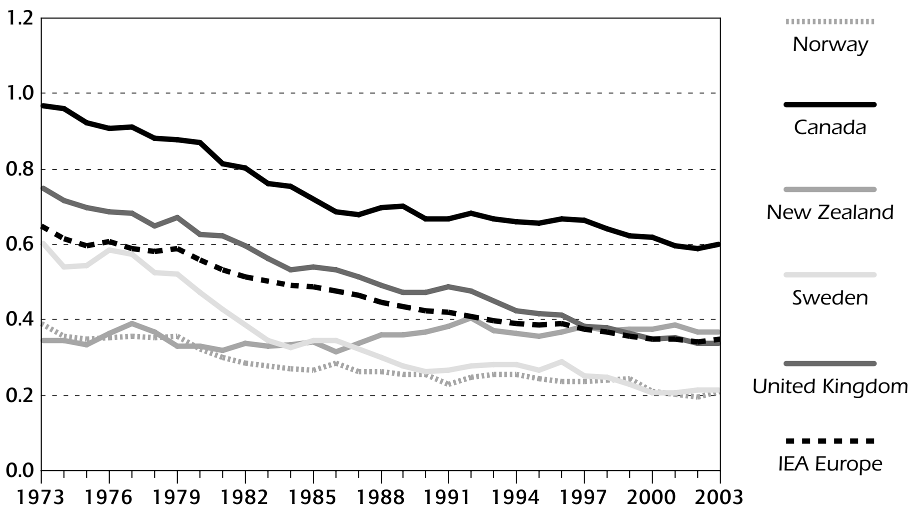
* estimated using the IPCC Sectoral Approach.

Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2005.

Figure 8

Energy-related CO_2 Emissions per GDP in Norway and in Other Selected IEA Countries, 1973 to 2003

(CO_2 emissions/GDP using 2000 prices and purchasing power parities)



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005 and *National Accounts of OECD Countries*, OECD Paris, 2005.

Methane (CH_4) emissions have decreased by 2% from 5.2 in 1990 to 5.1 Mt CO_2-equiv. in 2003. Nitrous oxide (N_2O) emissions have increased by 5%, from 5.1 to 5.3 Mt CO_2-equiv. between 1990 and 2003; 82% of the total N_2O emissions stem from processes that include production of fertilizers, agriculture, etc. and these emissions have decreased by 8% between 1990 and 2003.

POLICIES AND MEASURES

STRATEGY

Norway's policy is set out in a series of government white papers, the latest of which was published in 2002. Norway has not introduced an explicit national climate change strategy to support the achievement of the Kyoto target, but is pursuing a range of measures in parallel to reduce CO_2 emissions. These are set out in the white paper, together with an estimation of their impact. The major points suggested in the white paper were the following:

- The use of regulatory instruments such as emission controls at point sources.
- The use of flexible mechanisms at home and abroad.
- Taxation.
- Voluntary agreements.
- Subsidy schemes.

TAXATION

Norway has applied a CO_2 tax since 1991. The CO_2 tax is currently the most important climate policy instrument and covers about 64% of Norwegian CO_2 emissions and 52% of total GHG emissions. The highest tax rate applies in the offshore sector, with NOK 330 per tonne of CO_2 (tCO_2) emitted from petroleum production, since 1 January 2005. Some industry sectors were granted exemptions from the tax to preserve their competitive position. Total exemptions were granted to energy-intensive industries for energy used as a raw material in industrial processes, for gas consumption in refineries on land, international air traffic, the fishing fleet and the coastal traffic fleet. Furthermore, pulp and paper and the fishmeal industry only pay half the CO_2 tax on heating oil. The tax fully applies to the onshore transport sector and to fossil fuel household energy consumption. The tax rates vary between different emission sources.

The tax has been most successful in the offshore sector, where its presence has encouraged the development of carbon storage and a higher efficiency in power supply for offshore installations. Oil companies estimate that the tax reduces emissions of CO_2 from petroleum activities by 2 Mt per year, or 16%. The reduced emissions of CO_2 are a result of investments carried out during the years following the introduction of the CO_2 tax, and show that the tax has had an effect in the past. However, there is a general view that the CO_2 tax is not of vital importance for further investment in emissions reducing technology on the NCS but contributes to make investment decisions more profitable. In 2003, the tax raised NOK 3.18 billion revenue for the government from emissions of 12 Mt CO_2 in the petroleum sector.

Various studies in the 1990s, and an economic analysis by Statistics Norway, have estimated the effect of the CO_2 tax to be a reduction of 2.5-11% of Norwegian emissions under a business-as-usual approach. The study by Statistics Norway found that the main drawback in the effectiveness of the tax is that significant exemptions have been granted to major emitters to preserve their international competitiveness, while in other sectors the price elasticity and ability to shift fuel use to fuels with a lower CO_2 content is low, making it difficult for emitters to react to the tax despite its relatively high level.

The electricity tax in Norway has also been studied by Statistics Norway, and is credited with a slight reduction of use in households, but like the CO_2 tax, its effectiveness is limited by exemptions on major users, and low price elasticity in those users fully exposed to the tax.

Currently, vehicle taxation is indirectly designed to support better energy efficiency and lower CO_2 emissions. The vehicle purchase tax is levied on weight, and engine size and power. This encourages the purchase of lighter vehicles with smaller engines and less power, regardless of their comparative efficiency. The current annual tax on light vehicles has a fixed component only. However, Norway is considering introducing a system in which the annual tax is differentiated according to environmental criteria. A vehicle efficiency labelling system has been implemented.

Fuel taxation in Norway is encouraging diesel use, by giving diesel a NOK 1.1 per litre tax advantage (+VAT) over petrol. The weight and engine size-based purchase tax has the potential to counteract this, because it will lead to higher taxes for the purchase of diesel vehicles, which normally require more weight and engine size for a similar power output, compared to petrol engines.

The Storting introduced a tax on the fluorinated greenhouse gases HFCs and PFCs on 1 January 2003 to curtail the growth in their use as substitutes for ozone-depleting substances that are being phased out in accordance with provisions in the Montreal Protocol and regulation (EC) No. 2037/2000 of 29 June 2000 on substances that deplete the ozone layer. HFC and PFC gases are taxed differently according to their effect on the climate. From 1 July 2004, the tax has been supplemented by a reimbursement scheme to improve containment and encourage recovering (recycling or destruction) of used HFC and PFC. The reimbursement scheme ensures that anyone who delivers HFC or PFC to a reception facility approved for the destruction of these gases is entitled to have an amount of money equivalent to the tax rate of NOK 187.27 per tCO_2 equivalent refunded.

Taxes on waste disposal at a rate of NOK 409 or NOK 533 per tonne of landfill have been introduced to reduce methane emissions from landfill. Incinerated waste is taxed at NOK 40.57 per tonne in 2005.

FLEXIBLE MECHANISMS

Clean Development Mechanism (CDM) and Joint Implementation (JI)

The government views a co-ordinated international effort, based on burden-sharing and cost-effectiveness, as the key to climate change policy. The Norwegian climate change policy is based on the objectives of the United Nations Framework Convention on Climate Change (UNFCCC), and the Kyoto Protocol with its flexible mechanisms is seen as an important milestone. With no further domestic measures, current projections imply that Norway will have to trade an annual average of about 11 Mt CO_2 during the commitment period 2008-2012.

Norway has already been active in capacity building for CDM and JI, through co-operation with Poland, the Baltic Sea countries, Romania and the World Bank. The government has invested into co-operation funds with these partners to generate CDM/JI credits, and to learn more about project administration under the flexible mechanisms.

Emissions Trading

Through endorsing the main elements of the white papers on Norwegian climate policy, Reports to the Storting No. 54 (2000-2001) and No. 15 (2001-2002), the Storting decided that a quota-based domestic emissions trading system for GHGs should be implemented from 1 January 2005. A law proposal on the early introduction of an emissions trading system (2005-2007) had been subject to a broad public consultation, and the final proposal was accepted by the Storting in autumn 2004 and came in force in January 2005. The system as it has been implemented now reflects the changes in this policy arena since 2002, notably the coming into force of the directive on emissions trading in the European Union (EU). The system is in line with the EU emissions trading scheme (ETS), and will allow the linking of the Norwegian trading system to the EU-ETS at a later stage. The Norwegian industry covered by the national system has the same type of commitments as its European competitors.

The trading system covers CO_2 emissions which are not covered by the current national CO_2 tax and which fulfil the criteria of the EU-ETS. Most of the emissions covered are from the process industry. The system covers about 10% to 15% of Norwegian CO_2 emissions. A total of 51 installations performing the following processes are included in the trading system:

- Energy production (greater than 20 MW).
- Refining of mineral oil.
- Coke production.
- Production and processing of iron and steel, including roasting and sintering of iron ore.
- Production of cement, lime, glass, glass fibre and ceramic products.

A total of 20.5 million emissions allowances, each representing one tonne of CO_2, was allocated for the period 2005-2007, while a total of 22.6 million emissions allowances was applied for. A premise for this decision on allocation was that installations requiring permits would receive allowances equalling 95% of their demonstrated need.

About 67% of the total allowances for the years 2005-2006 is allocated to the petroleum-related industry, including gas-fired power stations, natural gas terminals and refineries, and the petrochemical industry. The mineral industry receives 26% of the allowances.

During the first period of the system, an overall increase in capped emissions can be expected, from 6 Mt CO_2 in 2005 to just below 8 Mt CO_2 in 2007. This increase is connected to the expected construction of the 400 MW *Naturkraft* gas-fired power station at Kårstø in 2007, the transition from oil to gas in the district heating and pulp and paper industries, increased production of natural gas in the gas terminals, and an increase in the production of lime.

Norway will continue to levy its CO_2 tax until the broader ETS, envisaged to start from 2008 in the white paper, is in place. This combination of instruments is seen as a more effective way of reducing Norwegian emissions in the short term, given that quota prices are likely to be low or moderate in this initial period. The CO_2 tax currently in operation and the trading mechanism are however generally seen as incompatible in the long term because they would lead to a double burden on CO_2 emissions from sectors simultaneously exposed to the tax and the ETS.

In the quota system for emissions trading from 2005 to 2007 the quotas have been issued free of charge. This is in line with the Report to the Storting No. 15 (2001-2002) and the EU emissions trading directive, which states that at least 95% of the quotas shall be issued free of charge. If the current CO_2 tax for the sectors to be covered under EU-ETS is entirely replaced by emissions trading, it will incur significant revenue loss to the Norwegian State. The loss of government revenue resulting from the requirement for free allocation of allowances is a barrier to the introduction of emissions trading in the offshore petroleum sector. It is therefore currently under discussion in Norway whether the offshore sector, which accounts for 28% of the total CO_2 emissions in Norway, will be included in the trading system from 2008.

Norway is in dialogue with the EU with the aim of linking the two emissions trading schemes, to provide more depth to the market for emissions in Norway. From 2008 onwards, the emissions trading system is to be expanded to include further sources of emissions, and it will thereby become the main policy instrument to fulfil the commitments under the Kyoto Protocol.

VOLUNTARY AGREEMENTS

For the parts of the process industry not covered by the emissions trading system, the government and the Federation of Norwegian Process Industries have agreed on voluntary commitments to ensure emissions reductions also from this part of industry. Since 2002, the government has reached agreement with some branches of industry, for example the electrical and electronic equipment industry, on reductions on emissions of SF_6, which was not regulated before. The government prefers emissions trading to voluntary agreements as the most appropriate long-term instrument for the reduction of GHG emissions (see Chapter 5).

REGULATION

Emissions of GHGs from large stationary sources are in general subject to licensing under the Pollution Control Act, with oversight provided by the Norwegian Pollution Control Authority SFT. Environmental questions are also treated in connection with the approval of new oil and gas developments under the Petroleum Act.

In the offshore petroleum sector, flaring of gas is not allowed, except for safety reasons, and carbon capture and storage is now strongly encouraged by the NPD where new developments are concerned.

GAS-FIRED POWER PLANTS WITH CO_2 CAPTURE AND STORAGE (CCS)

The previous government licensed the construction of three gas-fired power stations in 2001. Construction of conventional gas-fired power stations will increase Norwegian CO_2 emissions from electricity production. To avoid this, increased efforts to develop the technology for advanced gas-fired power plants with CO_2 capture and storage have become an important element in the government's energy policy. Adding carbon capture and storage (CCS) would considerably increase their cost, and the construction of the power stations had been delayed over this issue, amongst others.

The government's policy for constructing such power plants without CO_2 emissions to the atmosphere is based on the following elements:

- Strengthen R&D activities to promote gas-fired power plants with CO_2 capture.
- Establish a support scheme for investment in full-scale gas-fired power plants with CO_2 capture.
- Establish a public agency to manage the support scheme for investment in power plants with CO_2 capture (Gassnova).
- Consider governmental participation in development and management of CO_2 infrastructure, and prepare for enhanced oil recovery and CO_2 storage.

In all of these points, the government has made progress. The establishment of a new public facility, Gassnova, is a main instrument in developing technologies for carbon emission abatement. The source for financing Gassnova's projects is the returns from a gas technology fund of NOK 2 billion. In 2005 Gassnova will administer approximately NOK 100 million.

In addition, a national gas technology programme, CLIMIT, was established and has been operational since January 2005. Gassnova and the Research Council of Norway will collaborate in this programme. The programme will give priority to R&D and testing of technologies for gas-fired power plants with CO_2 capture and storage (see Chapter 9).

Despite Norway's substantial experience in CCS from the large-scale activity in the Sleipner field (see box on offshore R&D projects in Chapter 9), it appears at this stage that the first of the CCGT stations at Kårstø will be built without CCS technology, other than a preparation for a later addition of such technology. The construction of Kårstø will add 1.1 Mt CO_2 per year to Norway's CO_2 emissions.

PROMOTION OF RENEWABLE ENERGY SOURCES

Promotion of Renewable Energy in the Power Sector

Another objective of the government is to increase the use of renewable energy in the electricity sector. Given that the proposed gas-fired stations and a gas-fired combined heat and power (CHP) plant at Statoil's Mongstad refinery would increase Norway's CO_2 emissions and that CCS will not be installed in the initial stages, the government intends to promote renewables in the power sector through various measures to reduce the impact on CO_2 emissions (see Chapter 7). Nevertheless, the share of renewable power generation will inevitably go down from the current 99% and a target of 90% has been set.

Promotion of Waste Heat in the Stationary Sector

One of the government's targets is to reduce the use of mineral oils for heating by 25% in the first commitment period under the Kyoto Protocol (2008-2012) compared to the average use during the period 1996-2000. To achieve this, measures such as grant support and taxation changes to encourage greater exploitation of biomass and methane from the agricultural sector for energy purposes have been introduced. Support is also given for making greater use of waste as a source of energy to replace fossil fuels than is currently the case in Norway, thereby reducing the quantity of biodegradable waste that is landfilled and leading to methane emissions in the future. A prohibition on all landfilling of biodegradable waste from 2009 is under consideration. As a concrete measure to fulfil this objective, the Storting has approved an amendment in the tax on the final treatment of waste encouraging the use of waste in incinerators producing heat. The amendment is adjusting the focus of the tax so that the issues of air pollution and the emission of GHGs from waste disposal are addressed more effectively. In addition, also related to the climate policy, the Norwegian Pollution Control Authority is now working on the follow-up of a strategy on the management of degradable waste.

RESEARCH AND DEVELOPMENT[6]

The authorities are encouraging climate-related research by funding programmes run by the Research Council of Norway (NFR). This includes Klimatek (climate-friendly technology), research on efficient and new renewable energy technologies, cost-effective CCS, particularly related to gas-fired power plants, and hydrogen technologies. Since 2001, the government has allocated more than NOK 150 million to support the development of technologies for CCS. This strategy is now continued through the establishment of a fund of NOK 2 billion the return of which will be administered by Gassnova to support pilot and demonstration plants for CCS technologies.

As an initiative to increase the Norwegian efforts within hydrogen research, the government appointed a National Hydrogen Commission in June 2004. The commission's mandate is to propose a broad research, development and demonstration (RD&D) programme covering production, storage, distribution and use of hydrogen. The commission has addressed issues of the use of

6. See also Chapter 9: Energy Technology and R&D.

hydrogen both in the transport sector and in stationary applications. The commission has also proposed national targets and necessary measures for developing hydrogen as an energy carrier and as an instrument for national added value as well as for a cleaner environment.

OTHER ENERGY RELATED POLLUTION

AIR POLLUTION

Long-range Transboundary Air Pollution (LRTAP)

The Norwegian policy regarding LRTAP is founded on the objective of the LRTAP Convention and its underlying protocols, in particular the Gothenburg Protocol. Regulations of substances causing local environmental problems are based on cost-benefit analysis and/or international binding regulations such as Norway's commitments as a member of the EEA. As part of these agreements, Norway has undertaken to reduce its emissions of SO_2 to a maximum of 22 kt per year in 2010. This corresponds to a 58% reduction compared to the 1990 level. The targets for nitrogen are maximum emissions of 156 kt nitrogen oxides (NO_x) and 23 kt of ammonia (NH_3). This corresponds to a 28% reduction for NO_x. Measures to achieve these targets include taxes, regulations and voluntary agreements with the industrial emitters.

The most important SO_2 emissions from the Norwegian energy sector come from the use of mineral oil products and from refineries. Emissions from mobile sources have been reduced through regulations restricting the share of sulphur in fuels. SO_2 emissions from large stationary sources are subject to licensing under the Pollution Control Act. This regulation covers about 60% of Norway's total SO_2 emissions. Use of mineral oil has been subject to a sulphur tax since 1971. The tax rate is NOK 0.07 per litre (+VAT) at the ordinary rate in 2005. The scope of the sulphur tax was expanded to also cover emissions from the refining industry in 1999. In addition, the Ministry of the Environment has concluded an agreement with the process industry, committing the industry to further reductions of SO_2 by 2010. These measures are expected to enable Norway to meet the SO_2 emission level required in the Gothenburg Protocol. Policies and measures to fulfil the SO_2 target in the protocol are being evaluated constantly to ensure that the target is achieved.

Energy-related NO_x emissions stem from the same activities as the SO_2 emissions. An additional source is the use of natural gas in the oil and gas activities. Policies and measures to fulfil the NO_x target in the Gothenburg Protocol are being evaluated. The government is currently assessing the range of options for policies and measures to fulfil the Norwegian commitments in the Gothenburg Protocol on a cross-sectoral basis. The emissions of NO_x constitute the main challenge in this regard.

Offshore loading of crude oil is the largest source of non-methane volatile organic compound (NMVOC) emissions in Norway. Since 2001, NMVOC emissions from offshore loading and storing of crude oil have been subject to emission permits issued by the SFT under the Pollution Control Act. These require that the oil must be stored and loaded with the best available technology (BAT) for reducing emissions, specified by the SFT. Technologies, which can satisfy this requirement are being phased in under a specified timetable up to the end of 2008. Oil and gas companies operating in Norway have established an industrial collaboration to co-ordinate the introduction of NMVOC recovery technology for storage ships and shuttle tankers. These measures are expected to enable Norway to meet the emission level required in the 1991 VOC Protocol and the targets in the Gothenburg Protocol which apply from 2010.

More than 90% of the emissions of NH_3 in Norway derive from agriculture. However, there is a need to estimate the emissions of NH_3 more accurately before policies and measures to fulfil the target in the Gothenburg Protocol can be evaluated. Work on a more accurate estimate of these emissions is currently in progress.

Local Air Pollution

Transport is the main contributor to local air quality problems in Norway. Norwegian transport policy is aimed at reducing individual traffic by providing for modal shifts to public transport and at reduced vehicle traffic.

SEA POLLUTION

Potential pollution from offshore petroleum operations is a significant issue in the public debate in Norway, and fear of damage to fragile ecosystems has led to past and current restrictions on petroleum exploration. Norwegian policy is to restrict emissions and reduce incidents from exploration and production as far as possible. All incidents need to be reported, and are followed up by the Petroleum Safety Authority (PSA) and other relevant authorities. Safety and environmental standards on the NCS are consequently seen as among the highest in the world (see Chapter 6).

CRITIQUE

Norway´s ambition is to play an international leadership role in environmental protection,. For example, the Sleipner field is an important pioneering project in CCS, at least partly driven by CO_2 taxation. The country ratified the Kyoto Protocol which dictates a tough target for GHG emissions of 1% above 1990 level. However, present projections seem to indicate that emissions may be up to 23% higher than in 1990 by 2010. Meeting its Kyoto target without unduly compromising security of supply represents Norway´s single biggest challenge for energy policy, especially given the country´s ambition to further develop its oil and gas resources, and diversify its electricity generation mix to increase a larger non-hydro component.

Norwegian CO_2 emissions are rising owing to an increased production of offshore gas and oil, and to an increase of CO_2 emissions in all sectors of the economy between 1990 and 2002, even though energy intensity has been decreasing over the period. In terms of CO_2 emissions, the most significant contribution is resulting from the 13% increase in transport energy demand between 1990 and 2003. Higher increases of energy demand in other sectors (industry 17%; agriculture, commercial, public services and domestic 33%) have had a limited impact on Norwegian emissions mainly because of the production of CO_2-free electricity. However, growth in electricity demand is now leading to a necessity to build gas-fired power generation in the future, which will further increase CO_2 emissions in Norway. These factors will make the development of measures to reduce CO_2 emissions in Norway and the achievement of Norway's Kyoto target challenging, not to mention longer-term CO_2 emissions reductions.

Micromanagement of energy investment decisions down to individual project proposals, such as the requirement for CCS at CCGT power stations, may delay decision-making without contributing to the achievement of the Kyoto target. A comprehensive public and political debate looking at the entire portfolio of policy tools of climate change policy, including intensified use of Kyoto's flexible mechanisms, is recommended. While the 2002 white paper was a useful first step in this regard, it lacked the detailed description of measures and the corresponding reductions expected, and also the background information such as future energy projections, required for such a debate.

Norway has been a pioneer in introducing a CO_2 tax system. This tax has achieved results in the offshore sector. However, the main drawback in the effectiveness of the tax is that significant exemptions have been granted to major emitters to preserve their international competitiveness, meaning that the tax is only levied on 65% of Norway's CO_2 emissions. While onshore transport sector and household fossil fuel consumption are fully taxed, low price elasticity and limited ability to shift fuel use to low CO_2 emission fuels make it difficult for emitters to react to the tax despite its relatively high level. Given that CO_2 emissions from the electricity sector could increase owing to the start of two gas-fired power plants, the electricity tax could become more important as a tool for climate change mitigation. However, like the CO_2 tax, its effectiveness is currently limited owing to exemptions on major users and low price elasticity in users fully exposed to the tax.

Vehicle taxation is indirectly designed to support better energy efficiency and lower CO_2 emissions. Currently, the annual tax on light vehicles only has a fixed component. However, Norway is considering introducing a system in which the annual tax is differentiated according to environmental criteria. A vehicle efficiency labelling system has been implemented.

The government should further clarify the role of environmental taxation in climate change mitigation, evaluate its effectiveness and review the design if appropriate. For example, large parts of the Norwegian economy are exempted from environmental taxation or benefit from reductions. This limits the possibility of these taxes to change behaviour, and reduces them to merely revenue-raising instruments.

In order to evaluate the role of environmental taxation, the relation between CO_2 taxation and a quota-based ETS needs to be clarified. Norway is now introducing a quota-based ETS, which it is aiming to link to the EU-ETS. This will present a challenge to the future of CO_2 taxation in Norway. In general, emissions trading could be more effective when its market is large. In this context, the current trading system is restricted to a small basis of only 10% to 15% of total Norwegian emissions compared to approximately 30% in the EU-ETS and this may restrict its effectiveness. The intention by the government to link the Norwegian system to the EU-ETS is commended because Norwegian industry could benefit greatly from the linkage in order to allow it to handle carbon trading efficiently. At the same time, it would merit considering whether the ETS could be further broadened beyond the current coverage in line with EU-ETS. However, this will inevitably necessitate the review of current coverage of the CO_2 tax to avoid a double burden on CO_2 emissions from sectors simultaneously exposed to the tax and the ETS. Under a broader ETS, replacing the CO_2 tax with participation in the EU-ETS is a logical path, but this will result in a substantial decrease of tax revenue, which will probably not be welcomed by the Norwegian fiscal authority.

One big challenge in designing a quota-based ETS is the treatment of the offshore sector. Voluntary agreements with the petroleum industry coupled with CO_2 taxation have been working well. Emissions of CO_2 are reduced by introducing more energy-efficient technology, reinjection for storage, and a prohibition on flaring of gas unless it is required for safety reasons. The Norwegian offshore sector is a world leader in petroleum production with low CO_2 emissions. The introduction of the CO_2 tax has had an effect on emissions from the petroleum sector. However, there is a general impression that the CO_2 tax is not of vital importance for further investment in emissions reducing technology on the NCS but contributes to make investment decisions more profitable. As the CO_2 tax may have little effect on further investments, inclusion of the offshore sector in the ETS would not necessarily weaken the incentive to reduce CO_2 emissions from the sector. As the ETS is a cost-effective mechanism to reduce CO_2 emissions, inclusion of the offshore sector in the ETS would not increase aggregate national emissions but strengthen the ETS.

The greatest challenge for the government will now be to decide whether to include the sector in the ETS after 2008. While the sector has expressed a desire to be allowed to trade, the loss of CO_2 tax revenue could be substantial. Norway's ETS will most likely lack sufficient depth to function by itself without inclusion of the offshore sector. This decision will require thorough consideration and consultation, as well as studying the future development of allowance prices in the EU-ETS.

Even the combined effects of taxation and emissions trading are unlikely to suffice to reduce Norway's CO_2 emissions to the Kyoto target of +1% above the 1990 level.

Acknowledging that, the government intends to make use of the Kyoto Protocol's project-based CMD and JI mechanisms. Abatement costs are likely to be far lower in potential host countries than they would be in Norway, and pursuing the generation of credits from these mechanisms has the potential to significantly reduce the Kyoto compliance cost for the Norwegian economy. The government should be commended for its early efforts to build up capacity and understanding of these project-based mechanisms through investment and capacity building both in Norway and in countries that can host these projects. However, it should be borne in mind that the slow process experienced so far with the accreditation of CDM projects may hamper the achievement of this goal.

Norway is expecting that CCS will be able to play a significant role in reducing emissions from gas-fired power generation once these stations have been commissioned. There is however a risk that the Norwegian decision-makers and the public are not fully informed about the current technological status of CCS from power generation, and are expecting far too much from it in the short to medium term. The current technological and economical realities of onshore CCS deployment make it unlikely to be economic in commercial applications such as large-scale power stations, and this needs to be considered in the public debate. The government should make every effort to ensure that a realistic understanding of the possibilities of CCS from power generation informs the public debate and the decision-making process about diversification of the Norwegian electricity generation sources.

Non-CO_2 GHG emissions contributed significantly to Norwegian GHG emissions in 1990. Through regulation, voluntary agreements and taxation, the contribution of some of the most potent of them has been reduced by almost 70%, restricting the overall increase in GHG emissions to 6.1%, despite an increase in CO_2 emissions of 18%. Norway has done very well in reducing these more potent non-CO_2 GHG emissions. The review team commends Norwegian efforts in this area, and encourages the government to pursue reductions of methane and N_2O in the future.

Large parts of the Norwegian economy are exempted from environmental taxation or benefit from reductions. This limits the possibility of these taxes to change behaviour, and reduces them to merely revenue-raising instruments. The very open evaluation of the effectiveness of these taxes undertaken by the government is commended.

RECOMMENDATIONS

The government of Norway should:

- *Clarify how Norway´s climate change policy is supposed to meet its Kyoto target by a national climate strategy to allow secure investment decisions in the energy sector.*
- *Continue to evaluate the effectiveness of environmental taxation, and act on results from these evaluations to ensure the efficient development of the taxation system.*
- *Consider making stronger use of Kyoto's flexible mechanisms by putting Norway´s quota system as soon as possible on the same wide basis as the EU emissions trading scheme and pursue the integration of the EU and the Norwegian ETS.*
- *Widely and internationally disseminate Norwegian experience in CCS.*
- *Ensure that decisions about diversification of energy supply take into account the current technological realities of CCS.*
- *Pursue further cost-effective reductions of non-CO_2 GHG emissions.*

ENERGY DEMAND AND END-USE EFFICIENCY

OVERVIEW

Norway's energy consumption has traditionally been driven by the abundant availability of cheap and clean hydroelectricity. This has contributed to the extensive use of electricity to meet heating needs that are served by other fuels, such as natural gas, in other countries. This has also led to the development of power-intensive industries in Norway, for example the production of metal-alloys or aluminium. Norwegian electricity consumption is the highest in the world, with about 25 000 kWh per-capita consumption in 2002, compared to the IEA Europe average of 5 275 kWh in the same year. The average Norwegian household uses 19 300 kWh of electricity per year.

From 2006 Norway will turn from a net exporter to a net importer of power in years with average precipitation. In recent years, energy demand growth has outstripped supply growth, leading to domestic supply shortages in dry years, and these are covered by imports. Electricity production capacity rose by 5% in the 1990s, while in the same period electricity consumption rose by 13%.

TOTAL FINAL ENERGY CONSUMPTION

Total final energy consumption (TFC) reached 20.6 Mtoe in 2002, a decrease of 2.4% compared to the 21.2 Mtoe in 2001. In 2002, fossil fuels accounted for 48% of TFC, with the majority being 4.7 Mtoe of oil used in the transport sector, 23% of TFC. In 2002, electricity accounted for 46% of TFC, oil for 42%, coke and coal for 3.5%, biomass for 6%, natural gas for 2.4% and heat for 0.8%.

Over the last 20 years, there has been a marked shift from consumption of oil to consumption of electricity in stationary use. In 1973, oil accounted for 56% of TFC. Rising prices of oil and an extension of the hydroelectricity generating capacity in Norway during this period have contributed to this reduction, which was most marked in the other[7] sectors, where the share of oil in TFC

7. The "other" sectors comprise commercial, domestic, public services and agriculture.

reduced from 51% to 18.4%, a real reduction of 0.7 Mtoe. In industry, oil use reduced from 43% to 32%, a real reduction of 0.3 Mtoe.

In 2003, energy consumption in the industry sector totalled 8.6 Mtoe or 41% of TFC. About two-thirds of this was consumed in the energy-intensive industries. Energy consumption in energy-intensive industries has increased by about 20% since 1980. Electricity is the most important energy carrier in energy-intensive industries, and consumption totalled 2.6 Mtoe in 2003, having remained relatively stable over the last ten years. In non-energy-intensive industries the energy consumption has also been fairly stable over the last 20 years.

The other sectors accounted for 7.4 Mtoe or 36% of final energy consumption, and transport for 4.7 Mtoe, or 23%. Industrial energy demand increased from 7 Mtoe to 8.6 Mtoe, by 23%, over the period from 1973 to 2002. The major users are the chemical and petrochemical industry which uses 2.6 Mtoe, or 33% of TFC in the industrial sector, and are the largest users of petroleum products, consuming 1.4 Mtoe or 69% of petroleum products used in the sector. Other major users are the non-ferrous metals sector, which uses 1.7 Mtoe or 22%, and the pulp and paper industry, which uses 1.1 Mtoe, or 14%. These three sectors together account for two-thirds of industrial energy use in Norway.

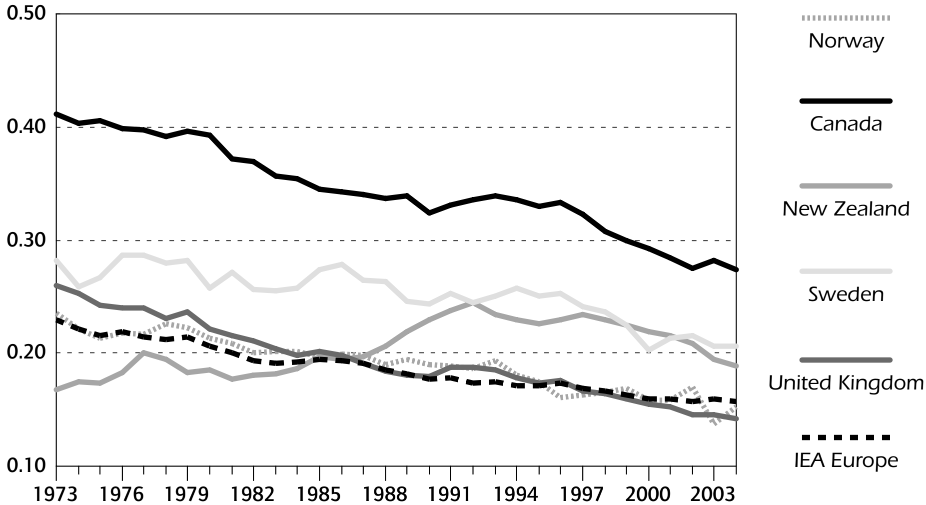
During the same period, the increase in energy consumption was greatest in the other sectors, where TFC rose from 4.2 Mtoe to 7.4 Mtoe, by 78%, of which 4.0 Mtoe, or 54%, is attributable to the industrial sector, and 2.6 Mtoe or 35% to the domestic sector. Electricity is the most important energy carrier in the domestic sector, supplying 5.2 Mtoe or 70% of TFC. A 1995 survey indicates that about 40% of electricity consumption in households is used for space heating. Transport fuel demand increased from 2.6 Mtoe to 4.7 Mtoe, by 80%, of which 3.2 Mtoe or 67% is attributable to the road transport sector.

In 2002, Norway's TFC measured in tonnes of oil equivalent (toe) per capita was 4.6, 89% above the IEA Europe average of 2.4. TPES measured in toe per capita was 6.4, 86% above the IEA Europe average. Norway's energy intensity, measured in 2000 US dollars and adjusting for purchasing power parities, decreased by 0.02 toe per USD 1 000/GDP from 0.19 to 0.17 between 1990 and 2002, a decrease of 10%. GDP increased by 50% between 1990 and 2002, from USD 116 billion to USD 174 billion measured in 2000 USD and accounting for purchasing power parity. Over the same time, energy intensity decreased by 13% in IEA Europe, to 0.16, while GDP increased by 28%. Figure 9 compares Norway's energy intensity with that of some other IEA member countries.

Figure 9

Energy Intensity in Norway and in Other Selected IEA Countries, 1973 to 2004

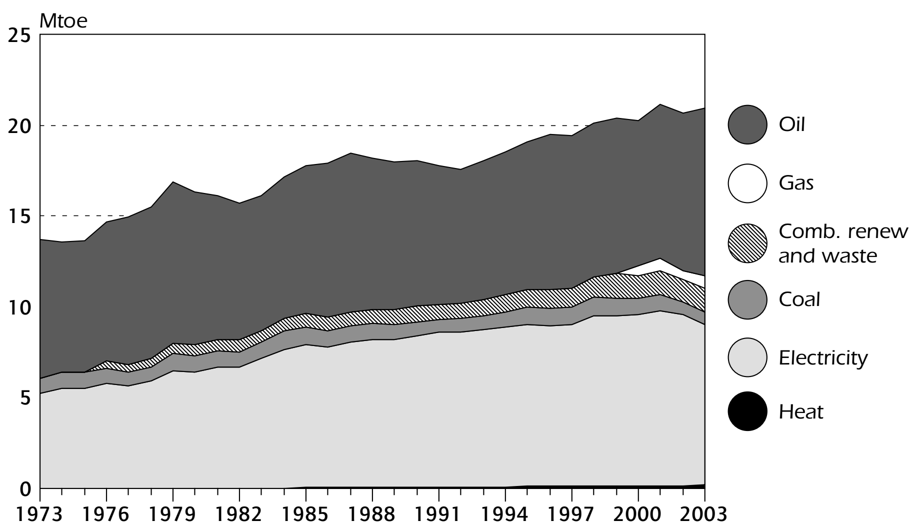
(toe per thousand USD at 2000 prices and purchasing power parities)



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005 and *National Accounts of OECD Countries*, OECD Paris, 2005.

Figure 10

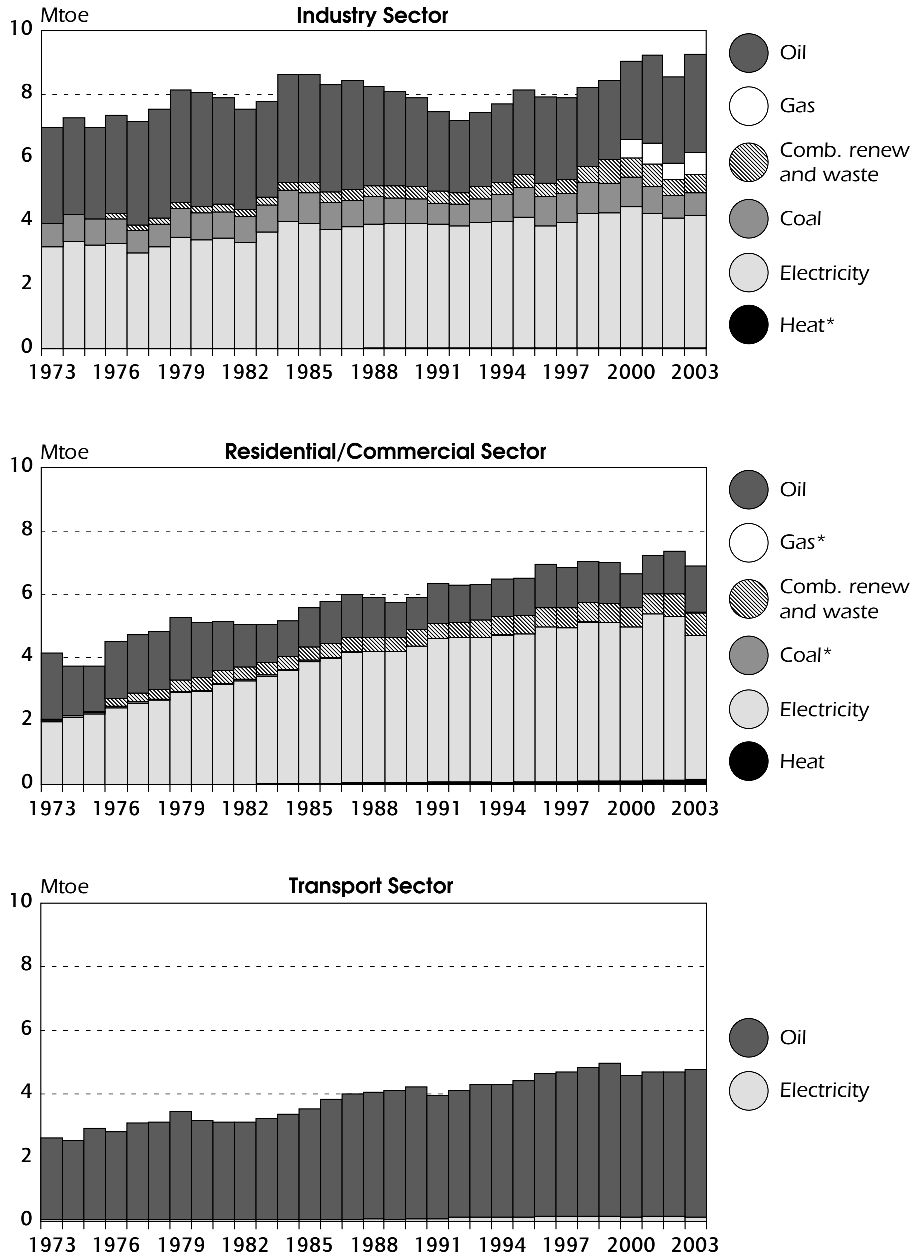
Total Final Consumption by Source, 1973 to 2003



Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

Figure 11

Total Final Consumption by Sector and by Source, 1973 to 2003



* negligible.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

ENERGY EFFICIENCY POLICY

BACKGROUND

Norwegian energy efficiency policy is based on the 1999 White Paper on Energy Policy and the 2003 White Paper on Security of Supply. For energy suppliers, the 1991 Energy Act sets out their responsibilities in relation to energy efficiency. The underlying aim of government policy is to reduce Norway's dependence on hydropower by restricting demand and increasing diversity.

