



Energy research Centre of the Netherlands

A photograph of a wind turbine test site at sunset. The sky is a vibrant mix of orange, red, and yellow. Several wind turbines are visible as dark silhouettes against the bright sky. In the foreground, a large crane is also silhouetted. The overall scene conveys a sense of industrial activity in a natural setting.

ECN Wind Turbine Test Site Wieringermeer



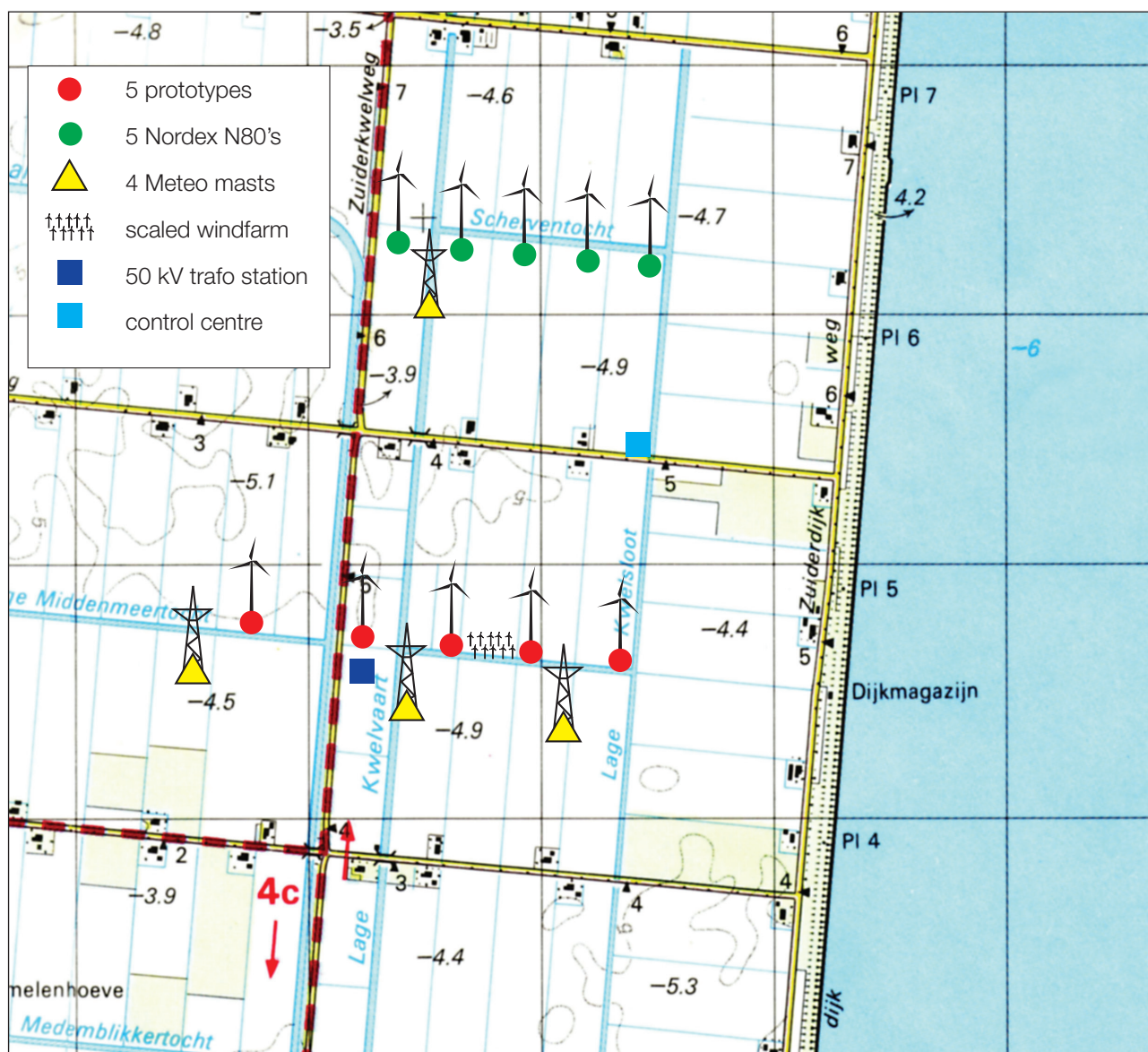
From 2003 ECN has expanded its wind turbine test facilities with a wind turbine test site in the municipality of Wieringermeer. The site is located just south of the village Kreileroord, at about 30 km distance from ECN's main offices in Petten. The harbour "De Oude Zeug" is at 8 km distance and can be used for the transport of large turbine components. The blade test facility WMC (Wind Turbine Materials and Construction) is located at the harbour. For visitors it's an easy drive from the Amsterdam airport "Schiphol". The highway A7 has an exits runs 8 km from the site.

