International Energy Agency

Energy Policies of IEA Countries

Norway

2011 Review

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Norway

Norway has a unique twin role as a major oil and gas producer and a strong global advocate of climate change mitigation. As the third-largest exporter of energy in the world, it contributes to global energy security by providing reliable supplies to consuming countries. At the same time, the Norwegians highly value environmental sustainability and the country is taking climate policy very seriously. Norway also manages its petroleum resources and revenue in a commendable way, setting a model for other countries. The challenge now for the government is to stimulate further increases in natural gas and petroleum production from safe and environmentally sustainable operations.

Norway's large potential for hydropower generation is an asset, as European electricity markets are integrating and variable renewable energy generation is set to increase. More cross-border interconnections are needed to realise the full potential of hydropower for balancing variations in demand and supply in the regional market. Increased interconnections would also improve electricity security in Norway in times of low hydropower availability. Gas-fired power plants should also be considered for use for the same purpose.

In order to meet its ambitious targets to reduce greenhouse gas emissions, Norway needs to step up efforts at home. Although the dominance of low-carbon electricity in the energy mix limits the scope for domestic measures, large potential for emission reductions remains in oil and gas production, manufacturing and transport. However, measures to promote energy efficiency and renewable energy should be carefully designed, because they often focus on electricity and would thus not reduce emissions. Recent large increases in spending on energy RD&D and ongoing efforts to develop carbon capture and storage are very welcome.

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INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 28 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

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Japan
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Netherlands
New Zealand
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The European Commission also participates in the work of the IEA.

International Energy Agency

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EXECUTIVE SUMMARY

Norway has a unique twin role as a major oil and gas producer and is a strong global advocate of climate change mitigation. As the third-largest exporter of energy in the world, after Russia and Saudi Arabia, Norway contributes to the energy security of consuming countries. At the same time, as Norwegians highly value environmental sustainability, the country is taking climate policy very seriously.

Norway has set itself an ambitious target to reduce global greenhouse gas emissions by 30% of Norwegian 1990 levels by 2020, and to become carbon-neutral by 2050. Meeting the 2020 target will be challenging, because both the country's electricity supply and energy use in buildings are already essentially carbon-free. Norway is determined and, with its large petroleum revenue, well placed to invest in developing new solutions for a low-carbon future.

OIL AND GAS

Oil and natural gas production is the largest sector in the Norwegian economy and will continue to generate significant wealth for the country as well as benefits for other countries. As a reliable and transparent supplier, Norway improves the energy security of a large number of IEA member countries. It has a consistent and predictable regulatory framework for exploration and production, and it manages both its petroleum resources and revenue in a transparent and competent manner. The IEA acknowledges Norway's contribution to global energy security and regards its petroleum resource and revenue management as commendable and a model for other countries to follow.

The IEA *World Energy Outlook 2010* contains three scenarios for global energy supply to 2035. In all three, oil and natural gas use is expected to increase beyond 2020 and, in the absence of strong new measures to limit CO_2 emissions, up to 2035. Against this background of rising demand for oil and gas, the IEA welcomes the Norwegian government's efforts to encourage increases in production and recovery. It urges the government to continue to do so by opening new acreage for exploration and by offering additional favourable fiscal and regulatory incentives, when appropriate. In this context, the IEA also welcomes the treaty between Norway and Russia which settles the maritime delimitation between the two countries in the Barents Sea and Arctic Ocean.

Environmental considerations are well integrated in the government policy on the management of petroleum resources, and the IEA encourages the government to continue to develop innovative acreage management approaches in an environmentally sound manner to stimulate exploration and production in both frontier and mature areas.

While oil production is expected to continue to decline, gas production is set to increase, leading to larger exports. Investments in transportation capacity are needed to avoid bottlenecks for the new gas from the Norwegian Sea and to allow Norway to maintain its

position as a major gas supplier to Europe. The IEA encourages the government to continue to facilitate investments in gas pipelines in light of the continuous need for securing regularity and integrity in the gas transport system.

REGIONAL ELECTRICITY MARKET

Norway deserves to be commended for the continued reliable and efficient performance of the electricity sector over the past few years. The country forms part of the regional Nordic wholesale market which is widely regarded as the model for effective cross-border market integration. Together with its Nordic neighbours, Norway is dedicated to developing the market further.

The prospects of regional integration of European electricity markets and anticipated renewable energy developments put Norway, with its large hydropower capacity, in a favourable strategic position. Many countries bordering on the North Sea and therefore close to Norway, including Germany, the United Kingdom and the Netherlands, plan to significantly increase their wind power capacity to meet their EU 2020 targets, in total by tens of gigawatts. To a smaller extent, Sweden and Norway will also be adding more wind power capacity.

Hydropower and natural gas are the most suitable technologies for backing up variable wind power generation. Norway has significant hydropower reservoir capacity and Statnett, the Norwegian transmission system operator, is planning for several new cross-border interconnections which will strengthen integration between the Nordic market and the rest of Europe. The IEA encourages Norway to use its hydropower capacity, the largest in Europe after Russia, to balance variations in demand and supply in the expanding regional market. This would increase flexibility and efficiency in the integrating regional electricity market and, therefore, enhance European electricity security.

Increased interconnections would also improve electricity security in Norway, because the almost complete dominance of hydropower in the generating mix exposes the country to supply constraints in times of low hydropower availability. Another relatively easy way to improve security of electricity supply, given Norway's natural gas production, would be to build gas-fired power plants. However, the government does not permit new gas-fired plants without carbon capture and storage (CCS) technology. This effectively rules out the gas option until CCS becomes more competitive.

Against the long-term need to decarbonise the power sector worldwide, it is perfectly understandable for Norway to avoid building more unabated carbon-intensive power capacity, but from the medium-term regional perspective, the matter looks different. In times of low hydropower availability in the Nordic market area, power is often imported from the region's coal-fired plants to meet demand in Norway. As a result, more CO_2 is emitted than would be necessary. The regulation also limits the use of natural gas as backup for wind power. Combined-cycle gas turbine plants would help reduce the carbon intensity of power generation, because under the EU Emissions Trading Scheme (EU-ETS), of which Norway is part, they would help push power plants with higher CO_2 emissions per kilowatt-hour gradually out of operation. The government should consider temporarily allowing the construction of gas-fired plants without CCS, but with readiness to install CCS, so as to enable to meet electricity demand in the Nordic market and in the EU-ETS area with lower total CO_2 emissions, and to help ensure security of supply.

Increasing consumer participation can provide an important source of flexibility in power systems. As a short-term measure, demand-side bidding in the balancing market is a best practice that other countries should consider. Over the long term, probably the most economical way to meet incremental demand is through the "negawatts" achieved by saving energy, but a considerable challenge for policy makers is to find effective ways to promote them in a country of generally low power prices and a very high level of per-capita use. Taxation, investment subsidies and regulation are among the options.

With its ample hydropower capacity, Norway could also help its neighbours to move towards a low-carbon future. The government should encourage further integration of the Nordic electricity market, both internally and with other market areas, to improve overall efficiency, flexibility and security of power supply. To this end, the government should facilitate increasing cross-border interconnections and demand-side measures.

CARBON NEUTRALITY

Norway has devoted considerable attention to environmental sustainability, and climate change mitigation enjoys broad popular and political support. Norway's global responsibility is manifested in the decision to assume a national emissions reduction target that goes beyond the country's target under the Kyoto Protocol (-9% vs. +1% from 1990 to 2008-2012). Regarding the post-2012 period, Norway has pledged to cut global greenhouse gas emissions by the equivalent of 30% of its 1990 emissions by 2020. Norway has also declared its ambition to become carbon-neutral (taking into account its contribution to emissions reductions abroad) by 2050 and, if a sufficient number of countries take on major obligations, to bring this target forward to 2030. With its strong commitment to global climate change mitigation, Norway has set a fine example to other countries.

In many ways, Norway already is a lower-carbon economy than most others by virtue of the historical predominance of hydropower. Widespread use of electricity, also for heating, means that energy use in buildings is already essentially decarbonised. The challenge is that only oil and gas production, manufacturing and transport have large potential for further cuts in energy-related greenhouse gas emissions. Norway should continue to consider further measures to internalise the costs of CO_2 emissions from these sectors.

Since the Parliament's 2008 Climate Agreement, public spending on climate change mitigation has increased substantially. Public funding for research, development and deployment (RD&D) of clean energy more than tripled from 2007 to 2009. In per-capita terms, public funding for all energy RD&D is the third-highest among the IEA member countries. Investment support for promoting energy efficiency and renewable energy through Enova, the government agency, was increased by NOK 1.2 billion (USD 191 million, EUR 137 million) from 2008 to 2009, in line with IEA's calls for green stimulus packages. Norway deserves applause for this intensified focus on climate change mitigation.

The IEA's view is that a global energy technology revolution is needed to meet climate change and energy security challenges. Norway's intensified focus on RD&D therefore is very welcome. The country is already showing global leadership as one of the front-runners in carbon capture and storage. It hosts two of the world's five large-scale CCS projects, and the government is strongly committed to significant support of further CCS technology development, demonstration and widespread deployment. Recent Norwegian RD&D efforts have also produced the world's first floating wind turbine, Hywind.

Long-term improvements in energy efficiency in buildings are guaranteed by the strict building code, introduced in 2007. The country has also set the passive house standard as the target level for the building code by 2020 and is working towards this goal in multi-stakeholder partnerships. In the transport sector, Norway's incentives for the uptake of electric vehicles are strong by international comparison; they include exemptions from toll road charges and various taxes, free access to public parkings and funding for infrastructure developments. The government is also planning to substantially increase public transport and the use of rail in freight transport.

Progress has been made also in the renewable energy sector. Norway has recently adopted an offshore wind strategy and is now taking steps to utilise the significant potential in the sector, amounting to tens of terawatt-hour (TWh) per year. The country also has untapped hydropower potential in tens of TWh and is likely to develop it under the green certificates market with Sweden, to be launched in January 2012. More detailed plans for renewable energy will be developed after agreeing on the terms for adopting the EU 2009 Directive on Renewable Energy in Norway and in the European Economic Area (EEA).

Measures to promote energy efficiency and renewable energy have to be particularly well targeted, because they will not necessarily contribute to carbon neutrality. This is because measures often target electricity generation or use, but electricity supply is already practically carbon-free. The government should also be careful to avoid any possible negative impacts from increases in renewable electricity supply on the incentives to use electricity more efficiently. Commendably, in its support policies and climate strategy, Norway is using cost-effectiveness as a key criterion (NOK/kWh, NOK/tonne of CO_2 avoided) for prioritising across measures. As mitigation efforts at home will likely be more expensive than purchasing emission credits from abroad, the government should also remain open to such purchases, as implied by the global nature of the carbon neutrality goal. To clarify the way forward, the government should develop a roadmap towards the objective of carbon neutrality. Once adopted, it should ideally begin to implement the roadmap without delay.

KEY RECOMMENDATIONS

The government of Norway should:

- *Stimulate further increases in petroleum production from safe and environmentally sustainable operations and continue to consider further measures to internalise the costs of CO_2 emissions from the sector.*
- *Promote further integration of the Nordic electricity market, both internally and with other market areas, to improve overall efficiency, flexibility and security of power supply; facilitate increasing cross-border interconnections and demand-side measures to this end.*
- *Develop and implement a roadmap towards the objective of carbon neutrality.*

PART I
POLICY ANALYSIS

Figure 1. Map of Norway

This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

2. GENERAL ENERGY POLICY

COUNTRY OVERVIEW

The Kingdom of Norway has a mainland area of 324 000 km^2 bordered on the east by Sweden and, within the Arctic Circle, by Finland and Russia. This includes some 50 000 islands that lie off a long, indented coastline along the North Sea, the Norwegian Sea and the Barents Sea in the Arctic Ocean. Norway also exercises sovereignty over Svalbard, an Arctic archipelago of 61 000 km^2 almost 1 000 km north of the mainland. The climate is considerably milder than at similar latitudes elsewhere, owing to the warm waters of the Gulf Stream. About two-thirds of Norway is mountainous and the mountains divide the country in both north-south and east-west directions.

The population of Norway was 4.9 million in September 2010; an increase of 0.4 million since 2001, mainly because of immigration. Norway is the least densely populated country in Europe after Iceland, with 15 inhabitants per square kilometre. Almost 80% of the population lives in urban settlements.

Norway is one of the richest countries in the world. It ranks second to Luxembourg among OECD countries in terms of GDP per capita, at USD 61 415 in 2009, according to the OECD statistics. Unemployment is low, at 3.2% in 2009. Average exchange rate of the Norwegian krona in 2009 was NOK 6.28 = USD 1; or NOK 8.74 = EUR 1.

The petroleum sector is the backbone of the Norwegian economy. In 2009, the sector generated 22% of GDP and 47% of exports. It also accounted for 26% of investment in the country and provided 27% of government revenue. The services sector contributed 56% to GDP, industry (including oil and gas) 43% and the primary sector 1%.

Norway is a constitutional monarchy, with a full parliamentary democracy. Executive power is vested formally in the King, but is exercised through the government headed by the Prime Minister. Legislative power is held by the *Storting*, the Norwegian parliament. Since autumn 2005, the country is governed by a centre-left coalition of the Labour Party, the Centre Party and the Socialist Left Party. The next general election is scheduled for September 2013.

As a member of the European Economic Area (EEA), Norway shares internal market legislation with the European Union and has therefore implemented several EU directives and regulations related to energy.

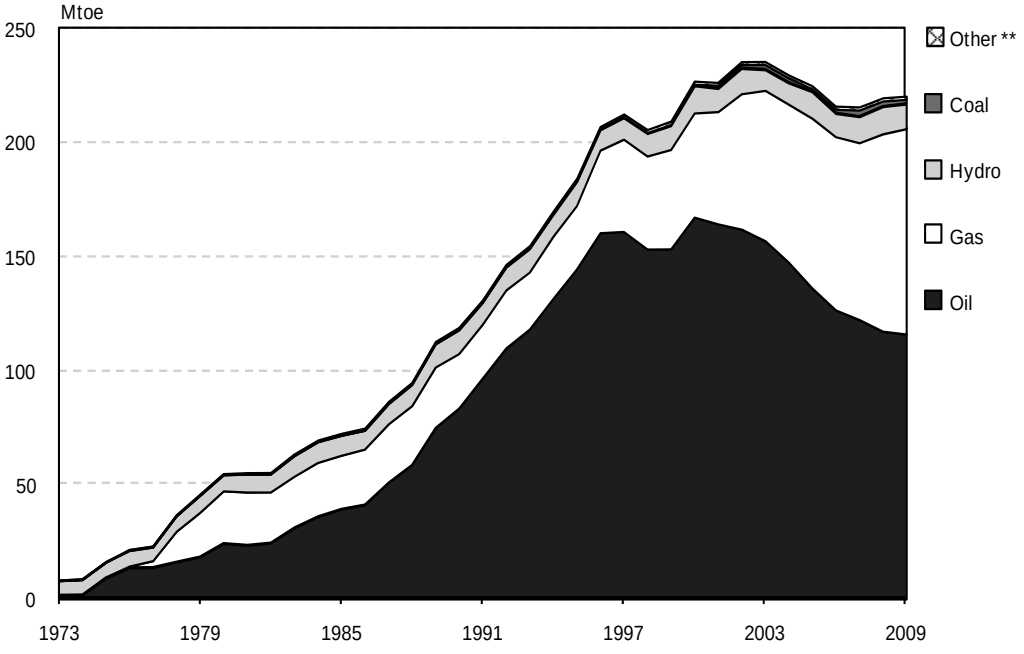
SUPPLY AND DEMAND

SUPPLY

Norway is the third-largest exporter of oil and gas in the world, after Russia and Saudi Arabia. In 2009, its energy production amounted to 220 million tonnes of oil equivalent (Mtoe), similar to the 2008 levels but 2% higher than in 2007 (Figure 2). Energy production increased fourfold in less than two decades, from 1980 to 1997, and has since then varied between 205 Mtoe and 235 Mtoe per year.

In 2009, oil accounted for a good half (52%) of Norway's indigenous production, but this share is in decline owing to the absolute reduction in oil production since 2001 and the increase in natural gas production. The share of natural gas in total production rose from 20% in 2000 to 41% in 2009. The remaining 7% of indigenous energy production came mainly from hydropower, while coal, biomass and wind power each contributed small amounts.

Figure 2. **Energy production by source, 1973 to 2009***



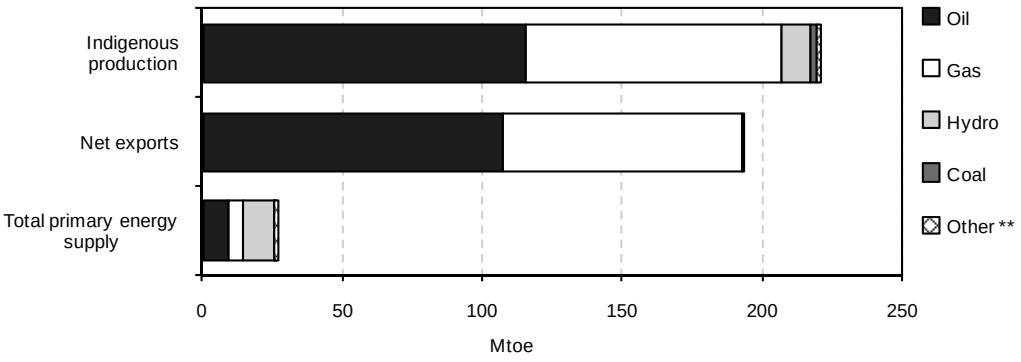
* Estimates for 2009.

** *Other* includes combustible renewables and waste, wind, and ambient heat used in heat pumps (negligible).

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010.

Norway exports most of its oil and gas production (Figure 3). In 2009, net exports were 192 Mtoe, or 93% of total oil and gas production. Norway's total primary energy supply (TPES) was 26.5 Mtoe in 2009 (Figure 4). Since 1990, TPES has increased on average by 1.3% per year, at less than half the pace of the economy (+2.8%). Norway's energy mix is dominated by hydropower, accounting for nearly 40% of TPES in 2009, followed by oil (34% of TPES) and natural gas (20%), Biomass and waste (5%) and coal (2%) are much smaller sources, and wind accounts for a negligible share. Compared to other IEA member countries, Norway has a relatively low share of fossil fuels, 55% of TPES, and it has by far the highest share of hydropower (Figure 5).

Figure 3. **Energy production and use by source, 2009***

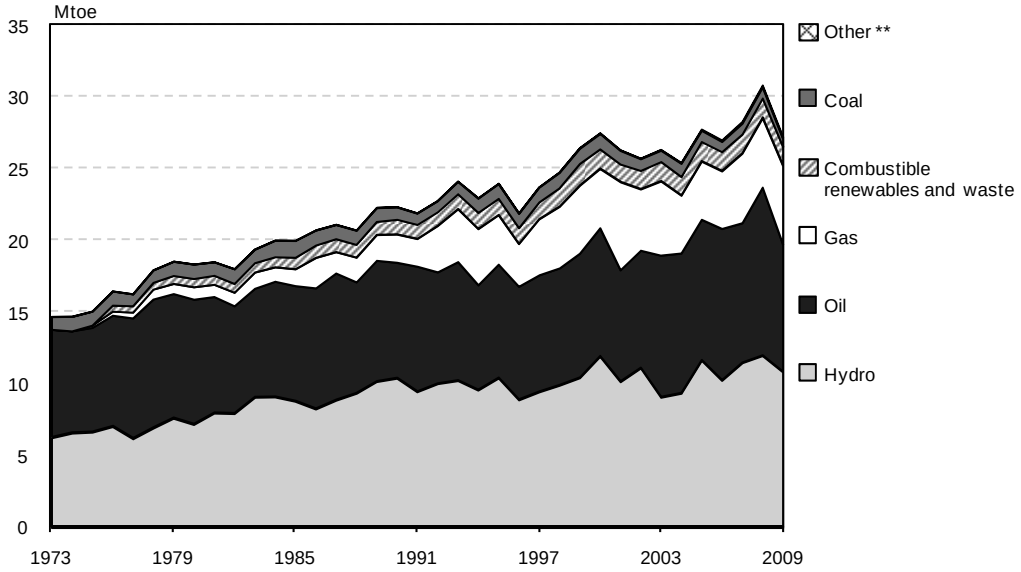


* Estimates.

** *Other* includes combustible renewables and waste, wind, and ambient heat used in heat pumps (negligible).

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010.

Figure 4. **Total primary energy supply, 1973 to 2009***



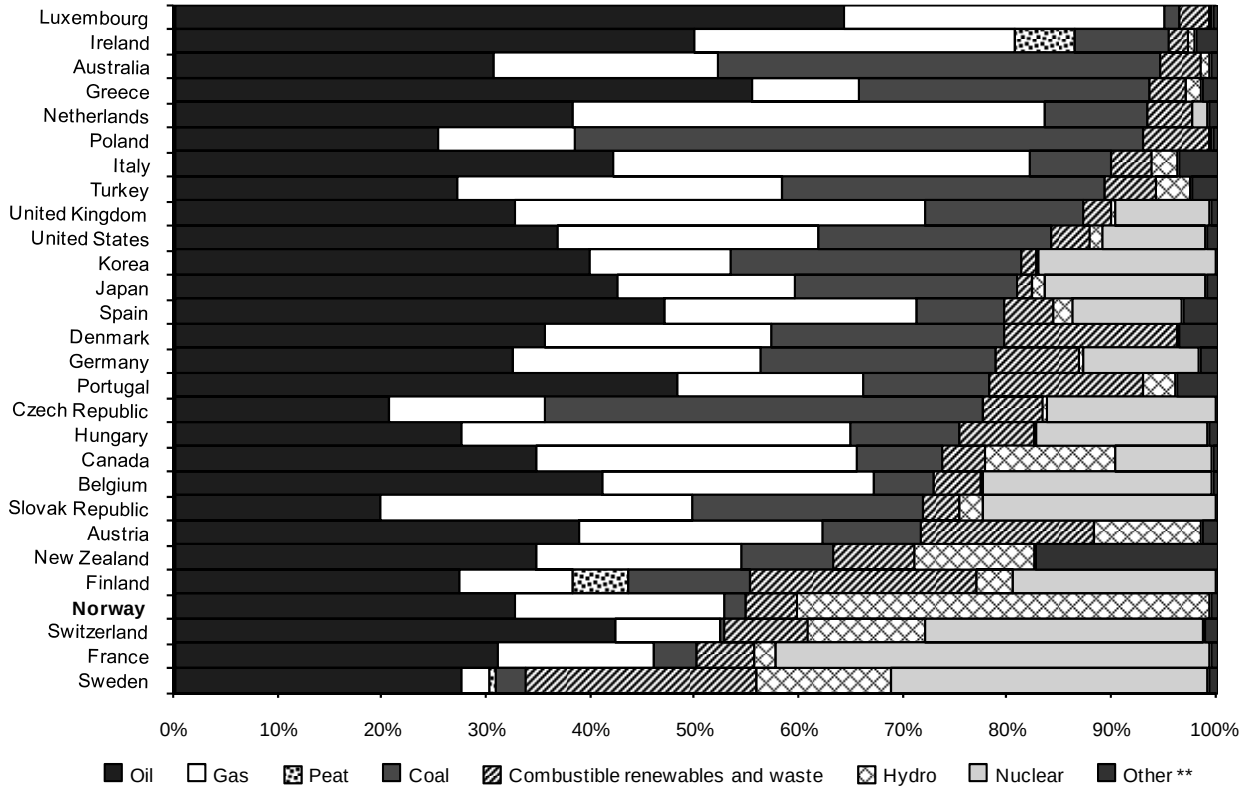
* Estimates for 2009.

** *Other* includes wind and ambient heat used in heat pumps (negligible).

Note: Supply of oil is the residual of two very large and opposite terms, production and exports. As a result, large statistical differences in some years may lead to discrepancies in the growth rates of oil supply and demand.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010.

Figure 5. **Breakdown of total primary energy supply by source in IEA member countries, 2009***



* Estimates.

** *Other* includes geothermal, solar, tide, wave, wind, and ambient heat production.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010.

Box 1. **Oil and natural gas supply in a global context**

Oil production in Norway is expected to continue to decline gradually, while natural gas production will likely increase from the current levels towards 2020 (see Chapter 5 on Fossil Fuels). Both trends are in line with the global scenarios presented in the IEA's *World Energy Outlook 2010* (WEO). They are consistent with keeping CO_2 emissions from energy use to levels that will limit the rise of global temperature to two degrees Celsius from pre-industrial times (450 Scenario).

According to the *WEO* scenarios, the global outlook for oil remains highly sensitive to policy action to curb rising demand and emissions. In the Current Policies and New Policies Scenarios, global primary oil use increases in absolute terms between 2009 and 2035, driven by population and economic growth, but demand falls in the 450 Scenario in response to radical policy action to curb fossil-fuel use (see Table 1).

Natural gas is set to play a central role in meeting the world's energy needs for at least the next two-and-a-half decades. Global natural gas demand grows across the three *WEO* scenarios, especially after 2015, though the rates of growth are markedly different, reflecting the differing impact of government energy and environmental policies. Nonetheless, demand is significantly higher in 2035 than in 2008 in each scenario (see Table 2).

Box 1. **Oil and natural gas supply in a global context** (continued)

Table 1. Primary oil demand* by region and scenario (mb/d)

			New Policies Scenario		Current Policies Scenario		450 Scenario	
	1980	2008	2020	2035	2020	2035	2020	2035
OECD	41.3	41.7	39.8	35.3	40.5	38.7	38.2	28
Non-OECD	20	35.8	44.1	54.6	45.4	59.4	42.2	45.6
Bunkers**	3.4	6.5	7.5	9.1	7.5	9.3	7.2	7.3
World	64.8	84	91.3	99	93.5	107.4	87.7	81
Share of non-OECD	33%	46%	53%	61%	53%	61%	52%	62%

* Excludes biofuels demand, which is projected to rise from 1.1 mb/d (in energy-equivalent volumes of gasoline and diesel) in 2009 to 2.3 mb/d in 2020 and to 4.4 mb/d in 2035 in the New Policies Scenario

** Includes international marine and aviation fuel.

Source: *World Energy Outlook 2010*. OECD/IEA Paris, 2010.

Table 2. **Primary natural gas demand by region and scenario** (bcm)

			New Policies Scenario		Current Policies Scenario		450 Scenario	
	1980	2008	2020	2035	2020	2035	2020	2035
OECD	958	1 541	1 625	1 758	1 637	1 840	1 528	1 330
Non-OECD	559	1 608	2 169	2 777	2 198	3 047	2 055	2 279
Bunkers*	1 517	3 149	3 794	4 535	3 835	4 888	3 584	3 609
World	37%	51%	57%	61%	57%	62%	57%	63%
Share of non-OECD	1980	2008	2020	2035	2020	2035	2020	2035

* Includes international marine and aviation fuel.

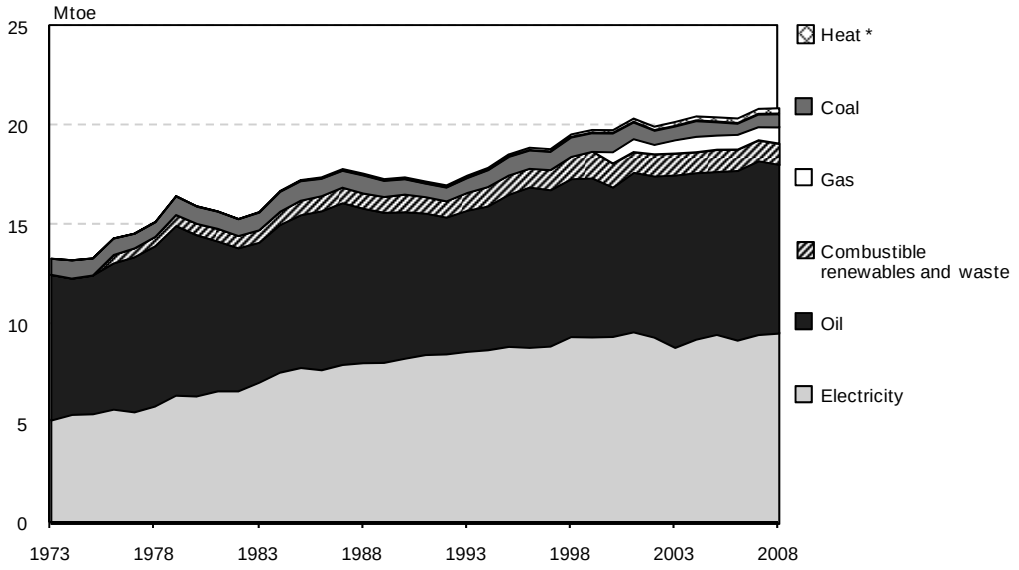
Source: *World Energy Outlook 2010*. OECD/IEA, Paris, 2010.

DEMAND

Norway's total final consumption of energy (TFC) was 21 Mtoe in 2008, the same as in 2007 and only 5.5% more than in 2000 (see Figure 6). Final energy mix has remained very stable over the last two decades. Since 1987, electricity is the main energy carrier used and its share was 46% in 2008. The second-largest energy source is oil. Its share has also remained relatively unchanged and was around 40% of TFC. Coal (3% of TFC), natural gas (4%) biomass and waste (5%) all contributed less than 1 Mtoe in 2008.

A large and mountainous country, Norway generates almost all of its electricity from abundant and affordable hydropower. This distinguishes Norway strongly from all other IEA members. Electricity use per capita is higher than in any other IEA member country and second only to Iceland in the world (Figure 7). In 2008, average use per capita was more than 23 megawatt-hour (MWh) in Norway, while the IEA average amounted to 9 MWh per capita and the world average to 2.5 MWh. Indeed, although energy use per capita is not far from the IEA average, electricity consumption ratio is very high, as this energy source often replaces oil and gas in industry and in space heating.

Figure 6. **Total final consumption by source, 1973 to 2008**

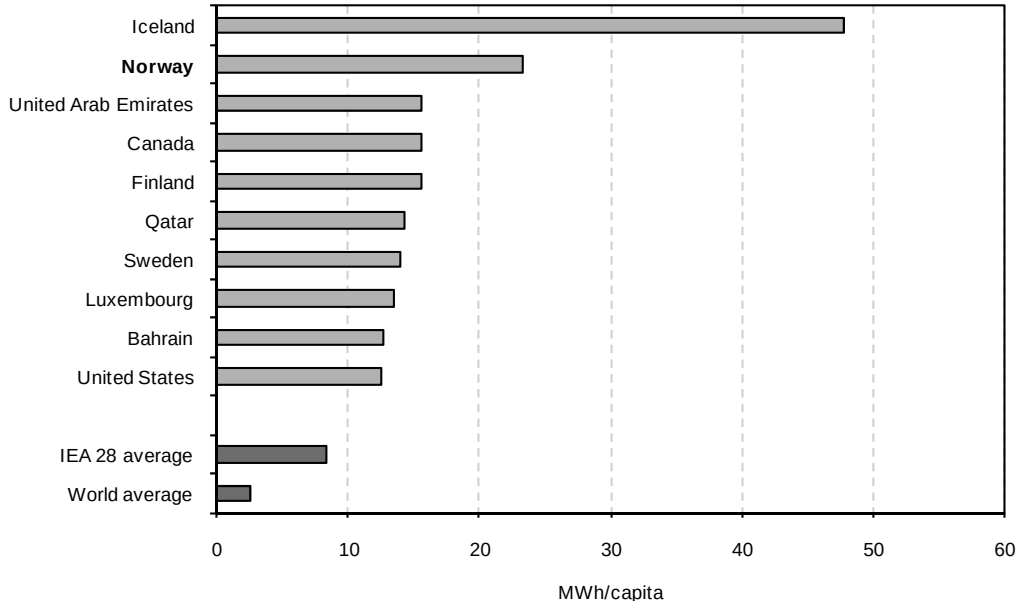


* Negligible.

Note: Data on gas final consumption are not available for the years before 2000.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2009.

Figure 7. **Electricity consumption per capita by country, 2008**



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010, and *Energy Balances of non-OECD Countries*, IEA/OECD Paris, 2010.

INSTITUTIONS

- The **Ministry of Petroleum and Energy** (MPE) holds the overall responsibility for the management of petroleum resources on the Norwegian Continental Shelf (NCS). This includes ensuring that the petroleum activities are carried out in accordance with the guidelines given by the *Storting* and the government. In addition, the ministry has a particular responsibility for supervising the state-owned corporations Petoro AS and Gassco AS. It also manages the state ownership in the oil company Statoil ASA in which the State holds a majority interest.

  MPE also ensures the sound management, in both economic and environmental terms, of water and hydropower resources and other domestic energy sources. On behalf of the government, MPE acts as the owner of Statnett and Enova (see below).

  The **Norwegian Petroleum Directorate** (NPD) manages petroleum resources and advises the MPE. It exercises authority in exploration and production of petroleum deposits on the Norwegian Continental Shelf. It is a subordinate agency of MPE.

  The **Norwegian Water Resources and Energy Directorate** (NVE) is a subordinate agency of the MPE responsible for the management of the energy and water resources on mainland Norway. Its task is to ensure coherent and environmentally sound management of river systems and to promote efficient electricity trading, cost-efficient energy systems and efficient energy use. NVE is the national regulatory authority for electricity. It also plays a central role in emergency response to flooding and dam failure, and heads contingency planning for power supply. It has duties regarding research and development and international co-operation. NVE also serves as Norway's national hydrological institution.

- The **Ministry of Labour and Government Administration** is responsible for the working environment in the petroleum sector, as well as for emergency response and safety aspects of the industry.

  The **Petroleum Safety Authority Norway** (PSA) is responsible for safety, emergency response and the working environment in the petroleum sector. It also regulates and supervises the use of land-based facilities relating to the petroleum industry. The PSA is subordinate to the Ministry of Labour and Government Administration.

- The **Ministry of the Environment** is responsible for environmental policy and also has an overall responsibility for climate policy.

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

- The **Norwegian Competition Authority** NCA (*Konkurransetilsynet*) monitors compliance with the Competition Act which regulates the parts of the power market that are subject to competition. The **Ministry of Government Administration and Reform** provides the framework for NCA's activities, and is the appellate body of NCA's decisions.

- **Statnett SF** is the transmission system operator. It owns about 87% of the transmission grid. It is owned by the government and supervised by MPE. Statnett's revenues are regulated by NVE, as part of NVE's regulation of monopoly operations.

- **Enova SF** is a public enterprise the task of wich is to promote energy savings, new renewable sources of energy and environment-friendly use of natural gas. MPE acts as its owner on behalf of the government. MPE also defines Enova's tasks and goals. Quantitative targets have been set for Enova's activities (see Box 2).

Box 2. **Enova SF**

Enova SF was established in 2002 as a public enterprise to promote energy savings, new renewable sources of energy and environment-friendly use of natural gas. To this end, it organises tenders for projects. Its target is to deliver 18 terawatt-hour (TWh) in energy conservation and renewable energy production by the end of 2011 and 40 TWh by 2020. By the end of December 2009, Enova had contracted projects with an estimated total energy result of 13.8 TWh per year. Of these, 5.1 TWh had been realised.

Enova is financed in an innovative way. In January 2002, the Energy Fund was established. It receives funds from an earmarked grid levy (currently NOK 0.01/kWh, around EUR 0.001/kWh) on the distribution tariff for electricity and directly from the state budget. In 2007 a new fund, the Basic Fund for Renewable Energy and Energy Efficiency (*Grunnfondet*), was created with a capital base of NOK 10 billion (EUR 1.14 billion). The capital base was later increased by NOK 10 billion in 2009 and by NOK 5 billion in 2010. The annual yield from the fund (a fixed interest rate on a 10-year basis) is transferred to the Energy Fund, subject to the approval of Parliament.

The administration of the Energy Fund is regulated by an agreement between 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 Parliament in the spring of 2000.

In 2009, Enova spent about NOK 3.4 billion (EUR 390 million), NOK 1.19 billion (EUR 136 million) of which was part of a government stimulus package, on projects involving renewable energy and energy efficiency.

Enova's aid schemes are aimed at triggering off investments as cost-effectively as possible. Projects with a high energy result per unit of aid are prioritised. Competition for aid between projects is an important principle. Enova's aid schemes also cover demonstration of immature technologies in order to bring research results to the market. However, Enova is not involved in R&D, which is under the remit of the Research Council of Norway. The different bodies have clearly defined roles along the innovation chain. Co-operation between Enova, the Research Council, Transnova and Innovation Norway is important to secure effectiveness in the different policy instruments (see Chapter 9 on RD&D). Co-operation is based on agreements and the different entities co-operate through joint activities, such as common conferences, instruction booklets, fact books and common studies.

The government evaluates Enova every four years. Following the 2006 evaluation, in 2010 the Ministry of Petroleum and Energy presented the evaluation of Enova’s results and activities for the period 2002-2009. The evaluation was presented to the Parliament in the Budget Proposition for 2011. It covers the organisational structure of the policy framework; the model of financing of Enova’s activities; targets, reporting and results; cost-effectiveness of measures across sectors and over time; additionality in the different aid schemes; project cancellations and the execution time for different project categories. Stability and the long-term perspective are key elements in the policy. The 2010 evaluation will be important for developing policies on renewable energy and energy efficiency.

KEY POLICIES

OIL AND GAS PRODUCTION

The government's main objective for the petroleum sector is to assure long-term management and value creation on the Norwegian Continental Shelf (NCS) within an environmentally acceptable framework and in coexistence with other users of Norway waters.

The petroleum activity is important for maintaining high employment and creating wealth in Norway. It is a key sector of the Norwegian economy and has contributed significantly to industrial development and the advancement of the Norwegian welfare society. A large part of the petroleum revenues devolves on the Norwegian State and contributes to the State's strong financial position.

Norwegian oil and gas exports help ensure security of supply in many IEA countries. Norway has attained the world's highest recovery rate for its offshore oil resources. Oil and gas are produced in an environment-friendly manner with low emissions of greenhouse gases (GHGs). Through various policy actions, the government's aim is for Norway to remain a world leader in this field, and thus to contribute to a global sustainable energy future.

ELECTRICITY SECTOR

Norway is a front-runner in electricity market liberalisation and cross-border integration. The country forms part of the regional Nordic wholesale market which is widely regarded as the model for effective cross-border market integration. Together with its Nordic neighbours, Norway is dedicated to developing the market further, including market coupling with other neighbouring market areas.

Efficient use of electricity resources requires a well-functioning electricity grid. The government emphasises the construction of new connections and the upgrading of existing ones domestically and across borders. The government also emphasises increased access to renewable energy and grants investment support to that end, in both electricity and heat generation. In September 2009 the governments of Sweden and Norway agreed on the principles of a common green certificates market. The Norwegian government intends to take on an obligation as ambitious as that of Sweden, and the intention is for the market to start on 1 January 2012.

Electricity accounts for close to a half of final energy consumption in Norway. In addition to increased energy production from renewable sources, a central element in the government's energy policy is to limit the growth in energy consumption and to make energy use more efficient. The government agency Enova is the main instrument to this end (see Box 2).

ENVIRONMENTAL PROTECTION

The government envisions Norway as a leader in the development of environment-friendly energy. Norway wants to be at the forefront in implementing new technologies which ensure a high degree of resource exploitation and the lowest possible emissions of greenhouse gases and other substances detrimental to the environment. The government wishes to align this leadership role with Norway's role as a petroleum producer and exporter. A key task is to develop new renewable energy and to minimise

CO_2 emissions from fossil fuel production. To this end, a comprehensive set of policy instruments has been developed to safeguard consideration for the natural environment in all phases of petroleum activities, from licensing rounds to exploration, development, operations and decommissioning. Also, all new concessions for gas-fired power plants shall be based on carbon capture and storage from the start-up.

In mitigating climate change, Norway has set a strict national target for the first commitment period under the Kyoto Protocol (2008–2012), and will voluntarily strengthen its Kyoto commitment by 10 percentage points, corresponding to 9% below the 1990 level. Further, Norway will undertake to reduce global greenhouse gas emissions by the equivalent of 30% of its 1990 emissions by 2020.

