

Gamesa G47 - Overview

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Abstract

This document describes the various characteristics and current status of a Wind power plant available for relocation. 19 WTG out of 22 production units will be available on the market for relocation from June 2024. All units are functional and currently in operation. The units have been upgraded over the years, using the philosophy of performing upgrades for the entire wind farm. The units have been properly maintained and the overall condition, considering the year of construction, is good. The latest maintenance records are available along with mechanical and electrical assembly manuals. All units are complete with tower, cables, transformers and control cabinets.



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Nomenclature

AC	Alternating Current
AVR	Automatic Voltage Regulator
DC	Direct Current
DCS	Distributed Control System
EPC	Engineering, Procurement and Construction
HMI	Human-Machine Interface
I/O	Input / Output
ISO	International Organization for Standardization
LHV	Lower Heating Value
LV	Low Voltage
MCC	Motor Control Cubicle
MV	Medium Voltage
HV	High Voltage
N/A	not applicable / not available
OEM	Original Equipment Manufacturer
P&ID	Process & Instrumentation Diagram
PC	Personal Computer
PFD	Process Flow Diagram
PLC	Programmable Logic Controller
WTG	Wind Turbine Generator
tbd	To be determined / To be defined

1. Introduction

Wind power plant available for relocation, this document describes the various characteristics of the plant and its current status. The subject of the opportunity is as follows:

General Data	
Manufacturer	Gamesa
Model	G47
Number	19
Available from	June 2024
Country	South Europe
With location	No

Technical Data	
Condition	Used
Year of construction	1999
Nominal power (unit)	660 kW
Tower height	45 m
Rotor diameter	47 m
Total weight	60 t

2. Description of Supply

2.1 Gamesa G47 wind turbine

Gamesa G47 wind turbine, with a rated power of 700 kW, is a wind turbine with a windward three-bladed rotor, regulated by a pitch change system and with an active orientation system.

The G47 wind turbine has a 47 m diameter rotor and uses the Ingecon W control system capable of adapting the wind turbine to operate over a wide rotor speed range.

The rotor consists of three blades with pitch change over the full span of the blade, pitch change bearing and a ductile cast iron bushing.

The blades are 22.9 m long and are made of fiberglass using prepreg technology. Each blade consists of two shells, glued to a support beam. The blade is connected to the bearing through an aluminum element called the blade root. The blade bearing is a 4-point ball bearing and is bolted to the hub.

The rotor pitch change system is equipped with the OptiTip system. This special system provides very fine adjustment of the blade operating angle at all times with respect to power output and noise emission.

At high wind speeds, the Ingecon W system and the pitch change system maintain the power output at its rated value, regardless of air temperature and air density. In low wind speeds, the Optitip system and Ingecon W control optimize power output by selecting the optimum combination of rpm and pitch angle.

The main shaft transmits power to the generator through the gearbox. The gearbox consists of three combined stages, one planetary stage and two parallel shaft stages. From the gearbox the power is transmitted to the generator via a cardan joint.

The electric generator is 4-pole, double fed, double wound rotor with slip rings.

The primary brake of the wind turbine is aerodynamic by flagging the blades. The redundant mechanical brake is a hydraulically actuated disc brake mounted on the output of the high-speed shaft of the gearbox.

All wind turbine functions are monitored and controlled by several microprocessor-based control units. The control system is installed in the nacelle. In addition, the operations of the control unit are monitored by the surveillance system so that if it fails, the safety system is activated immediately. The variations of the blade pitch angle are activated by a hydraulic system that allows the blade to rotate from -5° to 90° . This system also provides pressure to the mechanical braking system.

The yaw system consists of two servomotors that operate electrically and are controlled by the wind turbine control system according to the information received from the wind vane placed on top of the nacelle. The yaw system motor rotates the pinions of the yaw system, which engage with the teeth of the yaw ring gear mounted on the top of the tower, and by friction the nacelle is rotated.

The nacelle cover is made of fiberglass with polyester, which protects all components of the nacelle against rain, snow, dust, sun rays, etc. Access to the nacelle from the tower is through the central opening.

The nacelle contains a 125 kg lifting force service crane.

The wind turbine tower is 45 m high and is of tubular truncated cone shape made of carbon structural steel and built in two or three sections. The tower is painted with a special anti-corrosion protection paint.

2.2 Control system

The Ingecon W system ensures that the rpm and torque of the wind turbine always deliver stable electrical power to the grid. This control system also delivers the power with unity power factor to the grid.

The Ingecon W system consists of an asynchronous generator connected to 4-quadrant IGBT converters and the related protection.

