# RENEWABLE ENERGY AND ENERGY EFFICIENCY

## Recent developments and activities in Norway

***- Policies and priorities -***
***- Production and consumption of energy -***
***- Industry capacity and technology development –***

**July 2007**


Illustration: Hydro/Solberg Production Photos: Elkem and NRK

**For the Research Council of Norway**
**by**
**KanEnergi AS**

# About the report

This report is an update of new developments in the field of renewable energy and energy efficiency in Norway in the period from spring 2006 – July 2007. Greenhouse gas emission issues are also included as they are often closely connected to the energy sector.

The report is focusing on new developments only; it is beyond its scope to give a full description of legislation, markets and projects in Norway. Background information considered necessary to explain changes have been included, but only to a very limited extent.

Fairly static information, like the Soria Moria declaration of the Government from 2005, information about administration of policy instruments, lists of public R&D and innovation programmes and of international cooperation initiatives where Norway take part, have been included in the attachments. However, new developments in these sectors are included in the main report.

The report was prepared by KanEnergi AS (www.kanenergi.no) on behalf of the Research council of Norway (www.forskningsradet.no ). The report will be submitted to the International Energy Agency, IEA (www.iea.org ).

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**Further information**

The Norwegian energy sector:
FACTS 2006, Energy water and resources in Norway (2007 edition expected shortly)
www.regjeringen.no/en/dep/oed.html?id=750

Production, consumption and imports:
Statistics Norway, Energy theme page - www.ssb.no/energi_en/

Policy developments:
The Ministry of Petroleum and Energy - www.regjeringen.no/en/dep/oed.html?id=750
The Ministry of the Environment - www.regjeringen.no/en/dep/md.html?id=668
The Ministry of Transport and Communication - www.regjeringen.no/en/dep/sd.html?id=791
The Government - www.regjeringen.no/en.html?id=4
Technology development news – www.tu.no (in Norwegian)

***Additional links to further information can be found under the relevant chapters in this report.***

# Summary of developments 2006 – July 2007

**The energy situation in Norway**
Higher electricity prices and shut downs in some large enterprises contributed to a drop in electricity consumption in 2006 compared to the previous years, while petroleum products to transport and heating increased.

**Policies and priorities**
Securing supply of energy at predictable prices and reducing emissions of greenhouse gases are the top priorities in the energy field and during the last year, the Government has launched new and ambitious goals for renewable energy, energy efficiency and emission reductions.

In order to achieve these goals, the legislation on the energy field is being revised. New directives to ensure increased energy efficiency in buildings have already been passed. A revised legislation for emission trading is expected to be implemented shortly.

The long proposed green certificate system was called off and instead the Government has suggested a system of feed-in tariffs for renewable electricity. The scheme, if accepted by the ESA, will be financed over the new "Basic Fund for renewable energy and energy efficiency", which will also finance increased efforts for heating and energy efficiency solutions.

In 2007, the Ministry of Petroleum and Energy appointed a committee to establish a broad strategy for the energy sector that brings together a wide-range of R&D goals and communities (Energi21).

**Renewable energy production**
The wind power capacity is steadily growing, generating about 0.85 TWh in 2006. Licenses have been awarded to further 10 projects, but the realization of some of these is uncertain. The wind industry claims that the proposed feed-in tariff is too low to secure profitability for many of the projects.

**Energy efficiency**
Energy consumption in households and manufacturing industries was reduced in 2006 compared to the previous years. In a survey from 2005, almost half of the households answered that they had taken one or several measures to reduce their electricity consumption because of the major rise in electricity prices during the winter 2002/2003.

The use of heat pumps is increasing very rapidly, at the end of 2006, a total of 240 000 heat pumps was installed; about 95 % of these have been installed during the last five years.

The public programs are achieving results; for 2006, Enova SF had contracts for energy savings of about 1.3 TWh, of which 0.9 TWh in industry and 0.4 TWh in the building sector.

**Industry capacity and technology development**

*It is beyond the scope of this report to describe all new developments and projects in this field. Some trends illustrate the broad spectrum of activities:*

Offshore wind power – different concepts for this technology are under development, examples are Sway and HyWind.

Photovoltaics – The Renewable Energy Group (REC) has become the world's largest PV company. Elkem Solar is planning production of silicon metal and the newcomer NorSun will start the production of monocrystalline silicon wafers in the beginning of 2008.

Biofuels for transport – New production plants for biodiesel based on rapeseed/soy oil have been established/are under development. In addition, several research projects concerning production of 2nd generation biodiesel (based on wood) have been initiated.

Ocean Energy Systems

- A full-scale version of a pilot tidal power turbine that has been delivering electricity to the grid from the bay of Kvalsundet since 2005 will be in operation in the UK in 2009. The project is run by Hammerfest strøm.

- Three different concepts for wave energy are under development in Norway. The Norwegian wave power developer Fobox has an installation "Buldra" in the outer parts of the Oslo fjord, built in the scale of 1:3, and the two other projects plan to launch their pilots in the autumn of 2007.

- Statkraft is world leading on the development of osmotic power. The biggest challenge is the development of membranes with sufficient performance and Statkraft hope to have achieved this by 2010-2015.

Heat pumps - The research organization IFE has just sold the first version of their hybrid heat pump to the Norwegian meat preparation industry.

Hydrogen – one of many ongoing hydrogen-related projects is HyNor, the hydrogen road, which aims to establish a sufficient number of filling stations to make it possible to drive hydrogen vehicles from Stavanger to Oslo by the end of 2009. The first hydrogen station was opened in Stavanger in August 2006, the second in Porsgrunn in June 2007.

## Snapshots from the previous year

### Wind power capacity steadily increasing

Opening of the Kjøllefjord wind power plant in October 2006. The plant has a capacity of 39.1 MW divided between 17 wind turbines. Annual electricity production will be about 150 GWh. Source: Statkraft

### The first hydrogen station

Opening of the hydrogen station in Stavanger August 2006. The second station was opened in Porsgrunn in June 2007. They are both a part of the HyNor project. Source: HyNor


### New hybrid heat pump technology

The research organization IFE has developed a hybrid heat pump. A prototype has been in stable operation since 2005. In June 2007, IFE delivered the first heat pump to the meat industry. Source: IFE, photo: Teknisk Ukeblad


### White paper on climate

The three-party Government launched a white paper on climate in June 2007. The white paper contains new goals for emission reductions, and several measures related to the energy sector.

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# 1 Background: the energy situation in Norway

**Resources, production and imports**
*Nature has provided Norway with abundant reserves of crude oil, natural gas, water and wind. The annual production of energy is approximately ten times the domestic use, and more than 99 % of the Norwegian electricity production is hydropower.*

Electricity generation in Norway in a normal year is calculated to be about 119 TWh. There are large variations in production from one year to another due to variations in precipitation.

During the last years, the energy consumption has exceeded the domestic electricity production, even in a normal year. In a year with average rainfall, Norway imports about 9 TWh electricity from other Nordic countries.

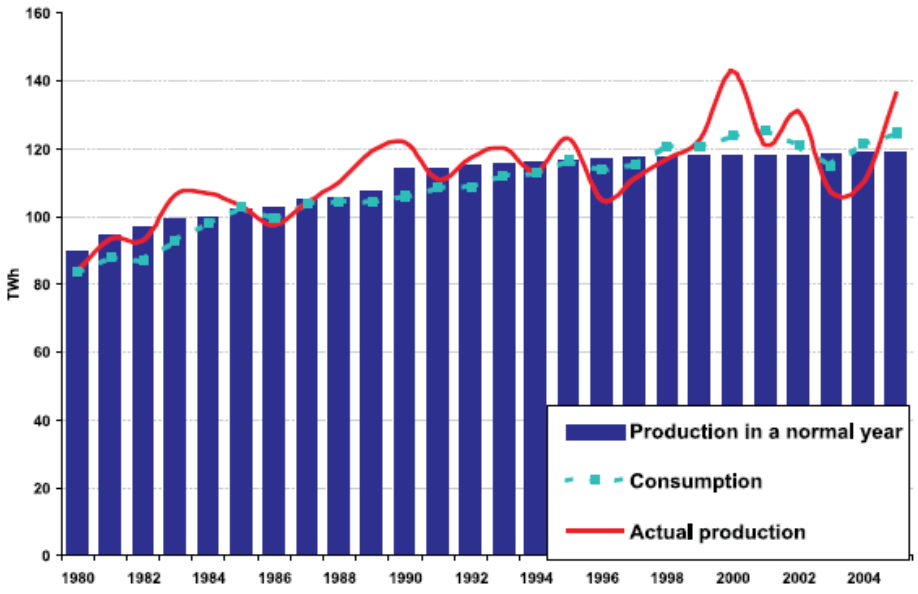


**Figure 1 Trends in hydropower output and consumption. Source: NVE**

The production of crude oil and natural gas amounts to approximately 90 % of the total production of primary energy carriers in Norway. The gross product from oil and gas production in 2005 amounted to around 22.5 % of the GDP in Norway. The total oil resources on the Norwegian continental shelf are calculated as 12.9 billion standard cubic meters of oil equivalent. 31 % of these resources have been used. Of the remaining 69 % almost one half is clarified for production.