ENOVA SF

The main implementing agency for government energy efficiency policy in the stationary sector is the state-owned enterprise Enova SF. Transport energy efficiency is directed by the Ministry of Transport. Enova is central to the implementation of the Norwegian energy efficiency policy in the stationary use sector, and is therefore the focus of this chapter. Enova is working to achieve the following targets:

- To limit energy use considerably more than would be the case if current trends were allowed to continue unchecked.
- To increase annual use of central heating based on new renewable energy sources, heat pumps and waste heat by 4 TWh per year by the year 2010.
- To increase wind power production capacity to 3 TWh per year by the year 2010.

Togetherl, these three elements should amount to at least 12 TWh per year of energy savings and new energy supply by the end of 2010, and by the end of 2004, Enova reported the following results for the first three years of its activity:

Enova works with both the energy supply and the energy demand sides, and the development and adoption of reliable methodologies for performance measurement and verification of results are high priorities of Enova's work. Enova is also not restricted by sector, and simultaneously works with the domestic and commercial, industry and public sectors.

To achieve the goals, Enova has organised its activities into main programme areas. Organisations interested in participating are invited to apply for funding within various programmes. In the prioritisation process between projects in the programmes, energy yield is treated equally in both energy saving and energy production projects.

Background of Enova SF

Enova SF was officially created on 22 June 2001 and became operational on 1 January 2002. Enova is a public enterprise owned by the Ministry of Petroleum and Energy (MPE). The basis for Enova's creation was a Storting decision in 2001. Enova's tasks are to promote more efficient energy use, production of new renewable forms of energy, and environment-friendly use of natural gas. Quantitative targets have been set for Enova's activities in a contract between Enova and the MPE. Enova's work within energy production and use was previously split between the Norwegian Water Resources and Energy Directorale (NVE) and the electricity distribution utilities.

Mission

Enova's main mission is to support the environmentally sound and rational use and production of energy, by using financial instruments and incentives to support the deployment of renewable energy production and development of energy efficiency in Norway. Enova has a limit on the number of employees, and is only supposed to work at a high strategic level, not in administering programmes. Enova relies on consultants for carrying out supporting work.

Finance

For the purpose of financing Enova's activities, the Energy Fund was established in January 2002. The administration of the Energy Fund is regulated by an agreement between the MPE and Enova. The purpose of the agreement is to ensure that Enova manages the Energy Fund in line with the objectives and intentions decided upon by the Storting in the spring of 2000. The Energy Fund is financed by a dedicated levy (raised to NOK 0.01 per kWh in 2004) on the transmission tariff for electricity, and an ordinary contribution of NOK 60 million from the state budget has been allocated for 2004. This delivered NOK 530 million to Enova's 2004 budget. The core budget is guaranteed to Enova under a long-term framework, and is not subject to annual allocation by the government. This gives Enova the ability to conduct long-term planning within a secure funding environment.

Impact

The establishment of Enova signalled a shift in the way the government organises and implements its energy efficiency and renewable energy policies. The aim of creating Enova was to gather strategic policy responsibilities in a small, flexible, independent, and market-oriented organisation, allowing more flexible decision-making. The intent by the government was to create a proactive agency capable of stimulating energy efficiency and renewables investment by market actors, leading to a self-sustaining market for these products without government support in the future. Enova has only been given very broad targets, and consequently enjoys considerable freedom with regard to the choice and composition of its operational focus and policy measures.

Enova also advises the ministry in questions relating to energy efficiency and new renewable energy. Enova is also involved in international projects through EU funding and represents Norway's energy efficiency and renewables policy in various international forums.

Table 6

Energy Results and Financial Investments into Energy Efficiency by Enova, 2002 to 2004

Sector	*2002 GWh*[a]		*2003 GWh*		*2004 GWh*		*Total GWh*	
Commercial	158	35%	180	43%	233	36%	571	38%
Construction	5	1%	26	6%	13	2%	44	3%
Residential	0	0%	49	12%	14	2%	63	4%
Newbuild	0	0%	0	0%	30	5%	30	2%
SME	n/a		n/a		65	10%	65	4%
Industry	140	31%	115	27%	291	45%	546	36%
Training	3	1%	40	9%			43	3%
Others	144	32%	13	3%			157	10%
Total	**450**	**100%**	**423**	**100%**	**646**	**100%**	**1 519**	**100%**
Sector	*2002 mNOK*[b]		*2003 mNOK*		*2004 mNOK*		*Total mNOK*	
Commercial	28	24%	38	38%	61	44%	127	36%
Construction	2	2%	5	5%	4	3%	11	3%
Residential	0	0%	14	14%	5	4%	19	5%
Newbuild	0	0%	0	0%	9	6%	9	3%
SME	n/a		n/a		10	7%	10	3%
Industry	9	8%	17	17%	51	36%	77	22%
Training	0	0%	17	17%			17	5%
Others	77	66%	10	10%			87	24%
Total	**116**	**100%**	**101**	**100%**	**140**	**100%**	**357**	**100%**

a. Over the lifetime of 10 years.

b. One-off investment in the year.

Source: Enova.

Enova works with a broad network of players in all sectors of the economy, including decision-makers in commerce and industry, end-users, municipalities and other public sector and regulatory bodies. Enova does not have regional offices, but has a network of subcontractors to co-ordinate and implement its programmes.

Reporting on energy results, activities and other achievements is done annually. In 2006 the MPE will formally evaluate Enova's activities and results and make recommendations on funding and objectives for the subsequent period from 2007 to 2010.

INDUSTRY SECTOR

INDUSTRY NETWORK

The industrial sector is one of the major energy users in Norway. Enova is managing the Industry Network, an organisation aiming to share experiences and best practice in energy management. In 2002, it covered 870 members, approximately 63% of Norwegian industrial companies, with an annual power consumption of 50 TWh, equivalent to about 40% of Norwegian electricity consumption. Within the network, specific projects are undertaken, and in some cases supported financially by Enova. These are primarily audits and analysis of energy use.

Understanding energy use is a key element in improving energy efficiency, and the network is collecting statistical data from its member companies that allow it to establish sectoral benchmarks. The comprehensive coverage of the Norwegian industrial sector by the network means that the quality of the data is high, and that the data are likely to be representative, although it is probable that the network membership primarily consists of companies already doing well in terms of energy management. The network is then publishing these figures, for example for average energy use per unit of output, to allow companies in the same sector to compare themselves to the sector benchmark, and to identify potential areas for improvement. If they lag behind the average in their sector, they can access Enova support for energy audits, energy management tools, and energy efficiency investment.

PROJECTS

Advice projects focus on the development of energy accounting systems (so-called Phase 1), to enable industrial companies to control their energy use, and these can be funded up to 90% and a maximum of NOK 100 000. Further funding of up to 50% or NOK 50 000 is available for follow-up action (EOS). Up to 50% funding to a maximum of NOK 200 000 is available for companies that implement suggestions developed during Phase 1, and this implementation phase is called Phase 2. Best practice examples are turned into case studies and published through the network to encourage action in other companies.

In 2004, out of a total of 55 projects in industry, 49 energy saving projects were carried out outside the network. In 2003, about half of the energy savings from industry were realised in the energy-intensive industry. The investment into all industrial projects in 2004 was NOK 58 million, and the direct savings result was 357 GWh (3 570 GWh over the assumed lifetime of ten years). Of these, 14 projects were in energy-intensive industry, and these alone saved 291 GWh, and required an investment of NOK 51 million. The cost per kWh saved in industrial projects over the lifetime was about NOK 0.016 per kWh, below the average of NOK 0.022 per kWh saved for all energy efficiency projects financed by Enova, and considerably below the market price for electricity in Norway.

VOLUNTARY AGREEMENTS

Voluntary agreements have been concluded with some industrial sectors in Norway, leading to an exemption from electricity tax in return for agreement to achieve specific energy savings targets. Energy-intensive companies may choose to participate in a five-year programme for energy efficiency. Commitments under this programme are considered to replace the steering effect of the electricity tax and the objective is to achieve more efficient use of energy. To participate in the programme, companies are obliged to use a standardised energy management system, assess the alteration of energy use and identify energy-efficient measures and finally report to NVE on the compliance of the agreement. Only companies in the pulp and paper industry obtain tax exemption by entering the energy efficiency programme.

RESIDENTIAL/COMMERCIAL SECTOR

Advice and analysis are also the focus of projects in the small and medium-size enterprise sector, where skills for energy management are likely to be lower than in the more energy-intensive industrial sector.

BUILDING CODE

Norway has a long tradition of setting energy performance requirements in the building regulations. The energy performance requirements are currently set as minimum requirements for energy use per square metre and heat transmission in building parts, and some elements of the regulations also affect refurbishment. On 25 June 2004 the government passed a proposal to the Storting suggesting that the Directive on Energy Performance of Buildings 2002/91/EC should be implemented in Norway. This implies that in addition to the existing energy performance indicators in the building regulations, an energy certification scheme for buildings and an energy inspection scheme for heating and cooling installations will be introduced. Both of these will promote energetic refurbishment of existing buildings. A study of office buildings in the Oslo region estimated that for a typical building constructed before the 1987 regulations, energy consumption was 213 kWh per m^2. The 1987 regulations reduced this to 188 kWh per m^2, and for a building constructed under the 1997 building regulations, this would have been reduced again to 149 kWh per m^2, a reduction by 30%, compared to the pre-1987 situation.

ENOVA PROGRAMMES

Energy Management in Commercial Buildings[8]...

Enova has set a goal to reduce the level of energy (primarily electricity) use in commercial buildings larger than 20 000 m^2 by 100 GWh per year by 2010 and in commercial buildings smaller than 20 000 m^2 by approximately 70 GWh per year. The programme's aim is to develop networks of expertise and contacts among owners of qualifying property through implementation projects. Project activities that qualify for funding are energy, training, dissemination of information, energy management and monitoring, and energy and environmental analyses. Projects where more than five building owners co-operate are preferred.

... and in Residential Buildings

Enova has a programme aimed at both new homes and rehabilitation of the existing building stock in the residential sector. Enova is particularly looking for examples where the best available climate-adjusted technology is being used that will minimise the need for heating, reduce heat loss and improve heat recovery. The total support expended on residential buildings is low, and results are also small, by comparison to other areas of activity.

In 2002/03, Enova ran a NOK 50 million (later increased to NOK 225 million to cope with high demand) emergency programme of direct financial support for heat pumps, pellet heating systems and control systems for the residential

8. This programme has been revised in 2004 in order to comply with EU regulations.

sector, in response to the precipitation shortage. In total, 47 159 households participated in the programme. Evaluation results indicate that the management of the programme was successful, and that households participating in the programme saved an average of 5 770 kWh per year, an average reduction of 33% of the electricity used for heating purposes. It is estimated that the savings effect was 129 GWh under 2002 climatic conditions for the participating households. .

Retrofitting of Street Lighting

This programme of Enova is aimed at owners of large facilities and outdoor lighting infrastructure that are considering the change of existing lighting fixtures. These could be municipalities applying to refurbish their street lighting, or companies with lighted areas under management. Enova estimates that up to 2 TWh of electricity are annually used for outdoor and street lighting in Norway, and that 0.5 TWh could be saved through the use of more efficient lighting technology. In 2004 the programme achieved 13 GWh of savings for an investment of NOK 4 million. The programme does not have specific targets, but is expected to contribute to Enova's overall target by 2010.

Information, Advice and Campaigns

This part of Enova's activities includes regular national television advertising campaigns, energy information and advice on technologies and solutions to end-users, both household and commercial. Information and advice are provided free of charge through a national energy information helpline. Queries that require concrete on-site follow-up are handled by local sub-contractors that represent Enova in the field. Enova is also providing literature and hand-outs.

Training and Education

These programmes aim to develop the skills base for energy efficiency at all levels in Norwegian society. They address all aspects of training needs in various sectors and include:

- Developing teaching materials and learning concepts.
- Developing a continued education course in energy for technical personnel and engineers (accredited).
- Improving energy planning skills in local municipalities.
- Training of maintenance personnel in commercial buildings and industry.

TRANSPORT SECTOR

Norwegian transport demand has seen significant increases since 1980, with passenger transport increasing from 40 705 million passenger-kilometres (Mpkm) in 1980 to 64 451 Mpkm in 2002, by 58%. A small modal shift has taken place in passenger transport from rail to air transport (see Table 7). Energy efficiency policy for the transport sector is under the responsibility of the Ministry of Transport, but there are few policies in place, compared to the stationary sector.

Goods transport is reported separately for two sectors, mainland transport and transport of goods to the NCS to support the offshore industry. Given the rapid increase of exploration and production on the NCS between 1980 and 2002, transport demand for supporting the offshore industry on NCS increased from 348 million tonne-kilometres (Mtkm) in 1980 to 26 736 Mtkm in 2002, by 7 583% in this sector, and in 2002 it contributed 47.4% to the total goods transport demand in Norway. Goods transport on the mainland (26 736 Mtkm) was carried in almost equal shares by sea (14 347 Mtkm) and road (13 614 Mtkm) in 2002, with the balance of 1 686 Mtkm provided by rail. Mainland goods transport has also significantly increased, and experienced a modal shift, with road transport increasing by 8 362 Mtkm, or 160% from 1980 to 2002. This increase is over three times the rate of sea transport, which increased by 4 509 Mtkm, or 46%, during the same period (see Table 8).

The Ministry of Transport and Communications adopts the basic policy to reward towns that provide for a reduced use of private cars and increased public transport, use of bicycles and walking. One of the ways this is achieved is through increased allocations of funds for public transport. Local authorities have free use of these funds, and may also use them to support the operation of public transport. In 2005, NOK 115 million was given to the five biggest cities in Norway, the only cities that can apply for these funds.

The government plans to implement mutually binding agreements between the State and the urban municipalities based on co-ordinated land-use and transport plans in order to achieve long-term, sustainable land-use and transport development. New forms of co-operation and co-ordination will also be tested and developed to ensure efficient, safe and environmentally sound urban transport by means of arrangements such as the Coordinating Body for Public Transport in Central Eastern Norway, a new public body that has the task of ensuring the efficient development and operation of public transport in the region of Oslo and supports experiments in the other large urban areas.

Table 7

Development of Passenger Transport by Mode in Million Passenger-Kilometres, 1980 to 2002

Mode	*1980*	*1985*	*1990*	*1995*	*2000*	*2002*	*Share 2002*	*Increase 2000/1980*
Sea	660	643	636	678	845	860	1.3%	30%
Rail	2 751	2 567	2 430	2 681	3 353	2 989	4.6%	9%
Road	35 819	42 299	48 092	49 206	54 156	56 573	87.8%	58%
Air	1 475	2 147	2 665	3 938	4 415	4 030	6.3%	173%
Total	**40 705**	**47 656**	**53 823**	**56 503**	**62 768**	**64 451**	**100%**	**58%**

Source: Ministry of Transport.

Table 8

Development of Goods Transport by Mode in Million Tonne-Kilometres, 1980 to 2002

Mode	*1980*	*1985*	*1990*	*1995*	*2000*	*2002*	*Share 2002*	*Increase 2000/1980*
NCS	348	2 718	7 603	18 509	20 710	26 736	47.4%	7 583%
Mainland	16 761	17 610	18 955	19 196	28 486	29 663	52.6%	77%
Sea	*9 838*	*9 335*	*9 104*	*9 419*	*13 675*	*14 347*	*48.4%*	*46%*
Railway	*1 657*	*1 771*	*1 632*	*1 835*	*1 775*	*1 686*	*5.7%*	*2%*
Road	*5 252*	*6 485*	*8 231*	*10 651*	*13 017*	*13 614*	*45.9%*	*159%*
Air	*14*	*19*	*19*	*20*	*19*	*16*	*0.1%*	*14%*
Total	17 109	20 328	26 589	33 039	49 196	56 399	100%	100%

Source: Ministry of Transport.

Norwegian Road Tolling

Norway has more than 70 years experience with road tolling. Although not very popular, toll systems are regarded as a success. Toll projects are subject to approval by the Storting, and the Public Roads Administration is responsible for the construction and maintenance of road toll projects. A non-profit company manages the toll collection and project loan financing.

The toll rings in the major cities operate more or less continuously and are not supposed to have any traffic managing effect. It is difficult to isolate the effect of the toll on behaviour, but it is believed that it has been a factor in reducing congestion. Today tolls contribute about 30-35% of the funds for the road construction budget, from 47 toll projects (as of 1 January 2005), both urban and inter-urban. In the cities of Oslo, Bergen and Trondheim, cordon tolls contribute significantly to road investments, and to a certain extent to public transport investment.

As the planned period of toll collection in the toll rings in Oslo, Bergen and Trondheim comes closer to an end, the question of whether to change toll rings to congestion charging systems has arisen. The original objective of the toll rings was to finance road construction. Using the toll to restrain traffic was not the intention. The necessary legal framework to introduce congestion pricing was approved by the Storting in May 2001. The necessary provisions to the act are still not given and the act has not entered in force.

The main purpose of a congestion pricing system would be to regulate traffic – primarily in larger cities – in order to reduce congestion and improve the local environmental situation. Congestion pricing will mainly be considered as a local measure aimed at solving or reducing local problems. Local authorities are in the best position to assess congestion pricing in connection with other local measures. Accordingly, they would play an important role in the decision process. The Public Roads Administration would then prepare the case to the Ministry of Transport, and the government would forward a bill to the Storting for adoption.

TRANSPORT FUELS

Norway is involved in R&D efforts seeking technological solutions, such as natural gas-propelled shipping, and hydrogen. The presence of natural gas as vehicle fuel is very different depending on location – 80 buses run on gas in Bergen, one in Oslo. Norway is undertaking research in the biofuels area, but has not adopted the EU Directive on Biofuels. Biofuels are not subjected to fuel tax. In addition, biodiesel mixed with conventional diesel is exempted from fuel tax.

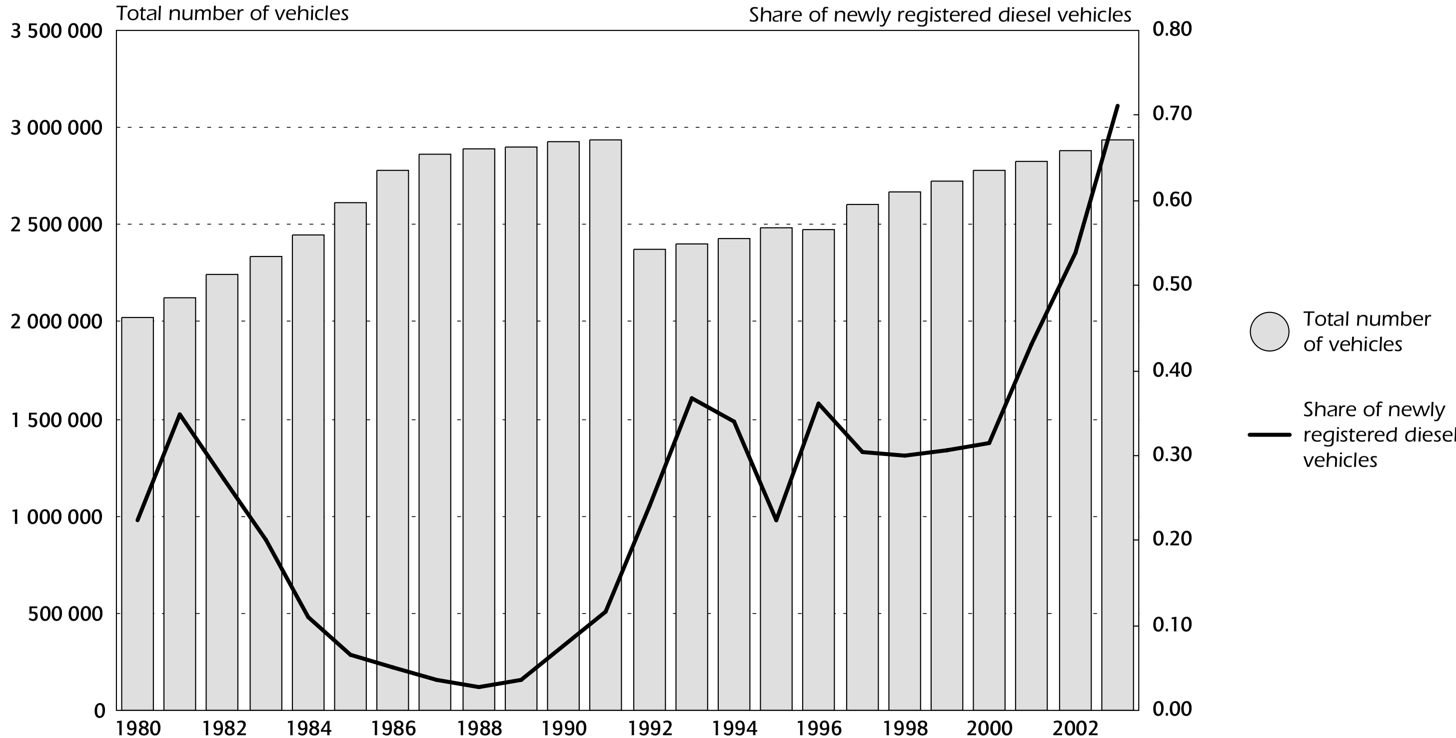
Like other EU countries, Norway has experienced a shift to diesel as preferred fuel, although this has been somewhat slower. The share of new diesel vehicles has risen from 3.6% in 1990 to 23.2% for passenger vehicles in 2003, and from 50.8% to 79.2% in the same period for light goods vehicles (see Figure 12 for the development of Diesel registrations among all road vehicles in Norway).

TAXATION AND PRICING EFFECTS ON ENERGY USE

Norway is taxing energy use both in stationary and mobile applications for environmental reasons, to encourage efficient use. Specific taxes levied for this purpose include the electricity tax, and the CO_2 tax, as well as special petroleum taxes. These taxes are reinforced by a 24% VAT applied in addition.

Figure 12

Development of Norway's Road Vehicle Stock and Share of Newly Registered Diesel-engined Vehicles, 1980 to 2003



Source: Ministry of Transport.

(see Energy Taxes and Prices in Chapter 3). The CO_2 tax primarily applies to the transport sector onshore, where it is seen to have relatively little effect given its low level of NOK 0.76 (+VAT) per litre of fuel, compared to ordinary fuel taxation of around NOK 4 (+VAT) per litre of petrol, and NOK 3.2 (+VAT) per litre of diesel.

Norway is levying a tax on electricity use at the level of NOK 9.88 per kWh (+VAT). On 1 July 2004, the system of electricity tax was changed to comply with EU regulations (Directive 2003/96/EC) while maintaining incentives for energy efficiency. Electricity used in certain production processes, such as electricity used for the purpose of chemical reduction, as well as electricity used in electrolytic, metallurgical and mineralogical processes, is now totally exempt from the electricity tax.

These exemptions will mainly benefit the metal industry, the cement industry and partially the producers of basic chemicals. In addition to the full tax exemptions, a new reduced electricity tax rate of NOK 0.45 per kWh was introduced, which is limited to certain industries that may participate in voluntary agreements to limit their energy use. For example, a programme for energy efficiency for the wood products industry has been designed and participation in this programme will qualify for the reduced rate. Households and business activities not within these sectors are paying the full rate of tax.

Norway has one of the highest post-tax prices for transport fuels in the OECD. Vehicle taxation is also levied in Norway, and an annual environmental tax on heavy goods vehicles was introduced in 2000. The tax rate is differentiated according to the EURO I-III requirements for exhaust gases. There is currently no possibility to link the vehicle taxation to the vehicle efficiency certificate system. Norway is also operating a small fleet renovation subsidy that is unlikely to have a significant impact given its small amount (NOK 1 500 at purchase if the old vehicle is scrapped).

The effectiveness of the Norwegian vehicle taxation regime was assessed by a working group for the government in 2003. The group found that the high purchase tax on private cars combined with no or low tax on business vehicles would lead to distortions of buying patterns, in that business-type vehicles were being bought for private use to avoid the tax. The group recommended that the taxes should be levelled out somewhat between the vehicle types. In addition, the group concluded that the diesel tax was too low regarding environmental costs and suggested that the annual tax should be differentiated according to environmental performance, but not fuel efficiency. The government has taken note of these recommendations, and has changed the taxation differential.

CRITIQUE

Norwegian energy demand is unusual in IEA member countries because it primarily consists of renewable electricity in stationary use and oil for transport use. Other forms of energy such as gas and coal are used in a limited amount in offshore[9] locations. In the past, the availability of cheap and clean, domestically produced electricity, has not encouraged the efficient use of energy in most forms of stationary uses. At the same time, it encouraged the development of energy-intensive industry, such as metal production, shipbuilding, and aluminium smelting.

While Norway has increased energy consumption and production considerably since 1973, there are now environmental constraints on a further increase of onshore supply. Demand has caught up with the excess supply capacity, and is expected to continue to grow in the future. Given parallel developments in the Nordic market, this may create problems in terms of security of supply in the future. Norway is also under the obligation to keep CO_2 emissions at 1% above 1990 levels, which limits Norway's ability to counteract this development through the construction of fossil-fuelled power generation.

Energy efficiency has the potential to increase security of supply in Norway, and the government has had explicit energy conservation policies in place since 1993, in order to restrain demand growth, and encourage fuel switching. Stationary energy use is a significant contributor to total energy demand in Norway. Investment into energy efficiency appears to be very cost-effective, with average lifetime savings cost as low as NOK 0.022 per kWh reported by Enova.

While Norway uses comparatively little fossil-fuel energy in stationary applications, reducing its use through energy efficiency can still be very beneficial for a number of reasons, including the following:

- Reduced overall demand would allow Norway to trade high-value, carbon-free electricity internationally at times of high demand.
- Marginal energy in the Nordic system at times of high demand is likely to be fossil-fuelled electricity exported from abroad, *e.g.* Denmark, Poland, or Germany.
- Reduced expenditure for energy in low-value uses can be reallocated to higher-value use in society.

Norway has set up Enova SF as a state-owned company tasked with achieving savings beyond business as usual (*i.e.* unrestricted demand increase). Enova has a dual function, with objectives relating to large-scale, industrial wind

9. Svalbard, petroleum production.

generating capacity, as well as industrial and domestic energy efficiency. Such a wide portfolio may not be easily achieved, because the management and strategies needed to develop the measures to fulfil the objectives are very different, and the government should observe closely if Enova's resources are sufficient for the tasks assigned to it. Nevertheless, Enova is so far performing very well against its targets, and should be commended for this. The underlying structure of Enova as an independent body with its own long-term funding and clear objectives set by the government is exemplary, and this approach chosen by the government is praiseworthy.

Financing energy efficiency in the industrial sector is a very efficient way for Enova to achieve its target, given the possibility to achieve large savings with a relatively small amount of investment and a small number of projects, leading to a low administrative overhead, which is important for Enova owing to a restriction on its number of employees. Enova is consequently delivering the bulk of its energy efficiency results from the industrial sector. Care should be taken to ensure that this is not done at the expense of promoting energy efficiency in the other sectors, even if the administration for smaller projects requires additional managerial resources at Enova. Also, the government should carefully evaluate the potential for free-rider effects when subsidising energy efficiency in the industrial sector, because the cost-effectiveness of any measures taken appears to be good even without government support.

Given the prevalence of electric heating in Norway, consumption of electricity reaches eight to ten times that of average households in other IEA countries, and it is likely that this demand is the least flexible in Norway. Higher electricity prices after the dry winter 2002/03 have led to a short period of reduced electricity consumption, showing the degree of price elasticity in electricity consumption. Meanwhile, consumption is rising again, caused by rises in the commercial and household sectors. Enova's programme to raise awareness of energy efficiency should be commended, and be given sufficient funding to achieve its goal. The precipitation shortages of 2002/03 showed that sectoral abilities to respond to energy shortages are very well developed in the industrial sector, while the other sectors[10] that consume 70% of electricity did not respond with similar levels of demand reductions. Enova should therefore focus on these sectors.

There is potential for energy efficiency from introducing modern technological control and metering solutions in the domestic sector. Studies in other countries have shown that energy demand can be reduced by as much as 5-10% in homes with electric heating, if information about real-time prices and load is given to householders, and their ability to act on this information by managing their energy use is improved. The introduction of such systems

10. Domestic, agriculture, commercial non-industry, public services.

would allow private consumers to avoid high electricity prices in times of peak load on the system and give them the opportunity to switch their demand to times of low load. The societal costs and benefits of such an approach will need to be judged by detailed studies taking into consideration future developments in generating capacity.

For these reasons, Norway should consider expanding efforts to reduce energy use in buildings, in particular in the household sector. The 2002/03 programme of support for heat pumps, pellet heating systems and control systems has shown that great success is possible for support programmes in the residential sector in Norway. Performance data from Enova indicate that the agency is already performing well in the commercial sector. This is commendable, and the successful effort should be extended further into the household sector. Also, the Norwegian State Housing Bank should consider making energy efficiency a more important item in its extended mortgage offered to home builders who add improvements to their new homes. At present, energy efficiency is not an item in its own right in the evaluation criteria.

Norway is not collecting official statistics that allow a detailed assessment of energy use in buildings. Collecting such statistics will enable much better targeting of measures in the building sector. A more detailed understanding of energy use in the household and commercial sectors could help Norway to develop and implement efficient policies leading to demand reduction. The latest publicly available figures for specific loads in households are based on a 1992 survey, and were published in 1995. The government should consider updating and expanding them through the use of monitoring and evaluation of energy efficiency gains from refurbishment, and other policies.

Norwegian transport energy demand has increased by 13% between 1990 and 2002. Road transport emissions are the fastest growing source of CO_2 among onshore emission sources, and increased by 22% between 1990 and 2002, while overall transport emissions increased by 13%. The continued growth of road transport emissions is putting the achievement of Norway's Kyoto target at risk, and the government should consider stronger measures to counteract this growth.

The geography, topography, and population density of Norway are major drivers for transport demand. Government regional policy is aiming to keep population stable in less densely populated parts of the country. To achieve this, the government is also subsidising the supply of transport, *e.g.* air services to and in these areas.

Local transport is governed by the local authorities on a county level. In the five largest cities, this can create problems in providing the best solution for local needs. The government has responded by introducing a special fund allocated on a competitive basis. Demand for this fund has been heavy, indicating a readiness to invest into sustainable transport solutions on the part of the cities who could bid. The government should consider an increase of available funds.

Norway has been a pioneer in access charging to city centres, and charging systems are in place in the five major Norwegian cities. This charging is currently not based on the principles of congestion charging but operates as a revenue raising tool for the cities. New legislation will give the cities the ability to introduce true congestion charging, and the opportunity to do this should be considered at the earliest opportunity. Achieving modal shifts in city centres to increase use of public transport will have advantages in reducing CO_2 emissions and local air pollution.

The move to a higher share of diesel vehicles is a positive development in terms of fuel efficiency, but can have negative consequences in terms of local air quality unless the new vehicles are equipped with the latest technologies. Special problems may occur in cities during winter days. The government should continue to monitor this development. The increase in diesel tax to take account of environmental externalities should address these problems to some degree.

The whole system of Norwegian vehicle taxation is complex and heavy. Vehicles are taxed at purchase according to weight, engine power and engine volume, which has only an indirect and weak impact on energy efficiency. Within this system, the impact of the CO_2 tax on encouraging more efficient consumption is generally seen as weak, and the CO_2 tax appears to be mostly a revenue raising device at its current level. There is also an annual road tax, which has no specific driver that directly or indirectly could link to vehicle efficiency. Norway has introduced vehicle labelling according to the EU directive.

RECOMMENDATIONS

The government of Norway should:

- *Evaluate whether Enova's objectives are delivering the expected improvements in all target areas of work, in particular energy efficiency.*
- *Closely monitor Enova's work and disseminate lessons learned internationally through publication of Enova's literature in other languages.*
- *Reconsider the need for direct investment aid to industrial energy efficiency.*
- *Consider measures to increase the household sector's ability to react to price increases by reducing and/or shifting load.*

- *Gather statistical data required for effective policy-making, in particular in the building sector.*

- *Pursue cost-effective technological solutions for public transport, such as ferries, buses and commercial vehicles as appropriate through, for example, further use of the public transport fund as an incentive to local authorities.*

- *Encourage congestion charging aiming to achieve modal shifts in city transport.*

- *Introduce a taxation link to vehicle labelling at the earliest opportunity.*

- *Evaluate the effectiveness of the CO_2 tax as a means of fulfilling Kyoto obligations cost-effectively.*

FOSSIL FUELS

BACKGROUND

Norway is producing oil, gas and coal, with almost the whole production for export. Norway is the third-largest exporter and seventh-largest producer of petroleum resources in the world, and the oil and gas industry is Norway's largest and most important industry. Since the start-up of the activities on the Norwegian Continental Shelf (NCS), the industry has been characterised by fast growth and increased production, and it is expected to reach a plateau in the near future. Crude oil production has declined since 2002, while natural gas production is still increasing. Coal production has increased since the opening of a new mine in 2002.

PETROLEUM

OFFSHORE PRODUCTION

Policy

The government's goal is to provide for economic production of oil and gas in the long term, and this goal is very broadly supported in Norwegian society. In the Report No. 38 to the Storting on the Oil and Gas Activities (2001-2002), the long-term scenario of the Norwegian petroleum sector gained widespread support in the Storting, and the government is now working towards its realisation (for a description of the scenario see also Chapter 3).

This scenario requires that all profitable petroleum resources on the NCS are produced, and that exploration and production are undertaken in the technically challenging areas of the Norwegian Arctic and in the deeper waters off the NCS to discover additional reserves. This is an ambitious goal, which is expected to result in oil production from the NCS for more than 50 years and gas production for up to 100 years, according to government estimations. The main challenge is to secure the possibility to conduct profitable exploration activities for the petroleum industry in order to prove these resources. On existing fields, it is important to recover the largest possible share of the economic resources in place through measures such as enhanced oil recovery (EOR) and marginal extensions in areas with existing infrastructure. Norway already has very high oil production rates, of up to 70% of estimated resources in some fields, compared to a worldwide average of 30%, and plans to increase these further (see also Chapter 9).

Several changes have been undertaken in recent years to increase the level of exploration on the NCS. Apart from changes to the licensing system, the petroleum tax system has also undergone a review, as described below. The recommendations regarding taxation made by the Ministry of Finance to the Storting are included in the report to the Storting No. 2 (2003-2004), which specifically looked at the influence of the level of taxation on the level of exploration. As a result of the review process, changes were implemented in the petroleum tax system. The changes implemented were intended to increase fiscal certainty for new companies and improve the profitability of new investments. They will also simplify trading in licences on the NCS. Despite requests from petroleum companies, however, there was no change to the 50% special tax levied on petroleum production, which is additional to the 28% ordinary business tax.

International Co-operation

An agreement reached in 2005 between the UK and Norway on co-operation for the exploitation of resources at the boundary between the two countries has opened the way for the development of these resources.

Domestic Oil and Gas Production

In the past, crude oil has been the main driver of the growth of petroleum production in Norway. During the last few years, however, oil production has been declining, and it is expected that in the absence of significant new discoveries the peak of oil production in Norway has been reached. This is partially offset by the very rapid growth of natural gas production in Norway, supported by significant new discoveries. Driven by an increase of natural gas production, it is now expected that between 2005 and 2009, petroleum production in Norway will increase by 10%.

Total reserves on the NCS were estimated at 12.9 billion standard cubic metres of oil equivalent (bscm oe) at the end of 2003. Of these, 3.8 bscm oe or 29.2% had been produced, and 4.1 bscm oe or 31.3% were classed in categories 1 to 3. Reserves are classed in the following four categories:

0 – Reserves produced and sold.

1 – Reserves in production.

2 – Reserves for which a plan for development and operation (PDO) has been submitted.

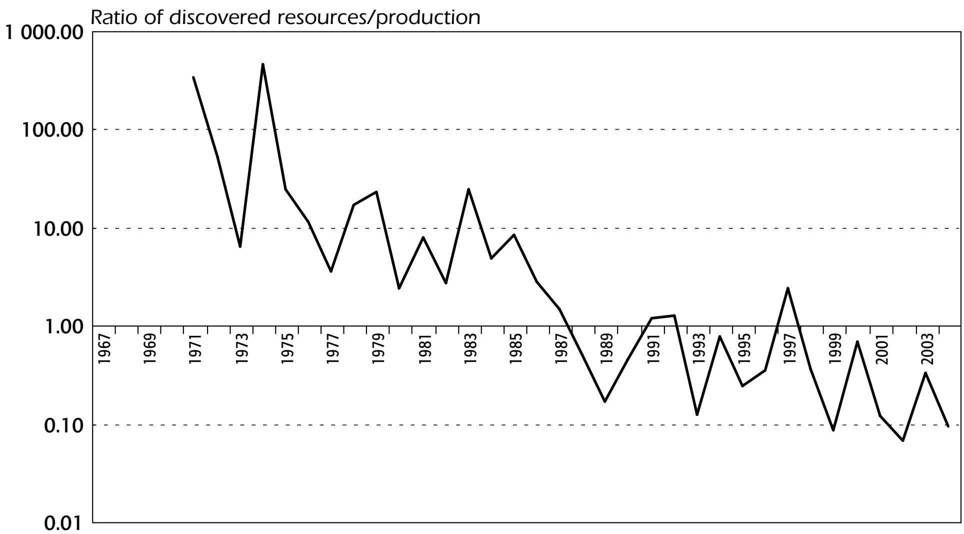
3 – Reserves for which the licensees have made a decision to produce them.

A further 1.3 bscm oe, or 9.8%, was classified as contingent reserves in fields and discoveries; 400 million standard cubic metres of oil equivalent (mscm oe) or 3.1%, was expected from enhanced oil recovery in the future, while 3.4 bscm oe, or 26.3%, was expected from as yet undiscovered resources.

