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OFFSHORE WIND CAPITAL GRANTS SCHEME

Scroby Sands Offshore Wind Farm
3rd Annual Report

JANUARY 2007 — DECEMBER 2007

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EXECUTIVE SUMMARY

Scroby Sands Offshore Wind Farm's third year of operation is summarised in this report. The operation in the two previous years has similarly been reported previously.

Scroby Sands Offshore Wind Farm is situated on a sand bank a little over two nautical miles off the coast of Norfolk and consists of 30 2MW turbines giving a capacity of 60MW. The wind farm has completed its third year of operation as summarised within this report.

Scroby Sands is a pioneering project being one of the first offshore wind farms in the UK. The learning and experience in operating and maintaining the wind farm has been instrumental in improving reliability, reducing maintenance costs and reducing repair durations.

The third year of operation has been successful with both the availability and production performance of the wind farm better than forecast. This was achieved despite the unexpected failure in April of both a cable transition joint (repaired promptly in April) and a sub-sea cable on one of the three electricity export circuits (yet to be replaced) which reduced the maximum output available from the wind farm.

The improved operational performance is the result of applying the valuable experience gained from previous operational years in the continual evolution of a proactive maintenance philosophy and the drive by the manufacturer for continual improvement. Furthermore, although the amount of work activity was greater than previous years, the amount of turbine downtime was significantly reduced.

Significant progress has also been made in resolving some of the long standing technical issues facing the wind farm. For example, the generator problems have been fully resolved, the effect of the gearbox defects minimised by pro-active maintenance, and a final solution of the gearbox defects planned to be implemented in 2008.

Future Forecast

With the main component technical issues being addressed and the manufacturer's drive to address availability and downtime paying off, the future for the wind farm looks very promising, with an expectation that both the production and availability will continue to increase beyond the original budget.

SITE PLAN

The site plan showing turbine positions, water depths and cable routes is shown in Figure1.

