WES30 COMPLETE DESCRIPTION

INTRODUCTION

The WES30 is a modern two bladed, high performance, reliable midsize 250kW wind turbine with a rotor diameter of 30 meters. The mechanical part of the WES30 was designed in 1983, the electrical part has been redesigned in 2005. WES30 turbines are manufactured and exported by WES in the Netherlands. WES30 wind turbines are sold, installed and maintained all over the world by a global network of certified and trained dealers.

WES30 MAIN CHARACTERISTICS

- With 6,5 m/s wind, more than 560.000 kWh/year.
- Over 400 units installed around the world.
- High reliability.
- High life expectancy, more than 20 years.
- Lattice or tubular towers, in different heights.
- Standard 40 foot container transport.
- Low mechanical loads on blades, gearbox and tower.
- Mechanical passive blade pitch and active yaw.
- Little maintenance needed.
- Easy installation.
- Ideal for hard to reach, remote locations.
- PLC and IPC controlled
- Advanced AC/DC/AC IGBT control cabinet.
- Frequency wind diesel control (patented).
- Internet monitoring.

WES30 ELECTRICAL SYSTEMS

WES30 CONTROLLER

The control of the WES30 is based on a Industrial PC or IPC. This IPC based system acts like a PLC and has I/O modules in the control cabinet and a remote I/O unit in the nacelle.

All sensors in the nacelle, switches, relays and the converter are wired to the I/O modules in the control cabinet. The IPC also runs an internal Ethernet LAN which connects the IPC to the I/O modules, the converter and the local control panel.

The control panel is located on the control cabinet door for friendly user interface. The screen shows the actual wind speed, wind direction, rotor-speed and the generated power. It also provides the cumulative kWh production and the historical data. Using the buttons on the control panel, parameters controlling the behaviour of the system can be changed. Some of these parameters can be set remotely over the Internet as well.

The controller and the electrical system are 'fail-safe' designed, which means that in case of a failure the turbine goes in a safe position.

The IPC logs detailed information about any failure. WES30 turbines are connected to the Internet. System log files, status reports, wind speed, the actual and cumulated performance can be monitored remotely. Each turbine can have its own URL, login and password and can be reached through any Internet browser.

Control cabinets being assembled

WES30 ELECTRICAL

Electrical energy is generated by the generator in the nacelle of the WES30. Cables run from the generator to the control cabinet. The flexible cable loop in the top of the tower is protected from twisting by an anti-twist sensor. When the nacelle has made 3 complete rotations in one direction the control system orders the yaw system to unwind the cables by turning the nacelle 3 times in the other direction.

The control cabinet is positioned in a shed nearby the tower. For safety reasons you have to be able to see the turbine reacting when operating the control panel on the control cabinet door.

The advanced IGBT technology makes the WES30 a relatively easy wind turbine to connect to any kind of grid. Local regulations can make that some components or security devices have to be adapted. Your WES dealer is aware of the specific regulations and restriction from your local electricity company.

WES30 GRID CONNECTION

The type of grid that is available, the cost price for electricity and the availability of a feed-in tariff define what the best way is to connect your turbine to the grid. There are 3 ways to connect your WES30 wind turbine to the grid:

Directly into the grid	Behind the meter	Hybrid (wind/diesel)
Electricity generated with a WES30 wind turbine can be sold back to the grid at an agreed feed in tariff. Once your WES30 is installed an approved kWh measurement device will measure the electrical energy that is exported into the grid. This amount multiplied by the price per kWh is what will be paid back for energy production or will be deducted from your regular electricity bill.	WES30 wind turbines can be used to reduce own energy import. The produced electricity is is used directly for own consumption. This is called "behind the meter". Behind the meter installations are interesting in those situations where electricity consumption is high and the feed in tariff is low compared to the purchase price of electrical energy.	WES30 Hybrid turbines offer a full integration with diesel generated power. When diesel engines are used to drive generators and generate electricity, economics change completely. Prices per kWh increase dramatically. When wind is available the WES30 can reduce your energy costs in a spectacular way.

Because regulations, grants, feed-in tariff and the price of electricity can change over time it is important to be able to change the way you are paid for the energy produced by your WES30. Changes between all 3 types off connections are possible. The installation change from one configuration to another is relative simple and will take little time.