Also, the oil price increases of recent years and the changes to the licensing regime have encouraged new exploration drilling activities, and it is expected that this, together with modern drilling techniques and the bringing into production of marginal fields on the mature NCS, will help to delay the entry into substantial decline until at least 2010. Drilling has been at historically low rates from 2002 to 2004, and it is hoped that the current high level of oil prices together with the licensing changes will encourage more drilling activities. With the exception of 1997, Norwegian reserve replacement rates have been far below 100% since 1995.

Figure 13

Reserve Replacement Rate of Norwegian Petroleum Resources, 1967 to 2004

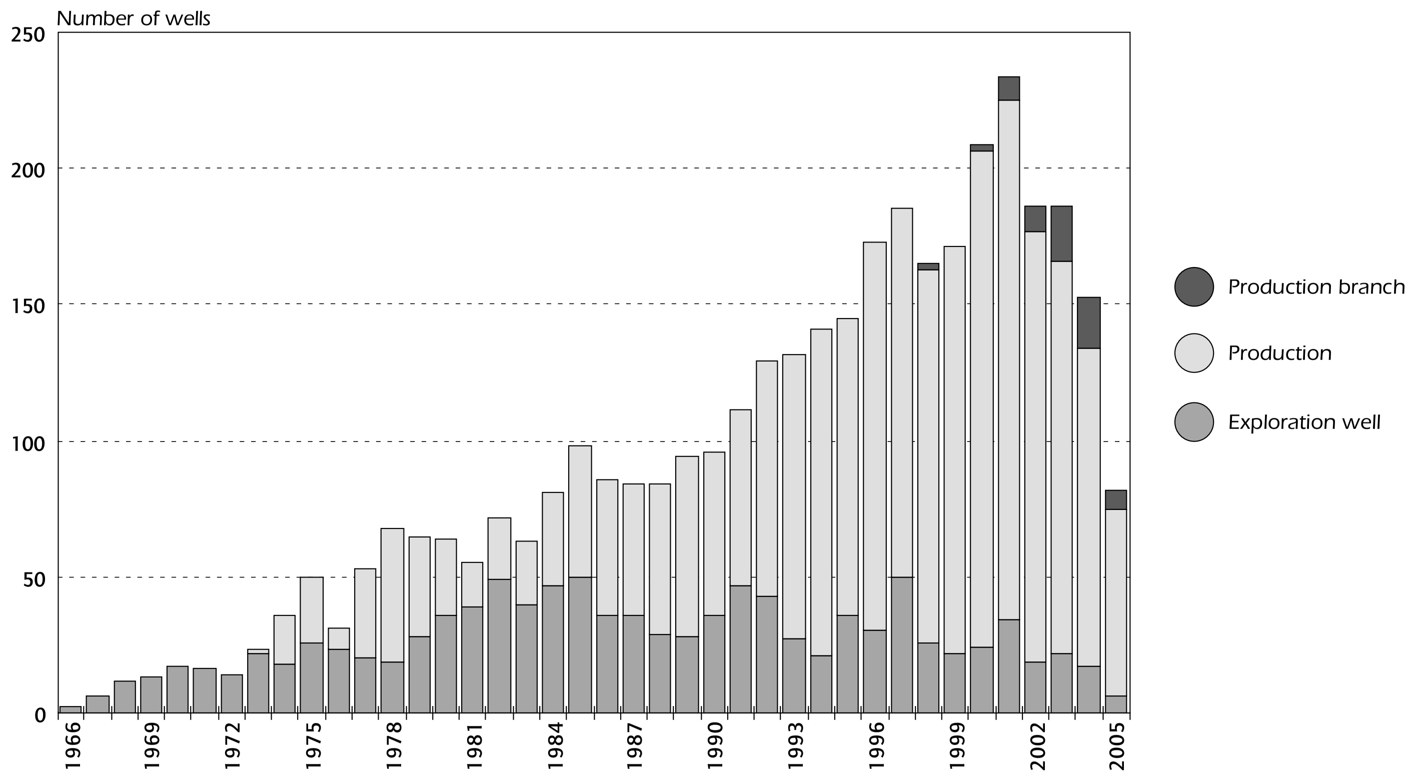


Source: Ministry of Petroleum and Energy.

Annual production of crude oil, natural gas liquids (NGL) and condensates reached 189.4 mscm oe in 2003, a decline of 3.9 mscm oe from the 193.3 mscm oe reached in 2002, or 2%. Gas production increased by 7.9 mscm oe from 65.5 mscm oe to 73.4 mscm oe between 2002 and 2003, by 12 %. Together this contributed to a net growth of 4 mscm oe, or 1.5%. Production of petroleum products in Norway reached about 4.7 million barrels of oil equivalent per day (mboed) in 2003 of all types of products, an increase from 4.6 mboed in 2002, or 2%.

Figure 14

Number of Wells Drilled in Norwegian Waters, 1966 to 2005*



* planned.

Source: Ministry of Petroleum and Energy.

The most significant recent development in Norway is the Ormen Lange gas/condensate field, which has seen its Plan for Development and Operation (PDO) accepted in 2004 by the MPE. With recoverable gas estimated at 397 bscm oe and 28.5 mscm oe of condensate, it is the second-largest gas field in Norway. Ormen Lange by itself will raise Norwegian gas production by 25%, to reach over 100 mscm oe by the time the field comes into production in October 2007. Most of the gas from Ormen Lange will be processed onshore in Norway, and then delivered to the UK through a dedicated 1 200 km-long pipeline, the *Langeled*. There are also plans to export some gas unprocessed, which would be a first for Norway, and this has proven to be a politically sensitive issue. Ormen Lange is the first development at a water depth of 850 to 1 100 metres in Norwegian waters, and is planned as a full sub-sea development. The government is significantly involved in Ormen Lange through its part ownership of Norsk Hydro (18.1% of the licence) and Statoil (36.5%), and a direct share of the State Direct Financial Interest SDFI managed by Petoro (17%). Another important and technologically challenging development is the Snøhvit field in the Barents Sea (described in more detail in Chapter 9.

Offshore Industry Structure

From the outset of the establishment of the Norwegian petroleum industry, the government has chosen to allow the entry of large international oil companies, which could actively contribute to the development of the resource base on the NCS. Simultaneously, one of the main goals throughout the 1970s and 1980s has been to encourage the development of the Norwegian petroleum competence. As the NCS is gradually maturing, a natural consequence is that the industry structure adapts accordingly to reflect this situation. The government's objective today is to achieve and retain a balanced and competitive industry structure best fit to develop and produce the remaining petroleum resources, either from mature or frontier areas. The government's policy tools to achieve this are discussed in detail below. This policy has led to the increasing entry of smaller Norwegian and international companies onto the NCS. These companies are mainly interested in fields in the tail-end production phase, when the final reserves are produced before the field becomes uneconomic. The government recognises that the NCS increasingly needs smaller companies with a more flexible organisational structure in addition to the already established large and experienced companies in order to realise the long-term scenario.

In recent years, 25 new companies have entered the NCS, as part of the drive by the MPE to increase the number of players on the NCS, and in particular to make it more attractive for smaller companies specialising in marginal and tail-end production to enter the NCS. It is expected that this will lead to increased production from assets that otherwise would be left undeveloped. As a consequence of this increase, there are now almost 30 international

Table 9

Daily Petroleum Production in Norway by Selected Multinational Oil Companies, 2002

(in barrels of oil equivalent per day)

Company	*Daily production*	*Share of daily production*
ExxonMobil	440 000	11%
Total	406 000	10%
Shell	174 000	4%
Eni	143 000	3%
Chevron	15 000	0%
Total Selected	1 178 000	29%
Total NCS	4 103 000	100%

Source: MPE.

companies engaged in the upstream sector of the Norwegian petroleum industry. More than half of these are appointed operators of one or more production licences.

While international oil companies play an important role on the NCS and in the development of the Barents Sea, there is also a high degree of state-ownership in the Norwegian petroleum industry. In addition to the international companies, two major Norwegian companies are heavily engaged in the petroleum industry, Statoil and Norsk Hydro. These two companies account for almost 70% of all operatorships on the NCS. Both companies are partially state-owned.

Statoil, originally 100% state-owned, was partially privatised and listed on the Oslo and New York stock exchanges in June 2001. The government retained ownership of 81.7% of the shares after the initial public offering. The Storting has decided that state ownership in Statoil can be reduced to 67%. In July 2004 and February 2005, the government initiated a further reduction of its shareholding in Statoil. These transactions involved offering shares to institutional investors as well as a retail offering to private individuals in Norway and the European Economic Area (EEA). The government now owns 70.9% of the shares in Statoil, while private investors own 29.1%. The company has set itself a target to produce 300 000 boed outside Norway by 2007, and the current level stands at about 200 000 boed, out of a total daily production of 1 175 000 boed planned for 2005.

The government also holds a 43.82% stake in Norsk Hydro. Besides the Norwegian State as main owner, Norsk Hydro also has significant foreign ownership (35.4%). Both companies are operationally independent from the government, and are treated like other major oil companies in terms of bidding for licences, taxation and regulations, although Statoil is marketing and selling the oil produced by the licence share held by the State Direct Financial Interest (SDFI) for the government.

Government Income from Offshore Oil and Gas Production

The government derives various forms of income from the petroleum production, and is liable for expenditures related to these licences. Net government receipts from the petroleum activities are invested in the Petroleum Fund. The fund is based on a 1990 act by the Storting and the first capital transfer into the fund took place in 1996 (see box in Chapter 3) and is financed by:

- Tax income from the special tax of 50% on petroleum activities and other taxes, including the CO_2 tax.
- Income from the State Direct Financial Interest (SDFI).
- Dividend income from Statoil.
- Income from area fees levied on licence-holders.

The SDFI is the second-most important of these sources, after tax income. It 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. An SDFI interest is incorporated in most licences awarded after 1985. The State pays a share, which corresponds to its direct financial interest of all investments and operating costs in projects. On the same terms as the other owners, the government receives a matching share of revenues from the sale of production and other income sources. The SDFI is controlled by the State, with the Storting voting on the SDFI budget and framework on an annual basis. Income, expenses and investments in the SDFI are channelled directly over the state budget, while the day-to-day management of the licence shares is in the hands of Petoro AS following the partial privatisation of Statoil.

Sales of oil from SDFI licences are still undertaken by Statoil, because it was felt that building up an additional marketing organisation was not an efficient process. Revenues arising from the sale of petroleum go directly from Statoil, under its role as the vendor of the petroleum, to the State's account and not via Petoro. Operating expenditure, investments and other expenditure incurred or relating to the management of the SDFI are covered by appropriations from the State. The State also provides funds to Petoro for the management of the company.

As part of the restructuring of state participation in Norwegian petroleum activities implemented in 2001 and 2002, 21.5% of the SDFI portfolio was sold to Statoil and other companies; 15% of the SDFI assets were sold to Statoil in May 2001 prior to the partial privatisation and the listing of the

Petoro AS and the SDFI

Petoro AS, established in May 2001, is a wholly state-owned limited company. As caretaker and manager of the SDFI portfolio, the company has a very important administrative function on behalf of the State. Petoro's role is to act as a commercial instrument for the State; it will not develop into a new oil company that is actively involved in exploration and production activities. Petoro was given the following mandate:

- Managing the State's participation interest in joint ventures.
- Monitoring Statoil's marketing of SDFI production.
- Financial management, including the keeping of accounts related to the SDFI.

The Storting has placed a limit of 60 employees on Petoro. It has also determined that Petoro will neither take on the role of operator nor be a passive partner in licences. It is intended by Petoro's management and supported by the MPE that Petoro will be an active partner, contributing to increased value creation on the NCS. The long-term objective for Petoro is to create the highest possible economic value from the SDFI portfolio.

Petoro's activities are regularly evaluated by external consultants to assess whether they have contributed to the value creation on the NCS, and these evaluations are made available to the public by the MPE. Evaluations show that Petoro has delivered some value above what could have been expected from a purely financial share management, although it is still too early to make a full judgement on Petoro's effects on the licences for which it holds shares.

company in June 2001. A further 6.5% was sold to other oil and gas companies in a sale completed in March 2002.

Exploration and Production Licensing

Title to petroleum resources on the NCS is vested in the State. The State's title to these resources establishes the legal basis for government regulation of the petroleum sector. The MPE is actively marketing the possibilities on the NCS to potential new entrants, and has established a pre-qualification process in 1999 through which 25 new companies had become eligible to bid for licences. The MPE has also established a dialogue with the oil and gas industry through mechanisms such as the Topplederforum (Forum of Senior Managers), joint programmes in R&D, supporting oil companies in developing countries, and joint promotion of the NCS. With the revision to the licensing process in 2003 described in the box below, an explicit distinction between mature and frontier areas was introduced into the licensing process. The licensing process in mature areas has been streamlined, and licensing rounds for this section are held annually. In frontier areas, licensing rounds are now conducted every other year. The eighteenth licensing round that was awarded in June 2004 had the most extensive announcement of blocks in frontier areas since the first round in 1965. In frontier areas, changes have also been made in the framework conditions to encourage fast and efficient exploration.

Before a licence that permits exploration drilling and production (a production licence) may be awarded, the area in question must have been opened for such activities. This cannot happen until the possible environmental, economic and social impact of such operations on other industries and adjacent regions have been assessed. Very large parts of the NCS have been opened for exploration.

The Norwegian government is increasingly focusing on so-called "fallow" areas on the NCS. These are areas where licences have been given under the old system, with only a weak incentive in the form of a low area fee to develop them, even if they are not included in a plan for development and operation (PDO). A possible measure to encourage the use or relinquishing of such fallow areas is to introduce a higher area fee. A suggestion for a new area fee is now out on a public hearing. One benefit of such a policy change is that more mature areas would become open for smaller operators on the NCS.

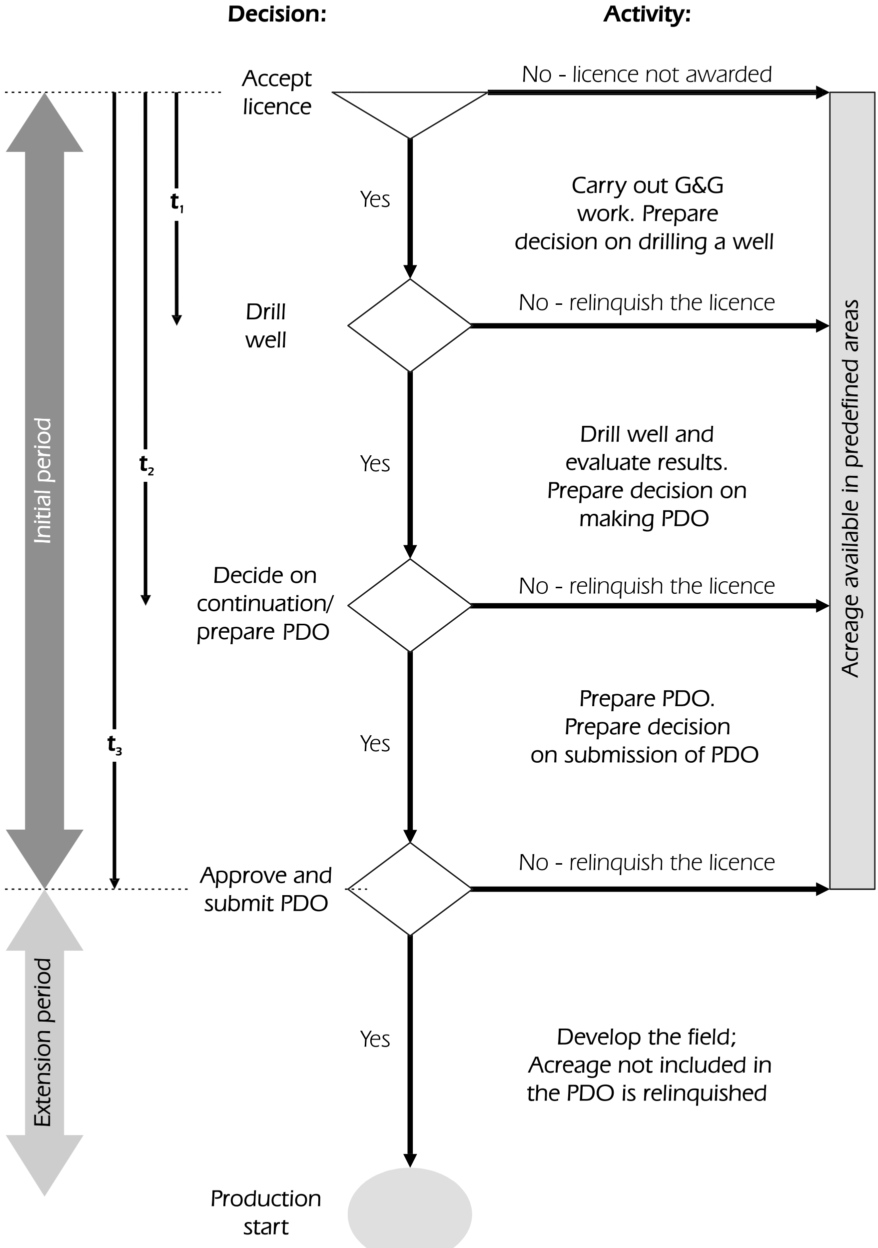
In the North Sea, it is only the Skagerrak area that is not opened for exploration. In the Norwegian Sea, most of the areas for which the industry has expressed an interest are open to exploration. Certain areas with environmental and fishery concerns, including the Lofoten area, remain closed however, despite pressure from the petroleum industry to open them. In the Barents Sea South, the government in December 2003 decided to allow for all-year petroleum activity, except for certain environmentally valuable areas.

Production licences are normally awarded through licensing rounds. The government invites applications for a certain number of blocks, and companies can apply for these individually or in groups. The Report No. 26 to the Storting (1993-1994) made it possible for applicants to submit a joint (group) application. This approach was first used in the Barents Sea project in 1997 and the North Sea round of 1999. The selection of blocks for licensing is undertaken in co-operation with the operators present on the NCS.

On behalf of the government, the MPE will continue to hold interests in production licences based on the potential profitability and value creation opportunities offered by each licence. The general rule for supplementary awards is that the State's direct interest will reflect its interests in adjacent fields or areas. The announcement text gives details of the terms and the objective and non-discriminatory criteria that will form the basis for awards. On the basis of the applications submitted, the MPE generally awards licences

Figure 15

The Licensing Process for Offshore Petroleum Production in Norway



t_1, t_2, t_3 is the timeframe within which a licence-holder has to make a decision.
G&G: geological and geophysical.
Source: Ministry of Petroleum and Energy.

to groups of companies. The MPE also appoints an operator for the joint venture. This operator is responsible for the daily management of operations in the licence. In some cases, one company can be the development operator, while another is the production operator.

The fifteenth licensing round in 1996 was the first round completed within the framework of the EU licensing directive. Statoil did not participate in competing for all licences and competed for participation in licences on equal terms with all other companies. In the seventeenth and eighteenth licensing rounds, the government extended the principle applied in the fourteenth to sixteenth rounds for the size of the State's interest in new licences.

Changes to the Norwegian Licensing and Upstream Taxation System

The need for a change to the licensing system was first set out in Report No. 38 to the Storting (2001-2002) "On Oil and Gas Activities". This report identified possible changes to the policy framework and licensing regime that were required in order to achieve the long-term scenario of developing the oil and gas resources in Norwegian waters, which was also described in this report for the first time (see Chapter 3).

The long-term scenario relies on the increased recovery of existing resources through tail-end recovery, the exploitation of marginal resources close to existing infrastructure, the increase of diversity of companies operating on the NCS, and the discovery of significant new resources in frontier areas. In the view of the MPE, all of these aims could be more adequately supported through the proposed changes to the licensing regime and policy framework, and in particular the modification of the licensing regime was seen as vital to achieve the long-term scenario.

Following the publication of Report No. 38 to the Storting (2003-2004) "On Oil and Gas Activities", in 2003 the government changed the licensing and taxation policy for upstream oil and gas activities, as outlined in the 2001-2002 report referred to above, which was accepted by the Storting. The main aims of the change were the following:

- To encourage new, smaller companies to enter the NCS and participate in award rounds.
- To encourage the speedy exploitation of awarded acreage.
- To increase exploration in mature areas with existing infrastructure.
- To increase information and choices available to companies.

A number of measures were taken to achieve these aims, affecting the timing and scope of licensing rounds, the terms of licences awarded, the tax regime, and the number of companies on the NCS. These involved a more detailed management process of acreage and a division between mature and frontier areas of exploration, as well as a move towards annual licensing rounds for the mature areas of the NCS, and a re-opening of part of the Barents Sea to exploration. There are set decision points in the licensing process at which a company has to commit resources, or give the acreage back to the government. Furthermore, areas of a licence which were not included in the production plan now revert back to the State, for inclusion in future rounds.

Mature areas are defined as areas where a good understanding of the geology and the possibility of finding and developing resources exist, and they exist both on the NCS and in the Barents Sea. They are characterised as "low risk/low reward" and can attract both major and minor oil companies. Frontier areas are those where much less is known, but where the potential finds are significantly larger. These are consequently seen as "high risk/high reward" and attract primarily major oil companies with significant resources. Further changes involved creating higher pressure on licence-holders to undertake exploration and production in mature areas through a detailed plan with key decision points at which the licence may revert back to the State. The possibility to reclaim licences or parts of them is also based on a more detailed management of awarded blocks. Furthermore, areas of a licence which were not included in the production plan now revert back to the State, for inclusion in future rounds.

Another important change affected the taxation regime for exploration expenditure, where the aim was to reduce the financial risk to companies should they fail to find exploitable resources in their licence area. Companies are now allowed to reclaim exploration expenses up to the level of the petroleum tax (78%) should they not be in a tax-paying position in Norway, *i.e.* if they have not been successful in discovering resources in their acreage. This encourages new entry into the industry, by removing the risk of facing 100% of the exploration bill in the case of unsuccessful drilling activity. Further changes to taxation include reimbursement of deficits at termination of activity, again a risk-reducing measure for new companies that are unsuccessful in Norway, and changes to the depreciation system for short-life assets, allowing a faster depreciation of the capital expenditure where the lifetime of an asset is shorter than six years.

The changes taken together encourage the development of either new marginal resources in close proximity to existing infrastructure, exploration in frontier areas, and the tail-end production from mature fields where minor investments in infrastructure are required. In both cases, the possible lifetime of the investment may be quite short, and the return uncertain. The changes appear to have had the desired effect by increasing drilling activity, and encouraging the entry of smaller oil companies into the NCS.

The MPE has also moved towards a long-term approach in managing award rounds, with each annual award round comprising acreage in mature and frontier areas, with a clear focus on either one or the other of these. Awarded acreage in mature areas has increased, in order to give companies a better chance of developing resources. The aim of the new system is to give the companies more predictability. Through the establishment of a fixed, predefined exploration area, the industry will be able to understand better which areas will be available in years to come and plan accordingly. In future years, there will be a pre-set time schedule for the execution of the licensing round.

The MPE will each year consider possible extensions of the predefined area and make necessary changes in the framework conditions, based on experience and feedback from bidders. The aim is to extend the predefined area when new areas develop into mature areas. The increased predictability with respect to the acreage available and the time schedule for the licensing rounds will allow for an improvement of the companies' long-term planning and the allocation of internal resources to the bidding and development process ahead of time.

In Awards in Predefined Areas 2003 (APA 2003), there was a mix of established and new companies and 13 companies were awarded shares in 19 production licences. Three new companies – BG International, Maersk Olie & Gas and Revus Energy – entered the NCS through this award, and it was the first time Talisman Energy Norge applied in a licensing round on the shelf. In APA 2004, the MPE offered 21 companies 28 production licences in the North Sea, in Haltenbanken in the Norwegian Sea and in the Barents Sea around the Snøhvit field.

The eighteenth round was the first round under the new licensing regime. It was comprehensive both in the North Sea and the Norwegian Sea, and included frontier acreage with a high potential but little certainty in addition to better understood areas on the NCS with lower risks. The announced area of the round was to a large extent based on the nominations from the oil companies present on the NCS and it was the largest licensing round in frontier areas since the first licensing round on the NCS. There were extensive awards in the deep-water areas of the Norwegian Sea. Further, two stratigraphic licences were awarded, because two licence groups saw opportunities in different layers of the same block. There was an interesting mix of large established companies and smaller, relatively new actors and in total 16 companies were awarded a share in 16 production licences.

Environmental, Health and Safety Standards and Labour Relations

Norway is imposing very high environmental performance and safety standards on the offshore industry, including specific regulations on exploration rigs that make it difficult for owners of exploration rigs from other areas of the North Sea to offer their services in Norway. In some cases, these standards are exceeded by internal company standards.

Labour productivity is lower on the NCS than it is in the UK, owing to more generous leave allowances. Direct personnel cost is twice as high in Norway compared to the UK, and overall cost for hiring technical services is 20-40% higher in Norway than in the UK. Offshore personnel cost contributes almost 60% to the total cost of drilling. Oil companies are reacting to this by an attempt to introduce more remote-controlled activities which can be directed from the shore through modern control technologies (see Chapter 9).

OIL

Resources

Crude oil has been the main resource on which the NCS production was built up. Production rose until 2002, and has since been declining slightly. Total reserves on the NCS were estimated at 5.9 bscm at the end of 2003. Of these, 2.7 bscm or 45.9% had been produced, and 1.2 bscm or 20.9% was classed in categories 1 to 3. A further 490 mscm or 8.3% was classified as contingent reserves in fields and discoveries; 300 mscm or 5.1% was expected from enhanced oil recovery in the future, while 1.2 bscm oe or 19.7% was expected from as yet undiscovered resources.

Supply

Daily crude oil production (including NGL/condensates) amounted to 3.26 million barrels of oil equivalent (mboe) in 2003. This places Norway as number seven on the list of the world's leading oil producers. However, the NGL/condensate production that is normally associated with natural gas developments has continued to increase.

Section 4-4 of the Petroleum Act authorises the government to regulate petroleum production. 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.

Production regulations have been imposed three times, first in 1986–1990 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 of oil equivalent per day (boed). From 1 April 1999, a reduction of 200 000 boed was imposed. From 1 April 2000, the reduction reverted to 100 000 boed, and the regulation was abolished on 1 July 2000. For the first six months of 2002, the government imposed a reduction on oil production by 150 000 boed. The restriction was applied proportionately to all oil-producing fields. Since then, oil production has been at full capacity. Production was regulated in all cases because of the collapse in oil prices.

Table 10

Crude Oil Sales by Country, 2003

Country	*Volume Mtoe*	*Share %*
UK	38.9	24
Norway	21.2	13
Netherlands	20.9	13
France	18.8	11
Germany	15.5	9
USA	13.3	8
Canada	11.4	7
Sweden	7.4	5
Others	17.8	11
Total[a]	**164.7**	**100**

a. Numbers will not add owing to rounding errors.

Source: MPE.

External Trade

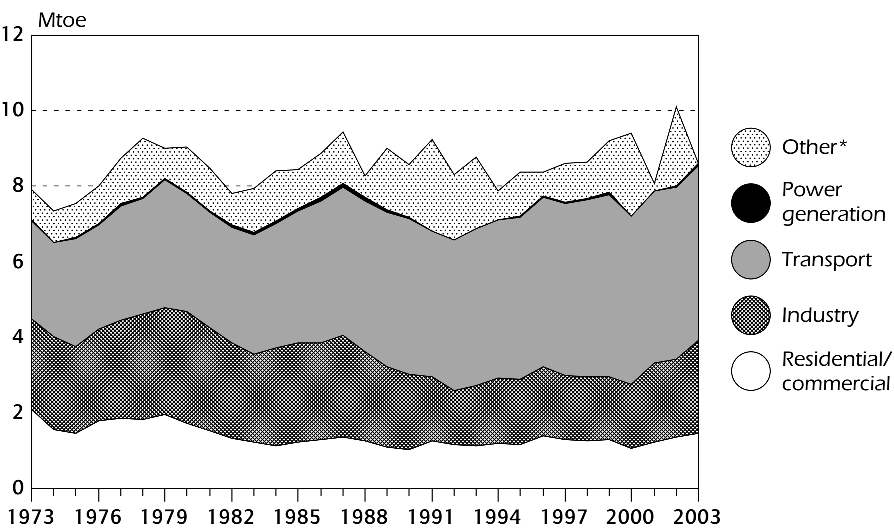
In 2002, Norway exported 154.6 Mtoe of oil and oil products, and imported 4.34 Mtoe. Other than adhering to oil sanctions decided by the United Nations (UN), the government does not involve itself in matters regarding imports and exports of oil. There are no quotas or restrictions for petroleum products or crude oil on import and export volumes, apart from the possibility to introduce temporary production regulation.

Domestic Demand

Total domestic supply of oil reached 10.1 Mtoe in 2002. Oil is primarily used in transport, which accounted for 4.7 Mtoe, 55% of the 8.64 Mtoe TFC of oil in 2002. The industrial sector accounted for 2.7 Mtoe in 2002, or 32% of TFC of oil, and the remaining sectors in the economy consumed 1.36 Mtoe. Between 1990 and 2002, oil demand increased from 7.96 Mtoe to 8.64 Mtoe, by 8.5%. In the industrial sector consumption slightly decreased, from 2.79 Mtoe to 2.73 Mtoe, by 0.06 Mtoe or 2.2%. In the transport sector it increased from 4.22 Mtoe to 4.71 Mtoe over the same time, by 0.49 Mtoe or 16%. In the other sectors of the economy, oil demand increased significantly from 1.02 Mtoe to 1.36 Mtoe, by 33%.

Figure 16

Oil Demand by Sector, 1973 to 2003



* includes other transformation and energy consumption.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

Refining

Norway has two oil refineries, namely the Mongstad facility close to Bergen, which is owned by Statoil, and the Esso refinery located at Slagen near Oslo. Their annual refining capacity totals an average of 300 000 boed to about 9% of Norwegian crude oil production. Mongstad has roughly twice the capacity of the Slagen plant. The two refineries buy crude oil from and sell products to the world market, so not all their feedstock is necessarily produced on the NCS. About 30% of the output from these refineries is consumed by the domestic market, while the rest is exported. Remaining domestic consumption of oil products, amounting to some 150 000 boed, is produced at foreign refineries.

The government has no particular policy for the domestic refining industry. The refineries are treated like any other industry activity in Norway. Product specifications are the same as in the EU.

Retailing

The retailing sector is dominated by five companies. Statoil holds the largest market share with 31% of the total sales of petroleum products in 2003, closely followed by Shell with 29% and Esso with 21.5%. Norsk Hydro and Texaco market their products jointly, and together accounted for 14.2%. Several other smaller companies make up the remaining 4.3% of sales in the retailing sector[11]. The sector is seen as highly concentrated, and Norwegian pre-tax petrol and diesel prices are among the highest in IEA member countries. Concentration is unlikely to be the only reason for this, because distribution costs for petroleum products are high in Norway owing to the geography and low population density of the country.

Emergency Response Measures

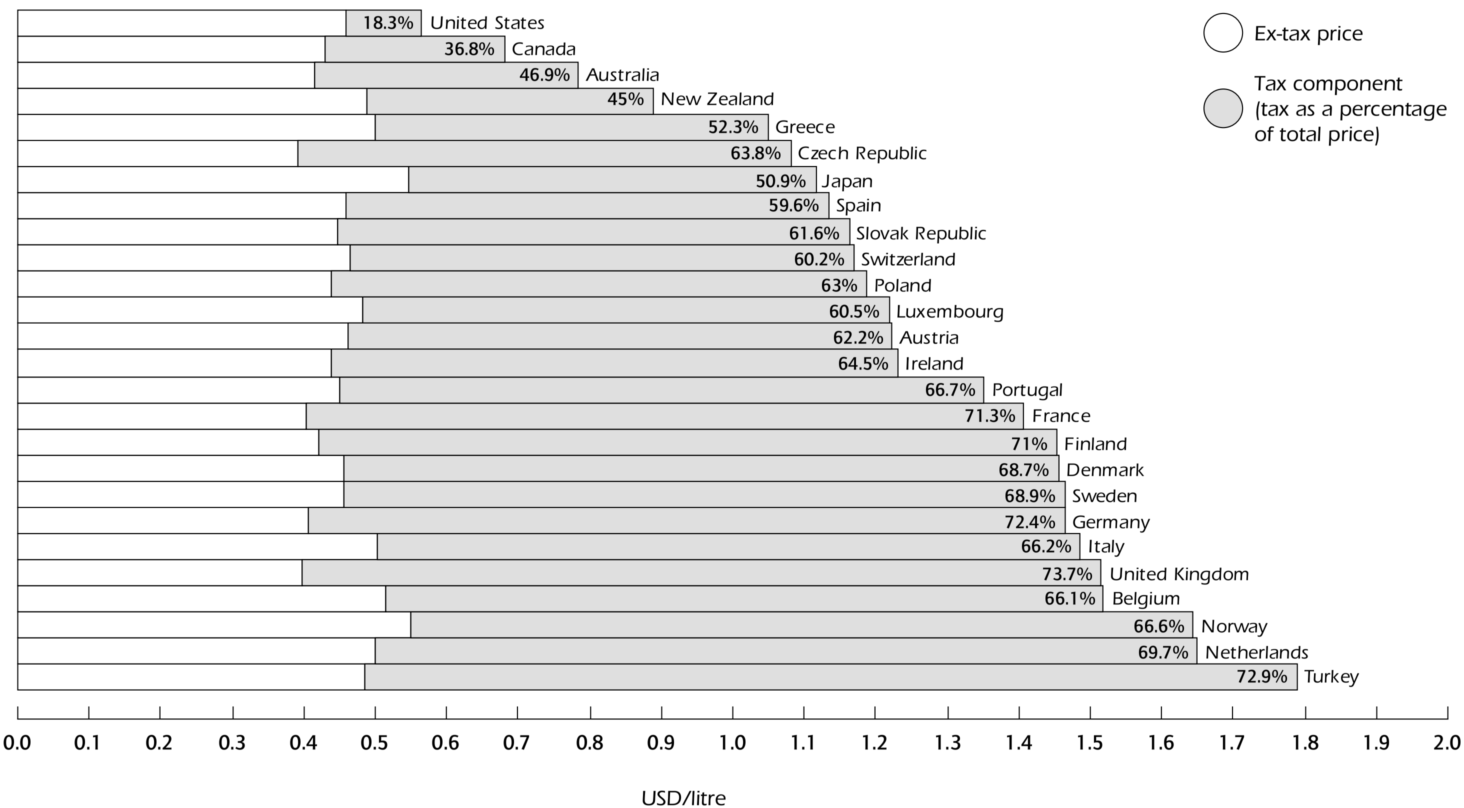
In case of a serious oil supply shortage, Norway has agreed to "contribute, by decision of the government, to a sharing programme by adding to normal supplies to Participating Countries of the Agency such additional deliveries as may be obtained from appropriate demand restraint measures and from the activation of any stand-by production capacity that may exist."[12] Norway is obliged to enter into consultation with a view to specifying its contribution whenever the International Energy 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,

11. Source: Norsk Petroleumsinstitutt.
12. Agreement between Norway and the International Energy Agency [IEA/GB(75)9].

Figure 17

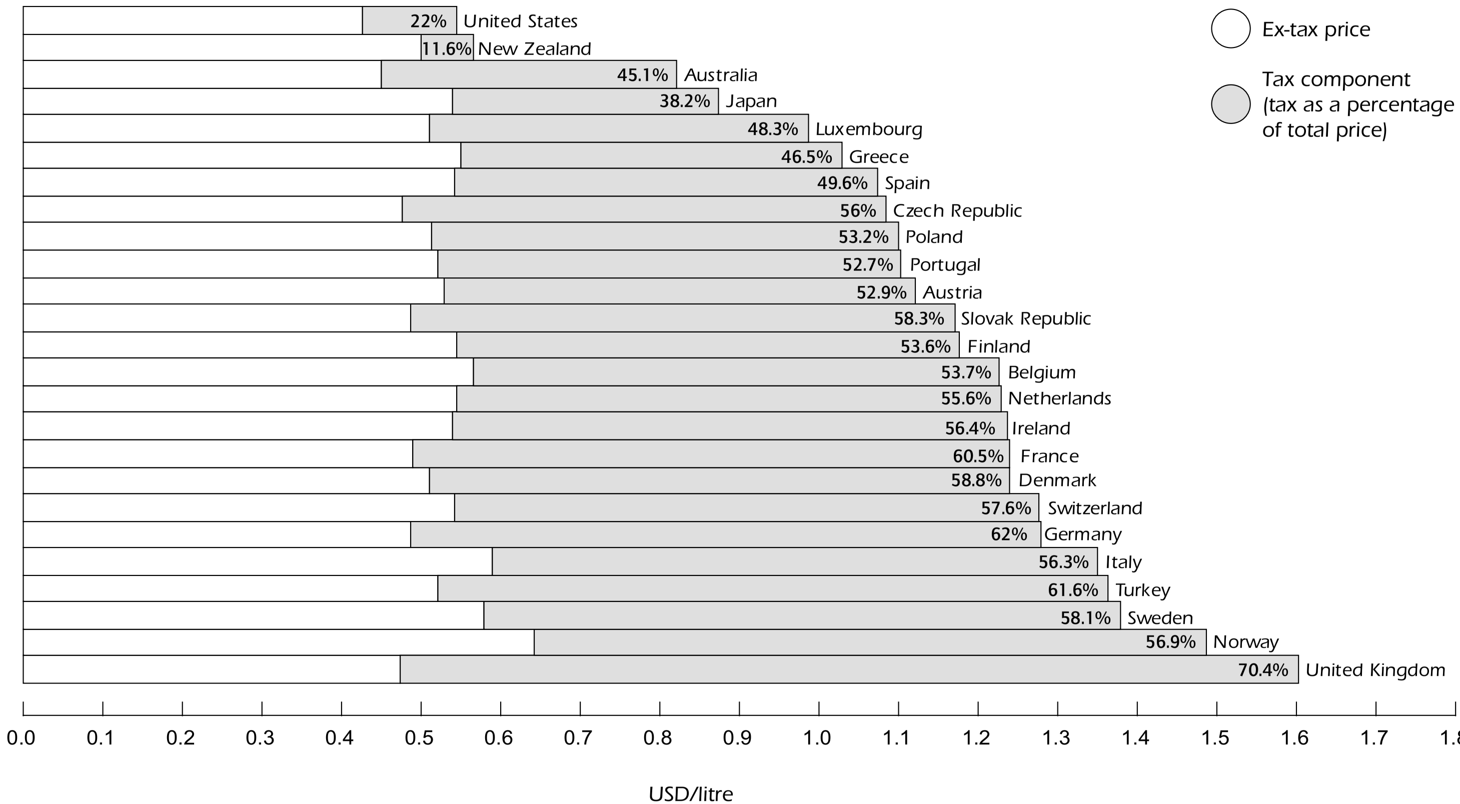
OECD Unleaded Gasoline Prices and Taxes, First Quarter 2005



Note: data not available for Hungary, Korea and Mexico.
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

Figure 18

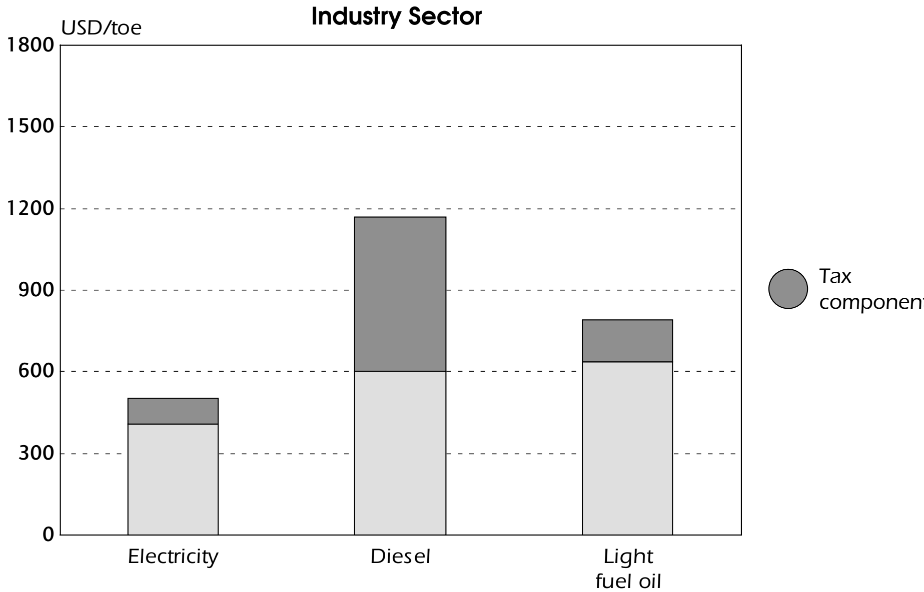
OECD Automotive Diesel Prices and Taxes, First Quarter 2005

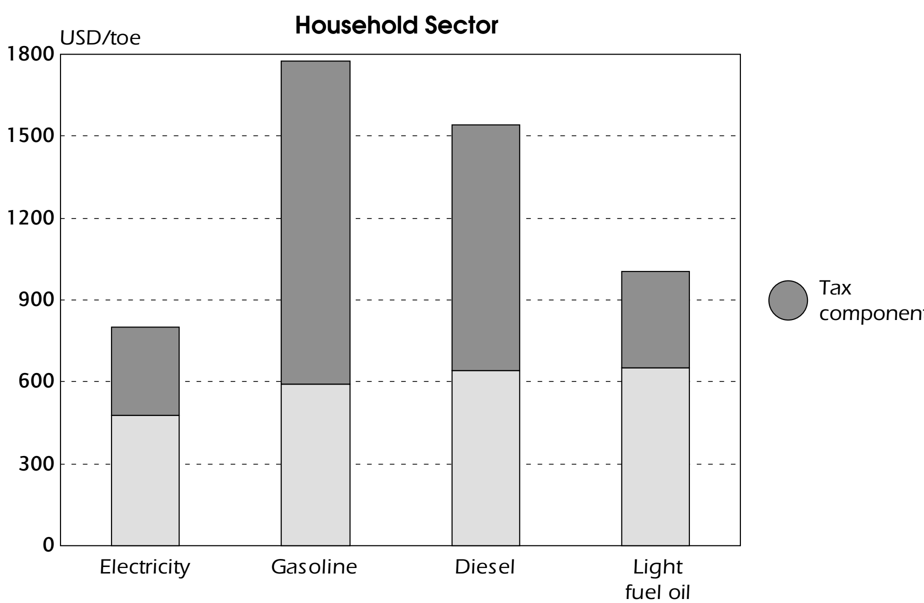


Note: data not available for Canada, Hungary, Korea and Mexico.
Source: *Energy Prices and Taxes,* IEA/OECD Paris, 2005

Figure 19

Fuel Prices in Norway, 2004





Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

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.

