

# GP16-30 Wind Turbine Generator System Specification



**Shanghai Ghrepower Green Energy Co., Ltd.**

## Modification record

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## 1. Wind Turbine Generator System Overview

### 1.1 System characteristic

- Low-speed permanent magnet generator, direct drive gearless transmission design.
- Optimal variable speed fixed pitch stall control technology ensures output power stability in strong wind.
- Active electric yaw to wind, automatic unwinding, automatic lubrication and perfect other self-management functions.
- Multiple safety protection for individual pitch, mechanical, electromagnetic brakes and active yawing.
- Equipped with low-speed magnet generator with full-power converter, suitable for multinational grid -tie system.
- Direct 400V to grid and connect to the nearby load distribution system, which is self-supply, self-consumption and sufficient electricity connected to grid, for efficient energy transmission.
- SCADA remote monitoring system is the feature of real-time monitoring, report statistics, fault diagnosis and integrated operation & maintenance management.
- Suitable for industrial park, seaport, oil-field, mine, village, expressway service area, etc.

### 1.2 Wind Turbine Brief Introduction

#### 1.2.1 Overall appearance of WTG



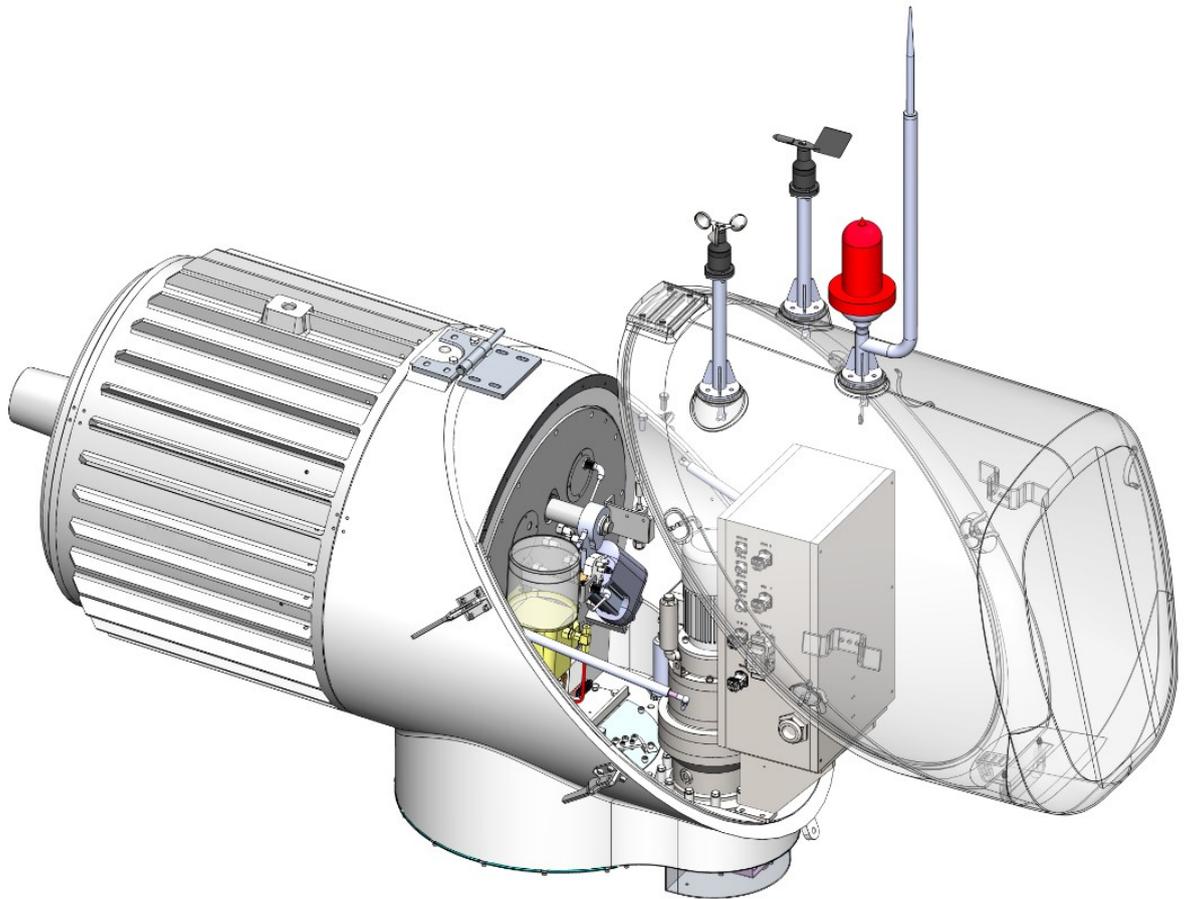
Figure 1 GP16 wind turbine generator system outline diagram

### 1.2.2 Wind rotor

The wind rotor is used to convert the kinetic energy of the air into the mechanical energy of wind rotor. The wind turbine adopts three-blade, upwind type. The blade material uses reinforced fiber glass.

