Anexo III: Fichas características de aerogeneradores tipo

PARQUE EÓLICO ASOCIADO A LA PLANTA DESALADORA DE RIEGO AGRÍCOLA GRAN TARAJAL EN EL SUDESTE DE FUERTEVENTURA.

PROYECTO DE MODERNIZACIÓN Y MEJORA DEL REGADÍO DE LA ZONA SUDESTE DE FUERTEVENTURA, TT.MM. DE TUINEJE (FUERTEVENTURA)

Departamento de Energías Renovables

División de Investigación y Desarrollo Tecnológico

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Contenido del documento.

1. OBJETIVO 1

2. GAMA GAMESA 1

3. GAMA ENERCON (E 82) 3

4. GAMA VESTAS (V 90) 5

5. GAMA SERVION 7

6. GAMA ACCIONA 10

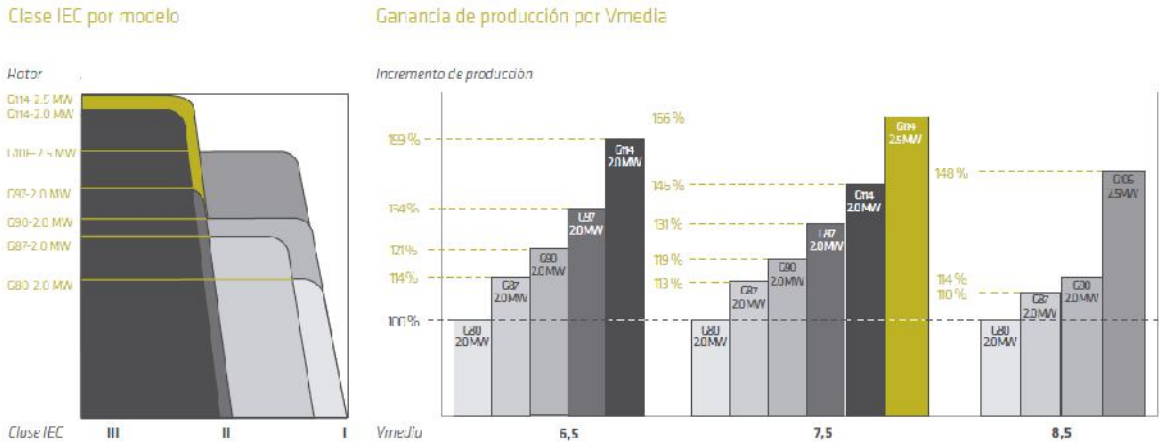
1. OBJETIVO

En el presente anexo al proyecto del parque eólico en régimen de autoconsumo Gran Tarajal se presentan las fichas características de las alternativas de aerogenerador de mayor interés conforme al análisis de los requerimientos exigidos en el proyecto y el estado actual del mercado de aerogeneradores. La opción finalmente seleccionada se determinará con el pertinente concurso de concurrencia pública de fabricantes de aerogeneradores.

