NoordzeeWind

Operations Report 2009

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Summary

In January 2007 the offshore wind farm Egmond aan Zee went into operation. This first Dutch offshore wind farm is a government demonstration project, which is developed, owned and operated by NoordzeeWind, a joint venture of Shell and Nuon. The wind farm comprises 36 Vestas V90 3 MW wind turbines, a 116 meter tall offshore meteorological mast, and an onshore transformer substation.

In the first 3 years of operations, the wind farm has faced several challenges, especially in technical reliability, which also had a significant impact on the availability and produced power in 2009. However, at the end of 2009 the gearbox replacement programme was successfully completed, which resulted into an availability on and above the warranted availability. Despite the lower availability, the wind farm has succeeded in achieving a production at a 315GWh level (the equivalent of the electricity consumption of approximately 95,000 Dutch homes) to the grid, which is an acceptable performance given the conditions.

Challenges appeared with the grouted (concreted) connection between the transition pieces and the foundation pile. In the course of regular inspections it has been discovered that, in a number of the wind turbines, more settlement in the vertical direction is occurring between the foundation pile and the transitional section than had been expected. Repair work on 3 piles has been successfully executed in December 2009. Repair of the remaining 33 piles will start in May 2010.

On HSE, the site has shown excellent safety performance in achieving zero recordable incidents. As of the end of the year, the plant had worked the full 3 years of Operations (1096 days) without any injury or incident. Total man-hours spent at site was over 70,000 for the year. Moreover, safety awareness at the contractor improved even further over the year, and the number of safety reports exceeded this year's target with > 100%.

An extensive monitoring programme is being carried out to better understand the behaviour of the wind farm and its effects on the environment. The effect monitoring (after construction) started early 2007 and was continued during 2009.

This report describes the general performance of the wind farm in the third operating year 2009, and summarizes the results of the monitoring program so far. This report is itself part of the monitoring programme. Further results of the monitoring programme will be published separately.

This and other reports can be downloaded from http://www.noordzeewind.nl or from http://www.senternovem.nl/offshorewindenergy .

Acknowledgement:
The Offshore wind farm Egmond aan Zee has a subsidy of the Ministry of Economic Affairs under the CO2 Reduction Plan of the Netherlands.

1 Introduction

In relation to emerging concerns on climate change and sustainable energy provision, the Dutch government identified offshore wind power as the largest feasible renewable energy resource in the country. In order to explore the viability of this technology, a feasibility study was carried out in 1997 on the development and construction of a 100 MW offshore wind farm. The report was issued in September 1997 by Novem (now SenterNovem) and concluded that such a wind farm would be technically and economically viable, provided that appropriate subsidies were granted. Subsequently, the government (through the department of economic affairs) initiated a demonstration project for a 100 MW offshore wind farm and acted in a lead role for site identification. This was the start of what is now the Offshore Wind farm Egmond aan Zee (OWEZ). In mid-2002 the site concession was awarded after public tender to NoordzeeWind (NZW), a joint venture between energy company Shell and utility Nuon. NoordzeeWind subsequently developed the wind farm, including obtaining all permits, grid connection, and securing the necessary contracts. After final investment decision in Q2 2005, NZW and Bouwcombinatie Egmond (BCE), a joint venture of Vestas and Ballast Nedam, signed the contract for the realisation of the wind farm.

The wind farm comprises 36 Vestas V90 wind turbines, associated support systems and an offshore meteorological measurement mast. The project is located in Dutch territorial waters of the North Sea, between 10 and 18 km from the coast. Each wind turbine is connected by a transition piece to a steel monopile foundation, piled to a penetration depth of about 30 m into sandy/silty seabed. The power is transmitted through three 34 kV cables to shore, which land north of IJmuiden harbour near Wijk aan Zee. A substation transforms the voltage from 34 kV to 150 kV and connects the plant to the national grid. The wind farm went into operation on 1 January 2007.

Part of the project is a Monitoring and Evaluation Program aiming to generate knowledge that will be beneficial to the development of offshore wind energy in The Netherlands. The program outline is defined by the Dutch government and covers two main areas:

- Environment, including public opinion;
- Technology & economics.

Design, construction and commissioning of the wind farm and the first two operational years were reported previously[1]. This Operations Report 2009 covers the third operating year, i.e. the period 1 January 2009 until 31 December 2009.

[1] OWEZ_R_141_20080206_General_report.pdf, OWEZ_R_000_20081023_Operations_2007.pdf and OWEZ_R_000_200900807 _Operations_2008.pdf. This and other reports can be downloaded from http://www.noordzeewind.nl/ or http://www.senternovem.nl/offshorewindenergy/.

2 Overview

Throughout the year management attention was focused on achieving good safety performance, as well as on wider HSSE (health, safety, security and environmental) matters. As a result of concerted efforts of everybody working on the project, the target of “no incidents” was achieved during the year.

After the acceptable performance in 2007, 2008 started with a low availability due to necessity of early gearbox maintenance. During 2009 all gearboxes were safely replaced and all 36 turbines were back online in November 2009.
During the year it became apparent that the grouted connections between the monopiles and the transition pieces showed more settlement than expected. The safety of the wind turbines and its environment was not in danger, but repair work on 3 foundations was considered necessary to maintain a safe situation. All turbines have been regularly inspected by ROV and dive inspections. Repairs on other wind turbines are still ongoing and are planned to be finished in the 3rd quarter of 2010.

Performance did suffer due to these phenomena and overall production over the year delivered to the grid was 315 GWh, which is acceptable. The resulting capacity factor is 33.3 %.

Throughout the year, the project attracted a lot of attention from the public and media. The public “Infocentrum NoordzeeWind” in Egmond aan Zee is meeting a need, and again welcomed over 50,000 visitors in 2009.

From the construction phase a number of so-called “punch list items” (open items from the construction phase) remained, which needed to be resolved during the operations phase. Although good progress was made during the year, at the end of 2009 some work was still ongoing. Close-out of all punch list items is expected during the first half of 2010.

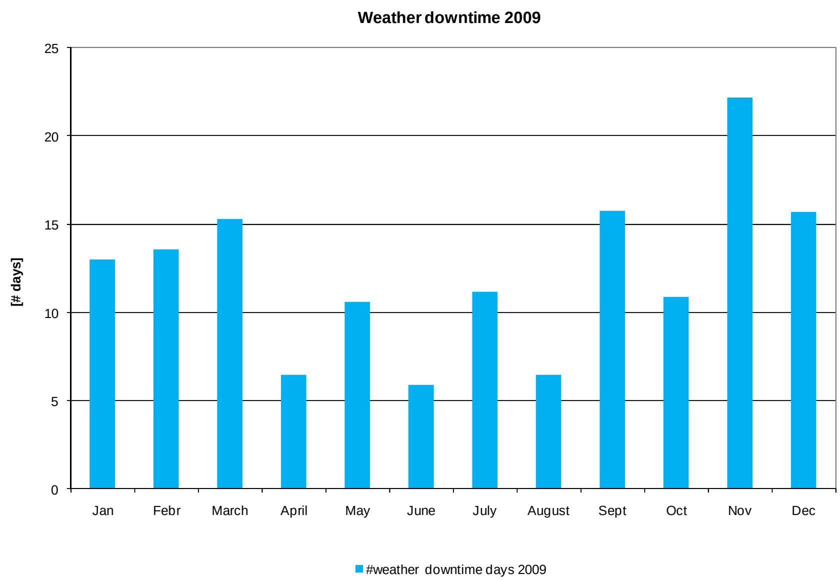
3 Performance

3.1 Scheduled Maintenance

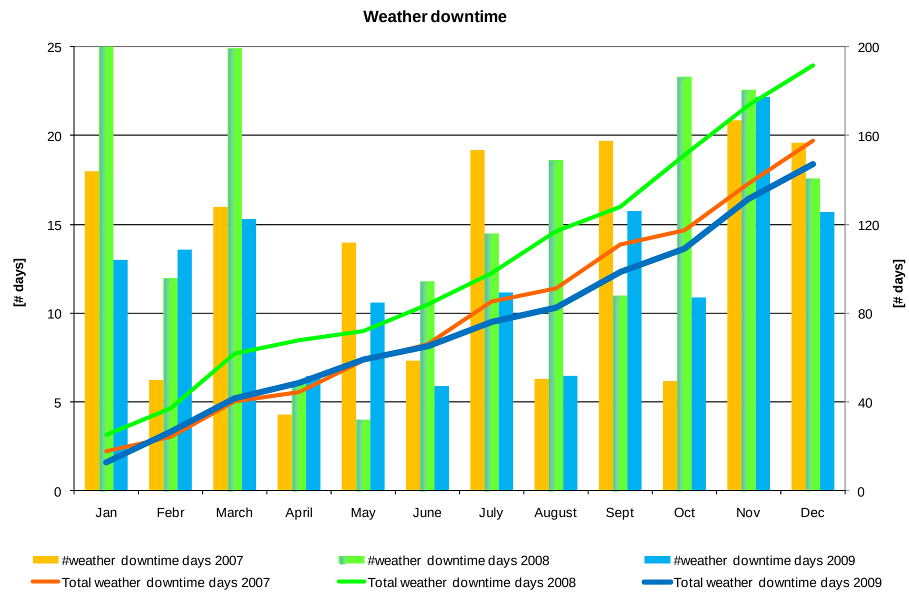
Following scheduled service was executed according the maintenance plan:
- Wind turbines: all maintenance was completed in Q2 and Q3.
- Coating inspections
- Underwater:
    - ROV inspections of the monopiles and transition pieces
    - Cathodic protection measurement
    - Scour protection surveys
    - Subsea cables surveys
- Onshore substation (incl. grid connection)
- Metmast (instrumentation and structure)
- Navigation aids and vessel support radars