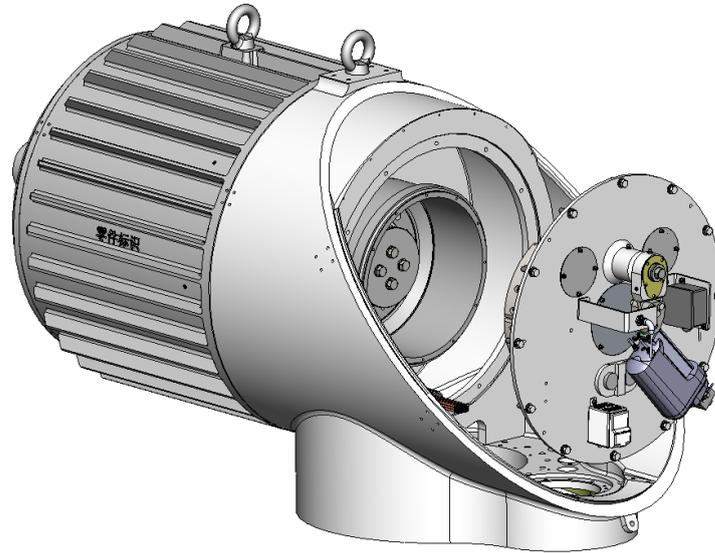
### 1.2.3 Nacelle

The nacelle is connected to generator and tower, which contains yawing transmission system, wind turbine control system, sensors, wind measurement system, aviation warning system, etc., as shown in the figure,



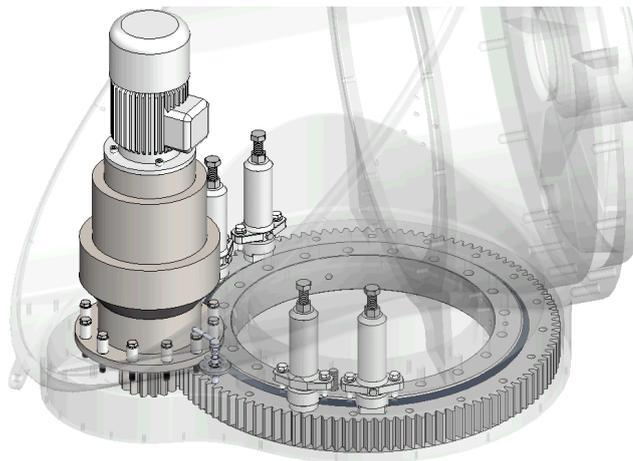
### 1.2.4 Generator & braking system

The generator converts the mechanical kinetic energy of wind rotor into electrical energy. It is composed of stator, rotor, brake disc, braking system and detection device. The main shaft of WTG is braked to realize blade braking, which is composed of brake disc and hydraulic braking system, as shown on the right above. As shown in the figure.



### 1.2.5 Yawing system

Wind turbine adopts active yawing to direct wind and consists of three yaws drive devices, yaw angle detection device, twisting detection device and hydraulic brake. Yaw braking is accomplished by yaw reduction motor, which uses an electromagnetic brake.



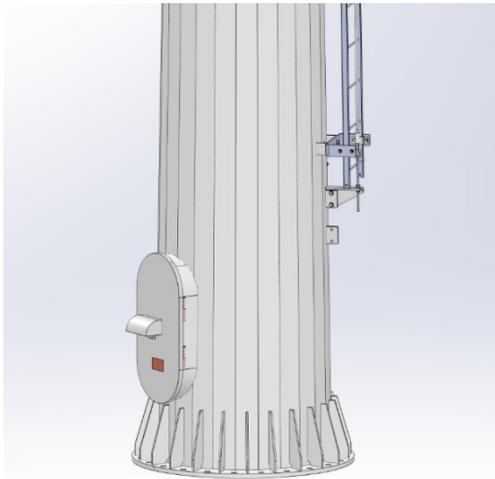
### 1.2.6 Lubrication system

The lubrication system of WTG consists of automatic lubrication and manual lubrication. The yaw pivotal bearing and the front and rear main shaft lubrication of the generator are automatic lubrication systems. Camshafts and adjusting arms of drum brakes are manually lubricated.



### 1.2.7 Tower

Tower mainly plays the role of supporting nacelle, generator and wind rotor. It consists of tower itself, ladder, lighting and inspection rack.



