Chapter 14
The Netherlands

14.1 INTRODUCTION

In 2003, the net increase in installed capacity in the Netherlands was 227 MW, bringing the total installed capacity to 905 MW.

In 2003, various changes in the financial framework for renewable energy stimulation were announced and implemented through government legislation. Support and incentives are gradually changing from demand stimulation to production stimulation between January 2003 and January 2005.

Also in 2003, the Ministry of Economic Affairs started the project, Connect 6000. The objective of the project is to develop a vision to integrate 6,000 MW of offshore wind power into the Netherlands electricity grid and to clarify the responsibilities; tasks; and authority of the government, TenneT (the national transmission system operator), and market parties. The technical background studies include: available areas and costs for installation of offshore wind farms, consequences for the land-based electricity grid, and possibilities for an electricity grid at sea.

On 4 July 2003, the Minister of Economic Affairs – as well as sub-secretaries of state from the Ministries of Transport, Public Works, and Water Management and the Ministry of Housing and the Environment – informed Parliament about their plans for wind energy offshore. They established the main points of a concession regime for wind farms at the North Sea, after the first consultation with offshore market parties.

Baseline measurements for the environment on behalf of the government for the Monitoring and Evaluation Program of the Near Shore Wind Farm (NSW) for birds, fish, sea-mammals, and sea-bottom organisms were started and first results obtained.

14.2 NATIONAL POLICY

The government policy for renewable energy was revised in 2001. Wind and biomass energy are now priorities and are supposed to give the greatest contributions to the 2020 target. The realization of 6,000 MW installed wind capacity offshore is considered possible and necessary. The targets are summarized in Table 14.1.

Targets	2005		2010				2020			
	%	TWh	%	PJ	TWh	MW	%	PJ	TWh	MW
Energy from RE			*5*	150			*10*	300		
Electricity from RE	*6*	6.5	*9*		10.6					
Possible from wind				20	3.5	*1,500*		130	22.4	*7,500*

Table 14.1 Targets are in italic. Percentages are renewable energy of national energy or electricity; avoided fossil fuel in petajoules (PJ)

Strategy

The government will create the conditions to reach its targets through various instruments that facilitate demand for renewables. The government instruments s include fiscal incentives and financial instruments, spatial planning, research programs, a competitive green market, administrative agreements, R&D programs, carbon dioxide reduction subsidies, and joint implementation mechanisms.

Progress Towards National Targets

In 2002, about 1.5% of national energy consumption was provided by renewable energy, mainly from biomass and wind. Renewable electricity generation was 3,600 GWh, about 3.4% of the total national electricity consumption. Estimated 2003 renewable energy generation was 3.9% of the total national electricity consumption.

14.3 COMMERCIAL IMPLEMENTATION

Installed Capacity

A total of 185 turbines were installed during 2003, with a total capacity of 234 MW – and 45 turbines, with a total capacity of 7.3 MW, were removed. This brings the total installed capacity at the end of 2003 to 905 MW. The final numbers for 2002 show a total increase in operational capacity of 192 MW. During the years 1985 through 2003, the total capacity of installed turbines was 964 MW, and the total removed capacity was about 60 MW. (Figure 14.1)

Rates and Trends in Deployment

The net increase installed capacity in 2003 of 227 MW is twice as much as in the record year, 1995. The average installed capacity per turbine decreased slightly from 1,306 kW in 2002 to 1,266 kW in 2003, mainly due to the large amount of wind turbines installed in small projects. The average hub-height decreased slightly from 66 m in 2002 to 61 m in 2003. This change is mainly due to the large amount of wind turbines installed in projects with one or two wind turbines in the range of 600 kW to 950 kW.

The installed swept-area-per-unit of power decreased slightly from an average value of 2.5 m^2/kW during the years 1994 through 2001, to 2.27 m^2/kW in 2002 and 2003. This change is mainly caused by the larger projects with Vestas V66, Enercon E66, and Nordex N80 turbines, which have a lower swept area. (Figure 14.2)

Contribution to National Energy Demand

Total national electricity consumption in 2002 was 106,815 GWh. Wind provided 910 GWh of electricity, which is about 0.8% of the total. In 2003, total national consumption is expected to be 110,241 GWh, with wind providing 1,610 GWh, or about 1.46% of the total (Table 14.2). The increase from 910 GWh to 1,610 GWh is mainly due to the large increase in installed capacity in 2002 and 2003. In a normal wind year, the installed capacity of 905 MW can generate about 1,900 GWh of electricity.