Norway has also made a political pledge to achieve carbon neutrality, undertaking to reduce global greenhouse gas emissions by the equivalent of 100% of its emissions by 2050 at the latest. If an ambitious global climate agreement is achieved in which other developed countries also take on extensive obligations, Norway will undertake to achieve carbon neutrality by 2030 at the latest.

RESEARCH AND DEVELOPMENT

The government sees research and development as crucial for increasing value creation from the Norwegian Continental Shelf. Currently, the most important challenges for the oil and gas R&D activities are related to the development of new methods and technologies for exploration and for improved oil recovery. Public funding also addresses technology for limiting emissions to air and sea.

The government considers R&D as vital also as a means to increase value creation in the transition to more environment-friendly energy systems and to develop further an internationally competitive energy sector. Public funding for R&D is a key element in the government's vision that Norway shall be a leader in the development of renewable energy. The government has more than tripled spending in R&D on renewable energy and CCS from 2007 to 2010.

Development of new technologies and solutions will also improve the competitiveness of Norwegian industries. Public R&D investments are important in areas where the industry typically will not engage, such as the long-term or basic research and competence building.

TAXATION

Taxes on energy use serve various objectives, including government revenue, pricing of external environmental effects and meeting energy policy goals (see Table 3). A value-added tax of 25% is also applied to energy consumption, after special taxes have been applied.

Of all energy taxes, those on fossil fuels bring the most revenue to the government. The CO_2 tax on fossil fuels for energy purposes was introduced in 1991. It is also applied to oil and gas production, helping to push the industry to seek technological solutions and to investigate storage solutions, as for example in the Sleipner and Snøhvit fields (see Chapter 6 on CCS). The tax has also helped to introduce more efficient solutions for power supply from offshore installations.

Several industries are exempt from the electricity tax, while the mineral oil tax is used to prevent customers from switching to oil heating.

Taxation on petroleum and hydropower producers differs from general company taxation, because of the excess profits in these sectors. In the petroleum sector, a special tax of 50% on income from petroleum extraction is applied, in addition to the ordinary capital income tax of 28%. Consequently, the marginal tax rate on the excess return within the petroleum sector is 78%. The excess return in hydropower generation is taxed at 30% and consequently the marginal tax rate is 58%.

Table 3. **Tax rates on energy products for 2010*, NOK**

Petrol tax		**Carbon dioxide tax**	
Sulphur-free	4.54	Petroleum activities, per litre or standard cubic metre	0.47
Low-sulphur	4.58	Mineral oil	0.58
		Mineral oil for domestic aviation	0.68
Auto diesel tax		Mineral oil for wood processing & fishing industry	0.3
Sulphur-free	3.56	Gasoline	0.86
Low-sulphur	3.61	Natural gas, per standard cubic metre	0.51
Biodiesel	1.78	Liquefied petroleum gas, per kg	0.65
Electricity consumption tax, per kWh		**Sulphur tax**	0.08
General rate	0.11		
Reduced rate	0		
Basic tax on heating oil, etc.			
Mineral oil	0.89		
Mineral oil for wood processing, production of colourants/pigments	0.13		
Lubricant oil tax	1.8		

* Per litre, unless otherwise indicated.

Source: Norwegian government.

CRITIQUE

Norway is in an enviable situation compared to most IEA member countries, with its abundant supply of crude oil, natural gas and hydropower, close links to markets, and relatively small population. Using the resources provided by its hydrocarbon exports, the government is committed to pursuing environmental goals. It remains a relatively energy-intensive country, but with low emissions, by virtue of its significant hydro resources. While not an EU member, it is a member of the European Economic Area and tied closely to the EU and Nordic markets, and is increasingly aligning its energy policies with EU directives.

Despite the relative abundance of clean energy, domestic energy security and mitigation of greenhouse gas emissions continue to be very high on the Norwegian political agenda. Because of significant barriers to developing gas generation, the hydro sector is required to demonstrate a high level of performance with support from a number of international

interconnectors. High demand in the winter 2009/10 due to the cold weather, coinciding with Swedish supply outages, demonstrated heightened sensitivities to security of supply. There is a significant policy focus on domestic hydro (and to a lesser but still significant extent, on wind) coupled with transmission network and international interconnector development to address these concerns. These priorities also afford attractive business opportunities for the dominantly publicly owned generation and network companies.

OIL AND GAS

The oil and gas sector underpins the economy. Domestically, the focus is on development to maintain economic stability (rather than energy), but there are significant energy implications for global markets. Norway is the third-largest exporter of fossil fuels and the second-largest gas exporter (including new LNG from Snøhvit). Major fields are in the early stages of decline, and further exploration is necessary in order to maximise resource development. The exploration industry has expanded quickly over the last few years thanks to a supportive fiscal regime which encourages exploration expenditure. However, the crucial issue will be opening up new areas for exploration.

While integrated management planning looks like a useful tool in managing community concerns about exploration in new areas, it must be completed as efficiently as possible to avoid unnecessary delays in deciding on opening new areas to environmentally appropriate exploration and development, particularly off the Lofoten-Vesterålen-Senja area and in the Barents Sea. The September 2010 treaty with the Russian Federation on the delineation of the Barents Sea and the Arctic Ocean demonstrates significant progress in this regard. The impact assessment of petroleum activities in the waters surrounding the Jan Mayen Island is another ongoing process. The white paper on exploration and development currently under preparation will be an important document in moving these access issues forward.

ELECTRICITY MARKETS

The electricity market functions well and the Nord Pool power exchange remains liquid and robust. The Nordic countries have agreed to work towards setting up a common retail electricity market by 2015. The last of the long-term discounted electricity contracts with Statkraft will expire in 2011, removing a historical distortion in the market. The high level of public ownership in generation has potential implications for competition and the functioning of the market, in particular the recent decisions to revert private hydro operations back to the government, should be kept under close review.

A central question concerns the need to alleviate domestic network constraints and expand the number of international interconnectors. Decisions on these major investments need careful analysis of the complex strategic, market, environmental and foreign policy dimensions of such choices. The present mechanism appears centred on Statnett making appropriate judgements on these issues. However, as they are fundamental to the long-term energy policy of Norway and its relationship with Europe, major network expansions should be considered by the government, as part of a broader energy policy development.

Within the economic regulatory framework, there is room for improved integration in planning processes. The government should review the potential for improvement in

distribution and transmission network planning processes, focusing on cost-benefit assessments of plans for new networks and network upgrades, and considering the implications of regulated outcomes for consumers who ultimately bear a large part of the costs. It would also be beneficial to ensure consistency between the energy efficiency targets of Enova and the future energy demand assumptions being used by transmission companies and the regulator to justify new investment.

TECHNOLOGY

Norway has retained a leadership role in technology development. A number of projects have global energy significance, for example carbon capture and storage at the Sleipner and Snøhvit fields, and the Technology Centre that is currently being built at Mongstad. While generally this work appears to be effective, clarity around objectives needs to be ensured. The multiple objectives of Enova, the flagship body for sustainability improvement, were an important case in point. The Storting has set very sound conditions for the establishment of Enova, declaring that the objective must be to obtain the highest possible number of saved units of energy in as environment-friendly and cost-effective manner as possible. Any changes in policy with regard to energy efficiency should be consistent with the existing innovative approach of promoting energy efficiency through Enova. However, care should be taken to avoid possible conflicting outcomes, such as decreasing power prices as a result of increased power generation, which in turn would have an impact on incentives for energy saving. Close co-ordination of efforts by Enova and other organisations, such as the Research Council and Transnova, is also crucial.

CLIMATE CHANGE AND PLANNING

The Parliament's 2008 Climate Agreement includes a political pledge to achieve carbon neutrality by reducing Norway's global greenhouse gas emissions by the equivalent of 100% of its own emissions by 2050. If an ambitious global climate agreement is achieved in which other developed countries also take on extensive obligations, Norway will further undertake to achieve carbon neutrality by 2030 at the latest. The mechanisms for meeting the target, particularly the more ambitious alternatives, are unclear but are under extensive review.

Inherent in these commitments are abatement options. The recent *Climate Cure 2020* document is a useful tool for identifying options which would enable reaching greenhouse gas emissions targets, which now needs to be actioned. Prohibitions on new gas-fired generation (without CCS) and commitments to expensive electrification of the offshore industry may be relatively costly mechanisms of abatement in the European context. Improved long-term energy planning would help. In addition to informing public debate, improving information around demand and supply outlooks would add to the analysis of costs and benefits of abatement choices and also assist in addressing the previously mentioned risk to consumers of paying for inefficient investments in the electricity sector.

RECOMMENDATIONS

The government of Norway should:

- *Proceed with the opening of the formerly disputed Barents Sea area for petroleum activities and expedite the consideration of whether or not to release acreage in the currently restricted Lofoten-Vesterålen-Senja area.*
- *Assume a stronger role in long-term electricity network development, including international interconnectors, with a strategic analysis of future options in terms of security of supply, cost-effectiveness and overall economic as well as environmental benefits.*
- *Develop and publish consistent energy projections which can be used as a basis for informed debate and long-term energy policy development.*
- *Ensure clarity of long-term objectives and close co-ordination between organisations promoting energy efficiency and renewable energy.*

3. CLIMATE CHANGE

OVERVIEW

GREENHOUSE GAS TARGETS

Norway is a Party to the United Nations Framework Convention on Climate Change (UNFCCC) and to the Kyoto Protocol. It will have to limit its greenhouse gas (GHG) emissions to an average of 1% above their 1990 levels over the 2008-2012 period.

Norway also has the following national targets which the Parliament set in the 2008 Climate Agreement:

- Reduce greenhouse gases by 9% from their 1990 levels over the 2008-2012 period, that is 10 percentage points more than under the Kyoto Protocol.
- Reduce global greenhouse gas emissions by the equivalent of 30% of Norway's 1990 emissions by 2020.
- Become carbon-neutral by reducing global greenhouse gas emissions by the equivalent of 100% of Norway's emissions by 2050, at the latest.
- If an ambitious global climate agreement is reached in which other developed countries also take on extensive obligations, undertake to become carbon-neutral by 2030, at the latest.

GREENHOUSE GAS EMISSIONS

Under the Kyoto Protocol, Norway may emit on average 50.1 $MtCO_2$-equivalent annually from 2008 to 2012. Norway's total emissions of the six GHGs − carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluorides (SF_6) − have increased modestly since 1990. The emissions have been fluctuating between 53.3 and 55.1 $MtCO_2$-eq in the period 2000-2008. According to Statistics Norway, in 2009 they amounted to 50.8 $MtCO_2$-eq, which is 2.2% more than in 1990. The 2009 emissions were the lowest since 1995 and 9% lower from the 2007 peak of 55.8 $MtCO_2$-eq. In 2008, CO_2 accounted for 82.2% of GHGs, CH_4 for 8.0%, N_2O for 7.0% and the F-gases (HFCs, PFCs and SF_6) for 2.7%.

CO_2 EMISSIONS FROM FUEL COMBUSTION

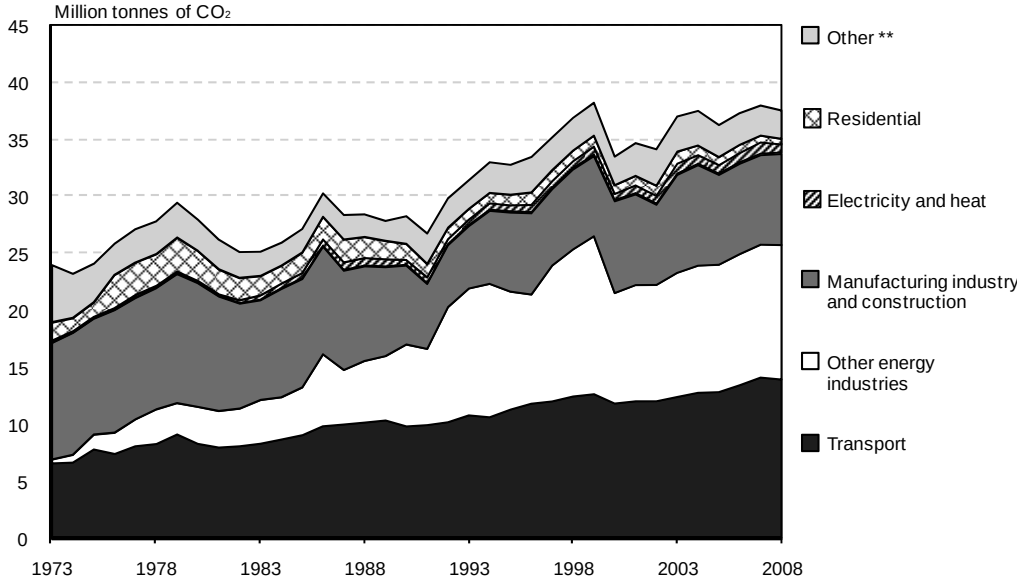
In 2008, CO_2 emissions from fuel combustion amounted to 37.6 Mt, 1% less than in 2007 and the same as in 2006 (see Figure 8). From 1990 to 2008, emissions increased by 33%, or on average by 2% per year. Emissions reductions from 2007 to 2008 mostly came from road traffic and coastal navigation.

Transport was the largest-emitting sector, accounting for 37% of total CO_2 emissions in 2008. Energy industry accounted for 31% of the total and manufacturing industry for 21%. In absolute terms, over the past two decades emissions have grown most in energy industry (by 6.4 $MtCO_2$), followed by transport (by 3.8 $MtCO_2$). By subsector, road

transport and offshore gas turbines (for electricity generation and pumping of natural gas in pipelines) are the largest emitters and have also seen the biggest increase in emissions since 1990. Other important sources are coastal navigation, energy use in the processing of raw materials, as well as oil and gas operations which give rise to significant amounts of fugitive emissions.

Oil consumption accounted for 61% of total CO_2 emissions in 2008. Natural gas consumption was the second-largest source of emissions, with 29% of the total (see Figure 9). CO_2 emissions from coal only amount to 8% of total emissions, less than a quarter of the average share of coal in CO_2 emissions in IEA member countries, reflecting the minor role of coal in the country. Coal is mainly used in the manufacturing industry. Between 1990 and 2008, 70% of the growth in total CO_2 emissions came from natural gas, as a consequence of increased production and pipeline exports.

Figure 8. **CO_2 emissions by sector*, 1973 to 2008**



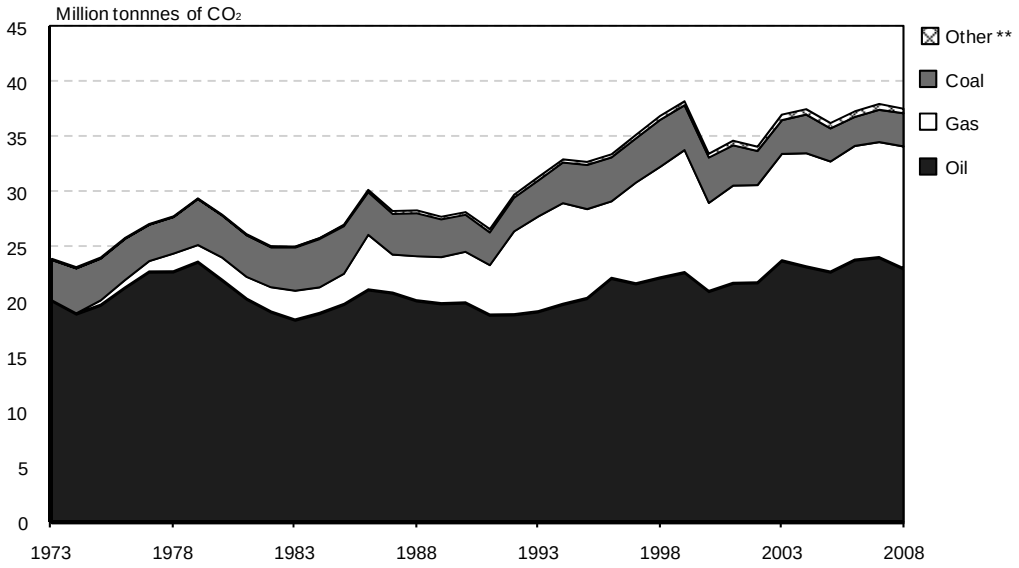
* Estimated using the IPCC Sectoral Approach.

** *Other* includes emissions from commercial and public services, agriculture/forestry and fishing.

Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2010.

Compared to other IEA member countries, Norway has the second-lowest CO_2 emissions per TPES, mainly because of the large share of hydropower in its energy mix (see Figure 10). In 2008, emissions were 1.3 tonnes of CO_2 per tonne of oil equivalent, while IEA Europe average was 2.2 tCO_2 per toe, 73% higher. CO_2 emissions from the electricity sector are very low, about five grams of CO_2 per kWh, almost negligible compared to the OECD average of 443 g CO_2 per kWh.

Figure 9. **CO_2 emissions by fuel*, 1973 to 2008**

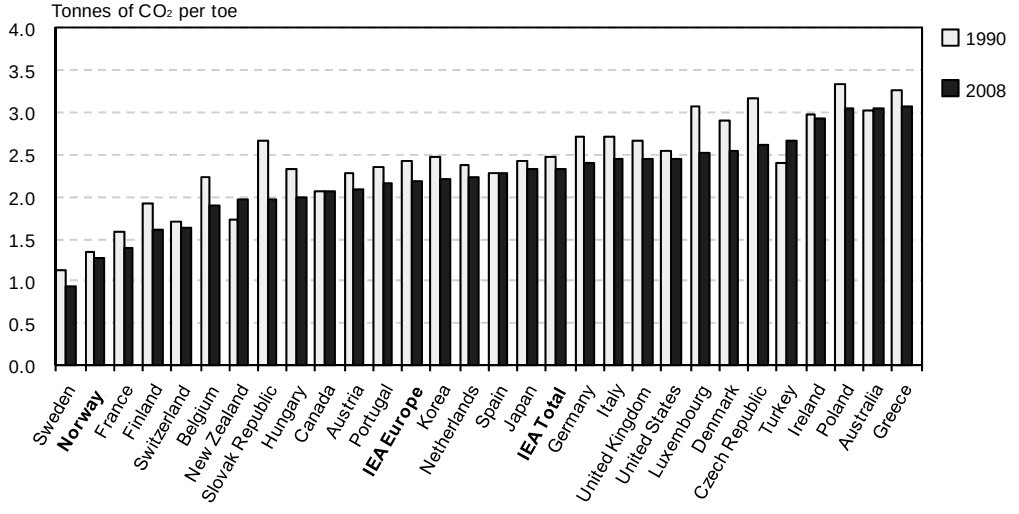


* Estimated using the IPCC Sectoral Approach.

** *Other* includes industrial waste and non-renewable municipal waste (negligible).

Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2010.

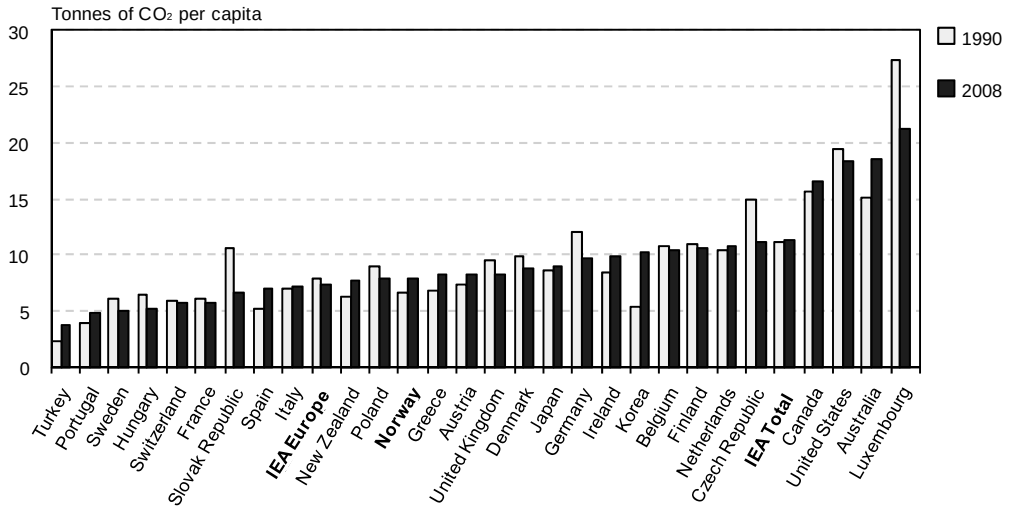
Figure 10. **Energy-related CO_2 emissions per TPES in IEA member countries, 1990 and 2008**



Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2010.

In per-capita terms, energy-related CO_2 emissions in Norway are closer to the IEA average. With 7.9 tonnes of energy-related CO_2 per capita in 2008, Norway is similar to coal-intensive economies like Poland and Greece, and higher than the IEA Europe average of 7.3 tCO_2 per capita (see Figure 11). High per-capita CO_2 levels partly result from emissions in export industries.

Figure 11. **Energy-related CO_2 emissions per capita in IEA member countries, 1990 and 2008**



Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2010.

INSTITUTIONS

The **Norwegian Parliament** sets the overall national climate change policies and the government implements and administers the most important policies and measures.

The **Ministry of the Environment** is responsible for co-ordinating Norwegian climate change policies. Several sectoral ministries are also involved in such policies, including the **Ministry of Petroleum and Energy,** the **Ministry of Transport and Communications,** the **Ministry of Trade and Industry** and the **Ministry of Agriculture and Food**. The **Ministry of Finance** is responsible for taxation policies, including environment-related taxes, as well as for the government programme for the purchase of emission credits under the Kyoto Protocol.

Local governments are responsible for implementing policies and measures at the local level, for example through waste management, local planning and transport measures.

POLICIES AND MEASURES

OVERVIEW

Norway plans to meet its +1% Kyoto commitment through a mix of domestic mitigation and the purchase of emission credits from abroad. Norwegian companies operating under the EU Emissions Trading Scheme (EU-ETS) received in 2008 and 2009 around 40% of allowances needed for free, or 7.5 million allowances (each allowance corresponds to 1 $MtCO_2$-eq of emissions). In addition, to fulfil its unilateral national target of -9% from the 1990 levels, the government expects to purchase around 3 to 4 $MtCO_2$-eq. of credits a year, mainly by buying UN-approved allowances generated by projects under the clean development mechanism (CDM).

Table 4. **Impact on GHG emissions of selected implemented or adopted policies and measures ($MtCO_2$-eq)**

	1995	2000	2005	2007	2010	2020
Policies and measures directly related to climate change						
- CO_2 tax offshore[1]	0.6	3	3	4.5	5.2[10]	6.9[10]
- CO_2 tax onshore[2]		0.8	0.8	0.85	0.85	0.85
- Requirement to collect landfill gas	0.2	0.4	0.4	0.4	0.4	0.4
- Other measures in the waste sector	-	0.01	0.1	0.1	0.1	0.5
- Climate change agreement with aluminium industry[3]	0-1.3	0.5-2.7	1.6-4.5	1.6-4.5	1.5-4.2	1.8-4.5
- Agreement on SF_6 emissions	-	-	0.06	0.06	0.06	0.06
- Tax and recycling schemes on HFCs	-	-	0.3	0.5	0.5	0.5
- Requirement of a 2.5% share for biofuels of in road transport energy use from 2009[4]	-	-	-	-	0.3	0.3
- CO_2 tax for new passenger cars from 1 January 2007[4]	-	-	-	0.04	0.1	0.4
Other regulations						
- VOC regulation offshore	-	-	0.2	0.2	0.3	0.1
- VOC regulation at the Stura terminal	-	0.01	0.02	0.02	0.005	0.005
Voluntary reductions						
- SF_6 reduction, production of magnesium	1	1.4	1.8	-[8]	-[8]	-[8]
- N_2O reduction, production of nitric acid	0.7	0.6	0.5	1.2	1.2-1.6[9]	1.2-1.6[9]
- Use of biocarbon in the cement production[5]	-	0.03	0.13	0.13	0.13	0.13
New policies and measures after 2008[6]						
- Emissions Trading Scheme (EU-ETS 2008-2012)	-	-	-	-	0-0.3[11]	0-0.3[11,12]
- Consensus with the process industry 2009[7]	-	-	-	-	0.2	0.2
Sum of implemented policies and measures	2.5-3.8	6.8-9	8.9-11.8	9.6-12.5	10.8-14.2	13.3-16.7

1. Estimates based on KonKraft report 5 and analyses by the Norwegian Petroleum Directorate.

2. Based on an equilibrium analysis for 1990-1999. Bruvoll A. and B.M. Larsen (2004) "Greenhouse gas emissions in Norway. Do carbon taxes work?" *Energy Policies* 32 (4), 493-505, and assessment for the Third National Communication. In addition, the effects of the increased rate of the tax for domestic air transport and shipping in 2006 are included.

3. Lowest number reflects direct effect of the agreement, while highest estimate includes voluntary measures taken before the agreement in 1997 and after the agreement 2005. Estimates by the Norwegian Pollution Control Authority.

4. The effect is included in the White Paper on Long-term Perspectives 2009.

5. The emissions are estimated by the producers.

6. These effects are not in the reference scenario in the White Paper on Long-term Perspectives 2009.

7. Includes the effect of the agreement from 2009 for the years 2009-2012 between the process industry and the authorities.

8. The magnesium plant was closed down in 2006, and emission reductions are not included in the estimated effects of policies and measures after this.

9. Lowest number reflects direct effects of measure included in the White Paper on Long-term Perspectives 2009, while the highest number reflects the effect of measure after 2008 and is not included in the reference scenario in the White Paper on Long-term Perspectives 2009.

10. The CO_2 tax for the petroleum sector was substantially reduced in 2008 as a consequence of the extension of the EU-ETS for 2008-2012. The petroleum sector has to pay for all their quotas. The effects in the table therefore show the combined effect of the CO_2 tax and the price of the CO_2 quotas.

11. Based on calculations by Statistics Norway, excluding reductions in N_2O emissions from nitric acid production.

12. A revised emissions-trading scheme from 2013 may include other effects.

Source: Norway's 5th UNFCCC National Communication.

Concerning the 2020 target to reduce GHG emissions by 30% from the 1990 levels, the government is working on a White Paper on Climate Policy, to be published in 2011. A background document outlining various scenarios and detailed cost analysis was published in February 2010. This *Climate Cure 2020* report ("Measures and Instruments for Achieving Norwegian Climate Goals by 2020") assesses possible measures and instruments for reaching the domestic target of reducing Norway's greenhouse gas emissions by between 15 and 17 $MtCO_2$-eq by 2020 when CO_2 uptake by forests is included. The

report was prepared by the Norwegian Climate and Pollution Agency, in collaboration with the Norwegian Water Resources and Energy Directorate, the Norwegian Public Roads Administration, Statistics Norway and the Norwegian Petroleum Directorate.

The report projected that baseline emissions would continue to rise to 59 $MtCO_2$-eq by 2020, an increase of 9 $MtCO_2$-eq from 1990. The projection was based on continued increases in transport emissions to 2030, in oil and gas sector emissions to 2020, and on stable emissions from the industrial sector. This baseline scenario includes the impact of all policies already adopted, such as operation of the carbon capture and storage (CCS) plant at Mongstad as from 2014 and assumed improvements in energy efficiency of 1% per year on average.

The report describes 160 measures that could reduce GHG emissions, totalling around 22 $MtCO_2$-eq (43% of the 2009 total emissions). These measures entail widely ranging costs per tonne of CO_2-eq abated, up to around EUR 500 per tonne (around NOK 4 370) for the most expensive ones. The report estimates that a reduction of 12 $MtCO_2$-eq by 2020, beyond what is already included in the baseline scenario, could be achieved by implementing all the measures investigated, at a cost of up to about EUR 135 (NOK 1 180) per tonne of CO_2-eq, and with a wide range in the estimated costs of the various measures.

According to a macro analysis undertaken as part of the report, an emission price of close to EUR 200 (NOK 1 750) per tonne of CO_2-eq would be required by 2020 to reach the domestic emission target, if all domestic sources faced the same price. If the sectors covered by the EU-ETS were to be sheltered from this full price (because prices in the EU-ETS were lower), the price facing the remaining sectors would have to reach about EUR 425 per tonne of CO_2-eq (around NOK 3 710). The report also suggests that to make additional emissions reductions in the EU-ETS sectors, the authorities could buy and cancel a volume of ETS permits corresponding to the emissions they wished to cut over and above those related to the EU allowance price, thus reducing the overall quantity of permits available within the EU-ETS.

DOMESTIC MEASURES OUTSIDE EMISSIONS TRADING

Domestic measures have since 1990 helped to avoid emitting between 10.8 and 14.2 $MtCO_2$-eq, according to the Ministry of the Environment. The measures cover many non-energy sources, but the main energy sector measures are the use of the CO_2 tax in offshore and onshore activities, plus transport sector measures (see Table 4).

Norway's CO_2 tax has been at the forefront of international climate policy. It was first introduced in 1991 in the offshore oil and gas sector as well as transport and heating sectors. Mainland energy-intensive industries were, however, exempted from the tax because of the perceived threat of carbon leakage.

The tax rate varies by fuel type and sector. The CO_2 tax has encouraged the offshore oil and gas industry to reduce flaring and adopt carbon capture and storage at the Sleipner and Snøhvit fields. Further measures include electrification of some processes and increased energy efficiency. The government plans to increase efforts to use carbon capture and storage (see Chapter 6). In 2008 the level of the CO_2 tax was reduced for the offshore oil and gas sector which entered the EU-ETS, with the intention to maintain the sector's overall burden roughly unchanged.

CO_2 taxes on transport and heating fuels have also contributed to emissions reductions. In the transport sector, CO_2 emissions have been further reduced by introducing CO_2-based vehicle taxation and biofuels blending obligations (see Chapter 4 on Energy Efficiency and Chapter 7 on Renewable Energy).

Domestic emissions reduction is somewhat challenged by the widespread use of near zero-carbon electricity. For instance, space heating is mostly by electricity. Oil use for space heating was almost halved from 1990 to 2007 and is low anyhow. Through Enova, the government has ambitious programmes to increase renewable energy use and energy efficiency, but they often do not replace the use of fossil fuels. Nearly all Norwegian emissions from process industry are either included in the EU-ETS or covered by voluntary approaches until 2012, and then will be included in the EU-ETS from 2013.

EMISSIONS TRADING

On 1 January 2005, the national Greenhouse Gas Emissions Trading Act came into force, establishing an emission trading system from 2005 to 2007. The system closely resembled the EU-ETS, but covered only 10% to 15% of Norwegian emissions. The sectors included from 2005 were energy installations over 20 MW; oil refining; calcining/sintering of iron ore; production of cast iron and steel; production of cement and lime; and production of glass, fibreglass and ceramics. Industries covered by the carbon tax were excluded, and allowances were distributed free of charge.

For the 2008-2012 period, the Norwegian ETS has been linked with the EU-ETS. Three subsectors were added to the 2005-2007 system: pulp and paper, fertiliser production, and offshore oil and gas installations. In February 2009, emissions from nitric acid production were added to the system.

The Norwegian scheme covers about 36% of total Norwegian GHG emissions. The total Norwegian cap is set at 75.2 Mt over the 2008-2012 period (15 Mt per year). On an annual basis, this is 22% less than the 2005 emissions from the installations covered by the scheme. Of this total, 35.8 million allowances are allocated free of charge to existing installations, 4.2 million allowances are reserved for new, highly efficient gas-fired power plants and 31.6 million allowances auctioned. Norway has no general reserve for new entrants. The offshore petroleum sector has to buy all the allowances it needs. Other installations are allocated allowances primarily based on their average annual emissions from 1998 to 2001. Installations established after 2001 and with at least a full year of emissions in the 2002-2007 period are allocated allowances based on average annual emissions in the active years in that period. Other installations established before the National Allocation Plan was submitted to the European Free Trade Association (EFTA) Surveillance Authority on 28 March 2008 are allocated allowances based on benchmarking. Installations may use credits from Kyoto flexible mechanisms for up to 13% of their emissions. In 2009, EU-ETS verified emissions in Norway amounted to 19.2 Mt, or 38% of total GHG emissions.

Norway and other EFTA countries are negotiating with the EU on the terms of transposing into national law the Post-2012 EU-ETS Directive (2009/29/EC). The government expects the EU-ETS sector share in total GHG emissions in Norway to rise from the current almost 40% to more than 50% in the 2013-2020 EU-ETS.

INTERNATIONAL MEASURES

To meet its unilateral obligation to reduce GHG emission by 9% from the 1990 levels to the 2008-2012 average, Norway intends to purchase carbon credits equalling on average 5 to 6 million tonnes (quotas) per year from 2008 to 2012. The country will only purchase quotas approved by the United Nations. The government purchases are done mainly through the clean development mechanism under the Kyoto Protocol, in addition to domestic emissions reductions and the installations' purchase of quotas through the EU-ETS.

Norway has also been a leader in international policies to reduce deforestation in tropical countries. It finances a comprehensive pilot programme of up to USD 1 billion (NOK 6.3 billion) support for capacity building and programmes to reduce deforestation in Indonesia.

CRITIQUE

Norway has devoted considerable attention to environmental sustainability, and climate change mitigation enjoys broad popular and political support. Norway's sense of global responsibility is manifested in its decision to assume a national target that goes beyond its target under the Kyoto Protocol (-9% vs. +1% from the base year to 2008-2012). For the post-2012 period, the government has committed to cutting global greenhouse gas emissions by the equivalent of 30% of Norway's 1990 emissions by 2020. Norway has also declared its ambition to become carbon-neutral (taking into account its contribution to emissions reductions abroad) by 2050 at the latest and, if a sufficient number of countries take on major obligations, it would bring this target forward to 2030. With its strong commitment to global climate change mitigation, Norway has set an admirable example to other countries. It should also be applauded for taking a leadership position in support for action in developing countries through its programme "Reducing Emissions from Deforestation and Degradation" with Indonesia.

In many ways, Norway already is a lower-carbon economy than most others by virtue of its historical predominance of hydropower. Widespread use of electricity, also for heating, means that households and services are already essentially decarbonised with regard to stationary energy use. The challenge is that only industry and transport have large potential for further cuts in energy-related greenhouse gas emissions.

More than 70% of greenhouse gas emissions are covered by emissions trading or the CO_2 tax. The Norwegian approach to emissions trading is exemplary in three respects: the use of auctioning went well beyond the EU average; the overall cap on emissions was tighter than that set by EU member states; and since 2009, the scope of the Norwegian system has been wider than that generally seen in the EU-ETS with the inclusion of nitric acid producers.

The context within which Norwegian energy-related policies are formulated and implemented changed significantly when Norway was linked to the EU-ETS. Because Europe-wide emissions levels are set by the EU-ETS cap, the introduction of supplementary policies (such as energy efficiency policies or renewable energy targets) in the capped sectors will not reduce total European emissions in the short term, even if they reduce Norway's. However, these policies can assist the capped industries to achieve reductions at lower cost, and free up surplus allowances that can be sold abroad. They also enable lower-carbon infrastructure to be locked in, which has the potential to lower the long-term costs of deep decarbonisation. To the extent that these

supplementary policies help short-term targets to be delivered at lower cost, this also increases the chances of EU -ETS caps being tightened in future.

The current negotiations with the EU over details for Phase III (2013-2020) give Norway the opportunity to integrate its ambitious targets into the parameters set for its ETS sectors. As it did in Phase II, Norway may wish to take on a different cap for its scheme than that which applies to the general EU-ETS, to help deliver on its 2020 ambitions.

The details and effect of supplementary measures applying in the capped sectors (such as the CO_2 tax level, energy efficiency and renewable energy policies) should be considered alongside the ETS cap, so that they are set to support, rather than undermine, the action of the ETS. Norway already has a dual system of carbon tax and EU-ETS coverage: the carbon tax rates and ETS cap for 2013-2020 will need to be set carefully to deliver the desired outcome.

Other policies to reduce emissions, ranging from waste management, urban and transport planning to building standards and educational programmes, also have important roles. As emissions are today higher than in 1990, Norway will be using offset schemes such as emissions trading and the clean development mechanism (CDM) to meet its commitments.

In addition to continued use of international flexibility mechanisms, the purchase or cancellation of EU-ETS allowances is an option that could be explored for offsetting emissions. However, given the large quantity of allowances currently banked in the EU-ETS, it is not clear whether this would deliver emissions reductions in Norway's 2020 target timeframe.

The government is preparing a new white paper on Norwegian climate policy to be finalised in 2011. To keep down the cost of meeting its future objectives, and to better demonstrate to other countries how to effectively cut emissions, Norway should prioritise the implementation of policies and measures to reduce greenhouse gas emissions, on the basis of their cost-effectiveness (NOK per tonne of CO_2 avoided). The *Climate Cure 2020* background analysis should be used in full in preparing the white paper.

RECOMMENDATIONS

The government of Norway should:

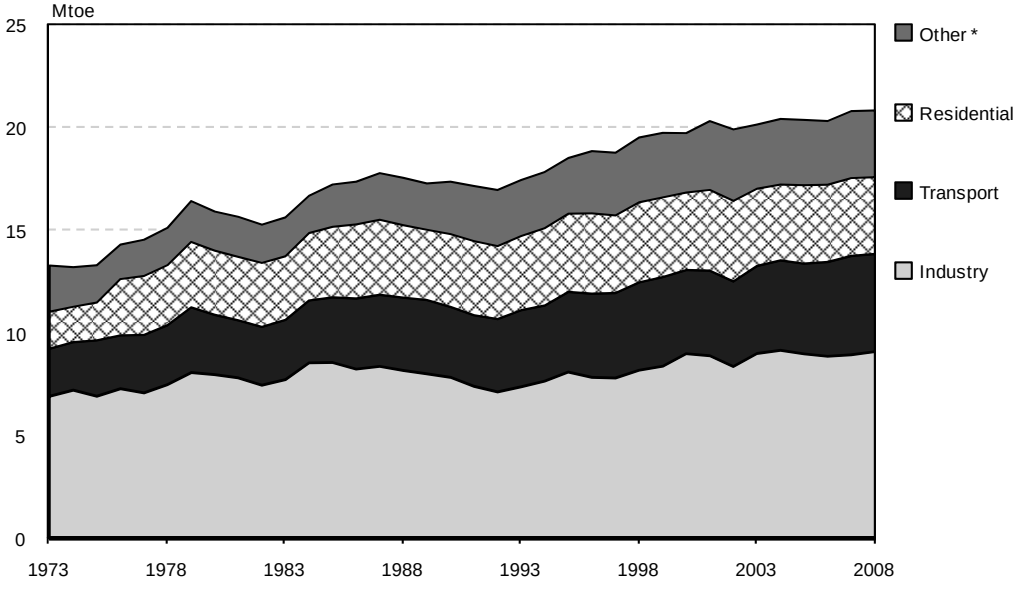
- ☐ *Continue to play a strong role in international climate policy.*
- ☐ *Prioritise the implementation of policies and measures to reduce greenhouse gas emissions, on the basis of their cost-effectiveness (NOK per tonne of CO_2 avoided), as analysed in the Climate Cure 2020 document.*
- ☐ *Consider using more international flexibility mechanisms as a cost-effective way to meet greenhouse gas emission targets in the long term.*

4. ENERGY EFFICIENCY

OVERVIEW

In 2007 and 2008, Norway's total final energy consumption (TFC) was around 21 Mtoe, which is 5% higher than in 2000 (see Figure 12). Industry accounted for 44% of this total, transport for 23%, residential sector for 18% and services, agriculture and fishing for 15% of TFC. Between 2000 and 2008 the transport sector was responsible for almost two-thirds of the growth in energy TFC. Over the same period, energy consumption in industry and residential and commercial sectors grew at a very moderate rate (see Figure 13).