**Energy consumption**

*Record high electricity prices and shut downs in some large enterprises contributed to a drop in electricity consumption in 2006 compared to the previous year, while petroleum products to transport and heating rose.*

The total energy consumption was almost unchanged from 2005, at around 222 TWh, which is 14.4 % more than in 1990. While the total energy consumption for heating, lighting, manufacturing etc. fell by 1 % from 2005, the energy consumption for transport rose by 3 %.

Around 50 % of the end consumption of energy is electricity.

The energy consumption of the households is on the same level as in the other Nordic countries, but due to the favourable price in the past, the share of electricity is higher.

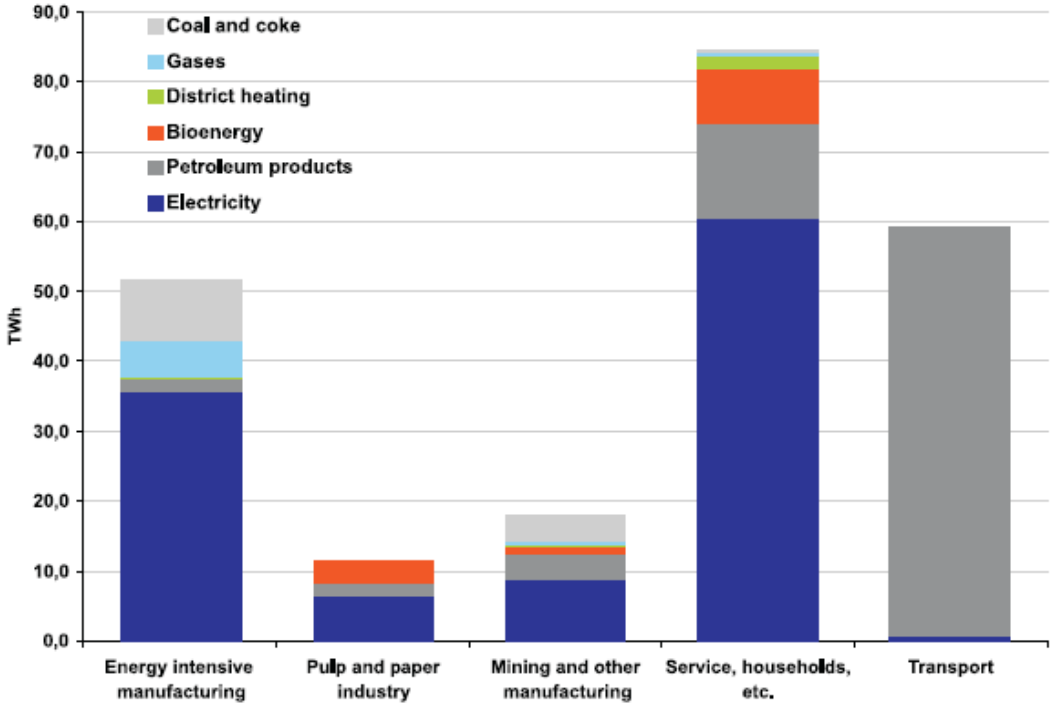


**Figure 2 Energy consumption by carrier and sectors in 2005. Source: Statistics Norway (SSB)**

The electricity intensive industry consists of about 50-55 big enterprises within metal and chemical production that make up about one third of the total electricity consumption in Norway. This corresponds almost to the households' total consumption of electricity.

Energy to transport purposes made up 27 % of the energy consumption in 2006. Transport consumption makes up more than a third of Norway's total $CO_2$ emissions.

**Norway's role in the international energy market**
Norway is a part of the internal energy market through the EEA Agreement and co-operates with the EU on several energy policy issues. Eighty % of Norwegian oil production is sold in the EEA market and almost all Norwegian gas production is delivered through five pipelines to continental Europe.

Norway is also an integral part of the Nordic and the EU/EEA electricity market. The common Nordic electricity market has a long record, and a Nordic power exchange (Nord Pool) was established in Oslo by the Norwegian and Swedish system operators. High voltage transmission and sub-sea cable connections have integrated the Norwegian electricity market with those of the Nordic countries.

# 2 Policies and priorities

## *2.1 Challenges*

In 2007, the two most important energy-related challenges in Norway are[1]:

- Energy security – To secure a stable energy supply with predictable prices
- Greenhouse gas emissions – To meet the Kyoto target on emissions of greenhouse gases

### 2.1.1 Energy security

*Traditionally, Norway has had an abundance of relatively cheap electricity from hydropower. Due to a higher increase in consumption than production of electricity, higher production costs for electricity and the introduction of carbon quotas, the average price of electricity has increased considerably in recent years.*

In 2006, the households paid 91.5 øre/kWh on average, which is 5 øre more than in 2003, the last time the electricity prices peaked.

Traditionally, the power-intensive enterprises have benefited from having long-term power contracts, but some of these contracts expired in 2006. All enterprises will have to pay market price for purchased electricity in 2011 at the latest. Many power-intensive companies already pay market price, with the consequence of large increases in their energy costs and possible shut-downs.

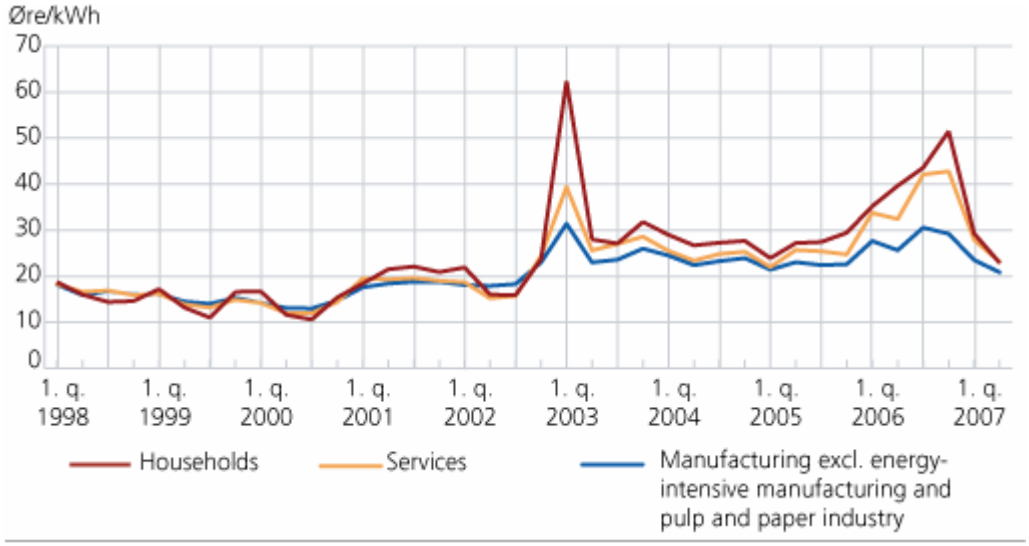


**Figure 3 Price of electric energy, taxes and grid rent excluded (øre/kWh). Source: Statistics Norway (SSB)**

[1] Ref Secretary of State, Dept of Petroleum and Energy

### 2.1.2 Greenhouse Gas Emissions

*The Kyoto-target for Norway during the first Kyoto-period (2008-2012) is a stabilization of the emissions at 1 % above the 1990-level.*

The Government recently proposed a new aim for emission reductions, corresponding to a 10 % improvement of the Kyoto-target (which means 9 % below the 1990-level). In the period 1990-2006, the emissions increased by approximately 8 %.

For the second successive year, greenhouse gas emissions fell in 2006. The 0.8 % decline is partly due to reduced oil production on the continental shelf and lower production and environmental measures in parts of the emission-intensive manufacturing industries.

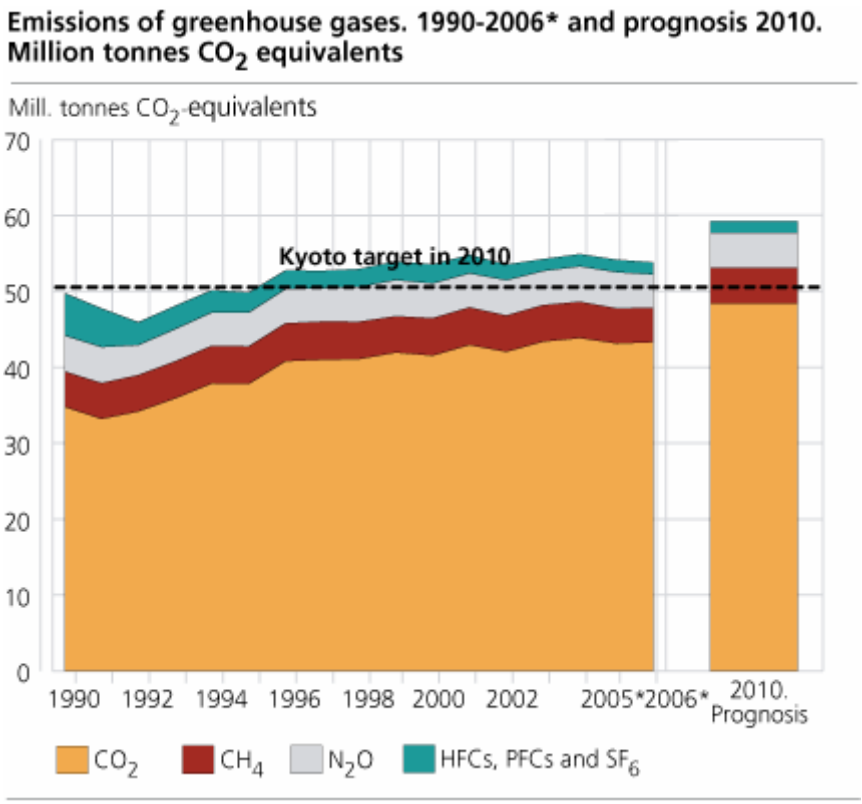


**Figure 4 Emissions of greenhouse gases 1990 – 2006 and prognosis 2010. Source: Statistics Norway and Norwegian Pollution Control Authority**

## 2.2 Aims and visions

*After the general election in September 2005, a new majority government representing the Labour Party, the Socialist Left Party and the Centre Party was formed. The basis for the new three-party Government is communicated through the so called "Soria-Moria declaration", which describes positions on future key political issues. For more details, please see Chapter 6.1.*

### 2.2.1 Energy

**Vision of the Government:**
Norway will become an environmentally friendly energy nation, and world leading within development of environmentally friendly energy.