3.2 Availability

The good wind resource in 2009 had an adverse effect on the number of workable days. A statistically normal year would show a bathtub-like graph of unworkable days (i.e. days with bad weather preventing offshore access, see chapter 6 for weather limits), with high numbers in autumn and winter, and low numbers in spring and summer. The actual number of unworkable days in 2009 was with 147 significantly lower compared to 2008 (191) and slightly lower than in 2007 (158), Beside the downtime due to high waves, current and swell, there were a few weather downtime days due to fog. This was the first year that the number of weather downtime days shows more or less the expected bath tub profile, except for the relatively high number in May and July. This posed a challenge for maintenance planning, which are normally planned in summertime, with disadvantageous consequences for availability.



Graph: Number of unworkable days for each month in 2009

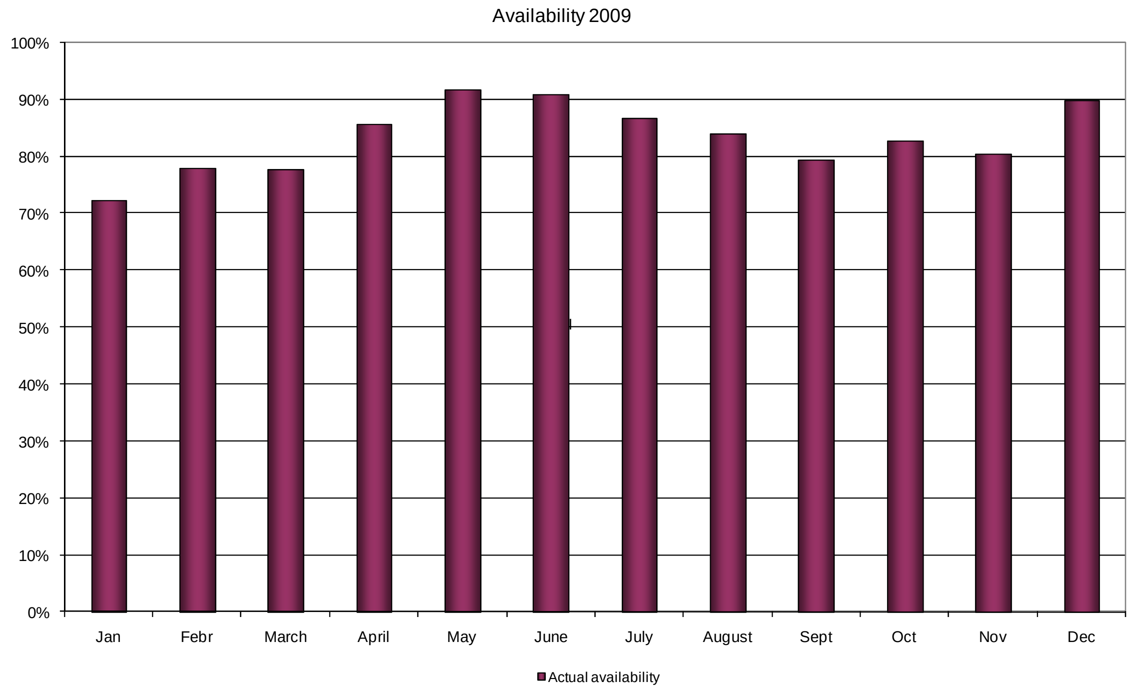


Graph: Number of unworkable days for each month over 2007, 2008 and 2009

The gearbox exchange program continued in 2009, which had a negative impact on the availability. During the year 34 gearboxes were replaced. In November all gearboxes were E-types and back online. Furthermore, during the cause of 2009, 8 generators were down with various failure causes and were replaced.

The inspection and repairs for the grouted connection between the transition piece and the foundation have limited impact on the availability (<1 day per turbine).

As a result the overall wind farm availability suffered a decrease in the same period. Monthly availability is shown in the graph below (please turn over). The average availability for the year is 83.5%.



Graph: wind farm availability for each month in 2009

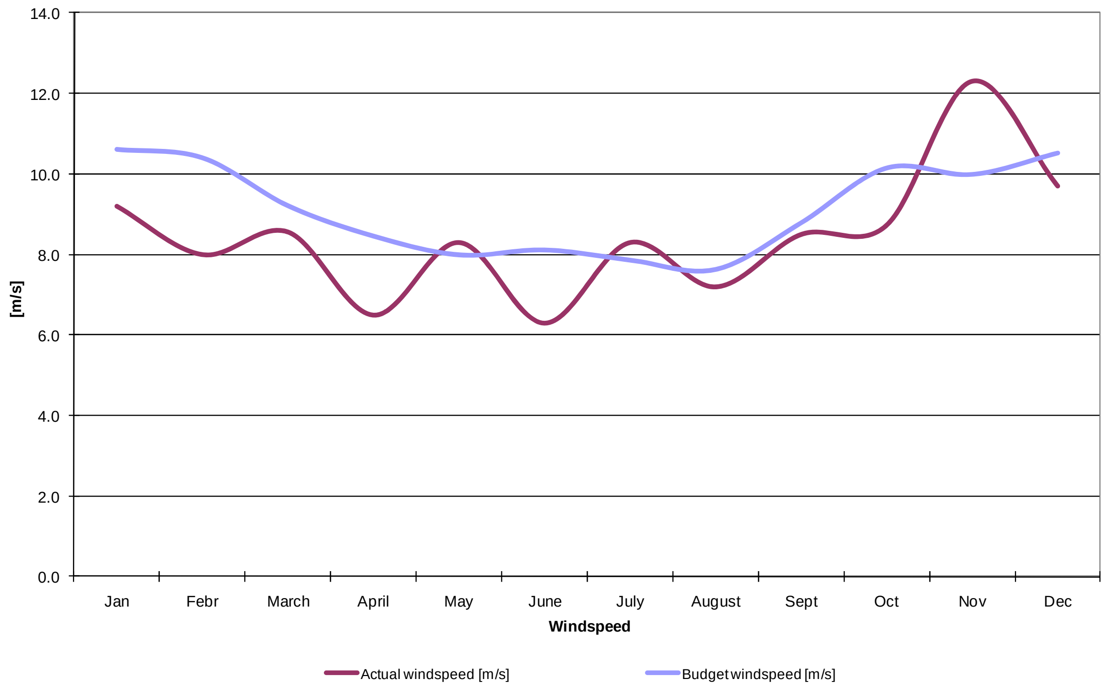
3.3 Production

The actual wind resource in 2009 fluctuated significantly over the year, as already mentioned in paragraph 3.1. On average, the wind resource was slightly less compared to the expectation. The following table and graph show the actual versus expected average wind speed, metered production delivered to the grid, and availability per month.