Figure 12. **Total final consumption by sector, 1973 to 2008**

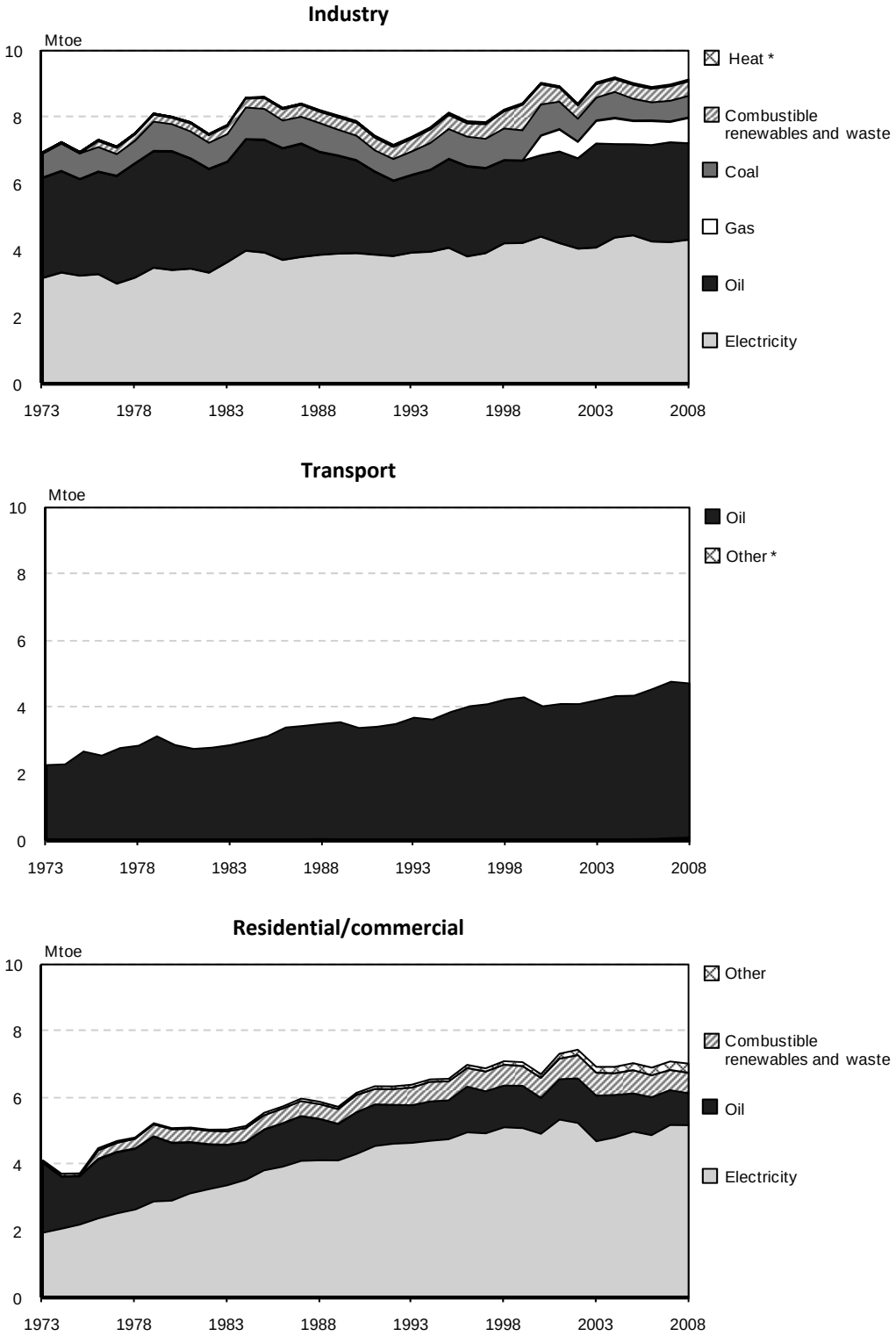


* *Other* includes commercial, public service, agricultural, fishing and other non-specified sectors.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2009.

Electricity is the main energy carrier in industry and buildings, accounting for 46% of TFC in 2008. With more than 23 000 kWh, Norway has the highest electricity use per capita among all IEA member countries. Measured in TPES per capita, Norway is one the five largest energy users among the IEA member countries and the third in IEA Europe, behind Luxembourg (where motor fuel sales to foreigners bloat the statistics) and Finland (a northern country similar to Norway with large heating needs, cheap electricity and significant energy-intensive industry).

Figure 13. **Total final consumption by sector and by source, 1973 to 2008**



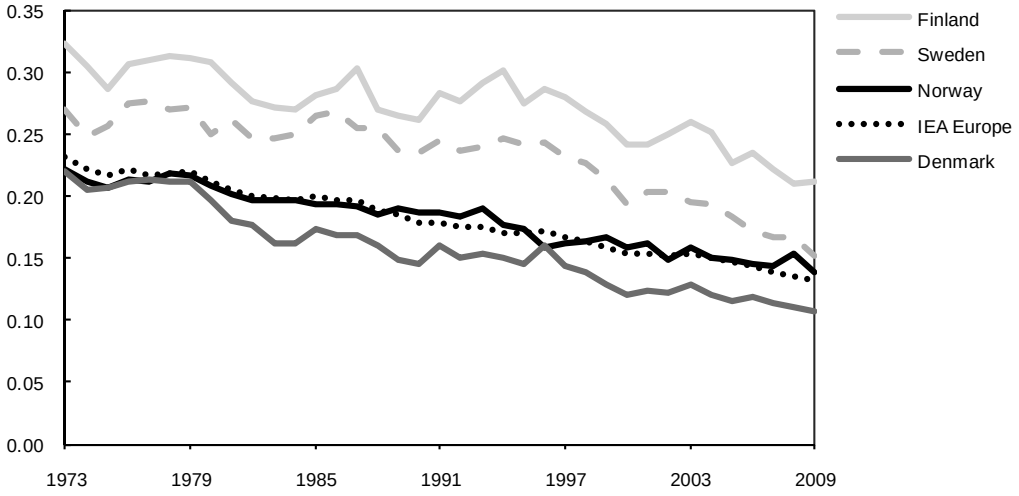
* Negligible.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010.

Energy intensity in Norway – the amount of primary energy used in a country per unit of GDP – is close to the IEA European average and has decreased on average by 1.4% per year in the last decade (see Figure 14), a better performance than its Swedish and Finnish neighbours. This decline in energy intensity is partly due to energy efficiency measures, but largely attributable to fast economic growth. The sudden jump in energy intensity from 2007 to 2008 mainly resulted from a decrease in oil exports and was therefore not linked to energy efficiency.

Figure 14. **Energy intensity in Norway and in other selected IEA member countries, 1973 to 2009***

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



* Estimates for 2009.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010 and *National Accounts of OECD Countries*, OECD Paris, 2010.

INSTITUTIONS

The **Ministry of Local Government and Regional Development** is responsible for Norwegian housing policy, district and regional development, local government and the administration of elections. The **Housing and Building Department** is responsible for implementing the government's housing and building policy. As part of the efforts to promote sustainable quality, security and high aesthetic standards in the built environment, the department takes measures to reduce energy use and the use of building materials that are hazardous to health and the environment.

The **Norwegian State Housing Bank** uses financial measures to facilitate the achievement of housing policy goals. The most important financial measures are basic loans, start-up loans, housing grants and housing allowances.

The **National Office of Building Technology and Administration** is the main agency for implementing building policy. It advises the **Ministry of Local Government and Regional Development** and other central government bodies on technical regulations and administrative provisions relating to building policy measures.

The **Ministry of Transport and Communications** is responsible for energy efficiency policy in the transport sector.

The **Ministry of Petroleum and Energy** (MPE) is organised in four departments. Within the Ministry, the **Water Resources and Energy Department** is responsible for energy

efficiency. The main objective of the department is to ensure sound management, in both economic and environmental terms, of water and hydropower resources and other domestic energy sources. The department currently has 46 employees.

Enova is a public enterprise owned by MPE, with a mission to promote environmentally sound and rational production and use of energy. Enova subsidises investments in energy efficiency in industry and buildings, and for renewable electricity and heat supplies. It also provides information, analysis, advice and consultancy services as well as targeted communication both to businesses and households. Both its mandate and its level of funding give it the potential to be a prime mover in accelerating the deployment of energy efficiency programmes, non-hydro renewable energy generation and other low-carbon energy technologies (see Box 2).

Regional and local governments have responsibilities associated with planning and building permits.

POLICIES AND MEASURES

OVERVIEW

Norway applies a wide range of policies and measures to improve energy efficiency. They are outlined in Table 5. Norway does not have a national plan for energy efficiency, nor individual targets, but Enova has an overall objective to deliver 18 TWh in energy savings and renewable energy from 2001 to the end of 2011. At the end of 2009, Enova reported total contracted results of 13.8 TWh. It also has a working target of delivering 40 TWh in energy savings and renewable energy from 2001 to 2020.

Table 5. **Main policies and measures to improve energy efficiency, 2010**

Measures	Sector	Comments
CO_2 tax and EU-ETS	General	
Electricity tax	General	
Fuel oil tax	General	
Investment support from Enova	Energy, industry, buildings	
Enova's household scheme	Households	
Research Council of Norway (RCN)	R&D	The RCN funds research and projects; several programmes are related to energy efficiency.
Programme for Energy Efficiency (PFE)	Wood-processing industry	Participants may be entitled to exemption from the electricity tax by pursuing certain measures in energy efficiency
Innovation Norway	Small and medium-sized enterprises	Energy efficiency is one of the main areas of focus in their Energy & Environment Programme.
Norwegian State Housing Bank	Buildings	Provides basic loans for building and renovating homes, with environmental requirements designed to stimulate environment-friendly buildings
Building regulations	Buildings	Directive 2002/91/EC
Eco-design regulations	Energy-using products	Directive 2005/32/EC
Energy labelling regulations	Energy-using products	Directive 92/75/EC
Energy labelling of buildings	Buildings	Directive 2002/91/EC
Enova's hotline	Households, companies	Enova funds a telephone and internet service for information and advice regarding energy and Enova's programmes.

Source: Ministry of Petroleum and Energy.

As explored in more detail in Chapter 7, Norway is negotiating with the EU on transposing into national law the 2009 Directive on Renewable Energy (2009/28/EC). The directive also includes a binding target of 20% renewable energy in gross total final energy consumption by 2020. If Norway adopts such a target, energy efficiency improvements will be very important in increasing the share of renewable energy in terms of final energy consumption.

TRANSPORT

Private cars are the dominant form of passenger travel in Norway (see Table 6). Traffic volume by passenger cars grew by a third from 1990 to 2008, according to the EU Commission's *Statistics Yearbook.* Over the same period, train travel increased by 46%, tram and metro use by 36%, and bus and coach use by 12%.

Norway has more than half a million more registered passenger cars than in 1990. Car density has increased from 380 per 1 000 residents in 1990 to 458 in 2008, slightly less than the EU15 average of 501. Over the same period, the Norwegian road network has expanded, but the mountainous and sparsely populated country has only 237 km of motorways (2007 data). The country's railway network has been expanded by 70 km since 1990, and 62% of the 4 114 km railway network is electrified, versus 55% in the EU15.

Freight is mostly transported by road, and the number of goods vehicles has increased from 308 000 in 1990 to 523 000 in 2008. Road freight transport doubled from 1995, to 20.6 billion tonne-kilometres in 2008, while rail freight increased by a third, to 3.6 billion tonne-kilometres over the same period.

International haulage accounted for 19% of all haulage by heavy-duty vehicles registered in Norway in 2008. Freight volumes are closely linked to developments in the overall economy and are currently declining.

Table 6. **Modal split of passenger transport on land, 2008**

	Car	Bus	Train	Tram and metro
Share, %	87.8	6.6	4.7	0.9

Source: *EU Energy and Transport in Figures – Statistical Pocketbook 2010.*

Transport fuel taxes are high by international comparison (see Chapter 5 on Fossil Fuels, section on Oil). In 2007, Norway introduced a CO_2-differentiated vehicle purchase tax. While vehicle-specific CO_2 emissions had been relatively constant for 15 years to 2006, the new tax made its impact felt quickly. Average CO_2 emissions from new cars have decreased from 177 g CO_2 per km in 2006 to 151 g CO_2 per km in 2009. In its 2008 Climate Agreement, the Parliament set a target of maximum 120 g CO_2 per km from new cars in 2012, to be reached by vehicle taxation. The tax basis was changed towards an even stronger emphasis on low-carbon vehicles in 2009 and the average CO_2 emissions of vehicles registered in the first half of 2010 came to 141 g per km.

Norway provides strong incentives for the uptake of electric vehicles, including exemptions from vehicle purchase tax, VAT, toll road charges and half of the company car taxes. Electric vehicles also have access to bus lanes and to free public parking and free entrance on state highway ferries. As part of the 2009 stimulus package, the Parliament granted EUR 6 million (around NOK 52 million) to fund electric vehicle infrastructure development. More than 1 600 charge spots received financial aid from

the programme. Most of them will be ready for use by the end of 2010. There are close to 3 000 electric vehicles in Norway.

A reward programme known as the *belønningsordning* in place since 2004 makes grants available those local authorities that reduce car use and increase public transport use. It encourages local governments to introduce congestion charges, cycling, parking restrictions and better public transport. The programme has grown considerably since its introduction, although local authorities often oppose road pricing and variable toll charges. The programme targets Norway's twelve largest cities. To be eligible for the rewards, the cities must enter into agreement with the State. The allocation of funds is being doubled for the period 2010-2013, to NOK 330 million a year (EUR 38 million), after a previous doubling in 2009.

The Storting decided, in relation to the National Transport Plan 2010-2019, to consider building long-distance high-speed rail lines, including between Oslo, Bergen and Trondheim, and Gothenburg in Sweden. The idea was to help shift traffic away from road and air. There are, however, doubts about the cost-effectiveness of such projects.

Norway also subsidises RD&D projects on alternative energy sources for transport and green transport technologies. The subsidy programmes are administered by the Research Council of Norway and Transnova (see Chapter 9 on RD&D).

BUILDINGS

Legislation

The building code is the main legal instrument for improving energy efficiency. It was revised in 2007 in accordance with the EU Directive on the Energy Performance of Buildings (2002/91 EC).

New and renovated buildings are subject to stricter energy performance requirements. The new requirements came fully into force on 1 August 2009. The 2007 requirements are expected to cut the need for energy for heating purposes by around 25% from the previous requirements.

Under the revised building code, new buildings and buildings subject to major renovations must meet either a set of limit values for individual building components, heat recovery and other technical requirements, or a single limit value on the total energy use for space heating, cooling and hot water for the whole building (kWh per m^2 of heated floor area per year). Regardless of which option is chosen, all new buildings in regular use must meet minimum requirements for windows (U-value 1.6)[1], roofs and floors facing free air (U-value 0.18), exterior walls (U-value 0.22) and air tightness.

The new regulations also specify that, as a main rule, a minimum of 40% of energy for heating and hot water in new and refurbished buildings must be provided by energy carriers other than electricity and/or fossil fuels. Typical solutions include district heating, local heating systems, heat pumps, solar heaters, pellet-based systems and wood stoves.

As from 1 July 2010, the energy labelling scheme requires buildings to have an energy certificate and an energy consumption label when built, leased or sold. The objective of

1. The U-value represents the rate of heat loss, *i.e.* how much energy passes through one square metre of a material by a difference of one degree in temperature. It is measured in watt (W) per degree Kelvin (K) per m^2.

the scheme is to provide basic information about the energy performance of buildings. This scheme will promote increased knowledge and awareness of energy consumption in buildings and may help ensure implementation of energy efficiency measures. The energy labelling scheme is part of the follow-up of the EU Directive on the Energy Performance of Buildings (Directive 2002/91/EC). The MPE is responsible for the scheme, which is executed by the Norwegian Water Resources and Energy Directorate (NVE).

As part of the 2008 Climate Agreement, the Parliament agreed to revise the energy requirements in the building code more frequently, at least every five years. The Parliament also agreed to pay close attention to the potential of "passive house" standards, and assess possibilities for introducing a requirement that all new buildings comply with the passive house standard by 2020.

In its environmental action plan for the housing and building sector (*Building for the Future 2009-2012*), the government has included a series of measures to improve the energy performance of buildings. A key focus is low-energy housing and a Working Group on energy efficiency with representatives from the authorities, industry and other stakeholders, has been set up to propose both regulatory and economic measures to this end. The government's aim is to reach passive house standards for all new buildings by 2020.

Support programmes

Norway has also established a Low-Energy Programme to promote energy savings and the conversion to the use of renewable energy in buildings. The programme participants are the Federation of Norwegian Building Industries (BNL), the Norwegian Association of Architects' Businesses, the Norwegian State Housing Bank, Enova, the National Office of Building Technology and Administration, the Norwegian Water Resources and Energy Directorate (NVE) and Statsbygg. The programme works primarily on capacity building and pilot projects to enable the building industry to design and build energy-efficient, good and safe buildings for the future. The level of expertise needs to be raised throughout, from architects to construction workers, and pilot projects are seen as essential in this. The programme aims to help ensure that the Norwegian building industry is a pioneer in Europe in terms of constructing energy-efficient and eco-friendly buildings, and that a large number of passive houses are built in Norway in the period 2014–2017.

In its June 2009 report to the Minister of Petroleum and Energy, the Low Energy Commission proposed halving energy use in buildings by 2040. A reduction of this magnitude calls for investments in energy efficiency in connection with major renovations; energy-saving measures in other existing buildings; and the introduction of tighter requirements for new buildings.

Enova operates a support programme for new buildings which focuses on passive houses. The programme grants investment aid for highly ambitious energy-efficient projects at a fixed rate (NOK/m^2). In terms of existing buildings, the programme has increased the focus on driving down the costs of best available technology. New components (lighting, ventilation, windows, etc.) have to be in line with the passive house requirements to be eligible for support.

Since 2006, Enova also manages a household support scheme, which helps individuals who invest in renewable heating systems or energy-saving products. The scheme

includes support to pellet stoves, pellet boilers, control systems, solar water heating systems and heat pumps with the exception of the air-air type (see Chapter 7).

Enova also runs a programme to improve energy efficiency in publicly owned buildings. A total of 650 public buildings received aid and these projects will give an estimated energy saving of 70 GWh per year. The programme budget is NOK 400 million (EUR 46 million).

Enova's programmes for new district heating plants and district heating infrastructure provide support for developing or establishing new infrastructure for district heating and associated generation of renewable energy. Enova's programme for local heating systems supports stakeholders who want to establish new heat generation based on renewable energy sources. These programmes promote infrastructure for distribution of heat which the household sector may utilise.

APPLIANCES

Mandatory energy labelling of household appliances is based on EU directives that cover lamps, ovens, refrigerators, freezers, washing machines, tumble-dryers and dishwashers. Appliances are classified from A to G, where class A is for the most energy-efficient appliances. In 2004, two new classes were introduced: compared to class A, electricity consumption in class A+ is 25% lower and in class A++ 40% lower. The mandatory labelling requirement will be expanded to cover commercial and industrial appliances and also energy-related appliances, following the adoption of the recast of the 1992 Labelling Directive in May 2010. These new requirements will become effective gradually.

In the coming years, minimum energy performance standards will be introduced in Norway, as in all EU member states, for several groups of appliances but also for other products that have an impact on energy use. These standards will be set by EU regulations based on the recast Ecodesign Directive (2009/125/EC).

INDUSTRY

The CO_2 tax and the EU-ETS have a strong influence on energy efficiency in energy-intensive industry. Enova works to promote more environment-friendly and efficient use of energy in industry through its programme on Energy Consumption in Industry. On the basis of applications from mainland companies, the programme can offer partial financing through investment support to trigger the implementation of:

- energy-efficient work models/processes/processing units;
- energy recovery/exploitation of waste heat;
- conversion to the use of renewable energy sources.

Projects must deliver at least 0.5 GWh per year. This may include both reduced energy consumption and use or production of renewable energy.

Enova can contribute up to 20% of the total project cost. This support is intended to trigger the projects. This means that Enova can provide funding up to a level where the project achieves a normalised rate of return. Projects that have a high energy dividend (kWh/NOK) are prioritised.

Enova has recently also studied the energy efficiency potential in the Norwegian mainland industry (*Potensial for energieffektivisering i norsk landbasert industri* -

2009/2010). The study shows that the greatest potential lies with the large companies. Enova does, however, aim to reach also smaller companies, and is in the process of further developing its range of programmes.

CRITIQUE

Norway has a broad set of energy efficiency policies and measures. They include taxes, subsidies, tax exemptions, labelling, building regulations as well as public awareness campaigns. These appear to have been generally effective, as the country's final consumption of energy has remained relatively flat over the past decade, despite economic growth.

The government has recently strengthened Enova by renewing its contract for the 2008 to 2011 period and increasing its annual budget by 86% from NOK 1.4 billion (EUR 160 million) in 2008 to NOK 2.6 billion (EUR 300 million) in 2009. These measures were taken in an effort to mitigate, in the long term, climate change and, in the short term, reduce the impact of the international financial crisis. Funding for 2010 was NOK 1.8 billion (EUR 207 million) and will be slightly more for 2011. The IEA notes the significance of increased funding for Enova as a way to contribute to improving energy efficiency and to increase renewable energy supply. To ensure that energy efficiency and renewable generation goals are achieved, the government should continue to regularly review the achievements of Enova's targets, focusing on the reported and verified results and building on the Ministry of Petroleum and Energy's evaluation of Enova in 2010. Norway should also verify compliance with energy efficiency policy by ensuring regular reporting in instances of non-compliance and establishing enforcement actions. This will allow for maximum energy savings and for ensuring the credibility of the schemes.

Public interest in energy efficiency is often linked with economic considerations. A standard global example would be the reaction to high and increasing oil prices. In Norway, electricity is low-cost and low-carbon by international comparison, which makes it harder to use energy efficiency for supporting the broader energy policy goals of security of supply, economic growth and environmental protection. Electricity accounts for close to half of final energy consumption, and if the government wishes to see more efficient electricity use, it should consider a broad suite of mechanisms, including pricing, to provide additional incentives to domestic users to increase energy efficiency.

The IEA is urging governments to take stronger measures to attract financing for energy efficiency – particularly from the private sector. Significant benefits can result from investments in energy efficiency. Financial institutions should develop energy efficiency investment products and risk-mitigation measures. Positively, the Norwegian State Housing Bank is already providing such funding for building and renovating homes.

BUILDINGS

Building codes are a key instrument for promoting energy efficiency. Buildings have the longest service life of all energy-using products, spanning decades or even centuries; they account for about one-third of all end-use energy in Norway. Therefore, strict building codes are a necessity in improving overall energy efficiency.

Norway has recently introduced more stringent energy performance requirements for new buildings, expected to save 25% more energy than the previous standards. It has also adopted energy labelling in summer 2010. The IEA congratulates Norway for this

progress. In addition to its stringency, other commendable features of the building code are its flexibility and openness to innovation. The code sets a goal for the overall efficiency (energy use per floor area), but leaves it to planners and builders to decide on how to reach this goal.

The government is working together with building sector stakeholders towards significantly reducing energy requirements in new buildings. The IEA applauds Norway's plan to introduce passive house standards by 2020. The current building code standards provide a solid basis for more ambitious measures and in 2008, the Parliament took a very important decision to revise the building code at least every five years. The code can thus be adapted for new technologies and improved building materials more quickly, facilitating a move towards passive house energy performance levels. Although Norway's housing stock is relatively new, regular renovations are common, providing a good opportunity for energy efficiency improvements. Norway should also continue to encourage the use of efficient heating and cooling systems in existing buildings to reduce peak load in electricity.

TRANSPORT

The transport sector accounts for 26% of total energy consumption in Norway and road transport for 19%. Energy efficiency measures in the sector are primarily designed to help reduce CO_2 emissions.

Norway has an ambitious national target of limiting CO_2 emissions from new cars to an average of 120 g CO_2 per km in 2012. It has differentiated the vehicle purchase tax by CO_2 emissions, which is a very good example of a strong incentive to consumers to purchase less-emitting vehicles. Financial incentives are also provided in order to encourage the use of electric vehicles; 3.5% of diesel and petrol must be biofuels. The focus on research and development through the creation of Transnova is also a positive step, though synergies should be considered with energy efficiency activities in other areas such as the electricity and district heating sectors. Norway should also consider implementing policies that address fuel efficiency standards for heavy-duty vehicles.

Norway is also taking steps to mitigate the environmental impact of public transport, for example a number of new ferries are powered by LNG. In addition, consideration is being given to ways to improve the rail network, in order to reduce road and air travel. Currently the rail network is mostly electrified, so emissions from this transport mode are very low; however, the rail network within the country is limited, encouraging people to use more polluting modes of transport such as air travel. The government also has plans to increase rail use for freight tranport. The IEA encourages the government to move ahead with these plans.

INDUSTRY

The availability of low-cost and low-carbon domestically produced electricity has encouraged the development of energy-intensive industry in Norway. Energy efficiency improvements have been made in this area as a result of a decrease in industrial activity and measures implemented through Enova. Norway's participation in the EU-ETS will likely continue to encourage further efficiencies in heavy industry.

IMPLEMENTING THE IEA ENERGY EFFICIENCY RECOMMENDATIONS

Finally, Norway should continue efforts to fully implement the IEA recommendations for improving energy efficiency (see Box 3). In particular, it should consider bringing together its various policies and measures under a single national strategy on energy efficiency.

Box 3. **IEA 25 energy efficiency recommendations**

To support governments with their implementation of energy efficiency, the IEA recommended the adoption of specific energy efficiency policy measures to the G8 summits in 2006, 2007 and 2008. The consolidated set of recommendations to these summits covers 25 fields of action across seven priority areas: cross-sectoral activity, buildings, appliances, lighting, transport, industry and power utilities. The fields of action are outlined below.

1. The IEA recommends action on *energy efficiency* across sectors. In particular, the IEA calls for action on:

- Measures for increasing investment in energy efficiency.
- National energy efficiency strategies and goals.
- Compliance, monitoring, enforcement and evaluation of energy efficiency measures.
- Energy efficiency indicators.
- Monitoring and reporting progress with the IEA energy efficiency recommendations themselves.

2. *Buildings* account for about 40% of energy used in most countries. To save a significant portion of this energy, the IEA recommends action on:

- Building codes for new buildings.
- Passive energy houses and zero-energy buildings.
- Policy packages to promote energy efficiency in existing buildings.
- Building certification schemes.
- Energy efficiency improvements in glazed areas.

3. *Appliances and equipment* represent one of the fastest growing energy loads in most countries. The IEA recommends action on:

- Mandatory energy performance requirements or labels.
- Low-power modes, including stand-by power, for electronic and networked equipment.
- Televisions and set-top boxes.
- Energy performance test standards and measurement protocols.

4. Saving energy by adopting efficient *lighting technology* is very cost-effective. The IEA recommends action on:

- Best-practice lighting and the phase-out of incandescent bulbs.
- Ensuring least-cost lighting in non-residential buildings and the phase-out of inefficient fuel-based lighting.

Box 3. IEA 25 energy efficiency recommendations (continued)

5. About 60% of world oil is consumed in the *transport sector.* To achieve significant savings in this sector, the IEA recommends action on:

- Fuel-efficient tyres.
- Mandatory fuel efficiency standards for light-duty vehicles.
- Fuel economy of heavy-duty vehicles.
- Eco-driving.

6. In order to improve energy efficiency in *industry*, action is needed on:

- Collection of high-quality energy efficiency data for industry.
- Energy performance of electric motors.
- Assistance in developing energy management capability.
- Policy packages to promote energy efficiency in small and medium-sized enterprises.

7. *Energy utilities* can play an important role in promoting energy efficiency. Action is needed to promote:

- Utility end-use energy efficiency schemes.

Implementation of IEA energy efficiency recommendations can lead to huge cost-effective energy and CO_2 savings. The IEA estimates that, if implemented globally without delay, the proposed actions could save around 8.2 Gt CO_2 per year by 2030. This is equivalent to twice the European Union's current yearly emissions. Taken together, these measures set out an ambitious road-map for improving energy efficiency on a global scale.

RECOMMENDATIONS

The government of Norway should:

- ☐ *Consider developing a national strategy on energy efficiency.*
- ☐ *Review Enova's results regularly to ensure that goals are reached and benchmark the resulting CO_2 reductions per NOK with similar programmes elsewhere; consider synergies between Enova and Transnova.*
- ☐ *Address the barriers to energy efficiency improvements in the residential sector posed by the availability of low-cost and low-carbon electricity.*
- ☐ *Review the energy performance requirements for buildings regularly and, as more efficient solutions become cost-effective, gradually make them more stringent; ensure any measures address both existing and new buildings.*
- ☐ *Continue to support electric vehicles both through funding research, development, demonstration and deployment in this field and through encouraging greater and faster penetration of electric vehicles into the car fleet.*
- ☐ *Maintain the purchase tax system for new cars in order to give very strong signals to consumers and to limit CO_2 emissions from new cars.*
- ☐ *Evaluate the benefits of accelerating improvements and extensions to the rail network to capture further greenhouse gas emissions reductions.*

PART II
SECTOR ANALYSIS

5. FOSSIL FUELS

PETROLEUM SECTOR

Norway is one of the leading petroleum exporters in the world. In 2009, its total oil and gas exports were third-largest, after Russia and Saudi Arabia. Its gas exports, at 100 billion cubic metres (bcm) per year, were the second-highest in the world and its net oil exports, at 2.1 million barrels per day (mb/d), the seventh-largest, according to IEA data.

The petroleum sector is the backbone of the Norwegian economy. In 2009, the sector generated 22% of GDP and 47% of exports. It also accounted for 26% of investment in the country and provided 27% of government revenue.

RESOURCES AND PRODUCTION

The government estimates the total petroleum resources on the Norwegian Continental Shelf (NCS) at 84 billion barrels (13.4 billion m^3) of oil equivalent. Around 40% of this total has already been produced, mostly in the form of oil. The remaining resources contain more gas than oil (62% vs. 38% of the total) and consist mostly of proven reserves and undiscovered resources, each accounting for around two-fifths.

The North Sea, where Norwegian petroleum production started, has around two-thirds of the remaining resources, while the Norwegian Sea contains 23% and the Barents Sea 7% of the total. The undiscovered resources, estimated at around 21 billion barrels (3.3 billion m^3) of oil equivalent are divided fairly equally between the three NCS regions, with 35% in the North Sea, 35% in the Norwegian Sea and 30% in the Barents Sea. The rest, one-fifth of the remaining resources, is made up of contingent resources in fields and discoveries, as well as of resources to be added through future measures for improved recovery (see Table 7).

At the end of 2009, Norway had 65 fields in production, while eight were being developed and 82 discoveries evaluated. The government expects petroleum production to fall moderately over the next few years. By fuel, the trends look very different, however. Oil production has declined by around 33% since its peak in 2001 and will continue to gradually decrease, while gas production is expected to increase from 106 bcm to between 110 and 130 bcm over the next decade. In 2009, gas provided 43% of total petroleum production (see Figure 15).

Table 7. **Norway's petroleum resources**

	Resource accounts, 31 December 2009					Changes from 2008				
Total recoverable potential	Oil	Gas	NGL	Cond	Total mcm	Oil	Gas	NGL	Cond	Total mcm
Project status category	mcm	bcm	Mt	mcm	o.e.	mcm	bcm	Mt	mcm	o.e.
Produced*	3 521	1 440	124	91	5 287	116	107	8	-5	233
Remaining reserves**	868	2 046	116	35	3 169	-51	-170	-4	-8	-237
Contingent resources in fields	367	249	27	3	670	34	68	-1	-2	98
Contingent resources in discoveries	208	454	16	24	716	-3	-58	2	-3	-59
Potential from improved recovery***	160	70			230	15	-7	0	0	8
Undiscovered	1 200	1 825	0	255	3280	-60	-50	0	-10	-120
Total	6 324	6 083	283	409	13 353	50	-110	5	-28	-78
North Sea										
Produced	3 068	1 263	99	66	4 585	93	61	5	-8	155
Remaining reserves**	658	1 366	65	3	2 152	-50	-39	0	4	-85
Contingent resources in fields	327	176	13	1	529	41	69	0	-2	108
Contingent resources in discoveries	178	188	8	15	398	48	18	4	-1	72
Undiscovered	620	500		55	1 175	0	0	0	0	0
Total	4 852	3 494	186	141	8 839	132	109	8	-6	250
Norwegian Sea										
Produced	453	171	25	24	695	22	42	4	2	74
Remaining reserves**	179	517	44	15	796	-32	-135	-5	-12	-187
Contingent resources in fields	40	66	14	1	133	-7	1	-1	0	-8
Contingent resources in discoveries	29	218	8	5	267	8	-8	-1	-4	-6
Undiscovered	225	825		145	1 195	5	0	0	-5	0
Total	926	1 797	90	191	3 085	-3	-100	-3	-19	-127
Barents Sea										
Produced	0	6	0	1	8	0	3	0	1	4
Remaining reserves**	31	162	6	17	222	31	4	0	-1	34
Contingent resources in fields	0	7	0	1	8	0	-1	0	0	-2
Contingent resources in discoveries	0	48	0	4	52	-59	-68	0	2	-126
Undiscovered	355	500		55	910	-65	-50	0	-5	-120
Total	386	722	7	78	1 199	-94	-112	0	-3	-209

* Includes historical sale of gas from Tambar and an historical adjustment of condensate from Gungne, Sigyn, Sleipner Vest and Sleipner Øst.

** Includes resource categories 1 (in production), 2 (approved plan for development and operation) and 3 (decided by the licensees) of the Norwegian Petroleum Directorate.

*** Resources from future measures for improved recovery are calculated for the total recovery potential and have not been broken down by area.

NB. The figures for the Barents Sea do not include the area which was formerly disputed by Norway and Russia. An agreement ending this dispute was signed in September 2010.

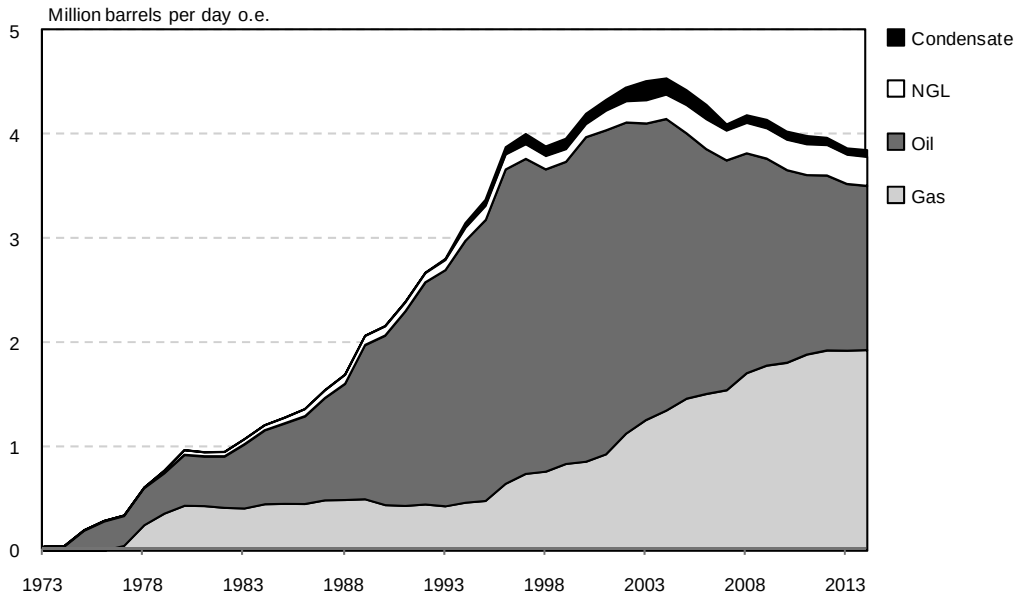
Source: Ministry of Petroleum and Energy, *FACTS 2010*.

Investments

Investments in oil and gas production have grown considerably in recent years, from NOK 75 billion (EUR 8.6 billion) in 2000 to NOK 110 billion (EUR 12.6 billion) in 2009, and are expected to remain high. According to a quarterly survey of petroleum companies by Statistics Norway, total investments in exploration and production will reach NOK 139.4 billion (EUR 16 billion) in 2010 and climb to NOK 148.1 billion (EUR 17 billion) in 2011. Spending on fields in operation is forecast to jump by 21% to NOK 82.2 billion (EUR 9.4 billion) in 2011, while field developments will attract NOK 29.4 billion (EUR 3.4 billion) and exploration NOK 30.6 billion (EUR 3.5 billion), a NOK 2.5 billion (EUR 286 million) increase from 2010.

The increase in investments over past years is largely explained by higher costs in the sector, a global development. After peaking in 2008, upstream costs have declined somewhat with the financial crisis, but remain high. Investments are also increasing because more mature fields call for more complicated and expensive methods for exploiting the resources. Cost inflation is a major concern for the government, and cost control is a constant challenge for all oil companies on the NCS.

Figure 15. **Total petroleum production, 1973 to 2014**



Source: Ministry of Petroleum and Energy.

A new record for exploration on the Norwegian Continental Shelf was set in 2009, when 65 exploration wells (44 wildcat wells and 21 appraisal wells) were spud, up from just 12 in 2005, and 28 discoveries were made. The discoveries are estimated to increase proven resources of oil by 226 to 591 million barrels (36 to 94 million m^3) and gas by 37 to 154 bcm. Many of the discoveries are close to fields in production and can come on stream fairly quickly.

PRODUCTION LICENSING

The 1996 Petroleum Act provides the general legal basis for the licensing system which regulates petroleum activities in Norway. The Act and related secondary regulations authorise the awarding of licences to explore for, produce and transport petroleum.

The Petroleum Act establishes that the Norwegian State has proprietary rights to subsea petroleum deposits on the Norwegian Continental Shelf. Before permission for exploration drilling and production (a production licence) may be granted, the area in question must have been opened up for petroleum activities by the Parliament. The Parliament may only take such a decision after assessing the environmental, economic and social impacts of petroleum activities on other industries and adjacent regions, and consulting local authorities and relevant stakeholder organisations.

Production licences are normally awarded through licensing rounds according to announced and non-discriminating criteria. The government invites applications for a certain number of blocks, and companies may apply individually or in groups. The Ministry of Petroleum and Energy (MPE) generally awards licences to groups of companies to maximise expertise and experience in operations. The ministry appoints an operator for the joint venture to manage the daily operations in the licence. The number of companies operating on the NCS has increased from 23 in 1997 to more than 50 in March 2010, of which 35 held operatorships in one or more production licences.

Many fields on the Norwegian Continental Shelf contain both gas and oil. When awarding production permits, the MPE takes into account the prospects for optimal recovery of the petroleum resources. On occasion, the ministry has awarded production permits for production of less gas than applied for by the companies, out of consideration for the need to produce oil.

Since the early days of the Norwegian petroleum industry, the authorities have been successful at attracting a large range of international companies which have made a strong contribution 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, the industry structure is changing to reflect this situation. An increasing number of smaller Norwegian and international companies have entered the NCS, with an interest in more specialised projects, developing more marginal resources or fields in the tail production phase. There has also been a trend whereby international utilities move upstream.

Mature areas

There are two systems for awarding licences on the Norwegian Continental Shelf. Licences for mature areas of the NCS are awarded every year under the Awards in Predefined Areas (APA) system. Acreage is announced in January-February and production licences awarded in December. In 2010, 41 oil and gas firms submitted applications. The APA system ensures that, with fairly known geology and presumably surmountable technical challenges, very large areas close to existing and planned infrastructure are available for the industry. The APA area will be expanded as new areas mature, but will not be reduced.

Frontier areas

Licences for frontier areas, in turn, are awarded in ordinary concession rounds held normally every two years. Frontier areas are characterised by less knowledge of the geology, possibly significant technical challenges and lack of infrastructure. The companies allowed to explore in these areas must have broad experience, technical and geological expertise, and a solid financial base. The 20th licensing round was awarded in the spring of 2009 and the 21st round is planned to be awarded in spring 2011.

The areas currently considered to be frontier areas on the Norwegian Continental Shelf include major portions of the Barents Sea and the Norwegian Sea. In the Norwegian Sea, this applies particularly to deepwater regions and the northern-most areas. The coastal areas in the southern part of the NCS are also relatively immature.

Unopened areas

The Norwegian Parliament has opened up for petroleum activities the greater part of the North Sea, the Norwegian Sea and the southern Barents Sea. Large parts of the Norwegian Continental Shelf remain to be opened up, including all of the northern Barents Sea.