**Aims:**
The Government launched its new energy aim in June 2006:
To achieve 30 TWh through new renewable production capacity and energy efficiency from 2001 to 2016. *(The previous aim, approved by the Parliament in 2000, was 12 TWh in 2010.)*

Minimum share of biofuels in the transport sector:
2 % by 2008
5 % by 2009
7 % by 2010

### 2.2.2 Climate

**Vision of the Government:**
Norway shall be a leading nation in environmental policy. Norway will follow up its commitments and reduce emissions nationally as well as internationally and will work for a more comprehensive and ambitious climate agreement to succeed the Kyoto Protocol.

**Aims:**
Originally, the Kyoto-target for Norway during the first Kyoto-period (2008-2012) was stabilization of the emissions at 1 % above the 1990-level. However, in its white paper on Climate of June 2007, the Government proposes that Norway should have the world's most ambitious climate targets:

- The country is to be carbon neutral by 2050, which means that all remaining emissions will be set off against emission reductions in other countries.

- We will improve on Norway's commitment under the Kyoto Protocol by 10 %, and plan to cut global emissions of greenhouse gases by the equivalent of 30 % of our 1990 emissions by 2020. These targets will be achieved both by substantially

reducing Norway's emissions and by paying for reductions in other countries. The whole of the extra 10 % will be accounted for by reductions outside Norway.

- The Government considers it realistic to reduce Norwegian emissions by 13-16 million tonnes $CO_2$ equivalents in relation to the reference scenario presented in the National Budget for 2007, when $CO_2$ uptake by forests is included. In this case between half and two-thirds of the cuts in our total emissions by 2020 would be made in Norway.

The proposal of setting off Norwegian emissions against emission reductions in other countries has started an extensive discussion around the ethics and actual reduction potential of emission trading.

## *2.3 Energy and Climate – Policies and Legislation*

*Energy policy, in the short and medium term, focuses on new renewable energy sources such as wind and bio, reduced energy consumption, a more flexible energy system, distributed power production and gas-fired power plants with reduced or no emissions.*

The policies and strategies are found under the headings energy supply, energy efficiency and climate. This only reflects the main objective of the policy; often the measures include the other fields as well.

### 2.3.1 Energy supply

**Revision of the Energy Act**

*The Norwegian electricity sector was deregulated and liberalized through the Energy Act of 1991. After the implementation of the Energy Act, the Norwegian electricity market was subsequently integrated with the Swedish, Finnish and Danish markets to become the Nordic electricity market: the first common, integrated, intercountry electric power market in the world.*

Following-up the Soria Moria-declaration, the Ministry of Petroleum and Energy will evaluate the legislation to see if the experiences and results are coherent with the aims of the energy policy.

The evaluation of the Energy Act will be based on four studies:

- The terms for new power production capacity;
- The use of the water reservoirs;
- The terms for developing the heating sector;
- Energy efficiency (end-user)

The studies are to be presented after the summer of 2007. Based on the results, the Ministry will consider possible changes to the Energy Act.

**EU Directive concerning Security of Electricity Supply**

*The objective of directive 2005/89/EC of the European Parliament and of the Council "concerning measures to safeguard security of electricity supply and infrastructure investment" (January 2006) is to ensure a well-functioning energy market, securing supply of electricity and sufficient investments in transmission lines to other countries.*

The directive focuses on the need for transmission capacity, measures on the consumption side and investments in production, especially concerning renewable energy and combined heat and power (CHP).

The directive was approved by the EEA committee – and thereby adopted by Norway – in June 2007.

**New feed-in system for renewable electricity production**

*In February 2006, after a relatively long planning process, the Government withdrew the proposal of introducing a Norwegian-Swedish green certificate market, the reason being that such a market would become too expensive for the Norwegian consumers and industry.*

In October 2006, the Government presented the criteria for a new support system for renewable electricity:

- Wind power producers will receive NOK 0.08 per kWh electricity produced (approx 0.009 Euros).
- Producers of electricity using immature technologies, and producers of electricity based on biomass will receive NOK 0.10 per kWh.
- Hydropower producers will receive NOK 0.04 per kWh for production representing the first 3 MW of the installed capacity. Owners of existing hydropower plants will also receive such support for upgrading the production capacity.

Support will be paid for 15 years. The support scheme will be financed through the new Basic Fund for renewable energy and energy efficiency (see below). The support scheme is dependent on approval from the EFTA Surveillance Authority (ESA)[2] before it can be implemented. The support system will be in effect from 1st of January 2008 at the earliest. http://www.regjeringen.no/upload/kilde/oed/prm/2006/0162/ddd/pdfv/299006-stort._m_11.pdf

[2] ESA ensures that Iceland, Liechtenstein and Norway respect their obligations under the EEA Agreement.

**The Basic Fund for Renewable Energy and Energy Efficiency**

In order to increase efforts in production and use of energy from renewable sources and energy efficiency, the Government has allocated NOK 10 billion (approx 2.3 billion Euros) in the 2007 State Budget and will suggest the allocation of another NOK 10 billion in 2009 to a new "Basic Fund for Renewable Energy and Energy Efficiency".

The annual yield from the Basic Fund is estimated at approx NOK 880 million (approx 100 million Euros) when fully financed.

About 1/3 of the total support will be allocated to production of renewable electricity (see above). The remaining 2/3 will be allocated to increased efforts in the areas of bio energy and district heating, energy saving and energy efficiency measures. Financing the production of renewable electricity under this support system will be subject to additional financing over the State Budget if necessary.

**The Hydrogen Strategy**

*In August 2005, the Norwegian authorities launched a new strategy in which all hydrogen related activities will be administered and financed on basis of a common platform. The activities include R&D, demonstration projects, development of safety standards, regulatory framework etc.*

A strategic council, representing personnel for R&D institutions, professional and industrial bodies etc., was appointed in December 2005. In January 2007, the council published the "Hydrogen Action Plan for 2007 – 2010". The action plan will form the basis for the work of the Hydrogen Platform.

www.hydrogenplattformen.no

**A new R&D strategy: Energi21**

*The Ministry of Petroleum and Energy has appointed a committee to establish a broad strategy for the energy sector that brings together a wide-range of R&D goals and communities.*

The objective of the strategy will be to provide a secure platform for the growth of sustainable economic activity and supply-side security in the energy sector by promoting and coordinating a commitment to research, development, demonstration and commercialisation of new technology.

Energi21 will encompass the entire chain of innovation with the exception of independent basic research – in other words, everything from strategic energy research to the introduction of new technology in the market. Relevant social science research will also be included.

Energi21 is open for all technology relevant to

- stationary energy production
- energy distribution (transport)
- energy use

The focus is on technology to be used in Norway with potential for international application.

The strategy document will be presented to the Norwegian Minister of Petroleum and Energy in February 2008.
www.energi21.no

**Bioenergy strategy**
The Government has decided to prepare a strategy for increased production and use of bioenergy. The first background studies will be ready November 2007.
www.dep.no/oed

### 2.3.2 Energy efficiency

**Energy efficiency in buildings**
*In 2004, the Parliament decided to implement the EU Energy Performance of Buildings Directive. The objective is to improve energy efficiency in private homes as well as commercial and public buildings.*

The implementation of the directive requires changes to the Norwegian Energy Act. A suggestion from the Norwegian Water Resources and Energy Directorate (NVE), which has been responsible for the preparatory work, was distributed in June 2007. The adaptations are expected to be implemented in 2008.

In connection with the adaptations, a new set of directives will be necessary. These will for instance define the system of classifying buildings by energy consumption. In addition, a new methodology for the estimation of energy efficiency in buildings will be prepared.