The generator is protected against short-circuits and overloads. The temperature is also continuously monitored by PT100 at stator and bearing points.

The generator of the Ingecon W system is a special asynchronous generator which is able to work with variable speed and maintain constant power simultaneously. This improvement is performed by controlling the intensities in the rotor.

By controlling the rotor currents, the power factor can be viewed as a definable parameter by the control system. As a result, no power factor compensation is necessary and losses in the power grid decrease.

Another result of the synchronous generation that characterizes the Ingecon W system is the "soft" connection to the power grid. Therefore, smooth connections and disconnections to the power grid are easily obtained.

The G47 turbine is capable of operating at a variable speed between 1200 rpm and 1800 rpm.

The Ingecon W has intrinsic flexibility with respect to energy optimization, minimum noise during operation and reduction of loads on the gearbox and other components.

2.3 Technical data

2.3.1 Rotor

Diameter:	47 m
Swept area:	1735 m ²
Operating rotation speed ²²	22.8 : 34.2 r.p.m.
Rotation direction:	Clockwise (front view)
Position:	Windward
Angle of inclination:	5°
Rotor pitch:	0° - 2°
Number of blades:	3
Aerodynamic brake:	Flagging of paddles

2.3.2 Blades

Structural concept:	shells glued to support beam
Material:	Fiberglass pre-impregnated - epoxy
Blade connection:	Aluminum flange
Aerodynamic profiles:	NACA 63 XXX + FFA - W3
Length:	22.9 m
Shovel rope (max. rope section / tip):	2.09 m / 0.29 m
Torsion:	15° at maximum rope section
Weight:	Approx. 1250 kg/blade
Blade bearing:	Type 4 – point ball bearings
Blade bushing:	Spherical, cast iron

2.3.3 Main shaft

Type:	Forged shaft
Material:	Hardened and forged steel
Material specification:	34 Cr Ni Mo6 per EN10083-1
Housing:	Nodular Cast iron
Bearings:	Spherical roller bearings

2.3.4 YAW system

Type:	Friction plain bearing system
Material Slewing ring bearing:	EN-GJS-500-7U by EN 1503
Material Plain bearing:	PETP
Orientation speed:	less than 0.5 °/s; 1 turn every 12 min. approx.
Mechanism:	Planetary / 2-stage helical gear combination Planetary / 1 Helical self-locking
Motor:	Asynchronous 1.5 kW 6 poles

2.3.5 Tower

Type:	Tubular truncated conical
Height:	45m
Material:	Structural carbon steel
Material specification Bolting:	S 275 JO by EN 10025
Material specification Flanges:	S 355 J2 G3 per EN 10025
Surface treatment	Painted
Corrosion type, external	C3
Corrosion type, interior	C2

Diameter of upper part:	2.0 m
Diameter of lower part diameter/ Bushing height*:	
2-span modular tower (45 m)	3.0 m / 45.6 m

(*) The exact height of the bushing includes 0.3 m distance from the foundation flange to the ground including 1.6 m from the top of the tower to the center of the bushing.

2.3.6 Gearbox

Type:	1 planetary stage/2 helical stages
Ratio:	1 : 52,651
Cooling:	Oil pump with heat exchanger
Oil heater:	1.5 kW
Supplier:	Valmet, Hansen, Flender, Fellar, Lomman
Couplings:	Main shaft-gearbox -> conical clamping disc Gearbox-generator -> cardan

2.3.7 Generator and Ingecon W

Type:	Double powered with rotorwinding and slip rings. NCR-400-X/4
Rated power:	700 kW (stator + rotor)
Voltage:	690 (star)
Frequency:	50 Hz
No. of poles:	4
Degree of protection:	IP54
Insulation class:	F (stator) / H (rotor)
Nominal speed of rotation:	1620r.p.m.
Rated current:	
	Stator: 552 A @ 690 V
	Rotor: 215 A
Power factor (default):	1.0
Power factor range (*):	0.95 _{CAP} - 0.95 _{IND} (option)
	*See section 3.4 general restrictions
Temperature sensors:	3x PT100 in windings, 1 per phase 2x PT100, 1 per bearing
Average bearing lifetime:	150000 h
Encoder:	POG-90 DN-25000+FSL-1800, B5
Supplier:	Indar

2.3.8 Emergency brake

Type:	Disc brake
Disc material:	GGG 70/sjv 300
Diameter:	600 mm
Braking surface:	1375 cm ²
Disc thickness:	23 mm
Mounting diameter:	100 H7
Number of clamps:	3
Fluid pressure:	Oil
Operating pressure:	21.5 bar