## 2. System technical parameter

### 2.1 Wind turbine generator system parameter

<b>Manufacturer</b>	<b>Shanghai Ghrepower Green Energy Co., Ltd</b>
Country of origin	China
<b>Parameter</b>	<b>Specs</b>
System model	<b>GP16-30</b>
Device model	<b>FD16-30</b>
Design standard	IEC61400-2
Design class	IEC II A
Type	Permanent magnet direct drive, three blades, horizontal axis, upwind
Design lifespan	20 years
Rotor diameter	15.6m
Hub height	20.6m
Tower type	Conical steel pipe tower
<b>Performance</b>	
Power regulation	Variable speed stall control
Rated power	30kW
Wind sweeping area per kilowatt	6.37 m <sup>2</sup> /kW
Rated rotation speed	69rpm
Max rotation speed	79rpm
Cut-in wind speed	3m/s
Rated wind speed	10m/s
Cut-out wind speed	20m/s(10min), 25m/s(10s)
Survival wind speed	59.5m/s

### 2.2 Wind turbine component parameter

<b>Weight</b>	
Blade	3*210kg
Nacelle & generator	3.0 t

Tower	6t@20m
<b>Brake system</b>	
Aerodynamic brake	Active install control
Mechanical brake	Mechanical main-shaft brake
Electromagnetic brake	Electronic dump load control
<b>Yawing &amp; untwisting</b>	
Yawing mode	Electric
Untwisting mode	Auto untwisting
<b>Control system</b>	
Control system	Industrial PLC controller
Inverter type	Full-power inverter
Monitoring system	SCADA Cube 3.0
<b>Generator</b>	
Generator type	Permanent magnet
Drive mode	Direct box (gearless box)
Rated voltage	400Vac
Insulation grade	F class
<b>Blade</b>	
Blade material	Glass fiber(FRP)
Blade length	7.5m
Blade quantity	3
<b>Tower</b>	
Surface treatment	Hot-dip galvanizing/painting
Height	20m
<b>Other</b>	
Noise level	<55dBA
Device position	Control system and converter are placed into integrated cabinet.
Lightening protection	Lightning receptors for blade tip connected to earth through loop.  Anemometer and wind vane have separate lightning arresters.

## 2.3 Environment request

Environment temperature	
Working environment	-20°C ~ +50 °C
Storage environment	-30°C ~ +60 °C
Relative humidity	≤95 %
Elevation	≤2000m, > 2000m, derating operation
Generator protection class	IP54、ISO 12944-2 C5
Other environment request	Conform to standard of EC 60721-2-1
Ground resistance	≤ 4Ω

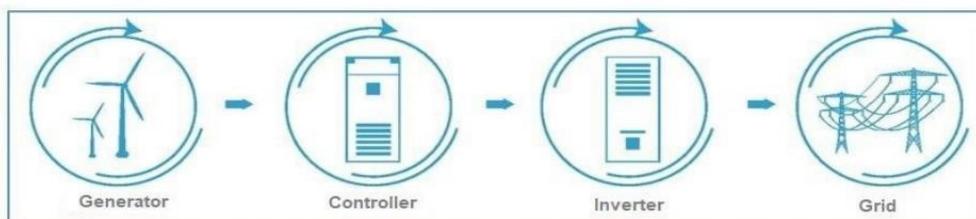
## 2.4 Grid connection request

Grid connection request	
On-grid voltage range	400V±15 %
Allowable frequency range	50/60Hz ±5%
Allowable voltage unbalance	≤3%
Interruption duration	≤7 days
Grid connection access standards	Distribution grid connection series GB standard
Auxiliary power supply	
Normal operation	≤2kW, 3P5L
Standby power	≤0.5kW
PCS standby consumption	≤0.2kW