Electricity companies all over the world are comfortable buying energy generated with WES30 wind turbines for a number of reasons, including:

Maximum power limitation.

The maximum power output of the WES30 can be limited through settings in the IPC control system. This can be useful when your local grid is not yet strong enough to support the maximum power generated by your WES30. Your WES dealer can adjust or remove the limitation on maximum power output of your WES30 once the grid has been improved and is strong enough to support the full power output.

Power factor improvement.

The WES30 control cabinet is able to influence the power factor of your grid. Through settings in the IGBT convertors the power factor can be moved in both directions. Besides generating electrical energy the WES30 is able to improve the quality of your grid.

Shut down during grid failure (anti islanding UK G59).

When the grid voltage or frequency are out of tolerances or when a grid black-out occurs the WES30 will shut down automatically within tens of milliseconds.

Remote access through the Internet.
WES30 turbines can be monitored and operated from a distance.

Future connections.

Your WES30 wind turbine will generate electrical energy in the same way for more than 20 years. The environment in which it will deliver its energy will change over time. Your WES30 is ready to deal with any change and will always be able to deliver its energy in the way that is most beneficial for you.

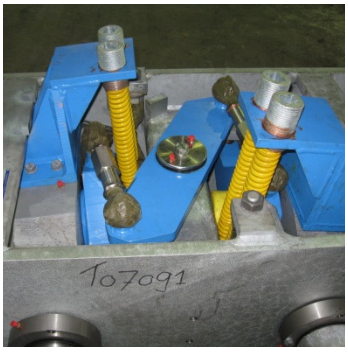
Your WES dealer is aware of local situations and can calculate for you how much will be paid for electricity generated with your WES30 or how much will be saved. Your local WES dealer will inform you when changes in regulations or laws have impact on the way you are compensated for electricity generated with your WES30.

WES30 GENERATOR
The generator is a 6 – pole, 3 phase asynchronous generator, which is able to generate a maximum nominal power of 250 kW. The generator is totally enclosed fan cooled and therefore this generator is **maintenance free**

The choice for a a-synchronous generator is key in the WES30 design. Fluctuations in wind speed are absorbed by rotor and generator frequency. Fluctuations in wind speed do not cause fluctuations in loads on blades, gearbox or tower. This is the main reason why the WES30 has a long live expectancy and needs little maintenance. The combination of an a-synchronous generator and IGBT technology allows the WES30 to deliver electricity in weak or small grids.

WES30 MECHANICAL SYSTEMS

WES30 ROTOR
The rotor of the WES30 is equipped with two blades and is characterised by the flexible (hinged) way of mounting the blades and the passive blade angle adjustment.



The possibility for the blades to hinge over a small angle has the advantage that the loads on the construction will be less. This way of mounting the blades is similar to the teetering hub construction but has the additional advantage that the blades can hinge independently. This allows for a lighter construction.

The operating principle is described as follows:

The pressure of the wind pushes the blades in the direction of the main shaft. Due to the hinges in the rotor hub, the actual position of the blades will be slightly backward. Instead of a disc perpendicular to the main shaft, the rotating blades will form a cone with the hub being top. The rotation of the rotor causes centrifugal forces on the blades, forcing the blades to stretch out and come forwards to a position more perpendicular to the main shaft. Mentioned opposite forces will come to an equilibrium. Bending moments and forces on the rotor hub and main shaft are being reduced considerably by this design.

The passive blade angle adjustment affects the blade angle. The blade angle is a major aspect with regard to the efficiency of the rotor and consequently for the generated power. The pitch can be altered by rotating the blades around a pitch shaft. The blade angles of both blades are always kept equal by means of a synchronisation mechanism located in the rotor hub.

The pressure on the blades causes a force which intends to reduce the projected area: increasing the blade angle. A spring is installed to withstand this force. Wind speeds less than 13 m/s will not affect the blade angle: it will remain in its most favourable position. The nominal power output of the turbine is limited to 250 kW by means of the back-to-back converter system. Wind speeds above 13 m/s will increase the rotor speed since the extra power produced by the rotor is not absorbed by the generator. However, due to the increased speed and forces at this point, the passive blade angle adjustment is activated since these forces will exceed the above mentioned spring forces. An increased blade angle will reduce the efficiency of the blades. Consequently the rotor speed is reduced. This procedure constitutes the first safety system of the wind turbine.

