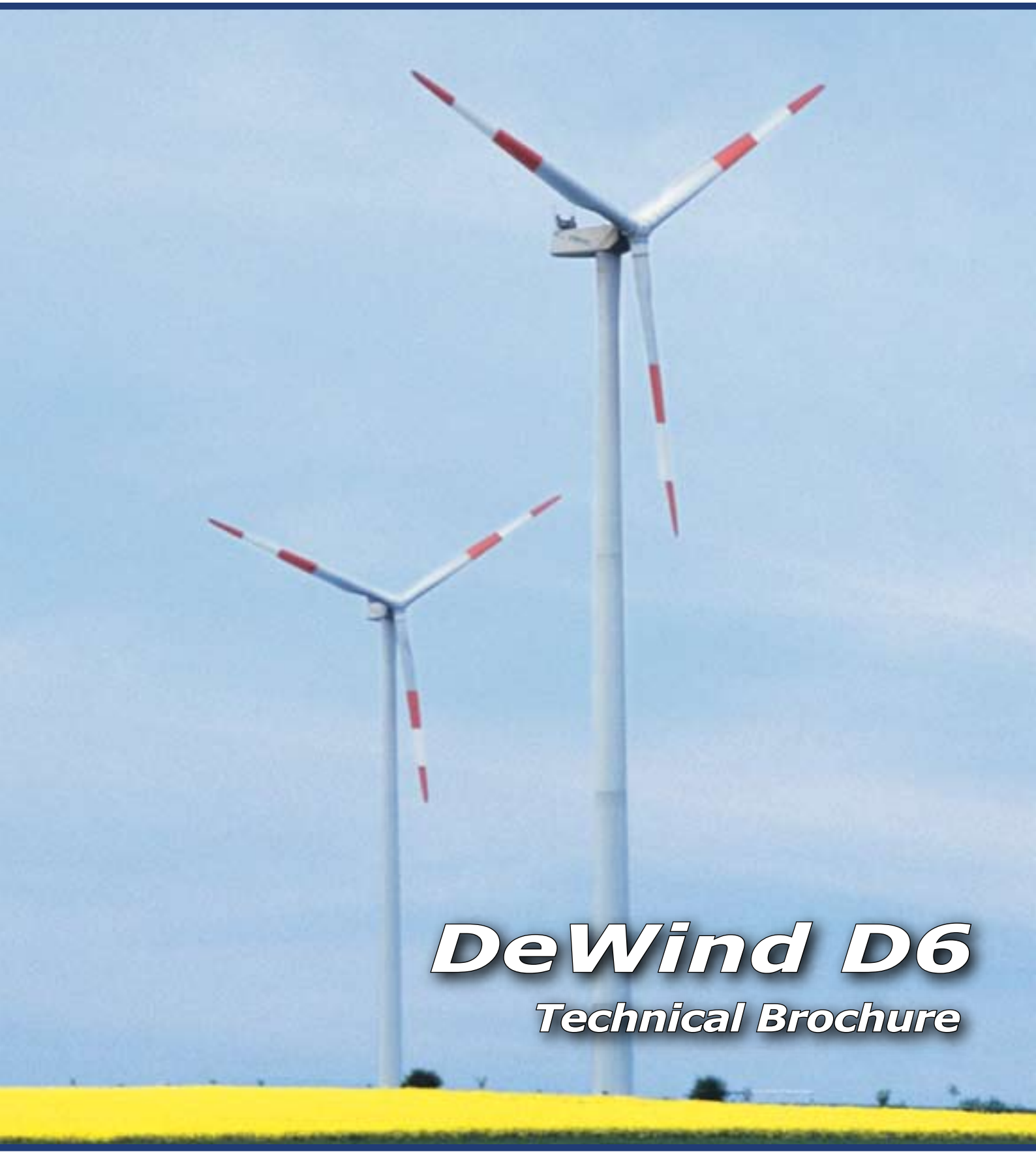
DE WIND



DeWind D6

Technical Brochure

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"... the alternative"

Ideas that shape the future ...

Composite Technology Corporation is a California based company that develops, manufactures & sells high performance electrical transmission cable and renewable energy-generation products. These products include ACCC transmission cable and the DeWind range of wind energy turbines, sold through its subsidiary companies *CTC Cable* and *DeWind*.