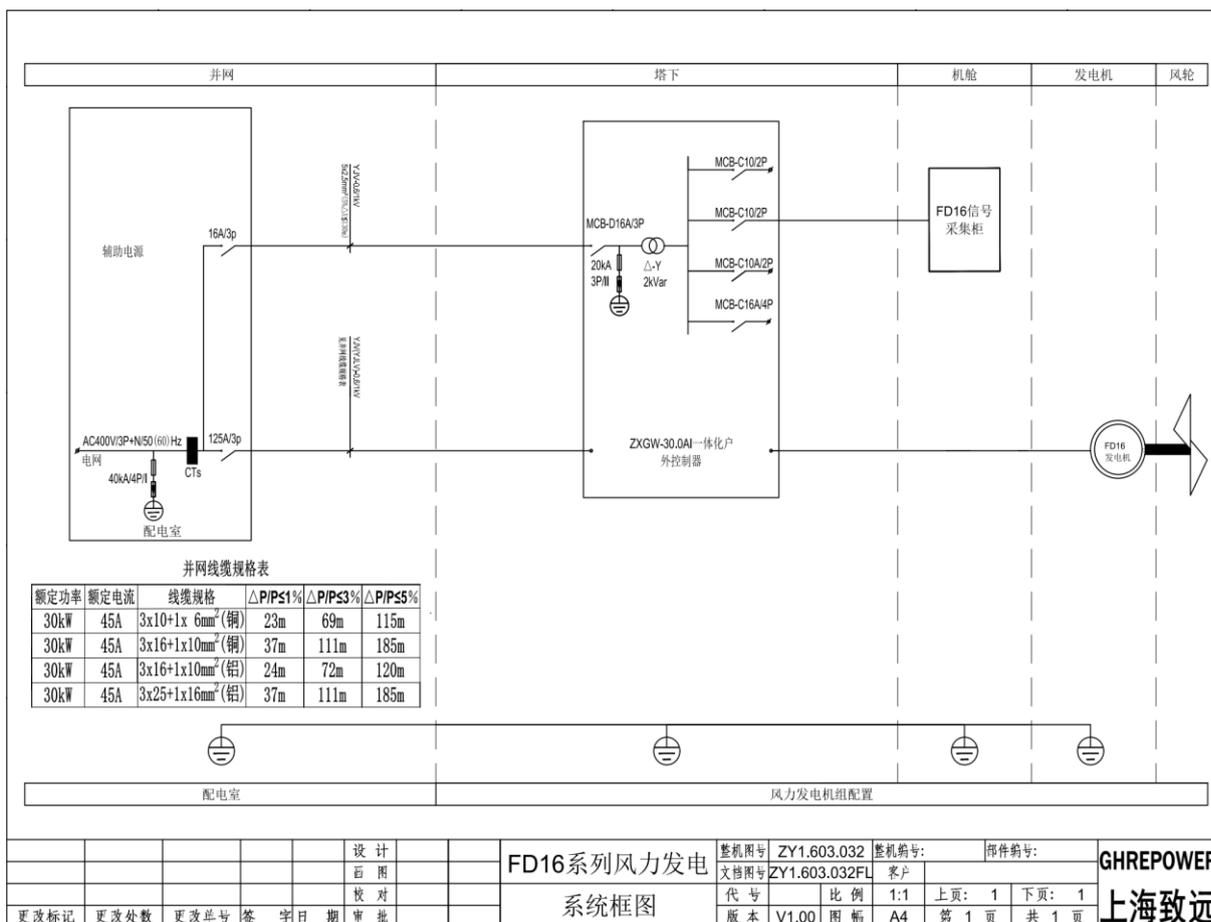
## 3. System configuration

### 3.1 System connection diagram

Wind turbine generator system is composed of wind turbine generator, on-grid controller and on-grid inverter. (see the following photo)

