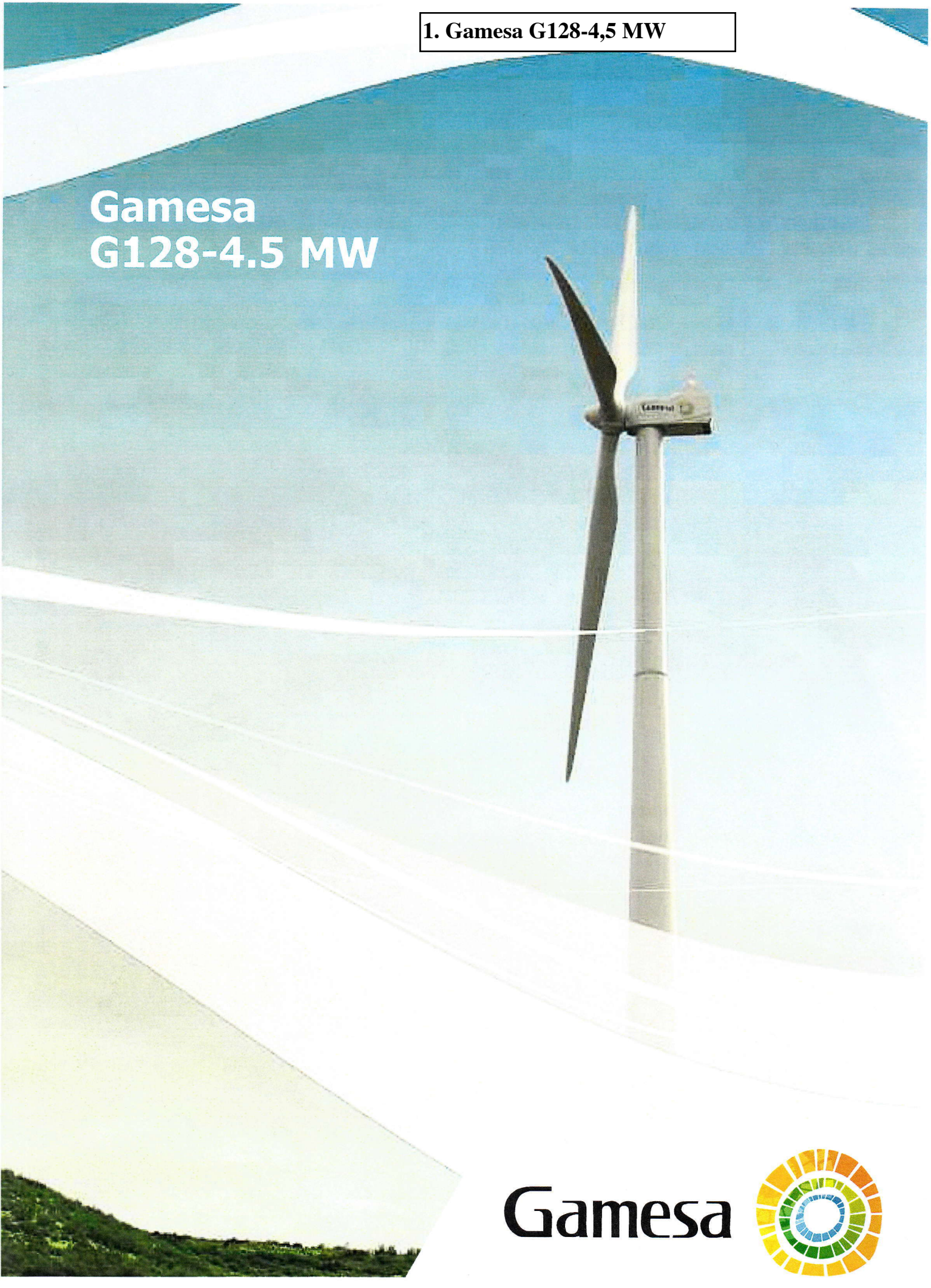
**1. Gamesa G128-4,5 MW**

# Gamesa G128-4.5 MW



Gamesa

# State of the art technology in wind

## Rotor

| | |
|---|---|
| **Diameter** | 128 m |
| **Swept area** | 12,868 $m^2$ |
| **Rotational speed** (stationary) | 12 rpm |
| **Rotational direction** | Clockwise (front view) |

## Blades

| | |
|---|---|
| **Number** | 3 |
| **Total length** | 62.50 m |
| **Length of inboard section** | 30.50 m |
| **Length of outboard section** | 32.00 m |
| **Material** | Organic matrix composite reinforced with fiber glass / carbon fiber |

## Tower

| | |
|---|---|
| **Type** | Trunk conical tubular |
| **Material** | Post-tensioned prefabricated concrete / Structural carbon steel |
| **Hub height** | 120 m |

