DeWind D8.2 50Hz Prototype Cuxhaven, Germany

Introduction

The first DeWind 2 MW D8.2 variable speed wind turbine, using a hydrodynamic WinDrive® from Voith Turbo Wind, directly coupled to a synchronous generator, was erected in Cuxhaven, Germany in December 2006.
The use of this technology provides an alternative to the more common full or partial power conversion systems that rely on power electronics.

DeWind took the well proven D8 2000 kW Doubly Fed Induction Generator (DFIG) wind turbine, which has been deployed in the field since 2002, and replaced the DFIG Generation system with a Conventional Generation system using a fixed speed Synchronous generator driven by a Torque controlling Variable speed Gearbox. The resulting system shares many common and well proven features, including the rotor, first two stages of the gearbox, front bedplate and yaw system.

This evolution of the well proven DeWind D8 – 2000 kW has been undergoing field testing at this near shore wind site, operated by DEWI-OCC, in order to verify the following design goals:

•Power performance as good as the Doubly Fed Induction Generator (DFIG) version,
•13.8 kV, medium voltage, operation,
•A larger power factor range than traditional power converter based designs,
•Flexibility in interconnection and ability to connect directly to a grid without a transformer,
•Improved Power Quality compared to a DFIG,
•Ability to meet grid standards for LVRT without additional equipment or software.

These design goals have all been achieved.

Commissioning and testing milestones.
Following assembly at the LMG facility in Lübeck, the turbine was moved to the DEWI-OCC off-shore test facility in Cuxhaven Germany.

- **Erected December 16, 2006**.
- **January 6, 2007. First Grid Connection**
- February 15 2007 Operational start.
- April 2, 2007 Supervised automatic daytime
- May 7 2007, Un-attended automatic operation.
- **May 29, 2007Continuous rated power operation**
- August 2007 the turbine nacelle was taken down and the WinDrive® was inspected by Voith. The WinDrive® showed no wear patterns. An updated version of the WinDrive® was installed which included efficiency improvements based on data gathered from the turbine since commissioning.

The D8.2 at the DEWI-OCC test site Cuxhaven

- September 1,Continuous power production resumed
- September 14, Power curve and Power Quality Measurement started.

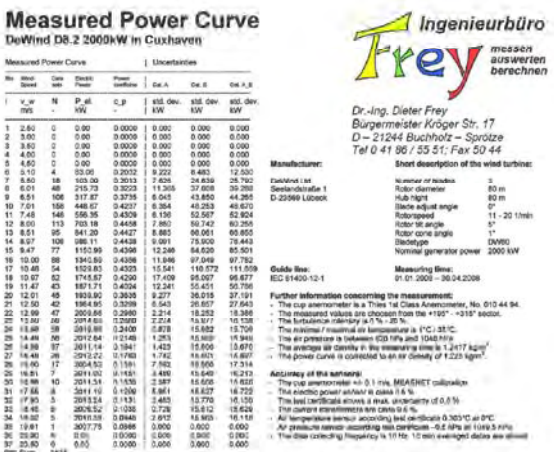
Optimization Steps

The test results enabled key improvements to be developed to the overall performance of the DeWind D8.2. These included:

•Tuning pitch controller to control highly turbulent wind conditions,
•Setting up the WinDrive® to optimize aerodynamic performance and drive train efficiency,
•Ensuring that the synchronization process minimized transients and ramped up smoothly,
•Optimizing the cut-in and ramp-up processes in order to minimize any adverse grid impacts such as Flicker.

Performance Curve

The power performance testing has been carried out by Dr. Ing. Frey,an accredited wind turbine performance test engineering consultant, to IEC 61400-12-1 specifications and the certificate is shown below.



