DEPARTMENT OF ENERGY & CLIMATE CHANGE

OFFSHORE WIND CAPITAL GRANT SCHEME

Barrow Offshore Wind Farm
2nd Annual Report

JULY 2007 - JUNE 2008

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EXECUTIVE SUMMARY

This report covers the second year of operation of the Barrow Offshore Wind Farm (BOW). BOW consists of 30 V90 wind turbine generators (WTGs) manufactured by Vestas, each with a rated capacity of 3.0MW. The total installed capacity is 90MW compared with a total capacity of maximum 108MW (30 WTGs of 3.6MW) provided for in the FEPA licence for the construction.

The wind farm was commissioned on 31 May 2006.

The commercial Take-Over Certificate (TOC) was agreed to be 1 January 2007, and the five-year service and warranty period commenced on that date.

During the reporting period a number of remedial and outstanding works from the Engineering Procurement Installation Contract (EPIC) contract was completed. It is expected that the remaining works will be completed by 31 August 2008, except for in-fields cabling work.

The production was disturbed by exchange of all 30 gearboxes during the summer and autumn of 2007. This resulted in a low availability of 78% and a Capacity Factor of 37% for the reporting period. In year one the availability was 67% and the Capacity Factor was 24%.

In the period after the exchange of gearboxes the availability has been close to the warranted availability of 95%.

The annual exported production during the reporting period was 273,426MWh compared to the budget of 314,300MWh.

Health and safety at BOW are considered to be of good standard. The frequency of accidents and incidents during the reported period has been low. Barrow Offshore Wind and its subcontractor Vestas have worked proactively to prevent accidents and incidents. A reward system has been put in place to encourage all on site to focus on health and safety.

A series of environmental surveys has been performed during this reporting period. The results are presented in the chapter ‘Environmental Monitoring’.

In year three the availability is expected to be 95%, with production of about 310 GWh.

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1 SITE PLAN

A location map of BOW is shown below. The 30 WTGs are placed in four rows of alternating 7 and 8 WTGs. The wind farm covers an offshore area of approx 4 x 2.5km, southwest of Barrow-in-Furness, with a distance of 8km from the shoreline to the first row of wind turbine generators. The general water depth in the area is about 15m below Chart Datum.

The route of the 27km offshore high-voltage export cable from the offshore substation to Heysham onshore substation is also shown on the location map below (Fig.1).

The geographical coordinates of each WTG are presented in Table 1 overleaf.

