NORWAY

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1.0 Introduction

In 2006, installed wind-power capacity in Norway increased from 270 MW to 325 MW (Figure 1). In Norway, interest in wind power as a commercial source of electricity is high. By the end of 2006, there were project plans for over 15,000 MW in Norway. However, financing and public acceptance remain substantial hurdles to overcome for the installation of wind turbines. Although the price for long-term future electricity has risen during past years, it is still not a strong enough incentive to spur new investments in wind energy.

2.0 Progress toward national objectives

2.1 Strategy

Norway's national goal for renewable energy production and energy savings in 2010 is 12 TWh above the 2001 level. At least 3 TWh of this production will be achieved from wind power and 4 TWh from water-based central heating systems. For the longer term (2016), the government has established a target of 30 TWh above the 2001 level of production from renewable energy sources and energy efficiency. To help achieve this goal, the Energy Fund, administered by the state-owned agency Enova, gives grants to energy saving and renewable energy production projects. Financed by a levy on the transmission tariff, the Energy Fund contained approximately 88 million € in 2006.

To strengthen efforts to increase the production and use of renewable energy and to improve energy efficiency, the Norwegian government in October 2006 proposed allocating 20 billion NOK (approximately 2.3 billion €) to a new fund. The first 10 billion NOK are proposed to be allocated to the state budget for 2007 presented to the Storting on 6 October 2006. Another 10 billion NOK will be proposed to be allocated to this Basic Fund in the 2009 state budget.

When the Energy Fund reaches its full size of 20 billion NOK, the yield from the new Basic Fund is estimated to be about 880 million NOK (approximately 100 million €) annually. This amount will more than double today's level of support, amounting to approximately 700 million NOK, which is financed by an earmarked levy on the distribution tariff. The state-owned agency Enova will administer the yield from the Basic Fund.

In 2006, renewable sources of electricity contributed 98.9% of national electrical demand. About 0.55% of the renewable supply comes from wind power. Since electricity production in Norway mainly comes from hydropower, the share of renewable energy varies considerably from one year to the next. It turns out that 2006 was a normal year with average hydropower production.

For 2010, the target set by the government for the renewable share of electricity consumption is 90%. According to a government statement, this target corresponds with approximately 6 to 7 TWh new production capacity of electricity from renewable energy sources being introduced from 1997 to 2010.

Table 1 Key Statistics 2006: Norway

Total installed wind generation	325 MW
New wind generation installed	57 MW
Total electrical output from wind	0.671 TWh
Wind generation as % of national electric demand	0.55 %
Target in 2010	3 TWh

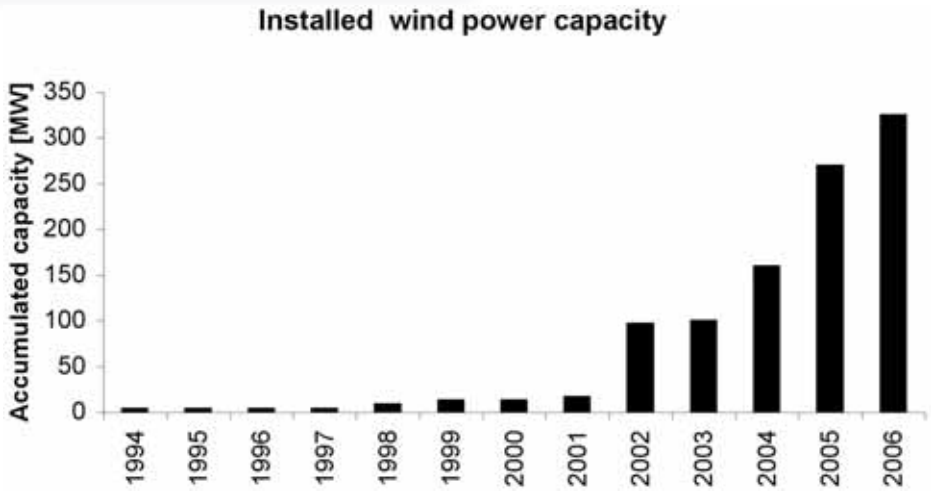

Figure 1 Installed wind power capacity in Norway.

2.2 Progress toward the wind target

Interest in wind power is high, and several projects have been submitted for approval. More than 1,200 MW has received approval. This indicates that the 3-TWh target can be reached by 2010, assuming that effective economic incentives can be put in place. In addition, projects totaling an annual production of 35 TWh have been proposed, including a 1,400-MW (4.5-TWh/year) offshore wind-power project, suggesting additional substantial development after 2010.

The target for wind power of 3 TWh of generation by 2010 represents approximately 1,000 MW installed capacity at the most favorable sites. Since 2001, Enova has signed contracts with energy utilities for 12 wind-power projects. The projects represent an estimated 1.56 TWh/year of energy production (approximately 500 MW). By the end of 2006, approximately 300 GWh was under construction. Enova did not give investment grants to new wind-power projects in 2006.