Box 4. **Oil spill preparedness**

In Norway, the preparedness for acute pollution consists of private-sector preparedness, municipal preparedness and state preparedness. The Ministry of Fisheries and Coastal Affairs and the Norwegian Coastal Administration are responsible for co-ordinating the total national oil spill preparedness, as well as the government's preparedness for acute pollution. The Ministry of the Environment is responsible for setting preparedness requirements for acute pollution in municipalities and for private enterprises. The Norwegian Climate and Pollution Agency (CPA) approves the emergency preparedness plans and ensures that the demands are complied with.

On behalf of the oil companies, the operators are responsible for handling acute incidents that are a result of their own activities, using preparedness resources that are designed for this purpose. The Norwegian Clean Seas Association for Operating Companies (NOFO), which consists of a number of companies that are licensees on the Norwegian Continental Shelf, has also established regional plans which take into consideration reinforcement of ocean-going preparedness, coastal preparedness and beach zone preparedness. NOFO manages and maintains preparedness which includes personnel, equipment and vessels. NOFO has five bases along the coast – Stavanger, Mongstad, Kristiansund, Træna and Hammerfest, in addition to some fields where NOFO equipment is permanently located. NOFO has a total of 16 oil spill preparedness systems and carries out training exercises each year.

Following the Deepwater Horizon oil spill in the Gulf of Mexico, Norway may tighten its already relatively strict offshore regulations, according to the Petroleum Safety Authority. In a report published in September 2010, the Norwegian Petroleum Directorate declared that geological formations, petroleum composition and sub-seabed reservoir depths make it "highly unlikely" that a well leak in the northern Norwegian Sea or in the Norwegian Barents Sea could release oil as fast as in the Deepwater Horizon accident.

Sources: Ministry of Petroleum and Energy; Petroleum Safety Authority.

In general, the gradual expansion of petroleum activities towards the vast frontier areas in the northern parts of the Norwegian Continental Shelf requires balancing the interests of the fisheries, the petroleum industry and the shipping industry, while protecting the environment. As a policy tool to this effect, the government uses specific integrated management plans.

The plan for the Norwegian Sea dates from 2009 and a management plan for the Norwegian part of the North Sea is being prepared. The government is also revising the 2006 plan "Integrated Management for the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands". As part of this revision, the government is expected to take up a position on opening the Lofoten-Vesterålen-Senja region to oil activities in early 2011. According to official estimates, the Lofoten-Vesterålen-Senja region holds some 1.3 billion barrels of oil equivalent, but also includes the spawning grounds of the world's largest cod stock and unique cold-water reefs.

In September 2010, Norway and Russia signed a treaty concerning the maritime delimitation line between the two countries in the Barents Sea and the Arctic Ocean. The treaty brings to an end a 40-year negotiation process and paves the way for oil and gas exploration in an offshore area covering 175 000 km^2. The Arctic is believed to hold vast untapped oil and gas reserves. Any oil and gas fields straddling the border would have to be unitised and developed jointly. The treaty will still have to be ratified by the national assemblies in the two countries.

STATE PETROLEUM REVENUE

The State receives a large share of the value created from petroleum activities through:

- taxation of oil and gas activities;
- direct ownership in fields and infrastructure through the State's Direct Financial Interest (SDFI);
- charges and fees;
- dividends from ownership in Statoil.

Taxation of petroleum activities is based on the rules governing ordinary business taxation. As the extraction of oil and gas generates considerable excess return (resource rent), a special tax of 50% on this income has been introduced, in addition to the ordinary capital income tax of 28%. Consequently, the marginal tax rate on the excess return within the petroleum sector is 78%.

Important auxiliary taxes linked to petroleum activities are the CO_2 tax, the nitrogen oxide ($NO_{x)}$ tax and the area fee. The CO_2 tax was introduced in 1991 and is an instrument for reducing CO_2 emissions from the petroleum sector. It is levied at a rate per standard cubic metre (scm) of gas burned or directly released and per litre of oil burned. The rate for 2010 is NOK 0.47 per litre of oil or per scm of gas (around EUR 0.05).

In order to fulfil its international obligations to reduce NO_x emissions, a NO_x tax was introduced from 1 January 2007. For 2010, the tax is NOK 16.14 (EUR 1.84) per kg of NO_x. The area fee in turn is used to encourage both efficient exploration of awarded

acreage, so that potential resources are produced as quickly as possible within a prudent financial framework, and extensions to the lifetime of existing fields.

The State holds around one-third of the reserves and has the largest portfolio on the Norwegian Continental Shelf. As of 1 January 2010, the State had direct financial interests in 137 production licences and 14 joint ventures for pipelines and onshore facilities. The state direct ownership is organised into the State's Direct Financial Interest (SDFI) and is managed by the state-owned trust company, Petoro.

MPE decides on the share of the State when production licences are awarded. This share varies from field to field, the average being around 27%. The State's share does not carry any privileges, as the State pays its share of investments and costs, and receives a corresponding share of the income from the production licence. The Norwegian State also owns 67% of Statoil, the largest producer of oil and gas on the NCS.

The MPE estimates net cash flow from petroleum activities to the State at NOK 265 billion (EUR 30.3 billion) for 2010. Company taxes and fees amount to NOK 156 billion (EUR 17.8 billion). Income from the State's Direct Financial Interest (SDFI) is estimated to NOK 96 billion (EUR 11 billion) and dividend from Statoil to NOK 13 billion (EUR 1.5 billion). Cash flow is expected to reach NOK 288 billion (EUR 33 billion) in 2011.

The State's revenues from petroleum activities are held in a separate fund, the Government Pension Fund – Global. At the end of 2009, the fund had NOK 2.6 trillion (EUR 300 billion) in diversified assets (stocks, securities and real estate) in a broad range of countries. The Fund's total assets equalled around 120% of the country's GDP. The Ministry of Finance is responsible for managing the Fund, while Norges Bank is responsible for its operational administration.

OIL

UPSTREAM

Resources and production

Norway has the fourth-largest oil reserves among the OECD member countries, after Canada, the United States and Mexico. The *BP Statistical Review of World Energy 2010* puts Norway's total proved oil reserves at 7.1 billion barrels, corresponding to the remaining reserves of oil, condensates and natural gas liquids in Table 7. The Norwegian government estimated "remaining oil resources" at 17.6 billion barrels (2.8 bcm) at the end of 2009 (see Table 7 above), of which 10.1 billion barrels (57%) are discovered and 7.5 billion barrels (43%) are undiscovered resources.

Norway is also the fourth-largest OECD oil producer, after the United States, Mexico and Canada; it produced 2.39 mb/d in 2009 and is expected to produce 2.2 mb/d in 2010. Oil production has declined by one-third from its peak in 2001, and the Norwegian Petroleum Directorate (NPD) forecasts a decline to 1.5 mb/d in 2015 (see Figure 16), which (excluding natural gas liquids from gas processing) is slightly more optimistic than the IEA medium-term oil market forecast, which sees a fall to 1.4 mb/d in 2015.

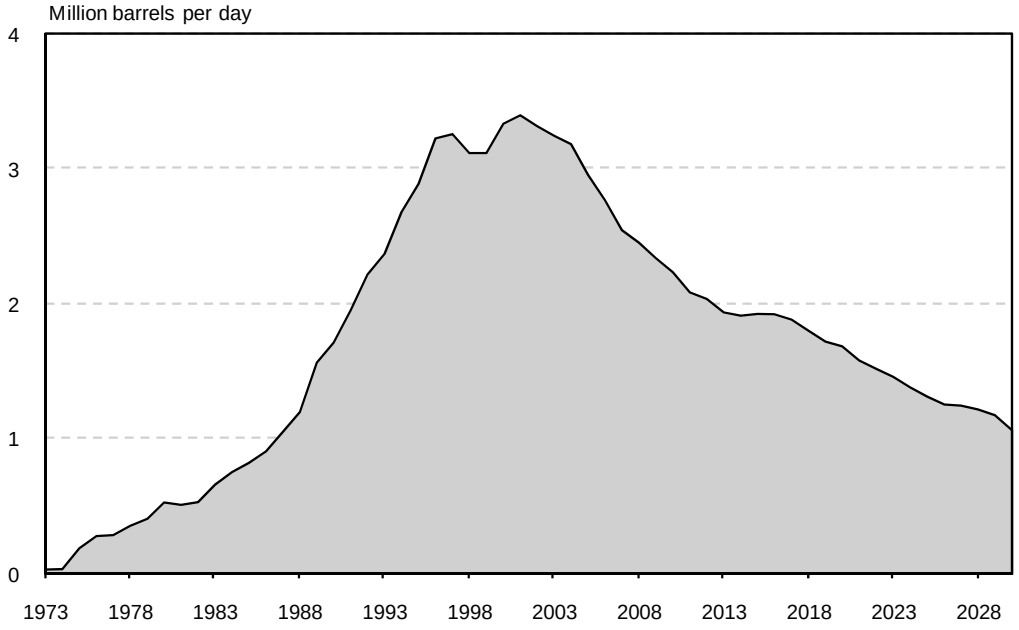
Crude oil is produced from offshore platforms operating on the Norwegian Continental Shelf (NCS). From the platforms, the crude oil is transported to onshore oil terminals

either by pipeline or by loading onto oil tankers for transportation to oil refineries. The Mongstad refinery is linked by pipeline to some of the offshore production. The North Sea will remain the main oil-producing region on the NCS, as it holds 80% of the discovered resources and half of the undiscovered resources.

In its efforts to increase oil production, the government is also focusing on easing recovery from existing fields. In September 2010, an investigative commission set up by the government recommended 44 measures for increasing the recovery rate to 60% from a projected rate of 46%. Among these measures is a change to speed up decision making among the licence-holders by allowing them to take more decisions by a simple majority. Other proposed measures include cutting costs, developing and introducing new technology and simplifying rules for moving rigs to and from Norway. Fully implementing the recommendations would lead to a recovery of an extra 2.5 billion standard cubic metres of oil (15.7 billion barrels), a tenfold increase to the current levels (see Table 7).

Nearly sixty oil companies are currently engaged in the upstream sector of the Norwegian petroleum industry. More than one-third of these are appointed operators of one or more production licences. Statoil alone accounts for almost 70% of all activities on the Norwegian Continental Shelf. With the maturing of fields on the NCS, there has been a renewed focus on attracting competent new players to the upstream sector.

Figure 16. **Historical and projected oil production, 1973 to 2030**



Source: Ministry of Petroleum and Energy.

Exports

Norway is the largest of the only three IEA net oil exporters, larger than Canada and Denmark. The country consistently exports close to 90% of its crude oil production and it is also a net exporter of oil products. In 2009, 90% of crude oil production was exported,

with 90% of the total to OECD European countries. Norway's net exports of oil (including products) stood at 2.1 mb/d in 2009. According to MPE, the United Kingdom received 39% of Norway's oil exports in 2009, the Netherlands 18%, France 8% and Germany 7%. OECD countries together accounted for 98% of Norway's crude oil exports.

Transport infrastructure

Norway has established an extensive network of subsea oil pipelines to link offshore oilfields with onshore terminals. Statoil operates the Oseberg Transport System (765 thousand barrels/day) to connect the Oseberg field with the Stura receiving terminal. It also operates the 265 kb/d Grane pipeline, linking its Grane field to Stura. The Stura terminal's storage capacity is 6.3 mb of crude oil.

Statoil also operates the twin pipeline system called Troll I and II (565 kb/d), connecting the Mongstad terminal to offshore oilfields. The terminal can store 9.4 mb of crude oil. Most of it is exported from Mongstad by tankers, but the refinery retains a certain amount for its own use.

Norpipe Oil AS is operated by ConocoPhillips Skandinavia AS. This oil pipeline (810 kb/d) is about 354 km, starting at the Ekofisk Centre and crossing the UK Continental Shelf to come ashore at Teesside in the United Kingdom. A tie-in point for UK fields is located about 50 km downstream of Ekofisk.

DOWNSTREAM

Demand

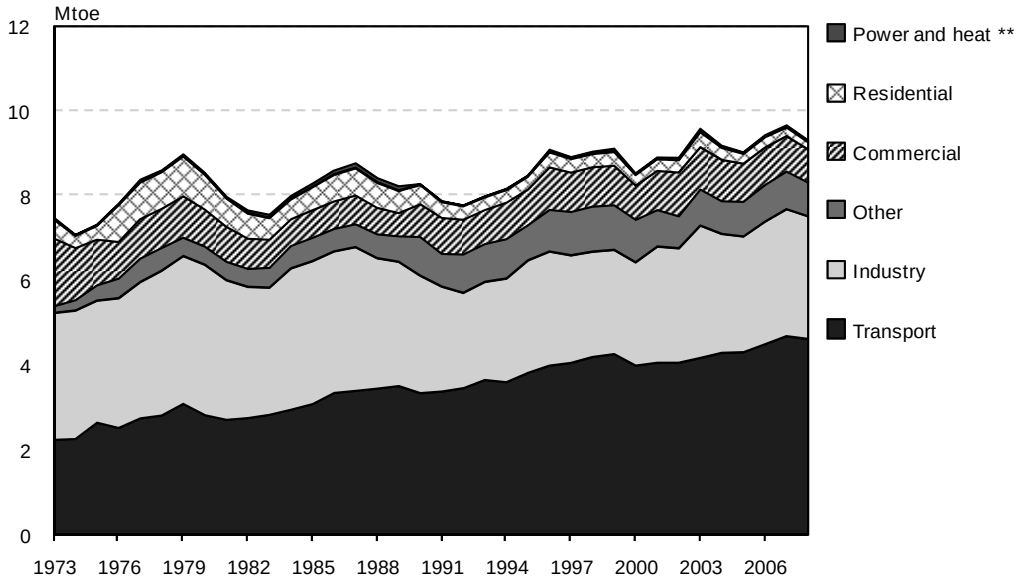
Oil demand in 2008 amounted to 9.2 Mt, 3% less than in 2007, and accounted for 28% of total demand.[2] The transport sector accounted for 50% of total oil demand. The petroleum sector consumed 9% of all oil, and other industry 31%. The service sector and households used the remaining 10%. Oil use for space heating is minimal, as electricity prevails. Over the last decade, total oil demand has increased slightly, while industry and transport have seen their share in oil demand increase (see Figure 17.). Oil demand peaked in 2007 and preliminary data indicate a decline also from 2008 to 2009. Oil demand is expected to continue along this gradual decline, mainly because of a progressive ebbing of gasoline demand. More than 40% oil product demand is covered by domestic production.

Retail supply

The four largest suppliers – Statoil, Shell, Esso and YX Energi (now Uno-X Energi) – controlled around 97% of the combined gasoline and diesel retail market in 2008. The top three alone (Statoil, Shell and Esso) accounted for 80% of the market. Statoil is the largest retail supplier, with close to 33% of combined motor fuel sales.

2. Demand equals TPES minus statistical differences. In Norway's case, this, rather than TPES, gives a clearer picture of actual oil use in the economy, because statistical differences can be very large, depending on the year. Statistical differences stem from the supply figures, which are calculated as the residual of two very large and opposite terms, production and exports.

Figure 17. **Oil supply by sector*, 1973 to 2008**



* TPES by consuming sector, minus statistical changes. *Other* includes other transformation and energy sector consumption. *Industry* includes non-energy use. *Commercial* includes commercial, public services, agriculture/ forestry, fishing and other final consumption.

** Negligible.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010.

Infrastructure

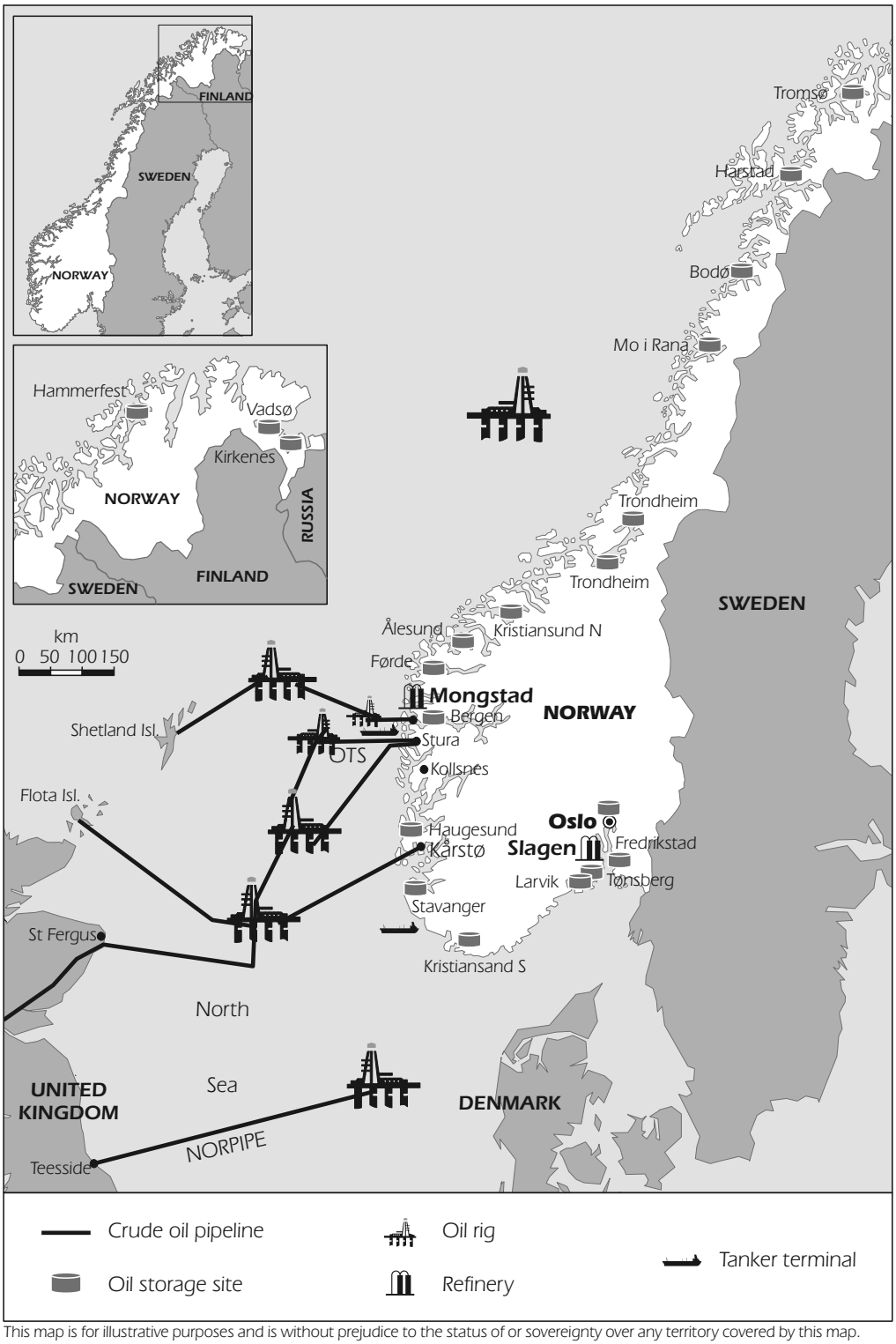
Refineries

Norway has two refineries: the Mongstad refinery close to Bergen is owned by Statoil (79%) and Shell (21%), and has a capacity of 200 kb/d. The Slagen refinery south of Oslo is owned by Esso, and has a capacity of 110 kb/d. The two refineries purchase crude oil from and sell products to the world market, and some of the feedstock is imported. Around 30% of the output from these refineries (90 kb/d) is consumed by the domestic market, whereas the rest is exported. Remaining domestic consumption of oil products, amounting to some 140 kb/d, is produced at foreign refineries.

Storage

The Slagen and Mongstad refineries together can store around 15.7 mb of crude oil. Oil trading companies have several types of storage facilities, but the MPE no longer collects and maintains information on their capacities. These facilities include 26 large storage terminals (supplied by tankers directly from the refineries), around 50 distribution storage facilities (supplied by tankers from the refineries or main storage sites) and coastal storage or sub-storage sites for delivering bunker oil to boats (supplied by boat and operated by independent dealers).

Figure 18. **Norway's oil infrastructure, 2010**



This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Sources: *Oil Supply Security 2007*, OECD/IEA Paris 2007; Ministry of Petroleum and Energy.

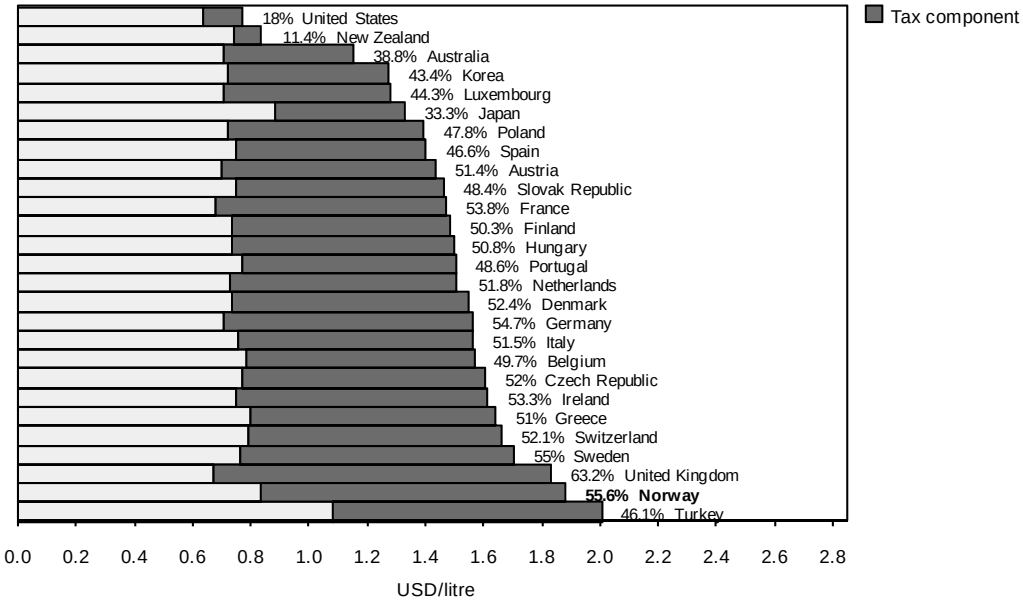
The companies also possess larger storage facilities situated on service bases for the offshore activity. These are operated by the service companies themselves. Additionally, there are inland depots for small-scale distribution ("peddlers") which deliver heating oil and auto diesel to households and agriculture. The products from main storage sites, distribution storages and peddler depots are delivered by truck. For deliveries to large customers, small tankers or barges are also utilised. If the sub-storage and inland depots are included, Norway has about 400 storage facilities altogether.

Prices and taxes

Gasoline and diesel are relatively expensive in Norway. In the second quarter of 2010, Norway had the second-highest gasoline and diesel prices among the OECD member countries, after Turkey (see Figures 19 and 20). High prices partly reflect the general price level in Norway, but are mostly a result of high taxes.

As is the case in many OECD countries, taxes on diesel are lower than taxes on gasoline, resulting in a progressive "dieselisation" of the vehicle fleet in recent years. As of October 2010, the combined excise plus CO_2 tax for diesel, NOK 4.14 per litre (EUR 0.47 or USD 0.66), is markedly lower than for gasoline, NOK 5.40 per litre (EUR 0.62 or USD 0.86). All oil products are also levied a 25% value-added tax (VAT), which in many cases is refunded to industrial and commercial users.

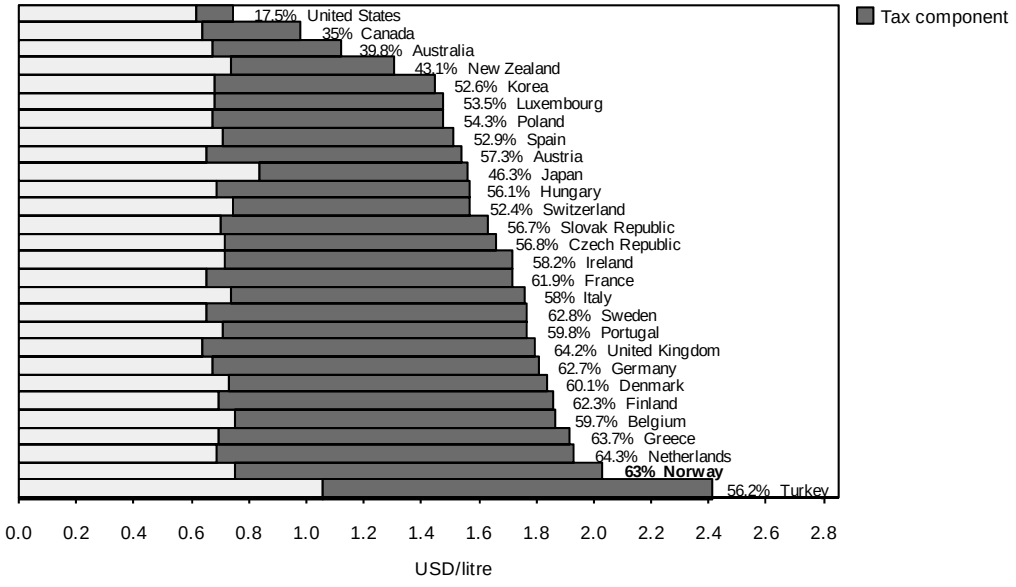
Figure 19. **IEA automotive diesel prices and taxes, third quarter 2010**



Note: Data not available for Canada.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2010.

Figure 20. **IEA unleaded gasoline prices and taxes, third quarter 2010**



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2010.

Security of supply

As a crude oil producer and a significant net oil exporter, Norway has a particular position within the IEA. Under the Agreement to the International Energy Program (IEP) concluded in February 1975, Norway formally has the right to decide whether and how (on a case-by-case basis) it would participate in the IEA oil-sharing system.

As demonstrated in 1991 and 2005 and also in specific situations when other IEA response plans have been put together but not implemented, Norway has thus far contributed to such plans with volumes of the magnitude as calculated on the basis of its inland consumption. Therefore, although the IEP Agreement gives Norway formal and special rights, Norway has not made use of this special position.

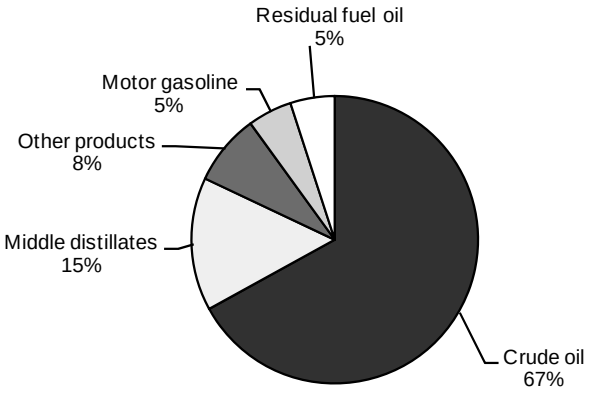
Emergency oil reserves

The 2006 Act of Petroleum Product Storing for Emergency Purposes imposes an obligation on companies to hold stocks of oil products equivalent to 20 days of their sales/imports in the domestic market. It also obliges them to implement stock-draw upon the government's request, in case of a supply deficit. The Act was provided with supplementary regulations, instituted in September 2006. As a consequence of this new legislation, the government stocks were sold in 2007.

The 2006 legislation covers only petroleum products and divides them into three categories, namely gasoline, middle distillates and heavy fuels. At least 40% of the stored products must consist of these three categories, and up to 40% of the total stockholding commitment may consist of crude oil, condensate or semi-finished products. The breakdown of oil stocks by category in May 2010 is depicted in Figure 21. The legislation mandates government control of company stocks during peacetime in the event of a supply disruption. However, in wartime, the government may still take control of all crude oil stocks as well as industry-held product stocks.

The compulsory stocks are commingled with commercial stocks. Several companies have entered into agreements on stock-draw in each other's storage facilities, thus reducing distribution costs. While there are no restrictions on location of stocks abroad, Norway has no bilateral stockholding arrangements with other countries and all stocks are held at home.

Figure 21. **Breakdown of oil stocks by category, May 2010**



Source: Ministry of Petroleum and Energy.

NATURAL GAS

UPSTREAM

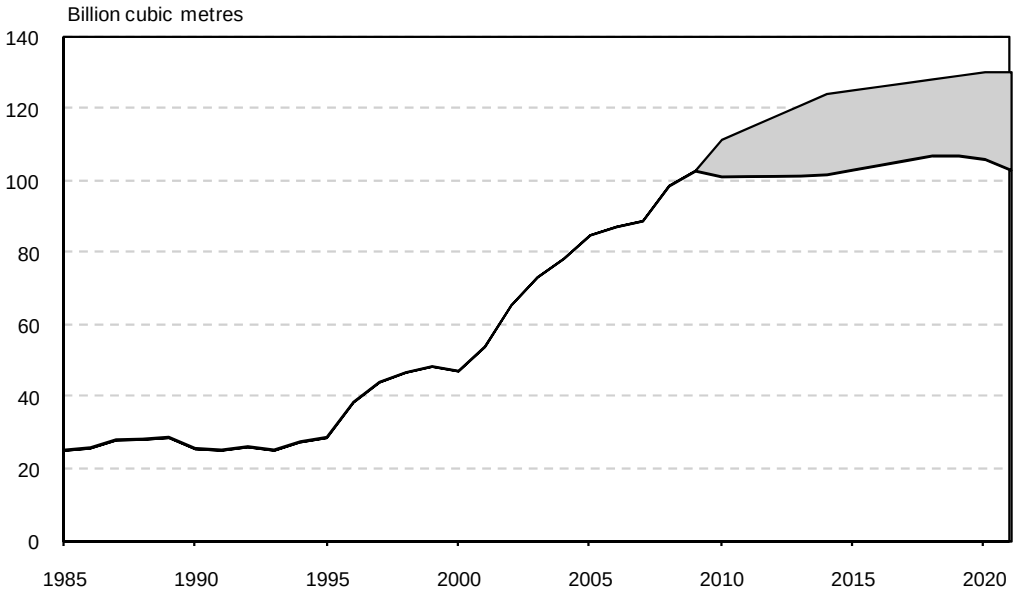
Resources and production

Norway has the second-largest reserves of natural gas in Europe, after Russia. Its gas reserves are the third-largest among the IEA member countries, after the United States and Australia. The Norwegian government estimated "remaining gas resources" at 4.6 trillion cubic metres (tcm) as of January 2010 (see Table 7 above), of which 60% are discovered and 40% are undiscovered resources. Three-fifths of the discovered resources are located in the North Sea, while those undiscovered are mostly to be found in the Norwegian and Barents Seas. The *BP Statistical Review of World Energy 2010* puts Norway's gas reserves at 2.05 tcm, corresponding to remaining reserves in Table 7.

Gas production has increased steadily since the mid-1990s. In 2009, the government indicated that total "marketed" gas production was 103.2 bcm,[3] of which 96.6 bcm was exported to Europe by pipeline and 3.4 bcm produced and exported from the Snøhvit LNG plant in the Barents Sea. The IEA estimates total indigenous production (including gas used for upstream oil and gas production) for 2009 at 105.9 bcm, up from 102 bcm in 2008. The government expects production to range between 105 bcm and 130 bcm from 2010 to 2020, depending on exploration results and when new projects come on stream (see Figure 22). Most gas is produced in the North Sea fields, while there is large potential for incremental production from the Norwegian Sea and Barents Sea (see Table 7).

3. Total "marketed" gas does not account for most of the gas consumed by the upstream business.

Figure 22. **Historical and projected natural gas supply, 1985 to 2021**



Source: Ministry of Petroleum and Energy.

Exports

Norway consistently exports almost 95% of its gas production (99.9 bcm in 2009, out of 105.9 bcm produced). Exports have traditionally been to Europe by direct pipeline (to the United Kingdom, France, Belgium and Germany). Norway is the second-largest exporter of gas to Europe, behind Russia but ahead of Algeria. According to MPE, Germany received 26.5% of Norway's gas exports in 2009, the United Kingdom 25.0%, France 14.2% and the Netherlands 10.7%. Another nine countries received the remaining 23.6%.With the opening of the Snøhvit LNG terminal, Norway's exports will be further diversified.

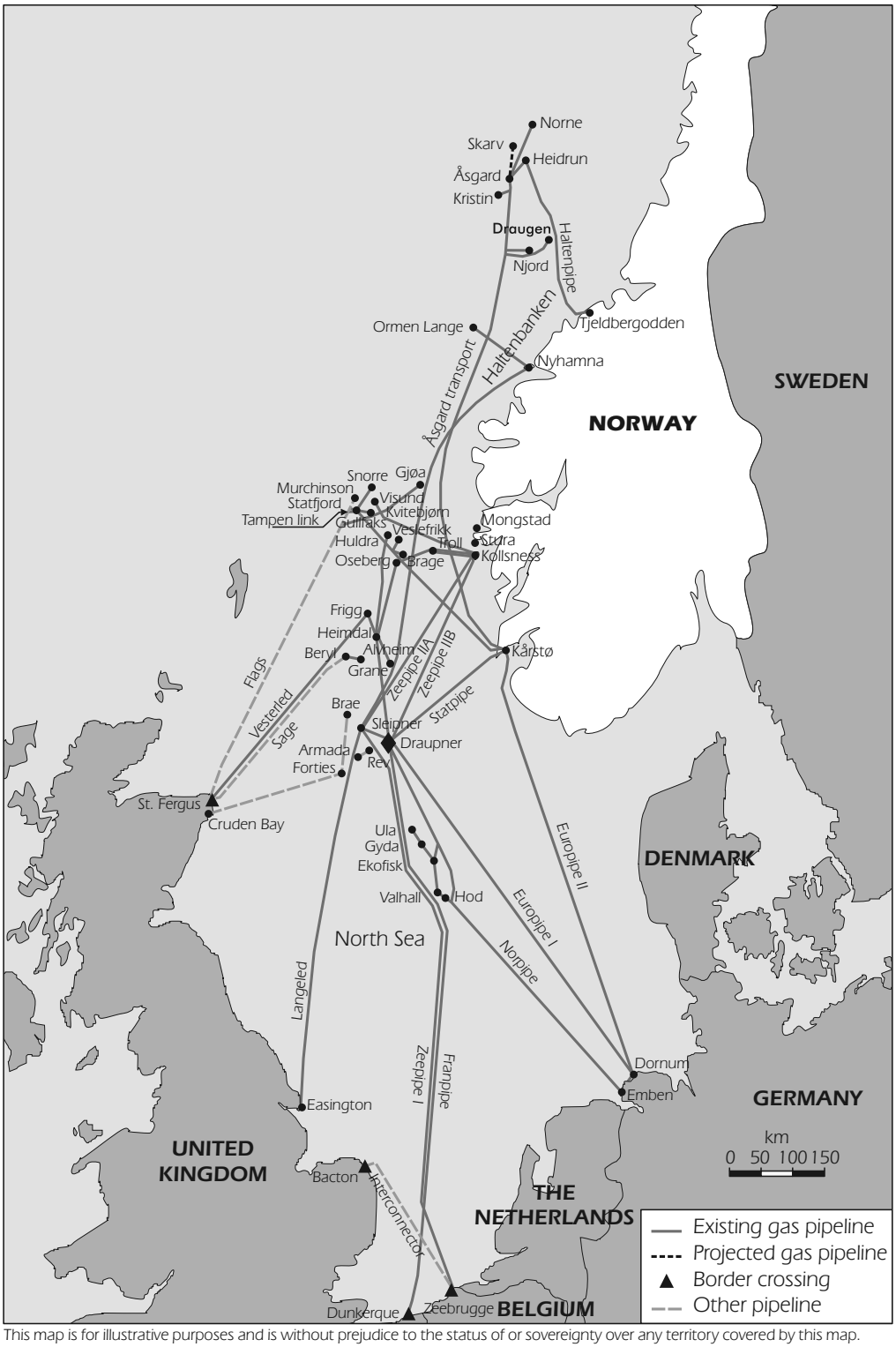
Most of the exported gas is supplied by Statoil which is the second-largest gas supplier in Europe and the sixth-largest in the world.[4] The company sells around 80 bcm per year, including the group's own production (around 40 bcm), third-party gas and gas sold on behalf of the State's Direct Financial Interest.

Gas transportation infrastructure and operations

The Norwegian gas transportation system consists of a network of more than 7 800 km of pipelines and has a capacity of around 120 bcm per year. There are four receiving terminals for Norwegian gas on the Continent: two in Germany, one in Belgium and one in France. There are also two terminals in the United Kingdom (see Figure 23).

4. The group sells gas to customers in Germany, France, Belgium, Italy, the Netherlands, the United Kingdom, the Czech Republic, Austria, Spain, Denmark, Ireland, Norway, Azerbaijan, Georgia, Turkey and the United States.

Figure 23. **Natural gas transportation system, 2010**



This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Source: Petroleum Directorate, Ministry of Petroleum and Energy.

The latest major addition to the Norwegian pipeline network was the 25 bcm Langeled pipeline which came on stream in October 2007. Another pipeline opened in 2007 is the 7 bcm Tampen Link connecting the Statfjord field with the existing Far North Liquids and Associated Gas System (FLAGS). Over the past few years, several other pipeline projects to Europe, such as Skanled and Gas Network Expansion, have been considered, but cancelled. If Norway wishes to reach the upper range of its gas export forecasts, additional capacity will be needed.

In 2007, Norway also launched Europe's first LNG export terminal, Snøhvit. The terminal has an annual export capacity of 5.75 bcm of LNG and uses the resources of three gas fields in the Barents Sea – Snøhvit, Albatross and Askeladd (240m to 345m deep) – which lie about 140 km north-west of Hammerfest. As exploration moves further north into the Norwegian and Barents Seas, transport of liquefied (LNG) or compressed natural gas (CNG) by ship may become more viable alternatives to traditional pipelines.

The Norwegian upstream gas transportation system includes three central instruments: the operator Gassco AS; the joint ownership company Gassled; and regulated conditions for access to the transportation system. They are described below.

Gassco

Gassco is the operator of the integrated gas transportation system from the Norwegian Continental Shelf to other European countries. Gassco is wholly owned by the Norwegian State. It was created in 2001 as part of an extensive reorganisation of the Norwegian oil and gas sector. Before that, gas transportation was provided by a number of companies.

Gassco's responsibilities include planning, monitoring, co-ordinating and administering the transport of gas from the fields to the receiving terminals as well as allocating capacity and developing the transportation system. It also serves as operator for the receiving terminals in Dunkerque (France), Zeebrugge (Belgium), Emden and Dornum (Germany). A neutral and independent operator of the gas transportation system, Gassco ensures equal treatment of all users of the system, both as regards utilisation of the system and consideration of capacity increases.

Gassled

The gas transportation system, that is pipelines and terminals, is mainly owned by the Gassled partnership (see Table 8). This common ownership structure was established in December 2002. Gassled encompasses all rich and dry gas facilities that are currently in use or are planned to be used to any significant degree by third parties. New pipelines and transport-related facilities are intended to be included in Gassled from the time they are put to use by third parties, and are thus part of the central upstream gas transportation system.

The State's Direct Financial Interest (SDFI) also owns 40.0% of Norsea Gas AS, and Petoro's share in Gassled will be increased by around 8% on 1 January 2011. The other licensees' shares will be adjusted correspondingly on the same date. All this means that the State, represented by SDFI, owned around 39% of Gassled from 2003 to 2010 and will own 46.327% from 2011. Most Gassled facilities are licensed until 31 December 2028.

Table 8. **Gassled ownership share by company, 1 June 2010**

Petoro AS*	38.435
Statoil Petroleum AS	32.068
Total E&P Norge AS	7.761
Exxon Mobil Exploration and Production Norway AS	9.401
A/S Norske Shell	5.338
Norsea Gas AS	2.718
ConocoPhillips Skandinavia AS	1,990
Eni Norge AS	1.521
DONG E&P Norge AS	0.66
GDF SUEZ E&P Norge AS	0.085
RWE Dea Norge AS	0.023

* Petoro AS is the licensee for the State's Direct Financial Interest (SDFI).