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 no scope for increasing production in the event of an emergency at this time, since petroleum production is running at full capacity.

Regulations on demand restraint were established in 1983. Revised regulations were put into effect in 1999. Voluntary restraint and stock draw are preferred rather than restrictions. Implementation of the agreement between Norway and the International Energy Agency [IEA/GB(75)9] and energy savings campaigns 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, and 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.

OFFSHORE NATURAL GAS

Resources

Growth of petroleum production in Norway is driven only by increased natural gas production at this stage in the development of the shelf. Norwegian reserves of natural gas are estimated to last up to twice as long as those of crude oil, and all the recent major discoveries have been gas discoveries with some associated NGL/condensates, even though some small oil discoveries have also been made. While Norwegian gas production reached about 73 billion cubic metres (bcm) in 2003, it is expected to rise in the short term as new fields come on stream, and peak annual gas production of approximately 120 bcm by 2010 is a possible scenario.

Unlike oil production, which is already in the phase of decline barring major new discoveries, gas production is not expected to enter into the phase of decline before 2015. The decision not to allow flaring of associated gas, made in the 1980s, has contributed significantly to the preservation of reserves, and the development of gas production in Norway. Remaining resources as of 1 January 2003 were estimated at 5 200 bcm, of which 60% are classed as reserves and 40% are undiscovered resources. At the annual production rate of 120 bcm expected from 2010, these would last for 43 years of production.

Norwegian gas is produced from pure gas fields, as well as from fields producing sizeable amounts of both oil and gas and as associated gas from oilfields. Gas is also used for reservoir management at several fields on the NCS where it is reinjected to increase oil recovery, and it is expected to extract this gas at a later stage.

Production

Natural gas sales from the NCS amounted to 75 bcm in 2004. Production is expected to rise in the short to medium term as new fields are coming on stream. In 2003, 14% of the gas consumed in OECD Europe was produced on the NCS. By being a stable and long-term supplier of natural gas, Norway contributes significantly to European security of supply.

Most of the gas produced from the NCS is exported to continental Europe and the UK, with only small volumes utilised domestically. It has not been profitable to undertake any major development of extensive transport systems for natural gas within Norway because of difficult topography, low population density and dispersed industry. Many of today's gas applications are accordingly found close to the landfall sites of pipelines along the coast. The steady development of gas fields on the NCS may facilitate the development of new landfall sites. The development of the Snøhvit field in the Barents Sea and the Ormen Lange field in the Norwegian Sea are two examples. Because of the infant state of the market, there is no specific policy concerning the security of gas supply.

Sales

In 2002, a major change in the gas management system was implemented. Prior to 2002 there was a system of joint marketing of Norwegian gas through the Gas Negotiating Committee (the so-called GFU). The GFU was permanently terminated as of 1 January 2002, and was replaced with company-based sales. All the producers now sell their own gas on an individual basis.

Table 11

Exports of Natural Gas by Country, 2003

Country	*Export volume Mtoe*	*Export share %*
Germany	24.3	34
France	13.4	19
UK	8.7	12
Belgium	6.5	9
Netherlands	6.3	9
Italy	5.6	8
Czech Rep.	2.5	4
Spain	2.4	3
Others	1.3	2
Total[a]	**71.1**	**100**

a. Numbers may not add up owing to rounding errors.

Source: *MPE.*

Upstream Pipeline Access

By Royal decree, new provisions for access to and use of gas pipelines and related installations on and from the NCS came into force in January 2003. The new access regime is neutral for users who have a need for transportation of gas and it reduces the transaction costs related to transportation. The ministry regulates the tariffs for use of the upstream pipeline network. This simplified the new system of company-based sales and transportation from the NCS.

EU Regulation

The implementation of the first EU gas market directive in Norwegian legislation made it necessary to establish a legal framework for downstream activities, *i.e.* transmission and distribution of gas, in Norway. The Natural Gas Act (No. 61, 28 June 2002) applies to the transmission, distribution, supply and storage of natural gas. It incorporates the central principle of the directive, which is that natural gas undertakings and eligible customers shall be given access to transmission and distribution networks for the transportation of natural gas. The gas directive is also implemented in the regulation laid down in accordance with the Natural Gas Act. This regulation includes provisions requiring companies that are engaged in at least two of these activities – transmission, distribution and storage of natural gas – to keep separate accounts for different activities, and provisions on third-party access (negotiated).

Offshore Infrastructure

At present, most gas is processed onshore in Norway before being exported. The first large-scale liquefaction plant is currently under construction at Melkoya near Hammerfest, to process into LNG the natural gas produced from the Snøhvit field in the Barents Sea that would otherwise be left stranded. A network of undersea pipelines is connecting Norway to its European trading partners across the North Sea.

Gassled, the Norwegian upstream pipeline network, is the most extensive offshore gas transportation system in the world and comprises more than 6 000 km of pipelines. The Storting requested the establishment of a common ownership structure, to open up the gas transportation system for more efficient operation and development. This common ownership structure was established in December 2002.

The state-owned operating company Gassco is in charge of the management of the oil company-owned Gassled, and was established in May 2001. It operates most of the upstream pipeline network and is responsible for the administration of the regulated access regime applied to the system and co-ordinates the process for its further development. The interdependence of the different pipelines and treatment facilities requires an overall management. Gassco, established as the neutral operator of the infrastructure, has the responsibility of allowing this. Decisions about pipeline access can be critical for decision-making on the exploration of new, marginal resources. Each production company books capacity in the transportation system, depending on their requirements.

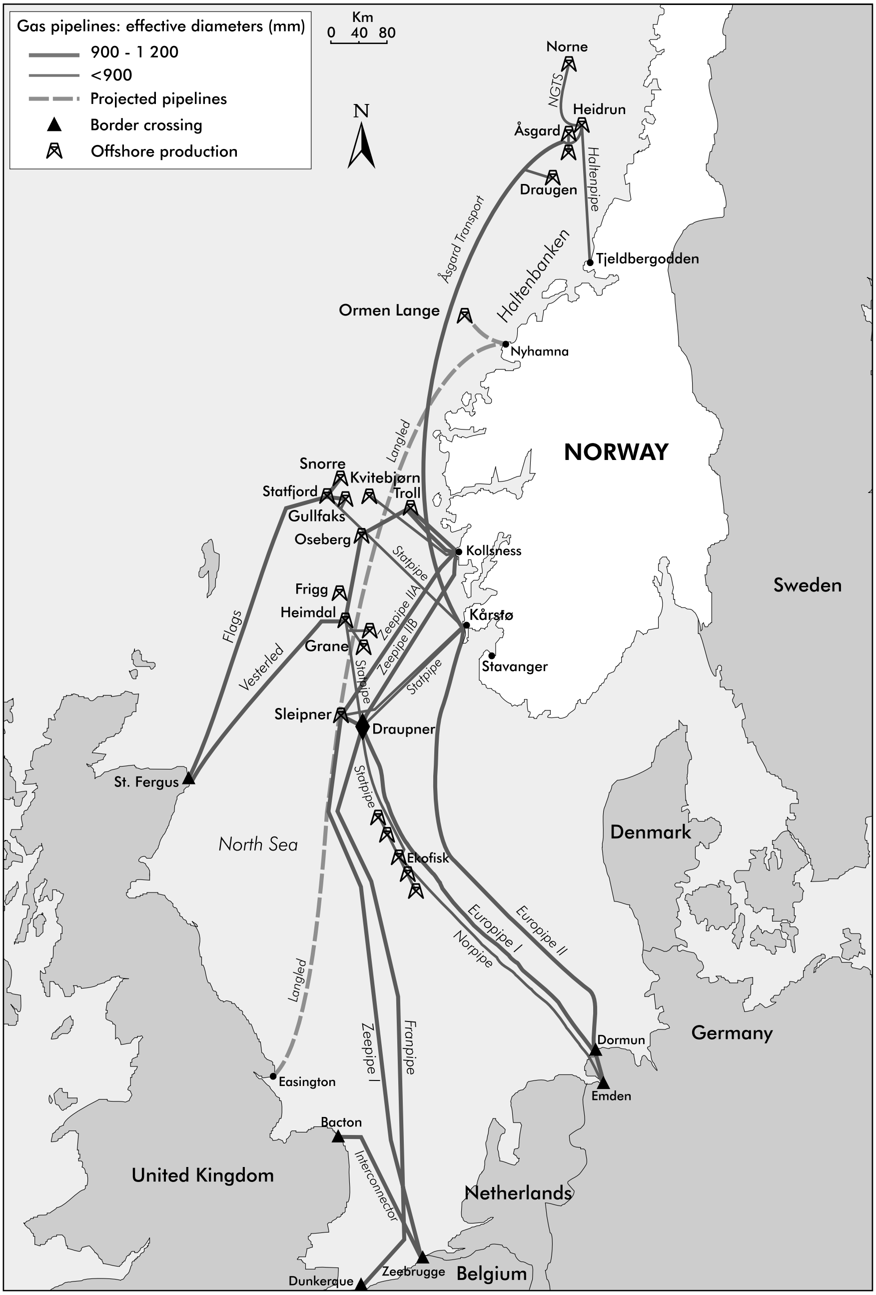
ONSHORE NATURAL GAS

Domestic Gas Market

Norway is a major gas producer but not a large consumer. Gas consumption in Norway is just below 1 bcm per year. That is less than 2% of the gas produced on the NCS in 2003. The largest consumer is the Tjeldbergodden methanol plant, which represents around 90% of Norwegian gas consumption. The rest of the consumption is concentrated around the gas processing facilities on the western coast. This means that the Norwegian gas market is very limited.

Figure 20

The Norwegian Offshore Gas Transportation System



Source: Ministry of Petroleum and Energy.

In association with the existing landfall sites, natural gas is used for a number of purposes, and interest in making further use of natural gas in Norway is growing. Various players have plans for different types of gas application (such as LNG production), both at existing landfalls and in association with possible future receiving terminals.

The Norwegian gas market is very immature. Two distributors of natural gas cover limited regions on the west coast, Gasnor ASA and Lyse Gass.

Infrastructure

Gasnor ASA is located in Karmøy/Haugesund on the west coast of Norway. Gasnor ASA has tied into the Statpipe II trunkline at Snurrevarden in Kårstø and distributes natural gas to customers in Karmøy and Haugesund. About 45 km of gas pipeline has now been laid in these municipalities. In 2004 Gasnor ASA delivered 40 mscm of natural gas through this distribution network. The company distributes about 10 mscm compressed natural gas (CNG) to the Bergen area.

Gasnor has also built a small-scale gas liquefaction plant in Karmøy with a capacity of 25 scm per year. LNG is distributed by ship and lorry. According to the company, the most important market for LNG are ferries and supply ships.

Lyse Gass is located in Stavanger. The company has built a transmission line from Kårstø to Stavanger with a yearly capacity of 1 bcm of natural gas. The transmission line was opened in March 2004. To date, the consumption in the area is only about 3% of the total capacity in the transmission line. Lyse Gass also operates a small distribution network for natural gas.

Several small companies provide small-scale LNG distribution locally, they own LNG terminals and established local distribution. These companies currently sell very limited quantities of natural gas.

The gas treatment facility at Kollsnes began operation in 1996 as an integrated part of the Troll development. Kollsnes Næringspark AS was established in 1995 to exploit gas available from Kollsnes. A major buyer of this gas is the compressed natural gas (CNG) plant established by Naturgass Vest in 2000. This facility permits CNG deliveries to the Bergen region.

Tjeldbergodden was established as a gas region through the landing of gas from the Heidrun field. The methanol plant at Tjeldbergodden represents the first use of natural gas for industrial production in Norway, and is the country's most important gas recipient. It consumes about 670 mscm per year. In addition, plants for gas liquefaction and air separation have been established at Tjeldbergodden. Bioprotein production based on natural gas and an industrial estate – the Tjeldbergodden Gas Park – intended for small-scale gas-based industry have also been established.

Policy

Norway implemented the Gas Market Directive (Directive 98/30/EC of the European Parliament and of the Council of 22 June 1998 concerning common rules for the internal market in natural gas) in 2002, with the act (No. 61, 28 June 2002) concerning common rules for the internal market in natural gas. The act has implemented the main rules and definitions contained in Directive 98/30/EC. According to Section 3 of the act, qualified customers include gas-fired power plants, regardless of their annual consumption, and all other end-users with a yearly consumption over 25 mcm per year on each location of consumption. Today, the Tjelbergodden plant is the only customer meeting these criteria in Norway.

The act is a framework act, with the implementation dependent on the MPE, and the MPE implemented the provisions to the act from 1 January 2004. Norway is expected to implement the Gas Market Directive II (Directive 2003/55/EC of the European Parliament and of the Council of 26 June 2003) during 2005.

The regulatory responsibility for the gas industry in Norway still lies within the MPE, and an independent regulator has not yet been established. The government is now anticipating the development of a domestic gas industry in Norway by developing proposals for economic regulation of the domestic gas industry. The onshore gas market is considered to be an emerging market.

The government presented a White Paper on Domestic Use of Natural Gas, Report No. 9 to the Storting (2002-2003), in November 2002. A strategy to develop domestic use of natural gas was presented. In August 2004, this was followed up in a new white paper from the government on setting up an innovation agency for environment-friendly gas technologies, Report No. 47 to the Storting (2003-2004). In this report the government discusses the development of infrastructure for natural gas and increased efforts to develop environment-friendly gas technologies.

In the preparation of Report No. 47, the Norwegian Water Resources and Energy Directorate (NVE) carried out extensive analyses on the economics of natural gas transportation in Norway. LNG and CNG transportation by ship has been analysed, as well as pipeline transportation. The analyses indicated that it could be possible to sell LNG in Norway at a price that covers the costs. The government's policy is to support the more flexible infrastructures, such as LNG distribution. Pipelines may be more profitable as the market matures, and the gas industry and industrial users are suggesting government support to help construct the pipelines.

Gas Production and Delivery

All the gas consumed in Norway is produced on the NCS. There are a number of different players on the shelf, ranging from the large super-majors to smaller companies. The gas is delivered through the Haltenpipe, and from the Kårstø and Kollsnes processing facilities.

The Haltenpipe gas is delivered directly to the Tjeldbergodden methanol plant, and the gas from the Kårstø and Kollsnes processing facilities is delivered to local distribution companies.

Natural Gas for Power Generation

The government gives a high priority to the efforts for developing environment-friendly gas-fired power plants. There is no direct policy regarding the share of gas in electricity generation, although the policy of maintaining a share of at least 90% renewables in power generation restricts the potential share of gas in power generation to 10% of the market.

Licences have been granted for three gas-fired power plants in Norway. In 1997, the company Naturkraft AS was granted construction and operating licences for two plants at Kollsnes in Hordaland and Kårstø in Rogaland. According to plan, each of the two CCGT plants is to have an installed capacity of about 400 MW, corresponding to annual production of about 3 TWh each. Naturkraft is now almost certain to build the plant at Kårstø. In 2001, the company Industrikraft Midt-Norge was granted a construction and operating licence and discharge permit for a co-generation plant in Skogn in Nord-Trøndelag. The plans are for a plant with an installed capacity of 800 MW, corresponding to electricity production of about 6.4 TWh and heat production of 1.5 TWh per year. The company is currently evaluating the situation with a view to taking up the licence. Another potential development is a gas-fired CHP with 260 MW electrical capacity, located at Statoil's Mongstad refinery. The government will consider new applications for licences for gas-fired power plants in accordance with the relevant legal framework.

All of these projects have the advantage that they are located close to sites with pipeline connections to the NCS, thereby keeping the construction costs lower than they would be if dedicated pipelines had to be built.

COAL

SUPPLY AND DEMAND

Coal and coke account for just 3.3% of TPES in Norway. Indigenous coal production is located only in Spitsbergen, the main island in the dependency of Svalbard, some 960 km north of both the Norwegian and Russian mainlands. Norway has sovereignty over the island, but other countries enjoy the right to pursue certain economic activities, including coal-mining.

The state-owned Norwegian company Store Norske Spitsbergen Kulkompani AS operates two coal mines through its wholly-owned subsidiary Store Norske Spitsbergen Grubekompani AS (SNSG) with 290 employees. Norwegian operation of coal-mining on Spitsbergen, through a state-owned company, serves multiple government goals, not all of them related to energy. Continued economic activity in Spitsbergen is required to support a genuinely sustainable island community in this environmentally hostile location, without which Norwegian sovereignty claims might be weakened.

Mine No. 7 has been in operation since 1975, and Svea Nord has been in operation since 2001. SNSG produced 2.0 million tonnes of coal equivalent[13] steam coal in 2002 and 2.9 Mtce in 2003, of which mine No.7 contributed 48 000 tonnes of coal equivalent (tce). In 2004, production from the two mines was 2.9 Mtce. Mine No.7 is expected to continue to produce 48 000 tce per year until 2010 when it is scheduled to shut down. Operations at Svea Nord are expected to continue for up to 25 years. The company's financial results for 2002 and 2003 indicate that the new mine is genuinely economic in terms of meeting its operating costs, and the company has reported a record profit in 2004 without receiving any state subsidies.

From mine No.7's production, 24 000 tce are used in Spitsbergen at Norway's only coal-fired power station to produce heat and electricity for the population of the island. The bulk of SNSG's coal production is coming from the new Svea Nord mine, and this is exported to international markets, with Denmark, Germany, Portugal and the UK being major customers for Norwegian coal. Coal required for Norwegian use is usually imported from the international coal market, with Poland, Russia, the UK and Germany being major suppliers. Coal is primarily used in the iron and metal industry in Norway, and these industries require a year-round supply of coal, which cannot be guaranteed from Spitsbergen owing to pack ice blocking the sea export route for most of the year.

The coal mine operations were subsidised until 2001, with subsidies supporting investment into opening of the new Svea Nord mine, and covering part of the production cost at mine No. 7. In 2002 and 2003, Store Norske Spitsbergen Kulkompani AS has operated with an after-tax profit of USD 8.1 million and USD 10 million, respectively, and profits increased to USD 107 million in 2004.

13. 1 Mtce = 1.0463 Mt.

UPSTREAM OIL AND GAS

Petroleum is the largest industry in Norway, comprising 21% of GDP and contributing 28% to the State's revenues in 2004, and therefore is a central concern to the government's economic and energy policy-making. The major concern is that the NCS is maturing. The government is actively trying to manage this process of peaking and then declining production with the aim to derive the maximum long-term value from the resources on the NCS, and to distribute wealth from the resources across generations. These are commendable goals, and are an example of best practice for the management of natural wealth in an economy.

The government has drafted two scenarios to inform the public debate by outlining the alternatives, namely the so-called decline scenario and the long-term scenario. The decline scenario takes the exploitation of the proven reserves as given, whereas the long-term scenario includes the exploitation of currently unproven reserves on the NCS, prolonging the production of hydrocarbons for at least another 20 years at the current level. The government should be commended for the transparent way in which it has set out the alternatives in a policy debate that is critical for Norway's future.

The result of the policy debate was that the government now hopes to realise the long-term scenario. This is the correct approach to the management of the petroleum resources in Norwegian waters, and the government should be commended for it. If the long-term scenario is not realised, a large source of economic activity in Norway is at risk. A large number of jobs will disappear and valuable skills may be lost, even though the high demand for skilled oil workers may allow them to work abroad for a time in the future.

The government has accepted that changes in the policy framework for taxation and licensing of oil and gas production are required, and that no single action can solve the challenge posed by the maturing of the NCS. A broad set of actions has been considered and some have already been introduced, *e.g.* within exploration area management, to increase the number and diversify the types of companies active in Norway's oil and gas sector, to achieve cost reductions, efficient regulation and R&D. The government understands that these actions must be designed and implemented so that they are effective both in the short and long term. The multi-pronged approach to the policy challenge is commendable, yet the government should continue to proactively engage with the oil and gas industry in the future to ensure that further actions are developed and taken if required.

The competitiveness of the Norwegian petroleum sector is also a key consideration for the government, and a number of actions have been taken that contributed to increasing it. As a consequence, the offshore industry structure has undergone substantial change in recent years. Gas sales have been liberalised, Statoil and Norsk Hydro have been further privatised, and some licence shares were sold to the private sector by the government. Partial privatisation has helped to transform Statoil from a purely regional company active in the North Sea to an international oil company. It is now in the process of diversifying into international oil operations, and has operatorships in Iran, the Gulf of Mexico, and other locations. To manage the SDFI, the government set up a new company called Petoro. All of these changes are commended, since they increase the commercial freedom and competitive pressures on the NCS, and will increase oil and gas production. Petoro in particular is a landmark example of the management of state ownership with low distortion in a fully competitive exploration industry. Abolishing the Gas Negotiating Committee GFU as from 2002 is commended because it supported the closer integration of Norwegian gas production with the European customer base, and encouraged the entry of major gas companies into Norwegian gas production.

The government actively promotes changes in the petroleum industry to make room for smaller companies that specialise in extending the field life in mature areas. The change to the taxation system to allow refunds on exploration expenditure to companies not earning a profit, and the open encouragement of new entry has been successful in encouraging such companies onto the NCS. This is a commendable development, because it will support the development of specialised production assets in fields coming to the end of their lives, or in marginal assets, that otherwise would not be developed at all. Working closely with the smaller companies and encouraging technological development to increase recovery rates has proven to be successful, and recovery rates on the NCS are extremely high by international standards.

Thus far, the government and Petoro have been reluctant to divest smaller shares in licences to new players on the NCS. Smaller and specialised players expect that they would be able to derive more value from the licences through tail-end production management than Petoro can deliver. The government and Petoro should consider, in the evaluation of stakes they wish to control, whether a sale may lead to increased production from another company.

In response to the maturing of the NCS, Norway has revised the awarding of acreage to open more areas, become more transparent, and with the aim to turn acreage over faster to allow more exploration. This should be encouraged. New areas are being opened in the Barents Sea, while recognising environmental and fisheries interests. The first result is the Snøhvit project, that will not only be important in developing the technology needed to operate in these Arctic areas, but will also be important for CO_2 storage and will result in the first LNG liquefaction facility in Europe. With this success in mind, the government is encouraged to investigate whether other currently closed areas, such as Nordland VI and VII, can be (re)opened, taking environmental issues into consideration.

The success of this government policy can also be measured by the increase in new drilling activity. This policy, together with the higher oil and gas prices, resulted in a tight rig market throughout Europe. This draws attention to the costs of drilling, which might become a bottleneck in future exploration on the NCS. Research indicates that drilling costs on the NCS are substantially higher than on the UK Shelf or in the Gulf of Mexico. A breakdown of costs shows that labour costs in particular are responsible for this difference, and that the cause is not only the higher production costs incurred given the NCS's challenging environment.

The high cost base of the petroleum industry in Norway presents a challenge for the achievement of the long-term scenario. Comparatively higher costs than in the UK sector of the North Sea are driven by a combination of high environmental standards, and significantly higher labour costs. These high costs add to the relatively high taxation levied on petroleum production on the NCS, and together influence decisions about the exploration for and development of marginal resources, such as new discoveries located near existing fields, and increased tail-end production, or investment in enhanced oil recovery. The changes to licensing and taxation will mitigate these influences to some degree, but they are unlikely to be sufficient to completely outweigh them. The government should closely monitor the situation and take all possible steps to ensure that the economics of marginal assets on the NCS are improved, taking into account environmental and safety considerations.

The high standards for environmental and safety performance have contributed to the shortage of rigs for exploration drilling in Norwegian waters, leading to much higher hiring costs for the few available rigs, although it is difficult to see by how much. This has consequences for the number of test wells that can be drilled, and consequently on the number of discoveries. Especially in the case of marginal drilling around existing infrastructure, time can be critical, and a rig shortage can lead to discoveries not being made during a time when their development would be economic. The higher Norwegian standards have thus far prevented the development of a North Sea wide market for exploration rigs, although a longer period of high oil prices may lead to rigs being refurbished to Norwegian standards, or new rigs being built. There are no indications that this is happening so far.

As the upstream gas transport grid is collectively owned by major operators on the NCS, problems relating to investment decisions to enlarge the grid to service also fields of operators who are not part-owners of the grid could develop in the future. Close monitoring by the competent authorities is advisable, and a process to help settle disputes should be implemented.

DOMESTIC GAS MARKET

The use of gas is very limited in Norway, even though it has increased slightly in recent years. Increasing domestic access to gas can make a significant contribution to security of supply in the power sector, as it contributes to the diversification of energy sources. There is significant commercial interest in establishing an industry, but this has to some degree been held back by uncertainties about the investment framework, and the failure to construct the licensed gas-fired power stations, which could become a major driver in creating demand pull for the industry.

Developing downstream gas pipelines is costly, especially in a country such as Norway, with its low population density and difficult topography. The current unclarified regulatory regime with no regulator and no long-term regulatory framework, will hinder the commercial development of onshore gas supply and use. The government should consider clarifying the regulatory regime at the earliest possible opportunity to ensure that the development of the industry can proceed quickly and on a commercial basis. The implementation of the relevant EU directives is commendable, and is a first step towards providing this secure investment framework.

COAL

The government assumes that coal production by SNSG in the years ahead will be run on a purely commercial basis and be independent of any state subsidies. This would be desirable.

RECOMMENDATIONS

The government of Norway should:

- *Promote the innovative and proactive approach to acreage management and the award of exploration and production licences internationally as an example of best practice.*

- *Consider the opening of currently restricted acreage off the Lofoten taking into account environmental concerns to ensure that environmental restrictions on offshore petroleum activities are not unduly hindering further exploration.*

- *Consider making available smaller stakes from the SDFI for new entrants and small specialised operators.*

- *Take all possible steps to control cost increases for operations on the NCS, as they might diminish value creation.*
- *Monitor closely the decision-making on upstream pipeline investments to promote the exploration and production from smaller or more remote fields.*
- *Support the market-driven development of onshore gas use by clarifying the legal and regulatory framework in order to give investors long-term security.*
- *Leave Store Norske Spitsbergen Kulkompani to operate on a commercial basis with no government support.*

RENEWABLE ENERGY

SUPPLY

HYDRO

Existing hydropower capacity is not included in this chapter as it is a conventional and commercial energy source in Norway. Currently, 99% of the electricity produced in Norway is hydropower, as is outlined in Chapter 8 on Electricity. Instead, this chapter will focus on government policy regarding new renewable energy production, including new small-scale hydro developments. Figure 21 shows the contribution of hydro and non-hydro renewables to Norwegian TPES.

NEW RENEWABLES

Renewables other than conventional hydro are referred to as "new renewables", and include solar, wind, wave and biomass. The supply from new renewables is relatively small in Norway, given the availability of cheap clean hydro-generated electricity that in the past could easily cover Norwegian energy requirements, including space heating. In particular, the use of electricity for space heating has delayed the development of biomass resources for heat production, which plays a major role in other countries such as neighbouring Sweden. Solar plays a very minor role in Norwegian energy supply owing to the northerly location of the country. Energy supply from new renewables, excluding waste, reached 494 GWh in 2003, compared to 184 GWh in 1990, and heat production from biomass reached 738 TJ, compared to 73 TJ in 1990.

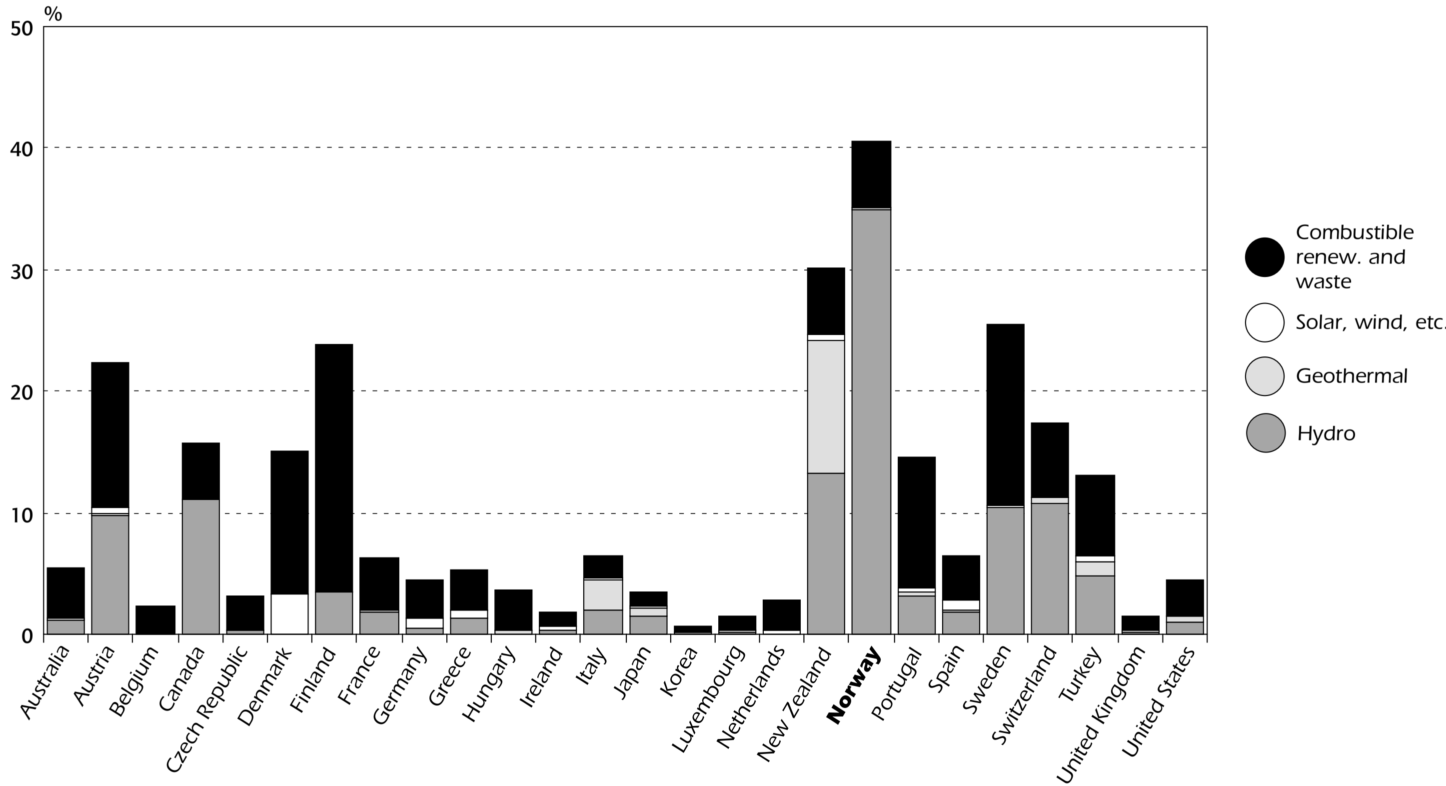
GOVERNMENT POLICY

The government has chosen to support new renewable sources of energy as a means to increase available electricity generating capacity in Norway in a way that is environmentally advantageous and fits well with the existing energy system. The overall target for renewable electricity production in Norway is 90% in 2010.

Currently most government support is given through Enova, in the form of direct capital subsidies to the construction of new renewable capacity (see box "Background of Enova SF" in Chapter 5). A move towards a green certificates system that should operate jointly with Sweden is planned, but has been

Figure 21

Renewable Energy as a Percentage of Total Primary Energy Supply in IEA Countries, 2004*

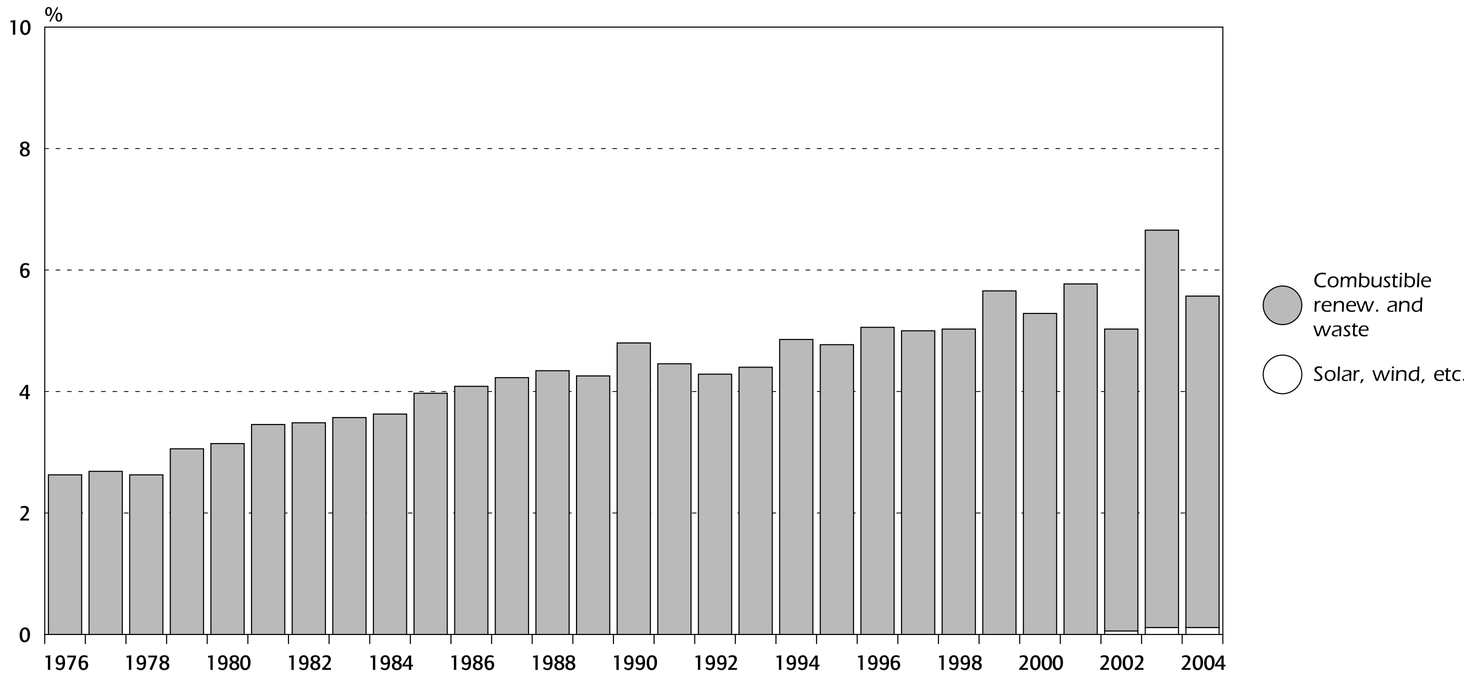


* estimates.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

Figure 22

New Renewable Energy as a Percentage of Total Primary Energy Supply in Norway, 1976 to 2004*



* estimates.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2005.

delayed. Any new renewables capacity that was first connected after 1 January 2004 would benefit from the green certificates retroactively.

To establish clear goals to be achieved by Enova, the government gave this agency explicit targets relating to renewables. These objectives were approved by the Storting in spring 2000 and adjusted upwards in September 2004 according to a revised agreement between Enova and the MPE on the management of the Energy Fund from which support for the renewables targets is derived. Enova has been given the responsibility to reach these targets. Enova has the role of a fund administrator, having to decide on the implementation strategy to achieve these targets, and then on the investments to be made to reach them.

The Enova targets related to renewable energy are as follows:

- To increase annual use of central heating based on new renewable energy sources, heat pumps and waste heat by 4 TWh per year by 2010.
- To increase wind power production capacity up to 3 TWh per year by 2010.

