Document #IC-12-GE-FE-002-EN

1 GEV MP-R WIND TURBINE- MAIN CHARACTERISTICS

The VERGNET GEV MP-R wind turbine on a self standing tower can be fitted with a 30 or 32 meters (98 or 105') rotor diameter and an output power from 200 to 275 kW, and has the main following features:

- GEV MP-R wind turbines are lightweight, easy to transport and can be assembled with a 60 ton crane (32.3 m hub height).
- GEV MP wind turbines are equipped with a control system allowing connection and production on any kind of grid while complying with the most demanding grid codes.

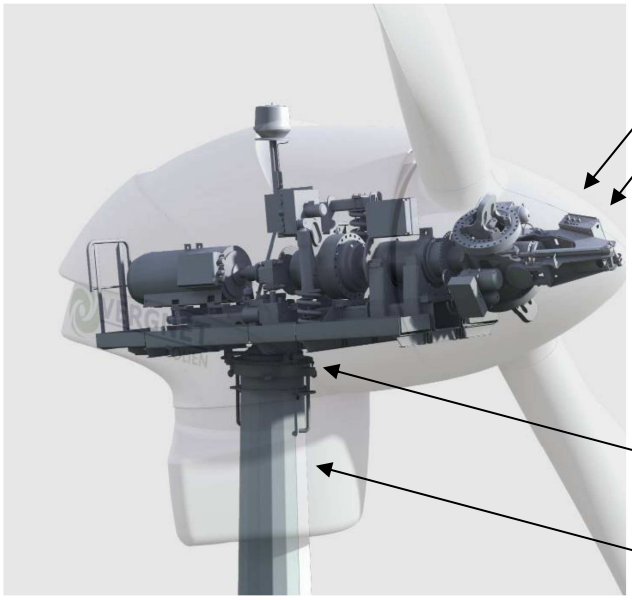


Figure 1 - VERGNET GEV MP-R wind turbine

Axis of the rotor : Horizontal (tilt + 5°)

Given project site wind conditions and/or grid requirements, the GEV MP can feature various rotor diameters and/or rated powers:

Rotor diameter	32 m (105')
	30 m (98')
Output power	275 kW – 50 Hz
	250 kW – 50 Hz
	200 kW – 50 Hz
	275 kW – 60 Hz
	250 kW – 60 Hz
	200 kW – 60 Hz

Rotor rotation speed: 2 speeds (31 and 46 rpm)

Orientation of the rotor: Slewing bearing – Active yaw by hydraulic system (also used for automatic untwisting of electrical cables when necessary).

Hub height :
Standard: 32.3 m (106') ;
Option: 52.3 m (172')

Power control system : Variable blade pitch control. Active hydraulic control

- Rated and cut-in wind speed:

Rotor diameter	Output power	Rated wind speed	Cut-in wind speed
32m	275 kW	12.5 m/s	3.5 m/s
	250 kW	12 m/s	3.5 m/s
	200 kW	11 m/s	3.5 m/s
30m	275 kW	13.5 m/s	3.5 m/s
	250 kW	13 m/s	3.5 m/s
	200 kW	12 m/s	3.5 m/s

- Cut-out wind speed: 20 to 25 m/s (29 to 36 m/s instantaneous) (44 – 65 mph to 56 – 80 mph) depending on turbulence level
- Maximum wind speed:
  30 m rotor diameter: 42.5 m/s (Class II IEC 61400-1: 1999) (95 mph)
  32 m rotor diameter: 30 m/s (Class IV IEC 61400-1:1999) (67 mph)

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2 GEV MP ROTOR

The GEV MP rotor is two-bladed, for purpose of light weight and easy installation.

- Manufacturer: VERGNET S.A.
- Material of the blade: Glass fiber Vinylester resin composite
- Length of the blade:
  32 m rotor diameter: 15.65 m (51')
  30 m rotor diameter: 14.65 m (48')
- Unitary weight of the blade:
  32 m rotor diameter: 750 kg (1,653 lb)
  30 m rotor diameter: 700 kg (1,543 lb)
- Material of the hub: Cast iron GS
- Total rotor weight:
  32 m rotor diameter: 1,900 kg (4,189 lb)
  30 m rotor diameter: 1,800 kg (4,000 lb)

3 LOW SPEED SHAFT AND BEARINGS

The low speed shaft is mounted on two spherical roller bearings, the fabricated bearing housings being bolted directly to the fabricated nacelle frame. The front (upwind) bearing takes out the thrust load with the rear bearing outer race being allowed to float.