2.3.9 Hydraulic unit

Pump capacity:	8.4-8.6 l/min
Max pressure:	200 bar
Pitch system pressure:	180-200 bar
Oil content:	60 l
Motor:	4 kW 690 V, 4 poles

2.3.10 Various

Anemometer type:	Optoelectric
Weights	
Nacelle:	20 t
Tower:	33 t
Rotor:	7 t
Total:	60 t

2.4 Wind farm composition

WTG UNIT	WTG SN	Main Item	OEM	Model
1	1110	Gearbox	Lohmann	GPV300S 3331
1	1110	Blades	Fiberblade	G 23PRC
1	1110	Shaft and Main Bearing	Gamesa	G-4X
1	1110	Transformer BT/MT	Siemens	Geafol TG5944M
1	1110	Generator	Indar	NCR-400-X/4
2	1224	Gearbox	Rexroth	Otros - Rexroth
2	1224	Blades	Fiberblade	G 23PRC
2	1224	Shaft and Main Bearing	Gamesa	G-4X
2	1224	Transformer BT/MT	Siemens	Geafol TG5944M
2	1224	Generator	Indar	NCR-400-X/4
3	1225	Gearbox	Lohmann	GPV300S 3331
3	1225	Blades	Fiberblade	G 23PRC
3	1225	Shaft and Main Bearing	Gamesa	G-4X
3	1225	Transformer BT/MT	Siemens	Geafol TG5944M
3	1225	Generator	Indar	NCR-400-X/4
5	1116	Gearbox	Flender	PEAS 4285.6
5	1116	Blades	Fiberblade	G 23PRN
5	1116	Shaft and Main Bearing	Gamesa	G-4X
5	1116	Transformer BT/MT	Siemens	Geafol TG5944M
5	1116	Generator	Indar	NCR-400-X/4
6	1172	Gearbox	Lohmann	GPV300S 3331
6	1172	Blades	Fiberblade	G 23PRN
6	1172	Shaft and Main Bearing	Gamesa	G-4X
6	1172	Transformer BT/MT	Siemens	Geafol TG5944M
6	1172	Generator	Indar	NCR-400-X/4
7	1173	Gearbox	Valmet	PLH-310X1G/I47
7	1173	Blades	Fiberblade	G 23PRC
7	1173	Shaft and Main Bearing	Gamesa	G-4X
7	1173	Transformer BT/MT	Siemens	Geafol TG5944M
7	1173	Generator	Indar	NCR-400-X/4
8	1179	Gearbox	Lohmann	GPV300S 3331
8	1179	Blades	Fiberblade	G 23PRC
8	1179	Shaft and Main Bearing	Gamesa	G-4X
8	1179	Transformer BT/MT	Siemens	Geafol TG5944M
8	1179	Generator	Indar	NCR-400-X/4