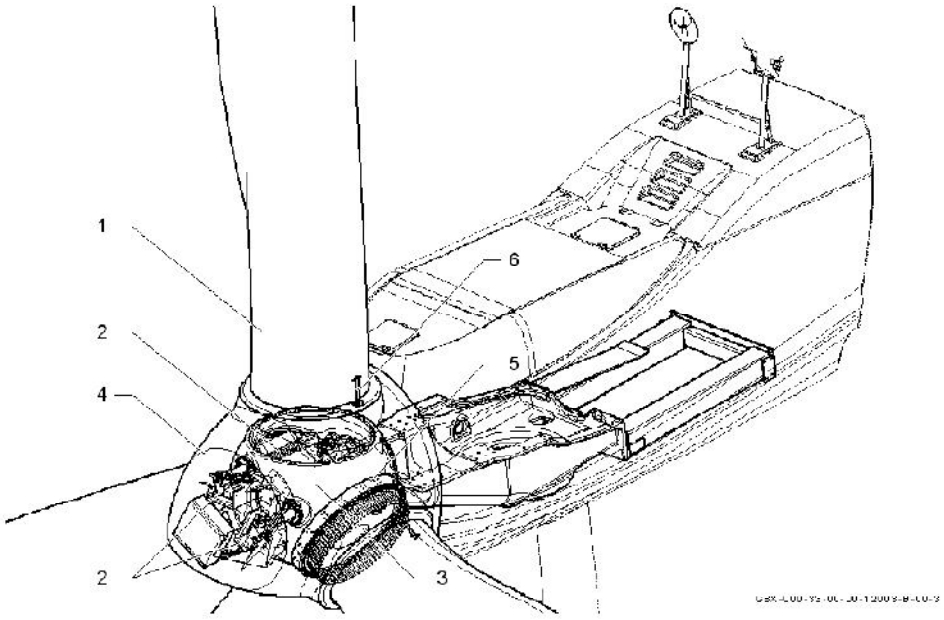
2. GAMA GAMESA

	G80 2.0 MW	G87 2.0 MW	G90 2.0 MW	G97 2.0 MW	G114 2.0 MW
ROTOR					
Diametro	80 m	87 m	90 m	97 m	114 m
Área de barrido	5.027 m^2	5.945 m^2	6.362 m^2	7.390 m^2	10.207 m^2
Velocidad de giro	9,0 - 19,0 rpm	9,0 - 19,0 rpm	9,0 - 19,0 rpm	9,6 - 17,8 rpm	7,8 - 14,8 rpm
PALAS					
Número de palas	3	3	3	3	3
Longitud	39 m	42,5 m	44 m	47,5 m	56 m
Perfil	NACA 63.XXX + FFA-W3	DU + FFA-W3	DU + FFA-W3	Gamesa	Gamesa
Material	Fibra de vidrio preimpregnado de resina epoxy	Fibra de vidrio preimpregnado de resina epoxy	Fibra de vidrio preimpregnado de resina epoxy + fibra de carbono	Fibra de vidrio preimpregnado de resina epoxy + fibra de carbono	Fibra de vidrio reforzada con resina de epoxi o poliéster
TORRE					
Tipo	Modular	Modular	Modular	Modular	Modular
Altura	60, 67, 78 y 100 m	67, 78, 90 y 100 m	55, 67, 78, 90 y 100 m	78, 90, 100, 104 y 120 m	80, 93, 125 m y según emplazamiento
MULTIPLICADORA					
Tipo	1 etapa planetaria 2 etapas de ejes paralelos	1 etapa planetaria 2 etapas de ejes paralelos	1 etapa planetaria 2 etapas de ejes paralelos	1 etapa planetaria 2 etapas de ejes paralelos	1 etapa planetaria 2 etapas de ejes paralelos
Ratio	1:100,5 (50 Hz) 1:120,5 (60 Hz)	1:100,5 (50 Hz) 1:120,5 (60 Hz)	1:100,5 (50 Hz) 1:120,5 (60 Hz)	1:106,8 (50 Hz) 1:127,1 (60 Hz)	1:128,5 (50 Hz) 1:102,5 (60 Hz)
GENERADOR 2.0 MW					
Tipo	Generador doblemente alimentado	Generador doblemente alimentado	Generador doblemente alimentado	Generador doblemente alimentado	Generador doblemente alimentado
Potencia nominal	2.0 MW	2.0 MW	2.0 MW	2.0 MW	2.0 MW
Tensión	690 V AC	690 V AC	690 V AC	690 V AC	690 V AC
Frecuencia	50 Hz / 60 Hz	50 Hz / 60 Hz	50 Hz / 60 Hz	50 Hz / 60 Hz	50 Hz / 60 Hz
Clase de protección	IP 54	IP 54	IP 54	IP 54	IP 54
Factor de potencia	0,95 CAP - 0,95 IND en todo el rango de potencias*	0,95 CAP - 0,95 IND en todo el rango de potencias*	0,95 CAP - 0,95 IND en todo el rango de potencias*	0,95 CAP - 0,95 IND en todo el rango de potencias*	0,95 CAP - 0,95 IND en todo el rango de potencias*

* Factor de potencia en bornas de salida del generador en el lado de baja tensión antes de la entrada del transformador.



* NOTA: producciones teóricas calculadas para k=2, densidad 1,225 kg/m3, con velocidad media a altura de buje.



Posición	Denominación
1	Pala
2	Sistema de cambio de paso
3	Buje
4	Cono
5	Rodamiento de pala
6	Armario eléctrico
7	Transmisor de rayos

Norma	IEC [1]										DIBt [2]						
Clase	I A			II A				III A			WZ II				WZ III		
Altura buje (m)	60	67	78	60	67	78	100	67	78	100	60	67	78	100	60	67	78
G80	✓	✓	✓	✓	✓	✓	✓										
G87					✓	✓	✓					✓	✓	✓			
G90					✓	✓	✓	✓	✓	✓		✓	✓	✓			

3. GAMA ENERCON (E 82)

WIND ENERGY CONVERTER CHARACTERISTICS

E-82 E2 2MW

Rotor	
Type	E82 E2
Rotor diameter	82 m
Swept area	5281 m^2
Power regulation	Pitch
RPM	6 –18 min^{-1}
Cut in wind	2,5 m/s
Cut out wind	28 – 34 m/s
Survival wind speed	59,5 m/s