Measured Power Curve
DeWind D8.2 2000kW in Cuxhaven

Measured Power Curve | Uncertainties

No	v_w m/s	N -	P_el kW	c_p -	Unc.A std. dev. kW	Unc.B std. dev. kW	Unc.A_B std. dev. kW
1	2.50	0	0.00	0.0000	0.000	0.000	0.000
2	3.00	0	0.00	0.0000	0.000	0.000	0.000
3	3.50	0	0.00	0.0000	0.000	0.000	0.000
4	4.00	0	0.00	0.0000	0.000	0.000	0.000
5	4.50	0	0.00	0.0000	0.000	0.000	0.000
6	5.10	4	53.06	0.2032	9.222	8.483	12.530
7	5.50	18	103.00	0.3013	7.426	24.859	25.792
8	6.01	48	215.73	0.3223	11.365	37.608	39.268
9	6.51	108	317.87	0.3735	6.043	43.850	44.265
10	7.01	158	446.67	0.4237	6.364	48.253	48.670
11	7.48	146	556.35	0.4309	6.156	52.567	52.924
12	8.00	113	703.18	0.4458	7.860	59.742	60.255
13	8.51	95	841.20	0.4427	8.865	66.061	66.655
14	8.97	106	986.11	0.4438	9.991	75.909	76.443
15	9.47	77	1152.99	0.4398	12.248	84.629	85.501
16	10.00	88	1340.89	0.4398	11.846	97.049	97.782
17	10.48	54	1520.83	0.4323	15.541	110.572	111.609
18	10.97	52	1743.67	0.4299	17.409	95.067	96.677
19	11.47	43	1971.71	0.4324	12.241	55.451	56.756
20	12.01	45	1933.90	0.3938	9.277	36.015	37.191
21	12.50	42	1964.95	0.3299	6.543	26.857	27.643
22	12.99	47	2009.86	0.2990	2.214	18.253	18.388
23	13.50	49	2014.63	0.2569	2.214	15.977	16.138
24	13.98	59	2010.88	0.2400	0.878	15.882	15.906
25	14.49	56	2012.64	0.2148	1.253	15.969	15.949
26	14.98	57	2011.14	0.1941	1.433	15.806	15.870
27	15.48	26	2012.22	0.1763	1.742	15.801	15.897
28	15.90	17	2004.53	0.1591	7.582	16.566	17.314
29	16.51	7	2011.02	0.1451	3.499	15.649	16.213
30	16.98	10	2011.54	0.1328	2.387	15.606	15.828
31	17.55	8	2011.19	0.1209	8.961	15.627	18.725
32	17.90	5	2013.24	0.1131	3.465	15.779	16.139
33	18.46	9	2005.52	0.1036	0.728	15.812	15.829
34	18.92	5	2010.58	0.0948	2.912	15.969	16.116
35	19.61	1	2007.75	0.0866	0.000	0.000	0.000
36	20.00	0	0.00	0.0000	0.000	0.000	0.000
37	20.50	0	0.00	0.0000	0.000	0.000	0.000

Ingenieurbüro Frey
messen auswerten berechnen

Dr.-Ing. Dieter Frey
Bürgermeister Kröger Str. 17
D – 21244 Buchholz – Sprötze
Tel 0 41 86 / 55 51; Fax 50 44

Manufacturer:
Seelandstraße 1
D-23569 Lübeck

Short description of the wind turbine:

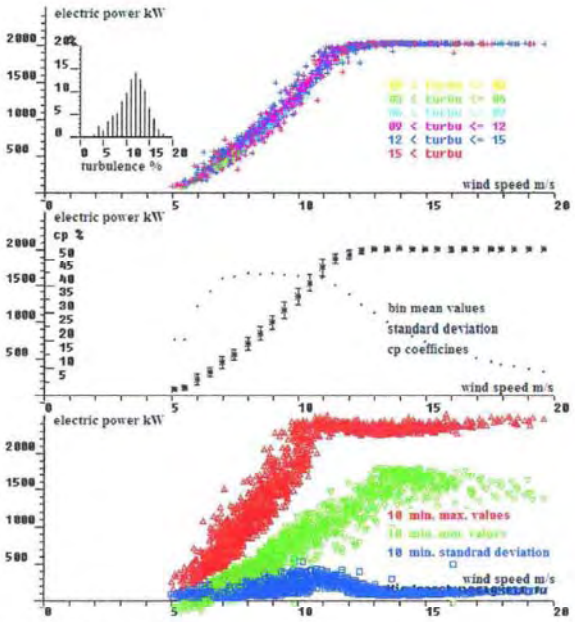
Number of blades	3
Rotor diameter	80 m
Hub hight	60 m
Blade adjust angle	0°
Rotorspeed	11 - 20 1/min
Rotor tilt angle	5°
Rotor cone angle	1°
Bladetype	DW80
Nominal generator power	2000 kW

Guide line:
IEC 61400-12-1

Measuring time:
01.01.2006 – 30.04.2006

Further information concerning the measurement:
- The cup anemometer is a Thies 1st Class Anemometer, No. 010 44 94.
- The measured values are choosen from the +195° - +315° sector.
- The turbulence intensity is 0 % - 20 %.
- The minimal / maximal air temperature is 1°C / 35°C.
- The air pressure is between 925 hPa and 1048 hPa
- The average air density in the measuring time is 1,2417 kg/m³
- The power curve is corrected to an air density of 1,225 kg/m³.