Source: Norwegian Petroleum Directorate, Ministry of Petroleum and Energy.

Regulated access to the gas transportation system

The pipeline system is a natural monopoly, regulated for non-discriminatory third-party access by a December 2002 Royal Decree. Gas transportation tariffs are governed by special regulations issued by the MPE. Gas companies' access to capacity in the system is based on their needs for gas transportation. Transport rights may be transferred between users when needs change. Gassco is responsible for allocating capacity.

The MPE plays an important part in ensuring transportation capacity and increasing system capacity. The authorities verify that alternative transport methods are examined properly in order to ensure efficient system development. At the same time, it is important to ensure efficient operation, including achieving economies of scale.

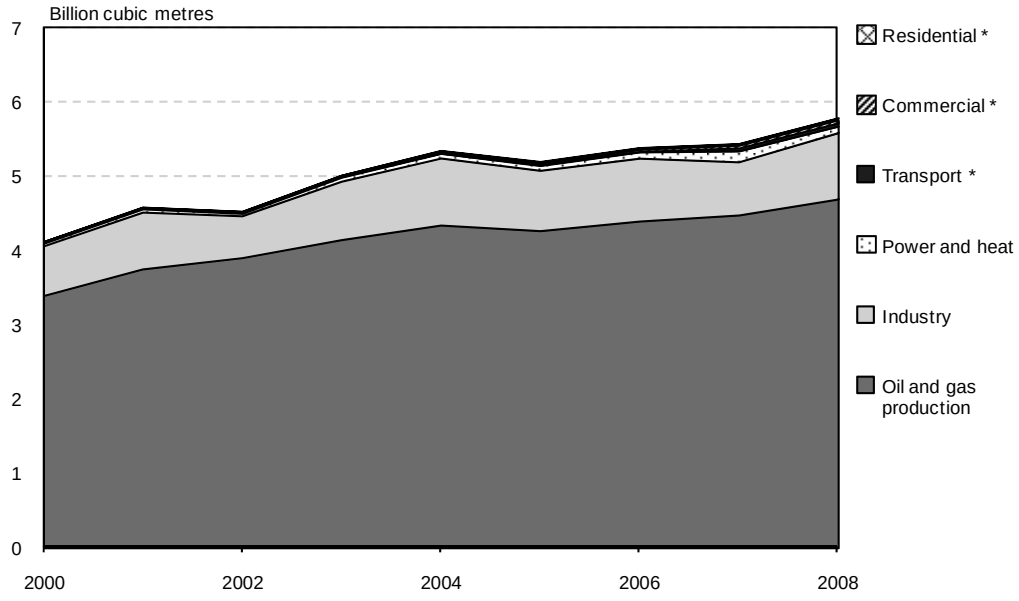
DOWNSTREAM

Demand

In contrast to the large upstream production, the Norwegian downstream natural gas market is small, with total domestic consumption of natural gas in 2009 standing at 5.9 bcm, equivalent to less than 20% of the total domestic use of energy. More than 80% of natural gas is consumed in the upstream oil and gas industry. Consumption in the residential, commercial and transport sectors is minimal (see Figure 24).

Outside the petroleum sector, the largest consumer of gas domestically is the Tjeldbergodden methanol plant, which uses gas as a raw material. The 420 MW gas-fired power plant at Kårstø which was commissioned in November 2007 was hardly used until early 2009, because of high short-run marginal costs and declining electricity prices. Lower gas and CO2 allowance prices resulted in a restart of the plant in February 2009. Gas use in power generation will remain limited, as the government requires all new gas-fired power plants to have CCS technology (see Chapter 6 on CCS).

Figure 24. **Natural gas consumption by sector, 2000 to 2008**



* Negligible.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2009.

Distribution and infrastructure

Norway has two main natural gas distributors; Gasnor AS and Lyse Gass AS. Gasnor has around 100 km of pipelines in the south-western part of Norway, in the Haugesund-Karmøy region. Lyse Gass AS has around 450 km of distribution pipelines and distributes natural gas in the Stavanger area in the south-west of the country. Lyse Gass AS delivered 602.5 GWh of gas in 2008, while Gasnor delivered 214.5 mcm in 2008, of which 55.5 mcm by distribution pipeline.

Small-scale LNG distribution has become a Norwegian alternative to gas transmission and distribution networks. In 2007, there were around 30 LNG reception terminals in operation in Norway. They serve industrial and commercial customers.

There is no public or strategic storage of natural gas or LNG in Norway. The Norwegian Water Resources and Energy Directorate is the regulator for the downstream natural gas market, and Norway has implemented the relevant EU directives.

The Ministry of Petroleum and Energy has tasked Enova to operate a support scheme for developing a domestic infrastructure for natural gas, especially where it brings environmental benefits. Natural gas distributed as compressed or liquefied provides a flexible and reliable supply of natural gas to many new users. The support scheme has been designed according to the principles of public service obligations. The infrastructure projects are announced for public tender and are awarded on the basis of competitive bidding and negotiations. Projects with a defined geographical coverage area where the bidder supplies gas to industrial enterprises, transport or shipping will be given priority.

Security of supply

According to the government, security of supply is not a concern in the small Norwegian downstream gas market. Natural gas customers in Norway will always be connected to the electricity grid, thereby supplying them with energy for various needs. Unlike in many other IEA countries, natural gas is not a key source of power generation. In 2009, it generated a record of 4 TWh, but this was only 3% of total generation, while hydropower provided 96% (see Chapter 8 on Electricity).

However, during the 2002/03 winter, Norway experienced a drought followed by a cold wave, severely depleting its hydro reserves and making electricity rates rise fourfold in a matter of weeks. In response to this, Norway's first commercial onshore gas-fired power plant was built by Naturkraft at Kårstø. Of note, five gas turbines also provide power to Statoil's LNG plant from gas from the Snøhvit field.

COAL

SUPPLY AND DEMAND

Coal is a minor fuel in Norway. In 2008, its supply amounted to 0.8 Mtoe, or 2.6% of TPES. Domestic production, however, was three times higher, making the country a net coal exporter. Norway has two coal mines, both in Spitsbergen, the main island on Svalbard, some 960 km north of the Norwegian mainland. The state-owned Store Norske Spitsbergen Kulkompani AS operates the mines through its wholly owned subsidiary Store Norske Spitsbergen Grubekompani AS (SNSG). SNSG produces both steam and coking coal: the Svea Nord mine produces around 2.5 million tonnes per year, and the Gruve 7 mine about 70 000 tonnes a year. The company is also planning to open a mine in Lunckefjell close to the Svea Nord mine to exploit an 8.2 Mt steam and coking coal deposit. The company hopes to be able to open the mine in 2013.

Mining employs around 350 people and supports a local community. As it helps to maintain Norway's sovereignty claims to the region, it forms an important part of Norway's Svalbard policy. Despite this broader role of coal mining, the government policy is to operate the company on commercial principles and with a view to a market rate of return on invested capital. The company has not received any subsidies since 2002. Coal mining is also subject to strict environmental regulations.

Around half of Norway's coal production in 2008 was exported to Germany, followed by Denmark and Portugal. Small quantities of Norwegian coal were exported to other European countries, including France, the United Kingdom, Greece and Poland.

Although Norway is a net exporter of coal, domestic demand is met mostly by imports. In 2008, coal demand amounted to 0.7 Mtoe, or 3.2% of TFC. Coal is used in process industries (iron and steel, chemicals, and cement) which require a year-round supply. The Spitsbergen mines cannot meet this requirement, as pack ice blocks the sea route for a large part of the year. Norway's only coal-fired power plant, in Spitsbergen, uses around 25 000 tonnes a year.

CRITIQUE

Norway is the largest net exporter of oil and gas among the OECD countries. As a reliable and transparent supplier, it improves the energy security of a large number of IEA member countries.

Norway has a consistent and predictable regulatory framework for upstream oil and gas exploration and production, and it manages both its petroleum resources and revenue in a transparent and competent manner. The IEA acknowledges Norway's contribution to global energy security and regards its petroleum resource and revenue management as commendable and a model for other countries to follow.

EXPLORATION AND PRODUCTION

Gas production on the NCS is expected to range between 105 and 130 bcm over the next ten years, as compared to a production of 106 bcm in 2009, but oil production has been declining since 2001 and this trend is set to continue. The government is fully aware that, in order to reduce the rate of decline, new resources will have to be discovered and produced, and recovery from existing fields increased.

Exploration activity is essential to reducing the rate of decline in oil production. Thanks to changes in acreage management and in the petroleum tax system, exploration activity has increased strongly since 2005 and a record number of exploratory wells were drilled in 2009. The discoveries, however, come mainly from mature areas and tend to be small. More potential for large discoveries lies in the frontier and unopened areas.

In general, the IEA welcomes the government's efforts to encourage increases in oil production and recovery, and urges it to continue to do so by opening new acreage for exploration and by offering additional favourable fiscal and regulatory incentives, when appropriate. Such measures could also help avoid increases in the already relatively high drilling costs on the Norwegian Continental Shelf. The government should continue to be innovative in its acreage management approach in order to stimulate environmentally responsible exploration activities in both frontier and mature areas.

Concerning potential areas to be opened for petroleum activity, the IEA welcomes the treaty between Norway and Russia which settles the maritime delimitation between the two countries in the Barents Sea and Arctic Ocean, and urges the government to open these areas for exploration as soon as possible.

The government is also expected to present a revised integrated management plan for the Lofoten–Barents Sea area in 2011. In the plan, the government will propose whether or not to open up the restricted areas around Lofoten to petroleum activity. The government is encouraged to expedite these considerations.

Environmental considerations are well integrated into the government policy on the use of petroleum resources. Following the Deepwater Horizon spill in the Gulf of Mexico, the Norwegian petroleum safety authority has decided to review the potential implications for deepwater drilling regulations on the Norwegian Continental Shelf. While this is appropriate, the IEA urges Norway to clarify quickly the current regulatory outlook in order to ensure that future investments in the upstream sector are made in a timely manner and work to limit the forecast production decline on the Norwegian Continental Shelf.

The IEA commends Norway for its extensive and reliable network of gas pipelines linking Norwegian gas production to other IEA member countries in Europe, and urges the government to continue to take steps to maintain such high levels of supply reliability. The current pipeline gas export capacity stands at 120 bcm, which is around 20 bcm higher than the current annual need, but seems too little, if Norway wishes to produce the projected maximum of 130 bcm per year (both pipeline and LNG) by 2020. Investments in transportation capacity are crucial to avoid bottlenecks for the new gas from the Norwegian Sea and to allow Norway to maintain its position as a major gas supplier to Europe. The IEA encourages the government to continue to attract investments in gas pipelines in light of the increased need for export capacity.

SECURITY OF SUPPLY

Norway is a net exporter of both oil and gas and can therefore more than meet its domestic needs for these two fuels under most plausible scenarios for decades to come. The capacity at the country's oil refineries exceeds the domestic consumption by a wide margin. Gas, in turn, is little used outside of the petroleum sector, and will remain so for several years unless the government relaxes the requirement for CCS technology in new gas-fired power plants. Energy security has therefore a very different context in Norway compared to most other IEA member countries.

As a net exporter of oil, Norway does not have any IEA stockholding obligation equalling 90 days net imports of the previous year. Nevertheless, the IEA estimates that Norway has domestic stock levels equivalent to well over 90 days of consumption. The IEA commends Norway for the resilience that such stocks bring both to its domestic market and to the IEA as a whole.

A recent development has been the introduction of the 2006 Act of Petroleum Product Storing for Emergency Purposes. This law imposes on companies producing or importing petroleum products to holding stocks equivalent in volume to 20 days of their sales or imports into the domestic market. In times of oil supply deficits, the Ministry of Petroleum and Energy can instruct the stockholding companies to release stocks as a crisis management measure or under IEA's co-ordinated emergency response action. This additional resilience in the oil sector further reduces the risk of any oil supply disruptions to the domestic market. However, compulsory stocks are commingled with operational stocks. The IEA encourages Norway to clarify which stocks are covered by the industry obligation and how they would be made available to the market if the stockholding obligation on industry were lowered in order to contribute to an IEA collective action.

RECOMMENDATIONS

The government of Norway should:

- *Continue to encourage increases in oil production and recovery by opening new acreage for exploration and by implementing additional favourable fiscal and regulatory incentives, when appropriate.*
- *Proceed with the opening of the formerly disputed Barents Sea area for petroleum activities and expedite the consideration of whether or not to release acreage in the currently restricted Lofoten-Vesterålen-Senja area.*

- *Continue to develop innovative acreage management approaches in an environmentally sound manner to stimulate exploration and production in both frontier and mature areas.*
- *Continue to facilitate investments in gas pipelines in light of the increased need for export capacity.*
- *Clarify which oil stocks are covered by the industry obligation and how they would be made available to the market in an oil emergency.*

6. CARBON CAPTURE AND STORAGE

OVERVIEW

IEA scenarios assume carbon capture and storage (CCS) to play a major role in global carbon dioxide (CO_2) emissions reductions. CCS is preferably applied to large-scale CO_2 emission sources in the power sector and in industry. CO_2 capture from gas streams and transportation and storage of CO_2 are well known in the oil and gas industry. Nonetheless, CCS is still an emerging technology given that experience in full-scale and integrated capture, transportation and storage of CO_2 is limited to five projects worldwide; CCS has not yet been demonstrated at a commercial scale in the power sector.

The Norwegian government is supporting CCS, in addition to renewables and energy efficiency, as a critical part of Norway's portfolio of greenhouse gas emission mitigation options. Spurred by a tax on CO_2 emissions for the petroleum sector, Norway has since 1996 gained extensive experience in offshore CO_2 capture from natural gas and in geological storage of CO_2 under the North Sea. Two of the world's five large-scale CCS projects are operated in Norway, and the government is strongly committed to significant support of further CCS technology development, demonstration and widespread deployment.

POLICY FRAMEWORK, FUNDING AND INTERNATIONAL ENGAGEMENT

POLICY FRAMEWORK

Norway has been actively involved in climate policy since the late 1980s. In 1991, a tax on CO_2 emissions became effective for petroleum activities on the Norwegian Continental Shelf, one of the main contributors to the country's CO_2 emissions given that Norway's onshore power generation is almost completely hydro-based. The level of the CO_2 tax has changed moderately over time, with for emissions from natural gas production ranging between NOK 200 and NOK 300 per tonne of emitted CO_2, or about EUR 23 to EUR 34 per tonne. According to the Norwegian Ministry of Finance, the tax is estimated to generate revenues of NOK 2.5 billion in 2010 (EUR 286 million). In 2005, Norway put a national Emissions Trading Scheme (ETS) in place, which is linked to the European ETS since 2008.

The CO_2 tax is seen as one of the main drivers for the first commercial-size CCS activity in Norway at the Sleipner gas field. Sleipner and the more recent CCS project at Snøhvit were authorised under existing petroleum legislation by the Ministry of Petroleum and Energy (MPE) and for matters related to the environmentally safe storage of CO_2 under existing pollution control legislation by the Ministry of the Environment. Regulatory authority related to CCS projects was delegated in 2009 to three ministries. The Ministry of Petroleum and Energy regulates the exploration, development and use of subsea reservoirs for permanent storage and transportation of CO_2 on the Norwegian Continental Shelf. The Ministry of the Environment regulates issues relating to pollution and protection of the environment, including permitting injection and monitoring of CO_2

in subsea reservoirs. Finally, the Ministry of Labour and Government Administration regulates issues related to health, safety and work environment. In 2010 these ministries started preparing a new set of regulations for the transportation and storage of CO_2 on the Norwegian Continental Shelf, on the basis of the existing national legislation. Provisions of the EU Directive on CO_2 Storage (2009/31/EC) are being adopted by Norway as a consequence of its participation in the European Economic Area.[5] In parallel, Norway engages in relevant international legal frameworks, such as the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) and the London Protocol by promoting amendments that will allow CO_2 transportation and storage of CO_2 across national borders offshore.

Since 2005, subsequent Norwegian governments have stated that all new onshore gas-fired power generation in Norway shall have CCS technology. Consequently, the government and industry are engaged in plans to equip two new large-scale power plans at Kårstø and at Mongstad with CCS technology; however, uncertainties in cost projections have delayed the implementation of CCS facilities at these plants up to now.

FUNDING AND INTERNATIONAL ENGAGEMENT

Over the last years, the government has provided substantial funding for CCS research, technology development and deployment in order to gain experience and further reduce CCS costs. In 2009 and 2010, the total funding for CCS amounted to NOK 5.24 billion, or roughly EUR 600 million. Norway's 2011 budget includes NOK 2.7 billion (EUR 310 million) for CCS. Apart from subsidising technology development, the government's investments in CCS are managed through an independent state-owned enterprise for CCS, Gassnova SF, which was founded in 2008 in order to also engage in the actual construction and operation of government-funded CCS facilities. Norway is supporting and actively participating in various international activities, such as the United Nations Industrial Development Organization (UNIDO) programme on developing a roadmap for the deployment of CCS within industrial processes, which received in 2010 a NOK 1.8 million (EUR 0.2 million) grant through the Ministry of Petroleum and Energy.

The government is highlighting the importance of global co-operation with respect to CCS. Norway supports global action under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. The government advocates establishing incentive schemes for CCS at an international level and has been promoting the inclusion of CCS under the clean development mechanism (CDM) defined in the Kyoto Protocol in order to stimulate investments related to CCS also in developing countries. Norway is participating in key ministerial-level international activities that promote CCS deployment, such as the Carbon Sequestration Leadership Forum (CSLF), which was co-hosted by Norway in 2009, the Clean Energy Ministerial (CEM) and its recently founded Carbon Capture Use and Storage (CCUS) action group. On a regional level, Norway is working together with neighbouring countries in the North Sea Basin Task Force in order to evaluate the sub-seabed storage potential in the North Sea basin and to undertake source-sink analysis. The Norwegian government sees the North Sea basin as playing a key role in the deployment of CCS in Europe through cross-border transportation and storage of CO_2, if CCS were to be deployed widely from 2020.

5. IEA Carbon Capture and Storage Legal and Regulatory Review, Edition 1, 2010.

KEY PROJECTS

Two out of the world's five commercial-scale CCS projects in operation today are located in Norway. Both projects, Sleipner and Snøhvit, are natural gas production facilities where CO_2 is separated from natural gas and injected into saline aquifers for permanent storage. In addition, over the past years several opportunities for large-scale CCS from onshore power generation have been investigated in Norway. The planning of a large-scale CCS project related to power generation has progressed substantially at the combined heat and power plant in the Mongstad refinery. The planning of a large-scale CCS plant at the natural gas combined-cycle plant in Kårstø has been paused owing to uncertainty about the operation of the power plant. Plans for a third large-scale CCS project, a new gas-fired power plant near Tjeldbergodden in central Norway with use of the captured CO_2 for enhanced oil recovery (EOR), were abandoned in 2007, because the feasibility study by Statoil and Shell found that EOR alone could not make the project profitable.

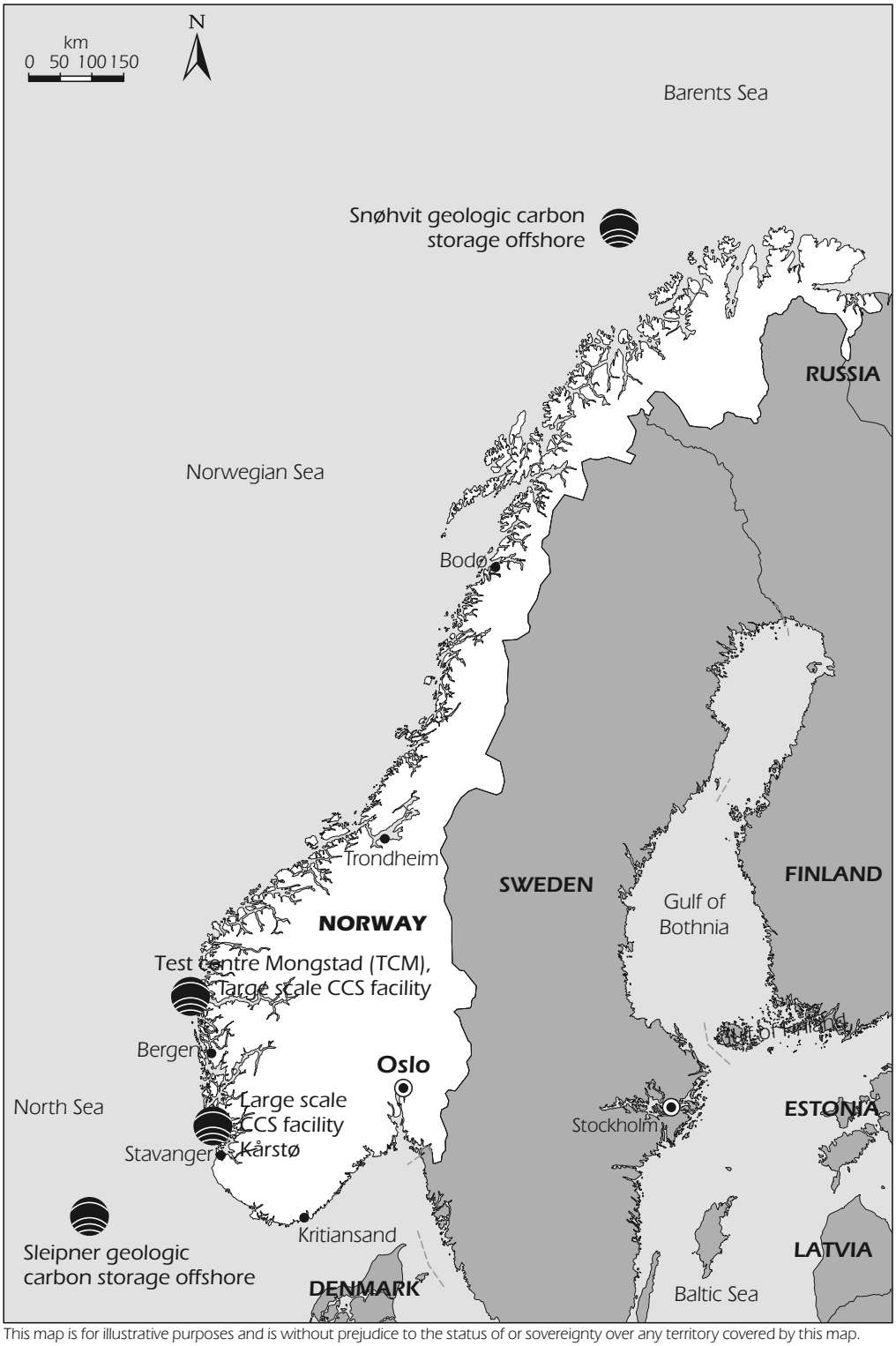
In addition, two pilot-scale capture plants are under construction as part of the Technology Centre Mongstad (TCM). Besides integrated projects with capture, Norway engages in geological mapping of potential CO_2 storage sites on the Norwegian Continental Shelf through work of the Norwegian Petroleum Directorate. Active and planned major CCS projects in Norway are described in detail in the following section and their location is shown in Figure 25.

PROJECT DESCRIPTIONS

Sleipner

Capturing and storing CO_2 from offshore natural gas production at the Sleipner West platform began in 1996. The natural gas in the reservoir at Sleipner, which is operated by Statoil, contains around 9% CO_2 content and requires a reduction in CO_2 concentration in order to meet customer requirements. The emissions tax for the offshore petroleum sector, in the order of USD 50 per tonne of CO_2 at that time (around NOK 310), was one of the main reasons to begin separating CO_2 from natural gas and injecting it into the Utsira geological formation more than 800 metres below the sea bed, beneath the Sleipner platform. About a million tonnes of CO_2 per year, and 12 Mt in total by 2010, have been stored at Sleipner. At the Sleipner field, more than a decade of seismic monitoring of the subsurface has illustrated the development of the CO_2 plume over time. The monitoring has enabled understanding of the behaviour of CO_2 in this geological formation, and has also demonstrated that the CO_2 has been confined securely within the storage reservoir.

Figure 25. **Location of major carbon capture and storage projects, 2010**



This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Source: Ministry of Petroleum and Energy.

Snøhvit

The Snøhvit field in the Barents Sea operated by Statoil provides natural gas to the world's first natural gas liquefaction plant with CCS. Natural gas with about 5% to 6% CO_2 content is extracted offshore and piped 145 kilometres to an LNG facility at Melkøya near Hammerfest in northern Norway, which has been in operation since the end of 2007. CO_2 has to be removed before liquefaction of the natural gas. It is then transported back to the Snøhvit field by a separate pipeline and stored in a geological layer of porous sandstone called the Tubåen formation, about 2 500 metres beneath the seabed. Opportunities for adding CCS also to existing and planned new gas turbine-based power generation at Melkøya have been investigated, but interest in the project was dampened in 2010 by a preliminary assessment which projected excessive costs. This, however, did not affect the ongoing CCS activities related to the Snøhvit LNG process, which started injecting CO_2 into the reservoir in April 2008. At full capacity, the project is storing some 700 000 tonnes of CO_2 from the liquefaction plant every year.

Kårstø

Considerable work has been undertaken to evaluate opportunities for CCS from a 420 MW_e gas-fired power plant, commissioned in November 2007 at the Kårstø site. Initial government plans from 2005 were aiming to have full-scale CCS from the power plant in place by 2009. Funding from the Norwegian State was supposed to cover the investment cost. However, in 2009 the government decided to halt the procurement process for the CCS facility, because the power plant had not been operating continuously until then. At the same time, a pre-feasibility study on potential integration options with a gas-processing facility at Kårstø was initiated. The study was completed in March 2010 and indicated that an integrated solution seems to be technically feasible, but that there are several complicated commercial and risk-related issues that would have to be addressed.

Mongstad

Major CCS activities are targeting the industrial complex at Mongstad north of Bergen. In 2006, the Norwegian government and Statoil agreed to build first a CO_2 capture test facility and to subsequently implement full-scale CCS from a combined heat and power (CHP) plant at Mongstad. The goal of the test facility, referred to as the Technology Centre Mongstad (TCM), is to develop and demonstrate CO_2 capture technologies at pilot scale, in order to reduce costs and risks for the full-scale capture unit. Two post-combustion capture technologies (amine and chilled ammonia technology) are to be tested in parallel with up to 100 000 tonnes of CO_2 capture capacity per year, using exhaust gases from the gas-fired CHP unit and the refinery cracker that has a CO_2 content of around 12%, which is comparable to exhaust gas from a coal-fired power plant. The CO_2 that is captured during testing will not be stored. The South African company Sasol joined the TCM consortium in 2010 as a partner, together with Shell, Statoil and the Norwegian State. Technology Centre Mongstad is under construction and is scheduled to be completed in early 2012.

The full-scale CCS facility at Mongstad is considered the second stage of the project and is currently in the planning phase, which apart from the capture concept also addresses the CO_2 transportation and storage. Originally, the large-scale CCS plant with a capture capacity of about 1.2 Mt of CO_2 per year was to be established by 2014. In 2010, the

government announced that the final investment decision for the large-scale capture unit at Mongstad would be postponed to 2014. In addition, the delay is supposed to provide more time for learning from the Technology Centre Mongstad, for selecting an appropriate CO_2 storage site, and for clarifying potential local plant emissions. The project will be financed by the government, and Statoil will be the main project executor. The government funding will cover the costs of investment and operation of the CCS facilities, and Statoil is to cover costs equal to the costs of the CO_2 emitted from the CHP plant, and overruns. In addition, the government has committed to funding the cost of transportation and storage related to the large-scale facility.

RESEARCH, DEVELOPMENT AND DEMONSTRATION

Government funding on CCS research, development and demonstration (RD&D) in Norway is organised through the CLIMIT programme. CLIMIT is the Norwegian Research and Development Programme on Power Generation with CCS that is managed by Gassnova SF jointly with the Research Council of Norway (RCN). While Gassnova is in charge of prototype and demonstration projects, RCN is responsible for research projects. Correspondingly, the CLIMIT budget contains two parts – R&D and deployment. The R&D budget for 2009 was NOK 68.5 million (EUR 7.8 million) and increased to NOK 99 million (EUR 11 million) for 2010. CLIMIT's demonstration budget was NOK 82 million (EUR 9.4 million) for 2009 and remained at that level for 2010. For 2010, the CLIMIT programme was expanded to include CO_2 emissions from industry sources.

Research funding is granted by calls for proposals issued by RCN and funding for demonstration projects is granted by calls for proposals issued by Gassnova. In addition, RCN initiated in 2008 the so-called Centres for Environment-friendly Energy Research (CEER) in order to promote focused long-term research in areas of strategic importance for Norway (see Chapter 9). While several Norwegian academic institutions have been very active on many aspects related to CCS over the last years, two CCS-related research consortia have been selected as CEERs: The BIGCCS centre addresses RD&D challenges across the complete CCS chain, and the SUCCESS centre specifically targets CO_2 storage in the subsurface. Both centres are broad research consortia that include Norwegian and international research institutions and industry partners. Their annual budgets are around NOK 50 million and 20 million, respectively, for eight years (EUR 5.7 million and EUR 2.3 million), and include government support of NOK 20 million and 10 million per year (EUR 2.3 million and EUR 1.1 million).

CRITIQUE

The Norwegian government sees CCS as crucial in meeting domestic and global climate-related emission targets. The CO_2 tax on petroleum activities was introduced in 1991, and over the years this tax has successfully given incentives to reduce CO_2 emissions in the sector. In doing so, the CO_2 tax has also contributed to the deployment of two front-running large integrated CCS projects at Sleipner and Snøhvit. As a consequence, Norway can look back to substantial experience in commercial-scale CCS, and accumulated know-how in storing significant amounts of CO_2 in geological structures over more than a decade. This early activity has helped Norway to assume global leadership in developing CCS technologies and promoting their widespread deployment.

CCS remains an evolving area of activity and the regulatory framework needs to be adapted to support and reflect such new developments. The government should continue updating regulations for CO_2 storage and transportation and harmonise legislation with the EU Directive on the Geological Storage of CO_2. Within the revised regulatory framework, it should continue a pragmatic and flexible approach in permitting CCS projects.

While general support of CCS remains high, government ambitions to quickly implement CCS also on new-built onshore gas power plants have been dampened over the last years, as CCS projects in Kårstø and Mongstad have been halted or postponed. Projected costs for implementation have increased, and this may well be partly a consequence of insufficient competitive elements in the project design. In order to promote the deployment of least-cost technology solutions, Norway should consider using additional competitive elements in CCS project design. To maintain its position as a global front-runner in demonstrating first large-scale CCS in the power sector, Norway should also analyse how to reduce the time needed for finding political agreement and consensus with the industry and for developing projects.

In general, the Norwegian government and authorities can be considered very engaged and proactive partners for the Norwegian industry. Regulatory frameworks, such as the EU directive, are adopted in close contact with industry. Also, the government has allocated significant funding to support CCS demonstration through the Technology Centre Mongstad (TCM) and the full-scale CCS facility at Mongstad. This is very welcome, and a timely establishment of TCM would validate capture technologies and help set up the planned large-scale CCS plant at Mongstad.

Norway's funding levels for RD&D on carbon capture and storage are substantial and have increased over the years. The recent selection of two centres of excellence related to CCS with significant and sustainable funding underlines the government commitment to further strengthen Norway's leading position in CCS technology development. The IEA urges the government to retain the current financial support for CCS research, development and demonstration, including for the large-scale development at Mongstad and Kårstø.

On the international arena, the Norwegian government continues to be very actively engaged and is a key promoter of widespread use of CCS. Jointly with other countries, Norway is also a key driver for exploring CO_2 storage options in the North Sea region. Norway should maintain its leadership and global engagement in CCS technology and policy development and deployment. The IEA also encourages the government to expand engagement with developing countries for sharing knowledge on CCS technology and demonstration.

RECOMMENDATIONS

The government of Norway should:

- ☐ *Continue updating regulations for CO_2 storage and transportation and harmonise legislation with the European Directive on the Geological Storage of CO_2; within the new regulatory framework, continue a pragmatic and flexible approach in permitting CCS projects.*
- ☐ *Retain the current financial support for CCS research, development and demonstration, including for the large-scale development of CCS at Mongstad and Kårstø.*

- *Support the establishment of the Technology Centre Mongstad in time in order to validate capture technologies and make it a key stepping stone for the planned large-scale CCS plant at Mongstad.*
- *Consider using additional competitive elements in the design of CCS projects in order to promote the deployment of least-cost technology solutions.*
- *Maintain Norway's leadership and global engagement in CCS technology and policy development and deployment.*
- *Expand engagement with developing countries for sharing knowledge on CCS technology and demonstration.*

7. RENEWABLE ENERGY

SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2009, renewable energy sources provided 12.3 Mtoe, down 9% from an all–time record in 2008, and 46% of total primary energy supply (see Figure 26). Hydropower accounted for around 89% of the total, while the remaining share was traditional biomass (8%) and waste (2%). Other sources had a negligible share.

The share of renewable energy in TPES typically varies between 40% and 50%, depending on hydropower availability. The current record share of 55% of TPES dates from 1990. Norway consistently has the highest share of renewable energy and waste in TPES among the 28 IEA member countries (see Figure 27). Among OECD member countries, only Iceland has a higher share.

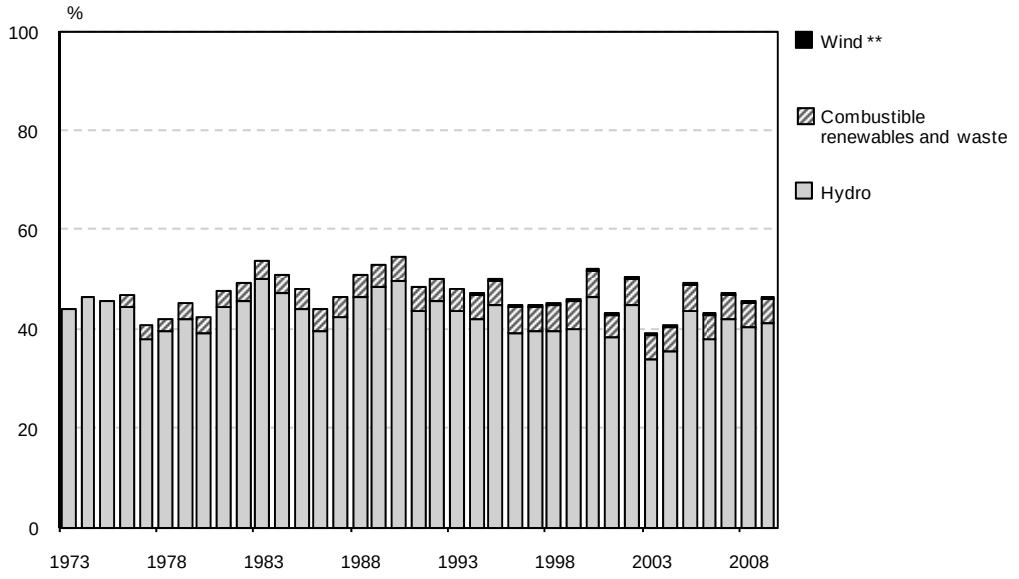
ELECTRICITY, HEAT AND TRANSPORT FUELS

Nearly all the electricity generated in Norway comes from renewable sources and almost exclusively from hydropower (see Chapter 8 on Electricity). Total electricity generated in 2009 was 132.8 TWh, while hydropower produced 127.1 TWh –the third-largest total among the IEA member countries, after Canada and the United States. Wind, the second-largest renewable electricity source, generated 1 TWh, and biomass and waste 0.5 TWh. Wind power generation has increased on average by 70% per year over the last decade, from 0.01 TWh back in 1998. At close to 100%, Norway has by far the highest share of renewable energy in its electricity supply among the IEA countries, followed by Austria and New Zealand (see Figure 28).

At the end of 2009, hydropower capacity amounted to 29 626 MW (of which 1 500 MW pumped storage) and wind power capacity to 431 MW. Capacity factor for hydro was 49%. For wind, it was 27% and the annual operating time varied from 1 500 to 3 800 hours by plant. Norway has large untapped potential for small hydropower, estimated at 20 to 30 TWh, while environmental protection rules out the development of most remaining large hydro resources. The country also is beginning to utilise its wind resources. Offshore wind resources are particularly extensive.

Heat production from renewable sources relied mainly on wood for residential heating, amounting to 0.6 Mtoe. Small amounts of heat were produced at combined heat and power (CHP) and heat plants. Biofuels use in transport was negligible, amounting to 8 000 tonnes of biodiesel in 2008.

Figure 26. **Renewable energy as a percentage of total primary energy supply, 1973 to 2009***



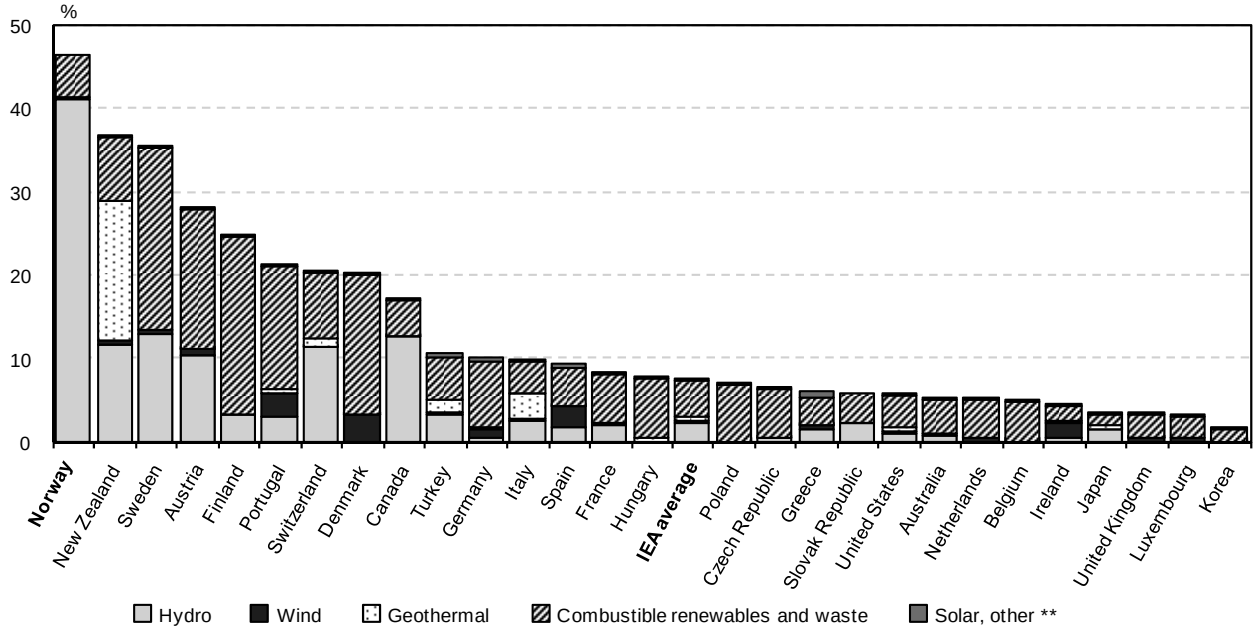
* Estimates for 2009.

** Negligible.

Note: Biofuel data are not included.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010.