Gear Box	
Not applicable	No gearbox

Blades	
Manufacturer	ENERCON
Blade length	38,8 m
Material	GRP (Epoxy)
Lightning protection	included

Generator	
Manufacturer	ENERCON
Nominal Power	2000 kW
Type (model)	Synchronous, direct-drive ringgenerator
Protection classification	IP 23
Insulation class	F

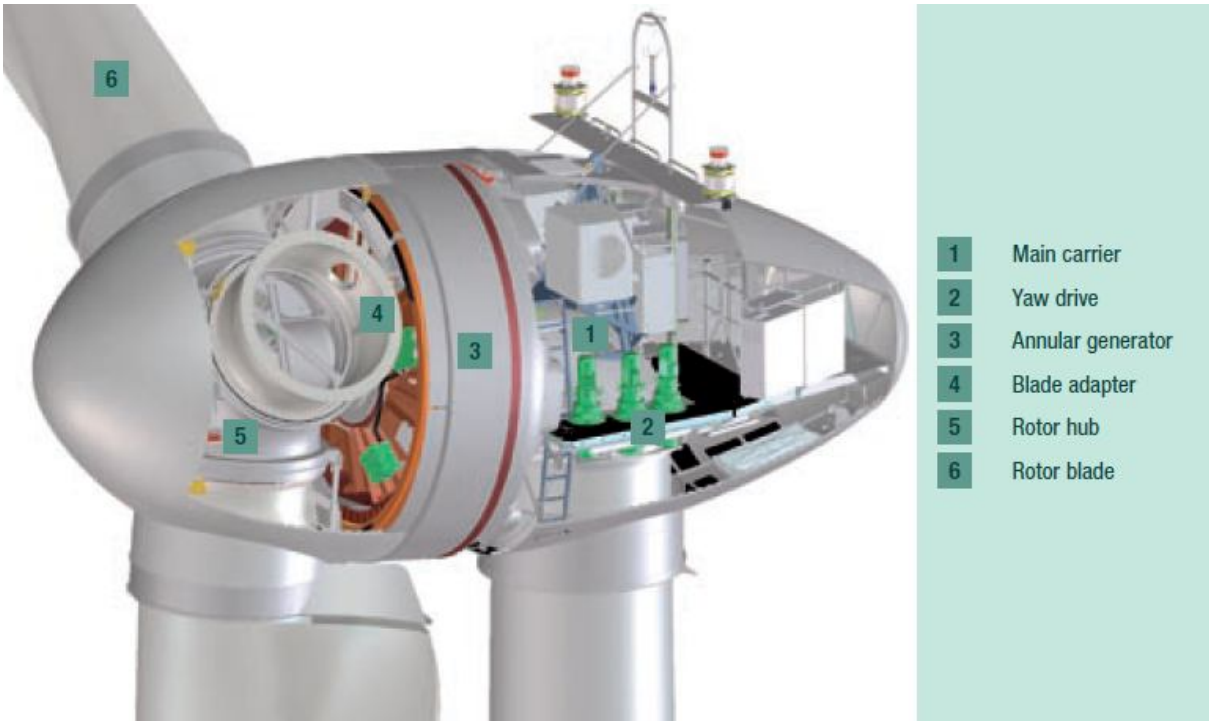
Yaw System	
Type	6 electrical motors
Yaw control	Active (based on wind vane signal)
Yaw rate	0,5°/sec