14.4 MARKET DEVELOPMENT AND STIMULATION

Main Support Initiatives and Market Stimulation Incentives

The history of support initiatives and market stimulation instruments, including fiscal incentives, can be found in the Netherlands's annual reports for 1999, 2000, 2001, and 2002. Information about the competitiveness of prices can be found online at http://www.greenprices.com. At the end of 2003, there were about 2.2

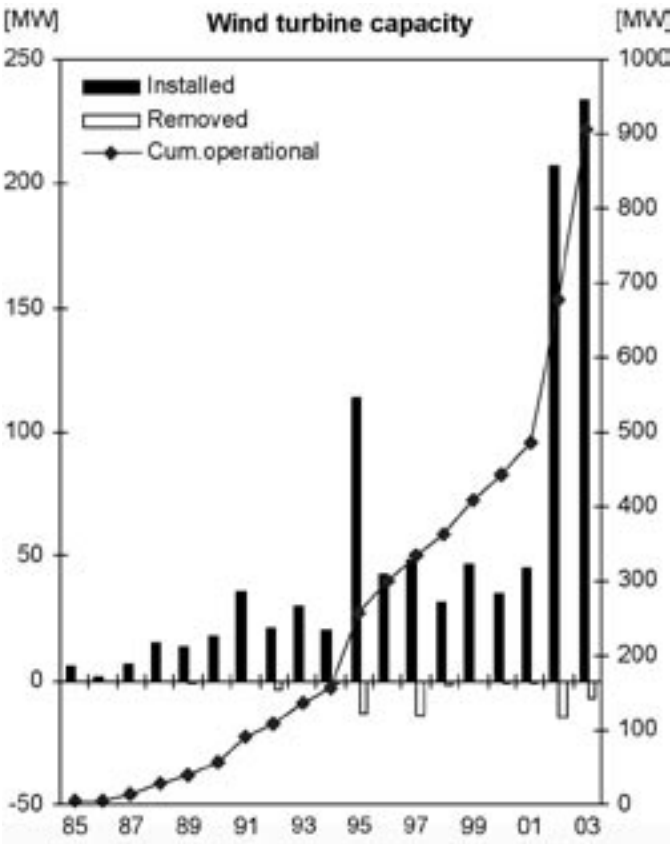

Figure 14.1 Installed, removed, and operational wind capacity in the Netherlands

million households that bought renewable electricity at the same price as grey electricity.

In 2003, various changes in the financial framework for renewable energy stimulation were announced and implemented through government legislation. Support and incentives are gradually changing from demand stimulation to production stimulation between January 2003 and January 2005. The following paragraphs summarize government legislation during this period.

Government legislation up to 1 January 2003 is outlined in the first section of Table 14.3; the information is taken primarily from the 2002 annual report.

Intermediary legislation existed from 1 January 2003 to 1 July 2003. Green energy for end users was no longer fully exempt from the ecotax of 0.0639 euro/kWh (REB 36i), but was taxed 0.029 euro/kWh. The production incentive of 0.02 euro/kWh was cancelled (REB 36o) for hydro energy, foreign wind, and biomass electricity imports. The incentive was adjusted for inflation to 0.0207 euro/kWh. The yearly budget for the Energy Investment Deduction (EIA) was decreased, but wind was still eligible. Energy investments were no longer eligible for Free Depreciation (VAMIL), and

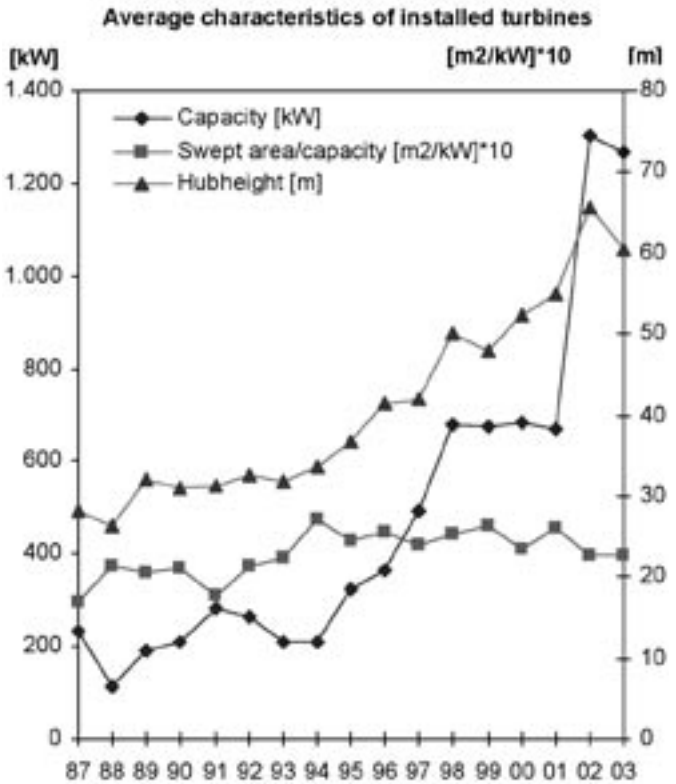

Figure 14.2 Average characteristics of installed turbines

the tax exemption for interest from green funds for investors changed slightly.