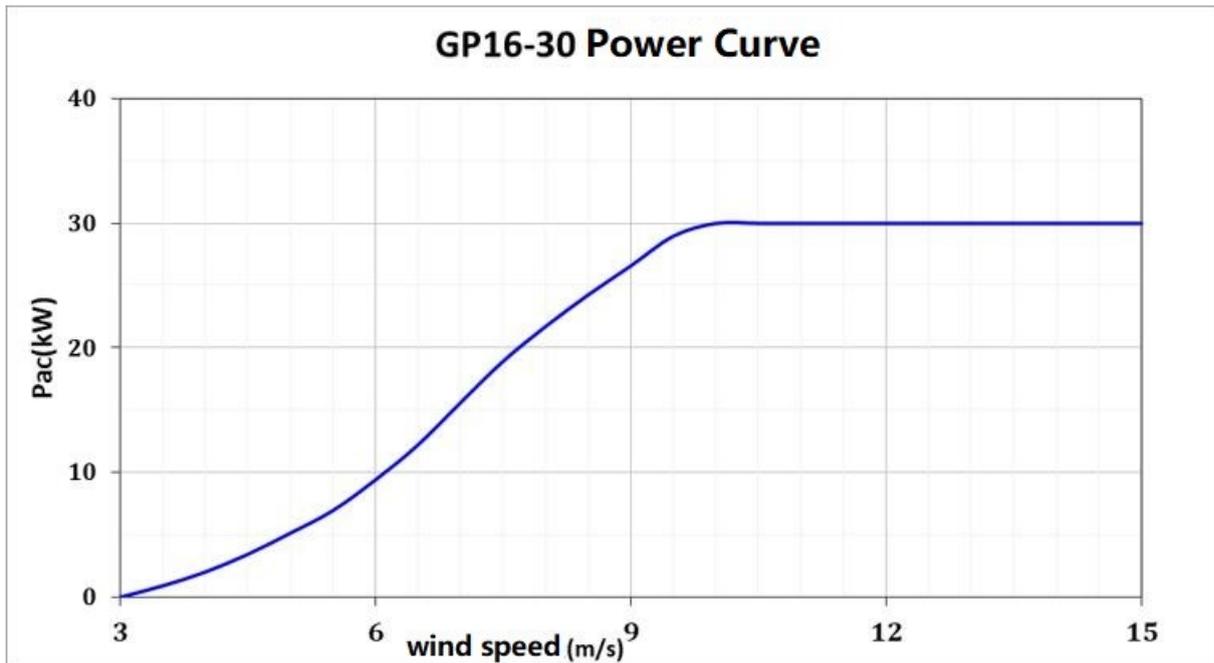


### 3.2 System electrical drawing



## 4. Performance

### 4.1 Power curve

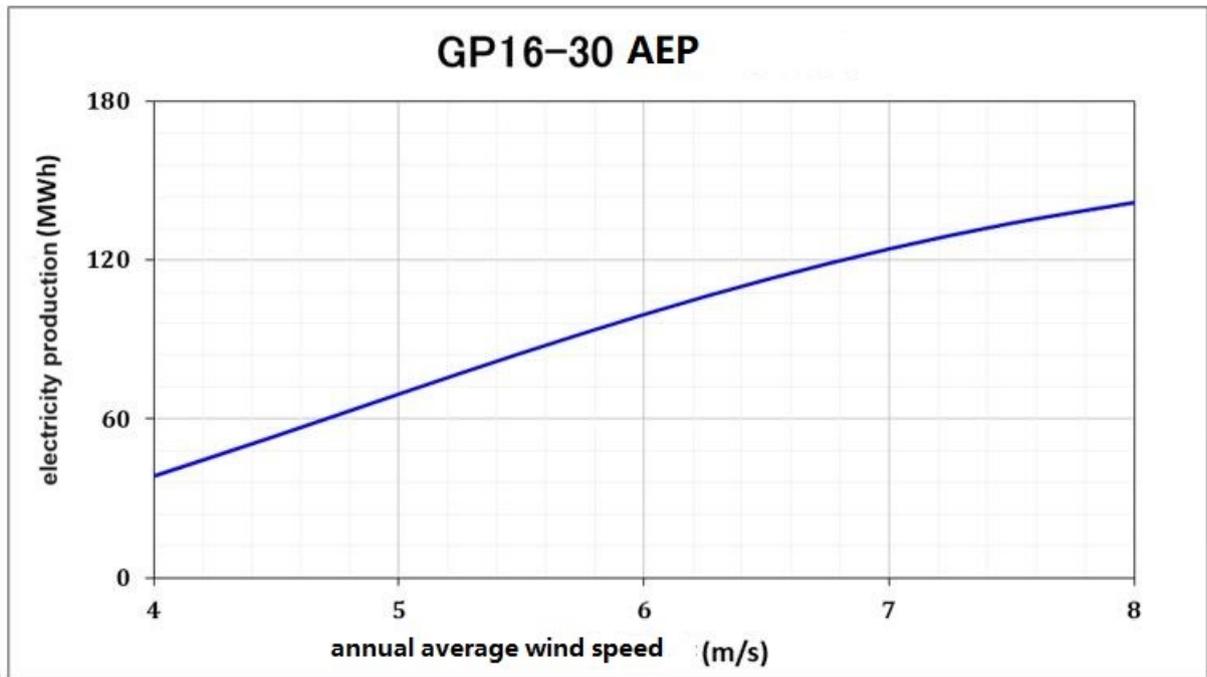


wind speed (m/s)	3.0	3.5	4.0	4.5	5.0	5.5	6.0
power(kW)	0.1	0.8	2.0	3.4	5.1	6.9	9.4
wind speed (m/s)	6.5	7.0	7.5	8.0	8.5	9.0	9.5
power(kW)	12.2	15.6	18.9	21.7	24.3	26.6	29.0
wind speed (m/s)	10.0	10.5	11.0	12.0	13.0	14.0	15.0
power(kW)	30.0	30.0	30.0	30.0	30.0	30.0	30.0

#### Usage instruction for power curve:

1. Data source: data source of power curve listed on the table is the result of calculation based on the theoretical aerodynamic efficiency data of blades and efficiency of each component of wind turbine generator system, which is equivalent to the data under standard air density (1.225g/L).
2. Reference standard: IEC 61400-12-1.
3. Application concern: when evaluating the site, power curve needs to be converted according to the actual air density of the site location. For related conversion methods, please refer to IEC 61400-12-1.