A new directive defining demands for energy efficiency in new buildings has been passed in the Parliament and is valid as of February 2007. In a transition period of 2 years, the old directive will also be valid. The new directive defines the maximum net energy consumption ($kWh/m^2$) for 13 different building categories. All new buildings will have to offer alternatives to electrical heating; however, buildings with very low heating demand are partly exempted.

http://www.buildingsplatform.org/cms/index.php?id=8
http://www.bygningsenergidirektivet.no/

### 2.3.3 Climate

**The Norwegian Greenhouse Gas Emission Trading Act**

*A Norwegian emission trading system entered into force January 1. 2005. The objective of the Act was to establish an introductory phase before the first Kyoto period of 2008-12, giving incentives to emission reductions end establishing necessary institutions and routines for emission trading.*

The system of allocation of emissions in specific sectors was only intended for the pre-phase and will no be changed. Norway has so far not adopted the EU Greenhouse Gas Emission Trading Directive, on which the trading scheme in the EU is based, but the Government has suggested that the Directive should be included in the EEA agreement. For Norway, this would mean that more sectors will be included in the emission trading scheme. In addition, Norway will have to submit national emission allocation plans to the EU.

The transport sector is not included in the EU Directive, and Norway will investigate possibilities for a separate system for this sector.

The new legislation passed the committees in the Parliament June 2007, and is soon to be officially adopted.

www.dep.no/md

**White Paper on Climate**

The Government presented a White Paper on Climate in June 2007. The White Paper contains climate action plans for the sectors with the largest GHG emissions.

For the energy sector, $CO_2$ taxation, GHG trading systems, technology development and increased recourses for the Basic Fund (see above) are suggested as measures.

The suggested measures include:

- Eliminating the use of heating oil in buildings;
- Increased production of bioenergy;
- Development and introduction of new technologies for renewable energy offshore.

www.regjeringen.no/nb/dep/md/dok/regpubl/stmeld/2006-2007/Stmeld-nr-34-2006-2007-.html?id=473411&epslanguage=NO

**The Norwegian Commission on Low Emissions**

*The Norwegian Commission on Low Emissions was appointed by the Norwegian government on March 11, 2005. The Commission was charged with the task of preparing*

*scenarios of how Norway can reduce its emissions of greenhouse gases by 50-80 percent by 2050.*

The Commission identified 15 measures to ensure the necessary reduction in Norwegian emissions in a long-term perspective. The measures are mainly directed at specific and major emissions sources, with the exception of two basic measures that the Commission sees as prerequisites for the realization of the other measures. The Commission's calculations show that the national costs need not be exorbitant, given that the measures are implemented when the need for renovation arises and as long as climate-friendly solutions are chosen systematically in new investments.

The Commission presented their final report to the Minister of the Environment on October 4th 2006. (NOU 2006:18: A climate-friendly Norway)

http://www.lavutslipp.no/english.shtml

**$CO_2$ Capture and Storage**

*Gas-fired power plants with carbon capture and storage is launched as a possible solution for a secure and sustainable energy system in Norway. The Norwegian Government has ambitious goals regarding capture, use and storage of $CO_2$.*

By developing efficient $CO_2$ capture and storage technologies security of energy supply could be increased and greenhouse gas emissions significantly reduced.

Gassnova, the Centre for Gas Power Technology, has been established to stimulate the development of technology for natural gas power generation with Carbon Capture and Storage (CCS).

www.gassnova.no

## 2.4 R&D and innovation programmes

The structures and priorities of R&D programmes and programmes supporting renewable energy production, increased energy efficiency and market introduction have stayed more or less unchanged during the last year. A brief overview can be found in Chapter 6.3.

**New developments:**

- The outcome of the strategy process "Energi21" will probably have great impact on Norwegian R&D policy in the years to come, see Chapter 2.3.1 for further details.

- The support scheme concerning investments in wind power projects will be continued until the new feed-in system (see Chapter 2.3.1) is established. Those

who have received the investment grant can transfer to the feed-in support scheme by returning the investment grant.

- Innovation Norway has defined "Energy and Environment" as one of five priority areas of their internationalization activities. The area includes renewable energy production, energy efficiency, hydrogen and fuel cells and $CO_2$ capture and is directed at SMEs.

## *2.5 Administration of policy instruments*

A brief presentation can be found in attachment 6.2.

**New developments:**

Extended responsibilities for Enova SF
*The activities of Enova are financed by the Energy Fund, which receives the revenues from a levy on the electricity distribution tariff (NOK 0.01 per kWh) and from state budget grants.*

In the 2007 State Budget, the Government has allocated NOK 10 billion (approx 2.3 billion Euros) to a new Basic Fund for Renewable Energy and Energy Efficiency, and will suggest the allocation of another NOK 10 billion in 2009. Enova SF will administer the new Fund.

Today, Enova manages over NOK 700 million per annum. Including this extra allocation, Enova will manage about NOK 1.6 billion (approx 180 million Euros) annually from 2010.

About 1/3 of the total support will be allocated to the new feed-in tariff system for the production of renewable electricity (see Chapter 2.3.1). The remaining 2/3 will be allocated to increased efforts in the areas of bio energy and district heating, energy saving and energy efficiency measures.

Possible new state owned enterprise "Transnova"?
The Government will investigate the possibility of establishing a new state owned enterprise that will be responsible for enhancing solutions for environmentally friendly transportation ("Transnova"). The task should include information and training, and could also give financial support to demonstration activities to all forms of transportation, testing of promising concepts and establishing of production and distribution of environmentally friendly fuels.

www.dep.no/sd

## 2.6 International R&D Cooperation

In the energy area, Norway collaborates primarily in the EU system, with the International Energy Agency (IEA) and at Nordic level.

For a list of other international cooperation initiatives, see Chapter 6.4 and
http://www.regjeringen.no/upload/kilde/oed/bro/2006/0004/ddd/pdfv/287581-kap.08.pdf

### 2.6.1 The EU

*Through the European Economic Area (EEA) agreement, Norway participates as a full member in the EU framework programs for research, technological development and demonstration.*

Norway was very active in the 6th Framework Programme (2002-06):

- One in 10 FP6 projects involved a Norwegian partner;
- Proposals involving Norway had a 28% success rate - significantly higher than the EU average of 18%.

Energy research (Sustainable Energy Systems) was among the prioritized areas in the Sixth Framework Program. Norway received about NOK 225 millions from the program. There were Norwegian participants in 50 projects, and in total 112 Norwegian actors participated in the energy program. Norwegian organizations have been the administrator of 5 projects. The Norwegian success rate in the energy field was 34 %, significantly more than the EU average success rate of 21 %.

There is a great interest for the 7th Framework Programme, and 1300 people participated at the Norwegian launch of the programme in November 2006. About € 225 billions is allocated for energy projects under the Seventh Framework Program.

http://cordis.europa.eu/norway/home_en.html
http://www.forskningsradet.no/english

### 2.6.2 The International Energy Agency (IEA)

*IEA has established a number of research programs on various energy-related topics through their technology collaboration programmes called Implementing Agreements (IA).*

As of July 2007, Norway was taking part in 23 Implementing Agreements in areas including end-use technologies, renewable energy technologies and cross-sectional activities. The Research Council of Norway and Enova SF coordinate the Norwegian activities.
www.iea.no

A new IA called Electricity Networks Analysis, Research & Development (ENARD) was established in July 2006. Norway has taken the lead to initiate one of the programme sub-tasks "Transmission System Issues".
http://www.iea-enard.org

Norway joined the IA "Ocean Energy Systems" in January 2007.
www.iea-oceans.org

www.iea.org

### 2.6.3 The Nordic Energy Research

*Nordic Energy Research is an institution under the Nordic Council of Ministers which aims to promote and extend regional cooperation in the field of energy research.*

The institution has concluded the activities of the former Nordic Energy Research Program (NEFP) spanning from 2003 to 2006, and has prepared a new strategy and action plan for the period 2007 to 2010. Its long-term objective is the development of expertise relevant to cost-effective reduction of energy use and the development of new renewable energy sources and environmentally-sound energy technology.

www.nordicenergy.net

### 2.6.4 Other initiatives

**Northern European Innovative Energy Research (N-INNER)** is a cooperation between the Nordic countries and Germany. The program runs from 2007 to 2010. 3 Norwegian projects (of 12 in total) have been included in the second round of the application process.

The objectives of N-INNER are:

- To produce new and innovative scientific knowledge for new, secure, clean and affordable energy systems;
- To create synergies between basic energy research communities in and between the Nordic countries and Germany;
- To increase mobility of young researchers and doctoral students;
- To strengthen the linkages between basic energy research and energy technology programmes in the Nordic countries and Germany; and
- To contribute to the quality and competitiveness of basic energy research in the Nordic countries and Germany.

# 3 Renewable Energy Production

## *3.1 Hydropower*

*Installed capacity in Norwegian hydropower plants is around 28 300 MW, and approximately 620 power plants have an installed capacity over 1 MW.*

At the end of 2005 the average annual production capacity was about 120 TWh.