Legislation from 1 July 2003 until 1 January 2004 canceled the intermediary legislation and the production incentive of 0.0207 euro/kWh (REB 36o). A new governmental scheme, Environmental Quality Electricity Production (Milieukwaliteit Elektriciteits Productie, or MEP) was introduced.

Under MEP, producers of green electricity in the Netherlands receive a fixed subsidy per kilowatt-hour for wind for ten years, to a maximum of 18,000 full-load hours. The effect is like an investment subsidy for investors in renewable energy. The MEP subsidy differentiates between energy sources and takes into account unprofitable top-of-the-investment and avoided carbon dioxide emissions. Only "new" installations – those built after 1 January 1996 – are eligible for MEP subsidies. The MEP onshore subsidy in 2003 was 0.0495 euro/kWh; for offshore, it was 0.0685 euro/kWh. The subsidies will be paid from an MEP fund, which will hold 141 million euro in 2003, 164 million euro in 2004, 181 million euro in 2005, and 199 million euro in 2006 for renewable energy.

The MEP fund is financed through an MEP surcharge on all customers' bills. The surcharge will be determined every year – in 2003 it was 34.00 euro. The customer will be compensated from the surcharge through a lower income tax. Producers sell their electricity to TenneT, the national transmission system operator.

Year	Wind generated electricity	Primary energy savings	National electricity consumption
	GWh	PJ	GWh
1985	6	0.05	
1986	7	0.06	
1987	14	0.12	
1988	32	0.26	
1989	40	0.33	
1990	56	0.46	
1991	88	0.73	
1992	147	1.21	
1993	174	1.43	
1994	238	1.97	
1995	317	2.62	85,641
1996	437	3.61	88,665
1997	475	3.92	92,000
1998	640	5.28	95,421
1999	645	5.33	97,549
2000	829	6.85	100,604
2001	825	6.82	103,495
2002	910	7.51	106,815
2003	1610	13.32	110,241
* 2003 numbers have been estimated			

Table 14.2 Wind-generated electricity, avoided fossil fuel, and national electricity consumption

Additional legislation will be implemented, beginning 1 January 2004. In September 2003, the government announced in the state budget that demand stimulation through exemption of ecotax has worked, and 1.8 million households in the Netherlands buy green electricity. On the other hand, this has not created enough generating capacity in the Netherlands, and green electricity is being imported and taxpayer money is leaking abroad. The government expects that the MEP scheme will create a higher demand for generating capacity.

The government proposes to further decrease demand stimulation through the exemption of ecotax (REB 36i) to 0.015 euro/kWh by 1 July 2004 and to 0.00 euro/kWh by 1 January 2005. Table 14.3 gives an overview of the financial framework for RE stimulation. And Table 14.4 shows the gradual change in payback rates for wind energy shifting from ecotax (REB 36i) to MEP subsidies.

Unit Cost Reduction

Reliable statistical data for 2003 do not exist; however, data from the Dutch Wind Energy Association, published in 2002, provide a breakdown of investment cost and operation and maintenance (O&M) cost for typical small projects. The project costs are 1,119.00 euro/kW, with 944.00 euro/kW for turbines. O&M costs are 38.00 euro/kW, or 3.43% of the investment. (Table 14.5)

14.5 DEPLOYMENTAND CONSTRAINTS

Wind Turbines Deployed

Of the wind turbines installed in 2003, 52% are from Vestas. For the first time, Enercon has a relatively large share in the Dutch market, with 26%. A new turbine type for 2003 was the NEG-Micon NM 2.75-MW, 92-m machine. (Table 14.6)

Nine wind farms, with an installed capacity higher than 10 MW, were installed in 2003. The largest wind farm is 21 MW, with 12 Vestas 1.75-MW, 66-m diameter turbines at Ooltgensplaat. The second largest wind farm has 10 Enercon 1.8-MW, 70-m diameter turbines at the Meeuwentocht near Lelystad in the province of Flevoland. This province houses 381 MW, of which 126 MW were installed in 2002, and 106 MW were installed in 2003, which is almost half of the total installed wind capacity in the Netherlands (905 MW). Additional details are noted in Table 14.7, and more project information can be found at http://home.wxs.nl/~windsh/nwturtab03.html.