ECN's test site is a unique facility and comprises a combination of a wind farm and prototype test locations. The wind farm - consisting of five Nordex N80 wind turbines - enables ECN to perform wind farm specific research and development programs. The site also comprises five prototype locations. These locations enable manufacturers to test, optimize and certify prototypes together with ECN. Supporting facilities are four meteo towers, a 36 MVA grid connection, data collection equipment and infrastructure and a test site control centre. The site has a favourable wind climate: the average wind speed at 100 m height is 8,3 m/s.

Wind turbines for state-of-the-art R&D

The five Nordex N80 turbines produce about 28.000.000 kWh per year. The income of this green electricity gives a solid base for the financial exploitation of the site.

The turbines are used by ECN for progress and development of our R&D programs. The focus on medium and long term R&D is important to assure future development and innovation. In general commercial wind farms use their capacity for achieving maximum energy production. ECN investigates aspects like operation and maintenance strategies; wake effects, and condition monitoring. Other important activities are the development of improved wind farm control strategies and new advanced measurement techniques like optical strain gauges.



Prototype lease

A wind turbine manufacturer can lease the location for a period of four to five years. He pays a yearly lease fee and receives in return the benefits of the produced electricity. The test site can accommodate prototypes with installed electrical powers up to 6 MW.

The test site has an environmental permit for wind turbines with a minimum hub height of 40 m and a rotor diameter up to approximately 125 m. The route to obtain a building permit is relatively short. Usually the civil activities at the site can start within three months

after the lease contract is concluded. The 10kV grid connection cables and the data communication infrastructure are already available at the prototype locations.

Extension of the test site

Thanks to the success of the test site, ECN will extend the site with both a wind farm for ECN's R&D programs and new prototype test locations. The prototype locations will facilitate turbines up to approximately 12 MW installed power.

Prototype wind turbines on the test site					
Manufacturer	Siemens Wind Power	General Electric	General Electric	Siemens Wind Power	XEMC-Darwind
Type	NG7	2.5 xl	2.5 xl	SWT-3.6-120	DD 115
Rated Power	3.0 MW	2.5 MW	2.3/2.5/2.75 MW*	3.6 MW	5.0 MW
Hub Height	90 m	85 m	100 m	80 m	100 m
Rotor diameter	113 m	88/100/110/103m*	94/100/103m*	107/120m*	115 m
(To be) installed in	2011	2004	2005	2005	2011

* Different configurations tested on the test site

Custom-made measurement programs

ECN offers manufacturers custom-made measurement programs to support the testing, optimising and certifying of their prototype turbines. Either the ECN in-house data acquisition system Dante or high-end data acquisition systems are used. The wind turbine data is transferred to the central test site building by means of glass fibre connections and is combined with meteo mast data, SCADA data and measurement results from remote sensing techniques like Lidar and Sodar measurements.

All measurements are captured in a central database at the ECN headquarters in Petten. This allows users to obtain easy access to all data, of which a back-up is made automatically.

IEC and MEASNET compatible measurements can be carried out on request using our four meteo towers. ECN is accredited to perform measurements of mechanical loads, power performance and acoustic noise production. ECN is specialized in custom-made measurement campaigns.

Organisation

The test site is managed by ECN Wind Energy Facilities BV, a 100% ECN subsidiary.

Many neighbouring farmers participate in the project and receive financial benefits. The objective of this company is to facilitate manufacturers in their prototype development and to support measurement and development programs of ECN. ECN Wind Energy Facilities B.V. also maintains the financial integrity of the test site operation.