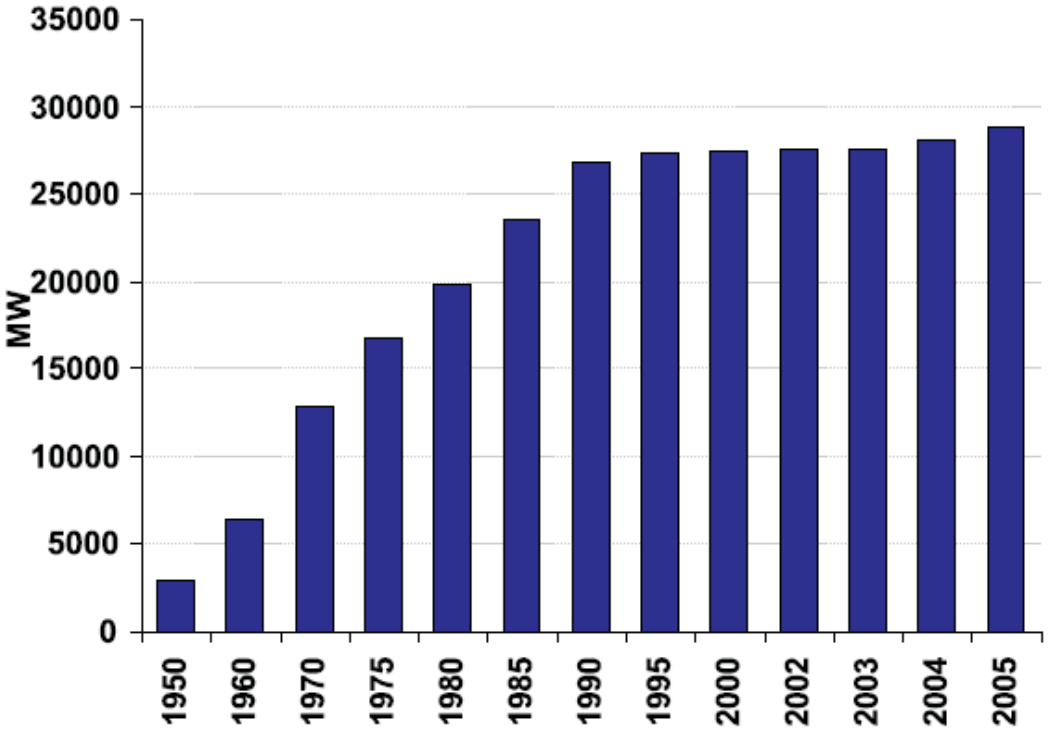


**Figure 5 Most hydropower plants were built before 1990. Source: NVE and SSB**

A potential of hydropower around 41.3 TWh/year is not protected and is available for development.

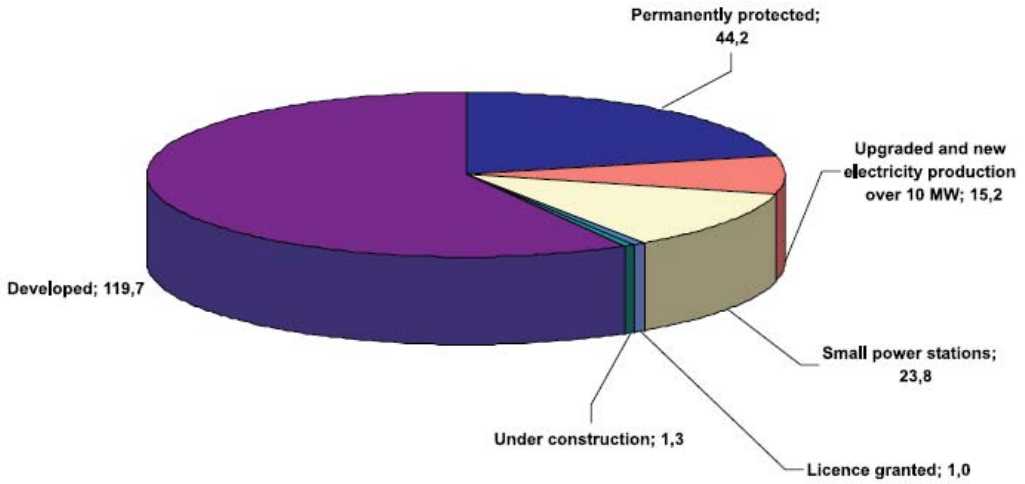


**Figure 6 Norway's hydropower potential January 2006, TWh/year**
**Source: Norwegian Water Resources and Energy Directorate**

*Small hydropower plants include power plants with installed capabilities of up to 10 MW. NVE has mapped the nationwide small hydropower station resources and found that the potential is around 25 TWh. It is stressed that this is a theoretical potential.*

Licences were issued for 34 small hydropower stations in 2005, with a total production of around 490 GWh per year. A resolution on licence exemption for 70 smaller power stations with a total production of around 200 GWh was also passed.

## *3.2 Wind Power*

At the beginning of 2006, 280 MW of wind power was installed in Norway, distributed across 138 turbines. This represents a production capacity of around 0.85 TWh. About 0.51 TWh was generated during 2005, which was almost a doubling from the previous year.

NVE has, in addition, awarded licenses to further 10 projects, with a total installed capacity of around 840 MW. If all these projects come to fruition, total production capacity will be just over 3 TWh/year. A total wind power production of 7-10 TWh is probable in 2020, according to NVE.

The realization of some of these projects was based on the expectations of a market for green certificates. The wind industry claims that the proposed feed-in tariff is too low to secure profitability for many of the projects.

## *3.3 Solar Energy*

In 2004, the total solar energy production in Norway was estimated to 10 GWh, of which half is produced from solar collector system and the other half from PV systems.

There are approximately 140 000 PV-installations in Norway, mainly in cabins not connected to the grid. In 2005, the total installed capacity was estimated to 7 MW. The corresponding annual energy production capacity would be in the order of 5 GWh.

## *3.4 Bioenergy*

The registered use of bioenergy was around 12.4 TWh in 2005. The industry accounted for around 4.4 TWh, the remaining 8 TWh is primarily used by households. Electricity from biomass accounts for about 170 GWh/year.

Processing of biofuel has increased in recent years. Biofuel in the form of pellets and briquettes is more suitable for storage, transport and use in automated incineration plants.

The interest for biofuels for transport has increased, especially after the new biofuel targets of the Government were launched (see section 2.2.1). New production plants for biodiesel based on rapeseed and soy oil are being established, and research projects on 2$^{nd}$ generation bio diesel (based on wood) have been initiated (Biofuels to Liquid – BTL).

### 3.4.1 District Heating

In 2005, the consumption of district heating was 2 350 GWh, 5.4 % higher than in 2004. The service industry consumed 70.4 % of the total, while households and manufacturing consumed 16.8 and 12.7 % respectively.

The net production of district heating in 2005 came to 2 562 GWh. Waste contributed to 40.7 % of the production, electric boilers 24.7 %, oil boilers 4.7 %, wood waste 15.1 %, heat pumps 6.0 %, waste heat 4.7 % and gas 4.2 %.

# 4 Energy Efficiency

## 4.1 Energy consumption trends

Record high electricity prices and shut downs in some large enterprises contributed to a drop in electricity consumption in 2006 compared to the previous year, while petroleum products to transport and heating increased. The total energy consumption was almost unchanged from 2005, at around 222 TWh.

However, consumption for different purposes changed. While the total energy consumption for heating, lighting, manufacturing etc. fell by 1 % from 2005, the energy consumption for transport rose by 3 %. This indicates that while Norway has achieved more efficient energy consumption for stationary purposes, it has been more difficult to limit the growth in consumption for transport.

## 4.2 Reduced consumption in the households

Since 2001, the electricity consumption per household has gradually declined. The consumption increased slightly from 2004 to 2005.

Higher electricity prices in Norway have contributed to higher investments in energy saving efforts such as heat pumps, heat recovery systems or temperature controlling systems etc. The electricity prices were record high in 2003, with 87 øre/kWh totally, and this gives a strong incentive to reduce the electricity consumption. The prices fell somewhat in 2004 and 2005, but peaked again in 2006 with 92 øre/kWh.

Almost half of the households in a survey from 2005 answered that they had taken one or several measures to reduce their electricity consumption because of the major rise in electricity prices during the winter 2002/2003. Of these, 60 % said that they had reduced the temperature, while 40 % switched to other energy sources. About a fifth had implemented changes in the house to reduce the electricity consumption, and a fifth had also carried out other unspecified efforts.

Other reasons for the decline in energy consumption per household are relatively warm winters in recent years, and increased construction of flats compared to detached houses.

## 4.3 Lower energy consumption in manufacturing industries

Higher electricity prices have been an incentive to limit electricity consumption for the manufacturing industries, by using more steam or installing heat recovery systems etc. In manufacturing industries, the electricity consumption fell by 4 % from the previous year. The largest decline was in electricity intensive industries, with a drop on 5 % from 2005, corresponding to about 1.8 TWh.

Traditionally, these enterprises have benefited from having long-term power contracts, but some of these contracts expired in 2006. This contributed to lower profit and shutdowns of some of the enterprises.

## 4.4 Increased use of heat pumps

While almost nobody had installed a heat pump in 2001, about 4 % of all households had a heat pump in 2004 (Source: SSB). In 2006, almost 80.000 heat pumps were sold in Norway, twice as much as the previous year. This gives a total of 240.000 heat pumps installed; about 95 % of these have been installed during the last five years (Source: Novap).

In particular, households with high energy consumption install heat pumps, because they gain more on this type of investments. About 84 % of households with heat pumps were either detached houses or farming houses, with a larger area and household size than the average in the sample.