		Before January 1, 2003		From July 1, 2003		From January 1, 2004	
	Name	Instrument	Effect	Instrument	Effect	Instrument	Effect
Investment support	EIA	Deduction of 52% of investment on company income	18% cheaper investment, about 1.1 eurocent/kWh	Continued	Same	Continued	Same
	VAMIL	Free depreciation of investment	9% cheaper investment, about 0.6 eurocent/kWh	Discontinued	Decrease in investment support	Discontinued	Decrease in investment support
	Green Funds	Exemption of tax on interest on provided capital	1% to 2% point cheaper capital for wind investors, about 0.5 eurocent/kWh	Continued under slightly different conditions	Unknown, but probably less cheap capital	Continued under slightly different conditions	Unknown, but probably less cheap capital
Production support	REB (36o)	Feed back ecotax 2 eurocent/kWh on top of basic feed back rates; foreign imports possible	Fixed income for producers on top of basic feed back rates for avoided costs	Discontinued	Foreign imports less attractive	Discontinued	Foreign imports less attractive
	Green certificates	Certification of green electricity, also foreign	Free trade of green certificates	Continued	Same	Continued	Same
	MEP			Fixed for 10 years, wind on land 4.95 eurocent/kWh, wind off shore 6.85 eurocent/kWh, max 18,000 h (on top of basic feed back rate)	Risk profile investors improved, through fixed income per kWh produced	Fixed for 10 years, wind on land 4.95 eurocent/kWh, wind off shore 6.85 eurocent/kWh, max 18,000 h (on top of basic feed back rate)	Risk profile investors improved, through fixed income per kWh produced
Demand stimulation	REB (36i)	Exemption from ecotax (5.9 eurocent/kWh) for consumers of green electricity; compensation in income tax	Green has same price as grey; from the 5.9 eurocent/ kWh an extra 3 eurocent/kWh is passed on to producers	Ecotax 6.39 eurocent/kWh; exemption 3.19 eurocent/kWh; compensation in income tax	Green has the same prices as grey; from the 3.19 eurocent/ kWh an unknown amount is passed on to producers	Ecotax 6,39 eurocent/kWh; exemption 3.19 eurocent/kWh; compensation in income tax	Green has the same prices as grey; from the 3.19 eurocent/ kWh an unknown amount is passed on to producers
	MEP			Surcharge of 34 euro in 2003 for all customers; compensation in income tax	MEP fund of 141 million euro in 2003 for payment of MEP-subsidies via grid operators	Surcharge of 36 euro in 2004 for all customers; compensation in income tax	MEP fund of 164 million euro in 2004 for payment of MEP-subsidies via grid operators

Eurocent/ kWh	Wind on land	Wind at sea
1-7-2003	*4.9* + 2.9 = 7.8	*6.8* + 2.9 = 9.7
1-1-2004	*4.8* + 3.0 = 7.8	*6.7* + 3.0 = 9.7
1-7-2004	*6.3* + 1.5 = 7.8	*8.2* + 1.5 = 9.7
1-1-2005	*7.7* + 0.0 = 7.7	*9.7* + 0.0 = 9.7

Table 14.4 MEP subsidies for wind energy (MEP + REB = total)

In 2003, 45 turbines were decommissioned. They had an average capacity of 160 kW and a total capacity of 7.3 MW. Most of them were Lagerwey 80-kW, 18-m diameter machines. Of these decommissioned turbines, 35 turbines (with a capacity of 5.7 MW) were replaced with 32 turbines with a total capacity of 26.5 MW. The net re-powering effect was 20.8 MW.

Operational Experience

There were no major incidents or accidents in 2003.

Main Constraints on Market Development

Spatial Planning and Support

The main challenge in the Netherlands for onshore wind remains securing enough sites for wind turbines (i.e., spatial planning). Under the Administrative Agreement National Development Wind Energy (Dutch acronym, BLOW), each province has a target to designate locations for wind turbines, specified in megawatts, before 2005. The agreement is aimed at realizing 1,500 MW of wind capacity on land by 2010.

Spatial planning support is also a challenge in the Netherlands. The Netherlands Agency for Energy and the Environment (Novem) has formed a so-called BLOW Expert Pool of certified independent consultants to assist provinces and local councils (that do not have sufficient expertise) with activities to establish regional and local spatial planning for wind. Up to half of the costs – to a maximum related to the amount of megawatts of the wind farms to be realized – are subsidized by Novem.