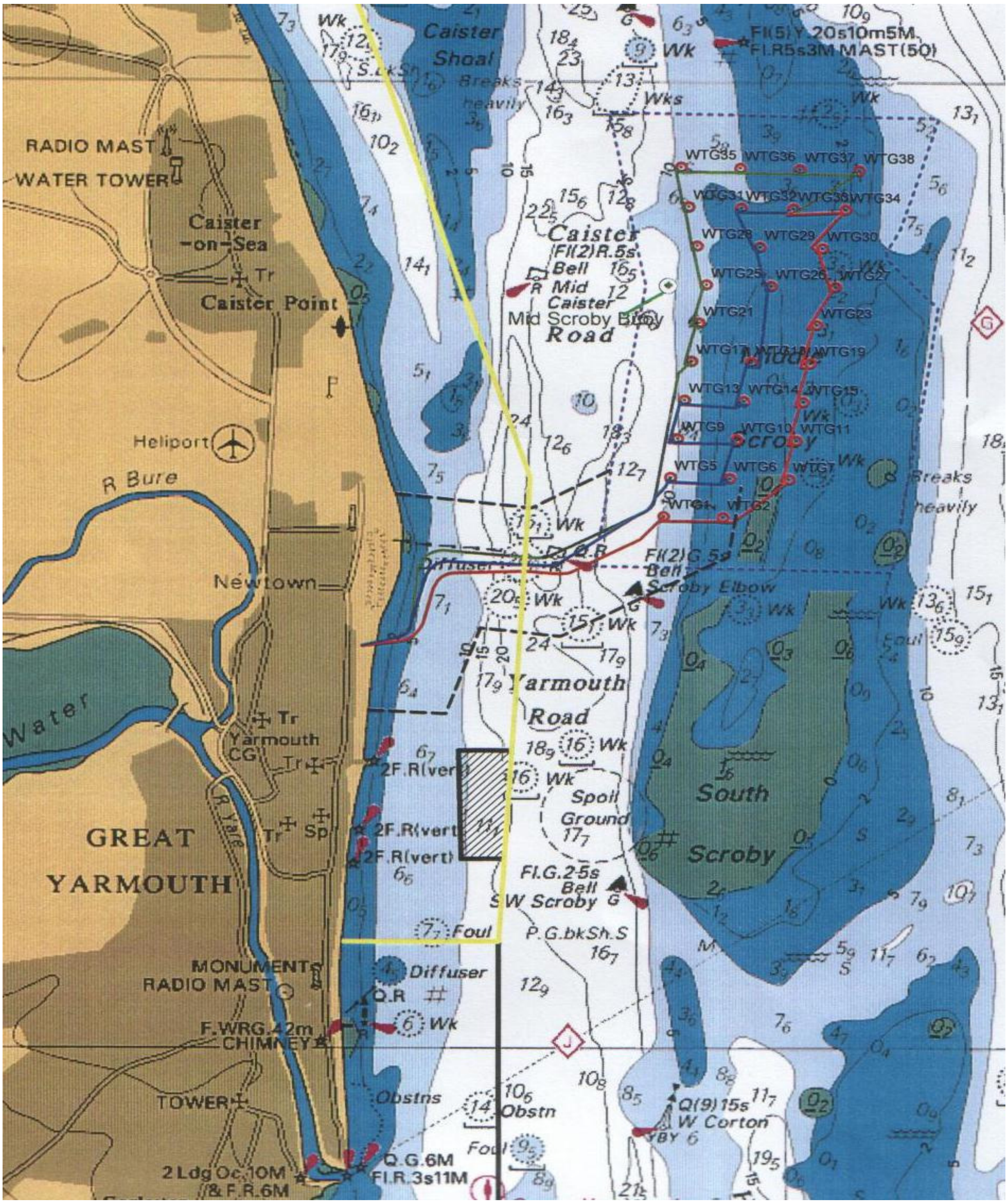

Figure 1- Site Plan

National Grid Reference			
East	North	East	North
655765	310945	656806	312673
655917	312384	657400	312200
655629	313600	657264	310997
657241	313600	655765	310945

Table 1 – Site boundaries

The three 33kV electrical circuits connect the turbines to the local 33Kv distribution network at Admiralty Road substation in Great Yarmouth. Each cable nominally connects 10 turbines but this can be reconfigured offshore to facilitate maintenance and minimise the impact of failure in one of the circuits.

WIND FARM ANNUAL OPERATIONAL INFORMATION

PERFORMANCE REPORTING

Availability

Three measures of availability are used to describe the performance of the wind farm.

- **Technical availability** of the wind farm is the actual availability, i.e. the time that the wind turbines are available to generate expressed as a percentage of the theoretical maximum. There is no allowance made for routine or breakdown maintenance activities or for the effects of external influences.

- **Commercial availability** is similar to the technical availability but also includes alleviation for requested stops, the loss of the external grid connection and for waiting on weather (WOW) days. Commercial Availability is always greater than or equal to the Technical Availability.

- **Planned availability** is the technical availability forecasted for the year, calculated by taking into account all of the planned work and available resources, calculated from the annual work plan. The work plan details all of the routine and planned works and was developed to ensure that all work was fully assessed, prioritised and completed within the required timescales.

Table 2 contains a breakdown of availability by month during 2007.

Month	Technical Availability (%)	Commercial Availability (%)	Planned Availability (%)
January	79.34	84.29	73.1
February	86.27	87.47	75.5
March	74.58	79.74	70.7
April	83.24	85.79	76.4
May	79.83	81.95	82.0
June	83.77	87.54	78.4
July	89.97	90.07	72.7
August	93.75	93.86	82.2
September	85.26	86.26	80.4
October	85.28	86.68	81.7
November	74.27	86.71	84.1
December	90.39	94.00	88.0

Average	83.83	87.03	78.8

Table 2 – Monthly Technical, Commercial and Planned Availability

Table 2 shows that Technical Availability performance was 6.4% higher than that of the Planned. It was also 12% higher than the previous year's Technical Availability of 75.1%.