CTC Cable produce composite rod for use in its proprietary ACCC (aluminum conductor composite core). ACCC conductors virtually eliminate the sag in power lines caused by high current and high line temperatures. ACCC conductors also reduce electricity line losses and have demonstrated significant savings in capital & operating expenses, when substituted for other conductors. ACCC conductors enable grid operators to reduce blackouts and brownouts, providing a 'reserve electrical capacity' by being able to operate at higher temperatures. ACCC conductors are an innovative & economical solution for reconductoring power lines, constructing new lines and crossing large spans. ACCC composite rod is delivered to qualified conductor manufacturers worldwide for local ACCC conductor production and resale into local markets.

DeWind (formerly EU Energy Wind) produce, sell, and license the DeWind series of wind energy turbines including the D6 rated at 1.25 megawatts (MW), the 50Hz D8 rated at 2 MW and the D8.2 rated at 2 MW. These turbine systems have been noted for their exceptional reliability record. The D8.2 utilizes the advanced WinDrive® hydrodynamic torque converter, developed by Voith AG, with a synchronous generator that is able to connect directly to the grid at medium voltage, without the use of power conversion electronics. The prototype was successfully installed at Cuxhaven, Germany in December 2006 and commissioned in January 2007. The new 2 MW D8.2 turbines are planned to be delivered to North American customers from assembly operations at TECO Westinghouse Motor Company in Texas.

DeWind D6: Setting the Pace

A mere two and a half years after the DeWind D4, the first DeWind D6 was erected. Initially designed as a 1 MW converter, a more advanced 1.25 MW DeWind D6 has been on the market since September 2000.

Choosing the most suitable wind energy converter for a particular site, needs careful consideration. There is an optimum converter size for each location. In the final analysis, this comes down to a cost-benefit analysis, in which conditions such as the available infrastructure and soft costs, such as acceptance at the location, play a role in addition to investment costs.

This makes it all the more important that DeWind has a complete converter portfolio on offer. The DeWind D6 plays a key role in this. It offers an excellent price-performance ratio, long life expectancy and high yields. Thanks to EU Energy's technical philosophy, it is one of the most advanced converters in its class.

A Classic Converter

After a period of intensive development work, the first DeWind D6 with an output of 1 megawatt and a 62 metre rotor diameter on a 68.5 metre tower was presented in 1999, followed by the 1.25 megawatt DeWind D6 in September 2000.

The converter can be supplied with a rotor diameter of 62m and 64m, and with hub heights between 60m and 91.5m.

The DeWind D6 is a classic mid-size, pitch-controlled, variable-speed converter. It has the largest rotor area in its class, guaranteeing high yields and a long life.

DeWind engineers selected new mainframe solutions for the new 1.25 megawatt converter. The weight of the components comprising the drive train, generator and gears was reduced by a further 40% in comparison with the 1 megawatt converter. This was largely achieved thanks to the division of the mainframe into two parts and the use of cast components. In turn, this means greater operational safety, lower costs and increased life.

In-house Blade

In 2000, DeWind's engineers took a major step: they developed rotor blades specifically designed for the DeWind D6. The blade was designed by DeWind engineers in close cooperation with Rendsburg-based engineering office, Aerodyn.

After an intensive period of development, DeWind's first own designed blades were delivered in spring 2001. Since then, they have been used with tremendous success. Not only has the shape

of the blade been optimised, but it is also considerably lighter than comparable blades in the same performance class.

The improved efficiency and reduced strain ensure higher yields and an even longer life expectancy for the DeWind D6. The high quality of production is guaranteed by our production partner Abeking & Rasmussen, based in Lemwerder near Bremen, a company known internationally for its production quality. In this way, DeWind D6 operators can profit from the close coordination of the converter's key components.