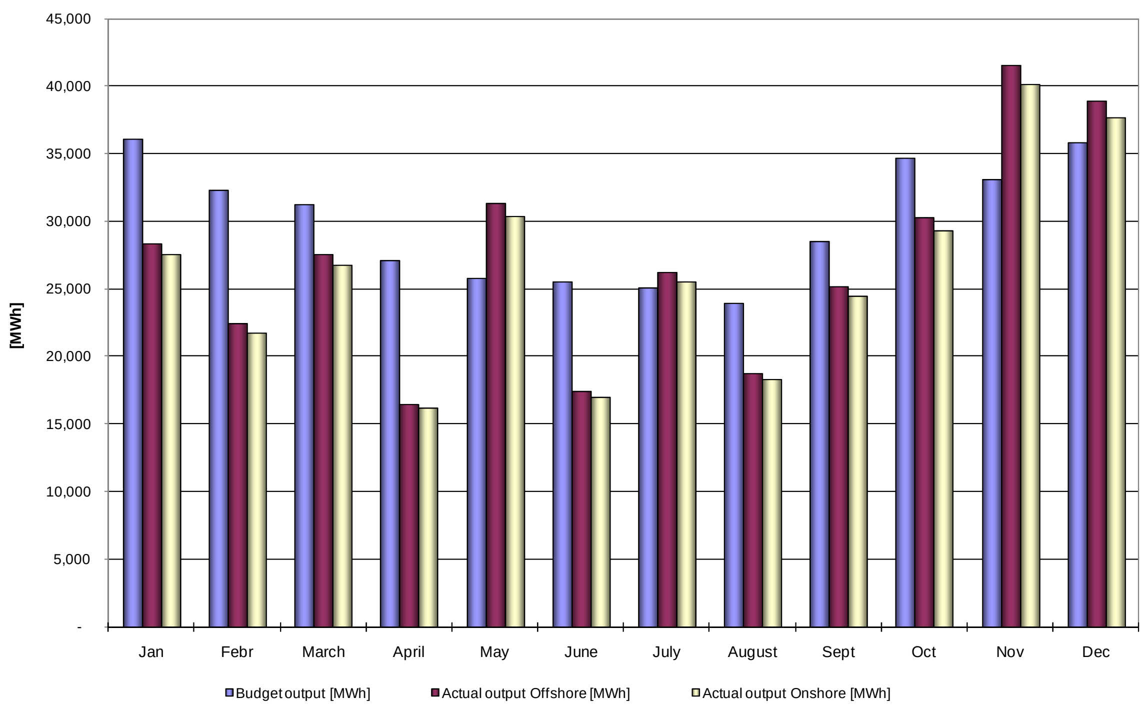
Month	Expected wind speed	Actual wind speed	Output	Availability
	(m/s)	(m/s)	(MWh)	(%)
Jan	10.6	9.2	27,585	72%
Feb	10.4	8.0	21,801	78%
Mar	9.2	8.6	26,763	78%
Apr	8.4	6.5	16,168	86%
May	8.0	8.3	30,413	92%
Jun	8.1	6.3	17,010	91%
Jul	7.8	8.3	25,530	87%
Aug	7.6	7.2	18,279	84%
Sep	8.8	8.5	24,466	79%
Oct	10.2	8.7	29,325	83%
Nov	10.0	12.3	40,183	80%
Dec	10.5	9.7	37,688	90%
Total	9.1	8.5	315,211	83%

Table: performance during 2009.

The total metered electricity production over the year was 315.211 MWh. The actual and expected monthly production is shown below. Remarkably, in November 2009 the highest production for the year was achieved even though availability was only about 80%.



Graph: actual versus expected wind speed



Graph: actual versus expected output

3.4 *Downtime per subsystem*

Wind farm performance is remotely monitored by a Supervisory Control And Data Analysis (SCADA) system, that allows access over a secure internet connection to a wide range of sensors installed in the turbines. These track a large number of operating parameters for the various subsystems in the turbines. To analyze the causes of reduced availability, the downtime of the wind farm has been split up into different categories for the main subsystems:

Ambient – All stops as a result of ambient conditions (e.g. wind speed, wind direction, temperature, lightning) being outside design limits.

Blade system – All stops as a result of failures in the blades and blade bearings.

Brake system – All stops as a result of failures in the main brake and auxiliaries.

Control system – All stops as a result of failures in the main controller and associated equipment (like sensors etc.), including remote communication system.

Converter – All stops as a result of failures in the generator power converter.

Electrical – All stops as a result of failures in the wind farm cabling, turbine transformers, substation etc.

Gearbox – All stops as a result of failures in the gearbox including its lubrication systems.

Generator – All stops as a result of failures in the generator including its cooling systems.

Pitch system – All stops as a result of failures in the blade pitch system including hydraulic controls.

Scheduled service – All stops as a result planned\scheduled service (including punch list work).

Yaw system – All stops as a result of failures in the yaw system (including yaw motors, yaw brakes and controls).

Structure – All stops as a result of failures in the support structure (foundations, transition pieces and towers).

Grid – All stops as a result of failures in the public grid.

The overview of the totals for 2009 can be found in the table overleaf.

Category	Lost MWh	%Lost MWh	# Stops	%Stops	Downtime (hrs)
Ambient	1335	2,0%	419	5,5%	474:25
Blade system	774	1,2%	88	1,2%	952:30
Brake system	107	0,2%	25	0,3%	73:53
Control system	4537	6,9%	2523	33,0%	3918:33
Converter	890	1,3%	228	3,0%	1173:42
Electrical	882	1,3%	69	0,9%	605:04
Gearbox	36713	55,6%	567	7,4%	30400:40
Generator	14920	22,6%	101	1,3%	11226:18
Pitch system	4382	6,6%	1599	20,9%	2633:41
Scheduled service	919	1,4%	858	11,2%	1706:22
Yaw system	502	0,8%	1127	14,7%	203:55
Structure	44	0,1%	15	0,2%	48:52
Grid	0	0,0%	31	0,4%	520:54
Total	66005	100,0%	7650	100,0%	53938:56

Table: calculated losses and downtime per subsystem

“Lost MWh” is the electricity production that is missed due to the downtime. This is a calculated number that uses actual onsite windspeeds over the period of the downtime as input. Hence, downtime occurring during low wind periods would result in a low number of lost MWh.

“# Stops” is the sum total of the number of stops in the specific downtime category occurring over the year. This figure includes stops on failures, which were automatically reset (this is the majority), remotely reset or locally reset. In the latter case, a site visit was required.

“Downtime” is the amount of time that any windturbine was not working, and is measured in turbine-hours. With 36 turbines * 8760 hours = 315360 turbine-hours in 2009, the total downtime is therefore 53939/315360 = 17.1%.

For the 3 different parameters (# Stops, Lost MWh and Downtime) pie charts (refer to annex 1) show the percentage contribution of each value to the total.

It is clear that the gearbox failure frequency is low but the impact on downtime and losses is high. This is due to the repair procedure, which requires a jack up vessel with a crane, working at height, and the gearbox exchange itself, and the work can only be performed at favorable weather conditions (limited wave height, limited wind speed). Furthermore for the same reasons, the impact of the failed generators is significant as well.

The grout issue has no impact on the failure frequency, the preventive grout repair campaign which started in 2009 and will finish in the first half of 2010 has limited impact on the downtime (<1 day per turbine)

The control system has the highest failure frequency. This system has a significant percentage in the electrical losses as well, as some failures (such as failing sensors) could not be reset automatically or remotely. This requires local repair, which is subject to weather delays. All failure data are collected by Vestas and fed back to their technology center. Together with data from similar turbines operating worldwide, this allows Vestas to define quality improvements. These are subsequently implemented at the site in a program of Continuous Improvement Management (CIM), and ultimately should lead to improved reliability and a reduction in the overall number of failures.

NoordzeeWind has chosen to access the wind turbines only by boat. As a consequence service staff has to be brought at site by crew vessels and transfer from the vessels to the turbines. The total number of service crew vessel visits in the year 2009 was circa 250. Each crew vessel trip contained a maximum of 6 to 12 persons for performing inspections, scheduled service, unscheduled service and punch list activities. On average nine people are on board of a crew tender and on average 1.5 wind turbines are visited during each trip. This results in a total number of offshore transfers in the year 2009of (250 x 9 x 1,5 x 2 [2] =) 6750.
During the gearbox and generator replacement activities and the initial grout repairs, access to the turbine was provided via a gangway from the repair vessel.


Photo: Crew tender “Tender Express” leaving the meteo mast

4 Remaining construction items

At the end of 2008 some small punch list items were still outstanding and transferred to the O&M team. Close-out of most remaining items was achieved in 2009 and a limited number of items are planned for the first half of 2010.

[2] Entrance and exit counted separately

5 Monitoring program

Part of the project is a Monitoring and Evaluation Program aiming to generate knowledge that will be beneficial to the development of offshore wind energy. The program outline is defined by the Dutch government and covers two areas:

- Environment including public opinion;
- Technology & economics.

The environmental research program comprises field surveys on birds, marine mammals, fish, benthos and a public opinion survey during the summer season. The program was started prior to construction in order to obtain good baseline data and will last for several years.

The public opinion program consists of opinion polls conducted along the shores from where the wind farm is visible. Since the first public opinion survey back in 2005 before start of construction, and the last one that was executed in 2008, the public opinion showed a continuous upward trend.

Under the technology research program a lot of meteo data, sea state data and operational data were gathered and special measurements were carried out. All data are brought together in a relational database with a synchronous time stamp as common parameter for all signals.

Results of the program that are available in the public domain are reported separately, and can be found on the websites of NoordzeeWind and Agentschap NL[3]. A summary of the work carried out in 2009 is provided below.

