Chapter 22

The Netherlands

1.0 INTRODUCTION

The share of renewable energy in the Netherlands energy supply increased to 4.2% in 2005 of the total primary energy consumption of 3,314 PJ. The domestic production of renewable electricity in 2005 increased to 7.3 TWh or 6.2% of the total electricity consumption of 118 TWh. The target was 6% electricity from renewable sources in 2005, so it has been met.

In 2005, the net increase in installed wind capacity in the Netherlands was 140 MW, bringing the total installed capacity to 1,213 MW. The production of wind electricity in 2005 increased to 2.0 TWh or 1.7% of the total electricity consumption (1).

2.0 PROGRESS TOWARD NATIONAL OBJECTIVES

The national targets in 2005 were 5% of total energy consumption from renewable energy in 2010 and 10% in 2020. The partial targets for electricity were 6% of total electricity consumption from renewable electricity in 2005 and 9% in 2010.

In 2005, in total 113 turbines were installed with a total capacity of 153 MW and 44 turbines with a total capacity of 14 MW were removed. The net installed capacity in 2005 was 140 MW and the total installed capacity at the end of 2005 was 1,213 MW. In 2005, in total 13.6 MW, being 66 turbines with an average capacity of 206 kW were decommissioned. Of the decommissioned turbines in 2005, 20 with a total capacity of 4.1 MW were replaced with 17 turbines with a total capacity of 19 MW. The net repowering effect was 15 MW.

During discussions in Parliament in 2005, the Minister of Economic Affairs confirmed that national targets are 5% of total energy consumption from renewable energy in 2010 and 10% in 2020. The partial targets for electricity are 6% of total

Table 1 Key Statistics 2005: The Netherlands	
Total installed wind generation	1,213 MW
New wind generation installed	140 MW
Total electrical output from wind	2.0 TWh
Wind sector turnover	≈168 million €
Wind generation as % of national electric demand	1.7%
Target:	6.0% RE electricity in 2005

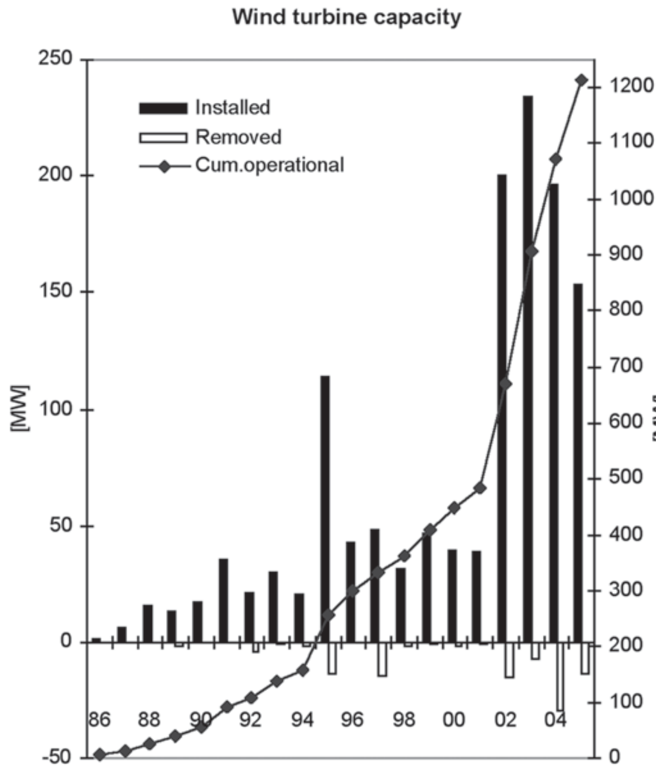

Figure 1 Installed, removed, and cumulative wind turbine capacity in the Netherlands.

electricity consumption from renewable electricity in 2005 and 9% in 2010.

The specific target of 6,000 MW of wind energy offshore was changed into an aspiration.