By comparing detached houses of similar size with and without heat pump, it is obvious that households with heat pumps use less energy per square metre dwelling area than the others. However, in some cases the heat pump replaces other energy sources as fuel wood and oil, and accordingly, a higher percentage of the energy consumption will be based on electricity, because electricity is needed to run the heat pump. Among households with high income in large detached houses, the saving effect seems to be somewhat lower than for others. This may be due to the fact that they use the heat pump also for cooling the air in the summer (air-condition), something that contributes to higher electricity consumption.

www.novap.no

## 4.5 Results of public energy efficiency programmes

*The state owned company Enova SF administers the public energy efficiency programmes. Companies that receive support for energy efficiency measures have to sign a contract stating how much energy their project will save.*

For 2006, Enova SF had contracts for energy savings of about 1.3 TWh, of which 0.9 TWh in industry and 0.4 TWh in the building sector.

www.enova.no

## 4.6 Improved energy efficiency due to new regulations

A directive defining demands for energy efficiency in all new buildings was passed February 2007 (see Chapter 2.3.2). The energy savings during the first years is expected to be about 400 - 450 GWh, corresponding to the annual energy consumption of 20 000

households. After ten years, the annual savings is expected correspond to the average electricity imports in a normal year, or the energy production of an average gas power plant. Savings due to housing renovation will come in addition.

# 5 Industry capacity and technology development

## 5.1 Hydropower

Norway is the sixth largest hydropower generator in the world and the biggest in Europe. Norwegian companies have developed competence that covers all aspects of a hydropower project; from planning and design to delivery and installation of hydropower technical equipment.

As a result of decreasing demand in Norway, the Norwegian supplier industry is increasingly looking abroad. In addition to turbines and electromechanical products, the deliverables to other countries include consultant services within planning, projecting and other engineering tasks. There is also an increasing demand for Norwegian competence in system operation and preparation for a power market.

www.ebl.no

## 5.2 Wind power

Norway has a rapidly growing wind power industry. Norwegian companies exported wind power technology for 50 million € in 2004, employing about 350 people.

A presentation of several key companies can be found here:
http://www.renewableenergy.no/sitepageview.aspx?sitePageID=1107

**Example: Offshore wind power technologies**

*Norway has a large oil and gas sector with very advanced offshore expertise. During the last years, several promising concepts for offshore wind power have been developed.*

**Sway**

The SWAY concept is based on a floating elongated pole extending far below the water surface with ballast at the bottom part. Since the centre of gravity in this manner is placed far below the centre of buoyancy, the tower has sufficient stability to resist the large loads and weight from the wind turbine placed on top of the tower. The SWAY foundation is capable of supporting a 5 MW wind turbine in water depths from 80 m to more than 300 m in some of the world's roughest offshore locations.


**Figure 7 Illustration by Sway**

Building of full-scale pilots for testing will be central in the further process and the first pilot can be completed within 2010. Commercial deliveries could be ready in 2012.
www.sway.no

Norsk Hydro has developed a new concept for producing power at sea - Hywind. Floating concrete construction technology - developed for the North Sea oil industry - will be applied to offshore windmills. Hydro currently has a license to place a demonstration turbine offshore near Karmøy, an island in the southwest of Norway. The company is also considering the possibility of locating the wind turbine near an oil installation with the aim of supplying it with renewable energy. Siemens will deliver the first wind turbine for the demonstration unit.
www.hydro.com
www.hydro.com/en/our_business/oil_energy/renewable_energy/wind_power/hywind.html

## *5.3 Solar energy*

*Norwegian companies are developing technologies in the fields of both solar heating and photovoltaic systems. A list of developers, suppliers, researchers and consultants can be found on http://www.solenergi.no/linker.html*

**Example: a fast growing PV industry**
*Norway's long tradition in metallurgic industry is an important reason why a country with low insolation has become an important player in the global market for solar energy.*

**Renewable Energy Corporation** (REC)
REC is the world's largest producer of silicon materials for photovoltaic (PV) applications and multi- and monocrystalline wafers, as well as a significant producer of cells and modules. REC Wafer established a new 200 MWp-capacity plant in 2006. Ramp-up to full capacity is expected to be achieved during 2007. The market shares of daughter companies REC Silicon and REC Wafer are about 17 and 14 %. REC made its

initial public offering of common stock on the Oslo Stock Exchange in May 2006. The market capitalization of REC based on the offering price was approximately NOK 46.9 billion. By the end of July 2007 the stock value has raised to NOK 115 billions.
http://www.recgroup.com/

**NorSun**
NorSun was established in December 2005 by Scatec AS, a company that serves as the point of origin for new business ideas within renewable energy and advanced materials. NorSun has secured access to the key technology for the 'pulling of' monocrystalline silicon ingots and will set up a plant for production of monocrystalline silicon wafers in Årdal, Norway, in the beginning of 2008. In the first phase, the capacity will be about 130 MW, increasing to a production capacity of 400 MW by 2011.
http://www.norsuncorp.no/

**Elkem Solar**
Elkem Solar is developing an efficient metallurgical process for producing silicon metal which meets the solar cell industry's requirements. Shortages of silicon metal with the right quality currently represent a constraint on the expansion of this sector. A production plan with a capacity of about 5000 tonnes of silicon per year is under planning.
www.elkem.com/solar

In addition, a number of suppliers to the solar industry have been established, including suppliers of silicon carbide: **Orkla Exolon, St Gobain** and **Metallkraft AS**. The company **CruSiN AS** plans to develop a new concept for melting pots for the production of wafers.

## *5.4 Bioenergy*

A list of suppliers can be found on the home page of the Norwegian Biomass Association NoBio: http://www.nobio.no/index.php?option=com_bransje&Itemid=114

**Example: Increased interest in biofuels**
*In 2010, Norway will need at least 250 million litres of biofuels for the transport sector to fulfil the goals of the Government. Several companies are looking into production of biodiesel, both 1st and 2nd generation.*

A Roadmap for Biofuels in Norway has been prepared by a consortium of companies and was presented to the Minister of Transport and Communications in May 2007. A summary is available here:
http://www.pfi.no/Biodrivstoff/From%20biomass%20to%20biodfuels%20-%20summary.pdf

The company Uniol AS has started the construction of a production plant for biofuels. The biodiesel will be produced from rapeseed and soy oil, and the production capacity of the plant will be about 100 000 tonnes/year. The construction phase is expected to last 1.5 years and the first deliveries from the plant can be expected mid-2009.
www.uniol.no

BV Energi started production of biodiesel based on rapeseed oil in January 2007. The production plant has a capacity of 120 mill litres, and the company plans to double the capacity in 2008.
www.bvenergi.no

**2nd generation biodiesel**
*The production of biodiesel is currently based on rapeseed or other oil-based raw materials. Wood-based biodiesel production requires the development of new technology, but the result could mean an even better product than today's biodiesel and an enormous resource base.*

Among other projects, Hydro and Norske Skog have agreed to carry out a joint feasibility study relating to the production of biodiesel from wood. The intention is to identify the feasibility of establishing a bio diesel production facility in south-east Norway. Such a plant could come on stream by 2012 at the earliest.
www.norskeskog.com
www.hydro.com

## *5.5 Ocean Energy Technologies*

*Norway's long coastline represents an excellent opportunity for exploiting ocean energy and several new technologies are under development.*

### 5.5.1 Tidal Power

*In 2003, a proto type of a tidal power turbine was installed in the bay of Kvalsundet. The pilot turbine was the first underwater turbine to deliver electricity to the grid.*

The technology has lived up to the expectations, and Hammerfest Strøm UK has decided to develop a full-scale turbine to be installed in Scotland in 2009. This is considered an important first step towards commercialization of the technology.
http://www.tidevannsenergi.com/

Statkraft and Hydra Tidal Energy Technology are in the process of developing and testing a tidal power plant based on a floating, anchored steel structure which will generate electricity via four large turbines driven by marine currents. The turbines and generators will be placed under the water line and can be easily brought to the surface for maintenance. Because it is a floating power plant, there will be no large-scale permanent disturbance to the sea floor, and the project will have minor environmental impact. The

entire plant, complete with anchor, can be easily moved or removed. The first demonstration plant will be put into operation in 2007 or 2008.
http://www.statkraft.no/Images/Tidal%20power%2C%20versatile_tcm3-6030.pdf

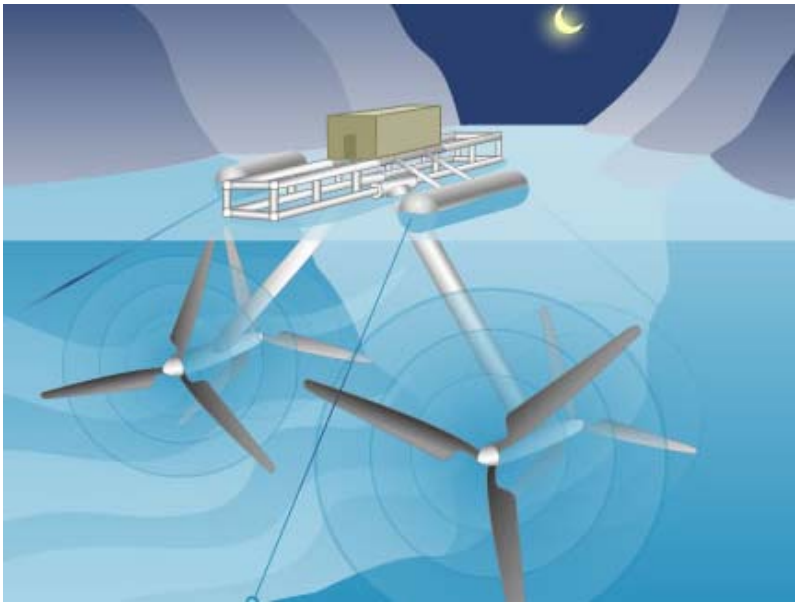

**Figure 8 Illustration by Statkraft**

### 5.5.2 Wave Energy

*A number of plants based on Norwegian technology and Norwegian companies are being planned and constructed.*

The Norwegian wave power developer Fobox (owned by Fred.Olsen) has a demonstration installation ("Buldra") in the outer parts of the Oslo fjord, built in the scale of 1:3. The wave-powered generator is integrated in a floating platform construction. Under the platform there are a series of plastic bridging boats that move with the waves. The bridging boats run a hydraulic system that again generates electric energy. The full-scale platforms will be 36 metres wide and 18 metres high. Installed output from the plant is planned to be 1.5 MW per platform.