5.1 Environmental research

The aim of the environmental research programme is to determine the impact of the wind farm on the (living) environment, such as birds, marine mammals, fish, benthos (life within and on the seabed) and also the perception of the wind farm by people visiting the beaches and living or working in the area. The environment at site may be influenced not only by the presence of turbines and the obstacle they present to e.g. birds, but also by operating turbines causing noise, as well as by human activities connected to the wind farm such as maintenance and repair. To get a comprehensive picture a wide range of field surveys are being carried out.
Reports on the work will be published in the course of 2010 and can be downloaded from the project web site and the web site of Agentschap NL.
The surveys executed in 2009 comprised bird surveys and field work on harbour porpoises. Work on fish, hard substrate and benthos (life in and on the sea floor) will be executed again in 2011.
To support coordination of all onsite research activities, a map was developed with all research areas (Annex 3).

[3] This and other reports can be downloaded from http://www.noordzeewind.nl/ or from http://www.senternovem.nl/offshorewindenergy/.

5.1.1 Local birds

A comparatively large area, of about 885 km², with the wind farm more or less at its centre was selected for the study of local birds. The wind farm itself covers circa 27 km². Within this area, ten survey lines were drawn that were to be surveyed during each subsequent seabirds survey (A-J from north to south, equidistant), refer to the figure below (green lines coincide with black dotted lines in Annex 3).

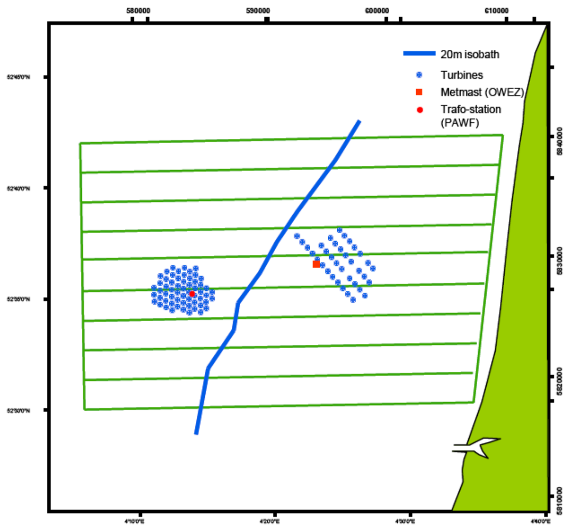


Figure: transect lines local bird surveys

In addition tracks across the wind turbines lines were sailed to retrieve more detailed information of bird occurrence inside and just outside the wind farm, see figure below.

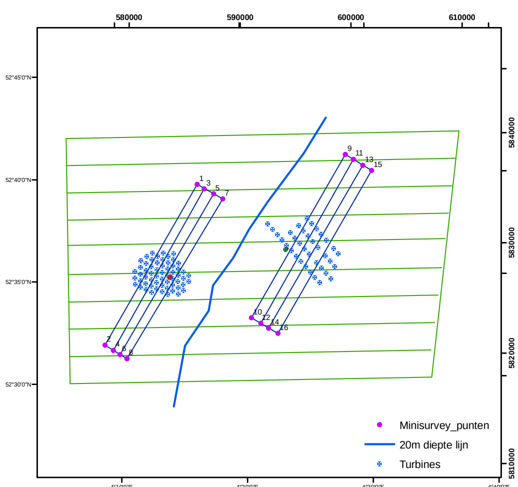


Figure: Detailed information observation tracks

During the third year of seabirds studies after commissioning of the wind farm, five surveys were executed using various survey vessels, see table below.

Survey	from	to	Survey vessel
April	9	9	Vos Northwind
June	22	25	Vos Northwind
October	5	9	Oil Express
November 2008	2	6	Oil Express
January 2010	18	22	Vos Northwind

Table: Local bird surveys

Several surveys were hampered by bad weather, particular lots of rain. Still, each transect line was covered at least once.

The June survey showed large plankton blossoms, visible as orange fields. Birds avoided these fields, except two common scoters.

Photo: Planktonfield, 23 juni 2009 (SCV Geelhoed)

5.1.2 Birds flight paths, large scale bird movements

To assess the flight paths of birds in the area of the wind farm, visual observations as well as fully automated radar observations and registration of birdcalls are being carried out from the meteo mast in the wind farm. Radar observations include a vertically and a horizontally operating radar, that collect data continuously through an automated detection system.

The study period in 2009 ran from January until the end of December. In this period, visual data were collected on a total of 20 observation days. Nocturnal bird calls were collected during a nights in spring and autumn, to gain insight in the species composition migrating through the area. An overview is given in the table overleaf.

date	weather conditions					
	wind dir	force Bft	waves cm	visibility km	T_a	clouds/rain
Winter 2008/2009						
Jan 8	SW	3	40	10-5	0	clear sky, later hazy
Jan 15	S	4	100	5	3	overcast, clear view
Jan 29	SE	3	100	3-5	3	overcast, dry
Feb 4	SE	1	50	5	2	almost clear sky, later hazy
Feb 18	SW	2	50	10	5	hazy then clearing partly
Spring 2009						
Mar 5	NW	2-3	20-80	25	5	sunny and clear, later cloudy
Mar 19	NNE	3-4	50-100	3-25	5	foggy start, later sunny and clear
Apr 1	NE	3-4	50-100	0,5-5	10	foggy start, later sunny and clear
Apr 2 (night observation)	ENE	4	80-100	-	8	clear start later cloud
Apr 9	S	3	50	0,1-10		fog late morning
May 20	SW	3	80	25	15	clear and sunny
Summer 2009						
Jul 14	S	2-1	30	25	20	clear and sunny
Jul 23	SW	3-4	100-150	10	20	cloudy, clearing, dry
Aug 25	WSW	3-4	80			overcast, showers
Fall 2009						
Sep 21	SW	2-4	100		17	overcast
Oct 14	E-NW	1-2	0,25-0,5	>25	15	clear and sunny, some cloud later
Oct 22	SE	4-5	0,25-0,5	2-5	8-12	rain first, later dry cloud remaining
Oct 28	S-SW	4-5	0,25-0,75	10-6	8-13	Cloudy but dry, later sun
Nov 11	NW	3-4	1.3	5	9	overcast, some spells of rain
Dec 16	SW	3-4	0,8-1,2	10		overcast, clearing, later sunny

Table : observation days and weather conditions during visual observations on meteo mast

5.1.3 Harbour porpoises

In order to observe and quantify the occurrence of porpoises, it is most suitable to use permanent acoustic recording stations such as anchored T-PODs (see below), as well as visual observations which could yield density estimates. T-PODs enable the researchers to record every porpoise encounter within a radius of some hundred meters and, as the stations were operating throughout the year, diurnal variation, seasonality and other variations in occurrence were analysed. The program that started in 2007 was closed in April 2009. All TPOD’s were retrieved and brought back to Imares at Texel. During the research two TPODs were deployed in the wind farm area and six in reference areas to the South and North, see map on the next page.

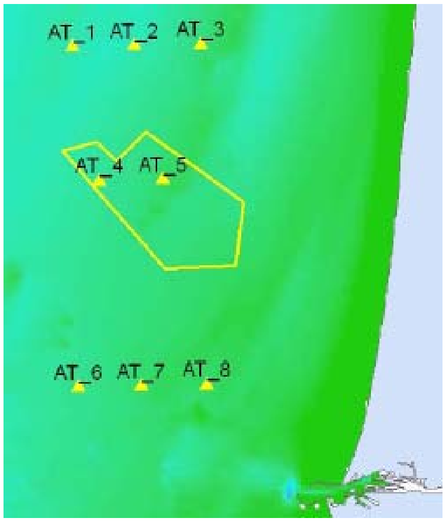


Figure: nine locations of T-POD stations; AT_4 and AT_5 are in the wind farm area.

5.1.5 Fish

Fish telemetry

Since fishing is prohibited in the wind farm, the farm could potentially serve as a refuge area offering 'protection' through creating a 'no take zone' in an intensively fish area. Whether positive effects occur ultimately depends on the behavior of individual fish in relation to the wind farm. For directly measuring the behavior of individual fish and what scale and periods they use the wind farm acoustic telemetry is used. By using fish with implanted transmitters and an array of detection stations in the wind farm, individual presence of fish in the wind farm can be measured throughout time. The array of receivers was set up in the summer. Forty cod and 40 sole were caught, implanted with a transmitter and released again in the wind farm. This research program was approved by the Dutch Commission on Animal Ethics. The receivers with the data were removed in April 2009.