Figure 27. **Renewable energy as a percentage of total primary energy supply in IEA member countries, 2009***

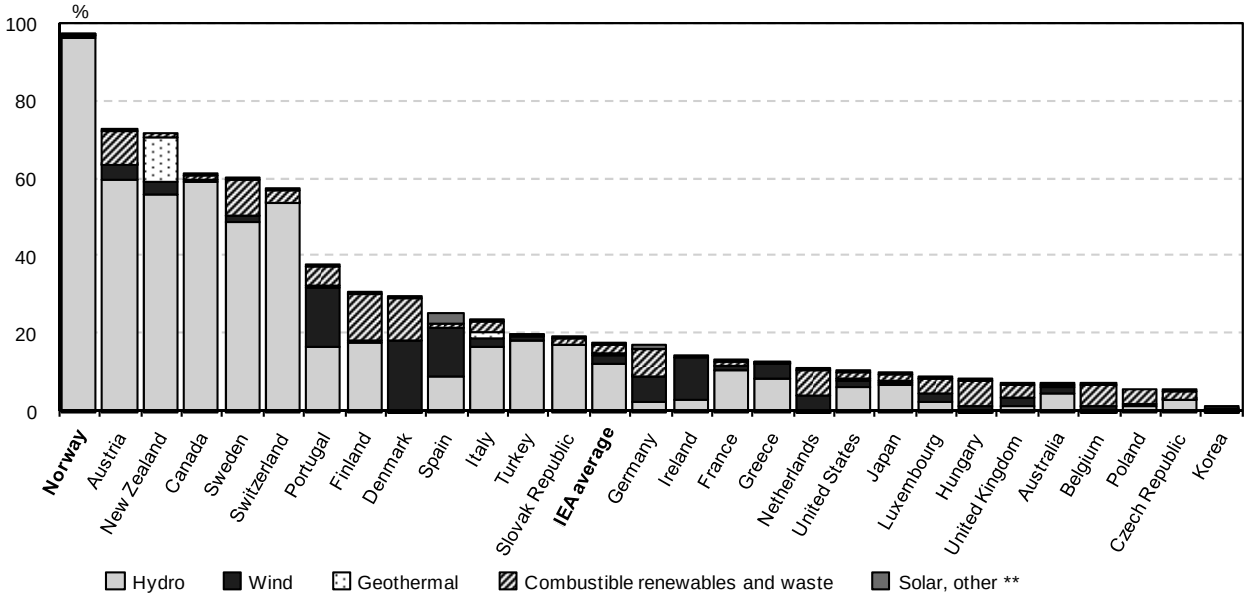


* Estimates.

** *Other* includes tidal and wave energy and ambient heat used in heat pumps.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010.

Figure 28. **Electricity generation from renewable energy as a percentage of all generation in IEA member countries, 2009***



* Estimates.

** *Other* includes tidal and wave energy and ambient heat used in heat pumps (negligible).

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010.

INSTITUTIONS

The **Norwegian Water Resources and Energy Directorate** (NVE), a subordinate agency of the Ministry of Petroleum and Energy (MPE), is responsible for managing energy and water resources on mainland Norway. NVE has a central role in the licensing of energy projects and has the authority to grant licences to small hydro (less than 10 MW), wind power, district heating and transmission lines. NVE departments working on energy (electricity market, grid tariffs and regulation, analysis of the energy system, resource-mapping, etc.) and licensing of energy projects have around 80 employees each. As power generation is almost entirely based on renewable resources, there is no natural borderline between personnel working with renewable energy and personnel working with other types of energy production in NVE. Since 2005, the number of employees working with licensing has doubled.

Enova is the government agency that promotes more efficient energy use, production of new renewable forms of energy, and environment-friendly use of natural gas (see Chapter 2 on General Energy Policy). Enova has 13 employees working full-time on renewable energy policy. Quantitative targets guiding its work are described below.

Regional and local governments have responsibilities associated with planning and building permits; **local grid owners** have an obligation to publish analysis of energy consumption and generation for each municipality.

POLICIES AND MEASURES

OVERVIEW

Hydropower is the dominant form of renewable energy in Norway. It is generally market-competitive and does not receive subsidies. The government promotes the use of other renewable energy mostly in the form of direct investment subsidies from Enova to increase power and heat generation. Enova also manages a demonstration programme for renewable energy and energy efficiency (see Chapter 9). Biofuels for transport are supported through a blending obligation.

In 2008, MPE and Enova agreed that Enova is to support, initiate or complete new projects that amount to 18 TWh of new renewable energy production and energy savings in 2011 above the 2001 level. Enova also has a long-term working target of a 40 TWh increase from 2001 to 2020.

Enova has two specific targets for new renewable energy production:

- increase the annual use of central heating from new renewable energy sources, heat pumps and waste heat by 4 TWh from 2001 to 2010;
- increase wind power generation to 3 TWh per year by 2010.

In addition, the Parliament adopted in 2008 a national target to increase bioenergy use by 14 TWh by 2020.

Norway's renewable energy policy and sector will be affected by the outcome of the current negotiations on the country's adopting the 2009 EU Directive on Promotion of the Use of Energy from Renewable Sources (2009/28/EC). The directive sets a binding national target for the share of renewable energy in gross final consumption in 2020. It also sets a sub-target of 10% of renewable energy in TFC in the transport sector in 2020. Norway's share of renewable energy in TFC (58% in 2005) is significantly higher than in any EU member state. Statistics Norway estimates that using the EU's own method of calculation without any adjustments, the share would have to increase to 72% in 2020. If the transport sector continued to use about 25% of all energy in Norway, and if the share of renewable energy in that sector increased to 10% (from around 3.5% now), then the share of renewable energy in other end-use sectors would have to reach 93% by 2020.

ELECTRICITY

Green certificate system

Norway and Sweden are developing a joint renewable electricity certificate system and have agreed to launch it on 1 January 2012. The system would build on the Swedish national green certificate system, launched in 2003.

Under this system, electricity generators using eligible renewable technology receive a certificate for each MWh of electricity generated, while electricity suppliers are required to hold these certificates equivalent to a predetermined percentage of the total electricity they supply. Suppliers may obtain the certificates through generation from their own eligible plants or through purchases from generating companies using eligible technologies. The size of this quota obligation changes from year to year, increasing the demand for renewable electricity and certificates.

Norway and Sweden agreed in September 2009 on key principles for the system, including equal ambitions in both countries, the launch date and technology neutrality, *i.e*. the same support regardless of production mode. More details were agreed in December 2010, including the volume of the quota: 13.2 TWh will be developed in each of the two countries by 2020. Norway and Sweden expect the joint electricity certificate market to help them reach renewable energy targets at a lower cost than purely national measures would. Norway has large economic potential for more hydro and Sweden for more biomass in power generation. Both countries also have more potential for onshore wind, and this technology is expected to set the marginal certificate price in the coming years. The market could also be expanded to other countries in the future.

In Norway, all renewable energy plants whose construction started after 7 September 2009 and all hydropower plants with an installed capacity below 1 MW whose construction started after 1 January 2004 are eligible for certificates. To avoid excessive subsidies, eligible power plants will be entitled to earn certificates for 15 years, starting from their commissioning date.

Licensing and planning

Licensing and planning regulations have a strong impact on all power plant projects. A developer must have a licence given by the energy authorities in order to build new installations for production or transmission of energy. Depending on the size and type of installation, the process of notification, public consultation, assessment of environmental impacts and application varies somewhat. The more relevant laws regulating the licensing, construction and operation of energy installations are the Watercourse Regulation Act, the Water Resources Act, the Industrial Concession Act and the Energy Act. Larger projects (wind power over 10 MW, and hydropower over 40 GWh) always start with notification and an environmental impact assessment (EIA) pursuant to the Planning and Building Act.

For all types of energy production, the first stages of the licensing procedure are handled by the Norwegian Water Resources and Energy Directorate (NVE). Depending on the size and type of production, the final decision is taken either by NVE, the ministry, the government or the Parliament. The licensing of hydropower projects with installed capacity of less than 10 MW, wind power, district heating, and transmission lines, is delegated to NVE. However, appeals on NVE's decisions, if applicable, are directed to the MPE.

In addition to a licence from the energy authorities, most installations also need to comply with the land-use plan of the local municipality where they are to be situated. Municipal land-use plans and zoning plans are made pursuant to the Planning and Building Act; this act corresponds to a large extent to the energy and water resources legislation. This means that almost all projects must be processed in accordance with both sets of legislation. The authorities' aim is that these parallel processes are co-ordinated. In the case of wind power, co-ordination of the processes is accounted for in the national guidelines on planning and localisation of wind power adopted in 2007.

The Planning and Building Act was amended on 1 July 2009. Central and regional grid systems are now exempt from having to prepare a zoning plan and to have it approved by the municipality. Municipalities have wider options to exempt power plants from having to prepare a zoning plan. The new act also gives MPE powers to facilitate the establishment of power plants considered of national importance.

From 2010 on, network owners are legally obliged to provide grid access to new generators, but the financial responsibilities remain to be defined. The NVE has suggested that whenever a new generator triggers a need for larger network capacity or network upgrading, the network owners may charge the generator for the necessary upgrades.

Support programme for wind power

By 31 December 2009, Enova had contracted projects with an estimated energy result of 1.6 TWh per year. MPE informed the Parliament that the target of 3 TWh by 2010 was not to be reached, mostly because of project costs and low electricity prices. Enova will continue the investment support programme until the launch of the green certificate system, planned for 1 January 2012.

Enova provides investment subsidies to increase the production of wind power and further develop the Norwegian wind power market. Applications for support are submitted once or twice a year and they are ranked according to the level of support in NOK required per kWh of expected annual production. The investment support must be the triggering factor for construction of the facility and the most economical projects are granted support. The maximum support permitted is calculated on the basis of the following assumptions:

- required rate of return: 8% actual before taxes;
- lifetime: construction time + 20 years of production;
- power price: last six months' average of Nord Pool three-year forward prices as of the application deadline;
- revenues: power price times expected energy production.

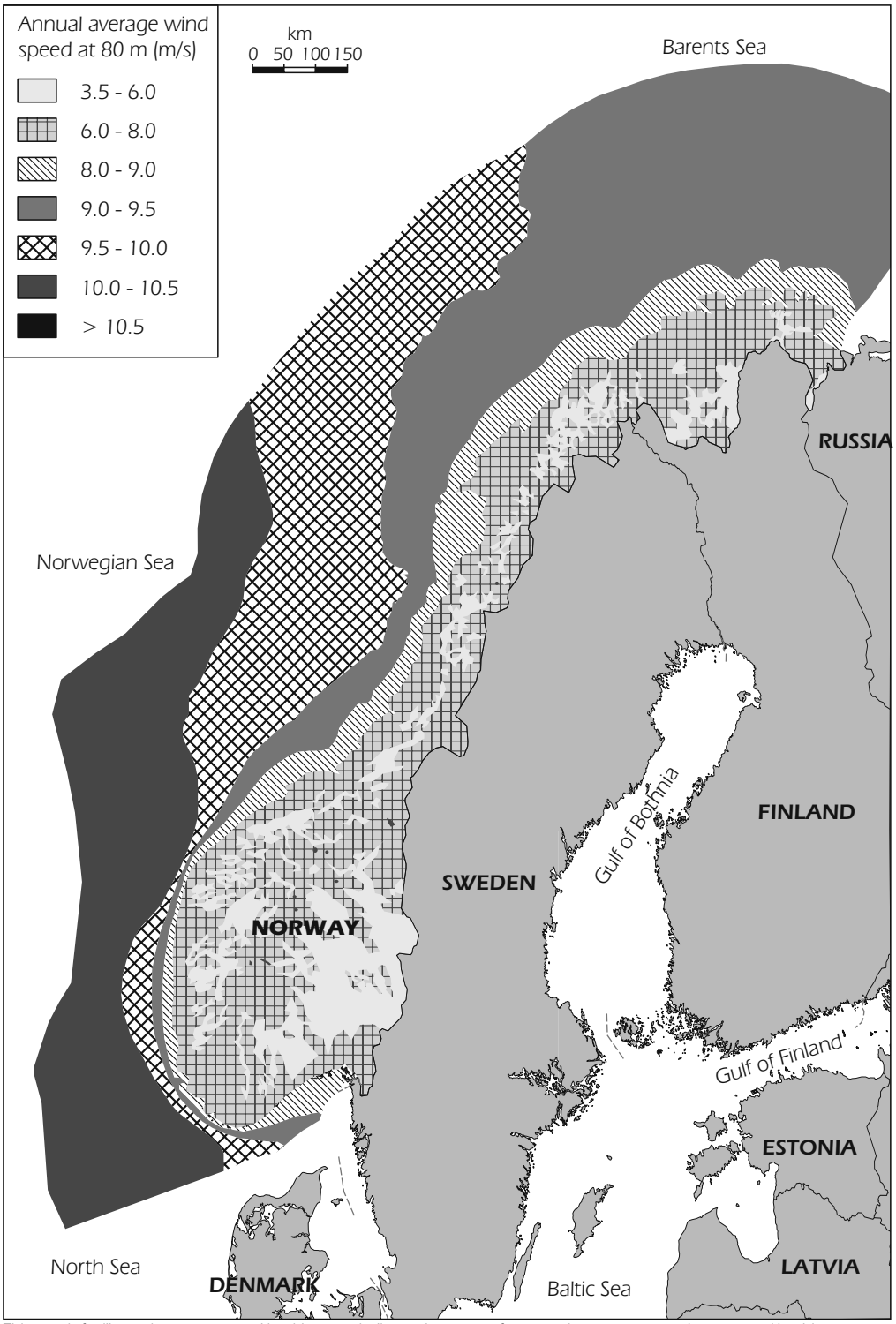
Offshore wind

Offshore wind energy is a promising option for future renewable energy supply in Norway. The country does not have any commercial offshore wind capacity yet, but is taking steps to tap its significant potential (see Figure 29).

In February 2010, Norway signed a political declaration on regional co-operation on developing an offshore electricity grid in the North Sea region. It thus joined nine EU member states in the region which had signed the declaration in December 2009. In a recent development the ten countries signed in December 2010 a Memorandum of Understanding to move the project ahead. The grid would help exploit the considerable offshore wind power potential in the region (see Chapter 8 on Electricity).

On 23 March 2010, the Storting passed an act on offshore renewable energy, including a national strategy. As part of the strategy, a process has been initiated to identify sea areas suitable for the future development of offshore wind power. A wide range of stakeholders collaborate in this work to identify and assess relevant issues at an early stage.

Figure 29. **Map of wind speed in Norway**



This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

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

A group of directorates led by NVE has started the first screening of possible sea areas. The result of this work was presented to the MPE in October 2010. In its report, the group stated that offshore wind deployment faces several technological and economical challenges, and that more information is needed on its impact on marine wildlife. The group's report also indicatively estimates that there is potential for 18 to 44 TWh of annual generation in the areas most suitable for production.

The government aims, on the basis of the results of the first screening, to initiate a strategic environmental assessment (SEA) during 2011. This SEA will be followed by the possible opening of sea areas for applications for offshore wind development. The government is still to decide upon the manner in which to take this process forward, once locations have been selected. A challenge for the government will be to decide where its role will end and where the role of business will commence with regard to preparing locations for offshore wind energy. A revised strategy should be presented to the Parliament in 2012.

Offshore technology development is also progressing. The government has recently increased funding to offshore wind RD&D and Statoil, with its experience in offshore oil and gas production, has developed the world's first full-scale floating turbine, Hywind. Statoil is investing around NOK 400 million (EUR 46 million) in the construction and further development of the pilot project and in the wind turbine concept. Enova has granted NOK 59 million (EUR 6.7 million) in support for the project.

HEAT

By 31 December 2009 Enova had contracted projects with an estimated energy production of 4.1 TWh per year. Of these, 1.3 TWh had been completed. According to MPE, Enova has thus reached its target of 4 TWh heat from renewable sources in 2010.

In 2008, the government adopted a bioenergy strategy, including a target of 14 TWh of new supply by 2020, roughly doubling bioenergy use to 28 TWh. According to Nobio, an industry lobby, Norway is currently using around 8 mcm of wood for energy, but could realistically increase this to 20 mcm.

Conversion to renewable energy sources in heating is one of Enova's largest and most important tasks. Enova's aim is to assist in the development of a viable heat market which will gradually function on its own, without government subsidies. During the last couple of years, Enova has therefore put in place a series of programmes that address various facets of the heat market. These programmes include investment support for new district heating plants and infrastructure (transmission and distribution facilities for district heating and cooling) up to the metering point for delivery. They also include projects to support biogas production and the conversion of fossil fuel-based small heat plants to using renewable energy sources. Since 2004 the annual budget for these programmes has increased from NOK 91 million to NOK 600 million (EUR 10 million to EUR 69 million) in recent years.

In 2006, Enova launched a programme in the household heating to stimulate energy efficiency and heating based on renewable energy in the household sector. The programme subsidises investment in technologies which reduce electricity use or are suitable replacements to electricity as a primary heating source. Initially the scheme covered pellet stoves and boilers, heat pumps connected to waterborne heating systems and control systems for reducing electricity use. Since August 2008, it also includes investments in solar heating collectors connected to waterborne heating systems. The

grants are disbursed *ex post*, after the recipient has submitted a proof of purchase. Private households may apply for a maximum refund of 20% of documented and eligible costs. The grants are limited to NOK 4 000 (EUR 460) for pellet stoves and electronic control systems. For heat pumps, pellet boilers and solar heating collectors, the limit is NOK 10 000 (EUR 1 140).

TRANSPORT FUELS

Renewable energy use in transport mostly comprises biofuels, but Norway is also promoting the use of electric vehicles, which are fuelled by electricity from renewable sources, by a suite of measures (see Chapter 4 on Energy Efficiency).

In 2009, fuel suppliers were obliged to put on the market a minimum of 2.5% volume biofuels as a share of total road transport fuel consumption. In April 2010, the government raised this obligation to 3.5% and is now considering a possible increase to 5% in 2011, which would be accompanied by mandatory sustainability criteria for biofuels. The government is also developing a strategy for increased research and development on second-generation biofuels.

In Norway, fuels in road transport are subject to both a fuel tax (petrol tax or auto diesel tax) and a CO_2 tax. All biofuels are exempted from the CO_2 tax. High-blend bioethanol is exempted also from the petrol tax, while low-blend bioethanol is not. Biodiesel (both high and low blends) is subject to 50% of the auto diesel tax since 2010. Since 2007, E85 passenger cars are eligible for a NOK 10 000 (EUR 1 140) reduction in the registration tax.

CRITIQUE

Norway has the largest share of renewable energy both in its TPES and in electricity supply among the 28 IEA member countries. This enviable position largely results from extensive use of electricity in the economy and almost total dominance of hydropower in electricity supply. Large potential remains for increased use of renewable energy − hydro, wind and biomass − and the use of the resources can take the country a long way towards its climate and energy security objectives. The government should therefore continue its efforts to increase the availability of renewable energy and the efficient use of energy by industry and households.

Renewable energy supply has mostly been developed without specific support schemes – hydropower has been competitive and will remain so. Other sources of renewable energy, however, need support, and Enova has been tasked to provide it. The short-term target for renewable heat (4 TWh in 2010) looks likely to be reached, whereas the wind energy target will not be met (3 TWh in 2010). Norway, however, does not have explicit long-term targets for renewable energy, although MPE has set Enova a working goal of 40 TWh above the 2001 level by 2020, which includes both renewable energy and energy efficiency. Norway also has a goal for bioenergy to provide 14 TWh by 2020.

The government is negotiating with the EU on transposing into national law the 2009 Directive on Renewable Energy. The directive includes a binding national target for 2020 which affects both renewable energy and energy efficiency, but the target for Norway remains to be set. The outcome of these negotiations is therefore crucial in several aspects. It will help to clarify the status of the current targets, Enova´s future work and, most importantly, the general context in which suppliers are to operate. For large

renewable energy projects, which tend to have long lead times, clarity of the governmental commitments is necessary.

In a positive development, Norway and Sweden have decided, after years of delays, to launch a common green certificate system in January 2012. This is to be applauded, as the certificate system is a market-based instrument. Its success will depend on design details, such as fixing the targets right and introducing strict compliance rules.

Norway and Sweden have agreed over key principles, including technology neutrality, equal size of the quota (13.2 TWh in each of the two countries by 2020) and eligibility criteria for Norwegian generators. The final design of the green certificate system should also take fully into account the opportunities for cross-border co-operation provided by the renewable energy directive. The government should ensure a smooth and timely transition to the green certificate system. It should also consider additional support to technologies that are not competitive under the certificate system, but the development of which is deemed beneficial.

Norway has large potential for both onshore and offshore wind power. Onshore wind has received support from Enova and offshore development, while still in its early stage, is gaining pace (see also Chapter 9 on RD&D). On the whole, Norway´s policy on wind energy promotion seems to be very well in line with the key recommendations of the 2009 IEA wind energy roadmap (see Box 5).

Box 5. **Key recommendations of the IEA Wind Energy Roadmap**

Set long-term targets, supported by predictable market-based mechanisms to drive investment, while pursuing cost reductions; set mechanisms for appropriate carbon pricing.

Advance planning of new plants to attract investment, taking account of other power system needs and competing land/sea usage.

Appoint lead agencies to co-ordinate advance planning of transmission infrastructure to harvest resource-rich areas and interconnect power systems; set incentives to build transmission; assess power system flexibility.

Increase social acceptance by raising public awareness of the benefits of wind power (including CO_2 emissions reductions, security of supply and economic growth), and of the accompanying need for additional transmission.

Exchange best practice with developing countries; target development finance at wind power deployment bottlenecks; further develop carbon finance options in developing regions.

Source: *Technology Roadmap – Wind Energy*. IEA/OECD Paris, 2009.

Increasing electricity supply from small-scale and variable sources requires timely access to a well-functioning grid. As in most countries, in Norway several issues require close attention from the authorities, such as the length and costs of permitting and licensing procedures; availability of grid capacity; and the level of grid connection fees. Since January 2010, consumers and producers of electricity have a legal right to be connected to the grid. This is a clear improvement, but the allocation of costs for grid connection and network strengthening remains to be defined. The government should investigate

mechanisms to ensure that renewable energy projects are connected to the grid efficiently and is urged to clarify the allocation of connection costs.

Beyond electricity, Norway has large untapped potential also for biomass for heating. Biomass offers a carbon-neutral way to improve security of supply by reducing electricity demand for space heating. Biomass use for heat in district heating systems and individual boilers will free valuable hydropower for international trade. Enova should be encouraged to continue and intensify its work in this area.

In the transport sector, Norway has a blending obligation for biofuels, which it plans to raise from the current 3.5% to 5% in 2011. Before raising the biofuels target, however, the government should carefully consider exactly what benefits this would bring. The country's oil reserves and ample refining capacity undermine the security of supply argument for using biofuels. Also, first-generation biofuels are a rather expensive way to mitigate CO_2 emissions (NOK/tonne of CO_2 avoided). Recent empirical studies show that life-cycle GHG emissions of biofuels can in some cases be greater than those of fossil fuels. Against this background, there are no strong rational energy policy arguments for first-generation biofuels use in Norway.

The adoption of a sound sustainability certification scheme, based on latest research results and on internationally agreed sustainability indicators, should ensure that biofuels will help Norway meet its climate targets. The country should also study options to further increase electricity use in transport, because it is practically all generated from renewable sources. Finally, Norway should consider enhancing RD&D efforts on second-generation biofuels, given the country's large resource potential.

RECOMMENDATIONS

The government of Norway should:

- ☐ *Maximise the potential for the use of renewable energy resources in a cost-effective and sustainable way and communicate the relevant long-term targets effectively.*
- ☐ *Ensure a smooth and timely transition to the green certificate system and consider additional support for more expensive renewable energy technologies.*
- ☐ *Investigate mechanisms to ensure that renewable energy projects are efficiently connected to the grid and clarify the allocation of connection costs.*
- ☐ *Continue and intensify work to promote biomass use for heat production.*
- ☐ *Adopt strict sustainability criteria for the use of biofuels in transport and study options for further electricity use in transport.*

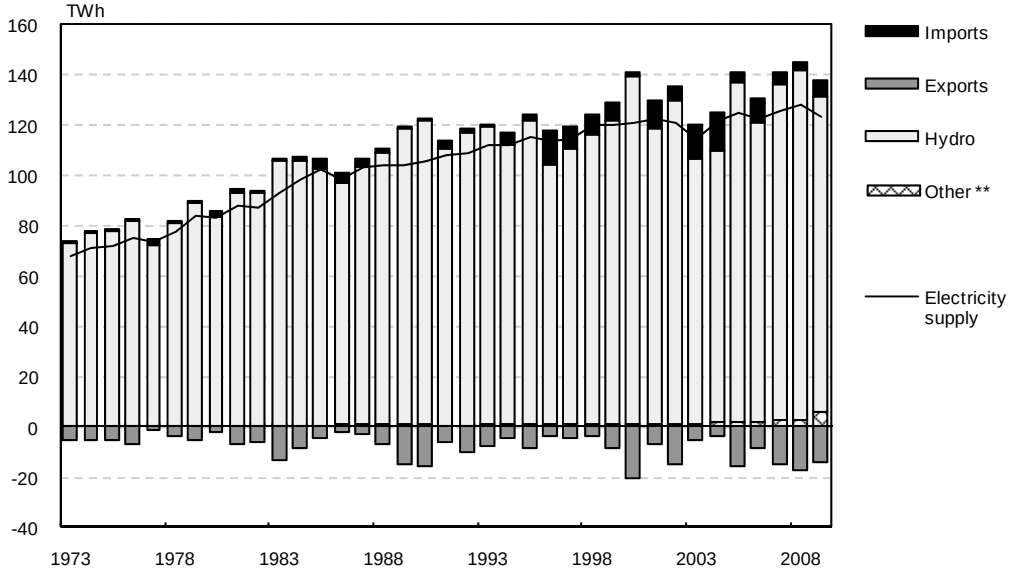
8. ELECTRICITY

SUPPLY AND DEMAND

GENERATION

In 2009, total electricity generation in Norway amounted to 132.8 TWh, a 6.9% drop from 2008. Hydropower generated 127.1 TWh (95.7% of the total), thermal power 4.7 TWh and wind power 1 TWh. Electricity generation can vary widely from one year to another, depending on rainfall and reservoir inflow which affect hydropower availability. Since 2000, hydropower generation has ranged from a low of 106 TWh in 2005 to an all-time high of 140 TWh in 2008. The record year was a relatively rainy one, with above-average inflow to the hydro reservoirs, which helped push the share of hydro to 99% of total generation (see Figure 30).

Figure 30. **Electricity supply by source, 1973 to 2009***



* Estimates for 2009.

** Negligible.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010.

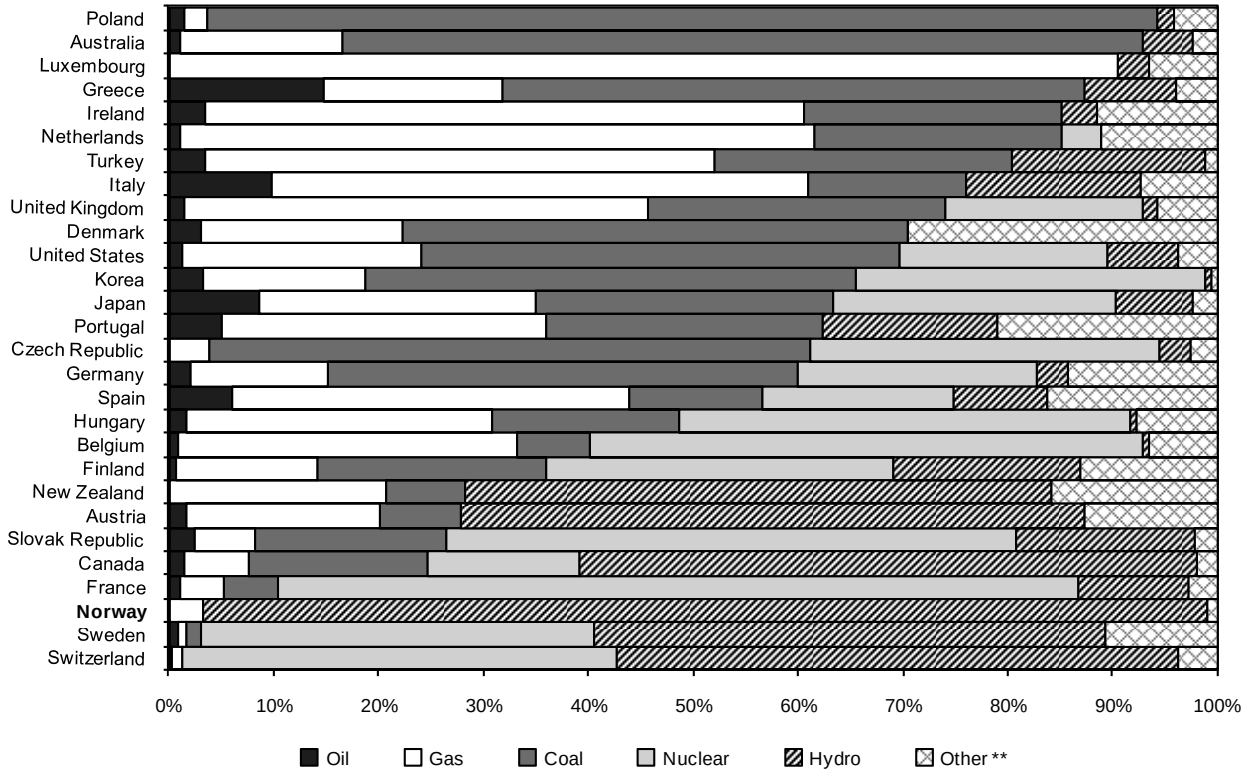
EXPORTS AND IMPORTS

Hydropower dominates the electricity supply not only in Norway but also in the whole Nordic market area. During wet years, Norway is a net exporter of power, reflecting the relatively low cost of hydropower. During dry years, however, the country becomes a net importer, importing mostly from Denmark, Sweden and Finland, which can compensate for the reduction in hydro by using other generating sources or by importing from other countries. Norway's net electricity trade has generally been closely

correlated with water inflows. Among the IEA member countries, Norway has the highest share of renewable energy in electricity generation and the lowest CO_2 emissions per kWh generated (see Figure 31).

In 2009, net exports of electricity amounted to 9 TWh, but total exports and imports were much higher, as Norway typically exports during the day and imports during the night and on weekends. Norway exported 7.8 TWh to Sweden and imported 2.6 TWh from Sweden. Exports to Denmark amounted to 3.9 TWh, while imports from Denmark were 1.4 TWh. Norway exported 2.9 TWh to the Netherlands and imported 1.2 TWh from that country. The trade between Norway and Finland was balanced with 0.1 TWh in both directions.

Figure 31. **Electricity generation by source in IEA member countries, 2009***



* Estimates.

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

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010.

GENERATING CAPACITY

Total installed generating capacity was 31 257 MW at the end of 2009. Hydropower capacity amounted to 29 626 MW (of which 1 336 MW pumped storage), thermal capacity to 1 200 MW, including two 150 MW reserve gas turbines in central Norway, and wind power capacity to 431 MW. Somewhat more than 80% of the total installed capacity is available in the winter season. Construction of gas-fired capacity is limited by an obligation to use CCS technology in all new plants.

Norway has a large reservoir capacity of 84.1 TWh (as of May 2010), and typically 60% to 70% of hydropower comes from these reservoirs. Reservoir-based hydropower has a high regulating capacity and is therefore well suited to balancing variations in the increasing wind power generation both in the Nordic and Central European market areas.

As of the beginning of 2010, NVE, the regulator, had granted licences to 1 100 MW of new hydropower projects, around 1 700 MW of thermal power projects and 1 900 MW of wind power projects. Some of these licence decisions have been appealed, however. By the same time, 700 MW of hydropower capacity was under construction, as was around 60 MW of wind capacity and 280 MW_e of CHP capacity.

Table 9. **Peak hour of electricity generating capacity use, 2002 to 2009**

Year	Weekday	Date	Hour	Demand, MW
2002	Friday	4 January	11	20 689
2003	Monday	6 January	10	19 085
2004	Monday	21 January	9	20 675
2005	Wednesday	3 February	9	21 401
2006	Monday	6 March	9	21 575
2007	Wednesday	21 February	19	21 450
2008	Thursday	14 February	10	21 589
2009	Monday	5 January	9	21 884

Source: NVE Annual Report 2009.

DEMAND

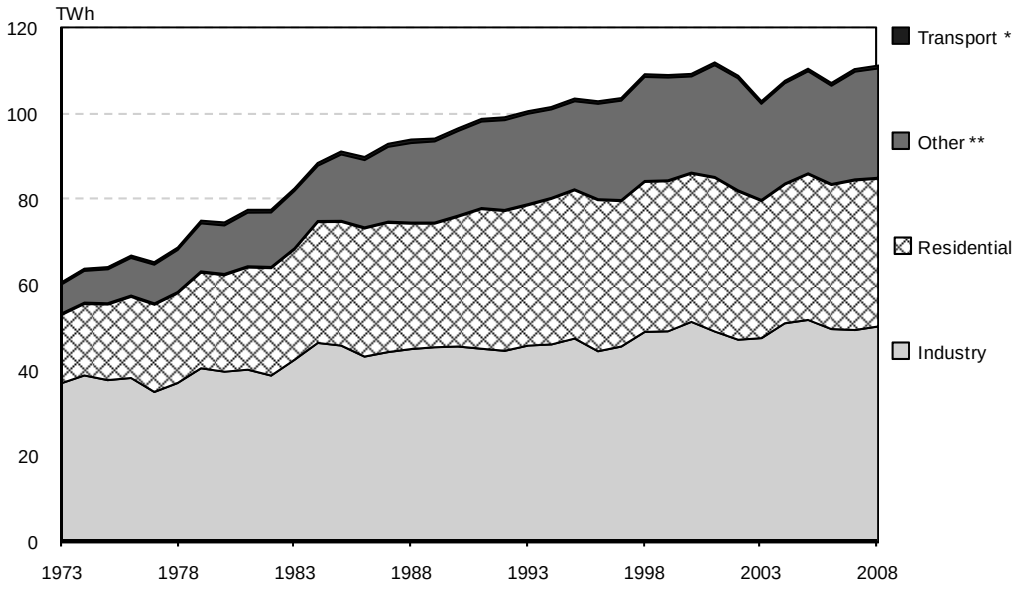
Electricity consumption amounted to 123.8 TWh in 2009, a 3.9% decline from 2008 (see Figure 32). The reduction mainly reflects lower consumption in industry. From 1995 to 2009, demand grew on average by 0.5% per year. The service sector accounted for two-thirds of the growth since 1995. In 2009, its share in total electricity consumption was 23%, while industry used 45% of all electricity and households 31%. Electricity use is likely to continue to increase gradually, with large medium-term potential in the petroleum sector.

Electricity is the main energy carrier in industry and buildings. Electric heating is the norm in Norway. As a result, electricity accounts for a very high 46% of total final consumption of energy in the country. Electricity use per capita reached more than 23 000 kWh in 2009, second only to Iceland.

Because of the widespread use of electricity for heating, demand peaks in winter and varies annually according to temperature. The highest hourly capacity use in the years 2002-2009 was 21 884 MW, reached on 5 January 2009 (see Table 9). This record was broken on 6 January 2010, when a cold snap pushed demand to 23 990 MW.

Statnett, the Norwegian transmission system operator (TSO), forecasts peak demand in winter 2012/13 to reach 22 700 MW, assuming average seasonal temperatures, but 23 800 MW with temperatures corresponding to a one-in-ten-years winter day.

Figure 32. **Electricity consumption by sector, 1973 to 2008**



* Negligible.

** *Other* includes commercial, public service, agricultural, fishing and other non-specified sectors.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010.

LEGAL FRAMEWORK AND MARKET DESIGN

LEGAL FRAMEWORK

As one of the front-runners in electricity market liberalisation, Norway deregulated its electricity market in 1991, which is now fully open for all producers and consumers. All end-users are free to choose their electricity supplier. Norwegian electricity-sector legislation is harmonised with EU legislation.

The 1991 Energy Act provides the legal base for Norway's electricity sector. Through different licensing schemes, the Act regulates the construction and operation of electrical installations, district heating systems, electricity trading, control of monopoly operations, external 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. The authority to take independent decisions pursuant to the Energy Act has to a large extent been delegated to the Norwegian Water Resources and Energy Directorate (NVE), the national regulatory authority for the electricity market. NVE's objectives are to control monopoly operations, to safeguard consumer rights, and to ensure efficient operation, utilisation and development of the grid.

The Energy Act encourages competition within power generation and trading. The Competition Act of 1 May 2004 provides the legislative framework for the section of the power market subject to competition and applies in addition to the Energy Act. The Norwegian Competition Authority (NCA) supervises compliance with the Competition Act. Monopoly control involves the following activities. The NVE determines income caps for each grid company in order to ensure efficient operation and development of the

grid, and reasonable charges for customers. The NVE also determines the overall legal framework and may issue the necessary instructions to ensure compliance with legislation and licensing conditions relating to the control of monopoly operations. Its decisions may be appealed to the MPE. The NVE is funded over the state budget. It works in close collaboration with the NCA in monotoring the wholesale market, including the balancing power market.

MARKET DESIGN

More than in the national context, the Norwegian electricity system should be seen as part of the regional Nordic electricity market, which also comprises Denmark, Finland and Sweden. The Nordic market, in many ways a model as an integrated regional market, is based on common rules and principles, which are endorsed by the Nordic governments and form a basis for close co-operation between regulators and between transmission system operators (TSOs).

The market comprises a common power exchange Nord Pool and common grid planning by the TSOs, *i.e.* criteria for transmission system planning, rules for system operation, and minimum technical requirements for connecting power plants to the grid. It also comprises co-ordinated planning of outages in the transmission grid and continuous exchange of real-time operational data to ensure that the power system is operated as a single regional market. Major areas of work over the next years, as outlined by the Nordic Prime Ministers in November 2010, include developing the grid to enable large increases in power supply from variable renewable sources, further facilitating grid investments, and developing a common Nordic end-user market.

Nord Pool is the world's largest power exchange in terms of physical contract volumes. In 2009, physical spot market trading amounted to 288 TWh, or 72% of total consumption in the four Nordic countries. The remaining 28% was traded bilaterally. Since its launch, Nord Pool has increased its share in electricity trade every year and 2009 also marked a new record. There is also an exchange of power derivatives and CO_2 allowances operated by Nasdaq OMX.

Nord Pool Spot AS is the marketplace for physical power contracts. It includes a spot and a balancing market. On the spot market (Elspot), physical power contracts are traded hour by hour for delivery on the following day. The Elspot market comprises Denmark, Finland, Norway, Sweden and Estonia. Prices are determined on the basis of the balance between bids and offers from all market participants and implicit auctions are used to allocate cross-border capacity. The spot market price provides the basis for the TSOs when balancing the flow of power between the Nordic countries. Nord Pool Spot AS is owned by the Nordic TSOs.

Elbas is the physical intra-day balancing market for trading in the Nordic countries, Estonia and Germany. It is the only cross-border intra-day market in the world, with a total volume of 2.2 TWh in 2009. The balancing market is used by power producers, energy-intensive industry, portfolio managers and traders. Contracts are hourly and are traded continuously around the clock. These contracts cover the period from when trading on the Elspot market for the following day has been concluded and the contracts can be traded up to an hour (for Norway, two hours) before the time of delivery. Norway joined Elbas in 2009. Statnett also operates a Norwegian balancing market (see section below on Security of supply).

The Nordic market is interconnected with Russia, Germany, the Netherlands, Estonia and Poland. It is becoming increasingly integrated with other regional European markets through new interconnections and market coupling – a development which should gradually lead to a single European market for electricity.

A major step in market integration was taken on 9 November 2010 when, in a joint effort of 17 TSOs and power exchanges, two initiatives were launched: the Central West Europe (CWE, covering Germany, France and the Benelux countries) price market coupling and the CWE-Nordic region Interim Tight Volume Coupling (ITVC). This created a day-ahead market area with 1 800 TWh of annual power production, the largest of its kind in the world, and will lead to prices converging in the two areas. Currently, the two market areas are connected by cables between Germany and Denmark, and Germany and Sweden. The NorNed cable between Norway and the Netherlands will be integrated into this system of implicit auctions of cross-border capacity in the near future and more interconnections are planned (see below Cross-border connections).

INDUSTRY STRUCTURE

The Norwegian power sector comprises a large number of mostly publicly owned participants in various areas of business. Depending on which activity is being pursued, companies can be designated as generating, network or trading companies, vertically integrated utilities or industrial undertakings. All companies in the sector must hold a trading licence from NVE. At the end of December 2009, 409 companies held a trading licence.