WTG UNIT	WTG SN	Main Item	OEM	Model
9	1184	Gearbox	Lohmann	GPV300S 3331
9	1184	Blades	Fiberblade	G 23PRC
9	1184	Shaft and Main Bearing	Gamesa	G-4X
9	1184	Transformer BT/MT	ABB	DTE 775/24
9	1184	Generator	Indar	NCR-400-X/4
10	1179	Gearbox	Moventas	PLH-312X1G
10	1179	Blades	Fiberblade	G 23PRC
10	1179	Shaft and Main Bearing	Gamesa	G-4X
10	1179	Transformer BT/MT	Siemens	Geafol TG5944M
10	1179	Generator	Indar	NCR-400-X/4
11	1222	Gearbox	Moventas	PLH-312X1G
11	1222	Blades	Fiberblade	G 23PRC
11	1222	Shaft and Main Bearing	Gamesa	G-4X
11	1222	Transformer BT/MT	Siemens	Geafol TG5944M
11	1222	Generator	Indar	NCR-400-X/4
12	1179	Gearbox	Flender	PEAS 4285.6
12	1179	Blades	Fiberblade	G 23PRC
12	1179	Shaft and Main Bearing	Gamesa	G-4X
12	1179	Transformer BT/MT	Siemens	Geafol TG5944M
12	1179	Generator	Indar	NCR-400-X/4
13	1228	Gearbox	Lohmann	PLH-308X1G/I47
13	1228	Blades	Fiberblade	G 23PRC
13	1228	Shaft and Main Bearing	Gamesa	G-4X
13	1228	Transformer BT/MT	Siemens	Geafol TG5944M
13	1228	Generator	Indar	NCR-400-X/4
14	1180	Gearbox	Lohmann	GPV300S 3331
14	1180	Blades	Fiberblade	G 23PRN
14	1180	Shaft and Main Bearing	Gamesa	G-4X
14	1180	Transformer BT/MT	Siemens	Geafol TG5944M
14	1180	Generator	Indar	NCR-400-X/4
16	1175	Gearbox	Metso	Otros - Metso
16	1175	Blades	Fiberblade	G 23PRC
16	1175	Shaft and Main Bearing	Gamesa	G-4X
16	1175	Transformer BT/MT	Siemens	Geafol TG5944M
16	1175	Generator	Indar	Otros - Indar
18	1193	Gearbox	Valmet	PLH-310X1G/I47
18	1193	Blades	Fiberblade	G 23PRC
18	1193	Shaft and Main Bearing	Gamesa	G-4X
18	1193	Transformer BT/MT	Siemens	Geafol TG5944M
18	1193	Generator	Indar	NCR-400-X/4
19	1194	Gearbox	Flender	PEAS 4285.6
19	1194	Blades	Fiberblade	G 23PRC
19	1194	Shaft and Main Bearing	Gamesa	G-4X
19	1194	Transformer BT/MT	Siemens	Geafol TG5944M
19	1194	Generator	Indar	NCR-400-X/4
20	1186	Gearbox	Lohmann	GPV300S 3331
20	1186	Blades	Fiberblade	G 23PRN
20	1186	Shaft and Main Bearing	Gamesa	G-4X
20	1186	Transformer BT/MT	Siemens	Geafol TG5944M
20	1186	Generator	Indar	NCR-400-X/4
21	1217	Gearbox	Lohmann	GPV300S 3331
21	1217	Blades	Fiberblade	G 23PRC
21	1217	Shaft and Main Bearing	Gamesa	G-4X
21	1217	Transformer BT/MT	Siemens	Geafol TG5944M
21	1217	Generator	Indar	NCR-400-X/4
22	1184	Gearbox	Lohmann	GPV300S 3331
22	1184	Blades	Fiberblade	G 23PRC
22	1184	Shaft and Main Bearing	Gamesa	G-4X
22	1184	Transformer BT/MT	ABB	DTE 775/24
22	1184	Generator	Indar	NCR-400-X/4