4 GEARBOX

- Manufacturer: Bonfiglioli or equivalent
- Type: Planetary with rectified teeth, ratio 32.6 / 1 (50 Hz) or 38 /1 (60 Hz)
- Weight: 1,200 kg (2,650 lbs)
- Number of stages: 2
- Maximum power: 280 kW
- Cooling: by oil circulation, oil-air cooler with fan

5 ASYNCHRONOUS GENERATOR

- Manufacturer: ABB or equivalent
- Type: Squirrel-cage asynchronous, two-speed
- Voltage and Frequency: 400 V – 50 Hz or 460 V – 60 Hz
- Rated power: 275, 250 or 200 kW at 40°C (104°F)
- Efficiency at full load:
  275 kW 400 V – 50 Hz: 95.6 %
  275 kW 460 V – 60 Hz: 95.8 %
  250 kW 400 V – 50 Hz: 95.6 %
  250 kW 460 V – 60 Hz: 95.8 %
  200 kW 400 V – 50 Hz: 95 %
  200 kW 460 V – 60 Hz: 95 %
- Rotation speed:
  400 V – 50 Hz: 1,514 or 1,010 rpm
  460 V – 60 Hz: 1,811 or 1,206 rpm
- Weight: 1,100 kg (2,425 lbs)
- Service: S1
- Index of protection IP: IP 55
- Cooling mode: IC 411 (totally enclosed fan-cooled)
- Class of insulation: F reinforced

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- Heating F
- Grid connection mode Soft-starter and direct connection

6 GEV MP ACTUATION SYSTEM

- Manufacturer VERGNET S.A.
- Type Hydraulic control driven by PLC
- Power control through blade variable pitch angle
- Aerodynamic braking
- Pitch variation by hydraulic actuators embedded in the rotor (2 independent systems)
- Teetering hub with shock absorbers

7 BRAKING SYSTEM - SAFETY

7.1 Main brake

- Manufacturer VERGNET S.A.
- Type Aerodynamic brake by pitch with hydraulic accumulator for safety
- System of activation / deactivation PLC

7.2 Parking and emergency brake

- Manufacturer SIME or equivalent
- Type Disc brake on high speed shaft
- Control system Hydraulic

8 YAW SYSTEM

- Manufacturer VERGNET S.A.
- Operating Active by hydraulic system (also used for automatic untwisting of electrical cables when necessary).

9 NACELLE

- Manufacturer VERGNET S.A.
- Material Steel
- Material of external envelope Polyester fibre glass
- Dimensions L 7.1 x h 3.2 x w 2.4 m (23’ x 8’ x 10’) (fitted with cover)
L 6.07 x h 2.08 x w 1.36 m (19' 11" x 6' 10" x 4' 6")
(without cover for container sea transportation)
- Total weight 9.1 tons (with generator, gearbox, cover and hub, without blades)

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10 TUBULAR TOWER

• Type	Tubular, self standing	
• Manufacturer	PETITJEAN or equivalent	
• Material	Galvanized steel ISO 1461 - optional painting on galvanisation	
	Standard (32.3 hub height)	Option (52.3 hub height)
• Height	31m (101’ 8")	51m (167')
• Number of sections	3	5
• Weight	12 tons	28.8 tons
• Volume of the base	30 to 50 m^3 of concrete (1,000 to 1,800 cubic feet) depending on soil study	approx 70 m^3 of concrete (approx 2,472 cubic feet) depending on soil study

11 LIGHTNING PROTECTION SYSTEM

• Description	Compliant with IEC 61400-24: Lightning rod on top of the nacelle Lightning arresters on nacelle and in shelter Antenna-shape earthing with equipotential connection of the concrete base Option: lightning protection within the blades