GENERATING COMPANIES

Around 90% of the generating capacity is in public ownership, while private ownership accounts for around 10%. Local municipalities and county authorities own about 52% of the country's generating capacity, often jointly by several municipalities in the region. The state-owned Statkraft is by far the largest individual generating company, with around 36% of total capacity, and the only one with more than 10% of the total capacity. A number of companies in this sector have more than one owner, and cross-ownership is common. In total, there were 64 generating companies at the end of 2009, and the ten largest had more than 70% of total capacity.

DISTRIBUTION AND RETAIL COMPANIES

As of June 2009, there were 162 distribution system operators (DSOs) in Norway, mainly publicly owned. Seven DSOs had more than 100 000 residential customers and were therefore legally unbundled. In total, they served more than 66% of the residential customers. In addition to the seven large DSOs, there were another 34 legally unbundled DSOs in Norway.

At the beginning of 2009, more than 74% of households were served by a dominant supplier whose market share within each network ranged from 31% to 91% of households. In contrast, some 727 000 household customers, or around 26% of the total, had switched away from the incumbent supplier. The dominant supplier within a network area is most often a vertically integrated supplier or a supplier within the same corporation as the DSO.

OWNERSHIP OF HYDROPOWER RESOURCES

The government views hydropower as a strategic resource and, as a consequence, it either owns or controls this resource. Under the 1917 Industrial Concessions Act, the government has a "right of reversion", which allows it to resume ownership of privately owned hydropower assets without compensation once the original 60-year licence expires. Under the Act, the government also has a "pre-emptive right" to resume ownership of hydro assets over the course of the 60-year licence whenever there is a change in ownership that would increase private ownership to more than one-third. As expected, the Act has resulted in privately developed hydropower plants gradually passing into public ownership.

The reversion scheme was amended in 2008 to incorporate the following four points:

- new licences for acquiring titles to waterfalls may be granted to public sector owners only;
- acquisition of reverted waterfalls and power plants is restricted to public sector operators;
- the right to a renewed licence for private entities lapses in the event of sale-back/lease after a reversion right has been exercised;
- the sale of more than one-third of publicly owned waterfalls and power plants to private entities is prohibited.

As a result, as the reversion date stated in the licence nears, private power plants will be sold to public sector companies or reverted to the government. In both cases, as in previous years, the restructuring from private to public sector owners continues.

NETWORK INFRASTRUCTURE AND OPERATION

INFRASTRUCTURE

As of January 2010, Norway's high-voltage transmission network consisted of around 2 900 km of 420-kV lines, 5 100 km of 300-kV lines and 570 km of 220-kV lines. Statnett owns around 90% of the transmission network. The rest is owned by 25 different companies, representing the private sector and county and municipal authorities. County and municipal authorities own most of the grid at the regional and distribution levels.

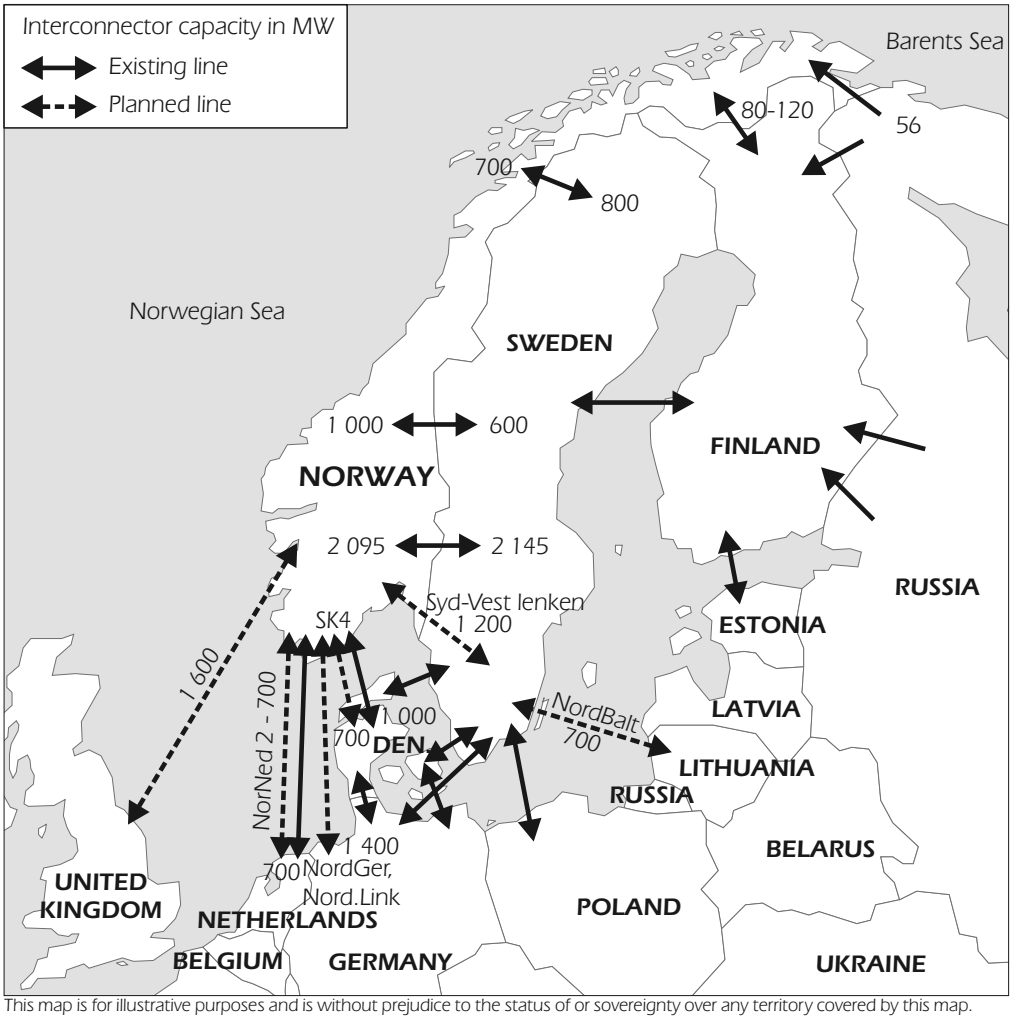
Statnett, the state-owned TSO, has been a legally unbundled company since 1992. Statnett and the state-owned generator Statkraft AS are since 2002 owned by two different ministries, complying with requirements for ownership unbundling. Statnett is responsible for operating and developing the core power transmission network in a socio-economically efficient way, which implies taking into account both costs and benefits.

CROSS-BORDER CONNECTIONS

The Norwegian transmission grid is interconnected with Sweden, Denmark, Finland, the Netherlands and Russia. The transmission capacity is largest from Norway to Sweden, about 3 450 MW, while the capacity in the other direction is about 3 000 MW (see Figure 33). Transmission capacity between Norway and Denmark is about 1 000 MW.

NorNed, the subsea cable between Norway and the Netherlands owned by Statnett and TenneT (the Dutch TSO), has a capacity of 700 MW. The interconnectors to Finland and Russia have a low capacity, and the one with Russia is only used for imports to Norway. The transfer capacity on the Nordic interconnectors is allocated through the power exchange (Nord Pool). Implicit auctions will be taken into use also on the NorNed cable in the near future.

Figure 33. **Existing and planned interconnections from Norway, 2010**



This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Source: Ministry of Petroleum and Energy.

Norway is involved in several projects to develop cross-border connections both within the Nordic area and with neighbouring areas. Generally, the projects are driven by trade opportunities, but also by the need to accommodate large projected increases in variable wind power supply in the coming years – which, in turn, will provide more trade opportunities.

In particular, offshore wind generation is expected to increase significantly in Norway's proximity, from 1 to 2 TWh per year today to around 125 TWh by 2020, assuming that EU member states follow their own 2010 National Renewable Energy Action Plans. In December 2009, nine EU member states (Belgium, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, Sweden and the United Kingdom) signed a political declaration on the North Seas Countries' Offshore Grid Initiative (NSCOGI) with the objective to co-ordinate the offshore wind and infrastructure developments in the North Sea and the Baltic Sea. Norway joined this declaration in February 2010, and in December 2010, the ten countries signed a Memorandum of Understanding. Working groups will be set up to cover the areas of grid configuration and integration; market and regulatory issues; and planning and authorisation procedures.

In the period leading to 2020, Statnett is planning to establish the following new cross-border interconnections, in joint ventures with other TSOs that will result in closer integration of the Nordic market area with Central Europe:

- Denmark/Skagerrak 4: a 450/500 kV high-voltage direct current (HVDC) connection with a capacity of 700 MW is a joint project with Energinet.dk and scheduled for completion by the end of 2014.
- Sweden/Sydvestlinken: 1 200 MW, a joint project with Svenska Kraftnät and scheduled to be operational by 2016.
- Germany/NorGer: the 1 400 MW HVDC link is a joint project of Statnett (50% of shares), Lyse and Agder (Norwegian generators) and EGL of Switzerland (16.67% each).
- Germany/Nord.Link: this project is pending a licence approval. Statnett expects to start construction in 2014 and to complete it in 2018.
- The Netherlands/NorNed 2: this second cable of Statnett and TenneT would have a capacity of 700 to 1 400 MW and is expected to be commissioned in 2016.
- The UK/BritNor: the 1 600 MW joint project with National Grid would be operational in 2017-2020.

NETWORK LICENSING AND TARIFFS

Both domestic network investments and international interconnectors are subject to a licence. International interconnectors also need export and import permits which are issued by the MPE. In accordance with the objectives of the Energy Act, licensing procedures take into account socio-economic considerations, the interests of the general public and of private individuals, as well as effects on the environment.

NVE uses income cap regulation for network operations. It defines the cap for each individual network company, considering cost-related factors, such as climate, topography and settlement patterns. On the basis of this income cap and regulations issued by NVE, each grid company sets its own tariffs. All network companies are required to charge at the point of connection, and the charges should be independent of power contracts. The charges have a variable component and one or two fixed components. The variable component, the energy charge, is generally intended to reflect the value of the marginal losses in transmission and distribution networks. There is also a capacity charge if there are bottlenecks in the transmission system.

Since 2000, the government is subsidising network tariffs for end-users that are connected to the distribution grid and face the highest average transmission costs. The subsidy is paid to the appropriate network companies which are then required to reduce their tariffs accordingly. The 2010 budget for the subsidy amounted to NOK 60 million (EUR 6.9 million).

NETWORK PLANNING

Statnett is responsible for the planning process of the transmission network. Its current transmission investment plan includes three scenarios for 2010-2019. Future investments will depend on a number of factors, such as growth in domestic demand (including electrification in the petroleum industry and transport), variable renewable power supply and trade potential within the Nordic market and the rest of Europe. Investment costs in the scenarios vary from a low of NOK 17.5 billion (EUR 2 billion) in the "Standstill" scenario to a high of NOK 33.5 billion (EUR 3.8 billion) in the "Expected scenario".

At regional level, network planning is organised through so-called power system studies to ensure co-ordination and information-sharing between different voltage levels and geographical areas. The 1991 Energy Act obliges all licence-holders or applicants for licences to participate in a co-ordinated planning scheme. Regional power system studies are undertaken by a DSO appointed by the NVE in each of the country's 18 regional planning areas. The power system studies are submitted to NVE annually.

The studies must cover at least ten years, describe bottlenecks and assess measures to address them. They also cover other topics such as energy and plant statistics, security of supply, environmental, economical and technical assumptions, as well as description of the existing grid, operating conditions, tariffs and future grid development. Local energy studies at the municipality level are also prepared and sent to the concessionaire responsible for the regional power system planning.

CONGESTION MANAGEMENT

Restrictions in the Nordic transmission grid, often termed bottlenecks or congestions, are managed by specifying price areas on either side of the bottleneck. Such price areas are determined by the TSOs, and the price within the price area is determined by Nord Pool. Regions with a power surplus have an area price lower than the system price. The position is reversed in areas with a deficit. Area prices help to balance supply and demand within each area while taking account of the bottleneck.

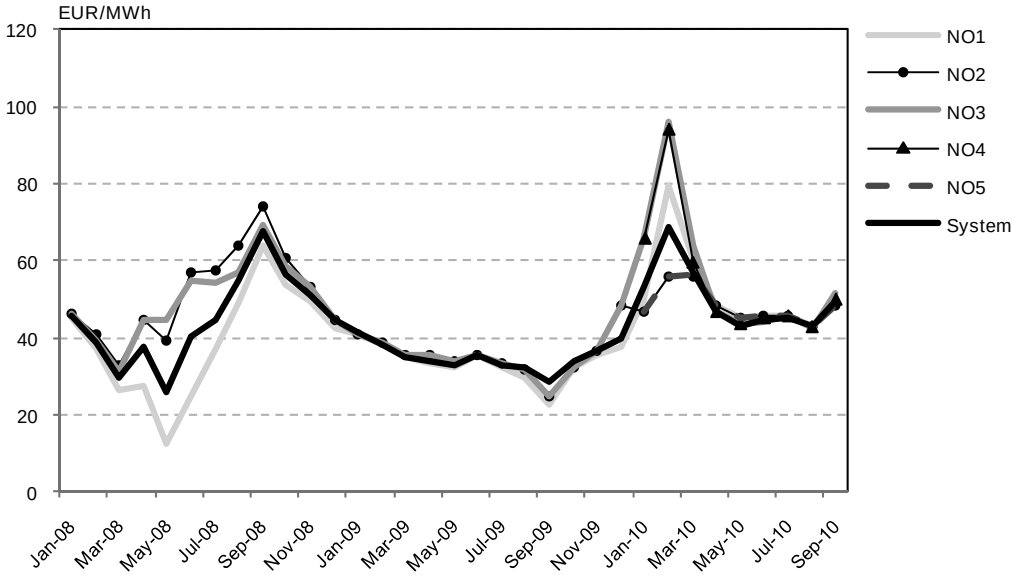
As a general rule, Norway uses price areas to deal with major or long-lasting bottlenecks at home and to manage congestion on the border with Sweden, Denmark (Jutland) and Finland. Counter-trade is used when smaller adjustments are needed. Since 2008, Norway has been divided into five price areas.

PRICES

WHOLESALE PRICES

Nord Pool spot prices are market-based and reflect changes in consumption, generation and transmission conditions in the Nordic market area. Hydropower generation in the Nordic market area ranges from 150 TWh to 250 TWh per year and is key to determining the general spot price level. In wet years, wholesale prices are dominated by cheap hydropower, while in dry years, more expensive thermal power, especially coal-fired condensing power in Denmark and Finland, is generated to compensate for low hydropower production in Norway and Sweden. Imports from Russia are also increased. Closer market integration with Central Europe is expected to reduce price fluctuations in the Nordic market area. In the Norwegian price areas, temperature also affects spot prices as cold weather increases the demand for electric heating (see Figure 34).

Figure 34. **Weekly Spot Prices in the Nord Pool system and in Norway by price area, 2008 to 2010**



Source: Nord Pool.

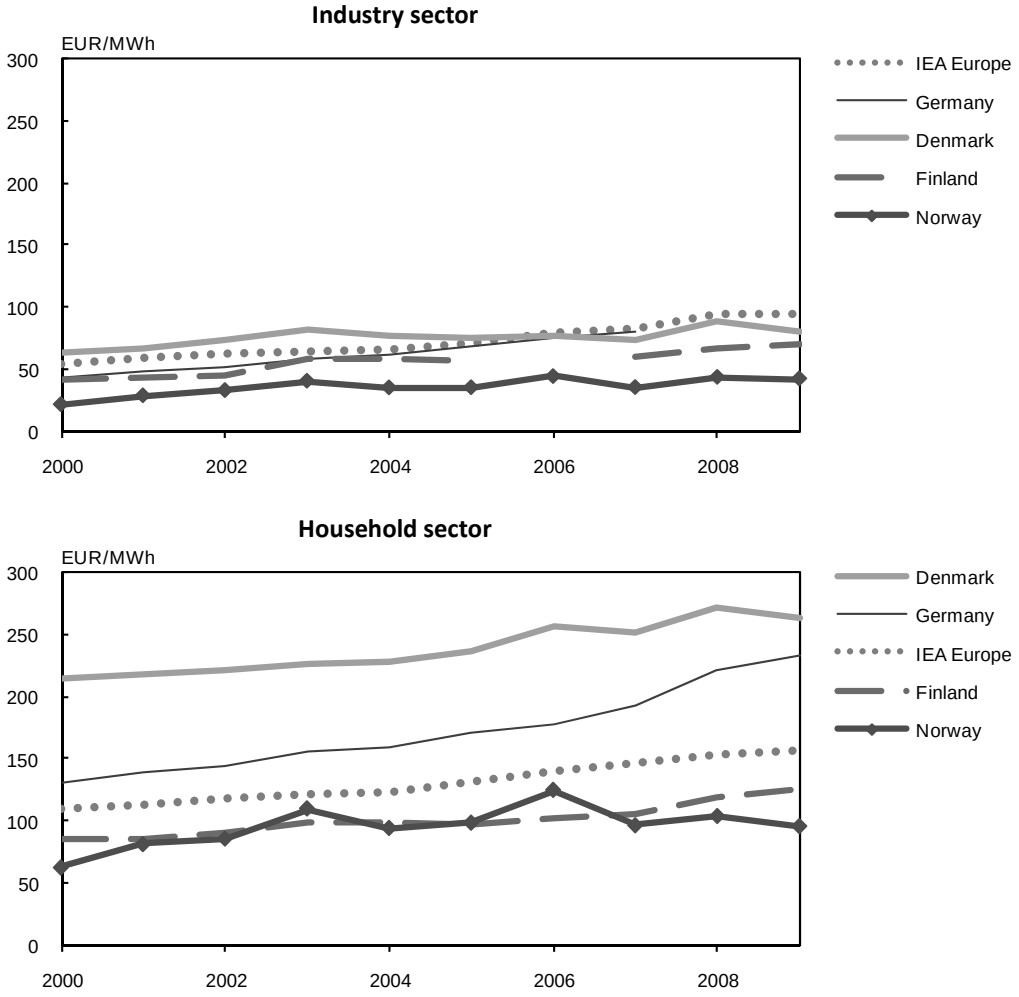
RETAIL PRICES

Electricity prices for households and industry in Norway are one of the lowest among the IEA member countries (see Figures 35 and 36). This is arguably the result of the large share of hydropower in the power mix.

Electricity use is subject to a consumption tax, at a rate of NOK 0.11 (EUR 0.012) per kWh in 2010. Consumers in the county of Finnmark and some municipalities north in the county of Troms are exempt from the electricity consumption tax. In industry, some sectors are exempt from the tax, while some others are subject to a reduced rate of NOK 0.0045 (EUR 0.0005) per kWh in 2010. A standard 25% value-added tax is charged on electricity. Household customers in the north of the country, in the counties of Nordland, Troms and Finnmark, are exempt from the VAT.

As a detail, Statkraft SF had entered into long-term supply contracts with terms set by the government for energy-intensive industry. Originally, these contracts were thought to reflect market prices, but it has become clear that the price level has been too low. The last of these contracts expires in 2011.

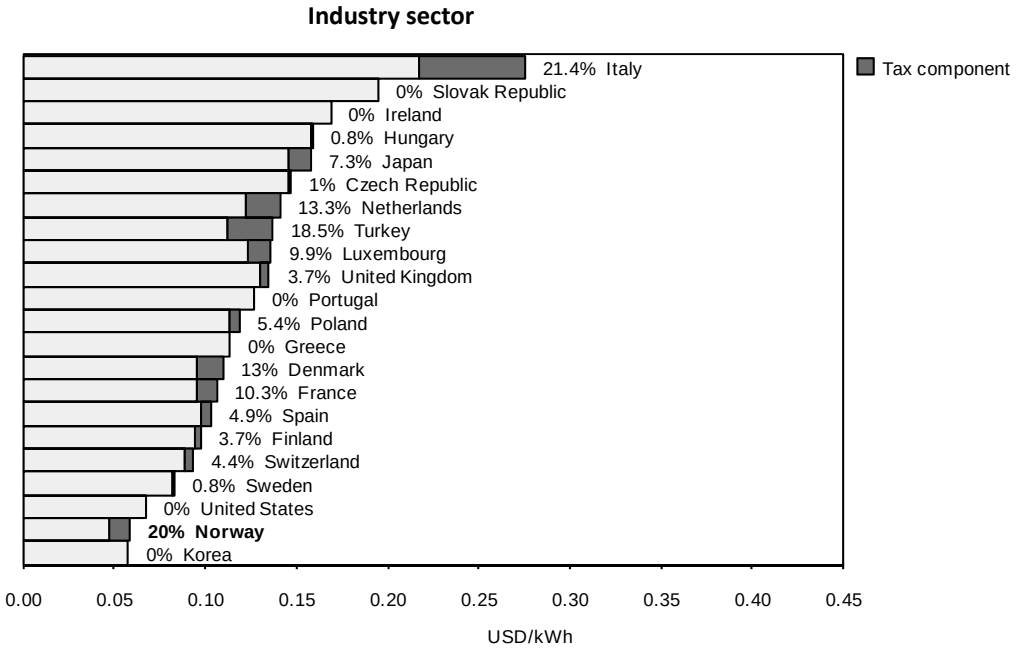
Figure 35. **Electricity prices in Norway and in other selected IEA member countries, 2000 to 2009**



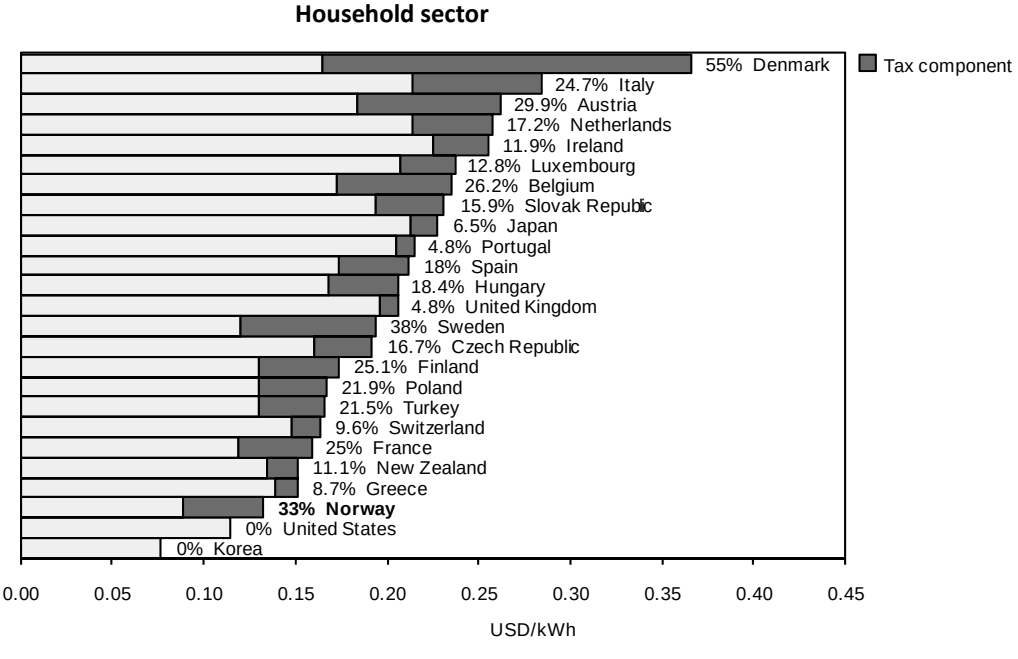
Note: Data partially unavailable for Finland and Germany.

Source: *Energy Prices and Taxes,* IEA/OECD Paris, 2010.

Figure 36. **Electricity prices in IEA member countries, 2009**



Note: Tax information not available for Korea and the United States. Data not available for Australia, Austria, Belgium, Canada, Germany, and New Zealand.



Note: Tax information not available for Korea and the United States. Data not available for Australia, Canada and Germany.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2010.

END-USER SUPPLY CONTRACTS

Although suppliers in the Norwegian retail market offer a variety of contracts, the contracts can normally be divided into three groups: spot price, standard variable price and fixed price contracts. Spot price contracts are based on daily Nord Pool spot prices plus a mark-up that consists of a variable and in some cases a fixed yearly fee. For a standard variable price contract, the supplier may freely choose the price and its duration given that any price change must be announced to its customers at least 14 days in advance. Fixed price contracts are based on an agreement to deliver electricity at a fixed price for the duration of the contract.

In 2009, around 57% of household customers had a spot price contract, while 38% had a standard variable price contract and 5% a fixed price contract, normally of one year duration. According to NVE, around 70% of commercial customers had opted for a spot price contract.

The extent of real-time pricing in the retail market is related to the degree of pricing for customers under a spot market price contract. However, customers under such contracts may be billed by using an average daily, weekly or monthly price. It is expected that the degree of real-time pricing will augment as advanced metering systems are rolled out. NVE is working on an amendment to the 1999 "Regulation concerning metering, settlement and co-ordination of electricity trading and invoicing of network services" to ensure a full roll-out of advanced metering systems (AMS) for all end-users. The implementation of the new regulation has been postponed until January 2018 in anticipation of EU standards for this technology.

SUPPLIER SWITCHING

The 1991 Energy Act authorised customers to switch supplier. The model was revised in January 2008 to increase automation of information exchange procedures and to limit the length of the switching process. Today, this process takes on average two weeks, and should not be longer than 21 working days. Switching rates in recent years are shown in Table 10.

Table 10. **Customers switching electricity supplier, 2003 to 2009**

	2003	2004	2005	2006	2007	2008	2009
Household customers	441 262	240 086	190 400	273 600	198 658	193 900	195 251
Switching rate	19%	10%	8%	12%	8%	8%	8%
Commercial customers	40 769	30 661	24 250	22 100	20 450	23 800	24 719
Switching rate	14%	10%	8%	7%	7%	8%	8%

Source: NVE.

The switching process can be carried out by the consumer directly through the new supplier. A contract must be signed before the supplier may notify the distribution company about the switching and the switching date. The date for the switch is set by the new supplier. The distribution company must be notified of the chosen date minimum six days before the switching date. The DSO must then execute the switch on the set date.

To facilitate competition, the Norwegian Competition Authority runs an official website for price comparison between the three most common contract types in the market. On average, nation-wide suppliers offer lower prices than vertically integrated suppliers or suppliers within the same group of companies as the DSO (incumbent supplier). Most suppliers offer their customers the possibility to upgrade/change to other types of contracts. Larger consumer groups, for instance housing co-operatives, may negotiate special terms in their contracts.

SECURITY OF SUPPLY

Owing to its strong dependence on hydropower availability, the Norwegian power system is particularly vulnerable to energy shortages. Regulations dating from 2005 on security of power system operations oblige the TSO to develop the necessary measures to ensure system balance at all times and the energy balance during the winter season.

Statnett, the TSO, uses a balancing market (*regulerkraftmarkedet*) to maintain a stable frequency and balance between generation and consumption. The balancing market opens after prices and quantities have been determined in the Nord Pool spot market. Statnett receives bids from major power producers or large consumers who are willing to change their production and/or consumption plans at short notice. Statnett can then use the bids to adjust the amount of power in the grid right up to, and also during, the hour of delivery.

To meet the legal requirements, Statnett aims to have access to at least 2 000 MW of capacity in the balancing power market every hour. If the bids in the balancing power market are insufficient, Statnett can conclude contracts for reserve capacity with producers and also major consumers in the balancing options market. These contracts help to make sufficient reserves available in the balancing market so that the balance between generation and consumption can be maintained. The power reserve contracts specify how much capacity, when and at what price each individual player can make power available to the balancing market.

Statnett also has two mobile 150-MW gas-turbine plants to be used in case of electricity scarcity, for example because of hydrological conditions. A precondition for initiating reserve power generation is the probability of an electricity rationing of more than 50%. Furthermore, Statnett's grid investment plan includes several projects to ensure and enhance security of supply, *e.g*. by increasing voltage in the existing grid and enhancing domestic and cross-border transmission capacity.

A standardised system for registering and reporting faults and interruptions is used in Norway. The system is called FASiT (Fault and Interruption Statistics in the Total network). It includes both long interruptions (of more than three minutes) and short ones (of up to three minutes). All network companies are obliged to report specific interruption data to NVE once a year. NVE publishes these indicators together with other supply interruption statistics every year.

CRITIQUE

Norway deserves to be commended for the continued reliable and efficient performance of the electricity sector over the past few years. The country forms part of the regional Nordic wholesale market which is widely regarded as the model for effective cross-border market integration. Norway's transmission grid is also becoming more closely interconnected with other market areas, starting with the opening of the NorNed cable in 2008. Statnett, the TSO, has ambitious plans to construct several new cross-border interconnections which will strengthen integration between the Nordic market and the rest of Europe.

MARKET INTEGRATION AND THE ROLE OF HYDROPOWER

Electricity markets in Europe are now being developed from a regional perspective, towards the goal of creating a single European market for electricity. This regional perspective is obviously nothing new to Norway, but it is worth noting that the regional context itself is changing and will continue to do so, thanks to new interconnections and market coupling. Norway, and the whole Nordic market, is becoming more closely tied with Central European electricity markets, and the market coupling in November 2010 is a milestone. Further integration has wide implications for the optimal use of the low-carbon Nordic power capacity, especially hydro. In the coming years, the Nordic market area will see large increases in low-carbon capacity, mostly nuclear and wind, while the EU-ETS is expected to drive wholesale electricity prices higher from 2013 on, as marginal prices in the spot markets will most of the time continue to be set by fossil-fired power, obliging to purchase emission allowances from a gradually diminishing total. Norwegian generators are likely to benefit from this, whether or not Norway is part of the post-2012 ETS.

The importance of hydro will be increased by the need of EU countries to meet their 2020 renewable energy targets. Many countries bordering on the North Sea and therefore close to Norway, including Germany, the United Kingdom and the Netherlands, plan to dramatically increase their wind power capacity, in total by tens of gigawatts. To a smaller extent, Sweden also and Norway itself will be increasing wind power capacity. This form of variable supply needs to be to some extent backed up by capacity that can be quickly scaled up or down, depending on the changes in wind power generation. Hydro and gas are best suited for this potentially very profitable role.

Given that Norway relies so extensively on its hydro resources for power generation at all times in the day, it may be prudent for the country to act more as the regional flexibility market for balancing wind rather than produce hydropower at near maximum output. It can likely strengthen its earnings by selling power into the regional peak and balancing market and buying power back to replenish reserves overnight from wind or fossil plants operating in the interconnected regional market, that might otherwise scale back their output. Norway would thus use its generating capacity in the same way as Switzerland and British Columbia do: increase the flexibility in their regional power system with their hydro capacity. The government should evaluate its role as a market facilitator and consider a more active role for Norway to use its hydropower for providing for regional power system flexibility.

A timely expansion of cross-border interconnections from Norway would enable the country to play a potentially more significant role in backing up the increasing wind

power in Europe, thus contributing to the development of more efficient internal electricity market, and enhancing European electricity security. This would also improve electricity security in Norway, because the almost complete dominance of hydro in the generating mix exposes the country to supply constraints in times of low hydro availability. Deficits in hydro production coupled with transmission bottlenecks can also result in abnormally high and volatile prices, as experienced in the winter of 2009/10. Statnett's plans for several cross-border interconnections are therefore very welcome.

ROLE OF NATURAL GAS

A relatively easy way to improve security of electricity supply, given Norway's gas production, would be to add gas-fired capacity to the generating fleet. However, the fact that no new gas-fired plant can be built without CCS effectively rules out the gas option until CCS becomes more competitive. Against the long-term need to decarbonise the power sector worldwide, it is perfectly understandable for Norway to avoid building more unabated carbon-intensive power capacity, but from the medium-term regional perspective, the matter looks different. In times of low hydro availability in the Nordic market area, power is often imported from the region's coal-fired plants to meet demand in Norway. As a result, more CO_2 is emitted to the atmosphere than would be necessary. The regulation also limits the use of gas as backup for wind power.

The EU-ETS adds a twist to the effectiveness of the ban to construct gas-fired capacity without CCS. If Norway stays in the EU-ETS from 2013 on, CO_2 emissions from any Norwegian combined-cycle gas turbine (CCGT) plant would not increase total CO_2 emissions in the ETS area, because these emissions are capped. To the contrary, CCGTs would help reduce the carbon intensity of power generation, because they emit less CO_2 per kWh than many other plants still in use in the ETS area. The government should consider temporarily allowing the construction of gas-fired plants without CCS, but with readiness to install CCS, to enable meeting electricity demand in the Nordic market and the EU-ETS area with lower total CO_2 emissions, and to help ensure security of supply.

DEMAND-SIDE MEASURES AND ENERGY EFFICIENCY

The planned ambitious deployment of variable sources of electricity, mainly wind power, poses challenges to grid operations, including voltage stability and system balancing. It also raises the need to increase the flexibility of regional power systems. For this purpose, Statnett is working to develop the transmission system domestically and, in co-operation with the regional TSOs, across national borders. Statnett's scenarios suggest a massive investment challenge to 2020. While acknowledging the potential for higher demand for electrification in the transportation and petroleum sectors, Statnett's projections of electricity demand may underestimate the potential for lower demand resulting from improved energy efficiency.

Increasing consumer participation can provide an important source of flexibility in power systems. As a short-term measure, demand-side bidding in the balancing market is a best practice that other countries should consider. Over the long term, probably the most economical way to meet incremental demand is through the "negawatts" achieved by energy savings, but a key challenge for policy makers is to find effective ways to promote them. Generally, a well-designed rate structure (without excluding very high prices at peak periods) coupled with the deployment of smart meters could help, but only if prices are high enough.

End-user prices in Norway are so low, especially compared to the general income level, that demand-side participation may not be attractive or cost-effective. In the future, prices may gradually rise through higher exposure to the Central European markets, or through the regional Nordic retail electricity market, planned for 2015. If, however, end-user prices do not increase to such levels that people start to pay more attention to how they use electricity, the government should consider further measures, such as regulation and subsidies. In contrast, raising taxes would be effective, but politically more challenging.

Intensified government action could lead to large electricity savings, especially in space heating, a major electricity user. The 2007 building regulations specify that at least 40% of the energy for space and water heating in new and refurbished buildings must come from sources other than electricity and/or fossil fuels. Enova, the government agency, already has several programmes in this sector. Much can be done by automated metering and the utilities should be encouraged in this respect. The government should also gradually increase minimum energy performance requirements concerning insulation and heating system efficiency. In addition, it should consider intensifying the gradual switch from traditional electric space heating to other heating forms, such as district heating and heat pumps. The investment costs could also be partly shared with generators, which would have more power available to sell to the spot market.

SPEEDING UP LICENSING AND PLANNING

The development of transmission infrastructure is often challenged by local opposition, regulatory obstacles and cost allocation issues. The Norwegian experience is that development of interconnections takes between seven to ten years. The long lead times between submitting planning applications and the beginning of operations means that infrastructure expansion needs to be carefully considered and projects to be undertaken expeditiously. Income cap regulation on electricity networks has been implemented and should provide incentives for investments in the power sector. The government should ensure that the siting and licensing process, including that of interconnection to the grid by renewable energy developers, is effective, efficient and timely. Since several jurisdictions may be involved in the permitting process, the government should work together with the regional and local authorities and other national authorities, if appropriate, to streamline and harmonise the permitting process and ensure transparency and consistency in the approval process.

PUBLIC-SECTOR OWNERSHIP

The electricity sector remains firmly in Norwegian ownership. The government decision in 2008 to remove options for long-term private leases in the hydro sector is essentially re-nationalisation, and may reduce private-sector incentives for meeting the large investment task ahead. Hydropower capacity is very valuable in a carbon-constrained world, and it is understandable that politicians want to keep these assets in public ownership. At the same time, however, significant public-sector ownership of generating capacity may complicate the effective functioning of the market.

RECOMMENDATIONS

The government of Norway should:

- *Encourage further integration of the Nordic electricity market, both internally and with other market areas, to improve overall efficiency, flexibility and security of power supply; facilitate the increase of cross-border interconnections and demand-side measures to this end.*
- *Consider temporarily relaxing the ban on the construction of gas-fired power plants without CCS to enable meeting electricity demand in the regional market with lower total CO_2 emissions.*
- *Take measures to shorten the administrative and regulatory approval processes for network and generation projects; continue to ensure an efficient process for cross-border interconnector projects.*
- *Evaluate the impact of the current and significant public-sector ownership in the generating sector on the efficient functioning of electricity markets.*

PART III
ENERGY TECHNOLOGY

9. ENERGY RESEARCH, DEVELOPMENT AND DEMONSTRATION

OVERVIEW

Norway's public funding of energy research, development and demonstration (RD&D) has multiple objectives. It should contribute to cost-effective value creation in the utilisation of Norway's energy resources, to the development of new industry and human capital and to the protection of the environment. The Ministry of Education and Research is responsible for basic research and co-ordination of the government's general R&D policies, while individual ministries are responsible for funding R&D within their own sector. The Ministry of Petroleum and Energy (MPE) is thus in charge of Norway's policy for petroleum and energy R&D.

The Research Council of Norway (RCN) is the government's strategic and advisory body on R&D. It has a key role in financing and following up R&D as well as giving policy advice to the government. The RCN distributes about 30% of public R&D spending. Funds go to higher education, research institutes and industry. Higher education is principally funded by the Ministry of Education and Research, with other ministries also funding specific institutes and industry. In addition to the ministries and RCN, industry and academia participate in designing and reviewing high-level strategic plans, in developing programmes and individual projects. Publicly funded demonstration programmes and projects are administered by several public agencies.

Norway has two major national strategies for energy RD&D: OG21 and ENERGI 21. These strategies are mainly implemented through five programmes: RENERGI, PETROMAKS, CLIMIT, DEMO 2000 and Centres for Environment-Friendly Energy Research (CEERs) (see Figure 37). The government is also funding several bodies that support energy RD&D, such as Enova, Gassnova and Innovation Norway (see below).

Public-private partnerships are encouraged through requirements for minimum levels of private-sector involvement in different types of RCN-funded projects. Research projects may be funded by RCN to a maximum of 100% of total costs, user-assisted competence-building projects up to 80% and user-driven innovation projects up to 50%. Norway has a strong tradition of private-sector participation in all stages of the energy RD&D process: priority-setting, development of strategies, and implementation.

STRATEGIES

Norway's two major strategies for energy RD&D are the OG21 for the petroleum sector and the Energi 21 for the other sectors.

OG21

The "Oil and Gas in the 21st Century" strategy was established on the initiative of the MPE in 2001, with the purpose of providing a unified national technology strategy for the oil and gas industry. It has a board of directors, determined by the MPE, with members and observers drawn from industry, academia and government departments

(MPE, RCN and NPD, the Norwegian Petroleum Directorate), and a Secretariat. The OG21 strategy was last updated in mid-2010. It is discussed and, depending on circumstances, reviewed every second year. The strategy is revised regularly in light of prevailing priorities and energy challenges. All interested parties can contribute. The strategy details the following four technology target areas:

1. value creation through production and reserve replacement;
2. energy-efficient and cleaner production;
3. value creation through technology export;
4. value creation through employment and competence development.

Follow-up groups are primarily led by oil and gas companies to ensure commitment from industry. The strategy constitutes the foundation of the roadmap for necessary research and technology development in Norwegian oil and gas activities, and is implemented by RCN's PETROMAKS and DEMO 2000 programmes.

ENERGI 21

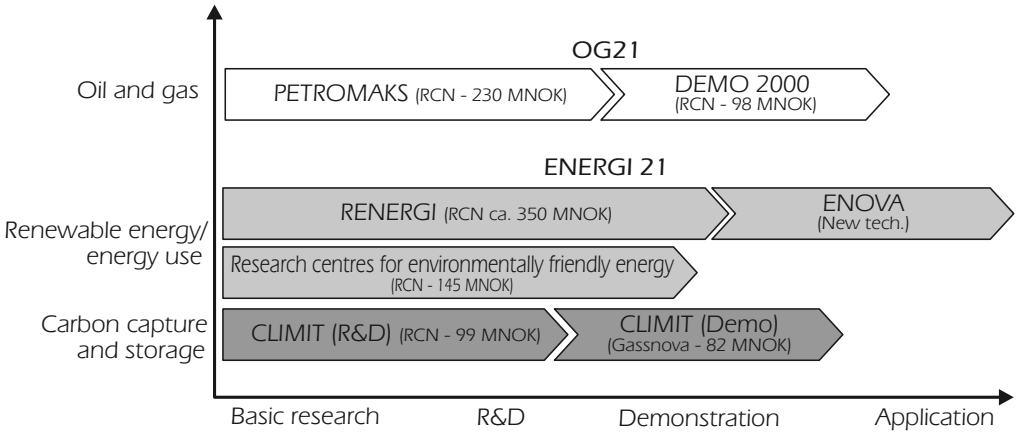
Following on the success of OG21, and to supplement that programme, Energi 21 was launched in 2007 as the national R&D strategy for the Norwegian energy sector. It promotes and co-ordinates research, development, demonstration and commercialisation of new technology in order to provide a secure platform for the growth of sustainable economic activity and supply-side security in the energy sector.