Table 1: component data

2.5 V47-G47 Blade design

V47 – 660 kW

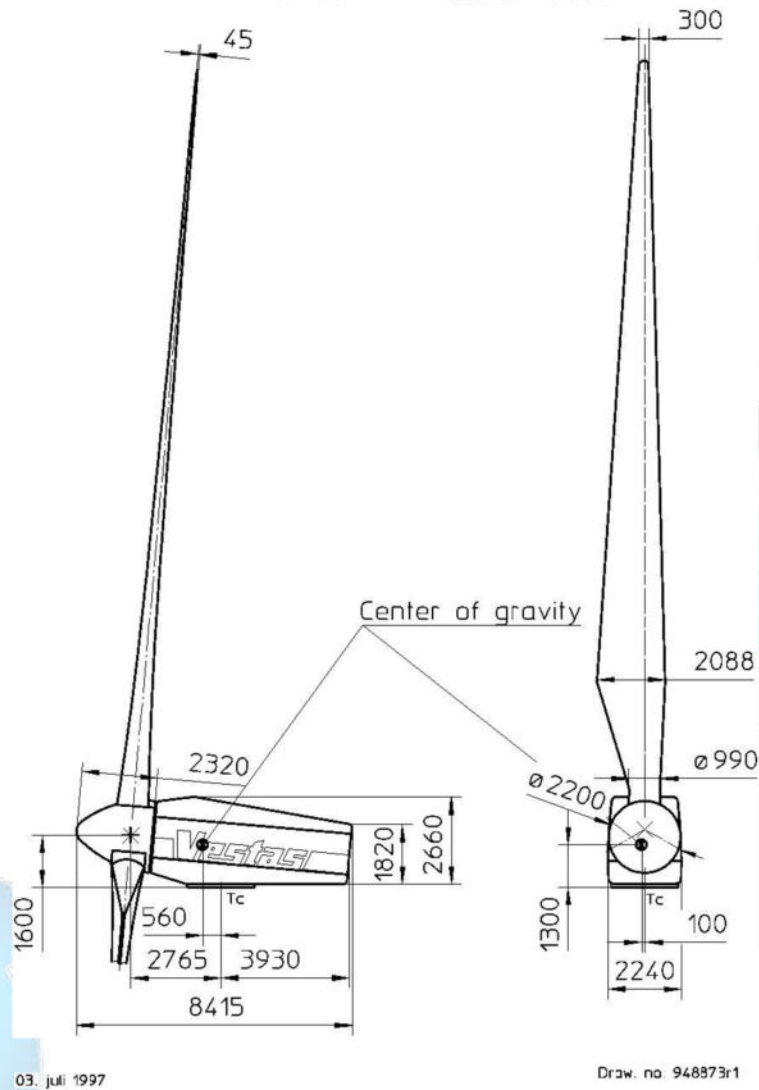


Figure 1: V47-G47 blade design

2.6 Electrical auxiliaries

Main Item	OEM	Model	Serial
MT Switchgear	MESA	CAS-424-OL+1L+1P	5865
Fuse Switchgear SSAA	ORMAZABAL	CGM-CMP-F	3948901
Line 2 Switchgear	ORMAZABAL	CGM-CMP-A	3948902
Line 1 Switchgear	ORMAZABAL	CGM-CMP-A	3948903
Main Switchgear	ORMAZABAL	CGM-CMP-A	3948904
MT Switchgear	ORMAZABAL	CGM-CMM	3948905
Secondary Switchgear	ORMAZABAL	CGM-CML	3948906

Table 2: electrical auxiliaries

3. Information for future integration

Electrical and mechanical assembly manuals are available.

3.1 Type approval

The G47 wind turbine is designed in accordance with IEC 1400 - 1.

3.2 Climatic conditions

The wind turbine is designed for ambient temperatures between -20°C and $+40^{\circ}\text{C}$. Special precautions should be taken outside these temperatures (see section 3.4 general restrictions).

The wind turbine can be placed in wind farms with a distance of at least 5 rotor diameters (235 m) between wind turbines in the prevailing wind direction. If the wind turbines are placed in a row, perpendicular to the prevailing wind direction, the distance between them must be at least 3 rotor diameters (141 m).

Relative humidity can be 100% (max 10% of the time). Corrosion protection according to ISO 12944-2 for corrosion type C3 (outside) and C2 (inside).

3.3 Connection to power grid

Intermittent or rapid fluctuations of the grid frequency can cause serious problems for the wind turbine. Stationary variations between $+2/-3$ Hz are acceptable. The operating voltage range should be within $+6/-10\%$ of the nominal value.

Grid outages should only occur once a week on average during the life of the wind turbine.

The Ingecon W system keeps the power constant, resulting in a unity power factor and a very smooth connection to the power grid.

A ground connection of max. $10\ \Omega$ must be present.

The grounding system should accommodate the soil conditions. The resistance to neutral ground shall be in accordance with local authority requirements.

In case of small independent electrical networks, it will be necessary to check the actual conditions.

3.4 General restrictions

During periods of low winds, an increase in power consumption for heating and dehumidification of the nacelle is to be expected.

With respect to the accumulation of heavy ice, interruptions in operation are to be expected.

In some combinations of high wind, high temperature, low wind temperature, low density, low voltage or low frequency, a decrease in power rating may occur to ensure that the thermal conditions of some major components such as the gearbox, generator, etc. are kept within limits.

It is generally recommended that the mains voltage be kept as close to nominal as possible. In case of mains failure and very low temperatures, a certain time for warm-up should be waited before the wind turbine starts operating.

3.5 Wind conditions

The wind conditions for a site are usually specified by a Weibull distribution. This distribution is described by the scale factor a and the shape factor k . The factor A is proportional to the mean wind speed and the factor k defines the shape of the distribution or, in other words, long-term variations of the number of hours at different wind speeds. Turbulence is the parameter describing the short-term variations / fluctuations of the wind. The design conditions of the G47 machine are given below:

CONCEPT	VALUE	UNITS	COMMENTS
IEC Class	S	-	IEC 1400-1
Average annual wind speed	10	m/s	Referred to hub height
Weibull shape parameter, k	2	-	
Turbulence intensity at 15 m/s, I_{15}	17	%	
Reference wind (10 min.)	50	m/s	Recurrence period 50 years
Reference wind (3 sec.)	70	m/s	Recurrence period 50 years
Max. wind gust acceleration	10	m/s ²	
Stop/restart wind speed	25/20	m/s	Filtered at 100 s.

Table 3: wind conditions

3.6 Power curve

The power curve has been obtained based on the aerodynamic characteristics of the NACA 63.XXX and FFA - W3 airfoils, with a turbulence intensity of 10%.