The government is planning to introduce a green certificates market for renewable electricity jointly with Sweden, as described below. It is currently not clear how this will affect Enova's target structure and programmes.

SUPPORT MECHANISMS FOR RENEWABLE ENERGIES

DIRECT SUPPORT

Enova is operating direct support schemes for various technologies, and since 2001 wind power has received a total of NOK 511 million, heat NOK 240 million, and other technologies NOK 36 million.

Wind Energy

The main wind energy programme is currently based on investment subsidy granted to good, cost-effective projects that would not otherwise have been realised. The maximum level of subsidy is currently 25% of the total investment. Projects have to be larger than 1.5 MW capacity, and Enova states that project economics, the likelihood of construction and the presence of a concession are important selection criteria[14].

14. Projects where construction started after 1 January 2004 will be eligible for green certificates if they pay back this support -(see box below on the Norwegian/Swedish Green Certificates Scheme).

Renewable Energy (other than wind)

The purpose of the support is to improve the chances of deployment of renewable energy technologies. Initially, priority has been given to solar space and water heating, and projects that combine solar heating with other energy sources except electricity. The investment subsidy can represent up to 25% of cost, with selection criteria similar to those for wind, except for the minimum capacity requirement. Hydropower projects, including small, micro- and mini-hydropower power plants, are not covered by Enova's grant schemes because they are considered commercial technologies. The total technical potential for hydropower in Norway is 185 TWh per year, and of this 118 TWh per year have been installed. A significant proportion of the remaining potential is permanently protected against development.

Heat Distribution (infrastructure) and Heat Generation

This relates to projects based on renewable energy sources, such as bioenergy and waste. Enova can contribute up to 15% of the total project cost, and all stages of the value chain can be funded, from wood chip production over heat production to distribution of the heat. The selection criteria are more complex than those for wind projects, owing to the higher complexity of heat projects. State support up to 15% of project cost can be given for capacity related to 100% of heat production from biomass and industrial waste, and for wood chip production of at least 60 GWh per year, or 10 GWh per year if the production is from sawmill waste. For heat production from heat pumps, only the net production can be subsidised. For heat production from waste incineration, only the share of waste that is not biologically recyclable can be counted for state support from Enova. The minimum capacity requirement, which is set at 2 GWh heat output per year and a minimum renewable energy production of 3 kWh per Norwegian crown of state support. There is a preference for wood chips over waste incineration, with the requirement for a local authority and energy supplier to be involved in the project.

Further direct support is coming from NVE, through research expenditure of NOK 3 million in 2002. This is focused on increasing the performance and lessening the environmental impact of small hydro plants. Norway also has active R&D efforts in wave generation, where the long Norwegian coastline is providing an excellent resource.

TAXATION

Norway is levying a CO_2 tax and an electricity tax. Renewable projects are not paying CO_2 tax. All power production up to 99 kW capacity is exempt from the electricity tax, while hydropower projects up to 1 MW are exempted from the investment tax of 28%. Biofuels are exempt from both fuel tax and CO_2 tax.

GREEN CERTIFICATES

To encourage the production of renewable electricity, the Storting asked the government in March 2003 to initiate a mandatory market for green certificates, preferably in co-operation with Sweden (Report No. 47 to the Storting, 2003-2004 of August 2004).

Norwegian/Swedish Green Certificates Scheme

The Norwegian/Swedish green certificates scheme will be the first cross-border green certificates scheme in the EU when it comes into operation. It is currently planned by the two governments to introduce a joint green certificates market in 2007.

A green certificates scheme was introduced in Sweden on 1 May 2003. Norwegian authorities have been in close contact with Swedish authorities since summer 2003, with the aim of introducing a common market for green certificates. The introduction of the certificates market has been delayed owing to the need to define a common certificate framework between Sweden and Norway.

Renewables capacity on which construction started after 1 January 2004 will be eligible for green certificates, but since the size of the target has not yet been decided, it is difficult to predict how much this support will be worth. To prevent the investors from holding back the development of further projects, recipients of Enova investment support for new renewable capacity will be allowed to participate in the market if they pay back this support.

Norway and Sweden have deregulated their electricity markets to a large degree and this has created a good framework for a joint certificates market. Both countries have a large share of renewables on their electricity network (Norway almost exclusively so), although the fuel is quite different, with Norway having significant potential for hydro and wind, while Sweden has a good potential for biofuels.

TECHNOLOGIES

Enova has the task of supporting renewable energy technologies, as outlined above. Table 12 gives details of energy production supported by Enova since 2001.

Table 12

Renewable Energy Support by Enova, 2001 to 2004

Support in GWh

Technology	*2001*[a]	*2002*	*2003*	*2004*	*Total*
Wind power	120	80	450	1 023	1 673
Heat	328	289	862	518	1 997
Other	n.a.	1	0	35	36
Total	**448**	**370**	**1 312**	**1 576**	**3 706**

Support in million Norwegian crowns

Technology	*2001*	*2002*	*2003*	*2004*	*Total*
Wind power		35	92	384	511
Heat		39	94	108	240
Other		3	0	33	36
Total	**0**	**77**	**186**	**525**	**787**

Support in million crowns/GWh

Technology	*2001*	*2002*	*2003*	*2004*	*Average*
Wind power		0.44	0.20	0.38	0.34
Heat		0.13	0.11	0.21	0.15
Other		3.00	0	0.94	1.31
Total	**0**	**0.21**	**0.14**	**0.33**	**0.21**

a. 2001 Figures from NVE.

Source: Enova.

WIND

Despite its very good resource base of high wind speeds and a very long coastline, Norway has a relatively small amount of wind generation installed, with only 160 MW generating capacity at the end of 2004, an increase of 59 MW from 101 MW installed in 2003. Wind power will be very compatible with the Norwegian electricity system because production from hydro plants can be adjusted depending on the prediction for production from wind power, but there are concerns about network requirements for new wind power plants. The barriers for wind power described below have made the development of the Norwegian market slow, compared to other markets in Europe.

The main support for wind energy in Norway is coming from Enova. Renewable energy delivers the bulk of the energy results from Enova, 3.7 TWh of the 5.5 TWh that Enova delivered between 2001 and 2004. Norway has a significant wind resource, especially offshore, but there are multiple barriers identified by Enova such as:

- Lack of a secure long-term support framework.
- Local environmental opposition.
- High investment cost requirements and lack of access to capital.
- Long and costly planning processes.
- Lack of experience in large-scale operations by Norwegian wind farm developers.
- Lack of network capacity, especially in northern Norway where wind resources are very good.
- Concerns about the impact on radar installations.

In 2004, a Norwegian wind developer submitted a plan for developing four large offshore wind farms in the More og Romsdal in the north-west of Norway. The combined capacity of the projects would be 1 400 MW. The proposals are now the subject of extensive local consultation, and the earliest the projects could get the go-ahead would be 2006. The total cost of the projects is estimated between NOK 10 to 12 billion.

MICRO HYDRO

As described in Chapter 8, large-scale hydro will be added to considerably over the next few years, under authorisations given by the regulatory body (NVE). In addition, there are plans to increase the number of small hydro stations, with a capacity below 10 MW. Enova is not supporting any form of hydropower developments because these are seen as economically viable without government support. On the other hand, government support for micro hydro is available through tax incentives and R&D funding from NVE (see Chapter 9). Depending on the final rules, new hydro developments up to a currently unspecified level are likely to be eligible for green certificates under the common Norwegian/Swedish market.

After the last World War, the focus of Norwegian energy production moved to large hydro plants, and most of the micro and mini hydropower plants were closed down. The main reasons for this development were operating costs and unreliable and inflexible electricity production from these small plants. During the last decade, there has been an increased interest in hydropower projects with capacity less than 1 000 kW (micro or mini), and in 1992 NVE conducted a study on the annual energy potential from upgrading and refurbishing this category of hydropower plants. The study concluded that approximately 400 GWh of additional production could be harnessed by improving old schemes, and approximately another 300 GWh could be produced additionally in new plants. The number of existing micro and mini hydropower plants was assumed to be 300, with an annual production of about 300 GWh. The NVE defines small hydro plant in three classes shown in Table 13 below:

Table 13

NVE Definitions of Small Hydro Plant in kW

Classification	*Capacity*
Micro	< 100
Mini	100 – 1 000
Small	1 000 – 10 000
Large	>10 000

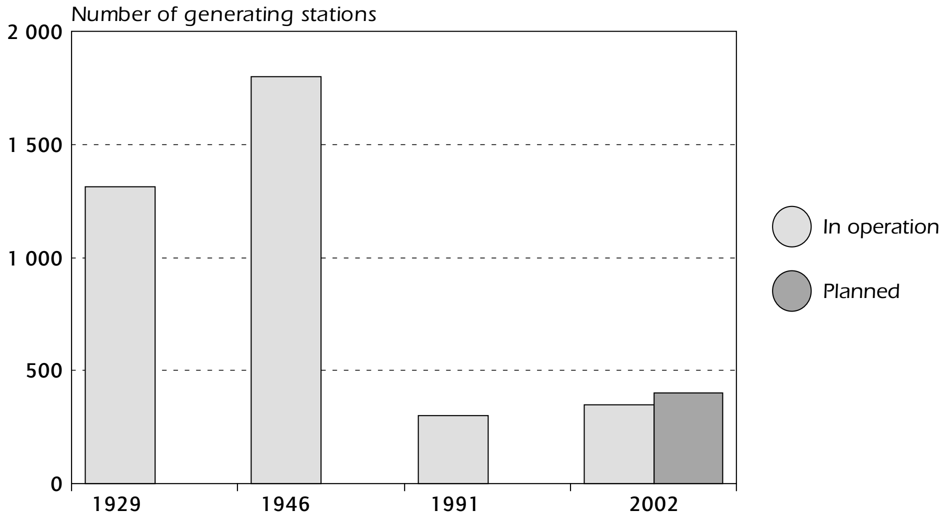
Source: *NVE.*

Norway is positive about developing micro- and mini-hydropower plants because they usually have a smaller environmental impact and are used as a local energy resource. But there can also be conflicts with protected watercourses and planned new larger projects. Therefore, for every initiative which will utilise a given watercourse, it must first be considered if it will need licensing. If that is the case, there must be an application for a licence. For projects not requiring a NVE licence, local authorities must approve the project. From 1996 to 2002, NVE received about 400 applications or requests for licensing, with various degrees of conflict with the environment and other interest groups. These projects, which represent approximately 500 GWh/year are now under different stages of development, but very few have been completed. In 2004 permission was given to 27 projects with a total energy production of 270 GWh/year.

The experience is that potential owners of a new hydropower plant often underestimate the construction cost, or they expect higher electricity prices than is feasible in the market and will consequently have financial problems. In both cases, the economic situation not just of the project but also of the owner is threatened. It is now assumed, however, that micro-hydropower plants' costs are on a level with other renewable energy resources. Micro hydropower plants with a capacity of less than 100 kW also do not pay electricity levies.

Figure 23

Development of Small Hydro Plant (<1MW) in Norway, 1929 to 2002



Source: Norwegian Water Resources and Energy Directorate (NVE).

Where it is economic, small hydropower could be a relatively easy and environment-friendly way of adding capacity to the Norwegian electricity system. To achieve this, licensing arrangements have been simplified, with NVE now allowed to give licences to projects up to 10 MW, and to grant developers (who are mostly land-owners, and not power companies) the needed support in the economic preparation of their projects.

Biomass, waste and Biogas

Biomass and waste have significant resource potential in Norway, but are hindered by a lack of potential on the user side. Given the dispersed nature of Norwegian settlements, achieving the density required for heat networks based on biomass is only possible in a few locations. Enova is supporting biomass heat through its heat programme, and in 2004 supported 518 GWh of heat from waste and biofuels.

Enova identified the following barriers to biomass in 2003:

- Lack of secure access to fuel of the right quality and price, especially for biomass.
- Problems with securing the right location for combustion installations, especially for waste combustion.

- High investment cost and lack of access to capital.
- High cost for heat distribution.
- Long planning process to install heat distribution systems.
- Lack of a secure long-term support framework.

BIOFUELS

Norway has not adopted the EU Directive on Biofuels. However, biofuels are not subjected to fuel tax. In addition, biodiesel mixed with conventional diesel is exempted from fuel tax. The government supports research activities and production investments related to production of biofuels.

RENEWABLE HEAT

The government aims to achieve a 25% decrease in the use of heating oil over the Kyoto commitment period 2008-2012 compared to the reference period 1996-2000. The government has established a strategy for the conversion of oil-based heat production to renewable energy-based heat production. The strategy includes measures to increase NVE's understanding about the heat market. The success of the strategy is dependent on the efforts made by Enova in introducing new renewable energy sources for heat on a broad basis, and on measures introduced in the agricultural and forestry sector in order to increase the production of biofuels for heating. Enova's reports show that there has been some success in increasing renewable heat production, and heat production from waste. However, the overall potential for such measures is low in Norway owing to the low population density, the absence of wet heating systems in many buildings, and the low cost of electric heating.

Norway is also giving preferential tax treatment to waste incineration over landfilling of waste, in order to encourage the development of district heating systems based on incineration (see Chapter 4).

CRITIQUE

The Norwegian domestic production of electricity onshore is based on hydropower, which contributes 99% of electricity generation. The government is encouraging the development of new renewables such as biomass and wind through the Energy Fund administered by Enova, and NVE is supporting small hydro through R&D funding. The approach to give Enova clear and achievable targets for the production of energy from renewables should be commended.

The flexible approach to increase these targets when they were shown to be insufficiently challenging should also be commended.

The goal of 3 TWh delivered wind energy for 2010 still represents a small share of the forecast electricity consumption of Norway by that date; Enova has also set a target regarding renewable heat. Increased use of biomass for heating in Norway will contribute to security of supply in a carbon-neutral way by reducing electricity demand for space heating. This will free valuable electricity generated from hydro for international trade. In combination with the intended increase of other renewables, especially hydro, this will become more significant and Enova's support will therefore contribute significantly to the security of supply in Norway, while preserving the political priority for CO_2 prevention.

Enova's contribution in adding generating capacity and reducing energy consumption can help to ease risks for security of supply that arise from the vulnerability of the hydropower-dominated system at a time of increasing demand and increasing climate risk. Consecutive dry years may reduce available capacity of hydropower by up to 25%, while coinciding sudden increases of consumption are possible; NVE is also observing a long-term decline of hydro generation in Norway. Enova's measures to support new renewables by themselves, however, cannot replace additional measures that are required to increase non-intermittent generating capacity. The future integration of wind into the Nordic grid should also be considered in expansion plans for renewable capacity.

The planned introduction of a green certificates system replacing direct subsidy is a positive development because it is a market-based mechanism, which is consistent with a liberalised electricity market and can lead to a more market-based and cost-efficient allocation of financial resources to the most cost-efficient renewable measures reducing GHG emissions. It is also a pragmatic approach to request renewable energy producers to return the direct subsidies, including interest, which they have received if they intend to participate in the certificates market. This will reduce the risk of over-subsidisation. The government should consider the introduction of support policies helping to overcome non-market barriers to renewable energy sources outlined in Enova's reports.

The efficiency and effectiveness of a green certificates system could be improved through international trading because this will increase the market size of the green certificates and further enhance the efficient introduction of more competitive renewable energy sources throughout the market. In this context, the intention to introduce a joint market with Sweden is to be praised. It will facilitate the introduction of various competitive technologies such as wind and small hydro in Norway, and wind and biomass in Sweden. For the success of joint green certificates markets, careful design of the systems in the two countries and their harmonisation is imperative. Norway should work closely with Sweden so that the integrated market can launch from 2007.

The definition of an obligatory quota for new renewable energy production will be decisive for a smooth functioning of the market: the volume of obligations has to be in line with the licensing practice for renewable power plants, in order to achieve the goal of cost reduction. If administrative barriers outside the green certificates markets block specific technologies, the price for certificates could increase excessively; which could lead to a volatile development of the certificates price, in turn undermining secure investment conditions for renewable projects. The government should aim to minimise as quickly as possible administrative barriers to give investors certainty about the future opportunities for renewables projects in Norway. Furthermore, it should be examined how the current specific targets for wind power production will be addressed under the new obligation scheme. In general, a quota obligation should preferably not have segmented targets for different types of renewables so that it can facilitate the most cost-effective renewable energy sources.

Norway has a good resource base of high wind speeds and a very long coastline. Wind power can be very compatible with the Norwegian energy system because production from hydropower plants can be adjusted depending on the production from wind power. Wind power can also offer suitable supply solutions in particular for remote communities, if combined with other new technologies as demonstrated in the Utsira project (see Chapter 9). However, to date only little wind power capacity has been installed in Norway, and there are barriers in the form of weak networks in areas with a good wind resource, and public resistance to onshore wind farms. In order to increase deployment in the future, internal grid and cross-border connections need reinforcement in order to solve frequent existing and possible future congestions that may increase with increased wind capacity deployment in remote regions. In order not to increase problems in the grid, it may be considered how financial support for new wind installations could be connected to a system encouraging the efficient use of the Nordic transportation grid. This could be achieved by, for example, increasing financial support next to the centres of consumption or in regions where transportation lines are not congested, *i.e.* southern or western Norway, or by factoring network losses into the value of green certificates. The newly introduced access tariff system already gives locational signals via a potentially significant loss factor for plant operators in locations far north, where the wind resource is good. For a grid that is not very strongly meshed, it seems to be an efficient tool contributing to the overall efficient location of new generation and of feeding into the grid of existing generating capacity.

While an increase of hydropower production is technically possible and offers significant potential, it is not likely that this will be achieved in the near future. For political reasons, especially environmental concerns (protection of nature and wildlife), it is likely that less economic and flexible small plants and small capacity additions will be authorized in the future. Additional hydro capacity would also not increase the diversification of supply sources and not lead to a reduction in vulnerability in dry years. NVE should be commended however for the efforts made to increase the economics and lessen the environmental impact of smaller hydro power plants.

Norway has a good biomass resource from agriculture and forests, and the exploitation of this resource for energy production has so far been held back by the availability of cheap hydro-generated electricity. Another barrier is the comparative smaller number of wet central heating systems, owing to the prevalence of electric heating. Norway should be commended for setting a high target for renewable heat development for Enova. The 4 TWh per year target would equate to over 100 000 Norwegian households being heated with biomass in the future, replacing equivalent demand for electricity. While Enova's focus so far has been on district heating networks, it should continue to evaluate the experience other countries have made with support for individual home biomass heating systems. The government may consider adopting a biofuels target in line with the EU goals.

Direct or indirect government support for renewables is an element of a sound energy policy because renewables carry positive externalities that are not yet rewarded by the market. Ultimately, however, the goal of policy cannot be a renewable energy supply that is indefinitely supported by non-market instruments. All government schemes must seek to gradually reduce their support for the preferred technologies with the goal of sustainably making them competitive with other energy sources within a framework that captures the externalities of energy production and use. Promoting renewables is not an objective in itself, but is a means to achieve certain energy policy objectives, such as energy security and environmental protection. Therefore, when considering further support for renewables, its cost-effectiveness should be closely examined and compared with other policy options. For example, if energy demand can be reduced through energy efficiency measures at a lower cost than production of energy through renewable energy means can be achieved, it could be more cost-effective to direct more emphasis and attention to energy efficiency. Enova's approach to value energy benefits from renewables and energy efficiency equally when evaluating project proposals should be commended, because it is in line with this goal. Such a comparison of the support cost can help to minimise the cost that taxpayers and the general public will incur while trying to achieve the nation's energy goals.

RECOMMENDATIONS

The government of Norway should:

- *Work to clarify as quickly as possible the regulatory framework for the green certificates system to be introduced together with Sweden from 2007, in order to provide the market with certainty and ensure timely implementation and smooth phasing-in.*
- *Further investigate the potential for heat production from renewable sources to make carbon-free hydroelectricity available for international trade.*
- *Examine the additional measures for wind generation management and smooth grid intergration with a view to avoid creating problems in the grid owing to the introduction of new wind generation.*
- *Take into account the cost-effectiveness of further support for renewable energy on the integrated power system and compare it with other energy policy options, such as energy efficiency.*

POLICY AND REGULATORY FRAMEWORK

Electricity is the most important energy carrier in stationary use in Norway. The availability of cheap and clean hydroelectricity has enabled the development of energy-intensive industries in Norway, and has kept the cost of energy use in stationary applications far lower than in other countries. Norway's electricity sector is integrated in the Nordic and European networks. Public ownership is predominant in Norway's electricity sector, which is governed by a complex regulatory system.

The Energy Act of 1990 provided the legislative framework for the reorganisation of the power supply sector in Norway, enabling competition within power generation and trading. Through various licensing arrangements, the act also provides for the regulation of the construction and operation of electrical installations; district heating systems; electricity trading; control of monopoly operations; foreign trade in power; metering, settlements and invoicing; the physical market for trade in power; system co-ordination; rationing; electricity supply quality; energy planning; and contingency planning for power supplies. Together with certain other statutes, the Energy Act also implements the EU Electricity Directive (96/92).

Other legislation having an important bearing on the operation and development of the electricity sector in Norway includes the Water Resources Act, the Watercourse Regulation Act, the Industrial Concession Act and the Planning and Building Act.

GOVERNANCE AND REGULATORY ARRANGEMENTS

The legal and strategic policy framework governing the energy sector and water resources management in Norway is determined by the Storting.

The Ministry of Petroleum and Energy (MPE) has overall administrative responsibility for these sectors, and is responsible for ensuring that activities are consistent with the policy intent determined by the Storting. Its key objectives in relation to the electricity sector include ensuring sound management of water and hydropower resources, both in economic and environmental terms. It is responsible for implementing the government's policy agenda in relation to the electricity sector.

The MPE has largely delegated its administrative powers under the Energy Act to the Norwegian Water Resources and Energy Directorate (NVE). The NVE is a subordinate agency of the MPE. Its key objectives include ensuring coherent and environmentally sound management of river systems and to promote efficient electricity trading, cost-effective energy systems and effective energy use. It also plays a central role in emergency response to flooding and dam failure, and heads contingency planning for power supply.

The NVE also operates as an autonomous and independent economic regulator of monopoly network services within the framework of MPE. Its objectives in this context include controlling and regulating monopoly operations, facilitating the electricity market, safeguarding consumer rights, and ensuring efficient operation, utilisation and development of the electricity grid. The NVE is responsible for regulating network access arrangements, setting methodology for network tariffs, and co-ordinating administrative procedures for licensing the construction and operation of generation and network infrastructure. The MPE is the appeals body for NVE decisions pursuant to the Energy Act, while the King in Council (the Cabinet) is the appeals body for MPE decisions under the act.

Norwegian competition legislation provides the legal framework for the section of the power market subject to competition and also applies to the Energy Act. The Competition Act is intended to promote competition in order to secure efficient use of society's resources. Enforcement decisions give particular weight to consumer interests.

Co-operation which inhibits competition and misuse of a dominant market position are prohibited under the act. The act also allows the competition authorities to impose substantial fines if these prohibitions are breached, and to reduce such penalties for companies, which assist the authorities in exposing such violations. The Norwegian Competition Authority serves as the regulator in those sectors of the power market that have been opened to competition.

LEGAL FRAMEWORK FOR HYDROPOWER OWNERSHIP AND INFRASTRUCTURE DEVELOPMENT

Hydroelectric development has proven to be a particularly sensitive matter in Norwegian society owing to the conflicting interests of a secure power supply, environmental protection, and other uses of water streams. Consequently, an extensive legislative framework has developed over time to manage the competing and sometimes conflicting economic, environmental and local interests of various stakeholders. Hydro projects must be consistent with the Master Plan for Watercourses developed by the Ministry of the Environment in close co-operation with the Ministry of Petroleum and Energy, and developers are usually required to obtain approvals and licences under the Industrial Concession Act, the Watercourse Regulation Act and the Water Resources Act.

The NVE is responsible for co-ordinating application procedures for hydroelectric facilities under these acts, with several bodies having authority over the examination and approval decision. These include the MPE, other government ministries (for example the Ministry of the Environment), the King in Council, the Storting, and local authorities within whose jurisdiction the development falls.

The approval process for licensing a major hydroelectric facility is outlined in Figure 24.

Once a project has been approved in the Master Plan for Watercourses, the actual application process starts when the developer sends notification of the project to the NVE. This notification is deposited for public inspection and circulated to local authorities and organisations for comment. The NVE then decides in consultation with the local authorities concerned and other authorities whether an environmental impact assessment (EIA) must be carried out in accordance with the provisions of the Planning and Building Act. Even if notification is not required pursuant to the Planning and Building Act, for example for smaller projects, the impact of the project must be described in detail as part of the licence application.

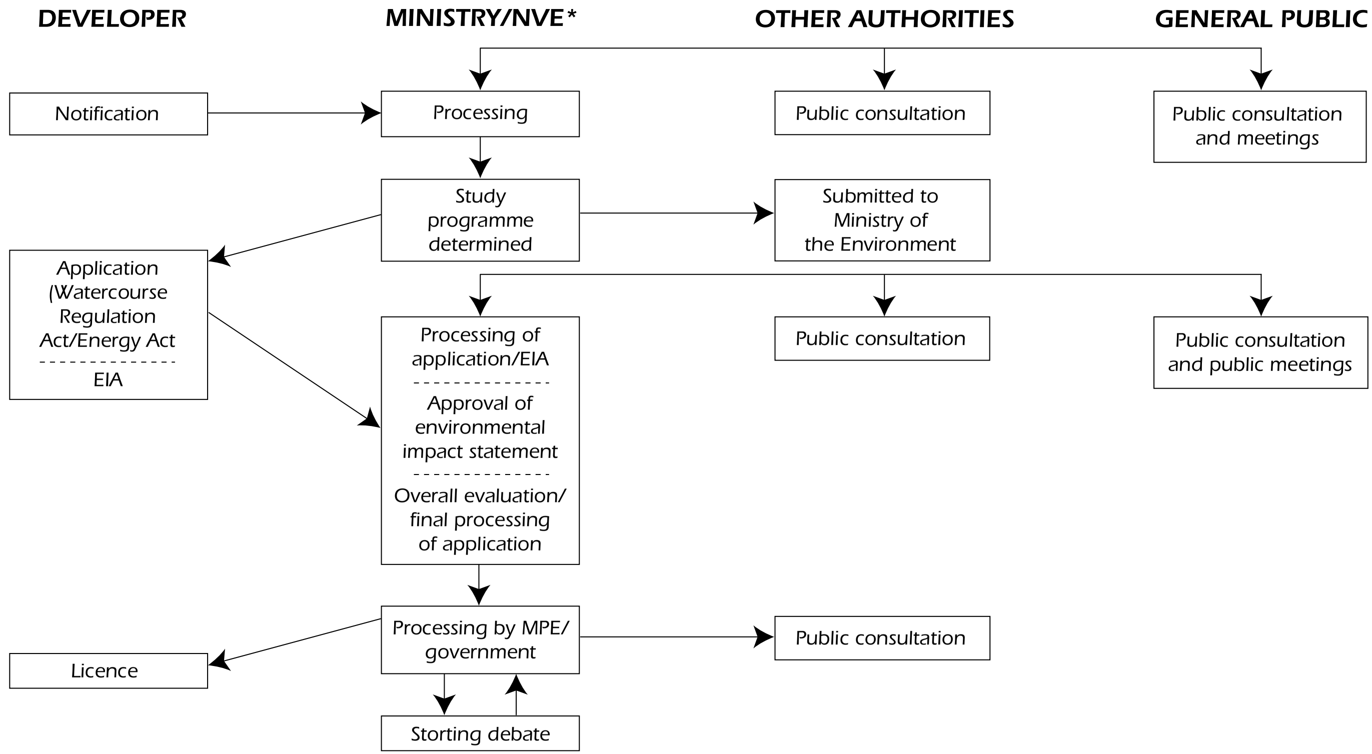
If notification is required pursuant to the Planning and Building Act, the NVE will determine the final content of the EIA study programme after submitting an outline to the Ministry of the Environment. The authorities and organisations which receive the application for comment also receive a copy of the final EIA study programme.

When the EIA study programme has been completed, it is submitted to the NVE together with the licence application. The application and environmental impact statement, if any, are then subject to a process of public consultation with government authorities, organisations and landowners affected by the proposal. The NVE then undertakes an overall evaluation of the project taking into account all comments received and submits its recommendations regarding the project to the MPE.

The ministry assesses the submitted evidence and submits its own recommendation on the project to the government. This recommendation is based on the application, the recommendations of the NVE, the views of the other ministries involved and of local authorities, and the MPE's own evaluation. The government then makes a decision on development and regulation in the form of a royal decree. In the case of a major or controversial watercourse regulation or hydropower development, a proposition is submitted to the Storting so that it has an opportunity to debate the matter before a licence is formally granted by the King in Council. It is likely that all significant projects would automatically be considered controversial and therefore submitted to the Storting for consideration. Some consideration is currently being given to rationalising these arrangements, in particular to

Figure 24

Administrative Procedures for Licensing Large Hydroelectric Projects



* For major projects and projects which satisfy specific criteria, the first stage is always notification and an environmental impact assessment (EIA) pursuant to the Planning and Building Act. Projects which do not require an EIA pursuant to the Planning and Building Act begin with an application pursuant to the Watercourse Regulation Act and an application pursuant to the Energy Act for licences for electrical installations in connection with the power station, including power lines for connection to the existing grid. If the project must be licensed pursuant to the Watercourse Regulation Act, an EIA pursuant to this act is required.

Source: *Facts 2004,* Ministry of Petroleum and Energy.

removing jurisdictional and administrative overlaps with the Planning and Building Act.

Power stations with an installed capacity of less than 5 MW are subject to a rather simpler process, compared to larger projects. In addition, the ministry has delegated the authority to the NVE to license power stations with an installed capacity of less than 5 MW pursuant to the Water Resources Act. This also contributes to faster consideration and is of special importance to projects increasing the capacity of stations already in existence by adding new inflows, since most of these would fall below the threshold capacity.

Projects that do not require an EIA pursuant to the Planning and Building Act begin with an application to the NVE in accordance with the Watercourse Regulation Act and the Energy Act. An impact assessment will need to be submitted with the application. The NVE will undertake a public consultation as part of the process. Documents will be made available and public meetings will be held where necessary. NVE decisions under the Energy Act can only be challenged through recourse to an appeal to the MPE, or legal action.

A number of conditions can be stipulated in generator licences, including a requirement for the installation to contribute to rational energy supplies, specific provisions to be fulfilled on project start-up, construction, conditions relating to technical operation and/or utilisation of capacity at each plant, terms intended to avoid or limit damage to the environment or to monuments, stipulations relating to the organisation and expertise of a company granted a licence, and other conditions that may be required in the individual case.

Hydropower is viewed as a strategic resource by the government, and is consequently subject to government ownership or control. Under the Industrial Concessions Act, the government therefore has a "right of reversion", which allows it to resume ownership of privately-owned hydroelectric assets without compensation once the original 60-year licence expires. Under the act, a hydro facility with more than one-third private ownership is considered a privately-owned asset. The government also has a "pre-emptive right" under the act to resume the ownership of hydro assets during the course of the 60-year licence whenever there is a change of ownership and the resulting aggregate share of private ownership exceeds one-third. Publicly-owned hydro facilities are not subject to the reversion or pre-emptive right clauses and may be granted perpetual licences. The act also entitles local authorities with jurisdiction over waterfalls associated with hydroelectric developments to buy 10% of the power generated at cost. Concerns have been raised about the potential for these clauses to constrain competition and hinder the evolution of an efficient industry structure. The European Free Trade Area Surveillance Authority (ESA) has stated that the reversion provision creates discrimination between private and public investment that is inconsistent with the European Economic Area Agreement, but the government has maintained that the current system is not subject to the EEA Agreement, and sees no role for the EFTA Surveillance Authority in this matter. A Commission for Reversion was appointed to consider the issue in April 2003. Its final report was submitted to the government in November 2004 and was then subject to public consultation, the conclusions of which have not yet been published. The following were the main suggestions made by a majority of commission members:

- The length of the concession period: an extension from 60 to 75 years with reversion at the end of the period was suggested.
- Existing private concessions: private concessions should be transformed to the same regime that is suggested for public concessions, *i.e.* they will be granted a new concession period starting from the implementation date of the new legal regime.
- Distribution of value at reversion: the continuation of the right of host municipalities to retain up to one-third of the installation or its value (at reversion) was suggested.

When applications to construct gas-fired power stations at Kollsnes and Kårstø were processed, the licences included a requirement to plan for CO_2 removal from the flue gases at a later date, but no requirement to capture CO_2 from the start of operations. The first of these plants to be built at Kårstø will include the latest technology for carbon capture and storage (CCS) to comply with the terms of the licence.

PRODUCTION AND WHOLESALE MARKET

GENERATION

Capacity

As at 31 December 2003, Norwegian generating capacity totalled around 28 000 MW, with hydroelectric plants representing over 98% of total installed capacity. The remainder was supplied by a combination of thermal and wind generation. Offshore installations and communities on remote islands are usually served by thermal generators.

Generating capacity has remained relatively stable over the last decade with around 750 MW of new capacity added between 1993 and 2004 as a result of upgrading and expanding existing power plants. Several hydroelectric upgrades and expansions are currently proceeding with the potential to add nearly 550 MW of capacity between 2004 and 2006. Norway's hydro resources are relatively well developed, with the majority of the remaining potential subject to permanent protection. As a result, the potential for new large hydro projects is limited.

Norway had an installed capacity of about 160 MW of wind power as at 1 January 2004. Wind turbines are exempt from the investment tax, and are eligible for investment support for up to 20% of total investment cost. Some 220 GWh were generated by wind turbines during 2003. In addition to the facilities built and put into operation, six new wind power projects have been licensed by the NVE. These could generate about 1.5 TWh per year if they are all constructed. Another six projects with a potential annual output totalling 1.8 TWh are under consideration by the NVE. Wind power is seen as a good match for the hydro resources in Norway, and the Norwegian wind resource is significant (see also Chapter 7).

Three licences have also been issued for the construction of up to 1 500 MW of gas-fired capacity. However, the likelihood of all three projects progressing is remote. The licences were originally issued on the condition that the proposed plant would incorporate the ability to add carbon capture and storage equipment at a later stage. Though technically feasible, such equipment is yet to be developed and demonstrated for large-scale power generation units. The licensing requirement therefore has the potential to add considerable cost and uncertainty for these projects, which are already marginal from an economic perspective at current spark spread levels in Norway. An investment decision in relation to Naturkraft's[15] 400 MW combined-cycle gas turbine project at Kårstø was taken during 2005. This project is expected to be commissioned in 2007.

Norwegian generators produced around 107 TWh during 2003, down by about 23.5 TWh from 2002 and the second-lowest annual output recorded during the previous decade. Precipitation levels are a key determinant of production levels and of the production mix in all power systems is dominated by low-cost hydro plant. 2000 and 2001 were wet years in Norway with high levels of hydroelectric production and substantial electricity exports. By contrast, 2002 was a very dry year with significantly lower hydro production and significant electricity imports. Total production capacity under normal hydrological conditions is estimated to be around 119 TWh, and can reach 130 TWh in a wet year. Normal demand is estimated at approximately 116 TWh, with an annual increase of 1 to 2%. As a consequence, NVE estimates that from 2006, Norway will become an electricity importer in a year with average precipitation.

15. Jointly owned by Norsk Hydro and Statkraft.

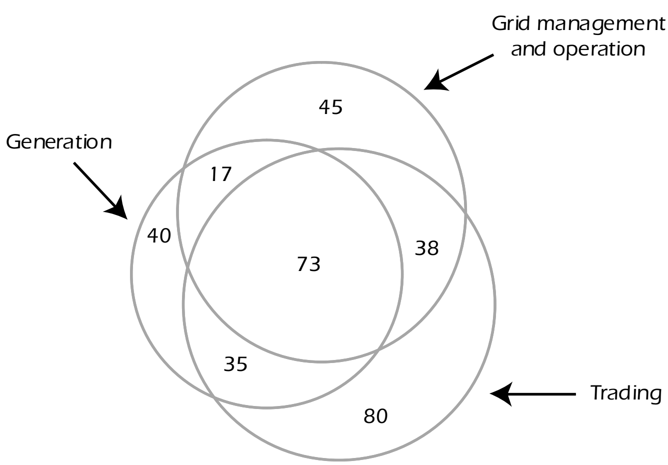
Industry Structure and Competition

The Norwegian power sector has a relatively fragmented industry structure. On 1 January 2005 there were 328 electricity utilities holding a trading licence; 128 of these utilities are vertically integrated, incorporating both competitive activities such as power generation and sales, and regulated activities such as distribution network operation. A total of 165 companies are engaged in electricity generation in Norway. Of these, 40 companies are active only in power generation, while the remaining 125 companies are also involved in grid and/or supply activities. 173 companies are engaged in grid management and operation. Of these 45 companies are merely involved in grid management and operation, while 128 are vertically integrated. In total, there are 226 companies engaged in trading, and 80 of these are not involved in any other activities along the value chain. Figure 25 summarises the different combinations of activities of the energy utilities. The overlapping circles indicate the extent to which the energy utilities are engaged in several types of activities.

Ownership of utilities is also relatively fragmented in Norway. Local authorities and county councils own some 50% of Norway's generating capacity, while the government owns around 37% through Statkraft SF, and private companies own around 13%. Foreign ownership is limited and concentrated in trading activities. Privatisation of electricity industry assets

Figure 25

Norwegian Electricity Utilities Classified by Activity, 2005
(number of companies)



Source: Norwegian Water Resources and Energy Directorate.

has not been part of the reform programme, and in the case of companies also owning power generation, assets would be hindered to some extent if the reversion system of concessions described above stayed unchanged.

Considerable sector rationalisation has occurred since the introduction of the Energy Act in 1991. Many local authorities have sold holdings in power companies, while larger regional power companies have been established through mergers and acquisitions. Industry restructuring between 1998 and 2004 saw a reduction in the number of vertically integrated companies, partly as a result of mergers forming larger vertically integrated companies. The number of companies engaged solely in competitive activities has also been rising and in 2003 exceeded the number of vertically integrated companies for the first time.