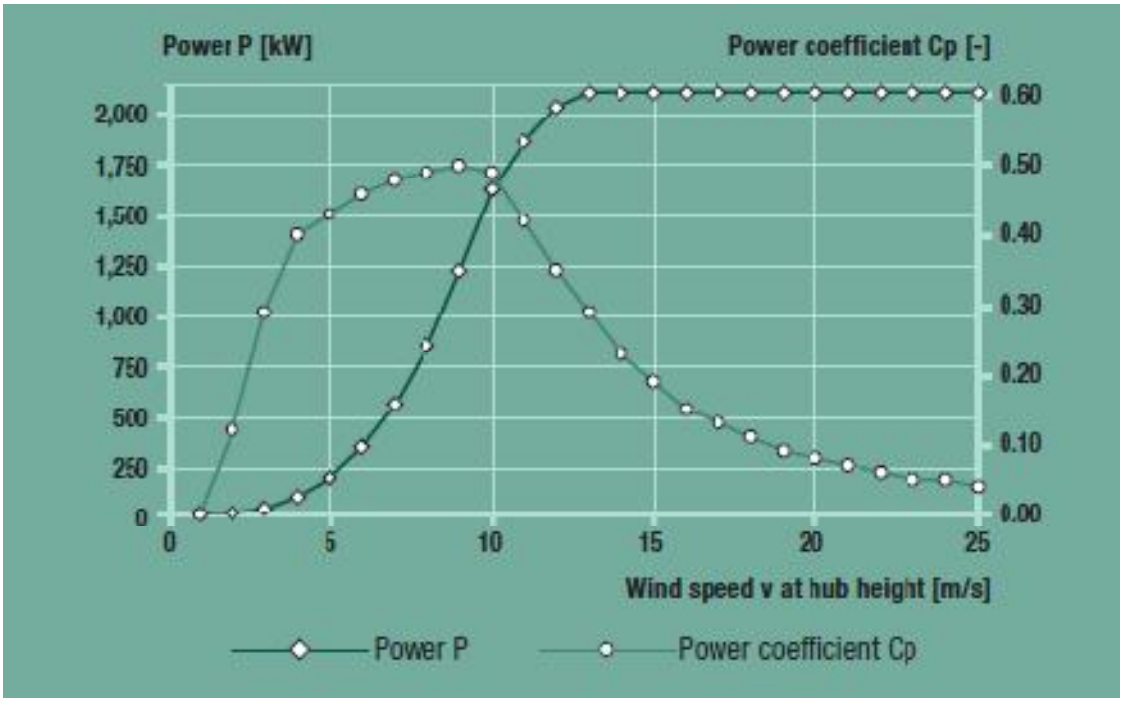
Controller	
Manufacturer	ENERCON
Type	microprocessor
Grid connection	Via ENERCON inverter
Remote communication	ENERCON Remote Monitoring System
UPS	included

Braking System	
Aerodynamic brake	- three independent blade pitch systems with emergency supply - rotor brake - rotor lock, locking at 30°

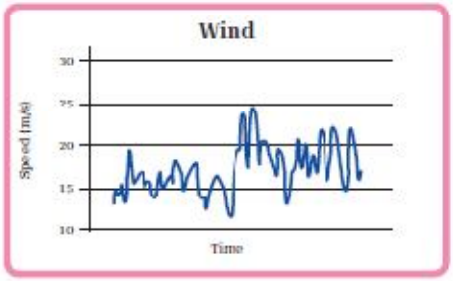
Tower					
Hub heights	78 m	85 m	98 m	108 m	138 m
Tower	Steel (4 + FS)	Steel + Prefab concrete (2 + 15)	Steel + Prefab concrete (2 + 18)	Steel + Prefab concrete (2 + 21)	Steel + Prefab concrete (2 + 21)
Design Wind Class	II	II	II	II	II

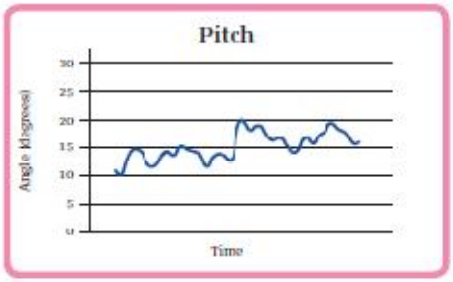
Weights	
Nacelle, excl. Rotor and hub	Approx. 18 to
Rotor incl. Hub/Main pin	Approx. 55 to
Generator	Approx. 62 to
Total Weight	**Approx. 135 to**

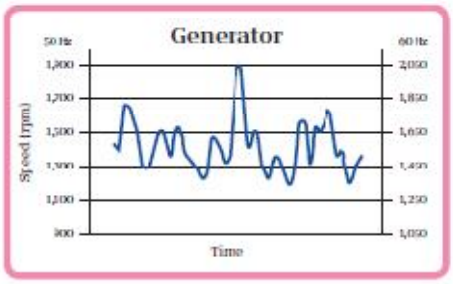


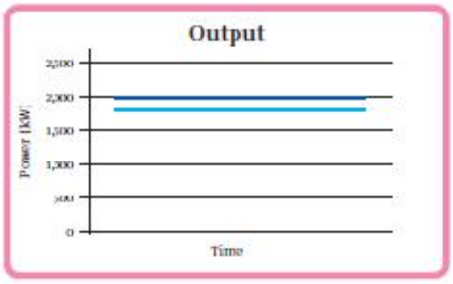


4. GAMA VESTAS (V 90)









OptiSpeed® allows the rotor speed to vary within a range of approximately 60 per cent in relation to nominal rpm. Thus with OptiSpeed®, the rotor speed can vary by as much as 30 per cent above and below synchronous speed. This minimises both unwanted fluctuations in the output to the grid supply and the loads on the vital parts of the construction.