## Gearbox

| | |
|---|---|
| **Type** | 2 planetary stages |
| **Ratio** | 1: 37.88 |

## Generator

| | |
|---|---|
| **Type** | Permanent magnet synchronous generator with parallel independent modules |
| **Rated power** | 4,500 kW |
| **Voltage** | 660 V ac |
| **Frequency** | 89.6 Hz |
| **Rotational speed** | 448 rpm |

## Converter

| | |
|---|---|
| **Type** | Full converter with independent modules |
| **Rated power** | 4,500 kW |
| **Voltage** | 690 V ac |
| **Frequency** | 50 Hz / 60 Hz |
| **Power factor** | 0.9 CAP – 0.9 IND for the entire power range (*) |

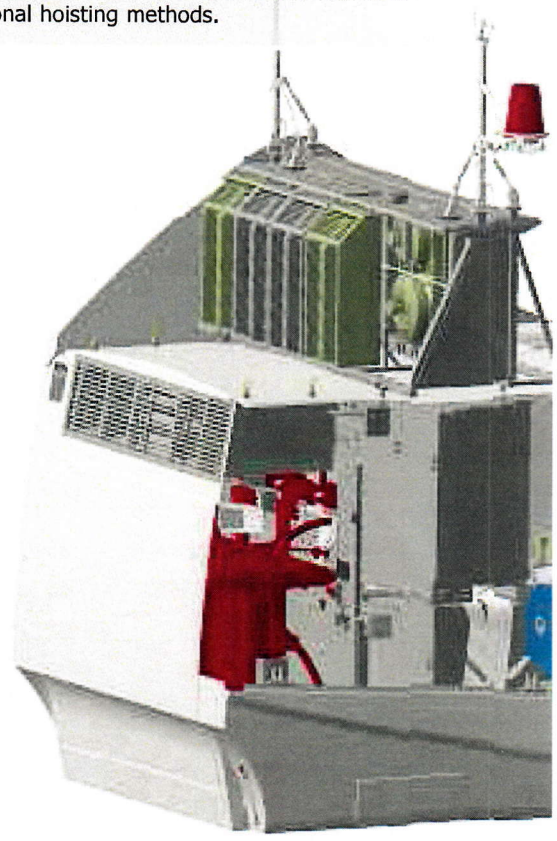
* Measured at generator output terminals, on the low voltage side before the transformer, at rated grid voltage.

## Transport and Assembly

Flexifit® and the modular design of its components allow the Gamesa G128-4.5 MW wind turbine to be transported and assembled using similar resources as are required for a 2.0 MW model.

### FlexiFit®

The FlexiFit® crane, coupled to the nacelle, is used as an assembly and service tool to hoist and lower main nacelle modules such as the drive train, generator and hub. Using this device makes it possible to assemble and service wind turbines without large cranes, providing a manageable and cost effective alternative to traditional hoisting methods.



### GridMate®

The Gamesa G128-4.5 MW wind turbine electrical system uses a permanent magnet synchronous generator and a full converter. The system comprises parallel modules which continue to function in the event of individual failure. GridMate® complies with the most demanding grid connection requirements.

# turbine design and development

## Reliable technology

The advanced technology used in the Gamesa G128-4.5 MW wind turbine makes for a more reliable system. Technological developments applied to improve reliability include load-reducing multivariable control, drive train with no high-speed rotating components and modular electric power system which allows partial operation of the unit and also isolates the mechanical train from loads caused by voltage drops.