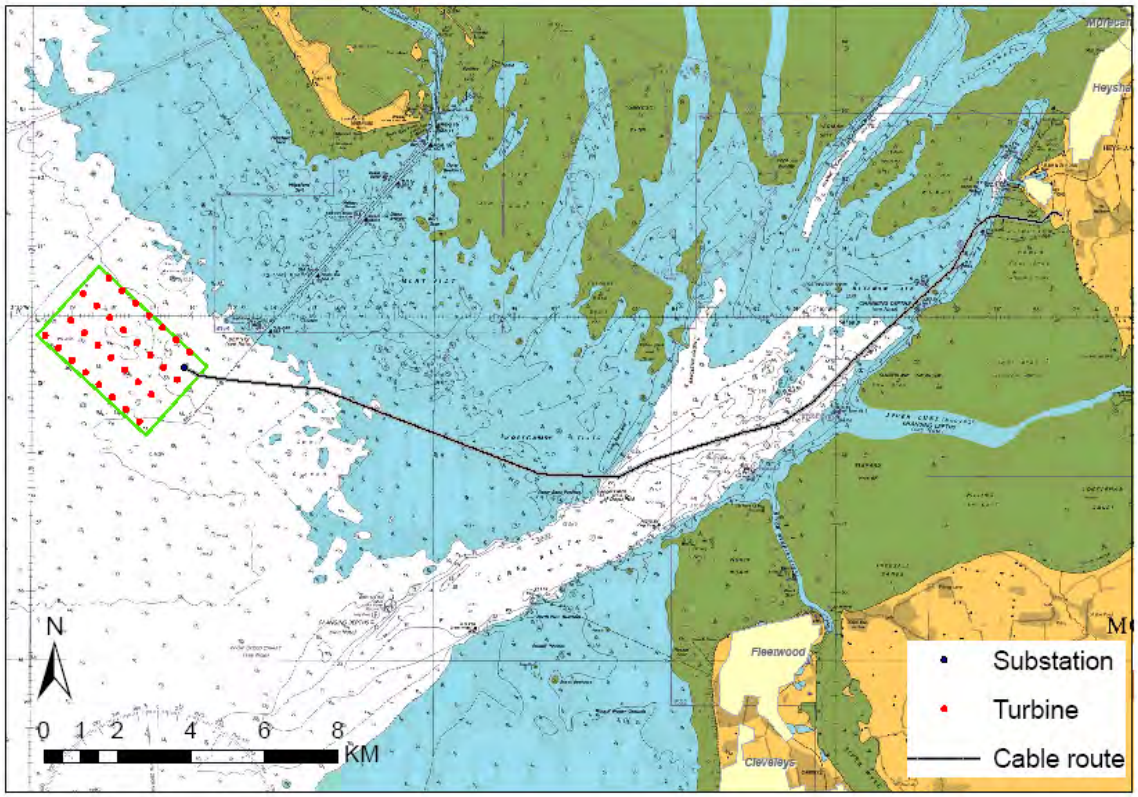

Figure 1 The BOW location map

WTG id		Position (WGS84)							
		Longitude (°, ‘, ‘’)				Latitude (°, ‘, ‘’)			
1	D8	3	19	45.167	W	53	59	42.878	N
2	D7	3	19	25.036	W	53	59	32.226	N
3	D6	3	19	4.908	W	53	59	21.570	N
4	D5	3	18	44.780	W	53	59	10.914	N
5	D4	3	18	24.653	W	53	59	0.254	N
6	D3	3	18	4.532	W	53	58	49.598	N
7	D2	3	17	44.412	W	53	58	38.939	N
8	D1	3	17	24.299	W	53	58	28.279	N
9	C7	3	19	6.974	W	53	59	56.004	N
10	C6	3	18	46.840	W	53	59	45.348	N
11	C5	3	18	26.712	W	53	59	34.692	N
12	C4	3	18	6.588	W	53	59	24.032	N
13	C3	3	17	46.460	W	53	59	13.376	N
14	C2	3	17	26.340	W	53	59	2.713	N
15	C1	3	17	6.216	W	53	58	52.054	N
16	B8	3	18	48.899	W	54	0	19.786	N
17	B7	3	18	28.768	W	54	0	9.130	N
18	B6	3	18	8.636	W	53	59	58.470	N
19	B5	3	17	48.509	W	53	59	47.810	N
20	B4	3	17	28.381	W	53	59	37.151	N
21	B3	3	17	8.257	W	53	59	26.491	N
22	B2	3	16	48.140	W	53	59	15.828	N
23	B1	3	16	28.024	W	53	59	5.165	N
24	A7	3	18	10.696	W	54	0	32.908	N
25	A6	3	17	50.557	W	54	0	22.248	N
26	A5	3	17	30.426	W	54	0	11.588	N
27	A4	3	17	10.295	W	54	0	0.929	N
28	A3	3	16	50.171	W	53	59	50.266	N
29	A2	3	16	30.050	W	53	59	39.602	N
30	A1	3	16	9.934	W	53	59	28.939	N
Substation		3	16	12.713	W	53	59	15.104	N
Landfall cable		2	54	42.552	W	54	1	27.840	N

Table 1 The geographical coordinates of each WTG

2 CONSTRUCTION

2.1 Overview of the Construction Programme until June 2008

The following table provides an overview of the actual progress in time of the procurement and construction works.

ID	Description	2004		2005				2006				2007				2008		
		3rd qt	4th qt	1st qt	2nd qt	3rd qt	4th qt	1st qt	2nd qt	3rd qt	4th qt	1st qt	2nd qt	3rd qt	4th qt	1st qt	2nd qt	3rd qt
1	Procurement of plant																	
2	Onshore work																	
3	Foundation installation																	
4	Turbine installation																	
5	Offshore cabling																	
6	Grid connection																	
7	Commissioning																	
8	Wind farm tests																	
9	Outstanding and remedial EPIC works																	

Table 2 The Construction Programme

2.2 Description of Construction Methods

2.2.1 Procurement of plant

The EPIC main contractor VKBR (Vestas Celtic and Kellog Brown) has procured and installed all items necessary for establishment of BOW.

VKBR used SIF & Smulders Hoboken as sub-contractors for the procurement of the foundation steel works, i.e. for manufacturing of monopiles, transition pieces and J-tubes and delivery to the load out site at Harland & Wolff in Belfast.

AREVA was engaged as the sub-contractor for supply and delivery of all electrical and related components, i.e. the offshore substation at BOW and the onshore substation in Heysham.

Vestas Celtic, the one partner of the VKBR Joint Venture, supplied the 30 wind turbine generators.

2.2.2 Onshore preparation

BOW is connected by a high-voltage export cable, which includes a 1.5km long onshore section, to Heysham electrical substation and the national grid. For the connection of BOW to the national electricity grid, a separate onshore substation has been constructed at Heysham substation.

Electrical installations for the BOW substation in Heysham are all complete, and the Supervisory Control And Data Acquisition (SCADA) system is linked up and running.

2.2.3 Foundation installation

The structure used to support the WTGs is a monopile foundation. This type of foundation has also been used for other large offshore wind farms. A main steel pile is driven into the seabed by means of a hydraulic hammer, being operated from a jack-up vessel ("Resolution"). At BOW, in 9 out of 30 monopiles it was necessary to drill out the internal soil plug prior to driving the pile to the final level. The monopiles installed all have a diameter of 4.750m and a length of between 49 and 61m – the actual pile length was determined on the basis of an assessment of the soil conditions at each WTG position. All monopiles were driven to a final level where each monopile has a top level of +5.0m CD (corresponding to Mean Sea Level (MSL)).

The transition pieces (TPs) with a service platform for operation and maintenance were then grouted onto the monopile. The transition piece is also provided with a flange onto which the wind turbine tower is bolted. The top level of each TP is +20.25m CD.

In order to connect the WTGs to the grid, the foundations hold internal J-tubes for installation of submarine cables. The foundation installation was started in May 2005 and completed in November 2005 using the jack-up vessel "Resolution". The installation of foundations was delayed for various reasons, for example design of grout seal connection, the required time for drilling of the soil plugs in nine monopiles and weather downtime.

2.2.4 Offshore turbine installation

After completion of the foundations, the WTGs were installed. The installation of WTGs was completed on 30 April 2006. Four complete WTG sub-assemblies were transported on "Resolution" from Belfast to BOW. Three lifts were required for each complete wind turbine:

- The first lift is the complete tower
- The second lift is the nacelle with two turbine blades ("bunny ears")
- The third lift is the final turbine blade, which finalises the mechanical installation.

The hub height of the WTGs installed is at a level of +80m CD, and the rotor diameter is 90m.