## 4.2 Annual electricity production

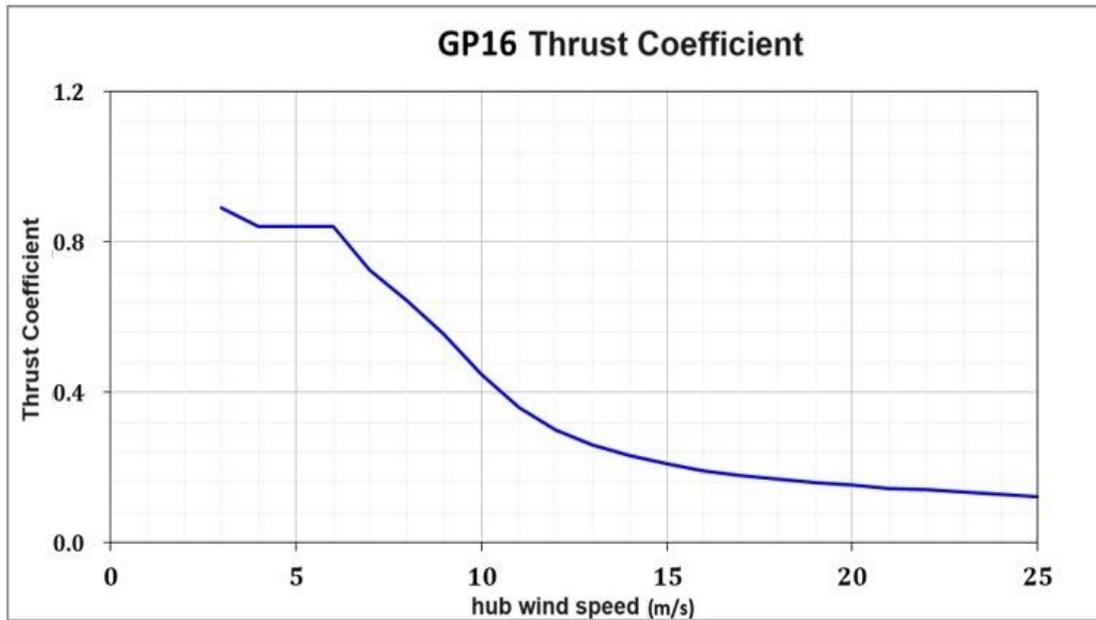


annual average wind speed (m/s)	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
annual electricity production (MWh)	38	54	69	85	99	113	124	134	142
annual electricity production (10MWh)	3.8	5.4	6.9	8.5	9.9	11.3	12.4	13.4	14.2
equivalent hours (h)	1281	1790	2315	2830	3315	3755	4140	4463	4722

### Usage instructions for electricity generation:

1. Data source: the electricity generation is a theoretical value calculated according to calculation method of IEC 61400-12-1 based on the above power curve.
2. Reference standard: IEC 61400-12-1, assuming that the wind distribution is Rayleigh distribution.
3. Application concerns: actual electricity generation of WTG is related to factors such as site temperature, altitude, wind distribution, nearby obstacles, over-limit environment, and grid transmission conditions.

#### 4.1 Thrust coefficient



Wind speed (m/s)	Thrust coefficient						
3.0	0.89	9.0	0.56	15.0	0.21	21.0	0.15
4.0	0.84	10.0	0.45	16.0	0.19	22.0	0.14
5.0	0.84	11.0	0.36	17.0	0.18	23.0	0.13
6.0	0.84	12.0	0.30	18.0	0.17	24.0	0.13
7.0	0.73	13.0	0.26	19.0	0.16	25.0	0.12
8.0	0.64	14.0	0.23	20.0	0.15	...	...

##### Thrust coefficient illustration:

1. Data source: thrust coefficient is a theoretical value obtained by Bladed software based on WTG data simulation.
2. Reference standard: IEC61400-2, thrust coefficient is the steady-state operating value of WTG.
3. Application concerns: actual thrust coefficient is related to factors such as s instantaneous wind speed, instantaneous rotational speed, pitch angle, blade surface roughness, and environment.

## 5. Electronic control system

Wind turbine generator control system includes the core control unit of WTG, pitch drive control, yaw drive control, environmental monitoring, human-computer interaction, and power conversion, that realizes automatic operation control of WTG and maximizes wind energy. Utilization and processing and recording of various events have the following characteristics,

- 1) Hardware stability & reliability: PLC-based distributed control system, using mature CANopen and EtherCAT buses for system connection.
- 2) software maturity & completeness: standard wind turbine code library and control strategy with superior performance in electricity generation efficiency improvement and load control.
- 3) Pitch control flexibility: use different control strategies under different working conditions such as light wind start-up section, rated wind speed section, strong wind control section, wind speed over-limit, etc. to maximize the wind energy utilization and safe operation of WTG.
- 4) Wind MPPT : combined with real-time air density and dynamically adjust the torque control parameters to ensure MPPT of wind energy  $C_p$ .
- 5) Intelligent yawing strategy: intelligent untwisting and wind-direction strategies balance wind-direction accuracy and action frequency to improve wind-catching ability.
- 6) Comprehensive protection: complete wind turbine protection system with multi-level protection strategies to maximize utilization.
- 7) Load optimization control: flexibility control, tower resonance zone vibration isolation, strong wind speed suppression, pitch rate flexible adjustment, etc.
- 8) Intelligent monitoring & diagnosis: complete status code, protection logic and user rights management to maximize safety of WTG.
- 9) Efficient operation & maintenance troubleshooting: abundant operation, failure, operation logs and failure recording records enable efficient operation & maintenance troubleshooting.
- 10) Abundant environmental monitoring: WTG has various monitoring functions such as wind speed, wind direction, air pressure, temperature, humidity, vibration, etc.
- 11) Convenient monitoring & debugging: real-time data monitoring and display of WTG, and LoT operation screen realizes the simultaneous uploading of operating data to the cloud.
- 12) Simple power grid connection: using a converter that meets the grid standards, which can be directly connected to the low-voltage 400V distribution network.