WES30 BLADES

The blades are manufactured from carbon fibre reinforced epoxy. Due to the properties of this material the blades are light, strong and flexible. The shape of the blades is based on the NLF 416 airfoil and has a tapered form and a slightly twisted chord. The length is 13,4 metre. The blades are mounted by means of an insert and bolted to the pitch shafts. This design has been tested thoroughly both under static and dynamic loading.

WES30 HUB FRAME

The hub frame is the connection point of the blades to the main shaft. In the frame the synchronisation mechanism and the blade hinges for flexible mounting of the blades are located. The blade hinges are provided with maintenance-free bearings. By means of a flanged connection the hub frame is mounted to the main shaft, being the low speed shaft of the gearbox.

De Veken 206, 1716 KJ Opmeer, the Netherlands
Tel: +31. 226.425150 Fax:31.226.425159
www.wes30.com www.windenergysolutions.nl

WES30 GEARBOX

The rotor speed is increased by the gearbox. In two stages a ratio of 1:26.6 is obtained. Therefore the outgoing shaft, and consequently the generator, will have an effective working range between approximately 1050 and 2250 rotations per minute. A built-in radial bearing and an attached radial/axial bearing allow the rotor to be mounted directly to the gearbox.

The high speed shaft is connected to the generator by means of a flexible coupling. Furthermore the gearbox is equipped with a brake which prevents the rotor of turning backwards. When the turbine is shut down and yawed 120^0 out of the wind, the rotor could rotate backwards. The above mentioned brake will be activated and the rotor will be stopped. With this procedure the turbine is shut down.

For maintenance the rotor can be locked. Therefore the high speed shaft of the gearbox is provided with a disc brake which can be activated manually. After having yawed the turbine out of the wind, the high speed shaft can be locked.

WES30 YAW-SYSTEM

The yaw-system controls the position of the nacelle in order to place the rotor in the required position. The system is driven by two electric motors, each provided with its own reduction. The yaw bearing is externally geared. The yaw system is controlled by an IPC In case of a failure of the grid, causing malfunctioning of the controller and the electric motors, the yaw motors are directly connected to the generator. The turbine will then yaw out of the wind independently. In order to avoid the moments and forces of the rotor, which are passed through to the nacelle, being projected on the yaw system, slip couplings and friction brakes are fitted.

WES30 NACELLE

The nacelle of the WES30 is equipped with a fully detachable canopy. The U-shaped nacelle frame carrying the drive train and some control equipment is constructed from hot dip galvanized steel and is mounted on the turbine tower with a large yaw bearing.

De Veken 206, 1716 KJ Opmeer, the Netherlands
Tel: +31. 226.425150 Fax:31.226.425159
www.wes30.com www.windenergysolutions.nl

WES30 TOWER

The tower consists of three or four cylindrical/conical parts, mounted to each other by means of a flanged connection. The tower sections are "nested" before and during transport and "un-nested" at the location before installation (see images below)

If a heavy lifting crane is not available, or the terrain does not allow access, a specially designed lattice tower (picture below) is used. The lattice tower is designed to avoid critical resonance at the normal rotational speed of the WES30 and ensure the necessary safety against dynamic and extreme loads. Sufficient clearance is provided for the rotor blades to pass the tower. This accounts for the giraffe-like appearance of the WES30.

Safe and sufficient access to the nacelle is provided directly from the tower using an internal ladder arrangement. A full platform is provided close to the top of the tower at an adequate height for safe and easy inspection of the yaw arrangement and for access to the nacelle. The full height of the tower and any working platforms are equipped with clearly identified points to which a fall protection device can be secured.

WIND ENERGY SOLUTIONS WES

De Veken 206, 1716 KJ Opmeer, the Netherlands
Tel: +31. 226.425150 Fax:31.226.425159
www.wes30.com   www.windenergysolutions.nl

WES30 FOUNDATION

The detailed design of the foundation depends heavily on the site conditions with regard to the material properties of the soil. These are established through probing.

In case of insufficient support, the foundation should be piled.