2.2.5 Offshore cabling

The cables from the WTGs interconnect in four rows of 7-8 WTGs, each having one cable connection to the offshore substation from which the export cable was laid to the shore at Heysham and onwards to the onshore

substation, also at Heysham, where it connects to the onshore grid. A special-purpose cable installation vessel was used for offshore cabling.

The cable burial depth was not sufficient according to requirements at some locations. After a survey of exact burial depth during the summer of 2006, which was undertaken as part of the post-construction survey as agreed in the FEPA licence, the target burial depth for the export cable was reduced from the original 3m to 0.6-1.4m, dependent upon the hardness of the seabed. Supplementary jetting of the offshore transmission cable was carried out in March-April 2007. To date, a few remaining sections are still in need of additional cable burial. Vessel mobilisation will take place in early July 2008, and jetting works will be undertaken in July-August. If sufficient burial is not achieved at all sections, mattresses will be placed as protection.

All infield cables were installed by 30 April 2006. Additional burial works (by jetting) of the inter-array cables were executed in April-May 2007. About half of the cable ends are in need of additional Uraduct protection, some have free spans substantially longer than assumed in the project design. Some parts lay exposed on the seabed, where the project requirement is 1m burial depth. Diving works for execution of supplementary protection works were initiated at the end of July 2007, but they were not completed. A solution for settling the cable end snagging works is currently being negotiated with the contractor.

2.2.6 Grid connection

The grid connection is available and the WTGs are producing power. First power was produced from WTG D6 on 4 March 2006 and by the end of May 2006, all WTGs were running.

2.2.7 Commissioning and tests

Commissioning and energisation of the WTGs was completed by 31 December 2006.

2.2.8 Outstanding and remedial works

A number of outstanding and remedial works related to the EPIC Contract is currently being undertaken by VKBR and was scheduled for completion in autumn 2007. However, adverse weather over the summer of 2007 delayed this work. Offshore works were halted during the winter 2007-2008, and it is now expected that the remaining snagging works will be completed by 31 August 2008, except for the infield cabling works.

3 WIND FARM ANNUAL OPERATION INFORMATION

3.1 Performance Reporting

3.1.1 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 calculated as a percentage of the theoretical maximum. There is no allowance for routine or breakdown maintenance activities or for the effects of external influence.

- **Commercial availability** is based on the technical availability but includes allowance for requested stops, loss of the external grid connection and for weather days.

- **Planned availability** is the technical availability forecasted for the year. Planned availability is calculated taking into account all of the planned work and available resources stated in 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 deadlines.

3.1.2 Output and Capacity Factor

The capacity factor is the amount of generation produced calculated as a percentage of 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 calculated as the budgeted production divided by the maximum output for 8760 hours in a normal year.

3.1.3 Availability (hours %)

Table 3 presents the monthly-recorded technical availability for each WTG at BOW over the period from July 2007 to June 2008.

Availability [%]

Year	2007						2008						
WTG id.	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	**Average**
A1	66	0	0	90	83	76	100	96	99	91	92	73	72
A2	0	0	67	94	100	76	100	99	98	99	94	99	77
A3	57	0	15	86	99	99	94	69	99	96	98	99	76
A4	82	99	8	61	99	100	67	99	99	96	91	98	83
A5	51	0	0	60	100	84	100	100	99	98	96	90	73
A6	0	6	52	66	92	100	99	100	100	98	93	98	75
A7	56	0	0	85	96	87	98	96	98	94	98	98	76
B1	0	0	36	97	99	100	99	99	97	99	97	97	77
B2	95	100	21	34	97	91	97	71	99	95	99	98	83
B3	68	0	2	93	95	100	100	98	99	99	97	99	79
B4	93	24	31	98	96	100	87	88	98	93	98	99	84
B5	0	4	86	86	98	85	94	95	55	100	90	97	74
B6	90	94	18	73	99	71	67	100	92	100	88	99	83
B7	96	98	14	71	99	100	100	82	99	97	94	98	87
B8	96	99	18	58	95	97	71	98	97	94	100	95	85
C1	0	5	35	76	98	98	35	99	98	99	97	98	70
C2	98	99	28	73	94	95	100	100	98	96	98	98	90
C3	71	0	63	97	98	93	89	100	99	93	100	91	83
C4	48	9	0	16	45	13	69	0	67	92	96	97	46
C5	29	53	0	56	97	100	15	96	95	93	98	100	69
C6	81	88	0	61	99	100	97	100	98	97	99	98	85
C7	96	100	35	60	100	100	100	100	98	96	100	99	90
D1	8	0	24	85	100	98	97	98	95	99	98	99	75
D2	0	0	14	72	97	98	90	99	100	95	93	100	71
D3	0	0	4	64	99	100	72	86	97	100	92	97	68
D4	96	99	33	43	99	100	100	97	90	95	97	99	87
D5	96	99	67	69	98	98	100	84	97	97	99	96	92
D6	0	0	87	95	98	96	99	99	99	98	93	100	80
D7	89	99	17	45	97	99	100	100	99	93	98	100	86
D8	0	15	79	71	68	99	39	64	92	98	93	98	68
Average	52	40	28	71	94	92	86	90	95	96	96	97	**78**

Table 3 Monthly availability of WTGs (% of time) from July 2007 to June 2008

The recorded average availability is 78%. The planned availability of the WTGs was 92%. Thus, actual availability has been significantly lower than planned.

The low availability in the first four months of the reporting period is mainly due to the fact that all of the WTG gearboxes were exchanged in this period. Also a number of WTG faults, mainly generator bearings and rotor cable faults have resulted in the low availability.