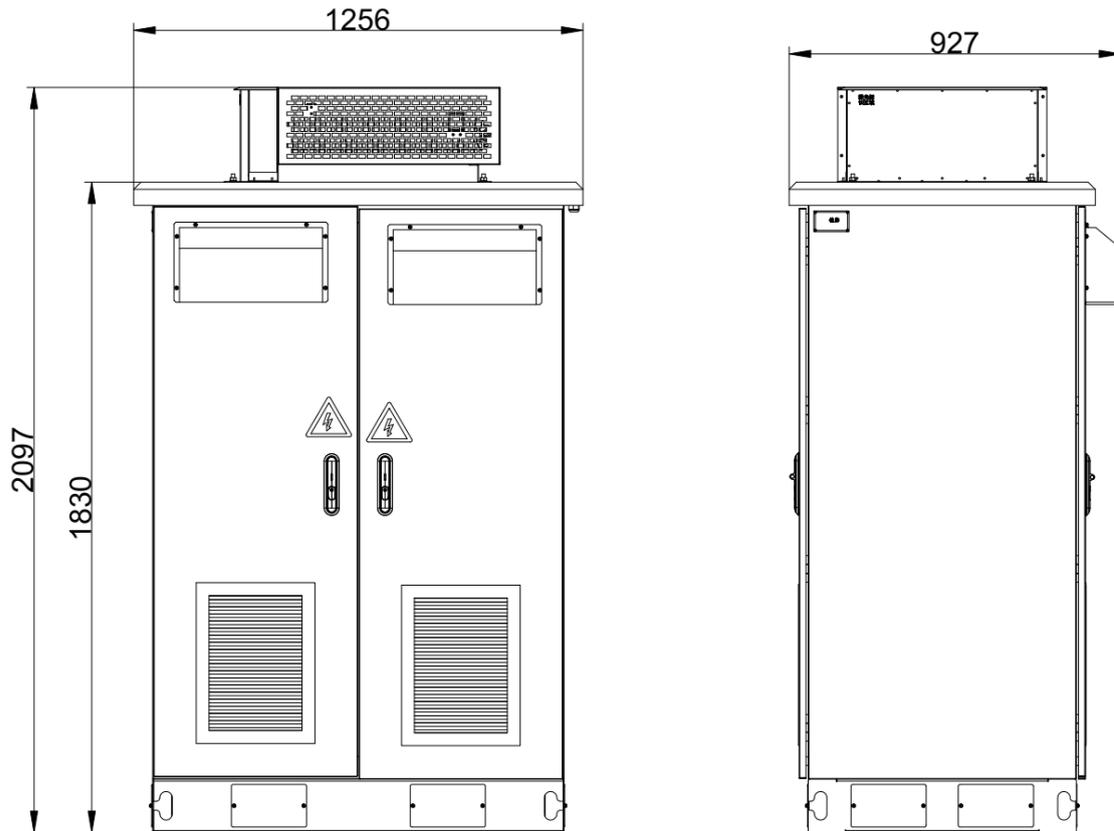
## 5.1 Controller

<b>Control parameter</b>	
Output voltage range	0 ~750Vdc
Rated rotation speed	69 rpm
Max control rotation speed	90 rpm
Yawing speed	0.55 °/s
Yawing accuracy	≤3.2°
Cabinet weight	650kg

## 5.2 On-grid converter

<b>Model</b>	<b>GNW30K3G/PWS2-30P</b>
<b>DC input</b>	
Working voltage range	350V ~ 750VDC
DC current	90A
<b>Network side parameter</b>	
Rated output power	30kW
Rated grid voltage	400Vac±15% 3 phase 3 lines
Rated working frequency	50/60Hz ± 5%
Power factor (PF)	>0.99 (0.85L~0.85C adjustable)
Maximum inverter efficiency	≥94%
Harmonic content (THD)	Total current harmonics <5%, each time <3% (rated power)
Grid-tie protection function	Overvoltage, undervoltage, overfrequency, underfrequency, unbalance protection, etc.
Other grid-tie functions	Low voltage ride through, islanding protection