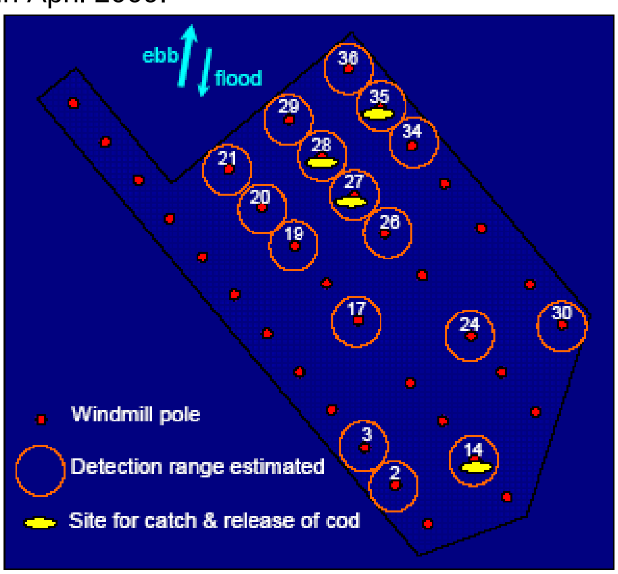


Figure: siting of receivers

5.1.8 Information center

To facilitate information demand of visitors to Egmond aan Zee and other interested parties, a dedicated information center was established in close collaboration with the local tourist office, VVV. This “Infocentrum NoordzeeWind” offers an exhibition on the wind farm and the monitoring program, and is operated by the tourist office. In 2009, like in the previous year, some 50.000 visitors were welcomed specifically to the wind farm exhibition.

Photo: interior of the Infocenter NoordzeeWind in Egmond aan Zee

5.2 Technology research

The aim of the technology research program is to support cost reduction for future off shore wind energy projects. For this purpose, many different data signals are collected from the wind farm and stored in a relational database with 10 minute time stamp as time base for all data. In addition, data are stored from two turbines (#7 and #8) equipped with strain gauges for dynamic measurements, and the data from the meteo mast. The data collection program commenced on 1 April 2007 and data collection was continued during the entire year 2009. Despite the complex hardware that is needed to generate all the required data, the data collection in general went smoothly. The most important component of the monitoring program, the meteo mast, has shown a number of instrument outages. The Acoustic Doppler Current Profiler (ADCP), mounted at the meteo mast foundation, suffered from biofouling leading to absence of water data during the entire year. The overall instrument availability of the met mast in 2009 was 72%.
The loads data measurement campaign at wind turbine 7 and 8 was closed in April.
The datasets are complemented by reports based on the measurements, and relevant design documents. In many cases the data are accessible to third parties, refer to section 5.2.3.

5.2.1 Database

The database contains: meteorological data (from the meteo mast, and wind speed of all 36 wind turbines), oceanographic data measured at the meteo mast (2007/2008 only), wind turbine production figures, failure ("event") data, operational status of all 36 wind turbines, detailed Scada data of wind turbines #7 and #8, measured load measurements at wind turbine #7 and #8, power quality data and cable temperatures measured in the shore connection cables. The following table summarizes the content of the data of 2009 in the database. Refer to annex 4 for an overview of reports published and data collected in 2007 and 2008.

Parameter	Number of signals	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Winddata metmast (10 minute average values)	50	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
PV data wind turbines	72	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Event data	252	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Operation status all WT's	684	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Detailed Scada data WT7&8	12	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Loads WT7&8	108	**X**	**X**	**X**									
SCC Cable temperature	3	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**

Table: overview of contents of database, note **X** indicates that data is present in the database, in general data availability for the month is between 70 and 100%.

The wind and metocean data are available per month in zipped Excel XLS files for downloading, on either http://www.noordzeewind.nl/ or http://www.senternovem.nl/offshorewindenergy/. Other data are available on request, refer to section 5.2.3.

5.2.2 Reports and documents

Reports were published on (long term) wind resource, wave conditions, influence of waves on O&M activities, the operations in 2008, and wake effects. Please refer to the table below.

Title report	Topic	Report reference
Operations report 2008	Operations	Operations report 2008 20090807
Analysis and evaluation on collected lightning strike data	Lightning	OWEZ_R_113_20090803_lightning.pdf
Meteorological Measurements OWEZ Half year report 01-07-2007 - 31-12-2007	Wind resource	OWEZ_R_121_20070701-20071231_wind_resource_2007_2.pdf
Meteorological Measurements OWEZ Half year report 01-07-2008 - 31-12-2008	Wind resource	OWEZ_R_121_20080701_20081231_wind_resource_2008_2.pdf
Measurements of wind, wave and currents at the OWEZ windfarm	Wave conditions	OWEZ_R_122_Wave_20050701_20081231-20100107.pdf
Predictions and Measurements of Wave Heights for O&M Procedures	Wave conditions and operations	OWEZ_R_152_Wave_height_forecasts_20060101_20081013_March2010.pdf
OWEZ Wind farm efficiency	Wind farm wake effects	OWEZ_R_183_20070101-20080301_wake_efficiency.pdf

These reports can be downloaded from http://www.noordzeewind.nl/ or from http://www.senternovem.nl/offshorewindenergy/. The database contains relevant design, inspection, and operational reports as well. Subjects include foundation design, corrosion protection, scour protection, and electrical infrastructure.

5.2.3 Requests for data and reports

NoordzeeWind is committed to making as much information as possible available into the public domain, subject to restrictions of prevailing commercial interests of any of the project partners. Several of the data and reports resulting from the technology program are (temporarily) confidential. Data that are freely available can be downloaded from the website[4]; confidential data may be available upon signing of a non-disclosure agreement.

Since the start of the program several research institutes like TUDelft and ECN approached NoordzeeWind with a request to make use of data derived out of the technical monitoring program. In all cases the requested data were delivered under an NDA to the respective parties.

[4] Refer to http://www.noordzeewind.nl/ or http://www.senternovem.nl/offshorewindenergy/.

6 Operations management

Operations management is built on a foundation of management of health, safety, security and the environment – abbreviated HSSE. All activities related to the performance of the wind farm asset, the electrical infrastructure and substation, as well as all surveying and monitoring activities are carried out in a structured fashion. HSSE is a core line management responsibility, built on a policy that is shared between all parties working on the project. The key aspects of this policy are:

- No harm to people;
- Protect the environment;
- Use materials and energy efficiently;
- Play a leading role in promoting best practices in our industry;
- Manage HSSE matters as any other critical business activity;
- Promote a culture in which all persons working on the project share this commitment.

6.1 HSSE aspects of operational strategy

Day-to-day operations are carried out by the main contractor BCE in accordance with criteria defined in the Operations and Maintenance agreement with the owner, NZW. All work is covered under a HSSE management system. This management system stipulates a pro-active way of working which includes the following.

Method statements
Method statements and risk assessments are developed for all on- and offshore activities. Frequently this is done by collaboration between (sub) contractors and the owner using "hazard identification" workshops. This provides an efficient forum for exchange of expertise, and fosters alignment between owner and contractor aspirations.

Safety reporting
All incidents, near-misses, unsafe situation and unsafe acts are reported, are regularly reviewed at project board level, and remedial actions defined and taken.

Offshore competence
Minimum offshore competence requirements have been defined for all project staff (i.e. owner, contractors, and subcontractors). Depending on the type of activities, these can be 3 day or 1 day offshore survival training, tower climbing training, and rescue from heights training.

Offshore site control
Access to the offshore site is strictly limited, as the entire area including a safety zone of 500 m around the wind farm perimeter is an exclusion zone to all vessels except those that are required for the operation of the wind farm. A Work Vessel Control procedure has been established to control and coordinate all vessel movements at the offshore site, and issue work permits. This has been done in close liaison with the authorities.

Work permits
Work permits are required for all non-routine activities and for all vessel activities. These are issued by the main contractor, BCE. See below for more details.

Regular meetings and toolbox talks
HSSE is discussed in all regular meetings including the toolbox talks held before the start of activities. Findings are systematically tracked and closed out.

Weather limits
Carefully maintained limits have been set to weather conditions for working offshore. Working at site is only allowed below a sea state of 1.5 meters of significant wave height, clear visibility and no lightning. Specific tasks (e.g. lifting at height) can also be limited by wind speed. Working at night is not encouraged but allowed in principle, provided sufficient precautions are taken.

Offshore transfer
Transferring from an access boat to the fixed structure of a wind turbine is one of the more hazardous activities in the project, due to the movement of the boat compared to the structure. Strict procedures apply as outlined in the section below.

Stopping work
All people working on site have the power and obligation to stop any unsafe activity. Work can only be resumed when the unsafe situation is resolved adequately. If such a safety stop occurs it is immediately reported to senior project management.

Emergency response
An emergency response plan is in place, which has been developed together with the authorities and emergency services. The plan forms part of the operating permit.