3.0 BENEFITS TO NATIONAL ECONOMY

3.1 Market characteristics

Based on an estimated average investment cost of 1,100 €/kW the total investment in 153 MW of new wind capacity was 168 million € in 2005.

On 29 December 2004, the Minister of Transport, Public Works and Water Management published the policy rules to issue building permits for the construction of wind farms under the Public Works and Water Management Act. During 2005, up to May 17, seven initiators supplied 57 inception memoranda to the Ministry for a wind farm location (3). For a complete updated list see http://www.senternovem.nl/Offshore_Wind_Energy/locations_and_licences/licence_system.asp . The initiators selected locations with a total surface of 2,200 km^2 on which, dependent on the layout, the installed capacity can be between 17.5 GW and 21.5 GW. However, the overlap in locations is about 1,200 km^2. That is why the installed capacity can at the most become around 8 GW to 10 GW. If realized, this wind capacity could yearly generate approximately 24 TWh to 29 TWh of electricity. This is roughly 20% to 25% of the present electricity consumption in the Netherlands.

Table 2 Wind generated electricity, avoided fuel, and national energy consumption

	Wind generated electricity [GWh]	Primary energy savings [PJ]	National electricity consumption [GWh]
1985	6	0.05	
1986	7	0.06	
1987	14	0.12	
1988	32	0.26	
1989	40	0.33	
1990	56	0.50	78,582
1991	88	0.78	80,803
1992	147	1.30	83,173
1993	174	1.56	84,318
1994	238	2.12	87,067
1995	317	2.79	89,058
1996	437	3.76	92,259
1997	475	3.98	95,735
1998	640	5.32	99,292
1999	645	5.34	101,508
2000	829	6.86	104,718
2001	825	6.98	107,144
2002	946	7.98	108,452
2003	1,318	11.11	109,777
2004	1,867	15.59	114,667
2005	2,036	16.85	117,658
CBS	* 2005 CBS estimate (2)		

3.2 Industrial development and operational experience

The financial closure and signing of contracts for the Near Shore Wind Farm took place on 31 May 2005. The Egmond Building Combination (EBC) will built and transfer the wind farm to NoordzeeWind a legal entity of Shell Renewables and NUON. Shell and NUON finance the 200 million €, 108-MW wind farm on balance. The EBC consists of Ballast Nedam and Vestas. The contract includes a 5-year maintenance and performance guarantee.

The planning foresees the installation of the foundations in April 2006, and the installation of the last turbine in October 2006. The end of October 2005 the tubes/pipes for the dune crossing of the electrical cables were installed at the beach of Wijk aan Zee (Figure 2).

The average installed capacity per turbine increased sharply from 671 kW in 2001 to 1,301 kW in 2002. This marked the introduction of wind farms of 5 to 20 MW with multi- megawatt turbines in the Netherlands. It decreased again to 1,266 kW in 2003 and 1,203 kW in 2004 and in 2005 rose again to 1,358 kW. The average hub-height seems to have stabilized around 60 m and the installed swept area per unit of power at around 2.3 m2/kW. See Figure 3.

Figure 2 Tubing for cables Offshore Wind farm Egmond aan Zee. Photo courtesy NoordzeeWind.

Table 3 Distribution of new wind turbines by manufacturer

Manufacturer	Turbines [-]	Installed [MW]	Installed [%]	Rotorarea [m²]
Vestas	82	101.6	66	237,967
Enercon	22	36.8	24	73,872
GE Wind	6	9.8	6	30,223
Siemens	2	4.9	3	12,011
Bonus	1	0.3	0	755
Total	113	153.4	100	354,828

Of the wind turbines installed in 2005, the Vestas' share was 66%. See Table 3. Enercon's share of 26% in 2003 fell to 4% in 2004 and went up to 24% again. Nordex's share has gone to zero in 2005. GE Wind and Siemens make up the rest.

