Chapter 16
Norway

16.1 INTRODUCTION

In 2002, two wind farms totaling 80 MW were erected, and the interest in wind power as a commercial source of electricity remains high. However, wind turbine installation still faces substantial hurdles such as financing and public acceptance. A recent price hike on electricity in the Nordic electricity market in the late fall of 2002 has increased the general energy interest dramatically and has had somewhat of an impact on wind energy as well. However, since the outlook for long-term electricity prices is still low, this situation in itself is not a strong enough incentive to spur new investments in wind energy.

16.2 NATIONAL POLICY

Strategy

Most electricity production in Norway is based on hydro-power, but because new hydro-power projects are limited in size and quantity, wind energy has become more focused.

The ambition of the Norwegian government is to have an annual electricity production based on wind energy of 3 TWh/year by 2010. This represents approximately 1,000 MW to 1,100 MW of installed capacity, at the average availability of the most favorable sites.

Progress Towards National Targets

Two wind farms of 40 MW each were finalized during 2002. No other wind farms received public funding in 2002. However, a technology implementation grant to a 3-MW, prototype, Scanwind turbine was given in 2002 and will be finalized in 2003. In 2002, wind energy production was approximately 75 GWh, with an estimated full-year production of approximately 292 GWh.

Further developments depend mainly on the long-term electricity market price, public grants in the coming years, and other incentives such as green certificates and tax credits linked to wind energy.

16.3 COMMERCIAL IMPLEMENTATION

Installed Capacity

Two wind farms were commissioned during September and October 2002, thus increasing the total installed capacity from 17 MW to 97 MW. The first wind farm consists of 20 turbines, each rated at 2 MW. It is located on the western coast of Norway on the island Smøla, and has an estimated energy production of 118 GWh/year.

The second wind farm consists of 16 turbines, each rated 2.5 MW. It is located close to the North Cape near the town Havøysund and has an estimated energy production of 19 GWh/year (see Figure 16.1).

An overview of the Norwegian wind turbines and the energy production in 2002 is shown in Table 16.1.

Rates and Trends in Deployment

Norway's deployment trend has been rather slow for many years. However, the two wind farms being finalized in 2002 (each rated

Figure 16.1 The Havøysund Wind Farm, Norway (Courtesy Arctic Wind)

40 MW) represent an initial step towards reaching the national target of 3 TWh/year by 2010. However, no other commercial wind farm received financial support in 2002, and therefore the next possible wind farm will at the earliest be constructed in late 2003 or during 2004.

Contribution to National Energy Demand

The total Norwegian electricity generating capacity is approximately 28 GW, of which approximately 99% is hydro-power. The mean energy production from hydro-power is 118.2 TWh/year. Therefore, the contribution from wind power, at estimated full year production, is still only 0.25% of the total production capacity.

16.4 MARKET DEVELOPMENT AND STIMULATION

Main Support Initiatives and Market Stimulation Incentives

Enova, a government enterprise established in 2002, is in charge of the Norwegian investment program for wind power and a technology implementation program that includes wind technology.

Enova offers investment grants with a maximum of 10% for new wind farms based on a maximum investment cost of 6,000.00 NOK/kW (826,000.00 Euros/MW). Wind farm owners also received a production subsidy of 0.0465 NOK/kWh (6.40 Euros/MWh) in 2002. The Norwegian Parliament decides this premium price annually.

Wind Turbine Projects	Year	No. Units	Total Power (KW)	Production 2002 (GWh)
Frøya	1986	1	55	0.02
Frøya	1989	1	400	0.79
Vallersund	1987	2	75	0.14
Kleppe	1988	1	55	0.04
Smøla	1989	1	300	0.43
Andøya	1991	1	400	0.77
Vesterålen	1991	1	400	0.58
Vikna I & II	1991/ 1993	5	2,200	5.98
Hundhammarfjellet	1998	1	1,650	2.77
Lindesnes	1998	5	3,750	8.93
Sandøy	1999	5	3,750	8.15
Kvalheim	2001	5	4,000	10.20
Smøla	2002	20	40,000	23.54
Havøygavlen	2002	16	40,000	13.18
TOTAL		65	97,035	75.52

Table 16.1 Norwegian 2002 wind turbine projects and energy production

16.5 DEPLOYMENT AND CONSTRAINTS

Wind Turbines Deployed

See Section 16.3, Installed Capacity, and Table 16.1.

Operational Experience

One serious incident occurred in 2002. During the construction period for a wind farm, a nacelle from a megawatt-sized machine fell 80 m – but no one was injured. The incident is reported to be due to a human fault in use of the control system.

Some cases of wind turbine failures due to lightning strikes have been reported, and some cases of fatigue (e.g., in gearboxes) have been reported.

Main Constraints on Market Development

In recent years, interest in wind energy has been high, and several projects have been considered, all of which are along the coastline from Lindesnes in the south and northwards. However, the main constraint has been the low energy price, both for the long term and the short term. Visual and environmental concerns are also major factors, which limit the possible deployment of wind energy in Norway.

16.6 ECONOMICS

Trends in Investment

The unit cost of the Norwegian wind turbines erected in 2002, including infrastructure and grid connection, was approximately 8,300.00 NOK/kW.