6.2 Work permits

A key step in managing safety is that for all non-routine and high-risk activities a work permit is required, called Permit To Work (PTW). In general, a PTW is needed for entry of the restricted area of the wind farm by work vessels, any work involving high voltage, hot work (welding etc), and any non-routine activities. In line with common practice a PTW has a validity of one activity. Each PTW is issued as the final step of a process:

1: a method statement\risk assessment to be made by the contractor;
2: approval by BCE of the method statement\risk assessment;
3: audit by BCE of the vessels used (if applicable);
4: site induction of the captain of the vessel(s) (if applicable);
5: evidence of adequate training of staff involved in the job;

6: coordination of jobs by BCE;
7: a request of the job leader to the BCE operations manager for a PTW;
8: Issue of the PTW by BCE after successfully concluded steps 1-7.

A method statement is required for each activity at site requiring vessels or non-routine activities. The statement at least states:

- The activity to be carried out (the more complex, the more detail will be required);
- The vessel(s) to be used;
- Required staff;
- A risk assessment including mitigating measures.

Vessels have to meet minimum requirements and are audited prior to being approved to work on the project. The vessel audit comprised general safety on board, presence of formal paperwork, compliance with legally obliged environmental and safety requirements, and a general introduction to the NoordzeeWind project.

6.3 Working at site, go/no go decisions

Access of the wind turbines is by vessel, operating out of the port of IJmuiden. Different crew transfer vessels have been used during the first operating year, like Fob Lady and similar vessels. Typical dimensions are an overall length of about 15 - 25 meters, width 6 meters, transporting capacity up to12 people and a speed up to 30 knots. For all these vessels the limitations of the suitable weather window are about the same, which in practice means 1.3 - 1.5 meter significant wave height. The vessels can operate in higher seas, but transfer of people from the vessel to the wind turbines and vice versa is considered to be unsafe under these conditions. Swell and currents may also have an impact on accessibility, as strong currents may occur which make docking at the turbines difficult. Strict procedures are in place for transfer from the vessel to the turbines, and back. These procedures include requirements on weather conditions, training of personnel, protective equipment, and safety devices such as mandatory use of immersion suits whenever the sea water temperature is 12 deg Celsius or lower, and the use of crew finder beacons.

Photo: Crew tender Fob Lady[5]

[5] Source: internet

In case the forecasts and on line data show marginal conditions, and there is doubt on the actual situation on site, the decision is usually taken to sail out and assess the local situation. In those cases the initial decision is with the captain of the crew vessel to allow or refuse the transfer, as is common practice in the offshore industry. In case the captain decides that access can be safely allowed, still any individual engineer has the full right to refuse transfer if he/she feels uncomfortable.

The actual sea state is also monitored via http://www.actuelewaterdata.nl/golfgegevens/ and http://www.hmc-noordzee.nl/, public web sites of Rijkswaterstaat that provide the last 24h of data and show measurements from various metocean stations in the vicinity of the project site. This combination of weather forecasts turned out to be sufficiently accurate, and was used for operations planning purposes.

In order to provide more data on actual sea state and wave heights the wave measurement system (Radac -wave radar) was installed at turbine 11 and is wave data is now available on line for vessel control purposes.

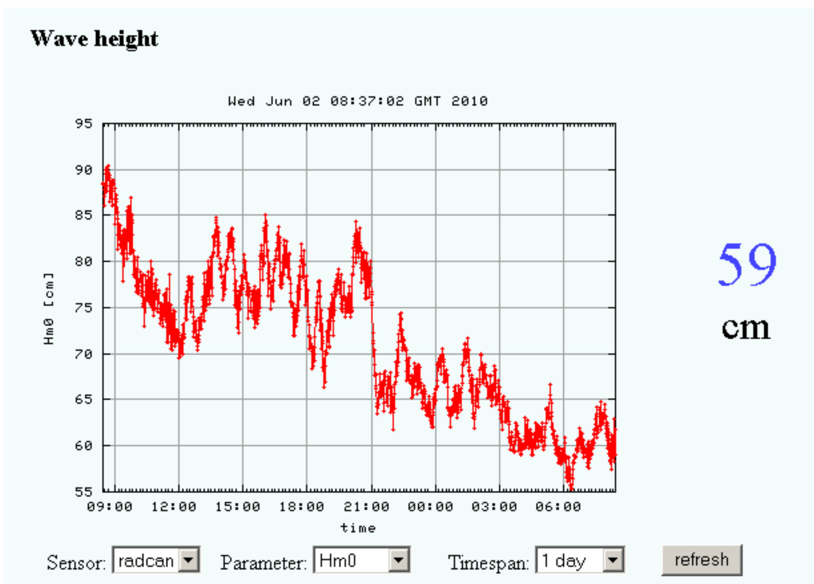


Figure: example of online wave data at turbine 11

6.4 Man hour recording and incident reporting

The total number of man hours spent at the project site in 2009 was over 70,000 hours (over 60,000 in 2007 and 2008). Helped by the joint efforts from all staff working on the project, including contractors, subcontractors, and owner representatives, again no injuries or incidents needed to be reported.

NZW stimulates and tracks the safety reporting to learn and to improve. Excellent reporting was done in 2009, resulting in over 200 reports.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total Exposure hours	4139	2285	9755	10349	7022	6031	7438	5423	6377	6655	4527	3925	73926
LTI	0	0	0	0	0	0	0	0	0	0	0	0	0
TRC	0	0	0	0	0	0	0	0	0	0	0	0	0
TRCF	0	0	0	0	0	0	0	0	0	0	0	0	0
HSE review	1	1	1	2	1	1	1	1	0	0	0	0	9
Unsafe acts\Near miss\Review	21	10	15	26	24	14	33	7	13	24	16	13	216
Safety improvements	3	0	1	0	0	0	1	0	0	0	0	0	5
Stop Work	0	0	0	0	0	0	0	0	0	0	0	0	0
Near Miss	0	0	0	0	0	0	3	0	1	1	0	2	7
Unsafe condition	1	0	1	3	6	0	0	1	5	5	4	4	30
Unsafe behaviours	0	0	0	1	0	2	3	0	1	1	2	1	11
Safety audits\reviews	0	1	1	1	0	1	1	1	1	1	1	1	10
Safety observations	13	8	12	17	17	10	23	4	2	14	7	4	131
Accidents	0	0	0	0	0	0	0	0	0	0	0	0	0
Stop work ambient	3	1	0	4	1	1	2	1	2	2	1	1	19
First aid	1	0	0	0	0	0	0	0	1	0	1	0	3

Table: HSE statistics 2009 LTI: Lost time injury, TRC: The sum of injuries resulting in fatalities, permanent total disabilities, lost workday cases, restricted work cases and medical treatment cases, TRCF: The number of total reportable cases per million exposure hours.

7 Conclusion and outlook

The offshore windfarm at Egmond aan Zee successfully continued the third year of operation. with just over 315 GWh delivered to the grid (enough electricity for approximately 95,000 Dutch households). The implementation of the updated gearbox has been successfully finished in 2009, although availability suffered as a result. Three foundations have been repaired and the repair of the remaining 33 foundations will have a limited impact of the downtime. Aside from this, performance of the plant has been good, and the outlook for 2010 is positive.