The electrical power [kW] as a function of horizontal wind speed [m/s] measured at hub height, averaged every ten minutes, for different air densities [kg/m³] is shown in the following table:

Electrical power G47 [kW]									
vel [m/s].	Air density [Kg / m ³]								
	1.225	1.060	1.090	1.120	1.150	1.180	1.210	1.240	1.270
4	9	7	7	8	8	8	9	9	9
5	43	35	36	38	39	40	42	43	44
6	91	78	80	83	85	88	91	93	96
7	156	132	137	141	145	149	154	158	162
8	235	200	207	212	219	225	231	238	244
9	333	286	294	303	311	321	329	337	345
10	451	393	402	413	425	435	446	456	465
11	566	504	516	527	537	550	561	570	577
12	660	610	619	630	638	648	658	662	667
13	698	667	673	679	684	692	697	699	702
14	710	695	698	702	705	707	710	710	710
15	710	705	706	707	708	709	710	710	710
16	710	707	708	708	710	710	710	710	710
17 25	710	710	710	710	710	710	710	710	710

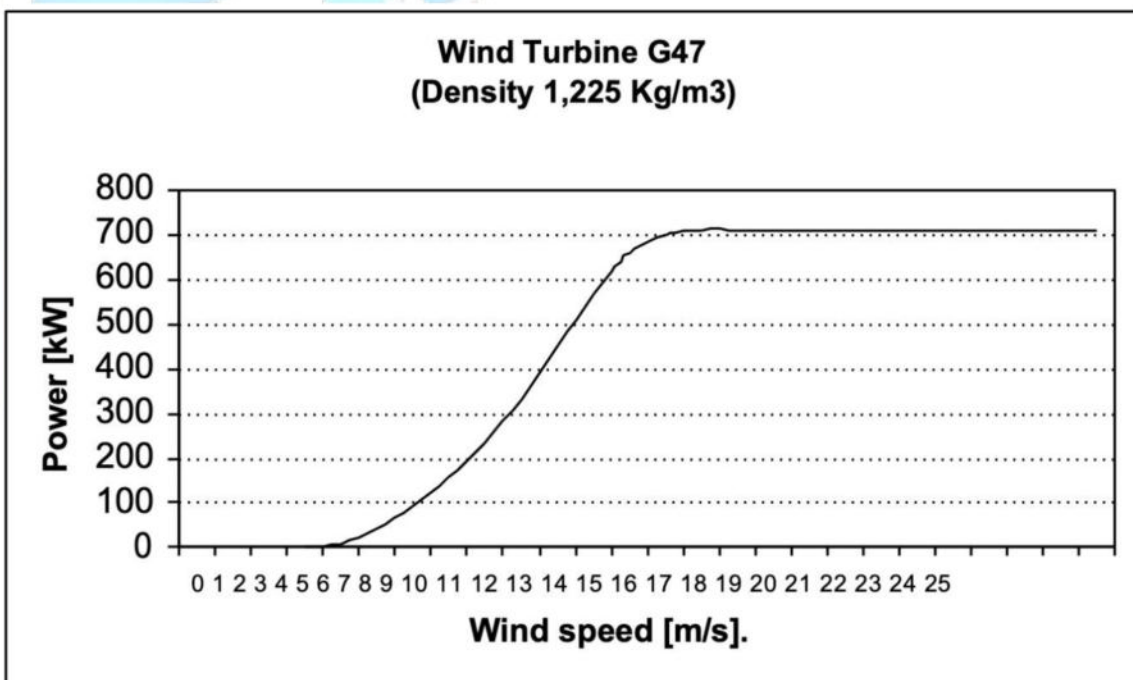


Table 4: power curve

3.6.1 Curves C_p and C_t

Vel [m/s]	C_T	C_P
4		0.129
5	0.887	0.323
6	0.878	0.398
7	0.878	0.427
8	0.833	0.432
9	0.811	0.430
10	0.753	0.424
11	0.662	0.400
12	0.570	0.359
13	0.396	0.299
14	0.306	0.243
15	0.243	0.198
16	0.200	0.163
17	0.166	0.136
18	0.141	0.115
19	0.120	0.097
20	0.104	0.084
21	0.090	0.072
22	0.079	0.063
23	0.070	0.055
24	0.069	0.048
25	0.056	0.043