12 GEV MP CORE (CONTROL SYSTEM)

• Manufacturer	SIEMENS
• Integration and software	VERGNET S.A.
• Type	Industrial PLC S7 Series 300
• Analogical and logical data	Frequency – Voltage Rotor rotation speed Blades pitch angle setting Temperature - Pressure
• Data network	Profibus on copper link to wind turbine shelter. Ethernet or Profibus on copper or Optical fibre communication network between the wind turbines and to wind farm substation
• Monitoring	Remote monitoring possible even on low bandwidth lines through internet or modem (Typical minimum data flow is 512kbits/s)

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13 SOFT SYNCHRONIZATION ELECTRONICS

- Manufacturer: SCHNEIDER
- Type: Synchronization by soft starter, bypassed at the end of starting period
- Nature of power components: Electronically powered thyristor contactors
- Rated current: 170 A
- Nominal voltage and frequency: 400 V three-phase 50 Hz, or 460 V three-phase 60 Hz
- Maximum withstand voltage: 1,000 V
- Rated power: 100 VA
- Location: In a cabinet ("shelter") at the base of the tower

14 GRID CONNECTION DESCRIPTION (supplies are optional)

Grid connection of GEV MP wind turbines can be ensured either in High Voltage or Low Voltage (possible in case of a single wind turbine, and depending on grid operator requirements).

14.1. High Voltage grid connection items

High Voltage grid connection is ensured by:

- Three-phased external oil-cooled step-up transformer at the base of each wind turbine
  - Manufacturer: PAUWELS, DURIEZ, TRANSFIX or equivalent
  - Rated Power: 315 kVA
  - Frequency: 50 or 60 Hz
  - In/out voltage: As per local grid specification (ex.: 400 V / 20,000 V, or 460 V / 34,500 V)
- Protections:
  - Combine switch-fuse, or circuit breaker, on each feeder in the wind farm HV substation
  - Grid protection relay (and optional reclosing system) in the wind farm HV substation
- Metering in the wind farm HV substation

14.2. Low Voltage grid connection items

Grid connection can also be ensured directly in Low Voltage, by :

- Protections:
  - Motorized circuit breaker in the wind turbine shelter
  - Grid protection relay in the wind turbine shelter
- Low Voltage Metering in the wind turbine shelter

15 WIND TURBINE MODEL VARIATIONS AND CODES

15.1 Model Codes

Commercial model codes are introduced as specific references for promotional and contractual use. Those codes shall describe the GEV MP, the electrical shelter and the SCADA system.

A Vergnet supplied Wind Turbine Generator (WTG) can be completely described by 3 model codes as depicted in Figure 2:

- "G" code describing the nacelle and the tower models
- "E" code describing the electrical shelter and its associated step-up transformer
- "V" code describing the SCADA and its network

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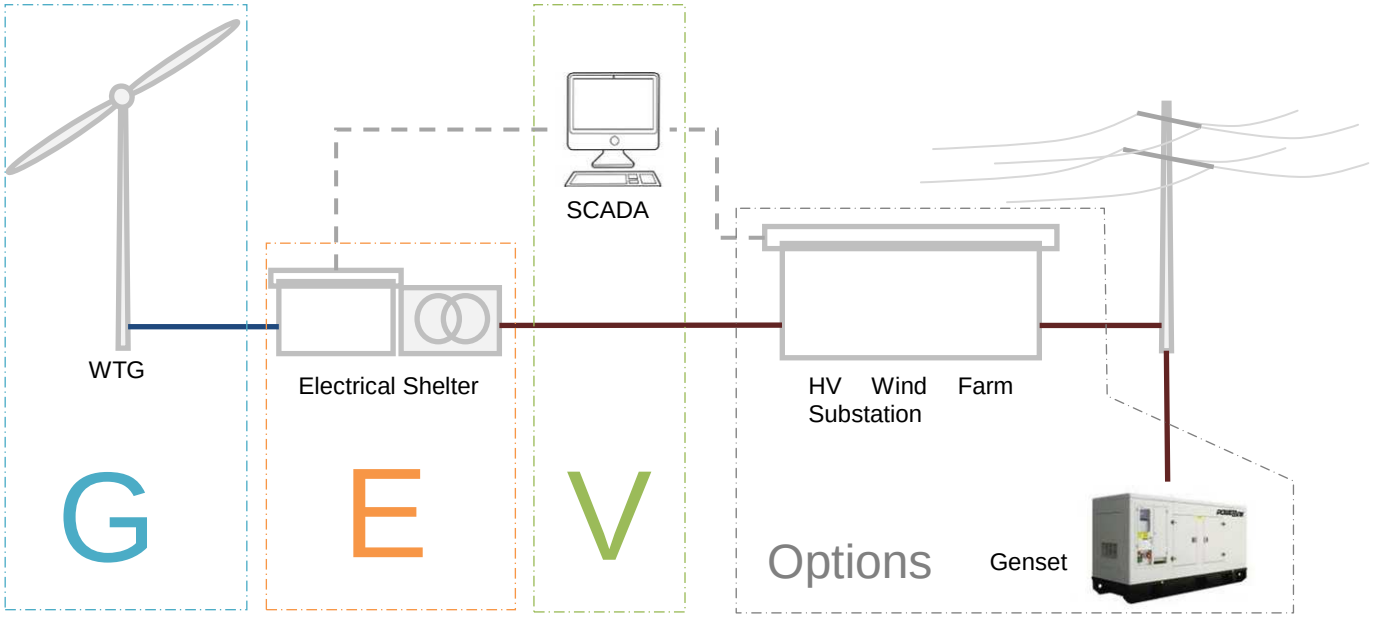