Under the BLOW agreement, each province has submitted its action plan to designate locations for wind turbines. On a lower level, several regions in various provinces are concluding wind agreements this year to designate locations with a total capacity of 140 MW. Table 14.8 outlines progress towards BLOW targets per province.

Unit costs wind farms 2003	
Break down investment costs	**Euro/ kW**
Turbines including foundation and transformer	944
Grid connection and farm cable	51
Roads, etc.	21
Plan development	52
Contingency (5%)	51
TOTAL investment	*1,119*
Break down O&M costs	
O&M contract	15
Insurance	3
Grid costs (fixed and system costs)	4
Lease	9
Management costs (0.2%)	2
Property tax (0.25%)	3
Contingency (10%)	3
TOTAL O&M costs	*38*
O&M cost as percentage of project investment	3.43%

Table 14.5 Unit costs for wind farms in 2003

Table 14.3 Financial framework for renewable energy stimulation

Manufacturer	Turbines	Installed		Rotor area
		MW	%	m^2
Vestas	100	120.8	52%	275,947
Enercon	33	60.0	26%	122,343
NEG-Micon	34	33.2	14%	80,283
General Electric	9	13.5	6%	34,636
Lagerwey	8	6.0	3%	16,343
Bonus	1	0.6	0%	1,521
Total	185	234.1	100%	531,073

Table 14.6 Distribution of new wind turbines by manufacturer

Offshore Concession Regime

On 4 July 2003, the Minister of Economic Affairs – as well as sub-secretaries of state from the Ministries of Transport, Public Works, and Water Management and the Ministry of Housing and the Environment – informed Parliament on their plans for wind energy offshore. They established the main points of a concession regime for wind farms at the North Sea, after a first consultation with offshore market parties.

The initial idea to use designated areas for offshore development has been abandoned. However, developers will be able to apply for planning consents for the entire Netherlands Exclusive Economic Zone (NEEZ), with the exception of areas such as shipping lanes and military practice zones. A planning consent grants the exclusive right to apply for a building permit on the basis of the law, *Management of Water State Activities* (Wbr), which will be adapted as the legal base for a concession regime.

Applicants must meet certain conditions and can apply for a planning consent for a maximum area of 50 km^2. The area for which a planning consent is granted is reserved exclusively for wind farms, and any other use of the area will be rejected. The government is preparing rules for planning consent, which should add as little time as possible for building permit granting procedures. These rules include a mandatory Environmental Impact Assessment and submission of a building permit application under the Wbr within a year. The government strives for the implementation of the concession regime in 2004.

Detailed information about the Dutch concession regime, as well as planning consents, are available online at http://www.offshorewind.nl.

Offshore Grid Integration

The Ministry of Economic Affairs is carrying out the project, Connect 6000, which maps technical and infrastructure conditions for the installation of offshore wind power. This project is a follow-up to the project, Survey of Integration of 6,000 MW Offshore Wind Power in Netherlands Electricity Grid in 2020. The objective of Connect 6000 is to develop a vision on the integration of 6,000 MW of offshore wind power in the Netherlands electricity grid and to clarify the responsibilities, tasks, and authority of the government, TenneT (the national transmission system operator), and market parties. Novem is consulting for the ministry on this subject and is conducting the

Wind farm > 5MW	Manufacturer	Turbines	Height	Diameter	Capacity	Swept area
			m	m	MW	m^2
Ooltgensplaat, WP Piet de Wit	Vestas	V 66 / 1.750	67	66	21.0	41,054
Lelystad, Meeuwentocht	Enercon	E 66 18.70	58	70	18.0	38,485
Rotterdam-Sufterdam-West	General Electric	GE 1.5 s	65	70	13.5	34,636
Wieringerwerf, Waterk.tocht	Vestas	V 66 / 1.650	78	66	13.2	27,370
Rotterdam, Hartelbrug-West	Enercon	E 66 - 20.70	85	70	12.0	23,091
Lelystad, Pijlstaartweg	Enercon	E 66 - 20.70	70	70	12.0	23,091
Zeewolde, Dodaars - Reigerweg	Vestas	V 52 / 850	37	52	11.9	29,732
Middenmeer, Groettocht	Vestas	V 66 / 1.650	78	66	11.6	23,948
Dronten, Ansjovistocht	Enercon	E 66 18.70	70	70	10.8	23,091
Middenmeer, Waardtocht	Vestas	4*V 66/1.750 en 1*V66/ 1.650	78	66	8.7	17,106
Dronten	Vestas	V 80 / 2.000	67	80	8.0	20,106
Swifterbant, Vuursteentocht	Vestas	V 80 / 2.000	67	80	8.0	20,106
Zeewolde, Grutto - Wulpweg	Vestas	V 52 / 850	70	52	7.7	19,113
Nieuwe Sluis, Ulketocht	Lagerwey	LW 51/750	55	51	6.0	16,343
Punthorst	Enercon	E 66 - 20.70	85	70	6.0	11,545
Various < 5MW	Danish/Dutch/ German	-	-	-	65.9	162,256
Total					234.1	531,073