Norwegian Pelagic Power bases their technology on a variant of the wave pump technology. Several pumps will be moored to the seabed, and floaters will run the pumps. The units will pump the sea water to a central turbine and generator that produces electric power. The plant will be built in a simple way and with economical materials, and the company will concentrate on low production costs rather than high efficiency. Pelagic Power will install a 1:3 pilot installation in 2007, and plans a full-scale installation in 2009.
www.pelagicpower.no/

**WAVEenergy AS** is planning a pilot wave energy installation on the small island Kvitsøy near Stavanger in the autumn of 2007. The company has developed a power plant that can utilize the energy in both small and large waves by building three reservoirs placed on top of each other, in which the potential energy of the incoming wave will be stored. The water captured in the reservoirs will then run through the multi-stage turbine. The multiple reservoirs will result in a high overall efficiency for the power plant.
www.waveenergy.no

### 5.5.3 Salt gradients

The Norwegian company Statkraft is world leading on the development of osmotic power. In collaboration with SINTEF, they have carried out an extensive research project, including the installation of small-scale salt power plants in the seashore at Sunndalsøra and in SINTEF's laboratories in Trondheim. Statkraft has expressed that they hope to achieve membranes with sufficient performance by around 2010-2015.
http://www.statkraft.no/Images/Osmotic%20power%2C%20a%20huge_tcm3-6032.pdf

## *5.6 Heat Pumps*

IFE and Hybrid Energy AS has developed a high temperature absorption-compression type heat pump. It is designed to upgrade industrial waste heat at temperatures between 20 and 60 °C to a temperature in the range of 75-100 °C. Standard components are used, and the Coefficient of Performance (COP) of the heat pump process can reach more than 3 depending on needed temperature lift. The relatively low investment cost combined with an efficient cycle makes the technology very fit for industrial processes, especially the food and drink industry. A prototype heat pump has been in stable operation since April 2005. In June 2007, Hybrid Energy AS delivered its first heat pump; a 650 kW hybrid heat pump to the Norwegian meat preparation industry.
http://www.hybridenergy.no/

## *5.7 Hydrogen*

An extensive number of hydrogen development projects are being conducted in Norway. A list of hydrogen-related projects can be found on www.hydrogenplattformen.no

**Example: The HyNor project**
*HyNor is a national development project which aims to establish sufficient filling stations to make it possible to drive hydrogen vehicles from Stavanger to Oslo by the end of 2009. Around 30 public and private partners take part in the HyNor project.*


**Figure 9 The hydrogen road. Illustration: HyNor**

Statoil opened the first hydrogen filling station in Stavanger in August 2006.
www.statoil.com

In June 2007, Hydro opened a second hydrogen station at Herøya (Porsgrunn). This station is the first ever to store hydrogen below the ground at 440 bars. This is done to increase safety at the station in densely populated areas, and to reduce the need for space.
www.hydro.com

In June 2006, the Scandinavian Hydrogen Highway Partnership (SHHP) was formed by the three hydrogen networking bodies of HyNor (Norway), Hydrogen Link (Denmark) and HyFuture (Sweden). The SHHP vision is to make the Scandinavian region one of the first regions in Europe where hydrogen is commercially available and used in a network of refuelling stations. SHHP is also collaborating with the BC Hydrogen Highway in Canada. This collaboration is advantageous because Canada is among the leading countries in the development of fuel cells and the use of hydrogen in vehicles.
www.scandinavianhydrogen.org

www.hynor.no

# 6 Attachments

## *6.1 The Soria Moria-declaration of 2005*

*After the general election in September 2005, a new majority government representing the Labour Party, the Socialist Left Party and the Centre Party was formed. The basis for the new three-party Government is communicated through the so called "Soria-Moria declaration", which describes positions on future key political issues.*

**Energy supply**
The Government's environmental goals will determine the energy production possibilities. Since the era for development of large hydro power projects is over, increased demand must be covered through new solutions.

The Government wants:

- To secure a more favourable electric power balance by increasing production capacity and reducing growth in demand by energy saving measures. Increased energy supply will be possible by focusing on new environmentally friendly energy sources, upgrading of hydro power installations and utilize natural gas in an environmentally sound way.
- To increase Norway's contribution on international cooperation on environmentally sound technology, energy system and emphasis on renewable energy.
- To provide for an efficient and safe power grid, with reduced losses and sufficient capacity for the whole country.
- A strong public ownership in the energy sector.

**Renewable energy**
Norwegian energy sector know-how must be used to develop new technology and solutions that lead to reduced emissions that cause climate change. Norway has a large potential for utilizing renewable energy sources like wind, biomass, solar, wave and tidal currents. Through emphasis on efficiency measures and renewable energy sources, Norway can achieve a varied and environmentally sound energy system.

The Government wants to:

- Increase targets / goals for energy saving and renewable energy production
- Renovate / modernize existing hydro power installations and increase construction of micro-, mini- and small hydro power plants.
- Introduce a green certificate market for renewable power production. If realization of such a market fails, other measures will be considered.
- Introduce environmentally friendly technologies that are not yet mature
- Increase environmentally sound wind power development, and through the concession system secure a regional and national coordination such development.
- Increase the governmental contribution to development and commercialization of hydrogen as an energy carrier.

- See to that renewable energy does not lose in competition with power production based on natural gas with $CO_2$ removal.
- Introduce a braking deposit scheme on oil furnaces that are replaced with equipment utilizing renewable energy sources.

**Waterborne heating systems and energy efficiency**
The Government wants to reduce dependence on electrical resistance heating, and instead increase the use of other heating alternatives. The largest barrier for such change is lack of infrastructure for heat distribution. Consequently, it is of major importance to establish district heating systems in densely built-up areas and waterborne distribution systems in buildings.

The Government wants to:

- Arrange for increased use of waterborne heating, and establish favourable financing mechanisms for district heating and projects based on biomass as source of energy.
- Require energy flexible systems in all new and rehabilitated public buildings of 500 sqm or more.
- Introduce a long term contribution scheme stimulating households to select energy efficient heating solutions or systems that utilize renewable sources of energy.
- Support construction of district heating infrastructure.
- Implement the EU building energy directive in 2006, and also prepare new building codes that will turn low energy houses into a standard. New energy standards for existing buildings and renovation of buildings will be introduced accordingly.

**Domestic use of natural gas**
The Governments target is that Norway shall become world leading in environmentally sound utilization of natural gas. Gas based power generation must not come in conflict with Norway's Kyoto commitments, but rather take part in the international trading system for climate gas quotas. Through financial support and emphasis on technology development, $CO_2$ from new power plants will be removed and either deposited in geological structures or used for enhanced oil and gas recovery.

The Governments wants to:

- Establish a Government owned company that contributes with financing of infrastructure for transportation of natural gas, and in cooperation with private companies, provide for $CO_2$ capture and transportation.
- Establish a Government owned company responsible for development of a value chain for transportation and injection of $CO_2$.
- Increase research and development on environmentally sound gas based power production.
- Increase capacity for small scale LNG terminals, and stimulate conversion from heavy oils to natural gas in the industry, shipping and transport sectors.

- Review the tax system on $CO_2$ in order to avoid situations where natural gas displaces more environmentally safer alternatives.