Figure 2 - Model codes by equipment

15.1.1. G code

This model code shall be established based upon the selectable features of Table 1, Table 3, Table 4 and Table 6.

G

GEV MP	-R	-32	X	275E	-T	X	-M32	B	5	X	-1	X
		❶	❷	❸	❹	❺	❻	❼	❽	❾	A	B
		Nacelle descriptor as per Table 1					Tower descriptor as per Table 3				Options descriptor as per Table 2	

15.1.2. E code

The Electrical Shelter is located at tower foot and includes the LV electrical equipment, the PLC and the step-up transformer.

E

E-SHELTER	RHE	-E1100A	/ M	E	F	X	X	X
	❶	❷	A	B	C	D	E	F
	Electrical Shelter descriptor as per Table 4		Options descriptor as per *Table 5*					



Figure 3 - Electrical Shelter outdoor

15.1.3. V code

The SCADA enables the balance of the wind farm, its remote control and the interfacing of additional grid functionalities.

V

SCADA	-WF	1	X	V
	❶	❷	❸	❹
	SCADA descriptor as per Table 6			



Figure 4 - V-SCADA screenshot

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15.2 WTG model variations

15.2.1 Nacelle Models

		Code	Default	MP-R	Comments
Rotor diameter ❶	32 m large	32	•	•	
	30 m	30		•	
Blade protection ❷	None	X	•	•	
	Lightning protection	K		•	Lightning conductor in blades
Output power ❸	275 kW – 50 Hz	275E	•	•	50 Hz asynchronous generator
	250 kW – 50 Hz	250E		•	
	200 kW – 50 Hz	200E		•	
	275 kW – 60 Hz	275U		•	60 Hz asynchronous generator
	250 kW – 60 Hz	250U		•	
	200 kW – 60 Hz	200U		•	
Ambiant conditions ❹	Temperate areas	T	•	•	Operation: -5°C to +40°C Survival: -10°C to +50°C
	Continental areas	C		•	Operation: -12°C to +40°C Survival: -20°C to +50°C
(reserved) ❺	None	X	•	•	

Table 1 - Nacelle model descriptor

15.2.2 Nacelle Options

		Code	Default	MP-R	Comments
Traffic lights A	None	X	•	•	
	Customized traffic lights [1]	1		•	
Maintenance hoist B	None	X	•		
	Manual hoist	M	•	•	
	Electrical hoist	E		•	

Table 2 - Nacelle options

Note:
[1] Development to be quoted on time & material basis.