3.1.4 Wind speed (m/s)

For the 12-month period, July 2007-June 2008, the yearly average wind speed was found to be 9.2m/s at hub height for all turbines. Table 4 also sets out the monthly average wind speed recorded at each turbine. However, for a number of turbines with limited data coverage, the recorded average wind speed has not been included. This is because data communication has been incomplete over long periods due to cable communication failure and/or WTG repairs and gearbox exchange during the summer and autumn of 2007.

Wind speed [m/s]

Year	2007						2008						
WTG id.	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	**Average**
A1	7.6		4.3	7.1	9.9	10.7	12.4	10.1	11.1	8.0	7.8	7.5	8.8
A2	8.0		9.1	6.8	10.0	10.6	12.5	10.2	11.3	8.1	7.8	7.5	9.3
A3	7.9		8.6	6.9	10.0	10.6	12.2	9.9	11.2	8.1	7.8	7.6	9.2
A4	8.0	7.9	10.1	5.3	9.8	10.4	12.0	9.7	10.9	7.8	7.2	7.4	8.9
A5	8.2			6.7	9.8	9.5	12.0	9.8	10.9	8.0	7.6	7.4	9.0
A6		8.8	8.8	6.9	10.1	10.8	12.3	10.1	11.3	8.3	7.9	7.7	9.4
A7	8.3			7.2	10.6	10.8	12.7	10.4	11.8	8.6	8.0	8.3	9.7
B1			9.4	7.2	10.1	11.0	12.4	10.0	11.0	8.1	7.8	7.7	9.5
B2	8.3	8.0	7.7	7.9	10.2	10.9	12.7	10.1	11.4	8.1	7.7	7.7	9.2
B3	7.4		5.7	6.7	9.8	10.5	12.2	9.9	10.9	7.8	7.3	7.4	8.7
B4	8.2	8.6	9.4	6.9	10.1	10.8	12.6	10.2	11.4	8.0	7.4	7.6	9.3
B5		8.2	9.0	7.1	10.3	11.0	12.5	10.3	11.0	8.3	7.5	7.9	9.4
B6	8.0	7.6	7.5	6.8	9.9	10.3	11.8	9.8	10.9	7.9	7.5	7.6	8.8
B7	8.3	7.8	7.3	6.9	10.3	10.7	12.5	10.0	11.5	8.2	7.4	7.8	9.1
B8	8.5	8.3	8.3	7.2	10.4	10.7	12.6	7.7	11.4	8.2	7.4	8.1	9.1
C1		7.4	8.4	7.0	10.2	11.1	12.2	10.6	11.5	8.2	7.7	7.8	9.3
C2	8.5	8.1	8.1	6.9	10.1	10.8	12.6	10.2	11.3	8.1	7.5	7.8	9.2
C3	7.8	6.1	9.2	7.0	9.9	10.5	12.1	10.0	11.0	8.0	7.3	7.6	8.9
C4	8.3	7.4		7.7	10.0	9.3		8.4	11.1	8.1	7.1	7.7	8.5
C5	8.4	7.9		8.2	10.7	11.3	12.3	10.5	11.7	8.2	7.4	7.9	9.5
C6	8.6	7.8		7.5	10.6	11.2	13.0	10.5	11.9	8.4	7.6	8.0	9.6
C7	8.0	7.9	8.2	7.0	9.9	10.4	12.0	9.8	11.0	7.8	7.0	7.7	8.9
D1	7.7		9.4	7.2	10.4	11.3	13.0	10.7	11.6	8.4	7.7	7.9	9.6
D2			8.3	6.8	10.1	10.9	12.6	10.3	11.3	8.0	7.3	7.8	9.3
D3				7.1	10.5	11.3	12.8	10.8	11.9	8.6	7.4	8.2	9.8
D4	8.7	8.1	8.1	8.1	10.6	11.3	13.1	10.7	11.7	8.5	7.6	8.2	9.6
D5	8.3	7.9	8.8	7.4	10.2	11.0	12.8	10.4	11.6	8.2	7.3	8.0	9.3
D6		8.9	8.9	7.1	10.2	10.9	12.7	10.3	11.4	8.2	7.1	7.8	9.4
D7	8.8	8.5	8.0	7.8	10.7	11.4	13.1	10.7	11.9	8.5	7.5	8.2	9.6
D8		7.7	9.5	7.6	10.3	11.1	12.4	10.0	11.7	8.5	7.3	7.9	9.5
Average	8.2	7.9	8.3	7.1	10.2	10.8	12.5	10.1	11.4	8.2	7.5	7.8	**9.2**

Table 4 Monthly average wind speed at each turbine July 2007-June 2008

The recorded average wind speed for individual turbines varies from 8.5-9.8m/s with an overall average annual wind speed of 9.2m/s. These observed variations from turbine to turbine can be assigned to the influence of data gaps, spikes in the data time series and effects of instrument calibration. Natural fluctuations from turbine to turbine, as a result of lee effects and impact of rotors running or not running, are also expected to have some influence.

A wind study undertaken by Tripod Wind Energy in 2006 showed that the long-term mean wind speed at Shell Flats (at a height of 75m which is representative of Barrow) is 9.2m/s. Thus, the average wind speed in the reporting period has been at the long-term mean level.

The wind direction on the wind turbines and at the meteorological station has been recorded, but unfortunately not been calibrated with respect to recording wind direction in comparison to the north direction. Some WTGs have been out for gear exchange and the wind speed has not been recorded in this period. Therefore, wind roses from the various turbines are not consistent. For a selected turbine, B6, where the wind data has been nearly complete, the below figure shows the recorded wind rose, illustrating the distribution of wind direction and wind energy direction.

The figures illustrate the distribution of the wind in the best-qualified way under the actual circumstances.