Energi 21 was adopted in 2008 and will be revised in the second half of 2011. It has an industry-led board, with 15 representatives from energy companies, technology suppliers, research communities and authorities. The strategy is implemented by RCN's RENERGI and CLIMIT programmes and has the following six priority areas:

- Renewable energy production: hydropower, wind power and solar energy.
- Energy systems (electricity):
  - transmission grid, offshore/onshore,
  - distribution grid,
  - policy structures, framework conditions, and power market.
- Raising energy efficiency in industry;
- Renewable thermal energy:
  - biomass heating,
  - geothermal energy,
  - distributed heating and cooling solutions.
- Carbon capture and storage (CCS).
- Frameworks and social analysis.

Figure 37. **Public RD&D programme structure for hydrocarbons and energy**

(total public contributions, 2010)



Source: Ministry of Petroleum and Energy.

PROGRAMMES AND SUPPORTING BODIES

The OG21 and Energi 21 strategies are implemented through four main programmes and through the Centres for Environment-Friendly Energy Research (CEERs). The OG21 strategy is implemented through the PETROMAKS and DEMO 2000 programmes, while the Energi 21 strategy is implemented through the RENERGI programme. For RD&D on carbon capture and storage, the CLIMIT programme has been set up. Several publicly funded organisations support programme implementation.

PROGRAMMES

PETROMAKS

The PETROMAKS programme was established in 2004 to implement the OG21 strategy. It encompasses basic and applied research in both academia and industry, and promotes industrial developments and knowledge creation to enhance the value of Norway's petroleum resources. The programme is planned to run until 2013 and a third of its 145 projects include international co-operation. Total budget for 2010 equals EUR 30 million (NOK 260 million), of which nearly half comes from industry. Projects cover all four technology target areas of OG21. Since the Parliament's 2008 Climate Agreement, increased focus has been placed on improving energy efficiency and reducing emissions both to the air and to the sea. PETROMAKS will be evaluated in 2011.

DEMO 2000

The DEMO 2000 programme was set up to help demonstrate and pilot specific projects both to increase the value of exploration and development of hydrocarbon resources on the Norwegian Continental Shelf and to develop Norwegian products and services for the global offshore market. Supported projects are concentrated in focus areas of the OG21 strategy, including exploration, improving hydrocarbon recovery and cost-effective operations in deeper waters and in the Arctic.

Since 2000, more than 215 pilot and demonstration projects have been carried out at a total cost equalling some EUR 300 million (around NOK 2.6 billion), 20% of which has been government-funded. The budget for 2010 is NOK 100 million (around EUR 11 million). DEMO 2000 was evaluated in 2005 (NIFU STEP report 7/2005). The report came out with a favourable analysis of the programme activities, concluding that without the support and funding from the DEMO 2000 programme, the majority of the deliverables from the projects would at best have become available at a later stage and at a smaller scale, or would not have materialised at all.

Both PETROMAKS and DEMO 2000 attract supplementary funding from oil companies and contractors through joint funding of projects. Several projects commence and develop in PETROMAKS and continue with demonstration in DEMO 2000, though there is no forced dependence between the two programmes.

RCN also finances petroleum R&D for technology-oriented strategic R&D programmes in universities and institutes. It also administers a tax scheme to promote R&D in industry (*Skattefunn*), which supports a large number of projects on petroleum and energy R&D. This support takes the form of an additional tax deduction of up to 20% of the costs related to R&D activity.

RENERGI

RENERGI is RCN's large-scale research programme on clean energy for the future. It aims to develop knowledge and solutions that enhance the environment-friendly and cost-efficient use and management of Norway's energy resources to ensure reliability of supplies and develop a competitive industrial energy sector. It was launched in 2004 and is planned to run until 2013. The programme is funding more than 250 projects in the following seven thematic areas:

- energy efficiency;
- energy systems;
- renewable power;
- CO_2-neutral heating and cooling;
- other energy carriers;
- transport;
- social science research.

The projects are funded at universities, institutes and companies. Around half of the projects are user-driven innovation projects. RENERGI will be evaluated in 2011.

CLIMIT

The CLIMIT programme focuses specifically on carbon capture and storage (CCS). It was launched in 2005 to support the development of gas-fired power plants with CCS – a long-standing policy goal. CLIMIT aims to:

- improve and develop technologies to enhance energy efficiency in power generation with CCS (since November 2009, the programme also covers CCS in industry);
- develop knowledge and understanding for safe and cost-effective transport of CO_2;
- develop methods for safe storage of CO_2.

Particular areas of work include reducing costs of CO_2 capture via technology development, scale-up and demonstration, and increasing the confidence of stakeholders in future storage projects, building on the experiences of operations at both Sleipner and Snøhvit sites.

The programme has an annual budget of NOK 180 million (around EUR 20.6 million) from 2010, an increase of NOK 30 million (EUR 3.4 million) from 2009. Around NOK 100 million (EUR 11 million) of the total is allocated to R&D and NOK 80 million (EUR 9 million) to demonstration projects. RCN provides around 70% of the total funding.

CENTRES FOR ENVIRONMENT-FRIENDLY ENERGY RESEARCH (CEERS)

In early 2009, the MPE established eight research centres, with the aim of developing expertise and promoting innovation in targeted energy R&D areas. The centres will focus on long-term energy research in close co-operation with research communities and users/industry, but also with international players.

The centres were selected from competing applications in response to a call for proposals; on merits including relevance, scientific merit, and potential for innovation and value creation. A key selection criterion was the degree of user/industry involvement. RCN administered the review process, and the centres are creating multi-partner teams to focus on the following topics:

- carbon capture and storage;
- environmental design of renewable energy;
- bioenergy innovation;
- offshore wind energy;
- offshore wind technology;
- solar cell technology;
- underground CO_2 storage;
- zero-emission buildings.

The centres will receive annual funding of NOK 10 million to 20 million each (EUR 1.1 million and 2.3 million), initially for five years, before being evaluated for further grants. The funding model and level had been designed to encourage long-term but time-limited research to solve specific energy challenges. The centres are co-financed by the host research institution and its research partners (up to 25%), the user/industry partners (at least 25%) and the RCN (up to 50%). The total funding for the eight centres from the RCN is NOK 125 million (EUR 14.3 million) per year from 2009 to 2017. In 2010, a call for proposals for two centres was organised. These centres would focus on research on societal aspects of energy and have a total budget of NOK 20 million (EUR 2.3 million) to 2017.

SUPPORTING BODIES

Innovation Norway and Enova

Innovation Norway and Enova provide funding for projects that are close to market deployment. Innovation Norway covers all sectors, including energy, while Enova, the state agency for promoting energy efficiency and renewable energy deployment, operates a demonstration programme for renewable energy and energy efficiency. In 2009, Enova granted the demonstration programme NOK 90 million (EUR 10 million) and in the first half of 2010 NOK 137 million (EUR 16 million). Enova works closely with the RCN under the RENERGI programme.

RCN, Enova and Innovation Norway co-operate closely on promoting investments along the "innovation chain". Enova and Innovation Norway have different roles and also use different instruments. Enova focuses on launching investments in large-scale demonstration projects, while Innovation Norway will helps promote technology through international networking services, general entrepreneur advice services and aid for third-party technology verification before application for Enova aid. The results and activities in all of Enova's programmes were evaluated by MPE in 2010, including the Demonstration Programme. On the basis of this evaluation, MPE will integrate demonstration efforts closer to Enova's overall long-term targets.

Gassnova

The state enterprise Gassnova was established in 2007 to support technology development and deployment of complete CCS business solutions. It manages the State's CO_2 interests at the Technology Centre for Carbon Capture at Mongstad (TCM), the full-scale carbon capture from the Kårstø gas-fired power plant and large-scale transport and storage. It also advises MPE on CCS and collaborates with RCN on the CLIMIT programme.

Transnova

Transnova is a trial RD&D funding programme for limiting CO_2 emissions in the transport sector. Initially, the programme will run from 2009 to 2011, with a budget of NOK 50 million (EUR 5.7 million) for each year. Transnova is managed by the Norwegian Public Roads Administration.

Transnova's funds may complement funds from other governmental funding programmes, for instance from the RCN and Innovation Norway. Transnova's area of focus will be in between that of these programmes, concentrating on testing, standardising, pilot projects and demonstration projects. Hydrogen projects have been the largest recipients of Transnova funding, accounting for around 40% of the total. In 2009, Transnova also funded the establishment of charge points for electric vehicles. This separate programme had a NOK 50 million budget and yielded around 1 600 new charge points.

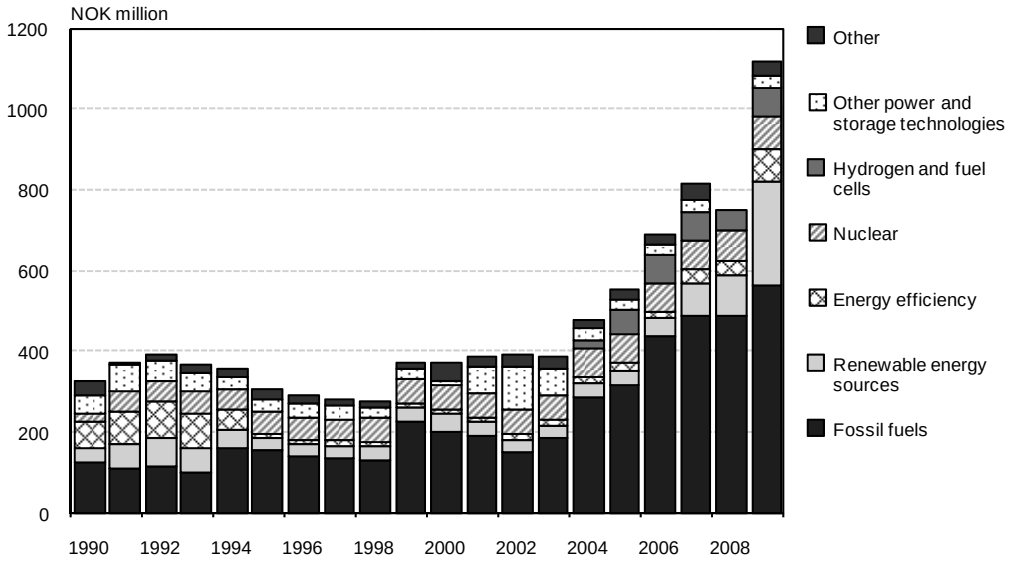
FUNDING

Since 2003, public spending on energy RD&D has dramatically increased, almost tripling to an estimated NOK 1.1 billion (EUR 126 million) in 2009 (see Figure 38). Following the

Parliament's 2008 Climate Agreement, funding was increased by more than a quarter from 2008 to 2009.

Half of the total in 2009 was spent in the fossil fuels sector, mainly oil and gas projects (around NOK 400 million, around EUR 46 million). Since 2006, however, government funding for petroleum R&D has remained between NOK 350 and 400 million, while funding on other energy technologies has increased fourfold to NOK 800 million (EUR 92 million). R&D funding has been increased particularly for CCS, but also for renewable energy and energy efficiency. Public R&D funding has been further increased for 2010, by around NOK 300 million (EUR 34 million) for renewable energy, energy efficiency and CCS, and by almost NOK 90 million (EUR 10 million) for the petroleum sector.

Figure 38. **Government RD&D spending on energy, 1990 to 2009***



* Estimates for 2009.

Sources: *OECD Economic Outlook*, OECD Paris, 2010 and country submission.

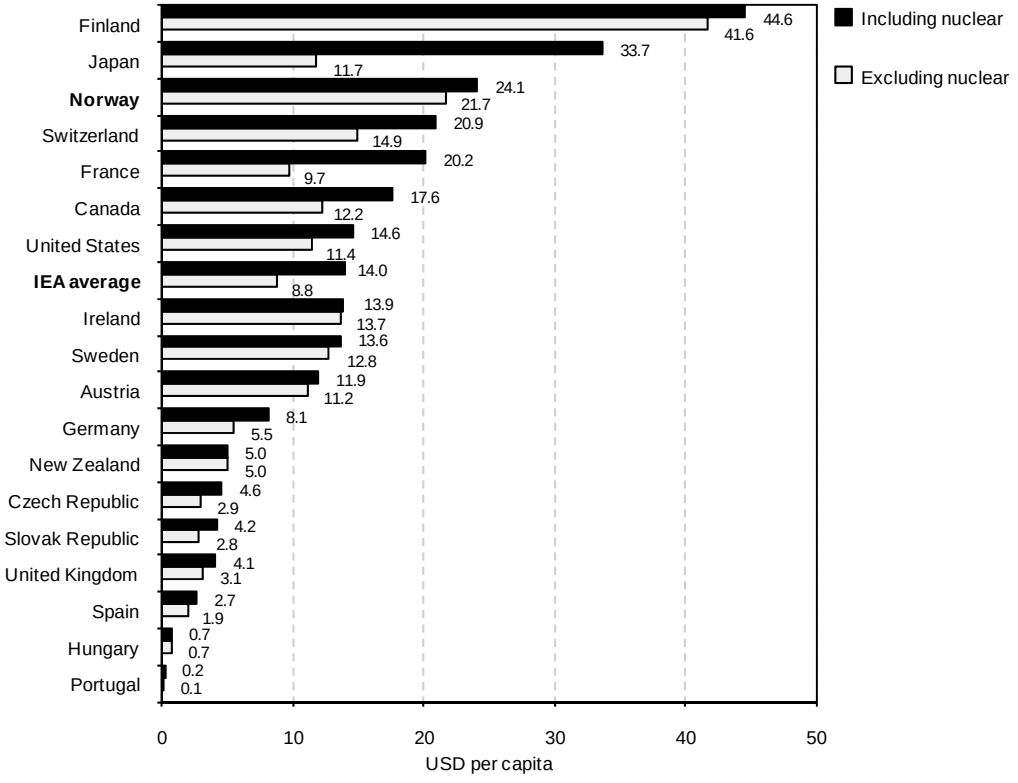
In 2009, public funding for carbon capture and storage projects amounted to NOK 170 million (EUR 19 million), or 15% of total RD&D.6 Funding on renewable energy and energy efficiency was more than doubled from 2008 levels. The renewable energy sector received 23% of the total funding, including 9% of the total for solar and 6% for wind energy projects. Energy efficiency received 7% of total RD&D funding, mainly for industry and buildings projects. The rest was spent on nuclear energy (7%, about half of which for the OECD Halden reactor project), hydrogen (6%), power storage (3%) and other sectors (3%).

The MPE is in dialogue with the RCN on the planned evaluation of MPE-funded R&D. This process will be co-ordinated with the planned evaluation of the RCN itself, scheduled to be completed by 2013.

6 This figure does not include the government's 75% share of the construction costs of the NOK 5.2 billion (EUR 600 million) Technology Centre Mongstad (see Chapter 6).

Compared to other developed countries, Norway is above the average in terms of RD&D funding per capita (Figure 39), thanks to the strong increase in funding in recent years. In 2008, the government spent USD 24.1 per capita (around NOK 150) on energy RD&D, the third-highest amount among 18 IEA member countries.

Figure 39. **Government RD&D spending per capita in IEA member countries, 2008**



Note: No data available for Australia, Belgium, Denmark, Greece, Italy, Korea, Luxembourg, the Netherlands, Poland and Turkey.

Sources: *OECD Economic Outlook,* OECD Paris, 2010 and country submissions.

INTERNATIONAL COLLABORATION

International collaboration is a cross-cutting policy goal for Norwegian research and energy research is closely tied to the international energy research community. Norway participates in multilateral co-operation with the IEA, the EU and the Nordic countries. It also has bilateral R&D agreements with several countries, such as the United States and Russia.

Norway participates in 23 of the IEA's 42 implementing agreements (IAs), including end-use technologies, renewable energy technologies and petroleum technology. Norway is a founding member of Nordic Energy Research, an institution under the Nordic Council of Ministers aiming to promote and extend regional co-operation in energy R&D on topics such as energy market integration, renewable energy and energy efficiency.

Through the European Economic Area (EEA) agreement, Norwegian research institutions and companies can participate fully in the EU's Seventh Framework Programme for research, technological development and demonstration activities (FP7) for 2007-2013.

Energy is one of the priority thematic areas and includes focus on renewable energy, hydrogen fuel cells, CCS and efficiency.

Within the FP7 framework, Norwegian companies participate in several energy-focused technology platforms, such as Biofuels, SmartGrids, Wind Energy, Photovoltaics and ZEP (zero-emission fossil fuel power plants). The European technology platforms bring together stakeholders in industry-led efforts to define medium- to long-term research and technological development. Covering the whole economic value chain, they aim to better align EU research priorities with industry's needs.

Under the EU Strategic Energy Technology (SET) plan, Norwegian research institutes are members of the European Energy Research Alliance (EERA), while Norwegian companies participate in several European Industrial Initiatives (EII) of the plan, particularly those on CCS, wind and electricity grids.

CRITIQUE

Over the past few years, Norway has strengthened its energy R&D efforts in an impressive manner. Government spending on energy RD&D has almost tripled since 2003. Following the Parliament's commitment − as part of its 2008 Climate Agreement − to increase energy RD&D funding by around NOK 600 million (EUR 69 million) from 2007 to 2010, funding for sectors other than petroleum, mainly for carbon capture and storage and non-fossil-based energy systems, has increased rapidly. Spending per capita is among the highest in the world. These very positive developments reflect a political commitment to respond to the new energy challenges.The IEA applauds Norway's decision to substantially increase funding for non-fossil fuel R&D and encourages the government to maintain this high level of funding and consider increasing it in the non-fossil fuels and CCS sectors.

Norway has two strategies for R&D in the energy sector. Since 2001, the OG21 strategy has brought together public- and private-sector stakeholders and the long timeframe of the strategy has helped research institutions to plan their work constructively. OG21 provides for stability of focus and funding, and industry and academics report to be satisfied with the model.

In another positive development, Norway adopted in 2008 the Energi 21 strategy for the non-petroleum sector. Early signs show that the strategy implementation is on a good path and the private sector is strongly involved, also helped by increased RD&D funding. As Energi 21 has a relatively broad scope, the government should consider making the strategy perhaps more action-oriented and possibly reducing the number of activities, when it revises the strategy in 2011. This would help give the strategy a stronger focus and have more impact. In general, the IEA encourages the government to evaluate, review and update the main strategies and programmes which are to reach their initial end-points in the coming two to three years.

Funding of demonstration projects and formulation of policies that support technology deployment are becoming increasingly important. Both Enova and Gassnova are active at this phase of technology deployment, which is an essential stage of testing and commercialising new techniques when the basic R&D work has already been completed. The government should continue to reinforce further the emphasis of technology demonstration and deployment, as it already started with programmes such as DEMO 2000, CLIMIT and Transnova.

The past years have seen an increase in new projects and also new institutions have been established (Gassnova, the Centres for Environment-Friendly Energy Research, or CEERs). The IEA applauds this increased activity, and at the same time encourages the government to examine whether there is any overlap between the increasing number of energy R&D strategies and programmes so as to ensure that synergies are realised and that actions between programmes and state entities are well co-ordinated. An area for potential synergies is the promotion of the commercial deployment of renewable technologies. Here, building on the 2010 evaluation of Enova's activities, the government should also evaluate the activities of Innovation Norway and the Research Council of Norway, and whether, together with Enova and the future green certificates system, they provide an adequate mix of instruments to promote the commercial deployment of renewable technologies.

International collaboration in R&D has continued to be a priority with respect to public energy and petroleum R&D – a laudable approach. Norwegian stakeholders are well represented in the IEA's implementing agreements and have been fairly active within the EU Seventh Framework Programme. The government should continue and strengthen international R&D co-operation both regionally in Nordic countries with similar climate and building standards, and multilaterally on technology-specific themes.

RECOMMENDATIONS

The government of Norway should:

- ☐ *Maintain the current level of RD&D spending and consider increasing it on non-fossil fuels and carbon capture and storage.*
- ☐ *Evaluate, review and update the main strategies and programmes which reach their initial end-points in the coming two to three years.*
- ☐ *Examine whether there is any overlap between the increasing number of energy R&D strategies and programmes so as to ensure that synergies are realised and that actions between programmes and state entities are well co-ordinated.*
- ☐ *Further reinforce the emphasis on technology demonstration and deployment, for example by evaluating potential synergies and gaps between the activities of Innovation Norway, the Research Council of Norway, Enova and the future green certificate system, and whether the mix of instruments is adequate to promote the commercial deployment of renewable technologies.*
- ☐ *Continue and strengthen international R&D co-operation both regionally in Nordic countries with similar climatic and building standards, and multilaterally on technology-specific themes.*

PART IV
ANNEXES

ANNEX A: ORGANISATION OF THE REVIEW

REVIEW CRITERIA

The *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 presented in Annex C.

REVIEW TEAM

The in-depth review team visited Norway from 3 to 7 May 2010. The team met with government officials, energy suppliers, interest groups and various other organisations. This report was drafted on the basis of these meetings, the government response to the IEA energy policy questionnaire and other information. The team members are grateful for the openness, co-operation and hospitality of the many people they met who greatly contributed to a successful and productive review. The team wishes to give particularly warm and sincere thanks to Ms. Eva Paaske, Deputy Director-General, for her professionalism and dedication displayed as the contact person for the whole review process. The team also wishes to warmly thank Ms. Helga Stenseth, Mr. Marius Knagenhjelm and Ms. Ellen Aamodt for their helpfulness and enthusiasm in guiding the visit. The team is also grateful to Ms. Elisabeth Berge, Secretary-General, for her hospitality and personal engagement in briefing the team on energy policy issues.

The members of the team were

IEA member countries

Dr. Chris LOCKE, Australia (team leader)

Mr. Eric LANDRY, Canada

Mr. Lubomír MAZOUCH, Czech Republic

Ms. Lynsey TINIOS, United Kingdom

Mr. Arjan WIERDA, Netherlands

IEA non-member country

Dr. Vladislav LEVANKOVSKIY, Russian Federation (special observer)

International Energy Agency

Mr. John CORBEN

Mr. François NGUYEN

Mr. Miika TOMMILA (desk officer)

Miika Tommila managed the review and drafted the report, with the exception of Chapter 6 on carbon capture and storage, which was prepared by Matthias Finkenrath. Several sections to individual chapters were provided by John Corben (RD&D), François Nguyen (electricity) and James Simpson (oil and gas). Georg Bussmann drafted statistics-related sections for most chapters. Many other IEA colleagues have provided helpful comments, including Robert Arnot, Ulrich Benterbusch, Adam Brown, Nina Campbell, Hugo Chandler, Anne-Sophie Corbeau, Anselm Eisentraut, Carlos Fernandez Alvarez, Paolo Frankl, Shinji Fujino, Rebecca Gaghen, Christina Hood, Emilie Jessula, Tom Kerr, Juho Lipponen, Samantha Ölz, Jungwook Park, María Sicilia, Aad van Bohemen and Dennis Volk.

Georg Bussmann and Bertrand Sadin prepared the figures. Karen Treanton and Alex Blackburn provided support on statistics. Muriel Custodio, Jane Barbière and Madeleine Barry managed the production process. Viviane Consoli provided editorial assistance. Marilyn Ferris helped in the final stages of preparation.

ORGANISATIONS VISITED

Bellona

Energy Norway

Enova

Federation of Norwegian Industries

Gassnova

Ministry of the Environment

Ministry of Foreign Affairs

Ministry of Petroleum and Energy

Ministry of Transport and Communications

Naturvernforbundet (Friends of the Earth Norway)

Nord Pool

Norsk Hydro

Norwegian Bioenergy Association (NoBio)

Norwegian Competition Authority (NCA)

Norwegian Oil Industry Association (OLF)

Norwegian Petroleum Directorate (NPD)

Norwegian Wind Power Association (NORWEA)

Research Council of Norway (RCN)

Norwegian Water Resources and Energy Directorate (NVE)

SINTEF

Småkraftforeningen (Association for small power producers)

Statkraft

Statnett

Statoil

WWF Norway

ANNEX B
ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY	1973	1990	2000	2006	2007	2008	2009E
TOTAL PRODUCTION	**8.06**	**119.07**	**226.96**	**216.00**	**215.65**	**219.66**	**220.37**
Coal	0.29	0.20	0.42	1.61	2.68	2.20	1.77
Peat	-	-	-	-	-	-	-
Oil	1.50	83.26	166.93	126.25	122.01	116.91	115.66
Gas	-	24.14	46.27	76.49	78.06	87.10	90.66
Comb. Renewables & Waste[1]	-	1.03	1.36	1.30	1.28	1.32	1.29
Nuclear	-	-	-	-	-	-	-
Hydro	6.27	10.42	11.95	10.26	11.49	12.00	10.86
Wind	-	-	0.00	0.06	0.08	0.08	0.08
Geothermal	-	-	-	-	-	-	-
Solar/Other[2]	-	0.02	0.02	0.04	0.04	0.05	0.05
TOTAL NET IMPORTS[3]		**-96.22**	**-200.73**	**-188.34**	**-188.97**	**-189.57**	**-194.86**
Coal Exports							
Imports							
Net Imports							
Oil Exports							
Imports							
Int'l Marine and Aviation Bunkers							
Net Imports							
Gas Exports							
Imports							
Net Imports							
Electricity Exports							
Imports							
Net Imports							
TOTAL STOCK CHANGES	**0.41**	**-1.84**	**-0.36**	**-0.57**	**0.77**	**-0.43**	**1.00**
TOTAL SUPPLY (TPES)[4]	**14.26**	**21.00**	**25.87**	**27.09**	**27.45**	**29.67**	**26.51**
Coal							
Peat							
Oil							
Gas							
Comb. Renewables & Waste[1]							
Nuclear							
Hydro							
Wind							
Geothermal							
Solar/Other[2]							
Electricity Trade[5]							
Shares (%)							
Coal	*6.4*	*4.1*	*4.2*	*2.6*	*2.7*	*2.6*	*2.1*
Peat	-	-	-	-	-	-	-
Oil	*52.8*	*38.4*	*34.6*	*39.1*	*35.6*	*39.6*	*33.6*
Gas	-	*9.4*	*16.0*	*14.8*	*17.7*	*16.4*	*20.7*
Comb. Renewables & Waste	-	*4.9*	*5.3*	*4.9*	*4.8*	*4.6*	*5.0*
Nuclear	-	-	-	-	-	-	-
Hydro	*43.9*	*49.6*	*46.2*	*37.9*	*41.9*	*40.5*	*41.0*
Wind	-	-	-	*0.2*	*0.3*	*0.3*	*0.3*
Geothermal	-	-	-	-	-	-	-
Solar/Other	-	*0.1*	*0.1*	*0.1*	*0.2*	*0.2*	*0.2*
Electricity Trade	*-3.1*	*-6.5*	*-6.3*	*0.3*	*-3.1*	*-4.0*	*-2.9*

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

2009E is estimated data.

Forecasts are not available.

Unit: Mtoe

DEMAND							
FINAL CONSUMPTION BY SECTOR	**1973**	**1990**	**2000**	**2006**	**2007**	**2008**	**2009E**
TFC	**13.36**	**17.44**	**19.80**	**20.38**	**20.87**	**20.90**	**..**
Coal	0.81	0.78	0.95	0.56	0.64	0.66	..
Peat	-	-	-	-	-	-	..
Oil	7.31	7.36	7.51	8.53	8.74	8.48	..
Gas	0.01	-	0.59	0.77	0.69	0.85	..
Comb. Renewables & Waste[1]	-	0.90	1.20	1.06	1.04	1.05	..
Geothermal	-	-	-	-	-	-	..
Solar/Other	-	-	-	-	-	-	..
Electricity	5.23	8.33	9.42	9.24	9.52	9.59	..
Heat	-	0.07	0.13	0.23	0.25	0.26	..
Shares (%)							
Coal	*6.1*	*4.4*	*4.8*	*2.8*	*3.1*	*3.2*	..
Peat	-	-	-	-	-	-	..
Oil	*54.7*	*42.2*	*37.9*	*41.8*	*41.9*	*40.6*	..
Gas	*0.1*	-	*3.0*	*3.8*	*3.3*	*4.1*	..
Comb. Renewables & Waste	-	*5.2*	*6.1*	*5.2*	*5.0*	*5.0*	..
Geothermal	-	-	-	-	-	-	..
Solar/Other	-	-	-	-	-	-	..
Electricity	*39.1*	*47.7*	*47.6*	*45.3*	*45.6*	*45.9*	..
Heat	-	*0.4*	*0.6*	*1.1*	*1.2*	*1.3*	..
TOTAL INDUSTRY[6]	**6.95**	**7.87**	**9.02**	**8.89**	**8.97**	**9.12**	**..**
Coal	0.76	0.77	0.95	0.56	0.64	0.66	..
Peat	-	-	-	-	-	-	..
Oil	2.99	2.77	2.43	2.89	2.99	2.89	..
Gas	0.00	-	0.59	0.73	0.62	0.77	..
Comb. Renewables & Waste[1]	-	0.38	0.60	0.40	0.43	0.43	..
Geothermal	-	-	-	-	-	-	..
Solar/Other	-	-	-	-	-	-	..
Electricity	3.20	3.94	4.44	4.29	4.27	4.34	..
Heat	-	0.02	0.02	0.03	0.03	0.03	..
Shares (%)							
Coal	*10.9*	*9.7*	*10.5*	*6.3*	*7.1*	*7.2*	..
Peat	-	-	-	-	-	-	..
Oil	*43.0*	*35.2*	*27.0*	*32.5*	*33.3*	*31.7*	..
Gas	-	-	*6.5*	*8.2*	*6.9*	*8.4*	..
Comb. Renewables & Waste	-	*4.9*	*6.6*	*4.5*	*4.8*	*4.7*	..
Geothermal	-	-	-	-	-	-	..
Solar/Other	-	-	-	-	-	-	..
Electricity	*46.0*	*50.1*	*49.2*	*48.2*	*47.6*	*47.6*	..
Heat	-	*0.2*	*0.2*	*0.3*	*0.3*	*0.3*	..
TRANSPORT[4]	**2.30**	**3.41**	**4.06**	**4.58**	**4.80**	**4.75**	**..**
TOTAL OTHER SECTORS[7]	**4.12**	**6.15**	**6.72**	**6.91**	**7.10**	**7.03**	**..**
Coal	0.06	0.01	0.00	0.00	-	-	..
Peat	-	-	-	-	-	-	..
Oil	2.07	1.24	1.07	1.13	1.04	0.96	..
Gas	0.01	-	0.00	0.03	0.04	0.04	..
Comb. Renewables & Waste[1]	-	0.52	0.60	0.66	0.61	0.62	..
Geothermal	-	-	-	-	-	-	..
Solar/Other	-	-	-	-	-	-	..
Electricity	1.98	4.33	4.93	4.89	5.19	5.19	..
Heat	-	0.06	0.11	0.20	0.22	0.24	..
Shares (%)							
Coal	*1.4*	*0.1*	-	-	-	-	..
Peat	-	-	-	-	-	-	..
Oil	*50.2*	*20.2*	*15.9*	*16.4*	*14.7*	*13.6*	..
Gas	*0.2*	-	-	*0.4*	*0.5*	*0.6*	..
Comb. Renewables & Waste	-	*8.4*	*9.0*	*9.5*	*8.5*	*8.7*	..
Geothermal	-	-	-	-	-	-	..
Solar/Other	-	-	-	-	-	-	..
Electricity	*48.2*	*70.4*	*73.4*	*70.7*	*73.2*	*73.7*	..
Heat	-	*0.9*	*1.6*	*2.9*	*3.1*	*3.3*	..

Unit: Mtoe

DEMAND							
ENERGY TRANSFORMATION AND LOSSES	**1973**	**1990**	**2000**	**2006**	**2007**	**2008**	**2009E**
ELECTRICITY GENERATION[8]							
INPUT (Mtoe)	**6.31**	**10.58**	**12.18**	**10.71**	**12.02**	**12.50**	**..**
OUTPUT (Mtoe)	**6.28**	**10.46**	**12.01**	**10.42**	**11.71**	**12.19**	**11.35**
(TWh gross)	73.03	121.61	139.61	121.21	136.11	141.70	131.96
Output Shares (%)							
Coal	-	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Peat	-	-	-	-	-	-	-
Oil	*0.2*	-	-	-	-	-	-
Gas	-	-	*0.2*	*0.4*	*0.6*	*0.3*	*3.2*
Comb. Renewables & Waste	-	*0.2*	*0.2*	*0.4*	*0.3*	*0.3*	*0.2*
Nuclear	-	-	-	-	-	-	-
Hydro	*99.8*	*99.6*	*99.5*	*98.5*	*98.2*	*98.5*	*95.7*
Wind	-	-	-	*0.5*	*0.7*	*0.6*	*0.7*
Geothermal	-	-	-	-	-	-	-
Solar/Other	-	*0.1*	-	-	-	-	*0.1*
TOTAL LOSSES	**0.86**	**3.72**	**4.95**	**5.51**	**5.67**	**5.91**	**..**
of which:							
Electricity and Heat Generation[9]	0.03	0.07	0.07	0.10	0.14	0.12	..
Other Transformation	0.09	-0.02	-0.02	-0.49	-0.49	-0.41	..
Own Use and Losses[10]	0.73	3.67	4.90	5.89	6.02	6.21	..
Statistical Differences	**0.05**	**-0.15**	**1.12**	**1.20**	**0.92**	**2.87**	**..**
INDICATORS	**1973**	**1990**	**2000**	**2006**	**2007**	**2008**	**2009E**
GDP (billion 2000 USD)	67.05	116.97	168.29	192.07	197.32	200.90	199.32
Population (millions)	3.96	4.24	4.49	4.66	4.71	4.77	4.79
TPES/GDP[11]	0.21	0.18	0.15	0.14	0.14	0.15	0.13
Energy Production/TPES	0.57	5.67	8.77	7.97	7.86	7.40	8.31
Per Capita TPES[12]	3.60	4.95	5.76	5.81	5.83	6.22	5.54
Oil Supply/GDP[11]	0.11	0.07	0.05	0.06	0.05	0.06	0.04
TFC/GDP[11]	0.20	0.15	0.12	0.11	0.11	0.10	..
Per Capita TFC[12]	3.37	4.11	4.41	4.37	4.43	4.38	..
Energy-related CO_2 Emissions (Mt CO_2)[13]	24.0	28.3	33.5	37.4	38.0	37.6	..
CO_2 Emissions from Bunkers (Mt CO_2)	2.8	2.6	3.6	2.8	3.2	2.6	..
GROWTH RATES (% per year)	**73-79**	**79-90**	**90-00**	**00-06**	**06-07**	**07-08**	**08-09**
TPES	4.1	1.3	2.1	0.8	1.3	8.1	-10.7
Coal	1.4	-1.3	2.2	-6.6	5.6	2.4	-27.2
Peat	-	-	-	-	-	-	-
Oil	2.4	-0.7	1.1	2.8	-7.9	20.3	-24.1
Gas	-	9.8	7.7	-0.5	21.0	-0.2	13.2
Comb. Renewables & Waste	-	5.6	2.8	-0.3	-1.1	2.9	-3.2
Nuclear	-	-	-	-	-	-	-
Hydro	3.3	2.9	1.4	-2.5	12.0	4.4	-9.5
Wind	-	-	-	62.4	40.0	2.6	6.3
Geothermal	-	-	-	-	-	-	-
Solar/Other	-	-	1.0	8.9	25.7	15.9	-
TFC	3.6	0.5	1.3	0.5	2.4	0.1	..
Electricity Consumption	3.6	2.3	1.2	-0.3	3.0	0.7	..
Energy Production	33.7	9.0	6.7	-0.8	-0.2	1.9	0.3
Net Oil Imports	..	..	..	..	..	..	..
GDP	4.5	2.7	3.7	2.2	2.7	1.8	-0.8
Growth in the TPES/GDP Ratio	-0.4	-1.3	-1.5	-1.5	-1.4	6.5	-10.1
Growth in the TFC/GDP Ratio	-0.9	-2.1	-2.3	-1.8	-	-1.9	..

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

Footnotes to energy balances and key statistical data

1. Combustible renewables and waste comprises solid biomass, liquid 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. In addition to coal, oil, gas and electricity, total net imports also include combustible renewables.
4. Excludes international marine bunkers and international aviation bunkers.
5. Total supply of electricity represents net trade. A negative number in the share of TPES indicates that exports are greater than imports.
6. Industry includes non-energy use.
7. Other Sectors includes residential, commercial, public services, agriculture, forestry, fishing and other non-specified sectors.
8. Inputs to electricity generation include inputs to electricity, CHP and heat plants. Output refers only to electricity generation. Electricity generation excludes pumped storage. Including pumped storage, gross electricity production in Norway was 132.8 TWh in 2009.
9. Losses arising in the production of electricity and heat at main activity producer utilities and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of 100% for hydro and wind.
10. Data on "losses" for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.
11. Toe per thousand US dollars at 2000 prices and exchange rates.
12. Toe per person.
13. "Energy-related CO2 emissions" have been estimated using the IPCC Tier I Sectoral Approach from the *Revised 1996 IPCC Guidelines*. In accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 2008 and applying this factor to forecast energy supply. Future coal emissions are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.

ANNEX C: INTERNATIONAL ENERGY AGENCY "SHARED GOALS"

The member countries* of the International Energy Agency (IEA) seek to create conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and to 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, member countries 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 are 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 respect the Polluter Pays Principle where practicable.

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

5. Improved energy efficiency can promote both environmental protection and energy security in a 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 encourages 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.)

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

ANNEX D: GLOSSARY AND LIST OF ABBREVIATIONS

In this report, abbreviations and acronyms are substituted for a number of terms used within the International Energy Agency. While these terms generally have been written out on first mention, 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
CCGT	combined-cycle gas turbine
CDM	clean development mechanism (under the Kyoto Protocol)
CCS	carbon capture and storage
CHP	combined production of heat and power
DSO	distribution system operator
EEA	European Economic Area
EIA	environmental impact assessment
EU	European Union
GDP	gross domestic product
GHG	greenhouse gas
GW	gigawatt, or 1 watt x 10^9
GWh	gigawatt-hour, or 1 gigawatt x 1 hour
IEA	International Energy Agency
kb	thousand barrels
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, or 1 kilowatt x 1 hour
kV	kilovolt, or 1 volt x 10^3
LNG	liquefied natural gas
LPG	liquefied petroleum gas

m	metre
m^2	square metre
mb/d	million barrels of oil per day
mcm	million cubic metres
MPE	Ministry of Petroleum and Energy
Mt	million tonnes
Mtoe	million tonnes of oil equivalent; see toe
MW	megawatt, or 1 watt x 10^6
MWh	megawatt-hour, or 1 megawatt x 1 hour
NCA	Norwegian Competition Authority
NCS	Norwegian Continental Shelf
NGL	natural gas liquids
NOx	nitrogen oxide
NOK	Norwegian crown = USD 0.159 or EUR 0.114 in 2009
NPD	Norwegian Petroleum Directorate
NVE	Norwegian Water Resources and Energy Directorate
PPP	purchasing power parity: the rate of currency conversion that equalises the purchasing power of different currencies, *i.e.* estimates the differences in price levels between different countries
RCN	Research Council of Norway
RD&D	research, development and demonstration
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, or 1 terawatt x 1 hour
UNFCCC	United Nations Framework Convention on Climate Change
VAT	value-added tax
VOC	volatile organic compound

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