WES30 TECHNICAL SPECIFICATIONS

WES30 GENERAL	
Supplier / manufacturer	WES BV
Life expectancy	More than 20 years
Service / maintenance	Twice a year
Nominal power	250 kW
Cut - in wind speed	2.7 m/sec. (6.7 mph)
Cut - out wind speed	25 m/sec. (56 mph)
Nominal wind speed	12,5 m / sec. (29 mph)
Survival wind speed	60 m/sec.
Fast passive power regulation	Pitching (blade angle adjustment)
Active power regulation	Fully variable back – to – back IGBT system.
Noise emission at 8 m / sec	Less than 45 dBa at 200 meter
Operating temperatures	From – 20^{o}C up to + 40^{0}C
Grid voltage	400V ± 10%
Grid frequency	50/60Hz ± 3 Hz
Connection	3 phase + neutral
Specific power	354 W/m2

WES30 Applied standards	
Degree of protection	IP55
Standards	NEN1010 (electrical); EN50308 (safety); EN6096 (wind turbines); UL1741 (anti islanding); UKG59 (anti islanding); IIEC61346-2000 (cabinet)
CE mark	Yes

De Veken 206, 1716 KJ Opmeer, the Netherlands
Tel: +31. 226.425150 Fax:31.226.425159
www.wes30.com www.windenergysolutions.nl

WES30 Electrical	
Grid voltage	400 V ± 10%
Grid Frequency	50 / 60 Hz ± 3 Hz (suitable for poor grids)
# Phases	3 + N
Specific power	354 W / m2
Convertor type	Back – to – back IGBT convertor

WES30 ROTOR	
Number of blades	2
Diameter	30 m
Rotor position	Upwind
Direction	Clockwise
Angle of the main shaft	7º with horizon
Swept area	707 m2
Speed	Variable 35 – 70 rpm
Power regulation	Passive: blade-angle adjustment
Min. Blade - angle	1.0
Flapping - angle	183º – 170.5º

WES30 BLADES	
Blade length	13.4 meter
Weight one blade	315 kg
Chord	500 – 1,200 mm
Twist	15º
Mounted	Flexible

WES30 GEARBOX	
Brand	Flender (= part of Siemens)
Number of stages	2
Weight	1850 kg (incl. oil)
Ratio	1: 26.6

WES30 GENERATOR	
Brand	ABB
Type	A - synchronous
Nominal ouput	250 kW
Number of poles	6 (double winding per phase)
Number of phases	3 + N
Nominal voltage	230/400 V
Frequency	Variable 25 - 75 Hz
Weight	1320 kg
Protection	IP 55

WES30 GRID-	

CONNECTION	
Converter	Back-to-Back
Converter principle	AC - DC – AC
Power supply	400 V / 50 or 60 Hz (± 3 Hz) / 3 phase + neutral (deviating voltage and frequency are available as an option)

WES30 TOWER	
Type	Conical tubular
Number of sections	2, 3 or 4 sections
Hub height	31m, 40 m or 49 m
Material	Steel
Location ladder	Internal
Type	Lattice
Hub height	36 m
Material	Hot dip galvanized steel, four legged.
Location ascent ladder	External

WES30 CONTROLLER	
Control by	IPC (Beckhoff)
Remote monitoring & control	Yes
Data logging	Optional

WES30 YAW-SYSTEM	
Yaw system	Active
Signal from	Wind vane
Driven by	Electro motor with worm-wheel reduction.
Power yaw-motor	2 x 1.5 kW
Yaw speed	0.77°/sec.
Yaw bearing	Single ball bearing; externally geared (Rothe Erde)
Yaw breaks	Constant friction break; 8 pcs.

WES30 SAFETY	
First safety system	Passive blade pitch
Activated by:	• rotor speed (70 rpm)
Second safety system	Yawing out of the wind
Activated by:	• rotor speed (>90 rpm) • excessive vibrations • failure anemometer • failure wind vane • failure in IPC • grid Failure • other failures
Blocking system	

Rotor blocking system	Parking disk brake on high speed shaft gearbox and pin in high speed shaft of gear box; for service purposes
Activation	Manual