Table 14.7 Size of wind plants installed in 2003

Province	Total 2003	BLOW Goal 2010
	MW	MW
Flevoland	381	220
Noord-Holland	149	205
Zuid-Holland	126	205
Fryslân	89	200
Groningen	62	165
Zeeland	57	205
Brabant	38	115
Overijssel	6	30
Drenthe	1	15
Limburg	1	30
Gelderland	1	60
Utrecht	0.2	50
Total	910	1,500

Table 14.8 Progress towards BLOW targets per province

necessary technical background studies with the help of ECN and KEMA.

A project team from the Ministry of Economic Affairs and Novem ordered a number of studies, which include the following issues:

1. Available areas and costs for installation of offshore wind farms
2. Consequences for the land-based electricity grid
3. Possibilities for an electricity grid at sea

Based on the studies, three possible scenarios were identified for the realization of 6,000 MW of offshore wind power in the Netherlands Exclusive Economic Zone (NEEZ):

1. A base scenario leading to 6,000 MW in 2020
2. A progressive scenario leading to 8,000 MW in 2020
3. A conservative scenario leading to 5,000 MW in 2020

The project team also looked at the international situation and the legal and ecological consequences.

The first study to identify available areas and costs for installation of offshore wind farms was carried out by ECN, which used its model, OWECOP. The study accounted for technical and economic aspects and the excluded areas for the NEEZ. Excluded areas included oil and natural gas exploration areas and shipping lanes. The point of departure was that connection to the grid on land would be at Maasvlakte and Beverwijk. Relative costs were determined, taking into account such issues as cable connection lengths, service harbor distances, and wind speeds. A strip of sea 25 km to 50 km from the coast appears to have the least expensive exploitable areas.

The study to determine the consequences for the land-based electricity grid was conducted by KEMA and is based on the former study carried out in 2002 (Survey of Integration of 6,000 MW Offshore Wind Power in Netherlands Electricity Grid in 2020). Connecting 6,000 MW of offshore wind power to the Netherlands electricity grid will make it necessary to reinforce the existing land-based electricity grid. The study examined which parts of the grid have to be reinforced in consecutive steps (of time and money) with increasing offshore wind power based on the three possible scenarios.

Total cost of reinforcements is estimated at 310 million euro. This can increase to 920 million euro if a part of these reinforcements have to be carried out underground (i.e., with cables). The preparations and implementation of these reinforcements may take of nine to fourteen years. (Table 14.9)

Figure 14.3 Wind farm Meeuwentocht in Flevoland

The study to determine the possibilities for an electricity grid at sea was also carried out by KEMA. It was meant to answer the question of whether or not it is desirable to design a part of the necessary electrical infrastructure "together" instead of using individual connections per wind farm. Four configurations were studied. They differ in use of alternating and direct current, number of cables, and costs. Although there are cost differences between individual connections and a grid at sea, it is too early to draw firm conclusions about the most economic configuration. Cable (laying) costs, especially, constitute a dominant cost factor that could not yet be accurately estimated. However, it seems that a grid at sea (i.e., bundling) is essential from the point of view of spatial planning and environment. (Table 14.10)

The three studies just discussed and the scenario study by Novem were integrated in the report, *Connect 6000 MW Scenarios Interim Report*, and published for consultation with interested and/or involved parties in November, 2003. After an update based on the findings of the consultation, the vision of EZ will be available in the first quarter of 2004. The full reports can be downloaded from the website http://www.offshorewind.nl.

14.6 ECONOMICS

Trends in Investment

Based on an average price of 1,119.00 euro/kW, the investment in 232 MW of new wind turbines totaled 260 million euro in 2003.