New turbine prototypes at the Energy Research Center of the Netherlands (ECN) test field in the Wieringenmeer were the GE Wind 94 m diameter 2.3 MW with a hub-height of 100 m and the Siemens 104 m diameter 3.6-MW turbine with a hub-height of 80 m. This also is now the largest wind turbine in the Netherlands.

Harokasan, a Japanese investment company with involvement of Japan Steel, took over bankrupt Zephyros. Production facilities are at Den Helder and producing 2-MW turbines for Taiwan.

Two wind farms, with an installed capacity of 10 MW to higher were installed in 2005. The largest is 12 MW, with 6 Enercon 2-MW, 71-m diameter turbines at Delfzijl, the first turbines of this type in the Netherlands. The farm at Amsterdam-Westpoort has the first three turbines of the Vestas V90.

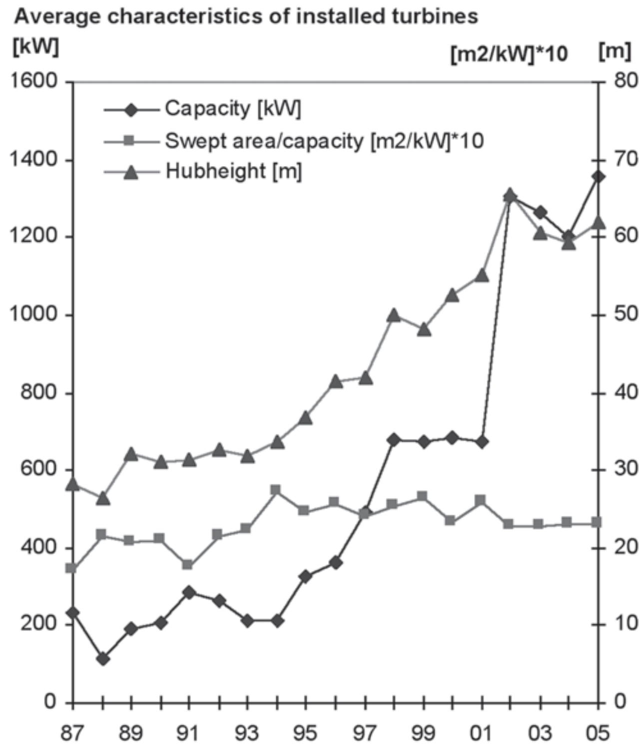

Figure 3 Annual average characteristics of installed turbines in the Netherlands.

3.3 Economic details

Please refer to the IEA Wind Energy 2004 Annual Report, pages 171 to 173 for a detailed description of trends in investment and financing.

4.0 NATIONAL INCENTIVE PROGRAMS

Please refer to pages 162 and 163, IEA Wind Energy 2004 Annual Report, for a description of support initiatives and market stimulation instruments.

The Ministry of Economic Affairs evaluated the MEP scheme in November 2004 and published the new tariffs for the period 2005 to 2007 (see IEA Wind Annual Report 2004). For offshore wind, a production subsidy of 0.097 €/kWh is available for an operational period of 10 years.

Members of Parliament voiced their concerns about the costs of offshore wind to society and asked for a detailed social cost/benefit analysis of offshore wind energy.

On 10 May, the government announced an immediate standstill for new offshore wind production subsidies in light of the possibility of over achieving the 9% sustainable electricity target for 2010. The Minister of Transport, Public Works and Water Management also suspended accepting and processing applications.

The energy report 'Now for later' of 8 July emphasizes an energy conservation goal of 1.5% per year. The target of 10% renewables in 2020 remains but is not specified per option.