Site Specifications	
Wind turbines owned by test site	
Number	5
Type	Nordex N80
Rotor diameter	80 m
Hub height	80 m
Rated power	2,5 MW
Erected in	March 2004
Distance	300 m
Prototype locations	
Number	5
Rotor diameter	up to appr. 125 m
Hub height	min 40 m
Rated power	up to 6 MW
Distance	400 m and 465 m
Electrical infrastructure	
Grid connection	at 10 kV level
Electrical grid capacity	36 MVA
Transformer station	10kV/50kV
Rated power per	
Meteo towers	
Number	4
Tower heights	2 times 108 m, 2 times 100 m
Measurement heights	various, from 25 to 108 m
Measured parameters	• wind speed • wind direction • air temperature • air pressure • relative humidity • turbulence • atmospheric stability
Measurement infrastructure	
Signal cables	Glass fiber multiduct system
Data acquisition	ECN DANTE systems/Compact RIO
Evaluation	• in Control Center at the site • at ECN via a direct glass fiber link
Control Center	
Offices	for manufacturers
Meeting room	max. 18 persons
Computer room	for data evaluation
Miscellaneous	kitchen, workshop and dressing room





Scaled Wind Farm

Background (why a scaled wind farm?)

For the development of large (offshore) wind farms it is essential to understand the detailed wind field in and around the farm. The wake effect of individual turbines have a strong influence on energy production and mechanical loads of other turbines. Understanding these influences strongly supports aerodynamic research programs and allows for the development of optimised control strategies. Reliable computer models are required that predict the steady and unsteady wind flows in wind farms and the response of individual wind turbines. For the development of these models adequate measurements are crucial. These measurements are not available yet. The main reason for that is that accurate flow determination requires many metrological towers. For full scale measurement this would be far too expensive. Therefore accurate wind flow measurements in wind farms are lacking. This has hindered research on wind farm aerodynamics and control. The value of wind tunnel data as an alternative for full scale measurements is limited due to scaling effects. ECN has overcome these problems by building a scaled wind farm facility. Its scale is large enough to alleviate the dominant scaling effects and the scale is sufficiently small to permit the building of sufficient meteorological masts.

Scaled Wind Farm layout

The scaled farm consists of ten permanent magnet, direct drive, pitch controlled wind turbines, to which hardware and software ECN has full access. The turbines have 10 kW rated power, a rotor diameter of 7.6 m and a hub height of 7.5 m. The scaled farm has been designed in a way that allows ECN to perform experiments without any risk for the environment as well as for the turbines themselves. Inside and around the wind farm a network of fourteen meteorological masts has been installed, which measure the wind velocity field from 3.6 m to 19 m height. This covers the rotor area and up to one rotor diameter above the rotor. The alignment of turbines and measurement masts within the wind farm permits to measure at the same time single, double, triple and quadruple wakes. This is supported by simultaneously measuring the external conditions with the three nearby 108 m meteorological masts. The unusually densely spaced wind measurements capture the complete wind field. This gives valuable additional information compared to the usual measurement of the wind speed at a single location.



Benefits of scaled wind farm

This worldwide unique research facility gives further insights in the field of wind farm aerodynamics, wake interaction and wind farm control. The high quality data are used for the development and validation of wind farm aerodynamic models and wind farm control strategies. This will allow operating a wind farm at maximum efficiency while guaranteeing at the same time a maximum in reliability and a minimum in mechanical and electrical loads.

ECN not only uses the scaled farm to improve its own knowledge but also to initiate other collaborations with national and international partners, coming from research institutes, universities and wind turbine manufacturers.



ECN Wind Energy Facilities BV

Scherveweg 35a, NL - 1771 RT Wieringerwerf

The Netherlands

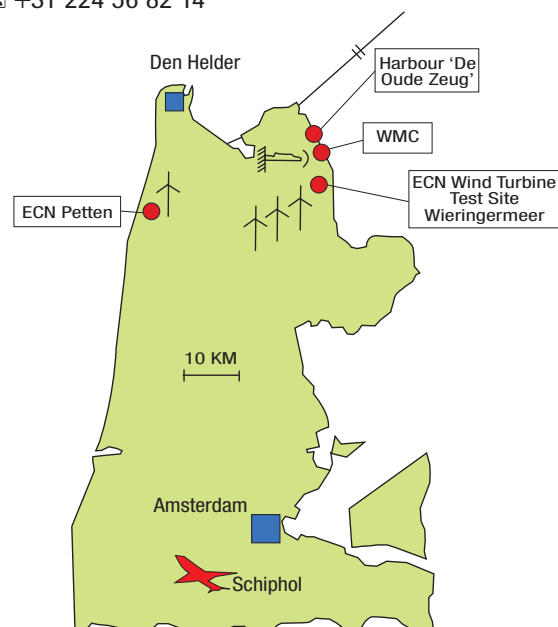
Wim Stam, Managing Director

✉ stam@ecn.nl

☎ +31 224 56 40 25

📠 +31 6 203 02 079

📠 +31 224 56 82 14



www.ecn.nl