15.2.3 Tower

		Code	Default	MP-R	Comments
Tower ❻	32m monopole	M32	•	•	Access ladder to nacelle is outside mast
	52m monopole	M52		•	
Color ❼	Galvanized	A	•	•	Galvanized steel 80µm
	RAL7035 (Same color as nacelle)	B		•	Liquid or powder painting system depending on source.
	RAL7038	C		•	
	RAL9003	D		•	
	RAL9010	E		•	
Protection ❽	Standard	4	•	•	Standard galvanized steel tower suitable for C4 areas.
	C5 areas coating	5		•	Additional painting system on top of galvanized steel. System is rated for C5 aggressive areas (coastal areas).
Cyclonic securing ❾	None	X	•	•	

Table 3 - Tower models description

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15.3 Electrical shelter model variations

15.3.1 Models

		Code	Default	MP-R	Comments
Shelter type ❶	MPR LV 50Hz shelter (SPE 175)	RLE		•	No electrical grid protection in shelter
	MPR HV 50Hz shelter (SPE 176)	RHE	•	•	
	MPR HV 60Hz shelter (SPE 177)	RHU		•	
Output Voltage / Frequency ❷	50 Hz 400 V	E0040X	•	•	Direct LV output
	60 Hz 460 V	U0046X		•	Direct LV output
	50 Hz 400 / 5.5 kV 315 kVA	E0550A		•	W/ step-up transformer
	50 Hz 400 / 11 kV 315 kVA	E1100A		•	
	50 Hz 400 / 15 kV 315 kVA	E1500A		•	
	50 Hz 400 / 20 kV 250 kVA	E2000B		•	
	50 Hz 400 / 20 kV 315 kVA	E2000A		•	
	50 Hz 400 / 23 kV 315 kVA	E2300A		•	
	50 Hz 400 / 33 kV 250 kVA	E3300B		•	
	50 Hz 400 / 33 kV 315 kVA	E3300A		•	
	60 Hz 460 / 6.6 kV 315 kVA	U0660A		•	
	60 Hz 460 / 11 kV 315 kVA	U1100A		•	
	60 Hz 460 / 12 kV 315 kVA	U1200A		•	
	Others [1]	xxxxxxx		•	

Table 4 - Electrical shelter model description

Note:

[1] Development to be quoted on time & material basis.

15.3.2 Options

		Code [2]	MP-R	Comments
Metering A	Contractual Metering [1]	M / X	•	Applicable to RLE shelters only. Contractual metering in shelter for LV connection. Requires a shelter extension or building.
Electrical protections B	Customized electrical grid protections [1]	E / X	•	Applicable to RLE shelters only. Protection settings require an electrical stability study. Requires a shelter extension or building.
LV Auxiliary Feeder C	LV auxiliary feeder to sub-station	F / X	•	Only for RHE and RHU shelters to save an auxiliary transformer. Auxiliary 32Amps feeder to substation
Disconnector switch D	Disconnector switch on shelter exit	S / X	•	Standard is a disconnector, and not a disconnector switch. Applicable to RLE shelters only.
Building E	Pre-fabricated concrete building	B / X	•	Shelter to be installed within building. Compulsory for "Continental" and "Polar" areas.
Shelter extension F	Extension cabinet for LV options	C / X	•	May be necessary for LV connection (if no prefabricated concrete building) to install Metering A, Electrical protections B, Disconnector switch D and optional Proxwind SCADA.

Table 5 - Electrical shelter options

Notes:

[1] Defined case by case as per Distribution Network Operator (DNO) requirements. Development to be quoted on time & material basis.

[2] "X" when none selected

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15.4 SCADA model variations

		Code	Default	MP-R	Comments
Versions ❶	Legacy SCADA	LG		•	
	V-SCADA Wind Farm	WF	•	•	Wind farm load sharing option is active. Available by end of 2012Q2.
	V-SCADA Proxwind	PX		•	Available by end of May 2012.
Wind Farm Network [1] ❷	Single way network	1	•	•	
	Redundant ring network	2		•	
Optional Functions ❸	None	X	•	•	
	Sub-station control	S		•	Only when sub-station PLC is supplied by VSA. Else [2].
	Power prediction	P		•	Only for V-SCADA
Remote access ❹	VNC access	V	•	•	For Legacy and V-SCADA. Mono user access to SCADA
	Web Access	W		•	Only for V-SCADA Multi user SCADA data display
	Remote SCADA	R		•	For Legacy and V-SCADA Multi user access to SCADA

Table 6 - SCADA models description

Notes:

[1] Includes only hardware and software for network, except interconnecting cables between wind turbines and from wind turbines to wind farm substation

[2] Development to be quoted on time & material basis.

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