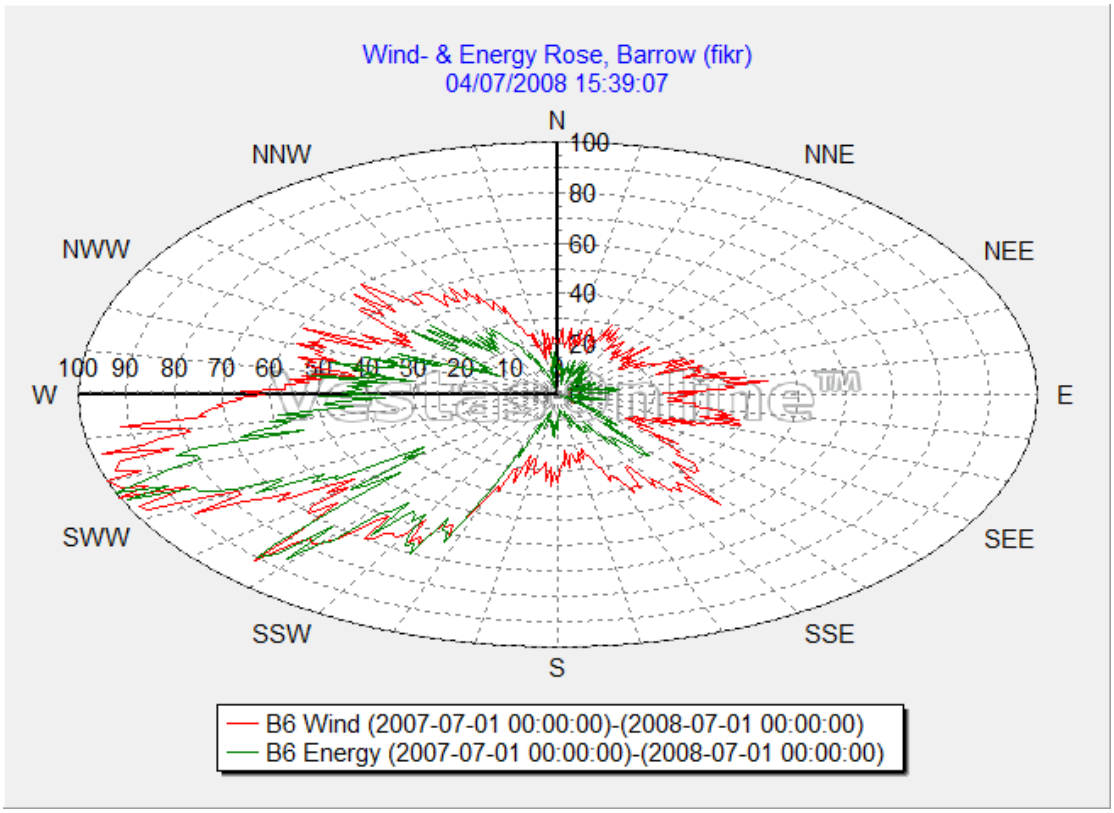

Figure 2 Wind and energy rose for WTG B6

3.1.5 Output (MWh)

Monthly power production from July 2007 to June 2008
The total annual power production generation from all 30 WTGs during the 12-month period was 273,426MWh, which was less than the expected budget of 314,300MWh. This represents 87% of the actual annual production target.

However, during May 2008 there was a problem with data availability for calculation of production at some WTGs. Table 5 shows that the total production for May was less than the exported production - 20,073MWh versus 20,260MWh. It is likely that the actual total production at the WTG was about 21,485MWh (instead of 20,073MWh), which would mean that the total annual production at the WTG was 291,372MWh instead of 289,959MWh.

Production [MWh]

Year	2007						2008						**12 month**
WTG id.	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	**period**
A1	518	555	0	579	915	913	1,477	1,028	1,296	799	639	481	9,199
A2	-3	446	717	569	1,140	879	1,452	1,002	1,269	819	743	688	9,721
A3	448	754	85	568	1,141	1,239	1,360	568	1,277	824	753	682	9,700
A4	663	762	96	329	1,146	1,236	989	995	1,275	819	603	623	9,536
A5	435	819	776	367	1,145	919	1,452	1,007	1,287	820	745	562	10,332
A6	427	31	400	385	1,018	1,245	1,441	1,014	1,296	828	741	701	9,528
A7	493	460	0	542	1,168	1,078	1,428	1,012	1,325	827	736	787	9,856
B1	417	647	399	628	1,157	1,311	1,515	1,036	1,274	860	749	703	10,694
B2	825	749	142	299	1,139	1,197	1,440	579	1,271	821	735	698	9,894
B3	511	814	4	591	1,080	1,268	1,468	996	1,268	817	705	652	10,172
B4	819	203	289	596	1,142	1,259	1,317	843	1,256	777	697	703	9,901
B5	0	-1	834	544	1,113	1,062	1,355	951	564	828	634	662	8,547
B6	820	694	123	488	1,166	858	899	999	1,166	837	5	719	8,774
B7	852	738	115	467	1,180	1,261	1,474	756	1,309	845	675	728	10,400
B8	884	803	142	393	1,133	1,106	982	726	1,321	831	703	735	9,759
C1	519	17	177	489	980	1,280	455	1,024	1,280	841	733	720	8,513
C2	858	754	197	410	1,099	1,201	1,482	1,023	1,265	819	711	714	10,534
C3	504	0	648	611	1,148	1,172	1,327	1,025	1,263	779	698	615	9,790
C4	413	24	0	84	410	94	0	0	767	745	629	704	3,871
C5	300	371	746	414	1,160	1,275	181	970	1,270	782	664	719	8,851
C6	694	604	0	417	1,165	1,252	1,442	1,006	1,276	806	679	717	10,057
C7	884	804	299	428	1,197	1,269	1,501	1,043	1,335	829	676	786	11,052
D1	71	521	258	568	1,205	1,347	1,494	1,096	1,296	882	741	779	10,258
D2	528	573	113	469	1,160	1,294	1,363	1,073	1,319	808	718	774	10,192
D3	0	624	0	492	1,164	1,311	1,075	970	1,288	865	646	749	9,184
D4	866	727	225	339	1,194	1,320	1,518	1,063	1,214	796	706	769	10,736
D5	850	744	597	488	1,155	1,290	1,503	920	1,302	811	666	716	11,043
D6	0	0	826	650	1,197	1,276	1,521	1,073	1,326	860	632	764	10,124
D7	864	801	127	351	1,182	1,324	1,524	1,070	1,338	844	679	768	10,872
D8	550	163	915	545	754	1,321	505	603	1,235	882	633	764	8,869
Sum at WTG	16,008	15,200	9,249	14,099	32,950	34,858	36,942	27,467	37,230	24,701	20,073	21,183	**289,959**
Exported	13,199	8,666	7,440	13,751	32,166	34,012	36,065	26,797	36,221	24,165	20,260	20,683	**273,426**
Imported	61	50	23	72	61	27	32	43	35	48	96	90	**638**
Budget	23,500	22,800	24,900	29,100	28,100	29,400	29,600	31,100	28,500	22,800	22,000	22,500	**314,300**