Rotor

Diameter:	90 m
Area swept:	6,362 m²
Nominal revolutions:	14.9 rpm
Operational interval:	9.0-14.9 rpm
Number of blades:	3
Power regulation:	Pitch/OptiSpeed®
Air brake:	Full blade pitch by three separate hydraulic pitch cylinders.

Tower

Hub height:	80 m, 95 m, 105 m

Operational data

	IEC IIA:	IEC IIIA/DIBt II:
	1,800 kW	2,000 kW
Cut-in wind speed:	3.5 m/s	2.5 m/s
Nominal wind speed:	12 m/s	13 m/s
Cut-out wind speed:	25 m/s	25 m/s / 21 m/s

Generator

	IEC IIA:	IEC IIIA/DIBt II:
Type:	Asynchronous with OptiSpeed®	Asynchronous with OptiSpeed®
Nominal output:	1,800 kW	2,000 kW
Operational data:	50 Hz/60 Hz 690 V	50 Hz/60 Hz 690 V

Gearbox

Type:	Planetary/helical stages

Control

Type:	Microprocessor based control of all the turbine functions with the option of remote monitoring. Output regulation and optimisation via OptiSpeed® and OptiTip® pitch regulation.

Weight

Nacelle:	68 t
Rotor:	38 t

Towers:

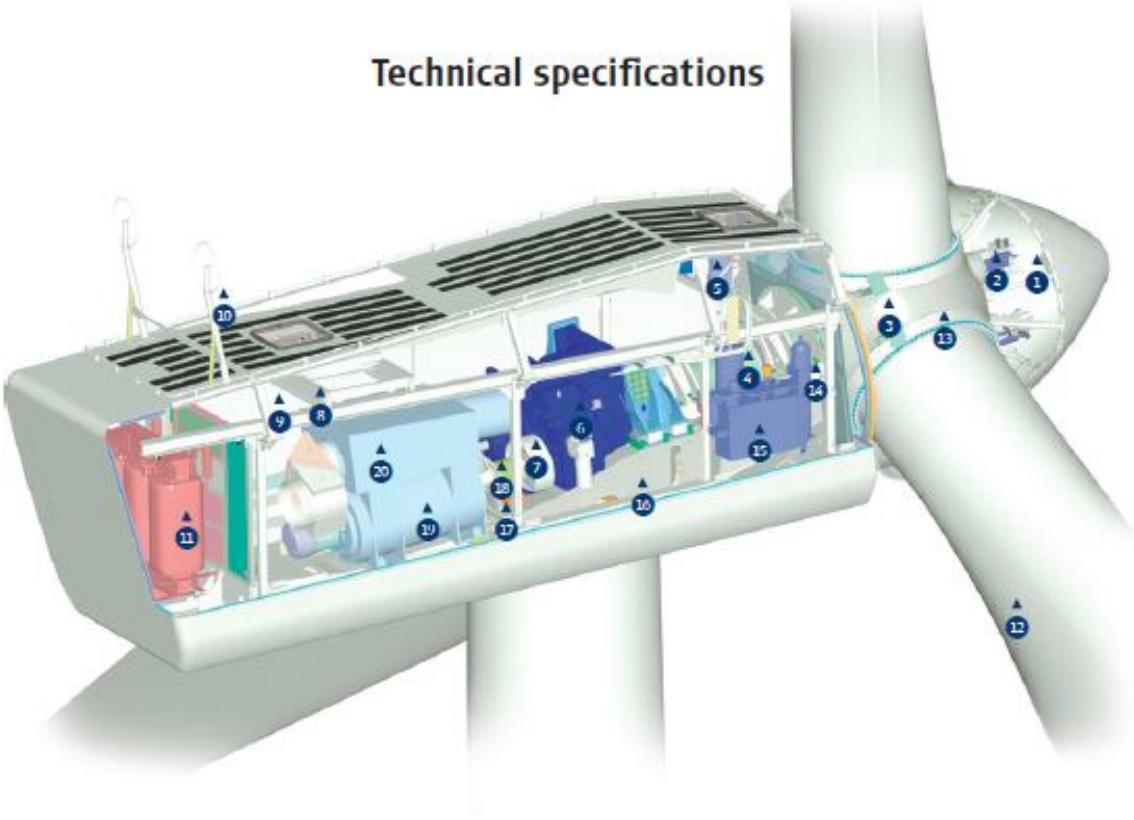
Hub height:	IEC IIA	IEC IIA	DIBt II
80 m	150 t	150 t	-
95 m	200 t	-	200 t
105 m	-	-	225 t

t = metric tonnes.