### InnoBlade®

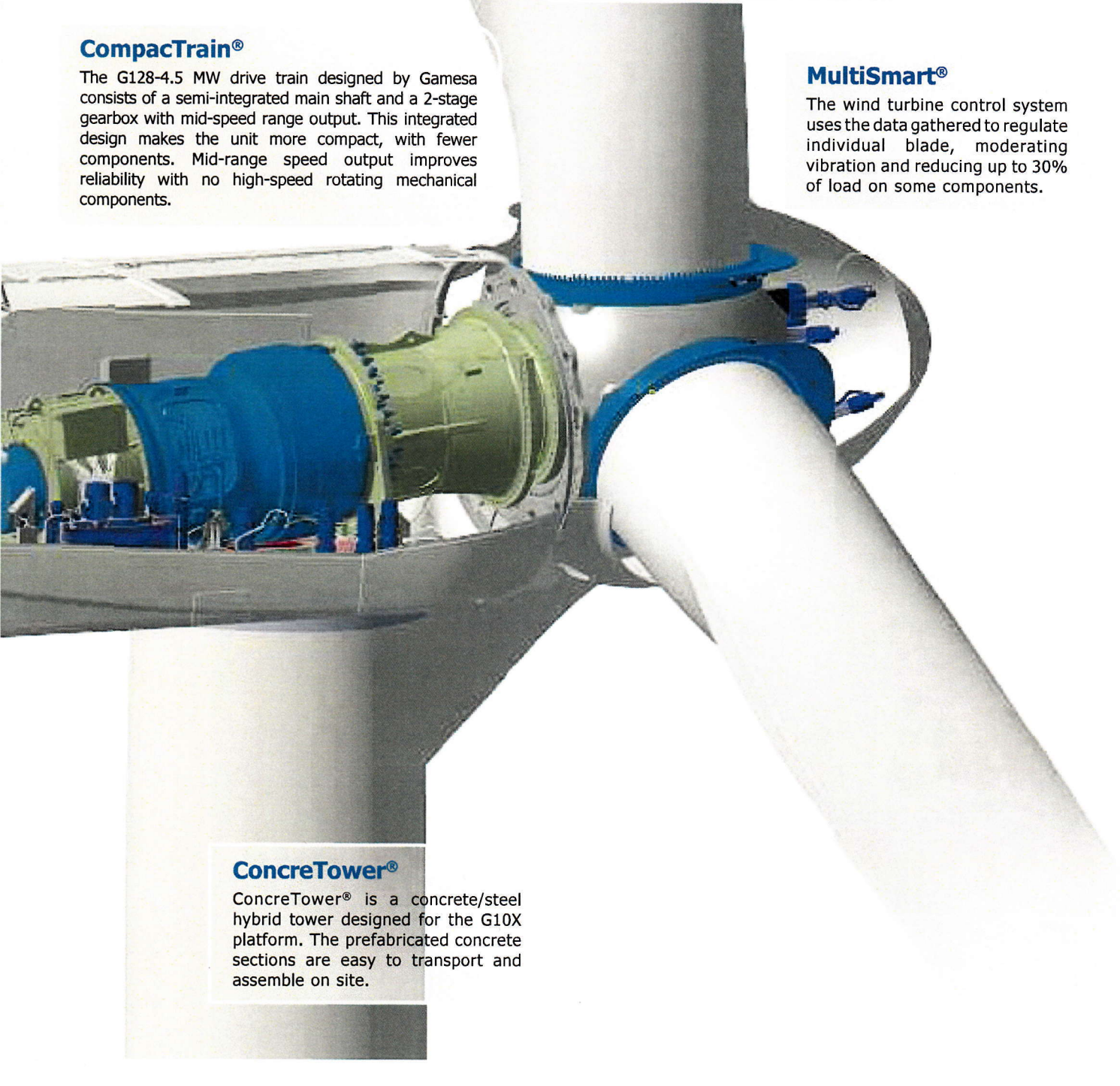
Gamesa's new aerodynamic profiles reduce noise and maximize production. The Innoblade® is manufactured using a combination of materials in a pioneering structure that reduces weight. Current tooling and equipment used to transport 2.0 MW models to the site are also suitable for this innovative sectioned-blade.

### CompacTrain®

The G128-4.5 MW drive train designed by Gamesa consists of a semi-integrated main shaft and a 2-stage gearbox with mid-speed range output. This integrated design makes the unit more compact, with fewer components. Mid-range speed output improves reliability with no high-speed rotating mechanical components.

### MultiSmart®

The wind turbine control system uses the data gathered to regulate individual blade, moderating vibration and reducing up to 30% of load on some components.



### ConcreTower®

ConcreTower® is a concrete/steel hybrid tower designed for the G10X platform. The prefabricated concrete sections are easy to transport and assemble on site.

## 2. WinWind 3MW med 109-120 m rotor

# 120 m Rotor

The biggest rotor in WinWinD's history and one of the biggest in the markets

- Excellent yields in low-wind-speed sites
- Compatible with WinWinD 3
- Manufactured in-house by WinWinD which enables full capacity and quality control