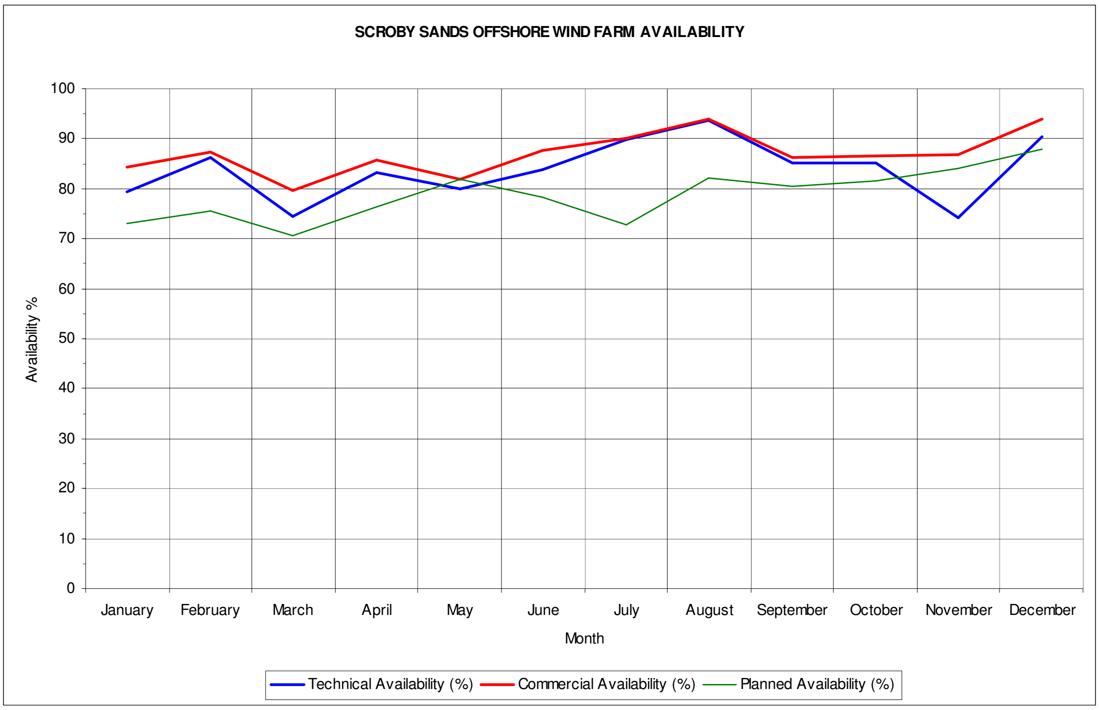

Figure 2 – Monthly Technical and Commercial Availability

Overall, Table 2 and Figure 2 show that availability has been much higher than predicted. This is because the major work completed during 2007 was proactive to improve reliability and availability rather than unplanned work. This work has significantly reduced wind turbine downtime and efforts to reduce repair duration have also been very successful.

Replacement of the remaining 11 generators was scheduled for July hence the drop in Planned Availability, whereas this was actually re-scheduled and undertaken in September, October and November. Technical Availability only suffered during November due to a high number of waiting on weather days which delayed returning turbines to service following the generator replacement work.

Wind Speed

The annual average wind speed was calculated at turbine 1 as 8.6m/s at 65 m above Lowest astronomical tide (L.A.T.) with a predominant south westerly wind direction. The monthly average wind speeds are shown in Table 3 and the wind rosette is shown in Figure 3.

Month	Mean Wind Direction	Wind speed (m/s)
January	WSW	11.1
February	SSE	8.4
March	SW	9.8
April	NWN	7.2
May	N	8.6
June	SW	8.9
July	WSW	8.2
August	NNW	7.7
September	NNW	8.7
October	ENE	6.1
November	W	9.5
December	SW	9.5

Table 2 - Monthly Average Wind Speeds and Direction for 2007.