DIBt towers are only approved for Germany.

All specifications subject to change without notice.

Technical specifications



1 Hub controller
2 Pitch cylinders
3 Blade hub
4 Main shaft
5 Oil cooler
6 Gearbox
7 Mechanical disc brake
8 Service crane
9 VMP-Top controller with converter
10 Ultrasonic wind sensors
11 High voltage transformer
12 Blade
13 Blade bearing
14 Rotor lock system
15 Hydraulic unit
16 Machine foundation
17 Yaw gears
18 Composite disc coupling
19 OptiSpeed® generator
20 Air cooler for generator

5. GAMA SERVION

MM82

Design data

Nominal power	2,050 kW
Cut-in wind speed	3.5 m/s
Nominal wind speed	14.5 m/s
Cut-out wind speed	25.0 m/s
Restart cut-in wind speed	22.0 m/s
Operating temperature range optional CCV	−20 °C to +35 °C to +40 °C −30 °C to +35 °C

Certification

Hub height	Wind class	DIBt Wind zone
58.5–59 m (50 Hz)	IEC IA	WZ 4, GK I
68–69 m (50 Hz)	IEC IA	–
78–80 m*	IEC S (based on IEC IA)	WZ 3

*60 Hz as CCV only.

Rotor

Diameter	82.0 m
Rotor area	5,281 m²
Rotor speed	8.5–17.1 min⁻¹ (+12.5 %)
Power control	Electrical pitch system

Rotor blade

Length	40.0 m
Type	Glass fibre-reinforced plastic (GRP)
Max. chord width	3.3 m

Gear system

Type	Three-stage planetary/spur gearbox
Gear ratio	i = approx. 106 (50 Hz)/84 (60 Hz)
Type of suspension	Three-point contact suspension

Weight

Rotor blade	Approx. 6.0 t
Nacelle (with drive train)	Approx. 70.0 t
Rotor hub	Approx. 17.0 t

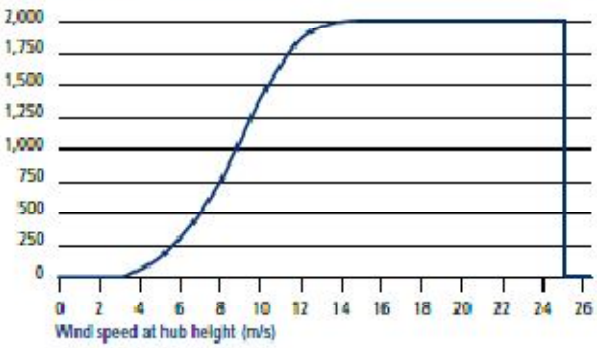
Electrical system

Nominal power	2,050 kW
Nominal voltage	690 V (50 Hz)/575 V (60 Hz)
Nominal frequency	50 Hz/60 Hz
Generator	Double-fed induction generator
Generator protection class	IP 54
Speed range	970–1,800 min⁻¹ (50 Hz) 720–1,440 min⁻¹ (60 Hz)
Transformer	Cast resin transformer (ITS) (50 Hz) Oil transformer (ETS) (50 Hz/60 Hz)

Sound power level

Maximum sound power level	104.0 dB (A)
Sound management I	Reducing the maximum sound power level in several stages
Sound management II	Reducing the maximum sound power level in the partial load range

Power curve



MM92

Design data

Nominal power	2,050 kW
Cut-in wind speed	3.0 m/s
Nominal wind speed	12.5 m/s
Cut-out wind speed	24.0 m/s
Restart cut-in wind speed	22.0 m/s
Operating temperature range optional CCV	–20 °C to +35 °C to +40 °C –30 °C to +35 °C

Certification

Hub height	Wind class	DIBt Wind zone
63.75 m–64.75 m	IEC IIA*	–
68–68.5 m (50 Hz)	IEC IIA	–
78–80 m**	IEC S (based on IEC IB), IEC IIA	WZ 4, GK I
98–100 m***	IEC IIA	WZ 2

*unspecific.
**60 Hz also as CCV.
***60 Hz as CCV only.