The Minister sent social cost/benefit analyses to Parliament on 19 September 2005. Central in the

Table 4 Size of wind plants installed in 2005						
Wind farms > 5MW	Manufacturer	Turbines [-]	Height [m]	Diameter [m]	Capacity [MW]	Swept area [m^2]
Delfzijl	Enercon	6	85	71	12.0	23,755
Rotterdam	Vestas	5	67	80	10.0	25,133
Willemstad	Vestas	11	44	52.2	9.4	23,541
A'dam-Westpoort	Vestas	3	80	90	9.0	19,085
R'dam-Dobbelsteen	Vestas	3	78	92	8.3	19,943
Herkingen	Vestas	3	80	80	8.3	15,080
Waalwijk	GE Wind	5	85	77	7.5	23,283
Culemborg	Vestas	3	80	80	6.0	15,080
Lelystad	Vestas	6	70	54.5	6.0	13,997
Zutphen	Enercon	3	85	71	6.0	11,878
Various < 5MW	Danish/German	-	-	-	70.8	163,300
Total					153.1	354,073

study was the finding that building 6,000 MW of offshore wind will only become economically viable with gradual investments under the so-called Strong Europe scenario (with strict climate policy) until 2030. This finding was amongst others based on assumptions that costs decrease over time, fuel prices remain high, and emission prices for CO_2 are higher or discount factors low.

The Minister of economic Affairs agreed with the national parliament on a policy effort for a maximum of 700 MW of offshore wind in 2010. This means the possibility for another 480 MW on top of the 100-MW Near Shore Wind farm and the 120-MW wind farm Q7. The minister further announced that for those 480 MW the MEP production subsidy will be tendered for the lowest kWh price.

5.0 R&D ACTIVITIES

5.1 National R&D efforts

EOS Long Term (EOS-LT) supports researchers with promising plans that in the long term lead to a sustainable energy supply. The EOS-LT R&D program aims at research that strengthens the Netherlands knowledge position and frees the way for the introduction of innovative energy technologies. One of the themes of the program is 'Offshore wind generation and electricity grids'. This theme has the four focal points:

1. knowledge for the design of wind conversion offshore with the objective of making wind conversion offshore competitive with fossil based generation in 2020
2. integration of 6,000 MW of offshore wind in the Netherlands electricity grid with the objective of it being economic, reliable, and stable.
3. technical transition of electricity networks
4. management and maintenance of electricity networks.

In 2005, under this program about 2 million € was granted to two wind projects with the main contractor of ECN. The first one is Rotorflow I a projects that researches new methods for the calculation of aerodynamic loads that combine the computational efficiency of Blade Element Impulse methods while aiming for the accuracy of Computational Fluid Dynamics. The second one is Sustainable Control that aims to reduce turbine costs through Optimized Feedback Control; Fault Tolerant Control; Extreme Event Control, and 'Optimal Shut-down Control'.

5.1.1 interesting completed research

In 2005, ECN completed the wind resource atlas of the Dutch part of the North Sea. (Figure 4) ECN made the atlas by combining data from two sources: the numerical weather prediction model Hirlam and the meteorological stations at the North Sea. In the final report, the public maps with the mean wind speed at 60, 90, 120, and 150 meter above sea level are presented. The local wind resource anywhere in the Dutch part of the North Sea is sufficiently described by the wind resource in one of five characteristic locations. The wind resource in such a location is expressed in terms of the wind speed and wind direction distribution, the turbulence intensity distribution, and the stability class distribution. The formats for these distributions are presented. The tables with the mean wind speeds and with the distributions are confidential but can be obtained from ECN.

Delft Technical University conducted Model Testing of a Motion Compensated Platform for Access to Offshore Wind Turbines. This gave a