Trends in Unit Costs of Generation and Buy-Back Prices

Trends in unit costs of generation are unknown, mainly due to the commercially sensitive nature of unit costs. The total payback rate offered by energy companies for five- to ten-year contracts in 2001 was between 0.068 euro/kWh and 0.080 euro/

Reinforcement		Wind power limit without reinforcement	Costs HV-lines	Costs with 30% cable
Landfall	Trajectory	MW	Million euro	Million euro
Beverwijk	Oostzaan-Diemen	500	48	114
	Beverwijk-Oostzaan	1,500	60	176
	Diemen-Lelystad	1,500	95	313
	Lelystad-Ens	3,000	29	79
Maasvlakte	Krimpen-Geertruidenberg	1,500	78	236
Total			310	918

Table 14.9 Order of trajectories, reinforcement capacity, and investments for the land-based electricity grid

		150 kV	380 kV	VSC	HVDC	Individual
Maximum cable length	km	>30	30	>140	>140	>30
Maximum power	MW	500	500	500	>1000	500
Module size	MW	500	500	500	1000	100
Maximum number of cables for landfall	Beverwijk	42	15 of 5x3	14	6	25
	Maasvlakte	30	21 of 7x3	10	4	35
Costs	Million euro	2.6	2.5	3.2	2.9	2.1

Table 14.10 Preliminary cost estimates for a grid at sea in various configurations

kWh. No numbers are known for 2002 and 2003, mainly due to the commercially sensitive nature of the contracts. The payback rate under the MEP is reported in Table 14.4. MEP subsidies wind energy (MEP + REB = total).

14.7 INDUSTRY

Manufacturing

In May 2003, the activities of Lagerway for the 2-MW, 70-m turbine were sold to Zephyros, which is a new company run by former employees and management from Lagerwey. Zephyros is owned by the Triodos Bank and BVT, a German wind farm developer. Lagerwey went bankrupt at the end of September 2003, and assets of its 750-kW technology are being sold to the highest bidder.

Industry Development and Structure

NEG-Micon has built a prototype of the 2.75-MW, 92-m turbine at ECN's test site in the Wieringermeer. Here, it will be put to extensive testing before this turbine type

will be used in the NSW. More information about ECN's test site can be found at http://www.ecn.nl/wind/products/mmt/index.en.html.

ECN also ordered five Nordex 2.5-MW, 80-m turbines to be placed on the production part of its test site. The investment costs are 11 million euro. These turbines will be among others used in the project, validation measurements of turbulence, wakes and of extreme fatigue loads at the ECN Wind Turbine Test Farm Wieringermeer, and the project, field experiment and development of acoustic-optic registration of bird collisions on wind turbines.

ECN and Delft Technical University (TU Delft) have built a new test facility for their new joint venture, Wind Materials and Construction Group, about 5 km north of the ECN test site. The facility is located at a small harbor, which enables water transport of large blades. Wind turbine blades up to a length of 70 m will be put to extreme fatigue load tests in this facility. More information is available at http://www.wmc.citg.tudelft.nl/index.html.

14.8 GOVERNMENT-SPONSORED R,D&D

In 2001, 2002, and 2003 Novem carried out the Renewable Energy Programme, in which all renewable options compete for subsidy in a tender process.

Priorities

The Netherlands R&D-strategy Wind Energy 1999-2003 (NRW) was still the background for the research programs of ECN and TU Delft in 2003. Priority subjects are as follows:

New developments – Offshore, innovative materials, and recycling
Testing and measuring – Condition-monitoring systems and wind turbine test facilities
Databases – Wind turbine and component failure
Design tools – Reliability, wind turbines, control, and aerodynamics

New R,D&D Developments

Several contracts were awarded under the Novem renewable energy program. In 2002, Novem carried out the Renewable Energy Programme, in which all renewable options compete for subsidy in a tender process. From the 22 million euro subsidy, about 4.2 million euro was allocated to the following wind energy projects, with total project costs of 10.6 million euro:

1. Database on Wind Characteristics, IEA Wind Annex XVII
2. Standards for Offshore Wind Turbines, contribution to IEC TC88
3. FYNDFARM, computer program for design and optimization of wind farms with regard to fatigue loads and sound emission from wakes
4. Extrapolation of extreme external loads
5. IEA Wind Annex XX: Analyse NASA-Ames Wind Tunnel Measurements
6. CONMOW: Condition Monitoring of Offshore Wind Farms
7. STABCOM: Aeroëlastic Stability and Control of Large Wind Turbines
8. Field experiment Offshore Access System
9. Detailed offshore wind resource map for the Netherlands North Sea
10. ERAO-3, IEA Wind Annex XXI verification of electric and control aspects of offshore wind farms
11. Fibre Optic Blade Monitoring
12. Design of high hybrid towers of concrete and steel for wind turbines
13. Field experiment and development of acoustic-optic registration of bird collisions on wind turbines at ECN test wind farm
14. SIROCCO, design procedures for silent rotors
15. BLADKNIK, improved predictions for buckling of rotor blades