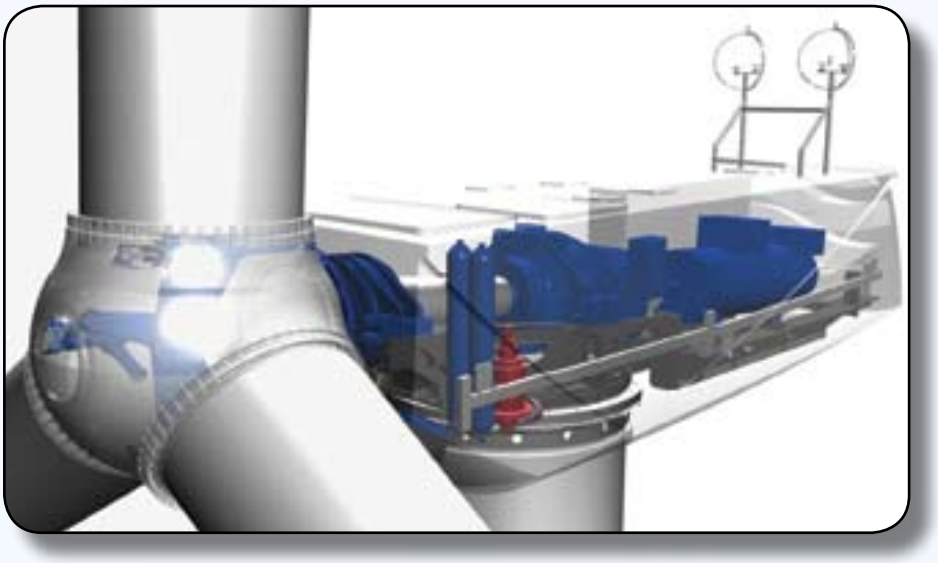
Rotor

A high-duty cast hub holds the three rotor blades, which are slewable by means of rapid pitching. The D6 Series is available with 62m and 64m rotor diameter. The rotor blades have an optimised aerodynamic and acoustic profile and integrated lightning conductors.

Pitch System

At wind speeds exceeding the limiting speed, the pitch mechanism of the D6 Series changes the angle of the rotor blades to suit the wind speed. This ensures optimum aerodynamic flow conditions on the blade, giving quiet, effective and low-load operation.

The combination of hydraulic central and single blade pitching, feathers the rotor blades when the turbine has to be switched off during heavy storms, bringing the turbine gently to a halt.



High Performance Gearbox

The D6 Series is equipped with a combined planetary spurwheel gearbox driving the generator. Superior engineering has ensured excellent noise and efficiency characteristics, and provided failure free performance for the D6-1250 gearbox.

Generator

The DeWind D6 is equipped with a doubly-fed asynchronous generator coupled with a frequency converter using IGBT technology. This enables the wind turbine to operate with variable speeds within a wide slip range. Power fluctuations, such as those caused by gusts, are almost completely avoided and the mechanical components are exposed to less stress.

Inverter

The air-cooled IGBT converter operates in a four-quadrant mode. Output voltage and frequency of the generator/converter system are regulated by controlling the exciting current and frequency of the rotor winding. This is achieved by a microprocessor-controlled power electronic controller, which triggers the IGBT elements using a pulse width modulation technique so that an almost pure sinusoidal voltage is produced at the output.

System control and Remote monitoring

All control and regulation functions are carried out by a state-of-the-art management system. The turbine is maintained at optimum operational status at all times, while the single components and operation parameters are continuously monitored. This system guarantees maximum security and productivity.

A remote monitoring programme (password protected) enables inquiry with regard to previous and current operating status. The EU Energy Service & Maintenance personnel can monitor the turbine and intervene if necessary.

Advantages on the Grid

The outstanding features of the DeWind D6 are effective utilisation of the available wind, quiet operation, good grid compatibility, longevity and attractive design.