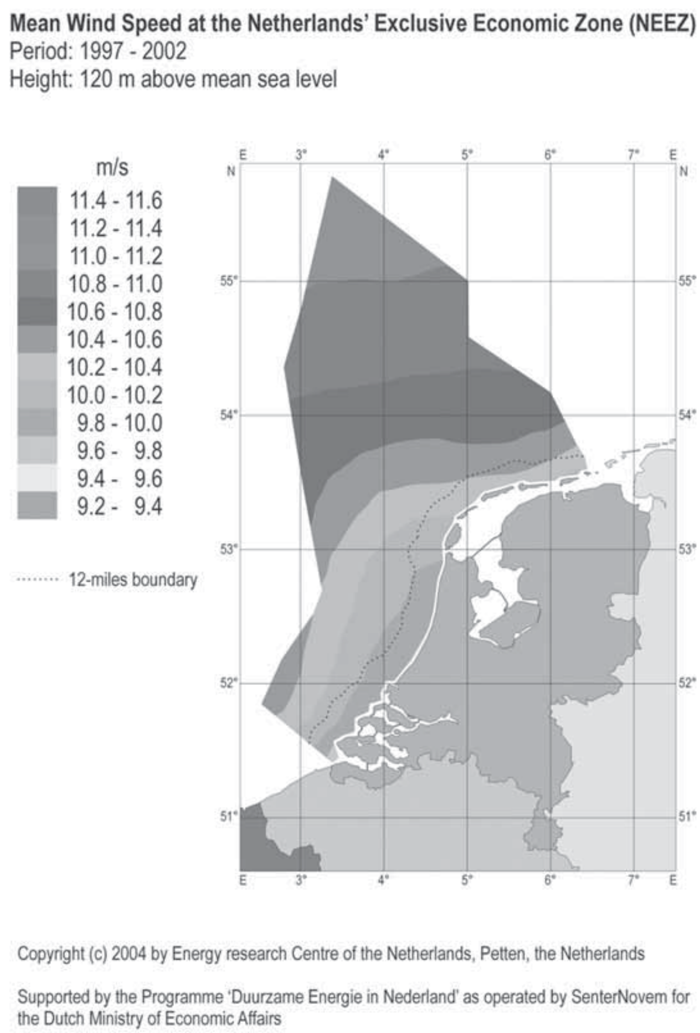

Figure 4 NL EEZ offshore wind map.

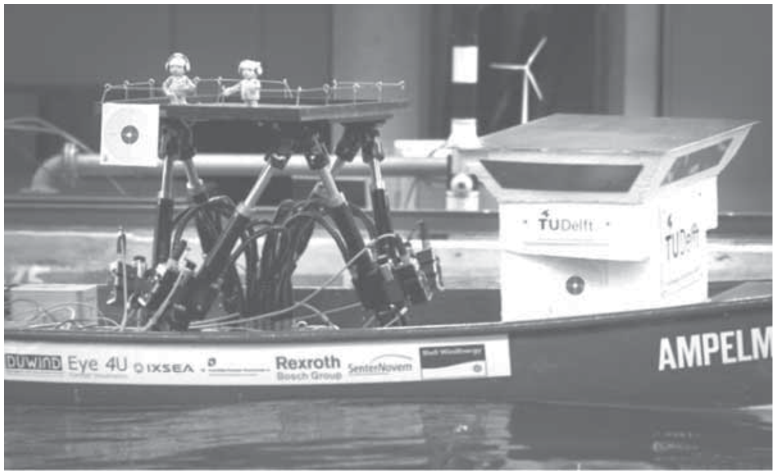

Figure 5 Model testing of Der Ampelmann Delft Technical University. Photo courtesy Delft Technical University.

proof of principle for an interesting new concept coined Der Ampelmann. (Figure 5)

Offshore access methods currently available are dangerous, very expensive or limited to calm weather conditions. To make offshore access safe, easy, and continuously possible, the Delft University of Technology invented the "Ampelmann". This system consists of a transfer platform on six hydraulic legs, a Stewart platform often used for flight simulators, mounted on a vessel. By measuring the vessel motions and real-time control of the actuators in the platform, the top plate becomes stationary compared to the fixed world.

To prove this concept, the Delft University of Technology made a test plan and had custom-made software written, while manufacturers provided a motion sensor and a small size Stewart platform available. The Ampelmann system was mounted on a small boat, creating a scale model of what the actual system should look like on an offshore supply vessel. The boat was tested in a wave basin leading to good results with wave frequencies between 0.2 and 0.55 Hertz. This is equal to wave periods between 1.8 and 5 seconds, which are the wave periods that cover about 90% of all sea states in the Dutch North Sea.