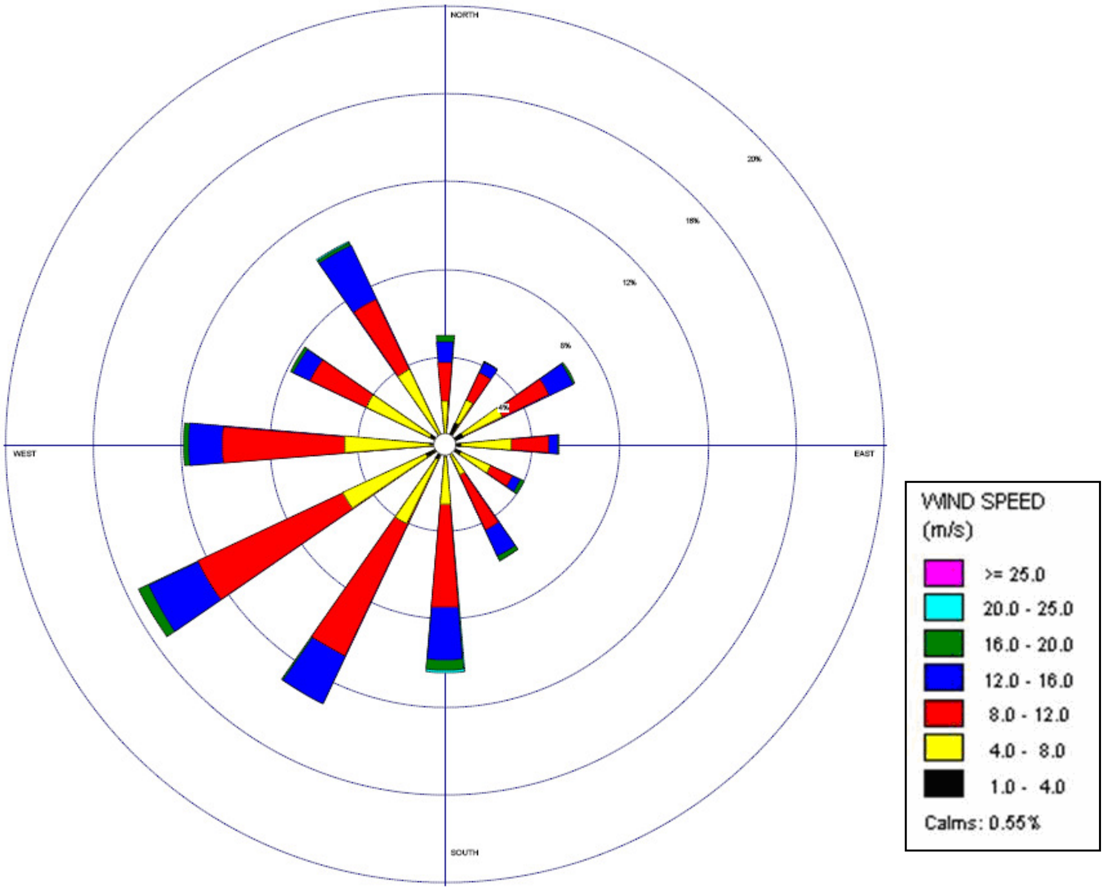

Figure 3 - Wind Rosette for turbine 1 for 2007

Output and Capacity Factor

The monthly wind farm output measured at the sub-station is shown in Table 4.