# 10 Technical specifications

**Table 2. Technical details**

| Technical Specification | WinWinD-3-D100 | WinWinD-3-D109 | WinWinD-3-D120 |
|---|---|---|---|
| **ROTOR** | | | |
| Description | 3 Bladed, Upwind | 3 Bladed, Upwind | 3 Bladed, Upwind |
| Diameter | 101.1 m | 109.1 m | 120.6 m |
| Swept Area | 7867 $m^2$ | 9348 $m^2$ | 11366 $m^2$ |
| Rotor Speed | 4-15 rpm approx. (Nominal – 13.4 rpm) | 5-15.75 rpm approx. (Nominal – 13.14 rpm) | 4-14.5 rpm approx. (Nominal – 12.5 rpm) |
| Power Regulation | Variable Speed, Pitch Regulation | Variable Speed, Pitch Regulation | Variable Speed, Pitch Regulation |
| **BLADES** | | | |
| Type | LM48.8 or similar | LM53.2 or similar | W120 |
| Blade Length (approx) | 48.7 m | 53.2 m | 59.0 m |
| Max. Chord (approx) | 3.9 m | 4.0 m | 4.2 m |
| Material | Glass fibre reinforced polyester | Glass fibre reinforced polyester | Glass fibre reinforced epoxy |
| Surface Colour | Light grey | Light grey | Light grey |
| **TRANSMISSION** | | | |
| Type | 2 stage planetary Gearbox | 2 stage planetary Gearbox | 2 stage planetary Gearbox |
| Ratio | 1:29.32 | 1:29.32 | 1:29.32 |
| Oil filtering | Inline and offline | Inline and offline | Inline and offline |
| Lubrication | Separated oil unit, forced circulation | Separated oil unit, forced circulation | Separated oil unit, forced circulation |
| **BRAKING** | | | |
| Aerodynamic | Full span individual Pitch, Electric, fail-safe. | Full span individual Pitch, Electric, fail-safe. | Full span individual Pitch, Electric, fail-safe. |
| Mechanical | Disk brakes located on generator side | Disk brakes located on generator side | Disk brakes located on generator side |
| **GENERATOR** | | | |
| Type | Synchronous, Permanent Magnets with full frequency converter | Synchronous, Permanent Magnets with full frequency converter | Synchronous, Permanent Magnets with full frequency converter |
| Cooling | Air-water-air | Air-water-air | Air-water-air |
| **INVERTER** | | | |
| Type | Full Converter | Full Converter | Full Converter |
| Controller | Microprocessor | Microprocessor | Microprocessor |
| Cooling | Water-Glycol | Water-Glycol | Water-Glycol |
| **YAW SYSTEM** | | | |
| Type | Active | Active | Active |
| Yaw System | Six motors with hydraulic brakes | Six motors with hydraulic brakes | Six motors with hydraulic brakes |

| | | | |
|---|---|---|---|
| Bearing | 2 row, 4 point Ball | 2 row, 4 point Ball | 2 row, 4 point Ball |
| **MONITORING SYSTEM** | | | |
| Controller | WinControl | WinControl | WinControl |
| Remote Monitoring | WinCare | WinCare | WinCare |
| **MASSES** | | | |
| Rotor | 63 tonnes (approx) | 65 tonnes (approx) | 65 tonnes (approx) |
| Nacelle | 80 tonnes (approx) | 80 tonnes (approx) | 80 tonnes (approx) |
| **OPERATIONAL DATA** | | | |
| Cut – in Wind Speed | 4 m/s | 4 m/s | 3 m/s |
| Rated Wind Speed | 13 m/s | 11.75 m/s | 11 m/s |
| Cut-Out wind Speed | 25 m/s | 25 m/s | 20 m/s |
| Extreme Wind Speed | 50 m/s (10 min average) | 42.5 m/s (10 min average) | 37.5 m/s (10 min average) |
| Survival Wind Speed | 70 m/s (3 sec. average) | 59.5 m/s (3 sec. average) | 52.5 m/s (3 sec. average) |
| Maximum flow inclination (Terrain Slope) | 8° | 8° | 8° |
| Ambient operating conditions* | acc. to IEC 61400-1 | acc. to IEC 61400-1 | acc. to IEC 61400-1 |
| Power Factor while operation | Fixed value, ± 0,95 When U=Un | Fixed value, ± 0,95 When U=Un | Fixed value, ± 0,95 When U=Un |
| Power Factor while stopped | < 1 ( Transformer reactive consumption ) | < 1 ( Transformer reactive consumption ) | < 1 ( Transformer reactive consumption ) |
| **CLASSIFICATION (IEC 61400 ed-3 and/or ed-2)** | | | |
| Type | IEC IA | IEC IIA | IEC IIIA |
| Reference wind speed | 50 m/s | 42,5 m/s | 37,5 m/s |
| Turbulence intensity | 16% (ed-3) including wake effects | 16% (ed-3) including wake effects | 16% (ed-3) including wake effects |
| *Site specific ranges possible if agreed so. | | | |
| **TRANSFORMER AND GRID** | | | |
| Apparent Power | 3300 kVA | 3300 kVA | 3300 kVA |
| Primary Voltage* | 20.5 kV ±2x2.5% | 20.5 kV ±2x2.5% | 20.5 kV ±2x2.5% |
| Secondary Voltage | 0.690 kV | 0.690 kV | 0.690 kV |
| Frequency | 50 Hz | 50 Hz | 50 Hz |
| Vector Group | Dyn | Dyn | Dyn |
| *Site specific ranges possible if agreed so. | | | |