Table 14

The Ten Largest Power Generating Companies in Norway at 1 January 2005

Generating company[a]	*Mean annual output*		*Installed capacity*	
	TWh	*Percentage*	*MW*	*Percentage*
Statkraft SF/Statkraft Energi AS	35.8	31.2	8 644	31.3
BKK AS	6.8	5.7	1 541	5.6
E-CO Vannkraft AS	6.8	5.7	1 887	6.8
Norsk Hydro ASA	6.6	5.5	1 339	4.8
Lyse Produksjon AS	5.9	5.0	1 544	5.6
Agder Energi AS	5.6	4.7	1 188	4.3
Skagerak Kraft AS	4.0	3.4	1 056	3.8
Nord-Trøndelag Elektrisitetsverk FKF	3.2	2.7	802	2.9
Trondheim Energiverk Kraft AS	3.2	2.7	746	2.7
Hafslund ASA - Sarpsborg	2.6	2.3	504	1.8

a. Excluding holdings in other companies, except Norsk Hydro, where the numbers include Norsk Hydro Produksjon AS and Norsk Hydro ASA

Source: *Norwegian Water Resources and Energy Directorate.*

Table 14 indicates that the top ten companies controlled a little below 70% of total Norwegian generating installed capacity in January 2005. Their combined annual mean output typically represents about 70% of total domestic production. The largest generator, Statkraft SF, controlled around 31% of total generating capacity in January 2005, with mean annual production typically representing around 31% of total domestic output. Statkraft SF is 100% state-owned. The top three companies controlled 44% of total generating capacity in January 2005, with a combined mean annual output typically representing around 43% of total annual domestic production. Statkraft is the only significant Norwegian producer from a Nordic market perspective, with total capacity accounting for around 9.4% of Nordic generating capacity in December 2003.

Competition in Power Generation in Norway:

A report by the Nordic competition authorities examining generator concentration and its potential implications for competition in Nordic electricity markets ("A Powerful Competition Policy", June 2003) concludes that although the Nordic market as a whole is only moderately concentrated, the individual geographic regions within the market can be very concentrated, increasing the potential for participants to exercise undue market power. The report indicates that the Norwegian wholesale market is the least concentrated of the Nordic markets, with a standard Herfindahl-Hirschman Index (HHI) score of 1 634.

However, if this score is adjusted to reflect the effect of cross-ownership and the related capacity of owners to co-ordinate the behaviour of jointly-owned facilities, the report suggests that effective concentration may increase dramatically, reaching levels consistent with the presence of market power. It also notes that the effects of any anticompetitive business practices in one regional market are likely to reduce efficiency and increase costs across the entire Nordic market.

The HHI is defined as the sum of the squares of the market shares of all firms in the relevant market. An index number of zero implies a completely atomised market; while an index number of 10 000 implies a perfect monopoly. Results above 1 800 to 2 000 imply relatively high levels of concentration. The adjusted HHI index score for Norway was 3 325.

Increasing integration of the Nordic electricity market through increased physical interconnection is likely to reduce the potential for exercise of market power in Norway, and throughout the Nordic market. However, it may not be sufficient to eliminate this risk. Other obstacles to competition remain in addition to high levels of concentration, and these include the relative inelasticity of demand, and in Norway's case, the challenges of developing new generation projects and the relatively limited pool of potential owners of generation assets within Norway.

The aforementioned report by the Nordic competition authorities recommends that Nordic governments pursue more co-ordinated competition supervision, including more integrated evaluation of merger activity and strengthening information exchange between Nord Pool, Nordic energy agencies, financial authorities and competition authorities. Other key recommendations are summarised below. The recently concluded Nordic agreement on information exchange between competition agencies represents a positive step in this direction.

The report proposed several actions to strengthen competition within the Nordic electricity market, including:

- Careful review of mergers that increase market concentration, taking account of broader Nordic market implications.
- Consideration of the potential for creating more competitive company and ownership structures.
- Improving effective capacity utilisation of transmission networks.
- Ensuring that evaluation of transmission network investment proposals takes appropriate consideration of the benefits for competition.

WHOLESALE POWER EXCHANGE AND TRADE

Wholesale Power Exchange

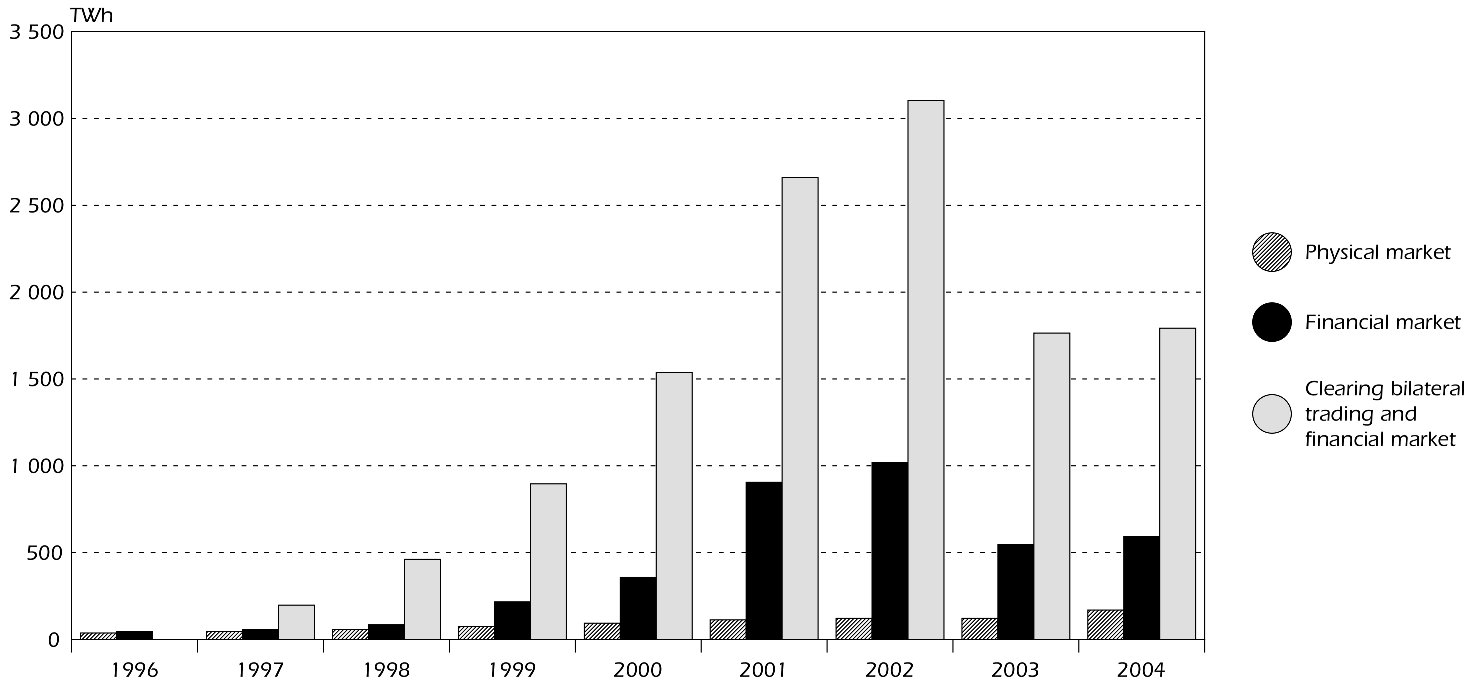
Norway is part of the Nordic power market (Nord Pool) along with Sweden, Finland and Denmark. Nord Pool has over 350 participants in one or more of its markets, including power producers, retailers, grid owners, brokers, traders and industrial companies. Nord Pool provides several market services, including a spot market for physical contracts (Elspot); financial markets; and a clearing service for contracts traded in over-the-counter and bilateral markets. Figure 26 provides a brief description of the various Nord Pool markets.

Nord Pool's turnover has risen considerably since it commenced in 1993; however, it experienced its first-ever decline in both the volume traded in the financial market and in clearing of over-the-counter contracts in 2003. The volume traded in the physical spot market fell by around 5% between 2002 and 2003 but rose again substantially in 2004 to 167 TWh, representing a 40% increase over 2003. 2004 began with a low trading volume, but the trend reversed in the fourth quarter to give an overall improvement compared to 2003. Trade on financial markets nearly halved between 2002 and 2003, with relatively low trading volumes continuing until the last quarter of 2004.

Lower volumes of financial trading during this period can at least be partially explained by the relatively low water levels experienced between mid-2002 and mid-2004, which had the effect of lowering market liquidity and trading volumes. However, financial markets appear to be recovering as water levels approach more normal levels. Turnover to date in 2005 for financial markets and clearing services are 2.7 times and 1.7 times higher, respectively, compared to 2004. Maintenance of these trends would imply annual levels of activity in 2005 consistent with the levels achieved in 2002.

Figure 26

Nord Pool Market Development, 1996 to 2004



Source: Nord Pool Annual Report 2004 (p. 7).

Overview of 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 next 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. Regional prices are established when congestions in the Nordic transmission system occur.

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 contracts, forward contracts and contracts for difference. Participants can hedge purchases and sales for up to four 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 daily, on the basis of 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. Contracts for difference provide opportunities for adjusting and hedging portfolios in terms of differentials between the system price and the various area prices in Elspot.

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.

Trade

Norway is well integrated into the regional electricity trade system in Northern Europe, and in particular, the flexibility provided by Norwegian hydro capacity is playing an important role in enabling the Nordic Market. Water inflows are consequently the key determinant of Norwegian, and Nordic, electricity trade patterns. During wet years with strong water inflows, Norway is a net exporter of electricity, reflecting the relatively low marginal cost of hydro generation, while during dry years Norway becomes a net importer. Norway's electricity trade is shown in Figure 27.

However, Norway has been moving towards becoming a net importer of electricity since the late 1990s, first during dry years. This reflects the growing domestic demand and the limited development of new generating capacity. During 2003, net imports to Norway represented 6.9% of consumption (around 7.9 TWh). Nordel forecasts suggest that this trend will continue, with an estimated import requirement of around 5 TWh per year in 2006, given normal precipitation conditions. Recent trends emphasise the growing importance of regional trade to Norway to ensure continued access to reliable and competitively priced electricity.

Wholesale Prices

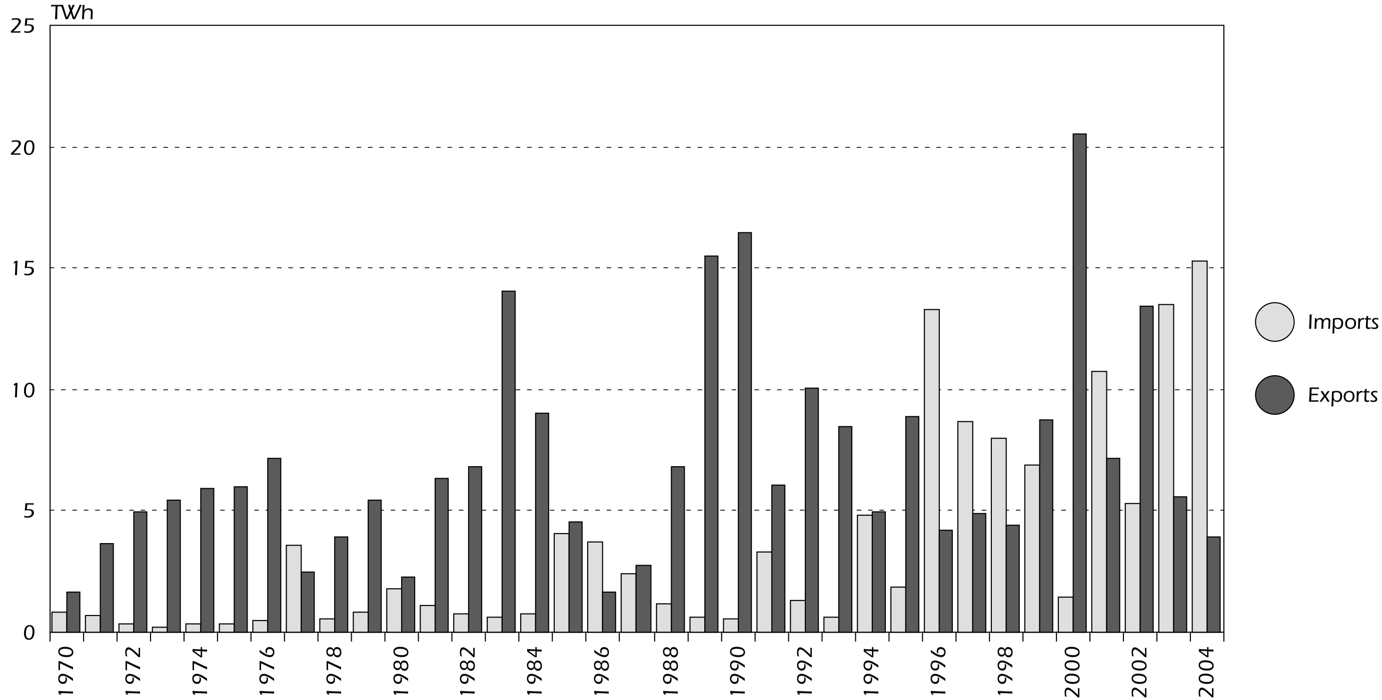
In Norway, and other Nordic countries, electricity prices are highly dependent on variations in hydroelectric generation. Hydroelectricity represents the lowest-cost form of large-scale generation and accounts for around 50% of total installed capacity in the Nordic region. Prices in a given year are largely influenced by hydroelectric production levels, but the prices of fossil fuels are also important.

Annual average Nord Pool spot prices rose significantly between 2001 and 2003, with the peak average monthly price of 54.4 ore per kWh recorded in December 2002. 2003 saw the highest average spot prices recorded to date on the Nord Pool market, with an annual average price of around 29 ore/kWh. Prices during this period reflected dry conditions resulting in relatively less hydro generation in Norway and Sweden from late 2002 and throughout 2003.

Prices fell from these peak levels in 2004, reflecting improving water reservoir levels. Annual average spot prices were around 24 öre per kWh in 2004, which was nearly 20% below the average annual spot price recorded in 2003. However, 2004 spot prices were still well above the average spot prices recorded in the late 1990s. It is possible that the higher average spot prices may also reflect an overall tightening of the supply-demand balance in the Nordic region. These higher average spot prices are beginning to be reflected in financial contract prices, with forward contracts currently trading for between 24 öre per kWh and 28 öre per kWh for the period from June 2005 to December 2008. Movements in the average monthly system prices on the Nord Pool spot market and some indicative forward contract prices are presented in Figure 28.

Figure 27

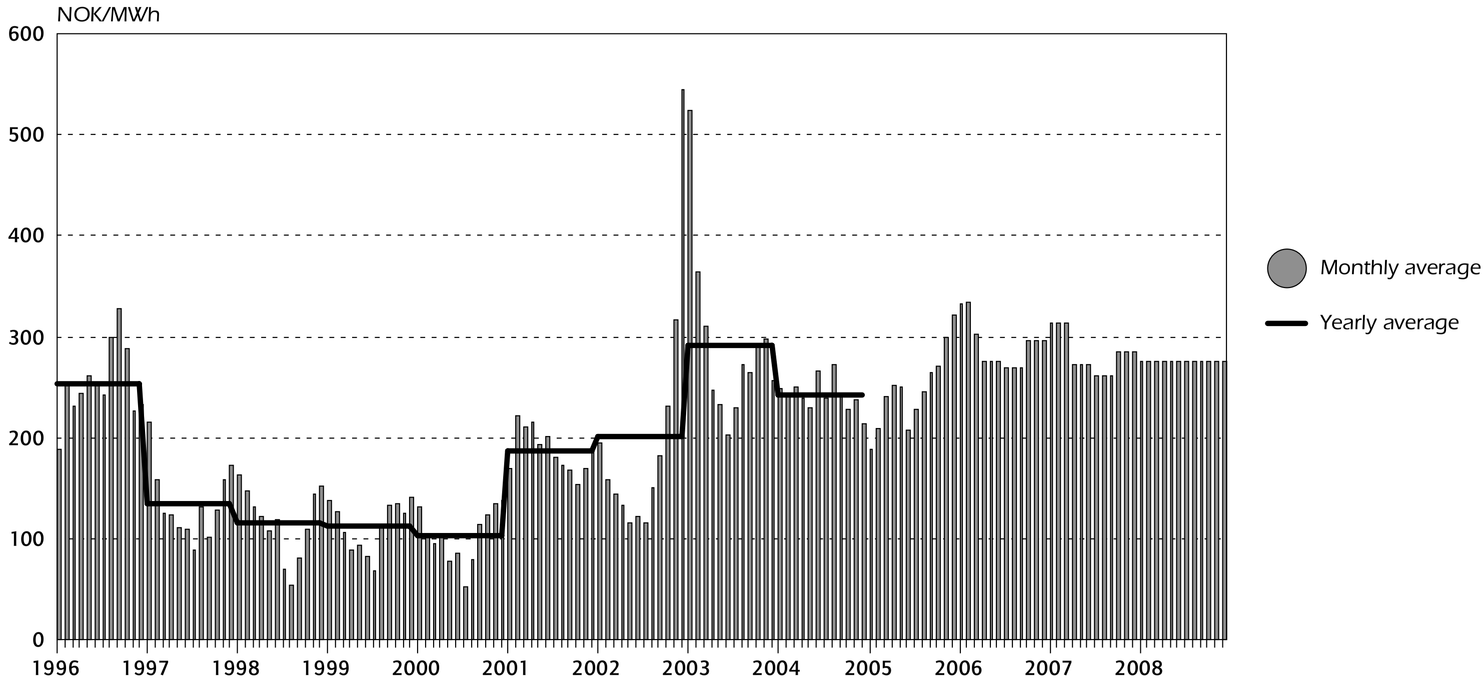
Norwegian Electricity Trade, 1970 to 2004



Source: Ministry of Petroleum and Energy.

Figure 28

Nord Pool Annual and Monthly Average System Prices and Forward Contract Prices, 1996 to 2008



Source: Nord Pool.

NETWORKS

INFRASTRUCTURE

Transmission

Norwegian networks consist of a national and regional transmission system and local distribution networks extending for around 300 000 km. The national and regional transmission system includes 7 700 km of 220 kV to 400 kV lines and around 10 500 km of 110 kV to 150 kV lines. 87% of the central transmission grid is owned by Statnett, which is wholly owned by the government and regulated by the NVE. Figure 29 identifies the main Norwegian transmission lines and interconnectors.

Interconnectors

Several interconnectors facilitate direct power exchange to Denmark and Sweden, and also minor power exchange to Finland and Russia. These countries are also connected to Germany, Poland and Russia, facilitating wider regional trading. The capacity of these interconnectors is provided in Figure 30. An agreement has been reached between Statnett and the Dutch transmission system operator (TSO) TenneT on the construction of a 700 MW interconnector between Norway and the Netherlands, to become operational by 2007/2008.

Distribution Networks

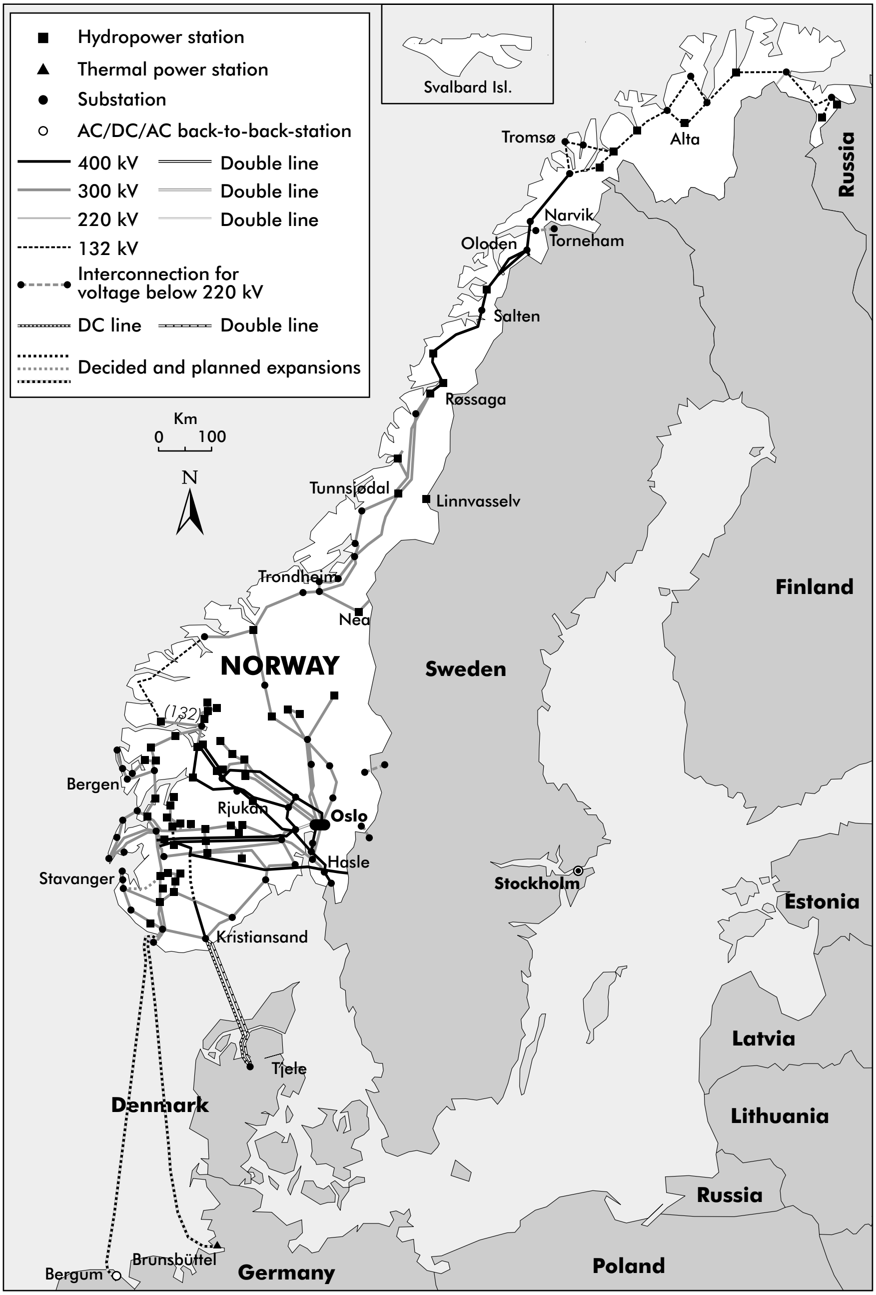
Local distribution is provided through 173 network service providers. Of these, 45 are pure grid companies while the remainder are part of vertically integrated electricity companies. Of the local network operators, 108 are organised as limited liability companies, 16 as co-operatives and 19 are directly controlled by local authorities or county councils. There has been some rationalisation of distribution companies since liberalisation, reflecting a regulatory drive to maximise the cost-effectiveness of network operations. Incentives are given to distribution companies who merge by allowing them to keep all the financial benefits from the merger until the next price control.

SYSTEM OPERATION

Statnett is the Norwegian TSO. Its responsibilities include co-ordinating and balancing generation and consumption and undertaking transmission planning and development. It also plays a central role in the operation and development of international transmission interconnectors. Clarification of Statnett's responsibilities in relation to maintaining reliable electricity supplies

Figure 29

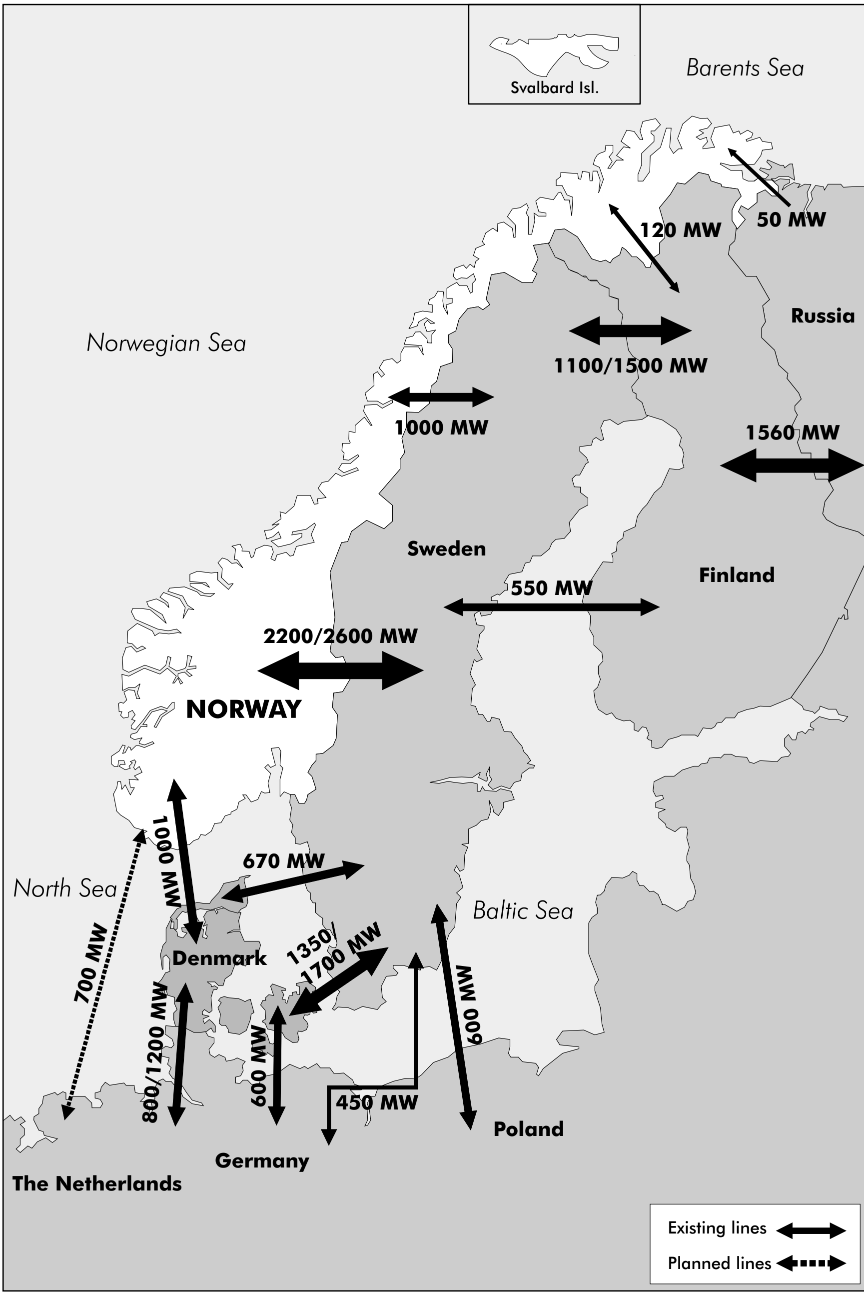
Norwegian Transmission Network



Source: Nordel.

Figure 30

Norwegian Interconnector Capacity



Source: Nordel Annual Report.

was provided in Report No. 18 (2003-2004) to the Storting on security of supply for electricity, following the security of supply concerns in 2003. Statnett is responsible for developing instruments to maintain system balance in real time when the supply-demand balance is tight, and to evaluate the performance of the instruments used for system balancing, and to propose new instruments if required.

Statnett uses the balancing (or regulatory) market to manage frequency and capacity balance between generation and consumption in Norway. The physical balancing market opens after prices and quantities have been determined in the electricity spot market. Statnett receives offers from major generators or consumers who are willing to alter their power output and/or consumption plans at short notice. In this way, Statnett ensures that it can adjust the amount of power in the grid either up or down right until the hour of contracted delivery.

Statnett also concludes contracts for power reserves with generators and major consumers for balancing options. This market reinforces the physical market by providing additional liquidity and depth. These option contracts help to make sufficient reserves available in the balancing market so that the balance between generation and consumption can be maintained even when the market comes under pressure. The power reserve contracts specify how much capacity each party will make available to the balancing market, the period of time involved, and the price for keeping this capacity in reserve. The smallest volume which can be offered is 25 MW within the specified grid area and time period. The contracts do not specify the price each bidder will receive for the specific volume of energy actually used. This is determined in accordance with the ordinary rules of the balancing market, and bidders are free to determine their own bid price in this market. When Statnett has determined which offers in the capacity options market to accept, all bidders having made the same type of bid within the same grid area and for the same period receive the same price per MW, and this price is equal to the highest price accepted for this type of bid. Statnett is also developing a capacity reserve programme in addition to its technical reserve procured through the balancing options market. This programme is discussed in the Security of Supply section below.

Domestic and interconnector bottlenecks in the transmission system are managed through a combination of regional price setting and counter-trading. Up to three separate regional price areas may form within Norway depending on transmission congestion. When a price area is formed, the system marginal price is determined by Nord Pool on the basis of regional supply and demand. The ensuing spot price difference represents the congestion rent. Small adjustments to address intra-regional congestion are handled through counter-trading, which involves Statnett paying generators to increase or reduce output in order to balance the regional market. Costs associated with counter-trading are borne by Statnett, and provide a financial signal for it to pursue investments to alleviate intra-regional congestion.

Effective co-ordination of system operation across the Nordic region is essential to maintain efficient and reliable market outcomes, given the highly integrated nature of the Nordic electricity market. Considerable co-operation has already been achieved through Nordel, the association of the five Nordic system operators, and as a result of the 1999 Nordic System Operating Agreement. Nordel is continuing work to facilitate Nordic system-wide planning and development, and to develop guidelines and protocols for seamless system operation within the Nordic region. Key initiatives include: implementation of a common Nordic regulating power market and sharing of reserves; annual publication of energy and power balance forecasts for the Nordic region; co-ordinated planning and assessment of projects to develop the transmission "backbone" to promote a more integrated Nordic market (the five reinforcements discussed below represent a recent example of this activity); assessing the potential for a Nordic Grid Code to further harmonise system operation and network planning arrangements; and progressing the development of common mechanisms for consistent management of network congestion.

At its September 2004 meeting, the Nordic Council of Ministers asked Nordel to investigate further opportunities to strengthen co-ordination to help create a "borderless electricity market", with particular emphasis on strengthening co-ordination of system operation, joint planning and financing of grid investment and strengthening joint handling of peak load situations. Nordel delivered a report to the Nordic Ministers in February 2005 presenting proposals to address these issues. The main recommendations focused on the following areas:

- Harmonisation of rules governing TSOs across the countries participating in the Nordic market.

- Clarification of respective TSO and government responsibilities in relation to security of supply.

- Establishment of clear division between TSO responsibilities for security of supply and other responsibilities.

- Avoiding government involvement in delivering peak demand security of supply.

Structure

The Energy Act also provides the legal basis for regulation of grid management and operation. Its main objectives in relation to regulating network services are to safeguard consumer rights, and to ensure the efficient development of the grid. The regulations require the grid owner to make transmission and distribution services available to all market participants with the same access 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.

NVE is responsible for regulating the activities of transmission and distribution network operators. Its main activities in this context are to establish the overall framework for network pricing, and to determine company-specific income caps to ensure efficient development of the grid and reasonable charges for customers.

Income Caps

Network companies have been regulated through income caps since 1997. NVE determines an income cap for each grid company, based on a range of factors that influence costs in the area served by the company, such as the local climate, the topography, and settlement patterns. This system is intended to ensure that grid companies do not make unreasonable profits from providing monopoly services, and that cost reductions in operation also benefit customers.

Income caps are set for a minimum of five years, based on historic information. For the period 2002-2006, income caps are based on the grid companies' costs for the period 1996-1999. Income caps are reduced each year on the basis of a general efficiency requirement of 1.5% and an individual efficiency requirement between 0% and 5.2%. The individual efficiency requirements are determined by comparing analyses of the network companies' costs and relative efficiency. Efficient network companies only have to meet the general efficiency requirement, while less efficient companies must also meet additional individual requirements. The weighted total average efficiency requirement for the current period is 2.1% every year.

The efficiency requirement does not make it obligatory for the companies to become more efficient, but their rate of return rises if they can reduce their costs. On average, for the income regulation period, the network companies are guaranteed a minimum rate of return of 2% and a maximum rate of return of 20%.

To take account of new investments in the distribution network, the income caps are adjusted annually using a parameter based on the average increase in the quantity of energy delivered for the country as a whole, combined with a factor related to the amount of newly connected customers in the area covered by each distribution grid company. Investments in the regional and central grids are considered on an individual basis in connection with NVE's licensing procedures. Income caps are corrected annually for the general rise in prices and changes in interest rates.

The income cap system creates an incentive for reliable delivery of transmission and distribution services through a mechanism which provides for a reduction in revenues when interruptions occur. A new regulation on the quality of the network is planned to be implemented in 2005.

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. This system aims to create an incentive for the merging of network companies to increase the overall efficiency of the system.

The regulatory methodology for the 2007 to 2011 period is currently being prepared. The new methodology will seek to address perceived weaknesses in the current methodology, particularly in relation to the efficiency and investment incentives. Key features of the new methodology may include:

- An annual updating of revenue caps to reflect new investment costs and improve allocation of efficiency improvements to consumers.
- Refinement of provisions to promote quality of service.
- Strengthening efficiency incentives through application of yardstick competition.
- Implementation of incentives for alternative (new renewable and distributed) energy.

The sum of the income caps for all grid companies in 2004 is approximately NOK 15 billion. Of the total revenues in grid management and operation, 15% accrue to the central grid, 22% to the regional grid and 63% to the distribution grid.

Network Pricing

All grid companies are required to charge at the point of connection, and charges should be independent of power contracts. All customers who are connected to the grid pay a charge – point tariff – for the electricity they feed into or tap from the grid. The main purpose of the charges is to encourage efficient utilisation and development of the grid. Network pricing principles imply that 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 as well as a proportion of the costs of the regional grid and the central grid. Charges for the distribution grid are higher than for the regional and central grids, reflecting the higher cost of operating these networks. Charges have a variable component and one or two fixed components unrelated to consumption. There is also a capacity charge if there are bottlenecks in the transmission system.

The energy charge is variable, reflecting the amount of energy that is fed into or drawn from the network. It is intended to reflect the value of the marginal losses in the transmission and distribution network. Losses on the central grid can vary between plus and minus 10%. In the central and regional grids, the energy charge is based on the percentage marginal loss in each node and on the spot price. Percentage marginal losses are calculated for the central grid at each node every eight weeks. For feeding into the grid, the energy charge is always based on the percentage marginal loss for that specific node, regardless of central, regional and local grids.

A capacity charge based on the difference between the regional system marginal spot price and the Nordic system marginal spot price is levied when transmission congestion leads to the formation of separate price zones within Norway.

The fixed components do not vary with the amount of electricity that is tapped from the grid. All network companies normally charge the same fixed components in the input tariff as the central grid. The charge for feeding into the grid in 2005 is NOK 0.05 per kWh for average production capacity, or NOK 50 per MWh.

Small consumers connected to the low-voltage distribution network normally pay a fixed charge, while larger consumers connected to the higher-voltage networks pay one or more charges. Network charges for electricity consumption vary considerably from location to location, reflecting natural conditions and the relative efficiency of network service providers. The average charge for a household customer consuming 20 000 kWh in 2005 was NOK 0.42 per kWh, including VAT, resulting in an annual charge of NOK 8 400 to cover network costs. The lowest charge was NOK 0.28 per kWh and the highest charge was NOK 0.53 per kWh.

A grant scheme was introduced in 2000 to help in levelling distribution tariffs between end-users in different parts of the country. In particular, it aims to reduce distribution tariffs for end-users connected to distribution grids in those parts of the country with the highest distribution costs, which are usually the ones with the most widely dispersed population. The subsidy is paid directly to distribution companies, which are then required to pass on the benefit through reduced network tariffs

From January 2002, Nordel TSOs introduced harmonised transmission tariffs and implemented a transit agreement to provide compensation for losses associated with inter-Nordic electricity flows. Nordel is working to further develop the transit agreement mechanism to address the full cost of transit flows, including capital costs. At present, Statnett retains any settlement residue surpluses that may accrue when separate Nordic price regions emerge owing to physical congestion on interconnections between Norway and other Nordic countries. Some of these revenues may provide some compensation for other costs associated with cross-border electricity flows that are not explicitly recovered. Nordic TSOs have also agreed to use these revenues to help pay for five key transmission upgrades to be undertaken by 2010 (see below).

NETWORK DEVELOPMENT

Statnett SF is responsible for the planning and development of the national transmission network. In 2003, Statnett invested around NOK 670 million. Most network investment over the past decade has been devoted to maintaining existing capacity.

With growing demand for network services and diminishing spare capacity, the focus is likely to shift to new investment. According to its 2003 Annual Report, Statnett has identified around NOK 10.5 billion of capital investment in domestic network facilities that will need to be undertaken over the next ten years. This total includes around NOK 7.0 billion in new network facilities and around NOK 3.5 billion to maintain the existing network. The most pressing development challenges for Norway's networks relate to the need for a strengthening of the interconnection between the countries in the Nordic region.

During recent years, congestion on interconnectors has led to price separation in the Nordic region for at least half of the time. Price separation occurs when the interconnector capacities are insufficient to transfer electricity from a lower-priced market to a higher-priced market. In such instances, the export and the import markets split, with different prices established for each one. According to Statnett, bottlenecks led to price separation in southern Norway and Denmark 53% of the time between mid-1999 and January 2004. Similarly, interconnector bottlenecks resulted in price separation around a third of the time between southern Norway and Sweden over the same period. Interconnector bottlenecks can significantly increase electricity costs and reduce market efficiency. Statnett has estimated the cost of price separation resulting from interconnector bottlenecks within the Nordic market at around EUR 300 million between 1999 and 2003.

Efficient interconnection between Norway, the other Nordic countries and continental Europe is vital for achieving the government's efficiency and reliability objectives. Nordel has identified five transmission reinforcement projects that have the potential to substantially alleviate undue congestion on the transmission backbone of the Nordic market. Two of these projects relate to upgrading transmission links with Norway (Norway-Sweden and Norway-Denmark). In February 2005, the Nordic TSOs committed themselves to undertake these projects at a total cost of around EUR 1.0 billion. The package of reinforcements is expected to be commissioned by around 2010. The next Nordel network planning process is scheduled for 2007.

An agreement has recently been reached between Statnett and TenneT (the TSO in the Netherlands) to construct a sub-sea high-voltage direct current (HVDC) interconnector linking Norway and the Netherlands at an estimated cost of EUR 500 million. The NorNed cable will have a capacity of 700 MW and is expected to be commissioned in 2007/08. This interconnector has the potential to enhance market efficiency and reliability as a result of strengthening the potential for efficient international trade. Interconnection may also open the potential for market coupling between Nord Pool and the Amsterdam Power Exchange.

CONSUMPTION AND RETAIL MARKET

DEMAND STRUCTURE

In 2003, net domestic electricity consumption totalled 102.9 TWh, although this was an unusually low figure owing to the precipitation shortages. Nordel figures indicate that industrial consumption accounted for around 43.6 TWh (42.4% of net consumption in 2003), while households accounted for 35.2 TWh (34.2%) and trade and services for 22.4 TWh (21.7%) over the same period. Norwegian electricity consumption per capita is around 25 193 kWh, which is significantly higher than other countries within the Nordic market and well above the IEA Europe average of 5 275 kWh. This reflects the electricity-intensive nature of the Norwegian industry, the low cost of electricity and the unusual dominance of electricity for space and water heating.

Norwegian demand is winter-peaking, reflecting the cold climate and high proportion of electrically heated residences. Peak consumption rose steadily through the early to mid-1990s, then plateaued until 2001/02 when it rose significantly to record levels since liberalisation of around 23 000 MWh. Higher wholesale electricity prices resulting from very low reservoir levels since 2002/03 have been reflected in falling consumption levels. Peak consumption in 2002/03 and in 2003/04 was around 20 000 MWh, representing a 13% reduction compared to the peak consumption levels in 2001/-02, driven by the high prices during the year.