Month	Period Length Days	Import (MWh)	Theoretical Production at Maximum Rated Output (MWh)	Long Term Monthly Average Budget (MWh)	Actual Gross Power Exported (MWh)	Actual Capacity Factor (%)
January	31	10	44,640	16,929	21071	47.2
February	28	16	40,320	14,555	12714	31.5
March	31	6	44,640	15,030	15243	34.1
April	30	15	43,200	12,657	7607	17.6
May	31	33	44,640	11,549	10296	23.1
June	30	50	43,200	10,600	8673	20.1
July	31	47	44,640	9,176	10458	23.4
August	31	31	44,640	9,967	11089	24.8
September	30	31	43,200	11,549	11986	27.7
October	31	12	44,640	14,872	6960	15.6
November	30	2	43,200	15,188	14548	33.7
December	31	31	44,640	16,296	14556	32.6
Total	**365**	**284**	**525,600**	**158,368**	**145201**	**-**
Average	**-**	**-**	**-**	**-**	**-**	**27.6**

Table 4 - Monthly Production and Capacity Factor

The Long Term Monthly Average Budgeted production for the site was calculated at the outset of the project as follows:

- Wind data collected from the anemometer mast during the site development phase was compared with simultaneous data from the nearby Met Office station at Hemsby.
- The resulting correlations were used in combination with long term wind data from Hemsby to provide a view of the Scroby Sands wind resource as though the wind farm had been in existence for the past 20 years.
- In turn this wind resource, taken with the turbine manufacturer's power curves and our understanding of turbine wake effects and other losses, has been used to predict generation levels averaged over the life of the wind farm.

Therefore any variations against this long term budget production can be attributed to availability variations or variations in normal weather patterns (which lead to changes in average wind resource or to the number of bad weather days which prevent access to the turbines).

The capacity factor is calculated as a percentage comparing the amount of generation produced, with the theoretical maximum generation that would have been produced if the turbines operated at maximum output during a specified time period. The annual budgeted capacity factor is 30.1% but variation about this year on year is expected due to the natural variability of the wind.

A cable transition joint failed on one of the three export cables in April, this reduced the capacity factor in April while the repair was being carried out.

Due to a fault identified (during testing of the replaced cable transmission joint) on one of the three sub-sea export cables, all of the output power has been exported via the two remaining export cables. This has resulted in the maximum theoretical power output being constrained to the maximum power carrying capability of the remaining cables.

Wind Turbine Generator Analysis

The following Table 5 compares the performance of each Turbine during 2007.

Circuit	WTG Number	Production (MWh)	Capacity Factor (%)
String 1 Red	T01	5489.4	31.3%
String 1 Red	T02	6327.0	36.1%
String 1 Red	T07	5651.1	32.3%
String 1 Red	T11	4325.9	24.7%
String 1 Red	T15	5526.6	31.5%
String 1 Red	T19	4317.7	24.6%
String 1 Red	T23	4981.6	28.4%
String 1 Red	T27	3346.5	19.1%
String 1 Red	T30	4877.3	27.8%
String 1 Red	T34	4610.0	26.3%
String 2 Blue	T05	4491.9	25.6%
String 2 Blue	T06	5649.7	32.2%
String 2 Blue	T10	4614.9	26.3%
String 2 Blue	T09	5472.5	31.2%
String 2 Blue	T13	5039.2	28.8%
String 2 Blue	T14	4267.5	24.4%
String 2 Blue	T18	3986.6	22.8%
String 2 Blue	T22	4632.8	26.4%
String 2 Blue	T29	5073.8	29.0%
String 2 Blue	T32	5218.2	29.8%
String 3 Green	T17	6247.2	35.7%
String 3 Green	T21	5178.4	29.6%
String 3 Green	T25	3977.0	22.7%
String 3 Green	T28	5034.6	28.7%
String 3 Green	T31	5320.8	30.4%
String 3 Green	T35	2477.5	14.1%
String 3 Green	T36	4395.8	25.1%
String 3 Green	T37	3072.3	17.5%
String 3 Green	T38	4739.1	27.0%
String 3 Green	T33	4356.5	24.9%
Total		**142699.4***	**-**
Average		**4,756.6***	**27.1***

* These production figures are taken from the SCADA and WTGS controller, the values of which are indicative only and can be seen to be lower than the definitive value measured at the substation (Table 3). In reality the total figure should be higher than that recorded at the substation.