3.0 Benefits to the national economy

3.1 Market characteristics

Production of wind power is dispersed among seven energy companies, some of which are small local utilities. The largest wind-power projects are operated by big national energy companies that also own power stations in foreign countries. So far, there is no significant wind turbine manufacturing industry in Norway.

3.2 Industrial development

ScanWind Group AS is a new Norway-based manufacturer of large wind turbines (3 MW and larger) for use in Class 1 wind areas. The company has developed a 3-MW direct-driven wind turbine design (ScanWind 3000 DL) and a geared version of the same size (ScanWind 3000 GL).

Some of the Norwegian industry takes part in component production for wind energy systems, e.g., wind turbine blades and nacelles. A new initiative has begun to develop a new weight-reduced generator for wind-power applications. The main objective of this project is to develop a new permanent magnet generation system that reduces the generator mass by at least 25%.

3.3 Economic details

The unit cost of the Norwegian wind turbines erected in 2006 was on average 10,000 NOK/kW (1,250 €/kW), including infrastructure and grid connection. In some remote areas having favorable wind conditions, the cost of grid connection is too high to make the development of wind energy economical. In addition, the capacity of the existing grid is a limiting factor in many places and restricts the size of the wind farms being constructed. Most new wind farms are designed taking into account the limitation of the capacity of the grid. An increase of the grid capacity can be an option in some areas. Generally, areas with the best wind conditions are located in the northern part of the country, but these areas are too far from the consumer. Constructing

new transmission lines has been considered, but so far the lower cost for generation in the north, where wind conditions are more favorable, does not make up for the additional cost of building new lines.

Estimates of production costs from sites with good wind conditions suggest a production cost of about 370 NOK/MWh (46 €/MWh), including capital costs (discount rate 6.5%, 20-year period) and operations and maintenance. During the past few years, the spot market electricity price on the Nord Pool (Nordic electricity marketplace) has increased noticeably, leading the long-term expected price to be more than 320 NOK/MWh (40 €/MWh). Unfortunately, the cost of wind energy has increased during the same period of time, so it is still unable to compete on commercial terms.

Nor is wind energy competitive with the price of many new hydropower projects, which still is an option for new green power in Norway. Even though both wind and hydro resources are large, the development of hydropower is more controversial than the development of wind power.

4.0 National incentive programs

For renewable power production, the government plans to establish a feed-in system in which accepted projects will achieve a fixed support per kilowatt-hour in 15 years. The support level is proposed as is shown in Table 2.

5.0 R, D&D activities

The governmental research program for sustainable energy is called RENERGI. Its budget for wind energy R&D in 2006 was 12.5 million NOK (1.5 million €).

Table 2 Government support per kilowatt-hour

Type of production	Government contribution Euro/ kWh (NOK/kWh)
Hydropower production representing the first 3 MW of installed capacity	0.005 (0.04)
Wind-power production	0.010 (0.08)
Power production from biofuels and immature technologies	0.0125 (0.10)

The following wind energy R&D projects have been approved for funding:

- A study of the potential of offshore wind energy is planned.
- Two concepts for floating wind turbines are under development. The systems are designed to operate in areas of deep water (200 m to 800 m). A prototype is expected to be in operation during 2008.
- Several projects will deal with wind resource mapping and micrositing in complex terrain.
- In 2001, to assist the development of wind energy in Norway, SINTEF Energy Research, the Institute for Energy Technology (IFE), and the university in Trondheim (NTNU) undertook a joint initiative to develop a test station for wind turbines on the midwestern coast of Norway. The test site was opened during the summer of 2005 and is now operating. For more information, see www.viva-test.no.
- The wind/hydrogen demonstration project at Utsira has now been in operation for two years. The purpose of the project is to demonstrate how renewable energy can provide a safe and efficient energy supply to isolated areas. The system is based on wind energy as the only energy source. Excess power is used to produce hydrogen, which is to be used later in a fuel cell. The system was developed and is operated by Norsk Hydro ASA.

In addition, a wind power and hydropower integration study has been initiated to establish a dataset to represent the wind regime during the past 30 years. The data will be compared with the hydrologic data we already have. Because the Norwegian energy supply system is largely dependent on hydropower, it is therefore critically vulnerable to annual variations in precipitation and to prolonged droughts. An increasing share of wind power gives topical interest to the integration of wind power and hydropower, since both resources are naturally intermittent. The question is whether the two can be complementary and can be combined to improve overall performance or whether, combined, they tend to increase the problems of energy supply. The latter eventuality can be the case if drought years generally coincide with periods of low mean wind speed.

6.0 The Next Term

By the end of 2006, project plans for 120 MW of new wind capacity were under way, and more than 1,200 MW had received permission/approval. However, the availability of financing and public acceptance will determine how many turbines are installed in the coming term.

Authors: Knut Hofstad, NVE; Viggo Iversen, Enova SF, Norway.