Annex 1: Pie charts operations 2009

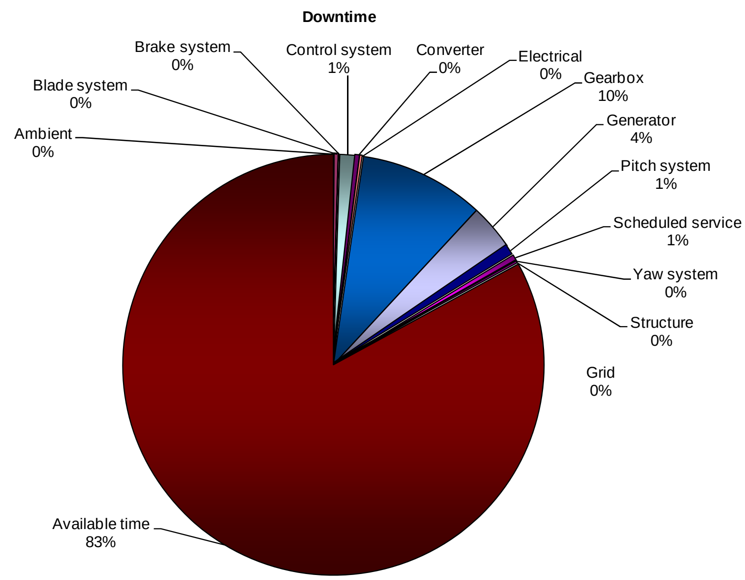


Figure: overview of the total available time and downtime for 2009

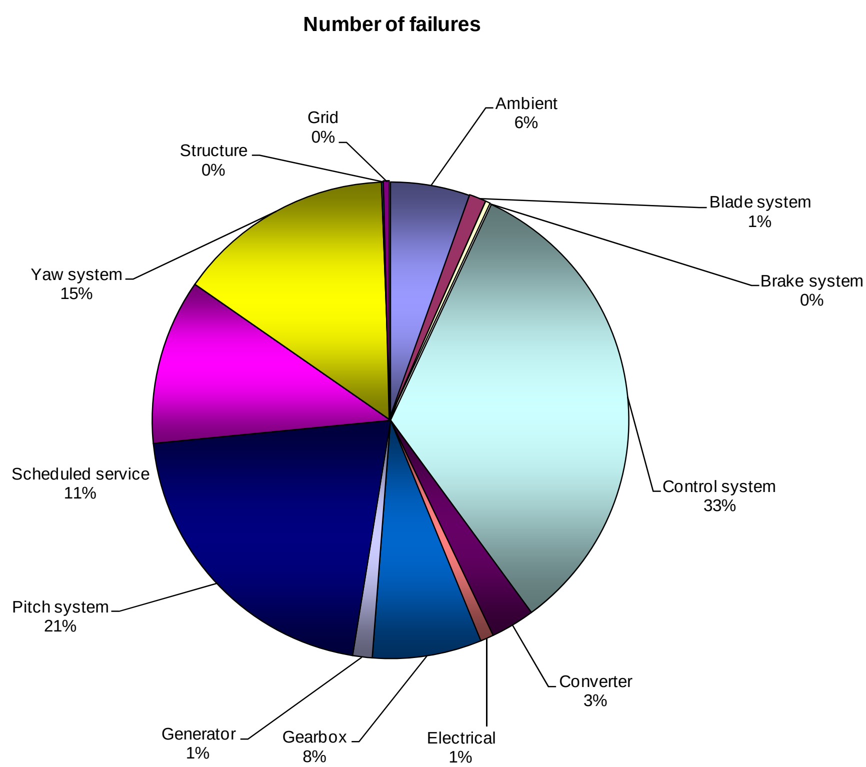


Figure: distribution of stops per subsystem

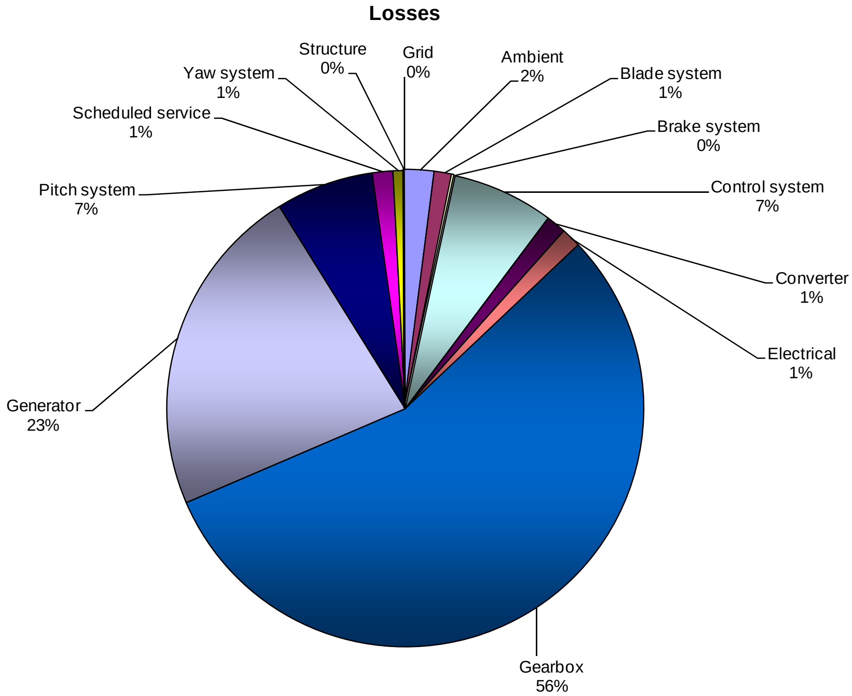


Figure: losses as function of failures of subsystems

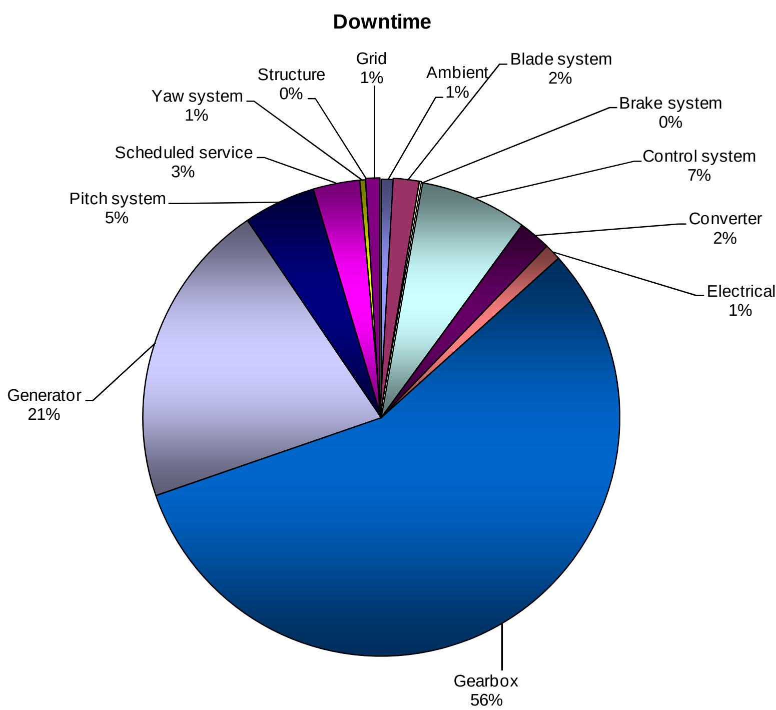
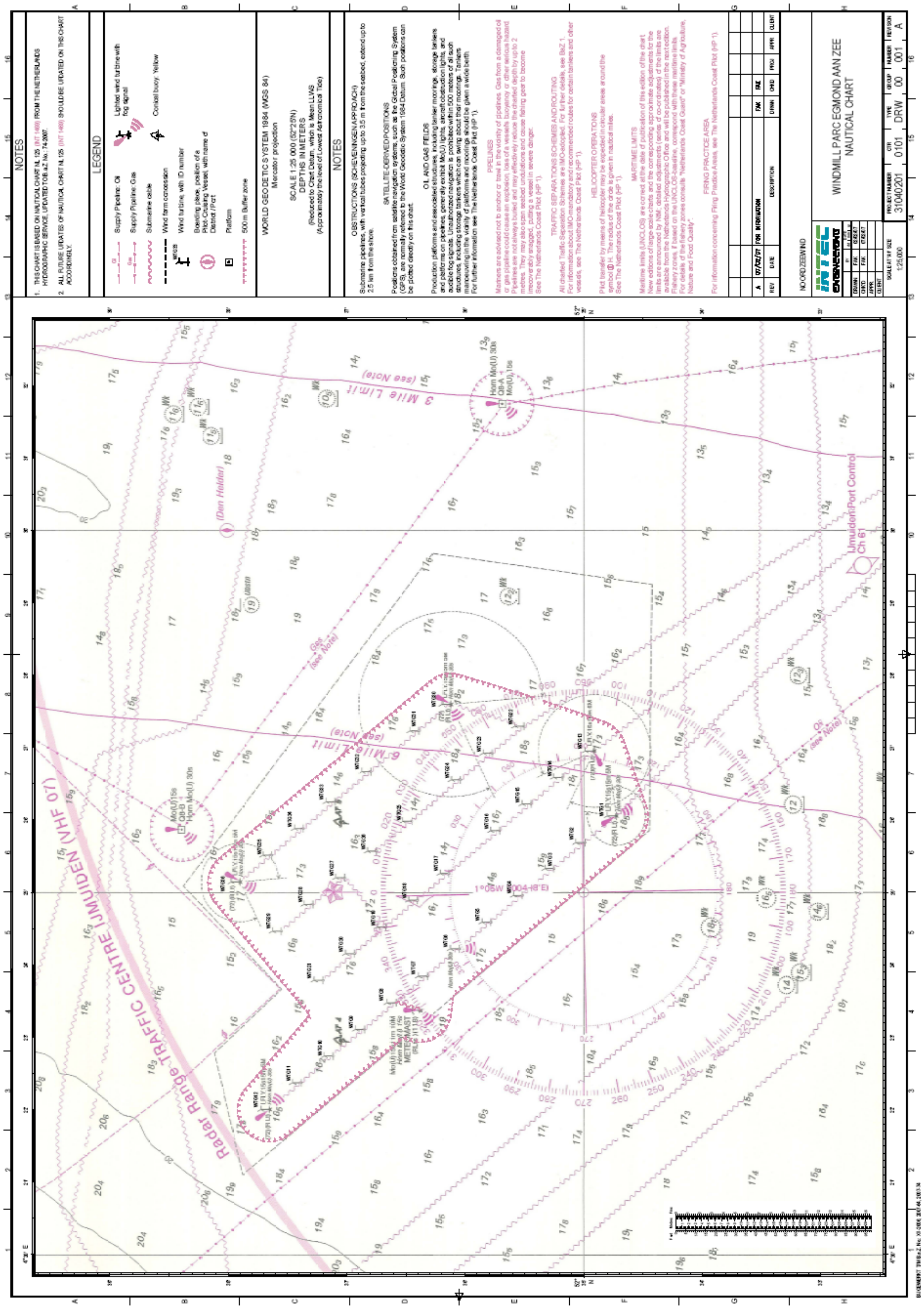
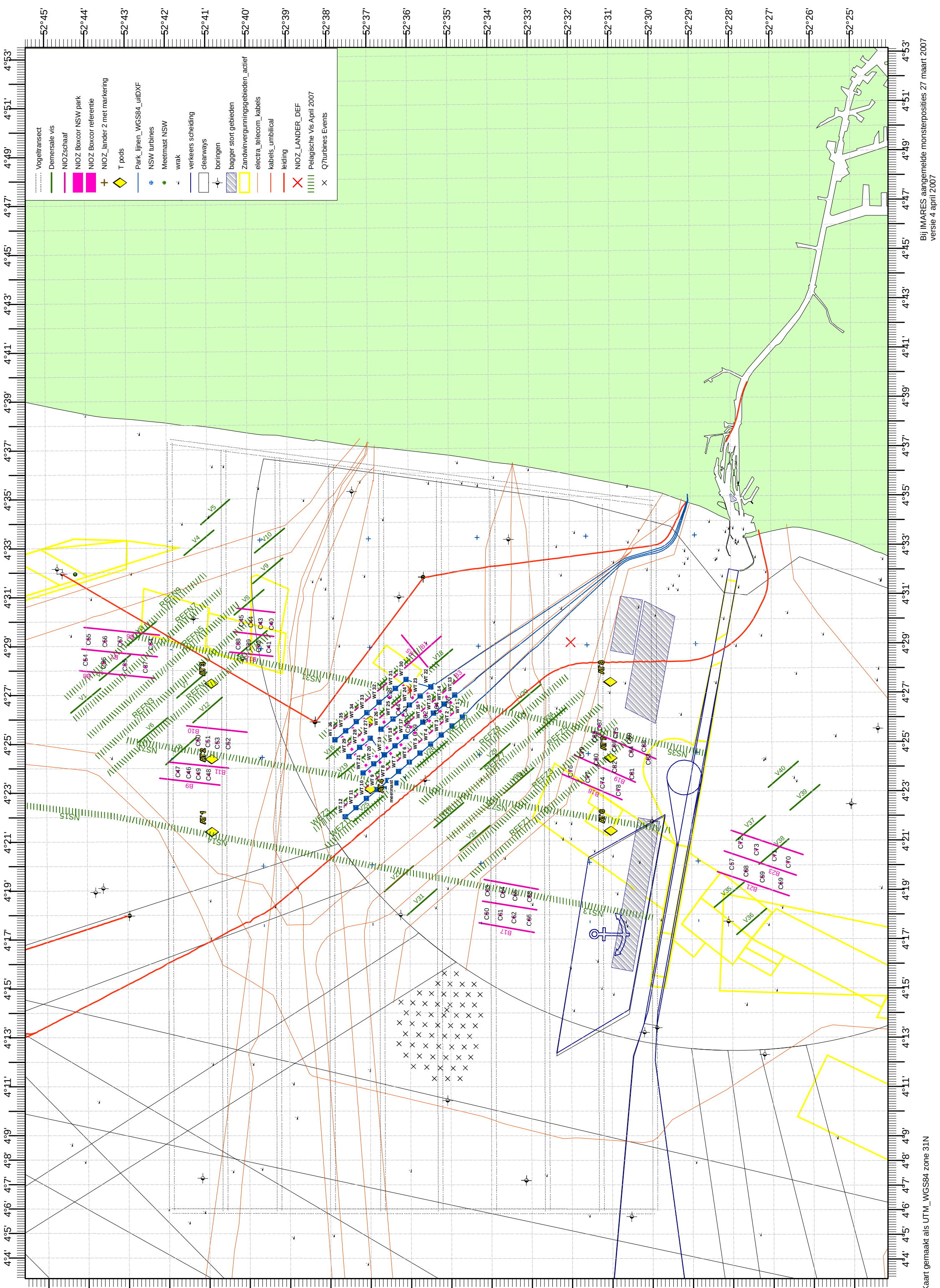


Figure: downtime as function of failures of subsystems

Annex 2: Nautical map



Annex 3: Research area map



Annex 4: Reports and data Technology program 2007/2008

Published in 2007:

Title report	Topic	Report reference
Pre-survey of marine fouling on turbine support structures of the Offshore Windfarm Egmond aan Zee	Biofouling	OWEZ_R_112_20060725.pdf
Meteorological Measurements OWEZ Half year report 01-07-2005 - 31-12-2005	Wind resource	OWEZ_R_121_20050701-20051231_wind_resource_2005_2.pdf
Meteorological Measurements OWEZ Half year report 01-01-2006 - 30-06-2006	Wind resource	OWEZ_R_121_20060101-20060630_wind_resource_2006_1.pdf
Meteorological Measurements OWEZ Half year report 01-07-2006 - 31-12-2006	Wind resource	OWEZ_R_121_20060701-20061231_wind_resource_2006_2.pdf
Meteorological Measurements OWEZ Half year report 01-01-2007 - 30-06-2007	Wind resource	OWEZ_R_121_20070101-20070630_wind_resource_2007_1.pdf
Off Shore Wind farm Egmond aan Zee General Report.	Construction of OWEZ	OWEZ_R_141_20080215 General Report. pdf
Short-term output prediction OWEZ Wind forecasting Reporting period 2004-06-01 - 2006-05-31	Power forecasting	OWEZ_R_172_20040601-20060531.pdf
Surrounding obstacles influencing the OWEZ meteo mast measurements	Wind measurements	OWEZ_R_181_T0_20070821 undisturbed wind.pdf
User manual data files meteorological mast NoordzeeWind	Wind measurements	NZW-16-S-4-R03 Manual data files meteo mast NoordzeeWind.pdf
Rapportage Proces vergunningverlening Offshore Windpark Egmond aan Zee (in Dutch only)	Licensing process OWEZ	OWEZ_R_192_20070820 vergunningen
Maritime and marine risk assessment of calamitous (oil) spills	Safety risks for shipping	OWEZ_R_280_20060720.pdf

Parameter	Number of signals	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Winddata metmast	50	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Metocean data	8										**X**	**X**	**X**