Table 5 – Turbine Production

Annual Import

The annual and monthly electricity imports are given in Table 4.

OPERATIONAL REPORTING

Operating and Maintenance Costs

Operational Costs	Budget (£)	Actual (£)
Scroby Sands Wind Farm	**1,729,960**	**1,642,736**

The Total annual operating costs in 2007 were below budget.

The Total annual operating cost was budgeted at **£1,729,960** which gives a cost of **£28,832/MW** or **£57,665/Turbine** and **£12.57 per MWh.**

However the total actual spend for 2007 (including turbine O&M costs) was lower at **£1,642,736** which gives an actual cost of **£27,378/MW** or **£54,756/Turbine** and £**11.31 per MWh.**

OPERATIONAL ISSUES

An unprecedented amount of work was successfully undertaken during 2007, which included:

- Routine work (routine preventive maintenance and legislative compliance inspections)
- Planned work (pro-active maintenance)
- Unplanned work (breakdown reactive maintenance)

Routine Work

The annual routine work included:

- Annual major service
- Interim minor servicing
- Annual HV apparatus maintenance
- Annual insurance inspections
- Legislative inspections of pressure vessels, lifting and safety equipment

Planned Work

To improve reliability and minimise downtime, E.ON has been working with the manufacturers to resolve the remaining technical issues. This has resulted in a substantial amount of planned proactive maintenance and modifications, particularly associated with the gearbox bearings.

In addition the manufacturers have implemented a successful programme of continuous improvement which has resulted in modifications based on the learning and experiences gained throughout the fleet.

The problems experienced with the generators has been resolved by replacing all the original generators with a generator of proven design with a reliable track record.

The gearbox bearing issues have been managed in the short term by the proactive replacement of the outboard intermediate speed bearings; which was completed on all wind turbines during spring and summer 2007. In addition twelve high speed shaft bearings were identified as worn during routine internal inspections and proactively replaced before failure.

During the autumn and winter of 2007, the remaining thirteen original generators were replaced. All of the generators are now of a design with a proven track record and are performing without any problems.

A work plan detailing all works was developed, to ensure that they were fully assessed, prioritised and completed within the required timescales. This work plan also allowed the availability to be accurately calculated (Planned Availability).

Unplanned Work

During routine internal inspection three turbine gearboxes were identified as requiring replacement. The turbines effected were stopped to minimise damage until a jack-up vessel became available and they were replaced.

Generating capacity was affected following a transition joint failure on one of the three export cables, causing the circuit to be taken out of service for repairs. A replacement joint was promptly installed in the beach. However, during commissioning tests a fault was identified on the sub-sea portion of the cable. The replacement of the sub-sea section of cable is planned for spring 2008.

Until a permanent repair is affected, the power output is shared between the two remaining export cables. This does not affect turbine availability as the system is designed to facilitate cable maintenance. However there is a reduction in generation as a reduction in maximum capacity applies when wind speeds are particularly high.

Turbine Access Arrangements

The wind turbines are accessed using specially adapted transfer vessels. Transfer can take place at wave heights up to approximately 1.5m, depending on wind and wave conditions. Adverse weather and sea conditions can prevent safe access to the turbines, and when this occurs this is agreed as a contractual ‘Waiting on Weather’ (WOW) day.

During 2007 there were a total of 116 WOW days when access to the wind farm was prevented, which are detailed in Table 6.

Month	Number of Adverse Weather Day	Monthly Average
January	11	35.5
February	4	14.3
March	13	41.9
April	8	26.7
May	7	22.6
June	9	30.0
July	6	19.4
August	8	25.8
September	12	40.0
October	7	22.6
November	17	56.7
December	14	45.1
Total	**116**	**31.2%**

Table 6 – Monthly Waiting on Weather (WOW) Days

Remote Monitoring

To monitor, control, communicate and maintain the wind farm, the following systems are operational.