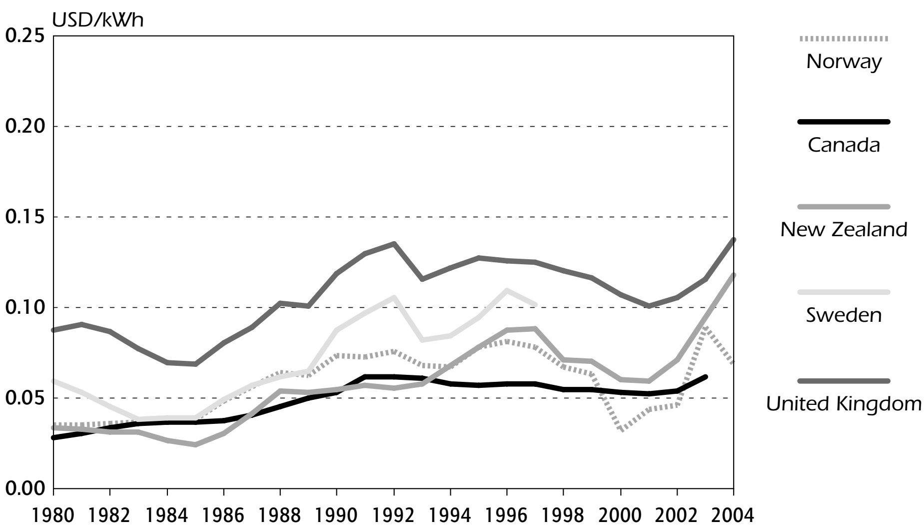
Total net consumption increased steadily in Norway during the 1990s, growing by around 23% between 1990 and 2001, implying an average compound growth rate of around 1.93% per year. This reflects both population and economic growth during the period. Consumption in 2003 was 6.4% below the 2001 peak, reflecting higher prices over that period. Consumption growth to 2010 is likely to remain more moderate than that experienced in the 1990s, with Nordel forecasting growth in peak consumption of around 8% between 2000 and 2010.

RETAIL PRICES

Final electricity prices for end-users include the wholesale price of electricity, network charges and taxes. At present, the wholesale price, network charges and taxes each account for around one-third of the final price for households. Figure 31 compares Norwegian retail prices for households with those of selected other countries for 1980 to 2004, while Figure 32 compares the 2004 prices for the industrial sector. Figures 31 and 32 suggest that household prices are considerably higher than industrial prices, largely reflecting the additional cost of distribution charges.

Figure 31

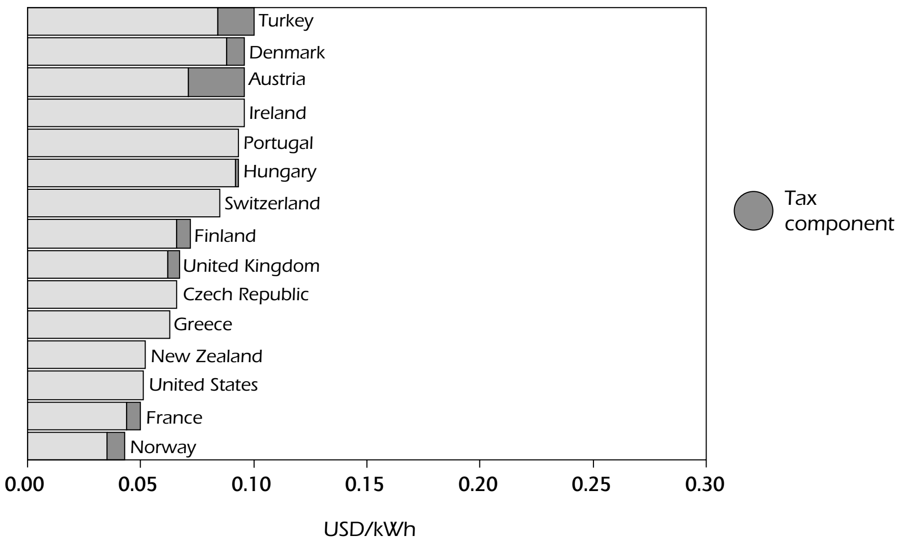
Domestic Electricity Prices in Norway and in Other Selected IEA Countries, 1980 to 2004



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

Figure 32

Industrial Electricity Prices in IEA Countries, 2004



Note: Price excluding tax for the United States. Data not available for Australia, Belgium, Canada, Germany, Italy, Japan, Korea, Luxembourg, the Netherlands, Spain and Sweden.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2005.

Norwegian electricity prices are among the lowest in the IEA. The average retail price for households on a standard variable priced contract was between 70 öre per kWh and 75 öre per kWh in April 2005. Rising prices in wholesale markets during 2002/03 affected retail prices for households, the majority of which were supplied through variable priced contracts. Prices for larger industrial customers also increased sharply, although long-term bilateral contacts helped to moderate the immediate impact for these users.

RETAIL MARKET DEVELOPMENTS

Customer Choice

The Norwegian electricity market is fully open for all producers and consumers. All end-users are free to choose their electricity supplier. Large customers, defined as customers using more than 100 MWh per year, must have a meter capable of measuring electricity consumption in hourly intervals, so that a precise settlement can be made. Smaller customers receive invoices based on a predetermined load profile, and they can change supplier without the need to meter consumption by the hour.

Household customers can choose between different kinds of contracts for electricity. The most common one is based on a variable price, which means that the supplier can change the price after having informed the customer directly. In the second quarter of 2004, nearly 65% of all households had contracts based on variable prices. Fixed price contracts are typically offered for one year or three years. They shield the consumer from volatile wholesale prices during the contract period. In the second quarter of 2004, about 22% of all households had contracts based on fixed prices, representing a nearly threefold increase over 15 months (8% of households had fixed price contracts during the first quarter of 2003). This increase is a clear response to the price increases many small consumers experienced in the wake of the high wholesale prices related to low reservoir levels in 2002/03. A third kind of contract is based directly on the spot price movements with a fixed retailer margin. In the first quarter of 2004, nearly 14% of all households had contracts based on spot prices.

Competition in Retail Markets

It takes between three and four weeks for a consumer to switch supplier. In the second quarter of 2004, 2.5% of customers switched supplier, and around 25% of household customers had a different electricity supplier than the main one in their area. The three largest suppliers in the household market are Haflund Strom, Fjordkraft, and LOS AS. Together these three suppliers have a market share of approximately 31%. The largest supplier in the household market is Hafslund Strom AS, a wholly-owned subsidiary of Hafslund ASA, which is a publicly-owned company with 35% municipal ownership. Statkraft SF and Norsk Hydro ASA together have a market share of approximately 50% in the industrial and commercial markets. Statkraft SF and Nosk Hydro ASA are also the largest generators in Norway.

Although retail margins appear to be falling at present, which may suggest relatively competitive conditions consistent with passing efficiency benefits through to end-users, the Norwegian Competition Authority is concerned about levels of concentration in retail markets and the potential for dominant distributors to charge higher prices to less active small consumers. The authority publishes retail prices on its website and has noticed increasing consumer interest and activity in the wake of the price spikes of 2002/03. It intends to carefully consider future retail merger proposals and to encourage increasing customer mobility.

Supply Contracts for Energy-intensive Users

About 17 TWh per year of power consumption by energy-intensive industry is currently met through long-term contracts with Statkraft SF on terms fixed by the Storting. This represents around 45% of total industrial consumption. The average price under these contracts is around NOK 0.12 per kWh. Most of these agreements expire between 2004 and 2011. However, some of these industry participants concluded new agreements with Statkraft in 2000 on terms set by the Storting. The new contracts cover about 2 TWh per year, and commence from 2007–2011 and run until 2020–2030. This sector, meets its remaining power requirements largely from its own power plants' long-term commercial contracts and purchases on the spot market. In spring 2004, the Storting requested that the government consider further new long-term contracts with terms and conditions set by the authorities rather than by the market. The proposal was rejected by the government as being incompatible with EU legislation. The government is currently considering another similar request from the Storting.

SECURITY OF SUPPLY

SUPPLY-DEMAND BALANCE

In Norway, both peak and absolute demand has grown since liberalisation, while generating capacity has remained largely unchanged, leading to a tightening supply-demand balance. The narrowing of the supply-demand balance is illustrated in Figure 33.

Nordel's most recent analysis of power and energy balances suggests that Norway will become a net importer during normal conditions from 2006, with net imports of around 5 TWh per year (or around 4.9% of total net consumption in 2003). During a one-in-ten dry year, the import requirement is projected to rise to around 14 TWh per year (or around 13.6% of total net consumption in 2003), while the requirement during an extremely dry year such as 2002/03 or during a period of successive dry years is projected to be around 18 TWh per year by 2006 (or around 17.5% of total net consumption in 2003). Nordel also estimates that by 2006/07, Norway could experience a small capacity shortfall of around 70 MW during a one-in-ten year winter peak.

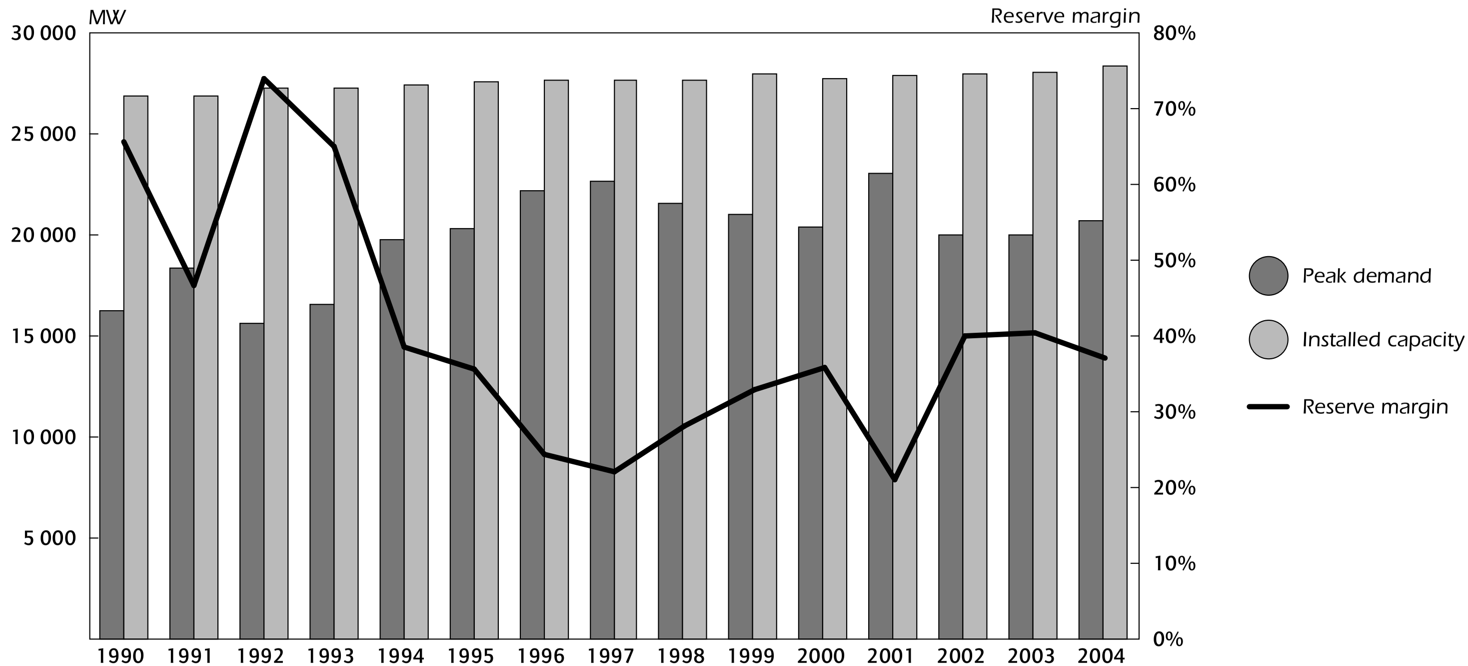
SECURITY OF SUPPLY ISSUES AND INITIATIVES

Tightening of the supply-demand balance over recent years has made the power system more vulnerable to capacity constraints, especially when combined with extremely cold weather. Such conditions emerged during the winter of 2002/03, putting the market under considerable pressure.

Hydroelectric reservoir levels fell to a 70-year low, as a result of an extremely dry autumn, raising concerns about the potential for water shortages to limit hydroelectric generation during the winter of 2002/03. Conditions were exacerbated by very low winter temperatures. This was a particularly unusual

Figure 33

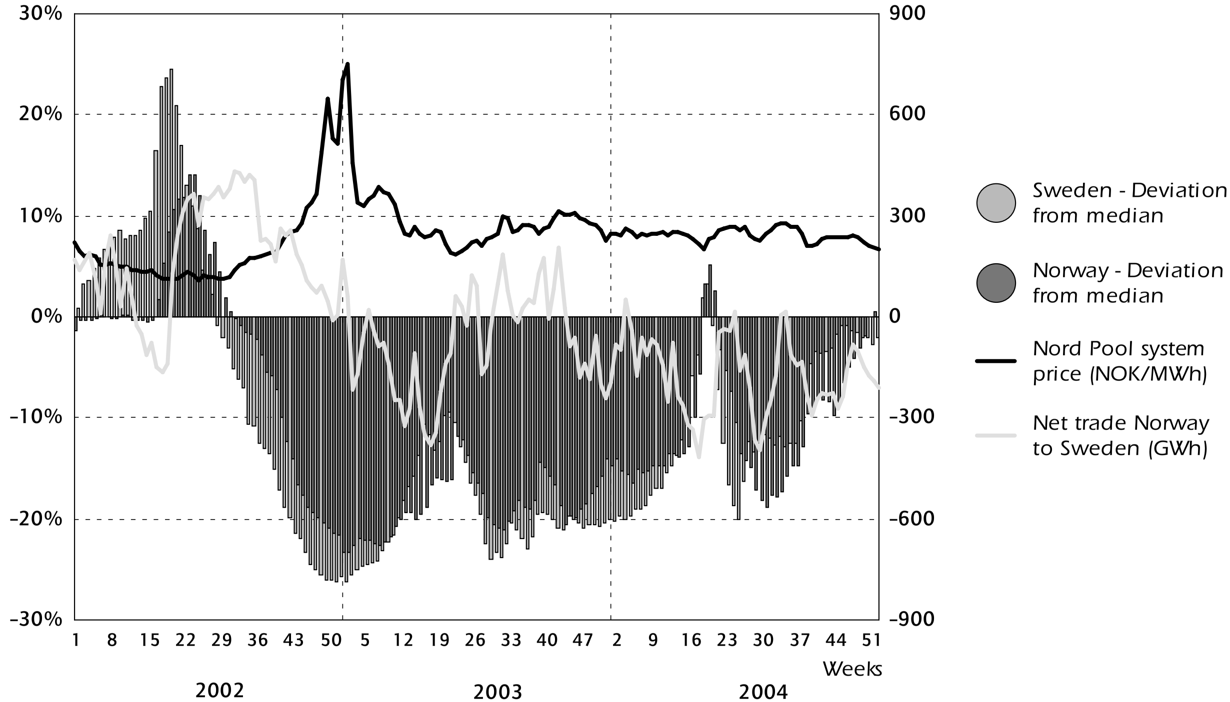
Movements in Peak Load and Generating Capacity, January 1990 to April 2004



Source: Nordel Annual Reports.

Figure 34

Movements in Reservoir Levels and Trade between Norway and Sweden, and Nord Pool Spot Prices, 2002 to 2004



Source: *Adapted from ECON Energy 2003.*

combination of events. Estimates published by the Norwegian Ministry of Petroleum and Energy suggest that this combination of conditions is likely to occur once every 100 to 200 years in Norway. During this period, Nordic spot prices rose to unprecedented levels as a result of the lack of precipitation combined with particularly cold weather. Between 30 November 2002 and 31 January 2003, average daily system prices ranged from 50 öre per kWh to 80 öre per kWh. At its peak the average daily system price reached 83.1 öre per kWh. The impact is reflected in the spike in monthly average prices recorded for December and January in Figure 34.

A well-functioning power market helped Norway emerge from the winter of 2002/03 without a supply crisis. Importantly, the market responded effectively to these extreme conditions. Imports increased, particularly from the Continent and Russia, while thermal peaking plant, which had been mothballed, returned to service in other Nordic countries. Norwegian demand showed significant responsiveness in the face of high prices. As a result, supply was sufficient to meet the reduced demand throughout this period without government or regulatory intervention. The box below provides further information about how the market responded during the winter of 2002/03.

Nordic Market Response During Winter 2002/03

Context

Reservoir inflow was unusually low in Norway, Sweden and Finland during the autumn of 2002. Total inflow in Norway, Sweden and Denmark from July to December 2002 was at least 35 TWh under the normal level. This decline corresponded to almost 9% of Nordic electricity consumption over a year. The drop in inflow led to a substantial decline in hydropower output. For the Nordic region as a whole, this was about 96 TWh in the second half of 2002 – roughly 7 TWh lower than in the same period of the previous year. Hydropower output in the first half of 2003 was only 84 TWh, about 26 TWh below the same period of 2002. In Norway it was almost 18 TWh below normal, which corresponds to almost 15% of Norwegian consumption in 2002.

Market Response

Market responses helped to reduce the impact of these extreme conditions. Internal Nordic trade in response to price signals worked to ensure that electricity flowed to those regions with the greatest energy shortage. Spare thermal capacity was brought back into service and significant volumes of electricity were imported from Continental Europe and Russia to supplement Nordic production. Consumption also fell in response to high spot prices.

Nordic trade ensured that power flowed where it was needed precisely when it was needed

Electricity flows between Norway and Sweden during 2002/03 reflected spot price movements, which were a function of the relative scarcity of water. Figure 34 shows the relationship between water levels, spot prices and trade between Norway and Sweden.

Norway's net exports were high until the beginning of October 2002, when they began to decline gradually, as the relative scarcity of water shifted from Sweden to Norway. Norway remained a net exporter until the beginning of December. Throughout the winter 2002 and spring 2003, net Norwegian electricity imports were substantial. Purchases from abroad were particularly high from mid-March until the beginning of May, when Norwegian reservoir levels were at their lowest. The power exchange fluctuated between net imports and exports during the summer of 2003. Taken as a whole, Norway had high net exports of more than 6 TWh in the second half of 2002. This was reversed to net imports on a corresponding scale during the first half of 2003. Efficient trade in response to effective price signals ensured that hydro production was efficiently allocated to help regulate and secure supply in those regions suffering from the greatest water scarcity.

Thermal plants increased output

The loss of hydropower output was offset to a great extent by increasing thermal power generation. Nordic oil-, gas- and coal-fired electricity output in the second half of 2002 totalled 45 TWh, about 9 TWh higher than in the same period of the previous year. These power sources accounted for about 57 TWh in the first half of 2003, up by 18 TWh from the same period of 2002. Nuclear energy output in the autumn and winter of 2002/03 was roughly unchanged from the previous winter.

Net Nordic electricity imports increased gradually from the summer of 2002 until the end of the year, and totalled 4.6 TWh for the second half of 2002. This figure rose to 10.2 TWh in the first half of 2003, as opposed to 0.8 TWh in the first half of the previous year. Russia was a substantial contributor with nearly 10 TWh of exports to the Nordic market between June 2002 and July 2003.

Significant demand responsiveness was observed, especially in Norway

Nordic electricity consumption was 2% higher in the second half of 2002 than in the same period of the previous year. During the first half of 2003, it was 0.5% lower than in the first six months of 2002. Total

Nordic consumption from July 2002 to June 2003 came to 388 TWh, an increase of 0.7% over the preceding 12-month period. The growth in consumption was highest in Finland, while Sweden and Denmark experienced a modest increase and Norway showed a decline. Total electricity consumption in the second half of 2002 was roughly on a par with the same period of the previous year. A particular decline in consumption compared with the previous year was recorded from January to April 2003, when wholesale prices were at their peak. Total consumption for the first half of 2003 was about 4 TWh lower than in the same period of 2002. A significant demand reduction was noted among power-intensive users and from electrical boilers. Gross Norwegian consumption of electricity over the 12 months from July 2002 to June 2003 totalled 117 TWh, a decline of 3.8 TWh or roughly 3% from the previous 12-month period.

The underlying growth in the electricity demand of the Nordic countries will continue to shift the region towards an increased reliance on imports of electricity, even in normal years. Nordel's energy balance analysis concludes that the entire region will still be able to cope with a single dry year up to 2006/07 without serious difficulties through reliance on imports. Nordel forecasts also suggest that while peak demand can be met throughout the region on normal winter days, exceptionally cold winter days will require a very high reliance on imports into the Nordic region. However, the combination of a dry year and an unusually cold winter, or two consecutive dry years, could seriously stretch security of supply, placing substantial stress on market mechanisms.

Norwegian government policy on electricity security of supply in reaction to the supply crisis was presented in White Paper No. 18 (2003-2004). The white paper emphasises that a well-functioning power market and an active exchange of power between countries are the basis for secure electricity supplies. The policy acknowledges that the Nordic electricity market has led to efficiency improvements in the power industry and a better utilisation of available resources. To improve security of power supply, the government will continue efforts towards increasing market efficiency and flexibility.

The white paper also confirmed Statnett's obligation to develop and implement special measures to handle system operation in situations of tight supply-demand balance. Statnett is proposing to implement a capacity reserve programme. Few details are publicly available at this stage. However, the proposal is expected to be built on the existing "capacity options" model used to procure regulated reserves in the balancing market. A proposal will be submitted to NVE for approval.

CRITIQUE

Provision of reliable and affordable electricity is central to Norwegian energy policy and the country has historically been able to achieve these goals. In the 1990s, Norway fundamentally reformed its electricity sector, leading to the development of the Nordic electricity market. This market has become a world leader, delivering considerable efficiency benefits for the Norwegian economy and consumers, including low wholesale prices, strengthened reliability and efficient trading opportunities. The resilience and effectiveness of these arrangements were demonstrated during the 2002/03 winter when market prices encouraged efficient use of the electricity system, enabling the market to maintain reliable services despite an extreme combination of a one-in-70 year water shortage and an unusually cold winter – estimated to be a one-in-100, or even one-in-200 year event.

Notwithstanding these successes, the 2002/03 experience has highlighted some emerging challenges, including the following:

- The tightening of the supply-demand balance throughout the Nordic market and in Norway, increasing the probability of reliability problems emerging during dry years, and increasing the need for efficient market responses.
- Emergence of significant congestion on the Nordic transmission network, particularly on interconnectors, with the potential to segment the Nordic market, effectively reducing system reliability and market efficiency, and increasing the potential for market power.
- Some differences in the policy and regulatory framework applying to the Nordic market, which has the potential to distort efficient market operation and development.

Trade in electricity has brought efficiency and reliability benefits to Norway and the Nordic region including the deepening of wholesale competition, more efficient utilisation of existing infrastructure enabling capital expenditure on new generating plant to be deferred, increasing the potential for efficient sharing of capacity reserves and facilitating greater use of imports to ensure reliable electricity supplies during dry years.

A critical factor in determining whether the Nordic electricity market can continue to deliver affordable and reliable outcomes for Norway is the degree to which it remains an integrated market. Market splitting as a result of transmission congestion can undermine effective competition, reducing reliability, increasing the cost of electricity and possibly creating opportunities for market power abuse. Congestion has become a more regular feature in the Nordic market in recent years. Although the cost of this congestion generally has not been substantial to date, the potential exists for these costs to increase as supply-demand balances tighten and Nordic regions become more reliant on inter-regional trade to support efficient and reliable outcomes. This could become an important issue for Norway, particularly in dry years.

Nordel's proposal to increase transmission capacity at five key points on the transmission backbone, including two interconnectors into Norway, has the potential to substantially reduce excessive congestion and strengthen the ability of the market to provide reliable and affordable electricity services. This is a very welcome development. However, the process to arrive at this outcome was slow and problematic, and co-ordination could perhaps be improved.

More integrated regulatory and planning arrangements supported by efficient, transparent and cost-reflective network pricing could help to remove uncertainty and strengthen signals for timely, well-located new transmission investment. Efforts to strengthen dialogue and improve co-ordination among Nordic regulators, through the Forum of Nordic Energy Regulators, and between Nordic regulators and TSOs are positive developments. Opportunities may exist to further clarify regulatory and institutional responsibilities and to strengthen co-ordination among and between regulators and system operators to ensure more effective developmental processes and to reduce regulatory risk for future transmission network developments. Opportunities may also exist for Norway to strengthen incentives for efficient transmission investments in the context of developing the new methodology for determining network returns for the 2007 regulatory period.

Network regulation is undertaken by the Norwegian Water Resource and Energy Directorate (NVE). Although NVE reports to government through the Ministry of Petroleum and Energy, it interprets and applies its regulatory powers independently from the policy arm of government. NVE sets the framework for tariffs and access conditions for transmission and distribution networks. It applies an income cap methodology incorporating "inflation minus x" incentives to encourage cost-effective operation. The methodology incorporates innovative features, including an individually tailored benchmarking approach, to enhance incentives for cost-effectiveness, and a performance incentive to encourage quality of service.

NVE is reviewing its income cap methodology in the context of preparing for the regulatory period commencing in 2007. It is aiming to improve incentives for cost-effective performance by strengthening its innovative benchmarking arrangements. Statnett has identified up to NOK 7 billion of new investments that may be required to maintain reliable and efficient electricity services in Norway over the next ten years. Getting the balance right between incentives for lowering costs and for efficient investment will be a challenge in this context.

The *2004 OECD Economic Survey of Norway* noted the degree of vertical integration of contestable and monopoly activities and suggested that the current practice of account separation should be replaced with formal separation requirements. The government is developing amendments to the Energy Act to implement legal and functional unbundling[16], consistent with the latest European Union Electricity Market Directive. The Norwegian proposals for unbundling have the potential to improve separation and reduce the scope for cross-subsidisation and cost-shifting.

The 2002/03 experience also highlighted the importance of wider trade beyond the Nordic market to secure reliable electricity services. The recent announcement of a new transmission link between Norway and the Netherlands (the NorNed cable) is a welcome development in this context and should be commended. Other similar interconnections should be pursued where economically feasible.

Efficient domestic investment in generating capacity could also strengthen the reliability of Norwegian electricity supplies. Over-capacity reflected in low wholesale prices together with regulatory hurdles has led to relatively little new generating investment in Norway over the last decade. However, this situation is gradually changing with a tightening supply-demand balance in Norway and in the emerging Nordic market. In view of this trend, it is important to ensure that any undue barriers to efficient diversification of ownership and investment responses are reduced, and that investors have a clear path for the approval of projects available to them.

Scope may exist to provide greater clarity and certainty for investment and to reduce costs associated with obtaining investment approvals. Opportunities may also exist to support greater diversity of private ownership. For instance, the current process for licensing of hydro facilities can be a relatively complex, time-consuming and uncertain process, involving up to five phases and three public consultation processes, including a final political approval by the Storting. Similarly, rights of reversion under the Industrial Concessions Act ensure that privately or partially privately-owned hydro facilities revert to the government after at most 60 years, while publicly-owned assets are exempt from this requirement. Such treatment may discriminate against private ownership and may discourage efficient diversification of ownership, reduce access to capital, and hinder efficient evolution of the industry structure.

Rationalisation and increasing diversity of ownership are positive developments. Increasing private ownership in particular may have the potential to help strengthen commercial discipline, strengthening incentives for efficiency, while larger businesses may benefit from economies of scale and

16. Norway's proposals go beyond the requirements of the EU Electricity Market Directive. The government will remain the controlling owner of Statnett and Statkraft, but the two companies will be completely separate.

improved capacity to cost-effectively raise capital for efficient investment. The *2004 OECD Economic Survey of Norway* concludes that removal of the asymmetry in the concession rules applying to private and public ownership of hydroelectric facilities could help to further stimulate private investment.

Although there has been no evidence of market manipulation by generators in Norway to date, increasing concentration in the Nordic market, and to a lesser extent in Norway, may raise more general concerns about the potential for individual or collective exercise of market power. Further diversification of the ownership base, for example through reform of the right of reversion legislation, may help to reduce this potential.

Uncertainty about the regulatory arrangements for gas-fired power plants and related infrastructure projects also risks discouraging potentially efficient generation investment that could serve to diversify the mix of generating technologies and help improve security of electricity supply in Norway.

The 2002/03 experience illustrated the vulnerability of hydro-based power systems to "energy" constraints. A capacity reserve programme has been proposed to address this concern. Under the proposal, Statnett will be required to procure a capacity reserve in addition to its technical reserves. A market-based approach using capacity options has been proposed. However, such mechanisms may also have the potential to crowd out efficient market responses and therefore need to be carefully developed and monitored. The choice of the trigger mechanism is critical in this context and could help to reduce the potential for this programme to discourage efficient market-based investment responses. In Norway with its high market transparency, linking the activation trigger to real water levels or supply-demand balances would be far superior to a price-related trigger.

Norway's security of supply needs to be understood in the context of the Nordic electricity market as a whole. Increasing trade and regional integration resulting from electricity market reform has enabled Norway to effectively draw on the reserves of other Nordic countries to enhance its security of supply, despite a continuing decline in excess Norwegian generating capacity over the period.

Nordel initiated a project in 2002 to investigate the potential for a Nordic market for disturbance and peak load reserves. The Nordic Council of Ministers revived the issue at its September 2004 meeting and invited Nordel to report on options to establish this market. Nordel's report has been submitted to the Council for consideration. A harmonised approach across the Nordic market has the potential to help strengthen liquidity and reduce costs. It could also be used to help strengthen market-based demand responsiveness. Given the potential benefits of a more integrated Nordic approach, further development of the proposed capacity reserve programme should be undertaken in the context of the emerging Nordic model.

One of the positive outcomes of the 2002/03 experience was the willingness of intensive energy users to reduce consumption in response to high spot prices. However, representatives of large energy users have suggested that the degree of flexibility shown in 2002/03 should not be taken for granted. During the winter of 2002/03, world markets for aluminium and metals were relatively subdued, enabling these users to respond rapidly and for longer periods by reducing demand by more than they might have been able or willing to, say, under the current, more favourable, market conditions for their products. Future responsiveness would reflect the terms of their supply contracts and the health of world markets for their products, with a less flexible and immediate response likely during boom times. Further promotion of market-based methods to stimulate efficient demand responsiveness, especially to broaden the potential group of responsive end-users, should be encouraged.

Demand responsiveness may be affected by the nature of electricity supply contracts. Many intensive energy users currently enjoy long-term supply contracts. These contracts may serve to discourage the development of efficient demand responsiveness among this key group of electricity users, and reduce the capacity of electricity markets to work efficiently during periods when supply-demand balances are tight.

While competition exists in the retail market in Norway, three-quarters of domestic customers stay with their local supplier. Stronger competition between retailers will help ensure that reform benefits are passed through the value chain to end-users in the form of greater choice, more innovative products and efficient prices.

RECOMMENDATIONS

The government of Norway should:

- *Continue to promote greater harmonisation within the Nordic market in relation to economic regulation, system operation, competition surveillance and co-ordinated planning and development of the Nordic transmission "backbone".*

- *Ensure that the income cap methodology adopted for the regulatory period commencing in 2007 provides sufficient incentive for efficient and timely network investments.*

- *Facilitate the development of efficient transmission links between Norway and other countries.*

- *Review regulatory arrangements with the potential to discourage or delay efficient investment in new generating capacity, or to hinder efficient diversification of ownership. In particular, opportunities may exist to: clarify regulatory requirements; streamline and accelerate licensing approval processes; and remove any inconsistencies in the treatment of public and private ownership.*

- *If introduced, ensure that the capacity reserve programme does not undermine the development of efficient, market-based demand responses or generation investment. Consider a transparent activation trigger linked to water reservoir levels. Ensure that any such programme is compatible with emerging Nordic-wide approaches.*

- *Further promote market-based methods to help broaden demand responsiveness. Consider pursuing this work in a Nordic context, as appropriate.*

- *Existing long-term supply contracts with terms set by the government for energy-intensive users should not be renewed.*

ENERGY TECHNOLOGY AND R&D

OVERVIEW

Norwegian research policy can be divided into *i)* a political level, at which ministries outline their research priorities, with the Ministry of Education in charge of overall political co-ordination and the establishment of priorities according to the political agenda; *ii)* a strategic level, at which the Research Council of Norway (NFR) is taking a key role by determining the implementation of the political agenda into a research framework; and *iii)* the performing level, where universities, research institutes, and industry carry out research with funding from government and third parties.

Like most other areas of Norwegian energy, research and development (R&D) is strongly influenced by the needs of the offshore industry, and more than half of the available government funds are spent on research relating to offshore technologies. The MPE has the primary responsibility for pursuing Norway's energy RD&D objectives. The MPE's R&D funds are channelled to the NFR, which receives its basic allocations for general research funding from the Ministry of Education. The NFR has the primary responsibility for the majority of government research, covering everything from support for higher education institutions to near-market applied research.

Compared to the OECD average, Norway is spending a lower amount of GDP on research, 1.7% of GDP, compared to an average of 2.2% for all OECD member countries in 2002. In 2001, 47% of Norwegian research expenditure was funded by business and industry. The latest available figures for 2003 indicate that direct government funding for energy R&D was only 3% of total government expenditure for R&D.

Norway's total government budget for energy RD&D was NOK 441 million in 2004, an increase of 15% compared with NOK 384 million in 2003 (Table 15). The 2005 budget rose again to NOK 508 million, NOK 300 million of which was allocated for petroleum-related research. After a period of sharp decline in spending levels in the mid-1990s compared to the early 1990s, budgets have again increased considerably. A large part of the increase in expenditure is accounted for by an increase in support for clean energy technologies, such as renewables and CCS.

About one-quarter of the funds the NFR receives from the MPE provides support for long-term basic and strategic research and the development of expertise at research institutes and universities. This provides a basis for other, commercially promising energy projects at these institutions in co-operation with industrial and other users, both nationally and internationally. The NFR

Table 15

Government Funding for Energy RD&D

Technology areas	*2003*		*2004*		*2005 (est)*	
	NOK million	*%*	*NOK million*	*%*	*NOK million*	*%*
Energy conservation	17	4 %	16	4 %	16	3%
Fossil fuels	184	48 %	205	47 %	322	57%
Renewable energy sources	29	8 %	29	7 %	40	7%
of which:						
Large hydro	*6*	*2 %*	*5*	*1 %*	*10*	*2%*
Nuclear energy	60	16 %	68	15 %	69	12%
Electric power technologies	30	8 %	28	6 %	22	4%
Cross-cutting technologies	65	17 %	95	22 %	96	17%
Total	**384**	**100 %**	**441**	**100 %**	**565**	**100%**

Source: Government submission.

is responsible for the allocation of all funds received from the MPE to specific projects and programmes in the petroleum and energy sectors.

The remaining three-quarters of the energy RD&D budget support user-driven programmes where the energy industry is directly involved. Organisationally, these are separated into programmes in the oil and gas sector (PETROMAKS), and in the general energy sector (RENERGI), covering renewables, energy efficiency, and hydrogen. A special CO_2 reduction research programme called CLIMIT is administered jointly by Gassnova and the NFR. RENERGI also supports research into gas-fired power plants with CO_2 management. All programmes are described below.

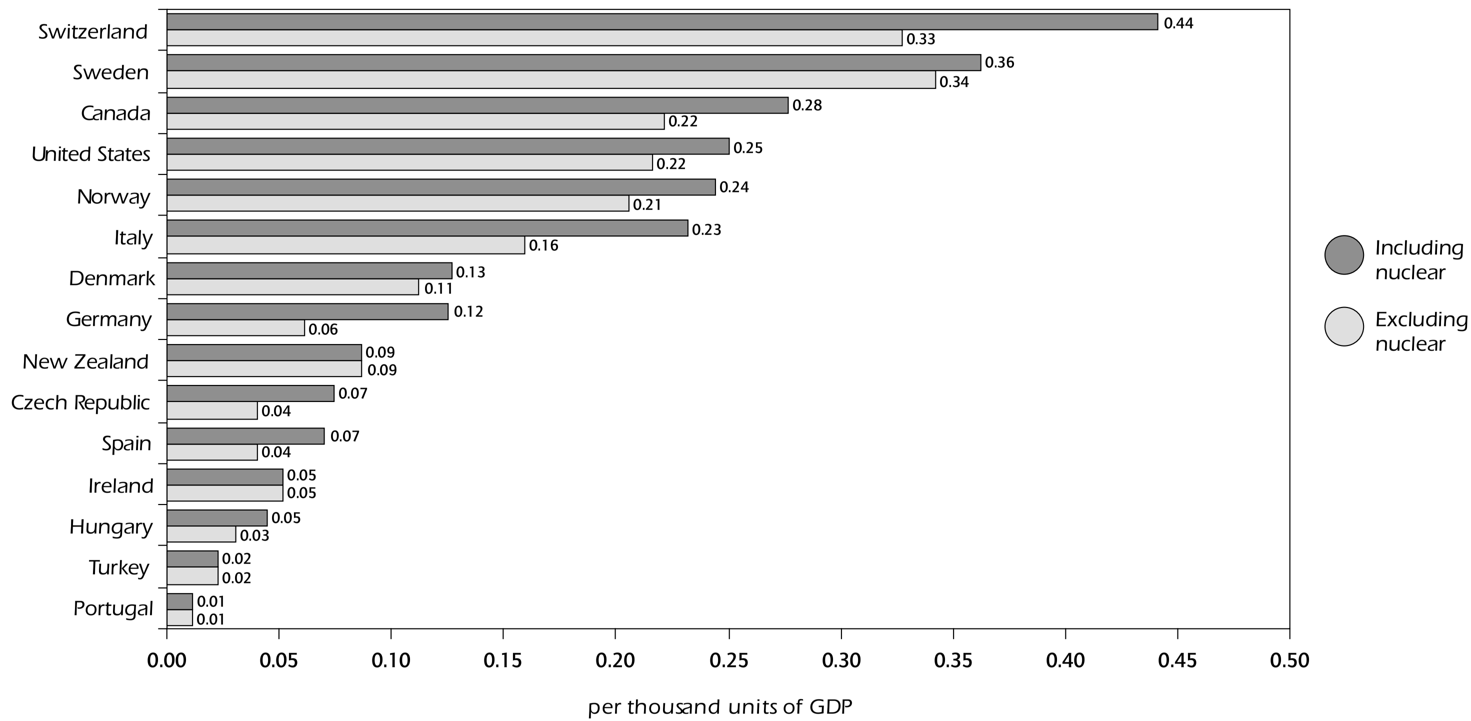
OIL AND GAS IN THE 21ST CENTURY (OG21)

Access to a significant part of Norwegian resources is dependent on new technological skills being developed and extended, and/or cost reductions in existing technologies being achieved through further development work.