Rotor

Diameter	92.5 m
Rotor area	6,720 m²
Rotor speed	7.5–15.0 min⁻¹ (+12.5 %)
Power control	Electrical pitch system

Rotor blade

Length	45.2 m
Type	Glass fibre-reinforced plastic (GRP)
Max. chord width	3.6 m

Gear system

Type	Three-stage planetary/spur gearbox
Gear ratio	i = approx. 120,0 (50 Hz)/96,0 (60 Hz)
Type of suspension	Three-point contact suspension

Weight

Rotor blade	Approx. 8.0 t
Nacelle (with drive train)	Approx. 72.0 t
Rotor hub	Approx. 19.0 t

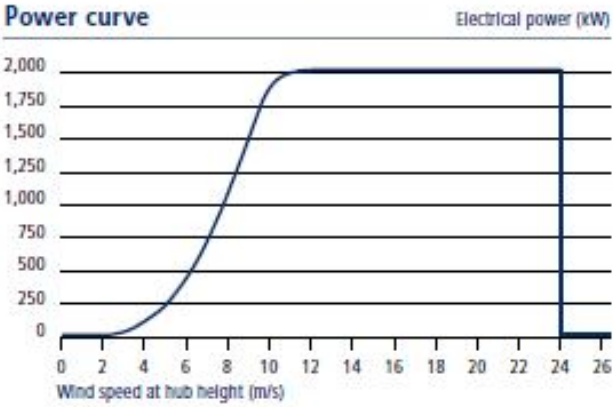
Electrical system

Nominal power	2,050 kW
Nominal voltage	690 V (50 Hz)/575 V (60 Hz)
Nominal frequency	50 Hz/60 Hz
Generator	Double-fed induction generator
Generator protection class	IP 54
Speed range	970–1,800 min⁻¹ (50 Hz) 770–1,440 min⁻¹ (60 Hz)
Transformer	Cast resin transformer (ITS) (50 Hz) Oil transformer (ETS) (50 Hz/60 Hz)

Sound power level

Maximum sound power level	103.2 dB (A)
Sound management I	Reducing the maximum sound power level in several stages
Sound management II	Reducing the maximum sound power level in the partial load range

Power curve



MM100

Design data

Nominal power	2,000 kW
Cut-in wind speed	3.0 m/s
Nominal wind speed	11.0 m/s
Cut-out wind speed	22.0 m/s
Restart cut-in wind speed	20.0 m/s
Operating temperature range optional	−20 °C to +35 °C to +40 °C

Certification

Hub height	Wind class	DIBt Wind zone
74.5–76.5 m*	IEC IIB	–
78–80 m	IEC IIB	WZ 2
98–100 m	IEC IIB	WZ 3

*for 50 Hz only

Rotor

Diameter	100.0 m
Rotor area	7,854 m²
Rotor speed	7.0–13.9 min⁻¹ (+12.5 %)
Power control	Electrical pitch system

Rotor blade

Length	48.9 m
Type	Glass fibre-reinforced plastic (GRP)
Max. chord width	3.6 m

Gear system

Type	Three-stage planetary/spur gearbox
Gear ratio	i = approx. 130 (50 Hz)/104 (60 Hz)
Type of suspension	Three point contact suspension

Weight

Rotor blade	Approx. 8.0 t
Nacelle (with drive train)	Approx. 72.0 t
Rotor hub	Approx. 19.0 t

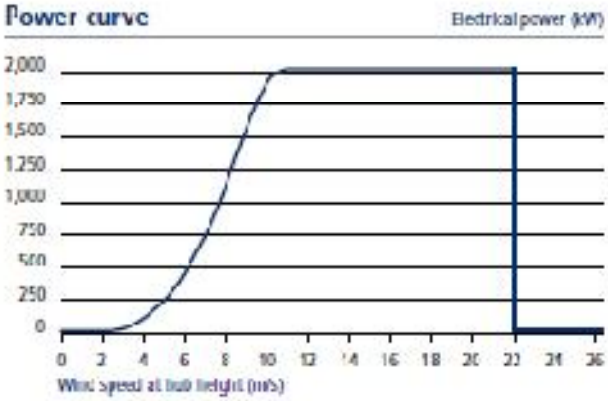
Electrical system

Nominal power	2,000 kW
Nominal voltage	690 V (50 Hz)/575 V (60 Hz)
Nominal frequency	50 Hz/60 Hz
Generator	Double-fed induction generator
Generator protection class	IP 54
Speed range	970–1,800 min⁻¹ (50 Hz) 720–1,440 min⁻¹ (60 Hz)
Transformer	Cas. resin transformer (TS) (50 Hz) Oil transformer (ETS) (50 Hz/60 Hz)

Sound power level

Maximum sound power level	103.8 dB (A)
Sound management I	Reducing the maximum sound power level in several stages
Sound management II	Reducing the maximum sound power level in the partial load range