- Vestas Online SCADA (Supervisory Control and Data Acquisition) system
- E.ON UK SCADA II (Supervisory Control and Data Acquisition system
- MAXIMO asset management and work planning system
- Site management database

Each turbine is controlled by an onboard intelligent control system which maximises the turbines output, provides plant protection and communicates with the SCADA systems to allow remote interrogation. Some faults are cleared by the onboard system and the turbines automatically restart. Where human intervention is required for safety or plant integrity reasons, the turbine will stop until remote or local interrogation is completed.

The daily remote monitoring is carried out by the Vestas Operations & Maintenance Team and the Offshore Design Engineering (ode) site management team at Great Yarmouth. Operational information is recorded in the ode Site Management Database.

When an error or alarm occurs the site operators are notified automatically and are able to interrogate the turbine, before sending a team out to reset or correct the defect. In some cases the alarms can be reset remotely removing the need to attend the turbine offshore.

The wind farm is monitored 24 hours a day with out of normal working hours monitoring occurring at the Vestas surveillance centre in Denmark. When an event occurs, the functionality exists within the control system to remotely reset faults and restart turbines where possible. This reduces the time turbines remain out of service for minor errors and defects.

E.ON have implemented a SCADA II system which integrates with the Vestas SCADA system and allows the owner to remotely monitor all of their wind farm assets from anywhere in the world.

Health, Safety and Environmental

Many initiatives have been implemented to further improve the health and safety standards at Scroby Sands and this is reflected by the reduced number of accidents during 2007 and the high number of proactive reported hazards and near hits, compared to the high work activity, number of man-hours worked and potentially hazardous nature of the work. No RIDDOR reportable events occurred.

Classification	Total
Fatality	0
Lost Time Injury	0
Medical Treatment Injury (treatment by a medical practitioner)	1
Minor Injury (local site first aid only)	3
Near Hits	9
Environmental Incident	0
Hazard Reports (safety improvement suggestions)	68

Table 7 – Health, Safety and Environmental Summary

Medical Treatment Injuries

- Engineer received cut to face during removal of turbine nacelle roof

Minor Injuries

- Technician twisted back manoeuvring equipment into a turbine
- Technician twisted back working in nacelle
- Sub contractor cut knee climbing down wind turbine ladder

Proactive Safety Initiatives

In order to support a continual improvement of health and safety standards a number of additional initiatives have been implemented and developed during the year. The expanded health and safety measures included:

- Further development of MAXIMO work management system

- Health and Safety Plan
- Behavioural Safety Training for all staff and sub contractors
- Implementation of E.ON UK Rule.One “We don’t hurt people” initiative
- Daily site based tool box talks
- Weekly site based safety meetings
- Hazard reporting system & proactive hazard spotting initiative
- Action plan for introduction of E.ON Electrical and Mechanical Safety Rules

Environmental Monitoring Programme

Environmental studies and surveys were previously completed in compliance with the Food and Environment Protection Act (FEPA) consent licence and confirmation that the wind farm has met all of the licensing conditions has been made.

To assist with asset risk management however, surveys of the seabed profile continue. A full site coverage bathymetric survey of the wind farm and export cables was undertaken, complete with side scan sonar and magnetometer surveys. The sea bed profiles were correlated from post construction and cable burial depth surveys to identify areas where further inspection may be required.

PUBLIC RELATIONS

Visitor centre

- The centre again proved to be very popular with tourists, locals and school bookings with an estimated 30,000 visitors attending during the holiday season

Community

- Sponsorship of International Chess Competition
- £14,000 Sponsorship of Great Yarmouth Borough Council Tourist firework display
- £5,000 Sponsorship for Caister Community Connection Information Point
- £4,000 Sponsorship for the Caister Lifeboat fireworks display
- Giving presentations to several interested parties.

This report was prepared by E.ON Climate and Renewables. For further information on the Scroby Sands Wind Farm contact:

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