## 6.2 Administration of Policy Instruments

The most important public or Government owned institutions being responsible for the administration of policy instruments within renewable energy and energy efficiency are:

**The Ministry of Petroleum and Energy**
The principal responsibility of the Ministry of Petroleum and Energy is to achieve a coordinated and integrated energy policy. A primary objective is to ensure high value creation through efficient and environment-friendly management of Norway's energy resources.
http://www.oed.no

**The Ministry of the Environment**
The Ministry of the Environment has a particular responsibility for carrying out the environmental policies of the Government.
http://www.md.dep.no

**The Norwegian Research Council**
The Research Council plays a vital role in developing and implementing the country's national research strategy, acting as a government adviser, a funding agency and coordinator of research activities. The Research Council is responsible for the administration of most of the public funding available for R&D in the field of energy and water resource management.
www.forskningsradet.no

**Innovation Norway**
Innovation Norway promotes nationwide industrial development profitable to both the corporate economy and Norway's national economy, and helps release the potential of different districts and regions by contributing towards innovation, internationalisation and promotion. Innovation Norway has offices in all the Norwegian counties and in more than 30 countries world wide. The core group of clients are Norwegian companies, predominantly SMEs (small and medium sized enterprises). Energy projects based on biomass (fuel wood, and heat production), especially in rural areas tied to agriculture, are given priority.
www.invanor.no

**The Norwegian Water Resources and Energy Directorate (NVE)**
The Norwegian Water Resources and Energy Directorate (NVE) is a directorate under the Ministry of Petroleum and Energy, with responsibility for managing the country's water and non-fossil energy resources and for monitoring the energy market. NVE's mandate is to ensure integrated and environmentally sound management of the country's watercourses, to promote efficient energy markets and cost-effective energy systems and to work to achieve a more efficient use of energy. NVE also has the overall responsibility

for maintaining national power supplies. NVE is involved in R&D and international development co-operation.
www.nve.no

**Enova SF**
Enova SF is a public enterprise owned by the Norwegian Ministry of Petroleum and Energy. The main mission is to contribute to environmentally sound and rational use and production of energy, relying on financial instruments and incentives to stimulate market actors and mechanisms to achieve national energy policy goals. Through the suggested Basic Fund and the new support scheme for electricity production from renewable sources, Enova will broaden its responsibilities.
www.enova.no

**Gassnova SF**
Gassnova is the state centre for sustainable gas technologies. The purpose of the centre is to promote innovative, sustainable and cost effective gas technologies. Gassnova was put into operation on 1. January 2005. Gassnova is a public agency reporting to the Norwegian Ministry of Petroleum and Energy.
www.gassnova.no

**Statnett SF**
Statnett is responsible for co-ordinating supply and demand in the power system. Being a transmission system operator (TSO), Statnett owns and operates large sections of the main Norwegian power grid and the Norwegian section of power lines and sub-sea cables to other countries.
www.statnett.no

**The Norwegian State Housing Bank**
The Housing Bank is the main instrument of the Norwegian Parliament, the Norwegian government and the Ministry of Local Government and Regional Development for the implementation of national housing policy. Additional loans at a modest interest rate may be granted for installations and efforts to reduce use of energy or use of flexible heating systems.
www.husbanken.no.
Separate web-page on low energy housing: www.lavenergihus.no

## *6.3 R&D, Innovation and Market Introduction Programmes*

### 6.3.1 Energy-Related R&D

*The energy-related public R&D programmes are mainly administered by the Norwegian Research Council.*

R&D programmes for fossil-fuel technologies are not included in this report.

**The Clean Energy System of the Future (RENERGI)**

RENERGI focuses on energy production and transmission, and to stationary and mobile energy use.

In 2006, the RENERGI-program focused on renewable energy sources. Further selection criteria were:

- Increased share of user driven research
- International networks within prioritized sectors
- Material research across prioritized sectors

The share of user driven projects increased from 20 % in 2005 to 44 % in 2006.
In 2006, RENERGI spent NOK 144 millions on research projects.

http://www.forskningsradet.no/servlet/Satellite?cid=1088801905079&pagename=renergi%2FPage%2FHovedSideEng

**Nanotechnology and Materials Technology**
Initiative within nanotechnology and materials technology (NANOMAT), with several projects related to photovoltaic. The program has set two major priorities:

- To develop new materials, with the focus on functional materials
- To focus on selected parts of nanotechnology

The programme runs 2002-2016.
http://www.forskningsradet.no/servlet/Satellite?cid=1088796688084&pagename=nanomat%2FPage%2FHovedSideEng

**Gas power technologies with $CO_2$ capture and storage (CCS)**
CLIMIT is the Norwegian national programme for gas power technologies with $CO_2$ capture and storage (CCS). Gassnova and the Norwegian Research Council are administering the programme on behalf of the Norwegian state.
http://www.climit.no/sw678.asp

**Strategic programs at research institutions**. The Research Council supports a number of strategic research programs at universities and research institutions. Programs should focus on topics of fundamental importance related to the production and use of energy.

**Applied research on energy and water resource management** is administered by NVE. These activities are a supplement to, and are coordinated with, the activities of the Research Council.

### 6.3.2 Innovation and Market Introduction Programmes

The public innovation programmes and support schemes are managed by Enova SF and Innovation Norway (see Chapter 6.2 for more information about the entities)

This Chapter only gives a very brief overview of ongoing public programs, focusing on new developments in 2006/07. For more details, see www.enova.no and www.invanor.no

## Renewable Energy Production

**Wind production investment grant** – ***transition scheme***
Since 2004, projects involving the actual construction of wind power plants may receive a grant of up to 25 % of project costs.

The support scheme will be continued until the new feed-in system (see Chapter 2.3.1) is established. Those who have received the investment grant can transfer to the feed-in support scheme by returning the investment grant.

**Heat – processing of biomass**.
The program is aimed at the entire chain, from harvesting and transportation to processing and trade with bio fuels.

**Heat**
The Heat program grants investment support to heat production plants and infrastructure for waterborne heating with annual capacities of 0.5 GWh or more.

**Bioenergy**
The aims of the program are increased commercial development in the agricultural sector and increased use of renewable energy. Biomass based heat production plants established by farmers or forest owners can receive investment grants up to 30 %.
http://www1-invanor.no1.asap-asp.net/templates/Page_Meta.aspx?id=49889

## Energy Efficiency

**Energy consumption – buildings**
The program objective is to reduce energy consumption in private homes as well as private and public commercial buildings.

**Energy consumption - industry**
The program supports initiatives for more energy effective processes, heat recovery, conversion to renewable energy sources etc.

**Energy management - SME Energy Networks**
The program target group is SMEs with annual energy consumption over 0.5 GWh.

**Intelligent Energy Europe (EIE) – participation grants**
The program motivates Norwegian participation in the programs included in EIE.

**Market introduction of new energy technologies**

**Introduction of new energy technologies**
The program aims at promoting new energy technologies that have only been tested in laboratories or small-scale pilots or does not exist in today's market, or technologies for which adaptations are necessary to function under Norwegian conditions.

**Pilot program - innovative energy technologies**
In order to support new and innovative energy technologies, Enova SF, the Research Council of Norway and Innovation Norway have jointly established a program for technology introduction. Projects with a high degree of innovation (although not R&D), good potential for business development and that are market based will be prioritized.

**Internationalization**
Innovation Norway has defined "Energy and Environment" as one of five priority areas in their internationalization activities. The area includes renewable energy production, energy efficiency, hydrogen and fuel cells and $CO_2$ capture and is directed at SMEs.

Innovation Norway offers assistance in network building, marketing and market analysis.
http://www1-invanor.no1.asap-asp.net/Internasjonale-markeder/Kontorer-i-utlandet/Tyskland/In-English/Main-Initiatives/Energy-and-Environment/

**Other Programmes**

**Municipal energy and environment planning**
The program grants support to the preparation of energy and environment plans in municipalities.

**Information**
In addition to the programs, Enova SF prepares and disseminates information material concerning renewable energy.

## *6.4 International cooperation initiatives*

See Chapter 2.4 for information about EU, IEA and Nordic Energy Research

**The Economic Commission for Europe (ECE)** is one of the UN's five regional commissions. Norway is one of the members of its Committee for Sustainable Energy. The committee functions as a meeting place for 55 countries, among them the USA, Canada and European countries. It has working groups for energy efficiency, gas and coal.

**The Baltic Sea Region Energy Cooperation (BASREC)**. This is organized as part of the cooperation under the Council of the Baltic Sea States (CBSS). Eleven countries and

the EU Commission are involved. BASREC has established ad hoc groups in the areas of climate change, energy efficiency, gas markets and electricity markets. In 2002, it was decided to make the region a testing ground for Joint Implementation projects for reducing greenhouse gas emissions in the energy sector.

**International Partnership for a Hydrogen Economy – IPHE** is a partnership with representatives from government authorities, R&D institutions and industry. A total of 14 countries and the European Commission take part in this partnership with the aim to coordinate, organize and establish international R&D and demonstration within the fields of hydrogen and fuel cells.

**Carbon Sequestration Leadership Forum – CSLF**. Norway together with 13 other countries and the European Commission were invited by the US Government to take part in this forum with the aim to reduce the greenhouse gas emissions. CSLF was established in June 2003, and will work for the development of technologies to manage $CO_2$ from production as well as systems that will facilitate the sequestration of $CO_2$.

**The Norwegian-Russian energy forum** includes a working group on energy. This group is, among other things, following up projects in Russia that are financed through the Central and Eastern European Action Program, mainly training programs and programs on bio energy.

**Bilateral R&D agreement between Norway and Japan** was signed in May 2003. This is a general R&D agreement which also includes energy and environment.

**Bilateral R&D agreement between Norway and the US** will cover fossil fuels including $CO_2$ management and hydrogen as well as energy efficiency and renewables.