Table 5 Power production in MWh for each turbine per month and year

The annual exported power production of 273,426MWh is 5.7% less than the power that is produced (289,959MWh). This is mainly due to cable and transformer losses.

3.1.6 Load factor (Capacity factor, %)

Table 6 sets out an overview of the observed capacity factors for the wind farm as a whole, calculated on the basis of theoretical production as well as the budgeted production. It is seen below that the actual capacity factor is 36.7% compared to the budgeted 39.8%, which at this stage is to be assumed to be due to the lower availability and the fact that budgeted production is based on the exported production.

Year	Month	Period length	Theoretical production at maximum	Budget production	Exported power	Import power	Gross power exported	Capacity factor (actual)	Capacity factor (budget)
		Days	MWh	MWh	MWh	MWh	MWh	%	%
2007	July	31	66,960	23,500	13,199	61.34	16,008	23.9	35.1
	August	31	66,960	22,800	8,666	50.06	15,200	22.7	34.0
	September	30	64,800	24,900	7,440	22.93	9,249	14.3	38.4
	October	31	66,960	29,100	13,751	72.19	14,099	21.1	43.5
	November	30	64,800	28,100	32,166	61.24	32,950	50.8	43.4
	December	31	66,960	29,400	34,012	27.16	34,858	52.1	43.9
2008	January	31	66,960	29,600	36,065	31.53	36,942	55.2	44.2
	February	29	62,640	31,100	26,797	42.93	27,467	43.8	49.6
	March	31	66,960	28,500	36,221	34.92	37,230	55.6	42.6
	April	30	64,800	22,800	24,165	47.98	24,701	38.1	35.2
	May	31	66,960	22,000	20,260	95.79	20,073	30.0	32.9
	June	30	64,800	22,500	20,683	89.77	21,183	32.7	34.7
	Total	**366**	**790,560**	**314,300**	**273,426**	**638**	**289,959**	**36.7**	**39.8**

Table 6 Overview of the observed capacity factors for BOW

3.2 OPERATIONAL REPORTING

3.2.1 Operation and maintenance costs

The operation of BOW has been subcontracted to Vestas/KBR on a five-year O&M contract. The cost of the O&M is an all-inclusive fixed price. BOW covers the management costs, environmental management costs and lease payment to The Crown Estate.

A breakdown with approximate figures for the period July 2007-June 2008 is presented in Table 7.

O&M offshore facilities incl. service contract Vestas	2,656
O&M lease and licence	362
Environmental Management	520
Other	8
Total O&M costs	3,546

Table 7 Breakdown of approximate O&M costs in the period July 2007-June 2008 (GBP 1,000)

For the 12-month period, July 2007-June 2008, with a total export production of 273,426MWh giving O&M costs of:

GBP 39,400	per MW installed
GBP 118,200	per WTG
GBP 12.96	per MWh produced/exported.

3.2.2 Operational issues

Work performed on the wind farm is categorised as scheduled or unscheduled maintenance.

Scheduled work

- 12-month service
  - The annual turbine service for the second year started in the beginning of April 2008 and was finished by the end of May.
- Monthly inspections of HV systems on offshore and onshore substations
  - The monthly inspections are carried out according to the manufacturer's recommendation.
- Annual offshore safety rescue exercise "Cumbrian Breeze" in cooperation with MCA and RNLI was postponed twice due to bad weather. The rescue exercise was held on 13 October 2007.
- Annual inspections of fire fighting equipment.
- Environmental surveys as agreed in the site consent.
- Epifauna diving work is planned for July 2008.

Unscheduled work

There has been a significant amount of unscheduled work on the turbines in the reporting period. Some of the issues have been minor technical problems, which have been solved by a local reset or minor work on the turbines. Others have been more severe like:

- Change of gearbox in all 30 turbines
- Change of generator in all 30 turbines
- Change of transformer in one turbine
- Cable burial work.

From the middle of July until the end of October, all 30 generators and gearboxes were changed. Two jack-up vessels were used for this major task. The vessel “Wind” is a self-powered vessel, and “ODIN” is a barge, which manoeuvres by means of anchors and tugboats. This major task involved approx 70-80 people on site over a period of 3-4 months.