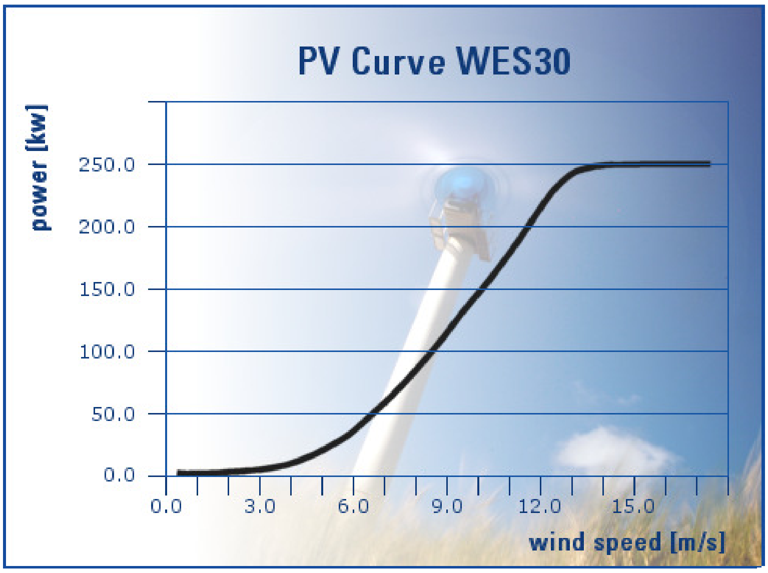
WES30 WEIGHTS	
Rotor incl. blades	3.600 kg
Nacelle excl. rotor	7.100 kg
Control cabinet	600 kg
Tower	12.500 kg (30 m tower)

WES30 MATERIAL SPECIFICATIONS	
Blades	Carbon and glass fibre reinforced epoxy.
Nacelle / rotor	Steel
Covers	Polyester
Tower	Steel (painted)
Foundation	Concrete block with steel anchor.

De Veken 206, 1716 KJ Opmeer, the Netherlands
Tel: +31. 226.425150 Fax:31.226.425159
www.wes30.com www.windenergysolutions.nl

WES30 measured power curve.

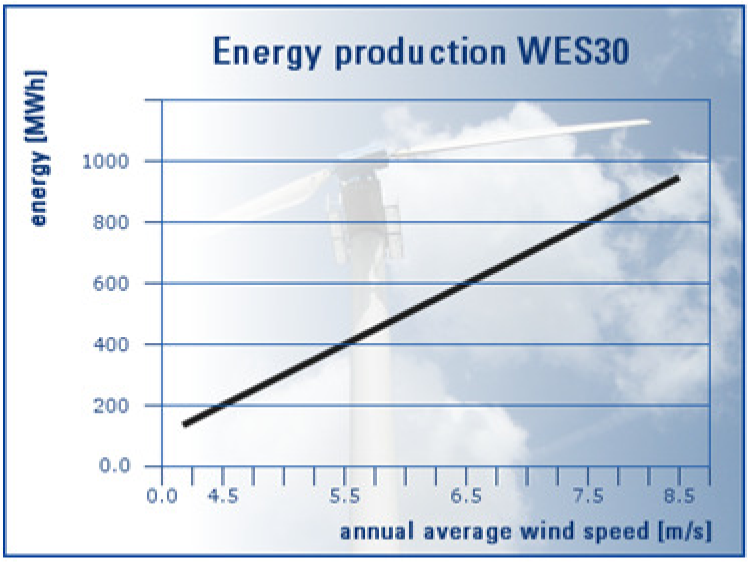
The curve data are valid for standard atmospheric conditions of 15° C air temperature, 1013 mbar air pressure and 1.225 kg/m³ air density, clean rotor blades and horizontal undisturbed air flow.



Wind speed [m / s]	Power [kW]
2,7	cut - in
3	1,5
4	4,4
5	14,9
6	29,3
7	56,3
8	77,2
9	116
10	145
11	179
12	222
12,5 - 25	250

WES30 measured annual production.

The annual energy production data for different annual mean wind speeds at hub height are calculated from the above power curve data assuming a Rayleigh wind speed distribution, K=2 and 100% availability and no reductions due array losses, grid losses, or other external factors effecting the production.



Wind speed [m / s]	Energy [MWh]
4	136
5	285
6	464
7	656
8	841
more than 8	841 ++

De Veken 206, 1716 KJ Opmeer, the Netherlands
Tel: +31. 226.425150 Fax:31.226.425159
www.wes30.com www.windenergysolutions.nl