PV data wind turbines	72	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Event data	252		**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Operation status all WT's	684	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Detailed Scada data WT7&8	12	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Loads WT7&8	108		**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Power quality	6				**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
SCC Cable temperature	3				**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**

Note: **X** indicates that data is present in the database, in general data availability for the month is between 80 and 100%.

Published in 2008:

Title report	Topic	Report reference
Operations report 2007	Operations	OWEZ_R_000_20081023 Operations 2007.pdf
Survey of marine fouling on turbine support structures of the Offshore Windfarm Egmond aan Zee	Biofouling	OWEZ_R_112_T1_20081030.pdf
Meteorological Measurements OWEZ Half year report 01-01-2008 - 30-06-2008	Wind resource	OWEZ_R_121_20080101-20080630_wind_resource_2008_1.pdf
Description of the relation of Wind, Wave and Current Characteristics	Waves	OWEZ_R_122_Wave_2006_20080409.pdf
The OWEZ Meteorological Mast Analysis of mast-top displacements	Wind resource	OWEZ_R_121_mast_top_movement.pdf
Short-term output prediction OWEZ Wind forecasting Reporting period 2007-01-01 - 2007-06-30	Short term power forecasting	OWEZ_R_172_20070101-20070630_PowerForecast_20081008.pdf

Parameter	Number of signals	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Winddata metmast (10 minute average values)	50	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Winddata metmast (raw data)	50	**X**	**X**										
Metocean data	8	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	
PV data wind turbines	72	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Event data	252	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Operation status all WT's	684	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Detailed Scada data WT7&8	12	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Loads WT7&8	108		**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Power quality	6	**X**	**X**	**X**									
SCC Cable temperature	3	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**	**X**

Table: overview of contents of database, note **X** indicates that data is present in the database, in general data availability for the month is between 80 and 100%.