Accuracy of the sensors:
- The cup anemometer +/- 0,1 m/s, MEASNET calibration
- The electric power wt/Nm is class 0,5 %
- The last certificate shows a max. uncertainty of 0,5 %
- The current transformers are class 0,5 %
- Air temperature sensor according test certificate 0,303°C at 0°C
- Air pressure sensor according test certificate -0,6 hPa at 1019,5 hPa
- The data collecting frequency is 1/1 Hz. 1,0 min averaged datas are stored



Power Quality

Power quality measurements to IEC 61400-21 were carried out by WINDTEST. The following bullets summarize the excellent results,(to be expected from a Synchronous Generator):-

•Voltage Ride Through (VRT) ability due to the natural behavior of the synchronous generator.
•Smooth synchronization process due to smart control algorithm.
•Long term flicker as good as the DFIG version.
•Flicker coefficient better than the DFIG version.

D8.2 Synchronization

The fully automatic synchronization is smooth and no significant transients are evident.

D8.2 Certification

DeWind has Statement of Compliance for Design assessment from DEWI-OCC to IEC 61400 for both the 50 & 60hz Turbines

DEWI-OCC Offshore and
Certification Centre GmbH
Am Seedeich 9, D-27472 Cuxhaven

Statement of Compliance
for the Design Assessment
STC – 080401, Rev. 0

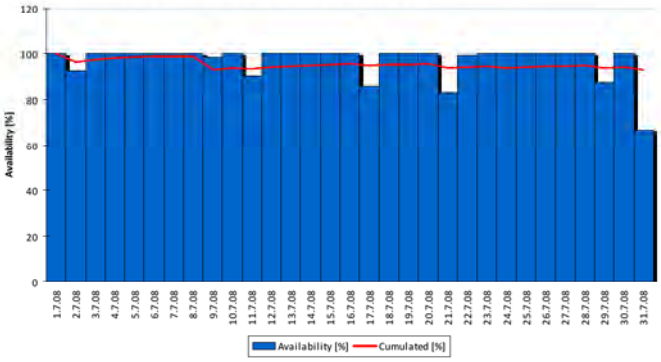
The Design of the wind turbine	**D8.2 - 2000 60 cps (Hz)**
designed and manufactured by	DeWind Inc. Seelandstr. 1 23569 Lübeck Germany

with characteristic basic data given in the annex and calculations and technical drawings listed in the relevant Certification Reports is conform to the following normative references:

IEC 61400-1	Wind Turbine Generator Systems – Part 1: Safety Requirements, Second Edition, 1999-02
assessed acc. to	IEC Type Class II A

Turbine Operation.

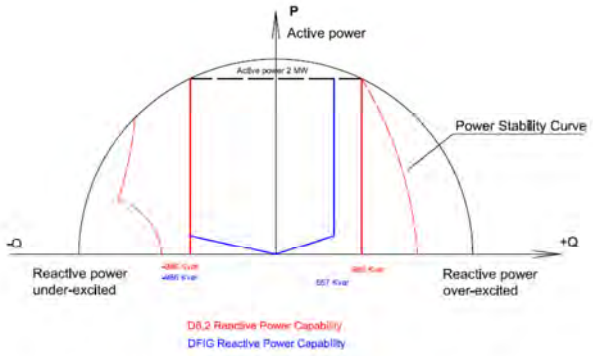
Availability 96.9% July 2008



Availability affected by software updates during the development process.

Reactive Power Capabilities

Measurements were taken to prove that the Generator can deliver 1MVAr leading and lagging at rated 2MW.



D8.2 PQ Stability capabilities measured

In summary, as of the end of January 2009 the DeWind D8.2 50 Hz prototype had run for over 7341hrs and produced more than 6.17 GWh of energy.
This was achieved despite the turbine being a test unit, with a range of optimization activities being undertaken. Proof gained that with 24/7 monitoring and service 97% availability easily achieved.

For further information on DeWind Turbines please contact us at (949) 428-8500 or (940) 455-7450