Due to insufficient burial depth of the array cables some additional work has been carried out. Some cables have been jetted in order to get them down to the required depth and other have been fitted with some extra protection by means of uraduct in order to compensate for the lack of depth.

In March 2008 it was discovered that the colour of the blades on one of the turbines was slightly different compared to the others. Investigations revealed that some locking pins rubbing against the structure caused the colour difference. It has been decided to replace the whole hub.

3.2.3 Access arrangements

Access to the wind farm is via transfer vessels.

Dependent on the size of the vessel, transfer to the turbines can be done safely up to a significant wave height of 2m. The only vessel on site, which can operate up to 2m Hs, is the Explorer. The average operation limit for the rest of the transfer vessels is up to 1.5m. It is entirely up to the skipper of the vessel to decide to which height it is safe to operate.

The wind farm is situated in an exposed area as demonstrated by the accessibility figure of 53.4%. The monthly number of days with weather downtime and corresponding percentage in the period July 2007-June 2008 is presented in Table 8. Total weather days in the reporting period was 170 days giving an average accessibility of 53.4%.

2007						2008					
July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June
15.6	14.20	11.20	12.40	17.20	21.60	24.7	17.20	20.20	3.8	1.6	10.25
50.3%	45.8%	37.3%	40.0%	57.3%	69.7%	79.7%	61.4%	65.2%	12.7%	5.2%	34.2%

Table 8 Monthly number of days with weather downtime

3.2.4 Remote monitoring

The production of the wind farm is monitored round the clock through the Supervisory Control and Data Acquisition (SCADA) system. The site operator monitors the wind farm in the daytime, and the operator’s 24h surveillance centre in Denmark takes over the monitoring outside normal working hours. Stopped turbines can be restarted through the SCADA system.

BOW has direct access to Vestas’s SCADA system. Vestas has developed a performance centre that monitors the performance of all Vestas V90 wind turbines. The performance centre reacts and sends out service bulletins to the site in order for them to check or correct minor faults.

3.3 Health and Safety

The health and safety standard at BOW is considered to be good. BOW has experienced a low number of accidents, although the incidents that have occurred are considered to be serious.

Through the year, the health and safety managers and the BOW site manager have been working proactively to develop a rigorous approach to health and safety to prevent accidents.

3.3.1 Accidents and incidents over the reporting period

5 July 2007
Painters lifted platform grids and tied them to the handrail. Open edges left with no protection. Method statement revised to include handing over of control of turbine between painters and site supervisor.

18 September 2007
While using a ratchet spanner to loosen a bolt, the ratchet slipped and cut a man's head. Toolbox talks were held about rushing work; time versus risk.

26 September 2007
While using a pallet truck, an employee tried to remove an object stuck to the wheels. He accidentally touched the release lever, lowering the pallet truck onto his hand. A toolbox talk was carried out covering the safe use of a pallet truck and the benefits of good housekeeping. The accident was reported to RIDDOR.

22 October 2007
While using a sharp knife to open a package an employee cut his left hand with the knife. Toolbox talks on safe use of knives were carried out. Retractable knives ordered and delivered for use on site.

7 November 2007
A member of the gearbox team was loading a cabin onto the lorry using an FLT. The cabin looked unstable and the gap through the gates was very narrow. Conditions were windy at the time. A fall arrester lanyard was being used to guide the cabin. The work was stopped. A person was nominated to be in charge of the task. Personnel not involved were told to move out of the area and a person was given the responsibility to control access to pedestrians and traffic. All personnel must wear hi-viz clothing in the area. The lanyard was replaced with rope and the lanyard destroyed.

21 December 2007
While lifting tools from the vessel to the substation using the davit with a rope and pulley system, the technician felt a twinge in his back. As the injury was assessed as acute and had no lasting effect, the incident was reported at the end of the shift to the site manager. Vestas offshore is trailing a mechanical lifting device to replace manual handling of tool and equipment from the vessel.

31 January 2008
The ferry Riverdance went out of control. Several rescue attempts were made by both boat and helicopter with all persons on board being airlifted off leaving a skeleton crew on board. This skeleton crew was unable to control the boat, and the Riverdance was beached on Blackpool Beach.

21 February 2008
When a technician was descending down the ladder from the transition piece, the platform hatch dropped down and hit him on the head. The procedure is to be changed to leaving the hatch open when you leave the transition piece.

21 February 2008
When opening the folding hatch to the nacelle, the hatch did not fold back into place and fell down onto the technician's head. This did not cause any injury but could have been worse if it had fallen further.

3.3.2 Proactive safety initiatives

In order to maintain focus on reporting of accidents, near misses and observations, the award system for personnel who reports HSE incidents is still being used.

From January, Vestas has held HSE meetings. The procedure for the site is that every month, the safety representative holds a meeting at which the technicians, the assistants, store man and vessel crew attend. The meeting provides a platform for everyone to discuss current issues on site and document them for action. It also provides the safety representative with the opportunity to give feedback from the site management including details of outstanding issues.

At the earliest opportunity following the safety representative's meeting, the site manager holds his meeting to discuss all current issues and outstanding near-miss/hazardous observation reports with the view of handling them and closing them down. The site manager invites the HSE manager, DONG Energy's site manager, the safety representative and the supervisor to attend.

Examples of observations:

- Ordering new lanyards
- Slippery area on the service boat
- Lifting equipment (incl. non-certified).

The observations give the Vestas HSE manager a good platform for identifying initiatives aiming at improving the HSE environment at BOW.