Power curve

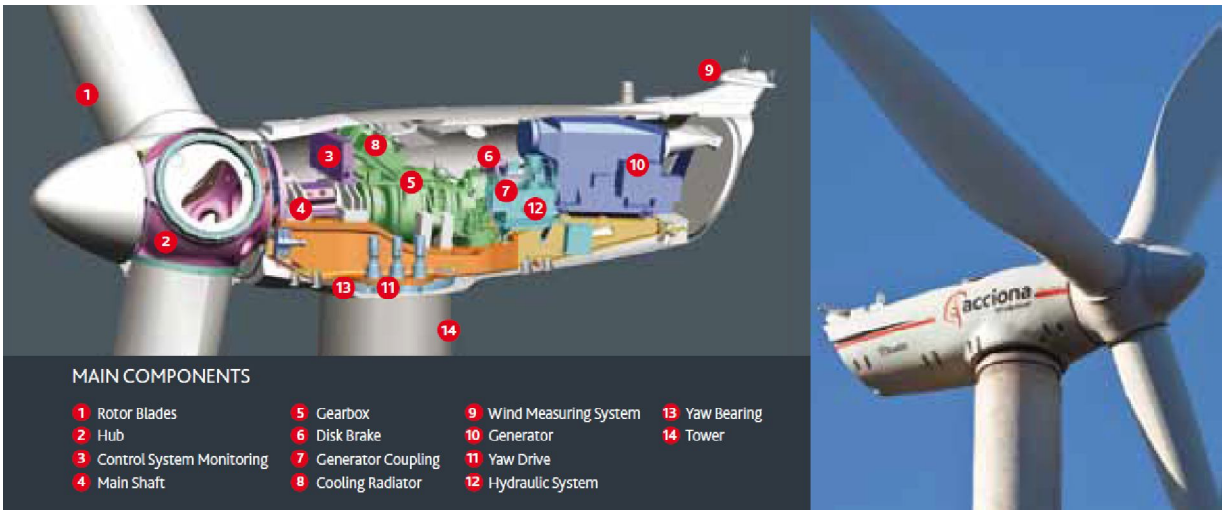


6. GAMA ACCIONA

TECHNICAL INFORMATION

AW1500

	AW 70/1500	AW 77/1500	AW 82/1500
Rotor diameter	70 m	77 m	82 m
Wind class	IEC IIa	IEC IIa+	IEC IIa
OPERATING DATA			
Cut-in wind speed	4m/s	3.5 m/s	3 m/s
Cut-out wind speed	25 m/s	25 m/s	25 m/s
Nominal power	1,500 kW		
Cold Weather Operational Temperature range (Optional)	-30ºC to + 40ºC		
ROTOR			
Swept area	3,848 m²	4,657 m²	5,289 m²
Nominal rotation speed	20.2 rpm	18.3rpm	16.7 rpm
Maximum sound level	105.4 dBA	104.9 dBA	103.9 dBA
Nominal tip speed	74.1 m/s	73.9 m/s	71.7 m/s
Power regulation	Independent pitch regulated with variable speed		
DRIVE TRAIN			
Gearbox	3 stages: 1 planetary, 2 parallel (helical)		
Bearings	Double spherical roller bearings		
Lubrication	Pressure and splash with oil cooler/oil filter		
PITCH SYSTEM			
Pitch bearings	Double row four point contact		
Actuation	Hydraulic		
Failsafes	Blade independent accumulators on hub		
YAW SYSTEM			
Type	Four point ball bearing, external gear		
Slewing ring	External		
Braking system	Hidraulic friction pads, plus electro-mecanical brake per motor drive		
GENERATOR			
Type	6 poles, double feeding		
Frequency	50/60 Hz		
Voltage	12,000V (able to eliminate step-up transformers depending on wind farm layout)		
Speed range	770 – 1,300 rpm 50 (Hz) / 920 – 1,560 rpm 60 (Hz)		
TOWER			
Steel hub height standard options (m)	60, 80	60, 71.5, 80	80
Steel tower number of sections	3	3	3
Concrete hub height standard options (m)	-	100	100
Concrete tower number of sections	-	5	5
NACELLE			
Weight (tons)	52.3 t		
Hub weight (tons)	15.2 t		
Nacelle dimensions	8.7 m (length) 3.4 m (width) 4.1 m (height)		
Transportability	One piece, rail-capable		
SERVICEBILITY			
Service lift capacity	250 kg		
Onboard crane hoist lift capacity	250 kg		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MAIN COMPONENTS
1 Rotor Blades
2 Hub
3 Control System Monitoring
4 Main Shaft
5 Gearbox
6 Disk Brake
7 Generator Coupling
8 Cooling Radiator
9 Wind Measuring System
10 Generator
11 Yaw Drive
12 Hydraulic System
13 Yaw Bearing
14 Tower
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