Since the last Norwegian in-depth review, good progress has been made in concentrating the public-private oil and gas-related research and technology efforts in Norway by the establishment of a new research framework, OG21, (Oil and Gas in the 21st Century), which is designed to achieve the goal of increased value creation on the Norwegian Continental Shelf (NCS). This initiative was established by the MPE in 2001 as the overall R&D forum for

Figure 35

IEA Government Budgets on Energy R&D per GDP, 2003



Note: data not available for Australia, Austria, Belgium, Finland, France, Greece, Japan, Korea, the Netherlands and the United Kingdom. Luxembourg has no energy R&D programme.
Sources: *OECD Economic Outlook No. 75*, OECD Paris, 2005, and country submissions.

the oil industry, related technology suppliers, the government, and researchers to define and implement a national strategy for research and technology in the oil and gas sector.

The aim of OG21 is not only to increase value from the resources on the NCS, but also to create new resources in the form of knowledge and expertise that will support the Norwegian economy once oil and gas resources begin to decline. The investment by the government is therefore seen as an investment with a potential double dividend, first in increased recovery, and then in export value from intellectual property and proprietary technology. The OG21 strategy is based on a considerable leverage effect from private funding, and is estimating that for every Norwegian crown of government investment into research under OG21, industry investment of NOK 3-4 will be realised.

OG21 is ultimately expected to cover all relevant oil and gas R&D collaboration in Norway, including longer- and short-term issues. Links between basic science and shorter-term R&D issues are created by involving participants from basic research such as universities, as well as representatives from industry and applied research into the OG21 R&D strategy and project work.

The following five high-priority areas were initially identified as the core focus of the OG21 strategy:

- Environment.
- Enhanced recovery.
- Deep water.
- Small fields.
- The gas value chain.

In order to focus more specifically on the most important technology challenges pertaining to these overall priorities, nine technology target areas (TTA) were identified in 2003 as areas where collaboration critical to the implementation of the OG21 strategy needed to be intensified. Collaboration within the different TTAs is currently pursued through a system of lead parties selected among the most important oil companies on the NCS. The lead parties manage the related collaboration activities, including involvement of technology suppliers and representatives from the research community. Lead parties are always major oil companies, ensuring that R&D is carried out with a focus on results that are applicable to the industry, and that sufficient resources are present.

Focus on longer-term priorities has been central in the definition of relevant public research programmes in the NFR within oil and gas. Broad consultation on OG21 priorities has been important in defining specific thematic priorities

Table 16

Technology Target Areas under OG21 and Lead Parties

Technology target area	*Lead party*
1. Zero harmful discharge to sea	Conoco/Philips
2. 30% reduction emissions to the atmosphere	Shell
3. Stimulated recovery	Statoil
4. Cost-effective drilling	ExxonMobil
5. Real-time reservoir management	BP
6. Deep-water floating technology	Norsk Hydro
7. Long-range transport of well stream	Statoil
8. Seabed and down-hole processing	Total
9. Competitive gas production and off-take	Shell

of relevant programme activities. Table 16 shows the technology target areas under OG21 and the lead parties. As can be seen from the table, private operators from outside Norway are very active in supporting OG21.

PETROMAKS

The PETROMAKS programme was initiated in 2004 by the NFR and is the main public instrument to implement the OG21 strategy. It is administered by the NFR and, in the context of NFR programmes, it replaced the older Oil and Gas Programme.

The ambition of PETROMAKS is to cover all the main target areas of OG21 described above. Owing to limited programme funds, only parts of the scope of the OG21 strategy were supported by the programme in 2004, namely enhanced oil recovery (EOR) and more efficient exploration. In 2005, the budget was increased to NOK 180 million and the programme expanded its activity to further areas. Ultimately, the ambition is to increase this budget to NOK 500 million per year.

One key aim of PETROMAKS is to develop the necessary competence, skills and alliances in the research community that will help to sustain the Norwegian oil industry through the period of falling output and beyond. Environmental and safety standards on the NCS are among the highest worldwide, ensuring that any technological approach developed for petroleum work on the NCS will be applicable in similar settings worldwide.

Four Examples of Norwegian Offshore R&D Projects

The four examples below show some of the cutting-edge technologies that are being applied by operators on the NCS in order to stay competitive and increase oil recovery under the very challenging circumstances of the NCS.

- **Sleipner CO_2 capture and storage**

The Sleipner area contains a number of gas and condensate-producing fields operated by Statoil since the early to mid-1990s. Parts of the area produce a gas that has a very high CO_2 content. Traditionally, this CO_2 would have been released to the air. On Sleipner West however, the excess CO_2 is captured from the natural gas and injected in the Utsira sandstone formation at a depth of 1 000 metres below sea level. This project dates back to 1996, and was incentivised by Norway's CO_2 tax. Daily tax savings are estimated at NOK 650 000. Sleipner is a first of a kind project because it is a pure storage project, given that the CO_2 is not used to achieve EOR by reinjection. The other first of a kind is the scale at which the project is storing CO_2: 1 Mt is stored each year, significantly more than any other CCS project currently active is achieving. Sleipner is part of the SACS project, to monitor and research the storage of CO_2, which is supported by the EU fourth framework R&D programme. This monitoring project shows that to date the CO_2 is remaining stable in the Utsira formation. Lessons learned from Sleipner will play an important role in evaluating the prospect of CCS worldwide.

- **Ormen Lange sub-sea development**

Ormen Lange is one of the latest gas/condensate developments on the NCS. It is the second-largest field on the NCS, and was discovered in 1997, with a plan for development and operation submitted by the end of 2003 by operator Norsk Hydro. Ormen Lange is at the cutting edge of production technology, with fully automated seabed separation at a depth of 800 to 1 000 metres, and an extended well stream transporting unprocessed material for 100 km to the Norwegian coast at Nyhamna, where an onshore plant will be used for processing.

- **Snøhvit CO_2 reinjection and sub-sea processing**

The advanced technologies that were developed for Sleipner and Owen Lange are now being used for Snøhvit, a gas/condensate development in the Arctic. Snøhvit is a field in the Barents Sea, environmentally one of the most challenging developments in Norway to date. It features CO_2 capture from natural gas, CO_2 transportation, and CO_2 sub-sea injection in a special well leading into a 2 600 metres below sea level geological formation, as well as sub-sea transportation and well stream processing of gas/condensates. Snøhvit is also the first large-scale development of LNG production for export in Europe, with the output of the LNG facility aimed at the Spanish and US gas markets. CO_2 from the liquefaction plant will not be captured. Snøhvit is operated by Statoil, and requires a total investment of approximately NOK 19 billion.

- **Use of modern information technology to support exploration and production – DART and OSC**

The DART project is a collaborative project involving a number of oil companies and oil service companies, and is aimed at utilising modern information technology such as GPS, satellite communication, and fibre-optical data transport in an attempt to improve recovery rates in existing fields. Following seismic exploration, GPS and high-speed data communication are used during test drilling to adjust well bearing and location, in order to hit the most productive area of a reservoir.

In order to utilise the investment into technology, Statoil has set up an onshore support centre (OSC) covering the Kristin, Asgard, and Heidrun fields and providing support for all three. From these fields, Statoil estimates that the support of the OSC will lead to increased recovery by 19 million barrels in total through better well positioning based on the visualisation support provided by the OSC. Using onshore support also reduces the offshore manpower requirements and thereby the labour costs for Statoil.

DEMO 2000

Most short-term technology development in the petroleum sector is carried out by industry alone with little need for government involvement. However, a limited number of new demonstration activities in industry are supported by the government through the Demo 2000 programme administered by the NFR. This support is in some cases vital to help bridge the gap between research and deployment of technology, and the Demo 2000 programme is seen as an important implementing instrument in the OG21 strategy. The government's Demo 2000 budget reached NOK 50 million in 2005, an increase of NOK 20 million compared to 2004. In total, NOK 1.26 billion has been spent under the programme in the period from 1999 to 2004, NOK 980 million of which was invested from the oil industry. Of this, NOK 630 million came from oil companies and NOK 250 million from supply companies. Among others, the Demo 2000 programme has supported the development of under-water processing, including compression systems. This technology is key to the development of the Ormen Lange field.

RENERGI

As of 1 January 2004 most of the research programmes within the energy sector excluding petroleum have been merged into one programme called

RENERGI (Clean energy for the future). RENERGI, as well as PETROMAKS, is part of a limited number of new major research programmes in which the NFR deploys a wide range of instruments and resources. These programmes are based on the NFR's new organisation, and are set up under the auspices of its Division for Strategic Priorities of the NFR. Close collaboration with Enova has been secured through a formal collaboration agreement between the NFR and Enova. The NFR and Enova have established regular contact meetings, and are arranging conferences together.

RENERGI's aim is to facilitate research in both the long term (30 years) and the short term (five to ten years) and it will cover energy production and transmission, and stationary and mobile energy use. A strong focus will be on hydrogen research, covering hydrogen production, storage, and safety questions. RENERGI has a work programme covering 2004-2013, and in 2005 it has a budget of approximately NOK 140 million, of which about NOK 90 million comes from the Ministry of Petroleum and Energy, and around NOK 23 million from the Ministry of Transport and Communications. The remaining figure is provided by the NFR through other funding mechanisms. In the field of research related to renewables and energy efficiency, NFR is closely co-operating with Enova.

The broad programme areas for RENERGI have been determined by the NFR in consultation with the MPE. The research priorities for these areas are initiated and developed by the NFR, following advice from its own advisory boards. The NFR is responsible for determining the goals of the individual areas and the exact balance of priorities between the areas. However, there is an understanding that these areas should be consistent with the needs and policy objectives of the MPE. Results are evaluated by the NFR, and programmes/areas are developed taking account of the evaluation results.

The primary objective for RENERGI is to develop knowledge and solutions as the basis for environment-friendly, efficient and effective management of the country's energy resources, security of supply and internationally competitive economic development related to the energy sector. The programme will initially have a duration of ten years. There will be an ongoing evaluation of the need to modify the programme priorities in the light of changing circumstances.

RENERGI represents a combination of the following three older programmes with quite different aims:

- Energy for the Future (basic research).
- Samstemt (socio-economic research).
- Energy, Environment, Building and Construction (EMBa), an innovation programme.

The plans for these older programmes and the project portfolios, which were supported by them, established important priorities that will be of relevance to the new RENERGI programme, while the emergence of new institutions such as Gassnova also affected the research agenda.

RENERGI will attach particular importance to the achievement of long-term objectives and stable framework conditions. The programme will be flexible over time to deal with evolving needs and opportunities. Flexibility will also be important for devising or framing particular research instruments. There will for example be one area focusing on long-term human resources development, while another area will focus on industrial innovation. Furthermore, the MPE and the NFR see it as essential that projects with special merit and value creation potential can be accommodated even though they may fall outside the predefined target areas. This flexibility will increase the complexity of the programme.

RENERGI will contribute public funding within the target areas based on an evaluation of needs and opportunities. Consequently, the management of financial resources has to reflect how important it is for public funding to trigger research that would not otherwise have been possible. This involves making difficult decisions in relation to the ability and willingness of business and industry to fund research. Equally important, RENERGI will seek to create new R&D opportunities by facilitating co-operation between public and private interests.

The establishment of RENERGI offers a good opportunity for evaluating the research needs of the social sciences and technical/natural sciences in Norway as a whole and, insofar as there is a need to do so, to initiate interdisciplinary research. In connection with the categorisation and designation of high-priority areas, importance has been attached to ensuring that most of the areas have the capability to accommodate research from several disciplines.

RENERGI covers a wide range of subjects, and there are significant differences between different fields of research when it comes to users' interest, supply and demand trends, public interest, etc. Accordingly, it is necessary to develop a strategy for each subject on the basis of the assumptions that were applied when it became part of the RENERGI programme. This work must be based on the nature of the research field, the opportunities that have been recognised, and an assessment of the need for public funding and organisation, and requires a good understanding of the research field by the NFR and its partners. The following fields are the priority areas within RENERGI:

- Renewable energy production.
- Natural gas.

- Hydrogen.
- Energy systems.
- Energy markets.
- Energy use.
- Energy policy and international agreements.

Many issues for research will cover several of the areas mentioned above, or must be considered "vertical" in the energy value chain from primary production to end-user, with the focus on the role of the authorities and private players.

Each of these fields has a set of stated goals that should guide the development of research in the field. For example, for natural gas, an important goal is to develop new products with export value.

Possible target areas identified for research that are expected to contribute to the goal include the following:

- New technology for the direct use of natural gas, including fuel cells.
- Decentralised heat production.

Research fields, goals and target areas are clearly defined in a strategic manner by the NFR, with a view to enhance value creation from R&D in Norway while serving society's goals and concerns. RENERGI therefore should be seen as a strategic R&D programme that is firmly embedded in the Norwegian energy and technology political debate.

CLIMIT

CLIMIT is a special programme focusing on CO_2 capture from gas use in power stations or industrial applications. It is administered and financed jointly by Gassnova and the NFR. Gassnova is a new public agency reporting to the MPE, set up in January 2005 to support the development of CO_2 management solutions for CO_2 emissions from natural gas used in power stations or industrial installations. The agency is financed through income from a NOK 2 billion fund generating NOK 95 million per year to finance its budget. While it is not quite clear how overlaps between CLIMIT and RENERGI are being resolved, Gassnova is responsible for the development and demonstration side of the innovation spectrum, while the NFR is responsible for the research side. The NFR has allocated NOK 50 million to CLIMIT in 2005. There is close contact and co-operation between the two organisations, and a joint application process is being used. CLIMIT provides financing to the following three applied areas of research:

- Technological and business-oriented feasibility studies in which new technologies are assessed individually or as part of a value chain. Studies in this area are expected to focus on the technological and commercial potential and cost-effectiveness of new solutions.

- Financial assistance to testing of technologies in pilot scale conditions, *e.g.* individual process stages.

- Financial assistance to demonstration of technologies. Testing and operation of plants in a technical or semi-industrial scale, where the purpose is to accumulate data which can demonstrate performance, availability, reliability and provide a basis for design optimisation. Projects under this heading are expected to generate scalable technical and commercial design results, to support design and commercial evaluation of full-scale industrial application, and to be sufficient to enable suppliers of such equipment to offer functional guarantees for users.

APPLIED RESEARCH ON ENERGY AND WATER RESOURCES

Applied research on energy and water resources is administrated by the NVE. Its objectives are to provide support for the MPE in carrying out its tasks and help the MPE to develop and disseminate knowledge that improves the basis for water resource management. These activities are a supplement to and are co-ordinated with the activities of the NFR, for example by participation in the NFR's projects and programmes. Funding is being allocated to projects and programmes related to two main areas, namely the energy sector as a whole and watercourse management.

NUCLEAR RESEARCH

Nuclear energy accounts for approximately 15% of the energy RD&D budget, NOK 68 million in 2004. This expenditure is devoted to an international collaborative research project located in Norway, the OECD Halden reactor, and to the research reactor at the Institute for Energy Technology's (IFE) facilities at Kjeller, near Oslo. The Ministry of Trade and Industry is responsible.

ENOVA[17]

Enova has a role in supporting technology, development and deployment of new energy efficiency and renewable energy technologies. Enova is co-operating closely with the NFR on technology development under the relevant topics of RENERGI. Among other research projects, Enova has, for example, supported the Utsira project (see box).

The Utsira Renewables/Hydrogen Project

Norway has a number of remote communities, either on islands or in remote areas of the mainland. The Norwegian State explicitly aims to keep these communities viable, and energy supply is considered as one of the elements of viability.

In 2002, work began on a project to achieve increased energy independence for the 240 inhabitants of the Utsira island 20 km off the west coast of Norway. Energy company Norsk Hydro and wind-turbine manufacturer Enercon, with financial support from Enova, NFR and the Pollution Control Authority, installed two 600-kW wind turbines, an electrolyser, compressor, hydrogen storage tank, a combustion engine and a 10-kW hydrogen fuel cell on the island, as well as a 5-kWh flywheel to smooth out the frequency of the electricity. Peak demand on the island was measured at 900 kW. The project budget was NOK 40 million, and the duration between start and inauguration was almost three years. The main challenge was to integrate the systems to achieve a reliable energy supply, and to learn about shortcomings in currently available technology.

Ten of the island's households are now solely supplied with renewable energy, either directly from the wind turbines, or through the hydrogen fuel cell. The remaining households are supplied with renewable energy from the wind turbines whenever possible. The wind turbines generate approximately 5.1 GWh per year, achieving a high load factor owing to the good wind resource on the island. Excess electricity is first used to produce hydrogen to run the fuel cell at times when no wind is blowing, while further excess generation can be sold on the Norwegian electricity market, to which the island is connected through a cable to the mainland.

Developing solutions for remote systems will play an important role in electrification in developing areas of the world, and experience from the Utsira project has the potential to put Norwegian energy companies into a leading role in this respect.

17. See also Chapter 5.

INTERNATIONAL RESEARCH COLLABORATION

Norway is participating in several international initiatives, including RD&D projects under the EU's sixth framework programme. Norway is also participating in the CSLF (Carbon Sequestration Leadership Forum) and the IPHE (International Partnership for the Hydrogen Economy). The Norwegian Petroleum Directorate chairs the IEA Implementing Agreement (IA) on Enhanced Oil Recovery (EOR). In the view of the MPE, the EOR IA represents a critical mass of competence on ongoing research globally of importance to long-term oil supply issues, and is of particular importance to the maturing NCS. Norway is also participating in the IEA's Zero Emissions Technologies Initiative and its associated CO_2 Early Markets activity, in a number of IEA Implementing Agreements, for example the IEA Greenhouse Gas R&D Programme, and in the CCP (Carbon Capture Project – technology cost assessment). Finally, an informal forum for dialogue on CO_2 for EOR has been established between Norway, Denmark and the UK.

CRITIQUE

There have been a lot of positive developments in Norway responding to the R&D recommendations of the 2001 Norwegian in-depth review. It is also commendable that Norway is, in general, successfully addressing the following common challenges on energy R&D policies, which were outlined in the 2004 IEA cross-country overview:

- Appropriate funding for government R&D.
- Coherent energy R&D strategy and clear prioritisation.
- Private-sector involvement to facilitate technology deployment.
- Careful monitoring and assessment.
- Strong collaboration.
- Multilateral and bilateral international collaboration.

Government funding for energy R&D has increased substantially over the past two years. The increase has largely been for oil- and gas-related R&D, and to a lesser extent for cross-cutting technologies. The increase is commendable and indicates that Norway is acknowledging the importance of scientific and technological development to maximise the long-term contribution of Norway's energy resources to the economic and social well-being of the Norwegian society. Nevertheless, the current funding level still does not appear to fully reflect the importance of the energy sector in the Norwegian economy, even after taking into account the leverage effect from private investment released through government investment, since only 3% of direct government R&D funding is going into energy R&D.

In order to achieve the long-term scenario for petroleum production (see Chapter 6), the government needs to consider further increases of the energy R&D budget to address the technological challenges of exploration and production in the extreme climatic conditions of the Arctic, and in the deep waters off the NCS. Increasing the funding of PETROMAKS to the required NOK 500 million per year and of RENERGI should be a first step in this direction, and would be especially valuable given the high expected leverage effect. At current high oil prices, and with the stated government policy of pursuing a research- and technology-intensive long-term decline scenario, these levels of investment should be attainable. Continued evaluation of the potential for closer co-operation between the two programmes should also be undertaken, in order to benefit from any potential synergies in the underlying sciences (*e.g.* materials, computational methods).

Norway's energy R&D is also closely aligned with Norwegian political priorities, with the majority of energy R&D spending going to the areas contributing most significantly to Norway's energy supply and wealth. Since the last in-depth review, further attempts to focus petroleum-related R&D have been made with the creation of the OG21 research strategy. OG21 is successfully delivering the research strategy and priorities required to keep the NCS an attractive exploration and production area, and to create knowledge and skills among Norwegian technology suppliers that will enable them to compete successfully in other basins as well. PETROMAKS is a focused research programme implementing the OG21 strategy. PETROMAKS is currently giving priority to EOR. This is in line with government policy that is trying to achieve an ambitious long-term scenario for the petroleum production on the NCS. Results from this programme will also contribute to EOR worldwide, and the government should be commended for its efforts in this research area.

Norway is a world leader in developing carbon capture and storage (CCS) technology, with the Sleipner field operating successfully since 1996 and the proposed Snøhvit project coming on stream in 2006. The level of government support for R&D and implementation of CCS is substantial and puts Norway in the forefront of the development of this technology.

Non-petroleum research is covered by the RENERGI programme, which was established in 2004 by consolidating almost all existing non-petroleum energy R&D programmes. RENERGI is managed directly by the NFR and covers a wide range of topics with relatively broad objectives. It provides the NFR with the opportunity to establish a comprehensive strategy for energy R&D and facilitates collaboration and interdisciplinary research, in line with the task set for the NFR by the government. Considering the scope of the programme and the increasing need for renewable and energy-efficient technologies, questions arise about whether the programme's funding is adequate. RENERGI's wide range and comparatively limited funding may lead to insufficient funding being available for any particular area, and require prioritisation among the research areas. The government may consider a more targeted approach to ensure that particular research areas receive sufficient funding to enable the creation of world-leading expertise in them in Norway. The prioritisation approach taken in OG21 could also be considered for RENERGI.

The strong involvement of the private sector is also commendable. OG21 is a successful attempt to closely involve industry players in the management of research activities. Identifying nine technology target areas with the lead parties seems to be working well to ensure successful public-private collaboration, which is critical to the implementation of OG21. Lead parties are ensuring that R&D is carried out with a focus on results that are applicable to the industry and that sufficient resources are present. This has led to a high rate of additional spending by the petroleum industry, at a rate of NOK 3-4 spent by industry for every NOK 1 spent by government.

Norway is also keen on monitoring and assessment of the energy R&D programmes. NFR is determining the goals of the individual programmes and will evaluate the results to optimise the programme taking account of the evaluation results. As discussed above, close involvement of energy industry players would ensure good monitoring of the results.

Government R&D in energy is influenced by all ministries and involves a number of second-tier institutions, of which the NFR is the most important. Overall co-ordination is provided by the Ministry of Education and Research, which co-ordinates the political level of research. The NFR has three distinct roles: as a government advisor, as a funding agency, and as a co-ordinator. Its role as a co-ordinator, in initiating networks and promoting co-operation and collaboration between research institutions, ministries, other sources of funding, and users of research, is invaluable. The research networks of the NFR provide a rich source of information that should flow both horizontally and upwards.

Another player in energy-related R&D is Enova. Enova's mandate includes the introduction and demonstration of new technologies. Enova's collaboration with the NFR provides assurance that the successful results of R&D from RENERGI will be demonstrated and deployed. Deployment is normally the stage along the innovation spectrum where many new technologies fail. Norway should be commended for giving Enova the mandate to aid the commercialisation of new energy technologies.

Norway has set up Gassnova as an agency dedicated to develop technological solutions for CCS and reduced emissions from onshore gas use. The agency is financed from the returns of a NOK 2 billion fund set apart for this purpose, following the successful Enova model, and promises to achieve quick successes. The set-up and work of the agency appears to be exemplary, and the government should be commended for its initiative in this area. Norway should ensure that Gassnova has the resources to manage the technological and project co-ordination issues in the complex field, while participating in international information exchange. The range of Gassnova's mandate – to support studies, pilot-scale testing, and demonstration projects related to gas power plants with CO_2 capture, transport and storage or EOR use, in conjunction with the national gas power programme "CLIMIT" – represents a well-designed and effective response to address a national priority issue. Norway should be commended on this comprehensive approach to technology development in response to a national priority.

Norway is very well integrated in international research networks, and participates actively in international research projects. Norway is very active in the IEA, and Enova is involved in a number of Intelligent Energy Europe projects, providing significant co-financing for these projects. The access to Norwegian research information is generally high given the availability of bilingual information in Norwegian and English. Norway should be commended for this high level of international co-operation.

RECOMMENDATIONS

The government of Norway should:

- *Examine the appropriateness of the current level of funding for energy R&D taking into account the importance of the energy sector for Norway.*

- *Continue to give the NFR the flexibility to manage the energy R&D programmes, in alignment with strategic guidance, to ensure the optimal mixture of top-down and bottom-up approaches to R&D management.*

- *Examine potential synergies between the PETROMAKS and RENERGI programmes with a view to realising any potential synergies in the underlying sciences.*

- *Continue and further deepen the commendable efforts in the area of international R&D collaboration through the IEA and the EU Research and Technology Development Framework Programmes, and through other bilateral initiatives such as Norway's recently adopted Strategy for Research and Technology Co-operation with North America.*

ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY

		1973	1990	2002	2003	2010	2020	2030
TOTAL PRODUCTION		8.08	120.30	234.18	233.21	..	..	..
Coal		0.29	0.20	1.43	1.98	..	..	..
Oil		1.52	84.51	161.05	154.40	..	..	..
Gas		–	24.14	59.15	66.25	..	..	..
Comb. Renewables & Waste[1]		–	1.03	1.40	1.48	..	..	..
Nuclear		–	–	–	–	..	..	..
Hydro		6.27	10.42	11.13	9.07	..	..	..
Geothermal		–	–	–	–	..	..	..
Solar/Wind/Other[2]		–	0.00	0.02	0.03	..	..	..
TOTAL NET IMPORTS[3]		6.15	-96.94	-205.40	-208.77	..	..	..
Coal	Exports	0.09	0.17	1.38	1.81	..	..	..
	Imports	0.67	0.84	0.69	0.71	..	..	..
	Net Imports	0.58	0.67	-0.69	-1.10	..	..	..
Oil	Exports	3.58	78.10	154.57	152.36	..	..	..
	Imports	10.23	4.47	4.34	4.41	..	..	..
	Bunkers	0.64	0.45	0.67	0.57	..	..	..
	Net Imports	6.01	-74.08	-150.90	-148.52	..	..	..
Gas	Exports	–	22.17	53.01	59.88	..	..	..
	Imports	–	–	–	–	..	..	..
	Net Imports	–	-22.17	-53.01	-59.88	..	..	..
Electricity	Exports	0.45	1.40	1.29	0.48	..	..	..
	Imports	0.01	0.03	0.46	1.15	..	..	..
	Net Imports	-0.45	-1.37	-0.84	0.68	..	..	..
TOTAL STOCK CHANGES		0.41	-1.87	0.03	-1.09	..	..	..
TOTAL SUPPLY (TPES)		14.63	21.49	28.81	23.35	..	..	..
Coal		0.91	0.86	0.81	0.79	..	..	..
Oil		7.90	8.57	10.11	4.88	..	..	..
Gas		–	1.98	6.14	6.37	..	..	..
Comb. Renewables & Waste[1]		–	1.03	1.43	1.53	..	..	..
Nuclear		–	–	–	–	..	..	..
Hydro		6.27	10.42	11.13	9.07	..	..	..
Geothermal		–	–	–	–	..	..	..
Solar/Wind/Other[2]		–	0.00	0.02	0.03	..	..	..
Electricity Trade[4]		-0.45	-1.37	-0.84	0.68	..	..	..
Shares (%)								
Coal		*6.2*	*4.0*	*2.8*	*3.4*	..	..	..
Oil		*54.0*	*39.9*	*35.1*	*20.9*	..	..	..
Gas		–	*9.2*	*21.3*	*27.3*	..	..	..
Comb. Renewables & Waste		–	*4.8*	*5.0*	*6.5*	..	..	..
Nuclear		–	–	–	–	..	..	..
Hydro		*42.8*	*48.5*	*38.6*	*38.9*	..	..	..
Geothermal		–	–	–	–	..	..	..
Solar/Wind/Other		–	–	*0.1*	*0.1*	..	..	..
Electricity Trade		*-3.1*	*-6.4*	*-2.9*	*2.9*	..	..	..

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

Please note: Oil production and export data reported to the IEA for 2002 and 2003 are under investigation by Statistics Norway.
As a consequence, revisions to these data should be included in next year's edition of the publication. Forecasts are not available.

Unit: Mtoe

DEMAND

FINAL CONSUMPTION BY SECTOR

	1973	1990	2002	2003	2010	2020	2030
TFC	**13.73**	**18.03**	**20.64**	**20.93**	**..**	**..**	**..**
Coal	0.81	0.78	0.71	0.70	..	..	..
Oil	7.68	7.96	8.64	9.20	..	..	..
Gas	0.01	–	0.51	0.70	..	..	..
Comb. Renewables & Waste[1]	–	0.90	1.22	1.28	..	..	..
Geothermal	–	–	–	–	..	..	..
Solar/Wind/Other	–	–	–	–	..	..	..
Electricity	5.23	8.33	9.38	8.86	..	..	..
Heat	–	0.07	0.17	0.19	..	..	..
Shares (%)							
Coal	*5.9*	*4.3*	*3.5*	*3.3*	..	..	..
Oil	*55.9*	*44.1*	*41.9*	*44.0*	..	..	..
Gas	*0.1*	–	*2.4*	*3.4*	..	..	..
Comb. Renewables & Waste	–	*5.0*	*5.9*	*6.1*	..	..	..
Geothermal	–	–	–	–	..	..	..
Solar/Wind/Other	–	–	–	–	..	..	..
Electricity	*38.1*	*46.2*	*45.5*	*42.3*	..	..	..
Heat	–	*0.4*	*0.8*	*0.9*	..	..	..
TOTAL INDUSTRY[5]	**6.96**	**7.89**	**8.55**	**9.25**	**..**	**..**	**..**
Coal	0.76	0.77	0.71	0.70	..	..	..
Oil	3.01	2.79	2.73	3.10	..	..	..
Gas	0.00	–	0.50	0.69	..	..	..
Comb. Renewables & Waste[1]	–	0.38	0.52	0.57	..	..	..
Geothermal	–	–	–	–	..	..	..
Solar/Wind/Other	–	–	–	–	..	..	..
Electricity	3.20	3.94	4.08	4.17	..	..	..
Heat	–	0.02	0.02	0.03	..	..	..
Shares (%)							
Coal	*10.9*	*9.7*	*8.3*	*7.5*	..	..	..
Oil	*43.2*	*35.4*	*31.9*	*33.5*	..	..	..
Gas	–	–	*5.8*	*7.4*	..	..	..
Comb. Renewables & Waste	–	*4.8*	*6.0*	*6.1*	..	..	..
Geothermal	–	–	–	–	..	..	..
Solar/Wind/Other	–	–	–	–	..	..	..
Electricity	*45.9*	*49.9*	*47.7*	*45.1*	..	..	..
Heat	–	*0.2*	*0.3*	*0.3*	..	..	..
TRANSPORT[6]	**2.62**	**4.22**	**4.71**	**4.78**	**..**	**..**	**..**
TOTAL OTHER SECTORS[7]	**4.15**	**5.92**	**7.37**	**6.90**	**..**	**..**	**..**
Coal	0.06	0.01	0.00	0.00	..	..	..
Oil	2.10	1.02	1.36	1.47	..	..	..
Gas	0.01	–	0.01	0.01	..	..	..
Comb. Renewables & Waste[1]	–	0.52	0.71	0.72	..	..	..
Geothermal	–	–	–	–	..	..	..
Solar/Wind/Other	–	–	–	–	..	..	..
Electricity	1.98	4.31	5.15	4.54	..	..	..
Heat	–	0.06	0.15	0.16	..	..	..
Shares (%)							
Coal	*1.3*	*0.2*	–	–	..	..	..
Oil	*50.6*	*17.2*	*18.4*	*21.3*	..	..	..
Gas	*0.2*	–	*0.1*	*0.1*	..	..	..
Comb. Renewables & Waste	–	*8.7*	*9.6*	*10.4*	..	..	..
Geothermal	–	–	–	–	..	..	..
Solar/Wind/Other	–	–	–	–	..	..	..
Electricity	*47.8*	*72.9*	*69.9*	*65.8*	..	..	..
Heat	–	*1.0*	*2.0*	*2.3*	..	..	

Unit: Mtoe

DEMAND

ENERGY TRANSFORMATION AND LOSSES

	1973	1990	2002	2003	2010	2020	2030
ELECTRICITY GENERATION[8]							
INPUT (Mtoe)	**6.31**	**10.58**	**11.43**	**9.49**	..	..	..
OUTPUT (Mtoe)	**6.28**	**10.46**	**11.20**	**9.17**	..	..	..
(TWh gross)	73.03	121.61	130.28	106.67	..	..	..
Output Shares (%)							
Coal	*0.0*	*0.2*	*0.1*	*0.1*	..	..	..
Oil	*0.2*	*0.0*	*0.0*	*0.0*	..	..	..
Gas	–	–	*0.2*	*0.3*	..	..	..
Comb. Renewables & Waste	–	*0.2*	*0.2*	*0.4*	..	..	..
Nuclear	–	–	–	–	..	..	..
Hydro	*99.8*	*99.6*	*99.3*	*98.9*	..	..	..
Geothermal	–	–	–	–	..	..	..
Solar/Wind/Other	–	–	*0.2*	*0.3*	..	..	..
TOTAL LOSSES	**0.86**	**3.67**	**4.27**	**4.45**	..	..	..
of which:							
Electricity and Heat Generation[9]	0.03	0.03	0.05	0.08	..	..	..
Other Transformation	0.09	–0.03	–0.42	–0.51	..	..	..
Own Use and Losses	0.73	3.66	4.64	4.88	..	..	..
Statistical Differences	**0.05**	**–0.20**	**3.90**	**–2.03**	..	..	..

INDICATORS

	1973	1990	2002	2003	2010	2020	2030
GDP (billion 2000 USD)	63.75	115.80	173.82	174.54	..	..	..
Population (millions)	3.96	4.24	4.54	4.57	..	..	..
TPES/GDP[10]	0.23	0.19	0.17	0.13	..	..	..
Energy Production/TPES	0.55	5.60	8.13	9.99	..	..	..
Per Capita TPES[11]	3.70	5.07	6.35	5.11	..	..	..
Oil Supply/GDP[10]	0.12	0.07	0.06	0.03	..	..	..
TFC/GDP[10]	0.22	0.16	0.12	0.12	..	..	..
Per Capita TFC[11]	3.47	4.25	4.55	4.58	..	..	..
Energy-related CO_2 Emissions (Mt CO_2)[12]	24.2	28.7	33.1	35.8	..	..	..
CO_2 Emissions from bunkers (Mt CO_2)	2.8	2.7	3.3	2.4	..	..	..

GROWTH RATES (% per year)

	73–79	79–90	90–02	02–03	03–10	10–20	20–30
TPES	4.0	1.4	2.5	–19.0	..	..	..
Coal	1.4	–1.3	–0.5	–3.0	..	..	..
Oil	2.2	–0.4	1.4	–51.8	..	..	..
Gas	–	9.8	9.9	3.7	..	..	..
Comb. Renewables & Waste	–	5.6	2.8	6.9	..	..	..
Nuclear	–	–	–	–	..	..	..
Hydro	3.3	2.9	0.6	–18.5	..	..	..
Geothermal	–	–	–	–	..	..	..
Solar/Wind/Other	–	–	–	52.9	..	..	..
TFC	3.5	0.6	1.1	1.4	..	..	..
Electricity Consumption	3.6	2.3	1.0	–5.6	..	..	..
Energy Production	33.7	9.1	5.7	–0.4	..	..	..
Net Oil Imports	–	20.4	6.1	–1.6	..	..	..
GDP	4.9	2.8	3.4	0.4	..	..	..
Growth in the TPES/GDP Ratio	–0.9	–1.4	–0.9	–19.3	..	..	..
Growth in the TFC/GDP Ratio	–1.4	–2.2	–2.2	1.0	..	..	..

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 main activity producer utilities (formerly known as public) and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of 100% for hydro.

10 Toe per thousand US dollars at 2000 prices and exchange rates.

11 Toe per person.

12 "Energy-related CO_2 emissions" have been estimated using the IPCC Tier I Sectoral Approach. In accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals.

INTERNATIONAL ENERGY AGENCY "SHARED GOALS"

Member countries of the 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 IEA members wish to retain and improve the nuclear

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

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 cost-effective 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. International co-operation 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 used within the International Energy Agency. While these terms generally have been written out on first mention and subsequently abbreviated, this glossary provides a quick and central reference for many of the abbreviations used.

b/d	barrels per day.
bcm	billion cubic metres.
bscm oe	billion standard cubic metres of oil equivalent.
boed	barrels of oil equivalent per day.
CCGT	combined-cycle gas turbine.
CCS	carbon capture and storage.
CHP	combined production of heat and power; sometimes when referring to industrial CHP, the term "co-generation" is used.
EC	European Commission.
EIA	Environmental Impact Assessment.
EU	European Union.
GDP	gross domestic product.
GHG	greenhouse gases.
GPS	Global Positioning System.
GW	gigawatt, or 1 watt x 10^9.
GWh	gigawatt-hour = 1 gigawatt x 1 hour.
IEA	International Energy Agency.
kcal	kilocalorie, or 1 cal x 10^3.
km^2	square kilometre.

kt	kilotonne.
ktoe	thousand tonnes of oil equivalent; see toe.
kW	kilowatt, or 1 watt x 10^3.
kWh	kilowatt-hour = 1 kilowatt x one hour.
kV	kilo-volt, or 1 volt x 10^3.
LNG	liquefied natural gas.
LPG	liquefied petroleum gas.
LRTAP	Long-range transboundary air pollution
m	metre.
m^2	square metre.
mboe	million barrels of oil equivalent.
mcm	million cubic metres.
MPE	Ministry of Petroleum and Energy
Mpkm	million passenger-kilometres
mscm oe	million standard cubic metres of oil equivalent.
Mt	million tonnes.
Mtce	million tonnes of coal equivalent.
Mtkm	million tonne-kilometres (a measure of freight transport).
Mtoe	million tonnes of oil equivalent; see toe.
MW	megawatt, or 1 watt x 10^6.
MWh	megawatt-hour = 1 megawatt x one hour.
NCS	Norwegian Continental Shelf.
NFR	Norges Forskningsråd (Research Council of Norway)
NH_3	ammonia.

NO_x	nitrogen oxide.
NOK	Norwegian crown = USD 0.148 in 2004.
NPD	Norwegian Petroleum Directorate.
NVE	Norwegian Water Resources and Energy Directorate.
PDO	plan for development and operation.
R&D	research and development, especially in energy technology; may include the demonstration and dissemination phases as well.
scm	standard cubic metre.
SO_2	sulphur dioxide.
Storting	the Norwegian parliament.
tce	tonne of coal equivalent..
TFC	total final consumption of energy.
toe	tonne of oil equivalent, defined as 10^7 kcal.
TPA	third-party access.
TPES	total primary energy supply.
TSO	transmission system operator.
TW	terawatt, or 1 watt x 10^{12}.
TWh	terawatt-hour =1 terawatt x 1 hour.
UNFCCC	United Nations Framework Convention on Climate Change.
VAT	value-added tax.

IEA PUBLICATIONS, 9, rue de la Fédération, 75739 PARIS CEDEX 15
PRINTED IN FRANCE BY STEDI Média
(61 2005 191 P1) ISBN : 92-64-109-358 – 2005