3.3.3 Alcohol and drug test

Vestas has introduced random drug and alcohol tests on site to ensure that all employees are fit for work at all times. There has not been reason to make any tests yet.

Other proactive safety initiatives include:

- Increase number of HSE meetings
- Make HSE a priority agenda item at each O&M meeting
- No work is executed without method statements and risk assessments having been reviewed and approved by BOW
- Regular inspections/audits made by Vestas HSE manager and DONG Energy HSE manager.

3.3.4 Emergency exercises

On 13 October 2007, Vestas carried out an offshore emergency exercise called Cumbria Breeze together with MRCC Liverpool and local RNLI.
The main objective was to practise communication between Vestas, MRCC and RNLI and at the same time test Vestas's emergency procedures and practice of rescuing an injured person from a wind turbine.

The exercise went according to plan, but a series of issues were raised after the exercise. These issues have subsequently been addressed, and recommendations for changes in procedures have been implemented.

3.3.5 Future events

An emergency response exercise will be planned when the replacement at the Marine Coast Agency (MCA) is ready. The HSSE Manager of Vestas will arrange a meeting with the MCA. A Safety Awareness course will be carried out for all employees during the autumn.

3.4 Environmental monitoring

The environmental monitoring programme is undertaken in order to comply with the supplementary conditions in the FEPA licence 31744/08/0. The environmental monitoring plan is agreed, and the results of the monitoring are reported annually to the Marine and Fisheries Agency (MFA). In the period July 2007- June 2008, the following monitoring activities have been carried out.

3.4.1 Seabed and scour monitoring

Monitoring of scour around turbines and along the export cable takes place in accordance with the FEPA Licence requirement and is undertaken at intervals of six months. The last survey is planned for 2009. The results of the third and fourth scour survey will be reported in the second annual post-construction environmental monitoring report in November 2008.

The third post-construction scour monitoring survey was undertaken in November 2007. The survey covered nine turbine foundations and the export cable.

The fourth post-construction seabed and scour monitoring survey was undertaken in April 2008. This survey included nine turbines and the export cable.

The results from the scour monitoring shows that some scour is present around the wind turbines and that the extent of the scour is as expected.

The survey of the export cable has identified that some section of the cable were exposed. Further work has been undertaken on the export cable in February 2008 at exposed sections along the export cable in order to bury these sections.

3.4.2 Archaeology

An archaeological analysis of the post-construction side scan data was undertaken in autumn 2007 and was reported in the first annual post-construction environmental monitoring report in January 2008.

In the wind farm area, a total of 53 side scan sonar anomalies were identified, and all exclusion zones were re-identified. The results indicate that the exclusion zones have been effective in protecting sites of potential archaeological importance.

A total of 47 side scan sonar anomalies were identified within the cable route area during the archaeological assessment. Two exclusion zones were defined in 2005. One was re-identified in the post-construction survey and does not appear to have been disturbed. The other was not re-identified, since the cable route has been moved slightly to the north to ensure that this site is not disturbed.

Two new sites of high archaeological potential were identified along the cable route during the post-construction survey. They are interpreted as being possible wreck sites due to their size and possible evidence of structure.

No further monitoring is planned.

3.4.3 Fishery monitoring

The third post-construction fishery was undertaken in October 2007. The survey results have been analysed and the results will be included in the second post-construction environmental monitoring report in November 2008. A comparative analysis between pre-construction and post-construction data will also be included in the annual report to the Licence Authority in autumn 2008.

No further monitoring is planned.

3.4.4 Benthic and sediment logical monitoring

A comparative analysis between pre-construction and post-construction data has been undertaken and was reported in the first annual post-construction monitoring report in January 2008.

In general the benthic and sediment surveys show differences in the physical and chemical data as well as the biological data collected in the pre- and post-construction surveys. These differences were not restricted to the sites that are located in the wind farm area. They were also present in the data from sites that were regarded as reference locations.

The fact that the results from these reference sites show a change between the pre- and post-construction surveys suggests that there have been natural changes throughout the area in sediment conditions, and that the changes at the sites within the area of possible influence are not caused by the construction or operation of the wind farm.

No further monitoring is planned.

3.4.5 Ornithology

Boat-based and aerial bird survey data were collected at the wind farm and in a reference area during the period July 2007-July 2008. Furthermore, an onshore ornithological survey was undertaken from Walney Island in September/October 2007. Data from the 2008 surveys will be analysed and reported in the second annual report to the Licence Authority in November 2008.

Boat-based surveys have been undertaken in August 2007, October 2007 and July 2008. A May 2008 survey was missed due to lack of appropriate vessel. Aerial surveys have been undertaken in October 2007 and March 2008.

Key conclusions from the ornithological monitoring show that Barrow Offshore Wind Farm does not constitute a barrier for passing or moving whopper swan or pink-footed goose. Furthermore, the aerial monitoring indicates that the wind farm does not lead to significant changes in the occurrence and distribution of common scoter, divers or other wildfowl in the vicinity of the wind farm.

Data from the 2007 surveys was reported in the first annual environmental monitoring report in January 2008.

3.4.6 Epifauna monopile survey

The survey is scheduled for July/August 2008.

3.4.7 Electromagnetic Field Measurements

The survey is postponed until the COWRIE 2.0 report has been published.

3.5 Annual reporting of monitoring results

The annual report covering the first year of post-construction monitoring was submitted to the Licence Authority in January 2008. The second year of post-construction monitoring will be summarised in a report and submitted to the Licence Authority in November/December 2008. The report will include technical reports.

3.6 Public relations

There has not been any notable media coverage of BOW in the reporting period.

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