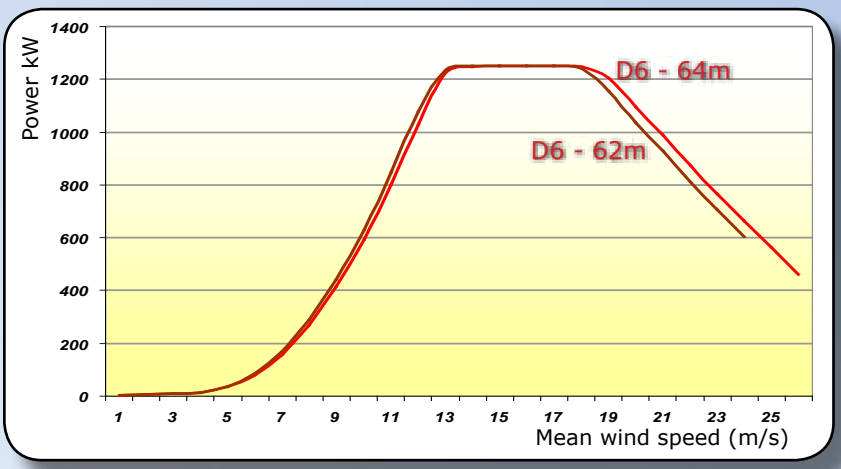
The turbine operates with variable rotor speed and is thus capable of producing electric power efficiently at low wind speeds, and utilising the energy of gusts without overloading the grid or turbine components. The combination of a doubly-fed asynchronous generator with a state of the art IGBT converter, isolates grid voltage and frequency from the generator speed, thus enabling connection of the turbine to most power supply networks. The generator produces sine wave voltage with a distortion factor of only 1 percent, and is almost free of harmonic frequencies, and filters are usually not required.

DeWind D6 1250 kW

Rotor Diameter:	62m	64m	
Hub height:	**65 m**	**68 m**	**91.5 m**
Total heights:	96 m	100 m	123.5 m
Noise at distance from mast base*:			
Mixed area 45 dB(A):	365 m	305 m	305 m
Residential area 40 dB(A):	545 m	445 m	475 m
Exclusively residential area 35 dB(A):	820 m	670 m	700 m
Wind class:	GLTK II	DIBT II/acc to IEC III	
Number of blades:	3		
Blade length:	30 m	31 m	
Swept area:	3019 m²	3217 m²	
Blade material:	GFRP		
Lightning protection:	metal receptor at tip		
Tower material:	tubular steel		
Structure-borne sound balancing:	elastomer elements at the drive train		
Cut-in wind speed:	2.8 m/s		
Nominal wind speed:	12.5 m/s		
Cut-out wind speed:	25 m/s	23 m/s	
Survival wind speed†:	55.3 m/s	48.9 m/s	50.5 m/s
Nominal rotational speed:	app. 22.4 rpm	app. 21.1 rpm	
Rotational speed range:	app. 13.9-25.9rpm	app. 13.2-24.5rpm	
Rotational speed control:	pitch, active blade adjustment		
Power regulation:	pitch		
Gearbox:	3 stage planetary spurwheel gearbox		
Transmission:	1:50.5	1:53.1	
Main braking system:	2 independent safety systems		
Parking brake:	disc brake		
Yaw system:	3 hydraulic geared drives		
Meteorology sensors:	sensors for wind direction, wind velocity & ambient temperature		
Remote monitoring:	automatic data transfer		
Rated Power:	1250 kW		
Generator:	induction, doubly fed		
Slippage:	± 30%		
Inverter:	IGBT-inverter		
Modulation type:	pulse width modulation		
Grid frequencies:	50 Hz		
Grid voltages:	10/20 kV, others on request		
Rated voltage:	690V		
Nominal current:	1046 A		
Peak current:	1.05		
cos phi:	adjustable		
Flicker coefficient c:	5		
Distortion factor:	1% approx.		
$Ki_{max}=I_{max}/I_{ng}$:	1.1		
Over/under voltage:	with adjustable parameter		
Over/under frequency:	±1 Hz, with adjustable parameter		
Trigger times:	with adjustable parameter		

* approx values. For detailed analysis, a noise emission investigation must be conducted.

† 5 seconds average wind speed at hub height



Dewind (Germany)
Seelandstraße 1,
D-23569 Lübeck,
Germany

Tel: +49 (0) 451-3073-0
Fax: +49 (0) 451-3073-730

Dewind (UK)
Technology House,
151 Silbury Boulevard,
Central Milton Keynes,
MK9 1LH,
United Kingdom

Tel: +44 (0)1908-424-455
Fax: +44 (0)1908-424-356

DeWind (USA)
2648 FM 407,
Suite 200,
Bartonville,
TX 76226
USA

Tel: +1 940 455 7450
Fax: +1 940 455 7451

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