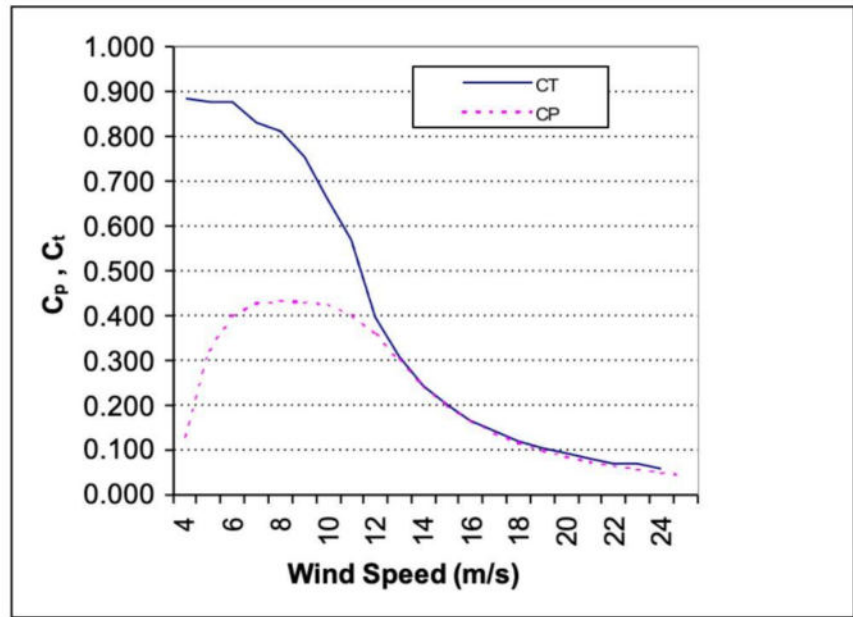


Table 5: curves C_p and C_t

3.7 Yearly Production G47

The following table represents the annual production for different annual average wind speeds and Weibull shape factor k , calculated for an air density of $1,225 \text{ kg/m}^3$:

Yearly Production [MWh]						
	Average yearly wind speed [m/s].					
G47	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
K = 1.5	1017	1488	1933	2321	2639	2883
K = 2.0	840	1371	1926	2453	2919	3307
K = 2.5	706	1241	1854	2469	3032	3520

Table 6: yearly production

4. Actual conditions

A full video is available to view the status of the components. The video was taken with the use of smart glasses on 2023-11-29, duration 1h 20 min. The inspection and photographic survey was carried out on WTG n° 5.

All units are functional and currently in operation. The units have been upgraded over the years, using the philosophy of performing upgrades for the entire wind farm. The units have been properly maintained and the overall condition is very good considering the year of construction. The latest maintenance records are available along with mechanical and electrical assembly manuals.

4.1 Upgrade list

WTG UNIT	WTG SN	Main Item	Year
ALL	ALL	Power cable holder and Power pitch plate retrofit	2001
ALL	ALL	Assembly of Gearbox Oil Fine Filtering System G47	2003
ALL	ALL	Fuses placing in G47 Wind turbine	2003
ALL	ALL	Smart Crowbar system implementation	2009