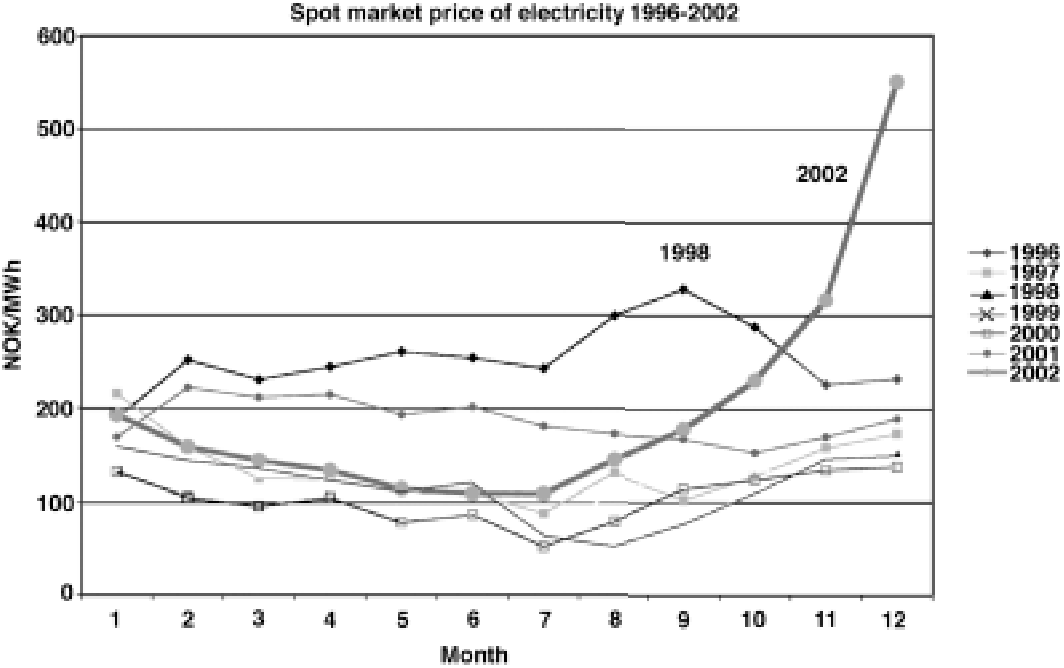

Figure 16.2 Norwegian spot-market price of electricity from 1996 to 2002 at the main grid level

Trends in Unit Costs of Generation and Buy-Back Prices

The Norwegian spot-market price of electricity from 1996 to 2002 at the main grid level is shown in Figure 16.2. This price represents the typical buy-back price for wind-generated electricity delivered to the grid transmission system. The average price on a yearly basis did, mainly due to ample supply of hydro-power, steadily decrease from 1996 to 2000, but it showed a slightly higher level in 2001. The year 2002 began like recent years, but at the end of 2002, the average price in December was as high as 550.00 NOK/MWh. However, because long-term electricity prices are still low, this situation in itself is not a strong enough incentive to spur new investments in wind energy.

During 2001 and 2002, several interesting commercial agreements were made based on export of wind energy produced in Norway to the European market, with a premium price on wind energy. It is anticipated that the focus on international renewable energy trade will keep investment focus high in Norway in the years to come.

In order to estimate the final wind energy price, the energy consumer must include costs to cover transmission and taxes, in addition to the spot-market price.

Estimations on production costs from sites with favorable wind conditions suggest a production cost as low as 250.00 NOK/MWh to 300.00 NOK/MWh, including capital costs, operation, and maintenance. Thus, compared to the spot-market electricity price, wind energy, on average, cannot yet compete on current commercial terms. However, compared to the price of new hydro-power projects, some wind energy projects are almost competitive.

16.7 INDUSTRY

Manufacturing

Currently, there are no manufacturers of complete wind turbines in Norway. However, the Norwegian/Swedish company Scanwind Group AS (SWG) is developing 3-MW wind turbines for directly driven generators with low maintenance in parks with difficult access. The turbines will be fully controlled (pitch/variable rpm) and linked to a main shaft system developed by SWG. The first prototype installations are expected to be ready during 2003.

The Umoe-group, a Norwegian-based investment company, recently decided to produce large wind turbine blades. It will be an independent blade sub-supplier to wind turbine manufacturers and deliver blades to megawatt-sized pitch turbines. The objective is to be competitive on the world market. In order to be fully competitive, Umoe also focuses on cost-saving technologies of the product and production process. Composite laminates used today are typically made of glass polyester or carbon epoxy, but Umoe has a project that will evaluate the application of low-cost, vinyl ester materials for wind turbine blades. In addition, new weaving techniques allow the direct application of thick reinforcements without building up many layers. The project will be finalized during the end of 2004.

16.8 GOVERNMENT-SPONSORED R,D&D

Priorities

Enova SF coordinates public support to projects in close collaboration with the Norwegian Research Council. Current priorities include projects close to market introduction, and researchers should have an industrial partner in the project, where appropriate.

New R,D&D Developments

The following 2002 wind energy projects were partly financed by the Norwegian Research Council and/or Enova SF.

- Pitch-control sensor to be applied on wind turbine blades: The company SensIT AS launched a project to develop a pitch-control system for wind turbines. This will be based on the continuous collection of stress and torsion measurement values, correlated to wind speed and generating capacity.
- Test station for wind turbines: In order to assist the development of wind energy in Norway, SINTEF Energy Research, the Institute for Energy Technology (IFE), and the University in Trondheim (NTNU) took a joint initiative in 2001 to develop a test station for wind turbines on the western coast of mid-Norway. However, the actual construction of the test station has been delayed due to difficulties in obtaining the required private financing to balance the public grant. It is expected that the installation work will take place during 2003.
- Strategic Institute Program (SIP) at IFE: Activities are focused on the further development of the micro-scale flow solver 3Dwind (i.e., improvement of pre and post processing and solver algorithms). Numerical investigations were carried out with a focus on wind development in complex terrain, which is typical for Norwegian wind parks. Numerical results have been verified with measured data, and these results provide a quantitative good prediction for occurring wind-flow patterns.

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