The proof-of-concept of the Ampelmann was a success, but moreover, a great deal was learned about the system's sub-components and the software, and the system was enhanced to perform in a wider range of frequencies.

5.1.2 Interesting new research efforts

In a series of projects with names like 'Fyndfarm', 'Heat & Flux,' and 'Controlling Wind,' ECN is conducting research that :

- tries to describe wind farm boundary layers,
- the effects that wind farms have on roughness length,
- the reduction of wind speed within a wind farm
- and the mutual influence on wind speed of large offshore wind farms,
- measures to mitigate reduction of wind speed due to these effects.

ECN studies all these effects with the aid of model wind turbines in the boundary layer wind tunnel of TNO in Apeldoorn (Figure 6).

5.2 Collaborative research

Egmond Policy Declaration

The Egmond Policy Declaration (5) is the leading document for work on offshore development in the Netherlands. As a follow up on that declaration the Copenhagen Policy Seminar on Offshore Wind Power produced the Copenhagen Strategy 2005 (6). Amongst other things, it recognized the importance of R&D for cost reductions of offshore wind energy. In relation to a Technology Platform for Wind Energy, the participants recognized the Strategic Research Agenda for the European Wind Energy Sector up to 2013. Long-term R&D priorities include: wind resource estimation and mapping; availability of robust, low maintenance offshore turbines; state of the art laboratories for accelerated testing of large components; planning and design processes for Trans-European grid with sufficient connection points to serve future large-scale wind power plants; and research and development of storage systems. Short-term operational measures include: standards and certification; acceptable operational and technical system integration measures; communication strategy as to the findings on impacts from wind farms on the eco-system, targeted at the general public and policy makers. Recognition of this Strategic Research Agenda in the Egmond Policy Declaration and in the Copenhagen Strategy 2005 have now made these R&D priorities part of the Netherlands R&D strategy.

References

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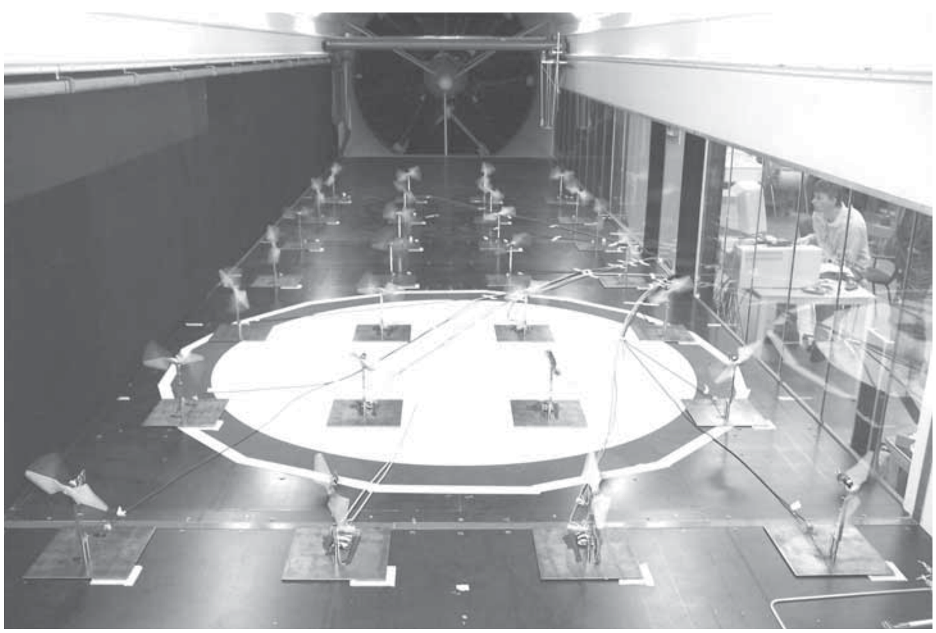

Figure 6 Model wind turbines in the boundary layer wind tunnel of TNO in Apeldoorn. Photo courtesy ECN.