Figure 14.4 NEG-Micon 2.75-MW turbine at the ECN test site

Photo courtesy: Jaap 't Hooft, Novem

16. Real-time Process Simulator for Wind Turbines, Phase 2
17. Validation measurements of turbulence, wakes and of extreme fatigue loads at the ECN wind turbine test farm Wieringermeer
18. ACCUWIND, tools and methods to improve the accuracy of cup and sonic anemometers

From the 2003 budget, only the projects of the first tender have been allocated. From a total of 8 million euro for renewables, 1.8 million euro was awarded to the following wind research projects, with total costs of 3.1 million euro:

1. Heat and flux turbine control, to enhance output of large wind farms
2. Heat and flux turbine fundamental theory, to enhance output of large wind farms
3. Controlling wind tunnel experiments, to enhance output of large wind farms
4. Technical development of the RailWind turbine concept
5. Fibre Optic Blade Monitoring, Phase III
6. Field experiment with innovative direct-drive wind turbine control
7. Field experiment and development of acoustic-optic registration of bird collisions on wind turbines at ECN test wind farm

Summaries in Dutch of the project proposals can be found at http://www.den.novem.nl/ under Gehonoreerde BSE-projecten, Windenergie.

Offshore Siting

NSW Demonstration, Monitoring, and Evaluation Program

The Near Shore Wind farm (NSW) is a 100-MW demonstration wind farm supported by the government of the Netherlands. It will be built by a consortium consisting of Shell Wind Energy and NUON Renewables near Egmond aan Zee. The wind farm will be built 8 km to 15 km from the coast in 15-m to 20-m deep water. It will use 36 NEG-Micon 2.75 MW, 92-m turbines, built on a monopile. Erection of the wind farm is expected in 2005. The monitoring and evaluation program (MEP-NSW) defined the required and recommended measurements to be carried out in the areas of (1) technology and economy and (2) nature and environment.

In September 2003, the consortium NoordzeeWind submitted the Environmental Impact Statement for the wind farm, which serves also as the application for the building permit under of the law *Management of Water State Activities* (Wbr). This was the subject of a public hearing on 30 September 2003. Taking into consideration any concerns voiced until 16 October, the minister issued

a draft building permit in November, which was available for public perusal within four weeks. The minister will publish the final building permit in March 2004.

In November 2003, the NSW consortium, NoordzeeWind, built the meteorological mast necessary to carry out all the planned measurements for wind and wave data. The mast has a height of 118 m above average sea level and is equipped with solar panels for energy supply (Figure 14.5).

NSW-MEP Project Organization

On the order of the government, Novem takes care of the project organization, NSW-MEP. The project organization guards and promotes the learning objectives. It reports results to the Ministry of Economic Affairs.

For the collection of data on nature and environment, Novem is collaborating with the State Institute for Coast and Sea (RIKZ), which is part of the Directorate North Sea of the Department of Traffic and Waterstate. NSW-MEP environmental baseline measurements on behalf of the government for birds, fish, sea-mammals, and sea-bottom organisms began 1 April 2003. The research work for these studies has been laid down in a strategy of approach, as described in the following paragraphs.

Baseline studies of birds will determine which species occur in what numbers on the site of the wind farm. For this, a distinction must be made by seasons, for spring or autumn migration, day/night, various weather conditions, migratory path widths, birds' flight patterns and intensity and height. Additionally, the measurements must occur at various distances from the coast (8 km and 12 km). Furthermore, specific quantitative data must be collected with regard to foraging behavior of coastal summer birds and resting birds.

The baseline studies for fish will have to answer three main questions: (1) What species of fish are found on the site and how many? (2) What is the level and nature of noise underwater in the situation without a wind farm? and (3) What is the sensitivity of fish to noise in order to be able to determine the interaction with noise and vibrations caused by turbines? The study on fish has been subdivided into two parts: Studies of demersal fish (benthic fish) and studies of pelagic fish (other fish).

As a baseline survey for benthos (organisms in and on the seabed), the occurrence,

Figure 14.5 Met mast NoordzeeWind

Photo courtesy of NoordzeeWind

density, and population structure must be examined. The first result of the baseline studies for benthos became available in December 2003.

The baseline study for marine mammals required by the national government consists of determining the occurrence of porpoises on the site of the wind turbine farm.

The other results of the baseline measurements on behalf of the government for birds, fish, sea-mammals, and sea-bottom organisms are expected during 2004. The NSW operator, NoordzeeWind, is responsible for collecting and supplying all the other data of the NSW-MEP. Initial measurements are expected in 2005. All background information and available data can be found at the website http://www.mep-nsw.nl.

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