Table 7: upgrades list

4.3 Photographic report of 2023-11-29



Rotor and tower



Tower gate



Tower and basement



Generator cabinet



Control system panel



Switchgear



Generator cables



Trafo view from bottom



Yaw actuator



Yaw system



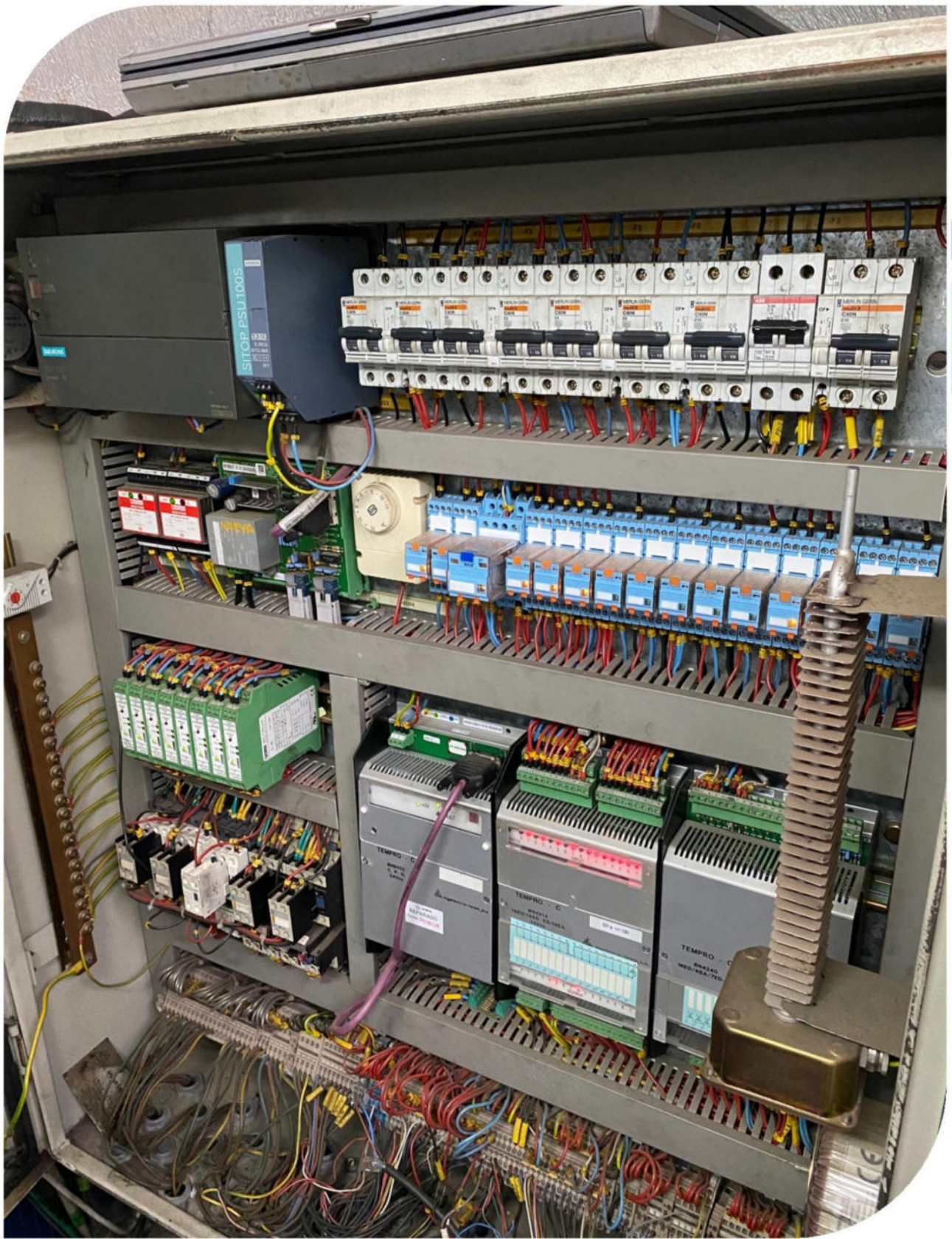
Yaw system



Inside the nacelle, view to the front with Gearbox



The oil cooling system inside the nacelle



Nacelle control cabinet



Manual Rotor positioning



Pitch system



Rotor Pitch Actuator



Hydraulic power system



Generator



Gearbox torque bracing with damper

4.4 Scope of Supply

Position	Quantity	Description
1000	19 unit	GAMESA G47 Wind Turbine
1001	19	Blades <ul style="list-style-type: none"> • <i>Fiberblade</i> • <i>G 23PRC</i> • <i>Pitch system</i>
1002	19	Tower <ul style="list-style-type: none"> • <i>45m</i>
1003	19	Trafo <ul style="list-style-type: none"> • <i>Siemens</i> • <i>Geafol TG5944M</i>
1004	19	Nacelle <ul style="list-style-type: none"> • <i>Gearbox</i> • <i>Generator</i> • <i>Shat and main bearing</i> • <i>Yaw System</i> • <i>Electrical cubicle</i>
1005	19	Switchgear and control cabinet <ul style="list-style-type: none"> • <i>Including protection</i>

Table 9: scope of Supply.

4.5 Exclusions

Scope not explicitly listed in the Scope of Supply (Table 9) is excluded.

The following items are explicitly excluded:

Mechanical
Modification of any existing systems not explicitly cited.
Missing parts and components.
Electrical
Modification of existing systems not explicitly cited.
Missing parts and components.
Civil
Land preparation
Temporary accesses and final accessing roads
Security plan and hardware.
Temporary accommodation
Finishing and fencing
First aid station and ambulances
Waste disposal facility

Table 10: exclusions from the Scope of Supply.

Project Management
Attainability of installation, commissioning and operation permits, or any other permit.
Assessment and acceptance of safety relevant issues.
Any study, engineering, documentation, or other service.
Additional works resulting from changes in laws or any other reasons, for which issuer is not responsible.
Building of Site Facilities of any kind (lights, water supply and treatment, heating, power supply, etc.).
Custom duties and taxes.
Engineering
Design and detailed engineering of existing equipment.

Table 11: exclusions from scope of Services.

4.6 Technical documentation

Following documents are part of the technical documentation (list is preliminary):

Pos.	Document	Available
1	General	
1.1	Document & drawing list	yes
1.2	Interface technical data	yes
2	Mechanical	
2.1	P&IDs	yes
2.2	Layouts	yes
2.3	External connection list	yes
2.4	External connection drawing	yes
3	Electrical	
3.2	Wiring Diagram	yes
3.4	Connection diagrams	yes
4	Civil	
4.1	Foundation interface plans	yes
5	Erection	
5.1	Mechanical assembly instruction	yes
5.2	Electrical connection manual	yes

Table 12: technical documentation.