### 5.3 Cabinet appearance



### 6 Tower & Foundation

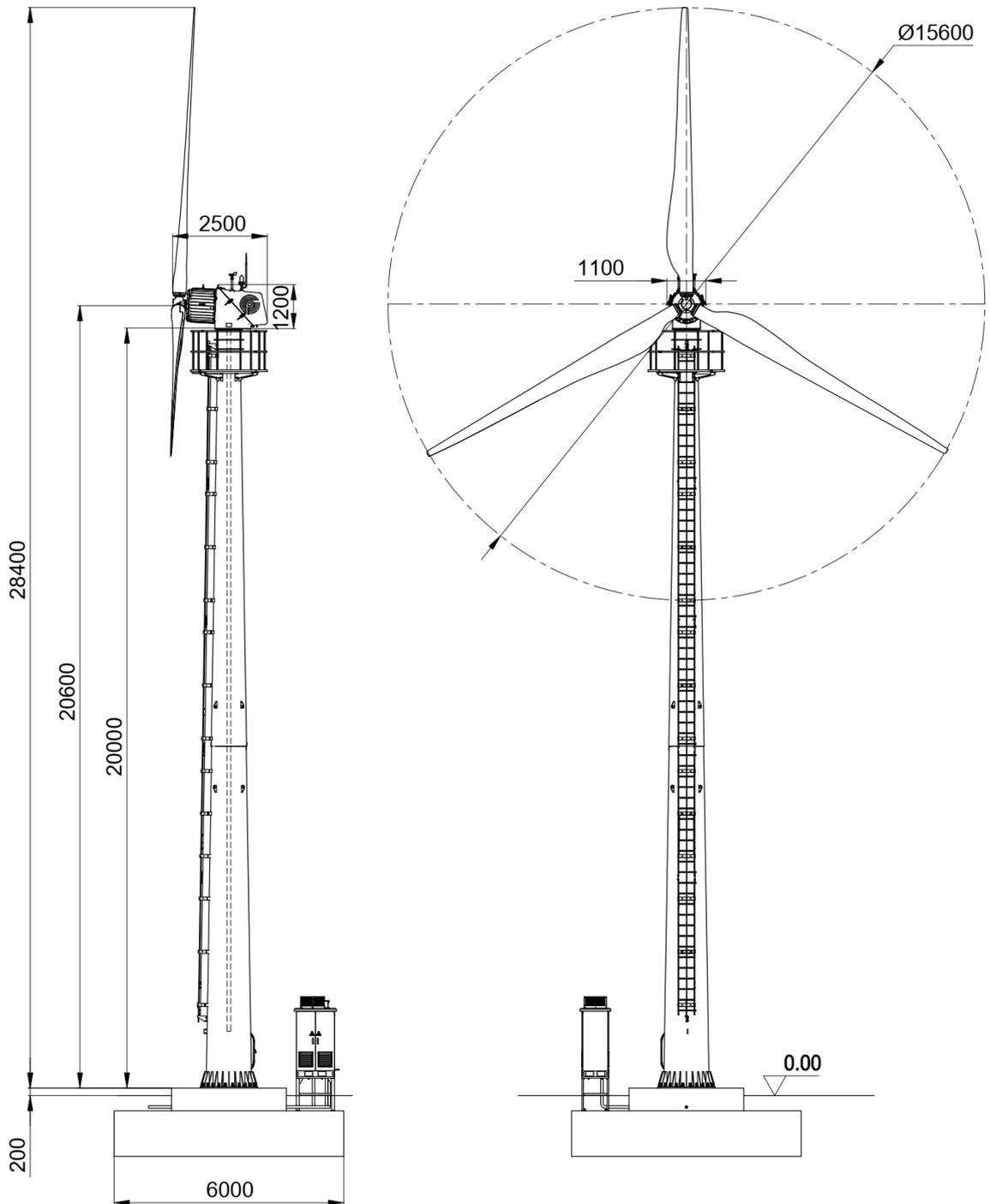
<b>Tower model</b>	TD6-20
Height	20m
Section	2
Thickness	10mm
Weight	18.2t
Material	Q355B
Flange diameter	Φ665mm (upper) /Φ1500mm (bottom)
Surface treatment	Hot-dip galvanizing /Painting
Weight	6000kg
Base reference value	6mx6mx1.8m

Foundation construction needs to go through start-up procedures, bring in machine tools and materials, excavation and leveling of the foundation pit, excavation of cable trenches and masonry manholes, pre-embedding of ground rods and cushion formwork and pouring (C25), installation

of foundation sections, the production and binding of embedded parts, formwork cutting and supporting, foundation pit pouring (C35), and foundation maintenance will take at least 20 days.



### 6.1 Overall appearance diagram



### 6.2 Upper foundation load

Load case	Tower Mxy [kNm]	Tower Mz [kNm]	Tower Fxy [kN]	Tower Fz [kN]	Safety factor
Normal run load case	404	20	23	-114	1.35
Ultimate load case	1249	-2.7	69	-117	1.35

Note: The above loads all include load safety factors, please see relevant documents for detailed data.

6.3 Reference foundation

291.361.74.2

排水管 ⑬

Φ10@200 ⑨

30°45°

Φ200#100#100 ⑩

① ② ③ ④ ⑤ ⑥

Φ10@200 ⑧

30d

1600

191

K

500

Φ200#100#100 ⑦

6200

14

15

12

11

30d

±0.00

70

16

3000

塔架地脚螺栓上端

塔架地脚螺栓下端

±0.00

20#2

仅供參考

**结构设计说明**

一、概况：

1. 本设计适用于上海致远绿色能源股份有限公司生产的D16风力发电机组20m塔架；
2. 本设计基础符合中国及上海市所有各项规范和规定，如在其它地方使用，需符合当地的标称；
3. 风力及电机基础平面位置因使用方案提供；
4. 本基础设计图仅供参考，是否应用应根据当地环境条件而定，如当地冬季积雪较深，则需适当加宽户外柜支腿。

二、使用环境要求：

采用本设计塔架施工时，当地的各项参数应符合下列规定：

1. 本设计基础适用于地基承载力不低于110kPa；
2. 本设计基础适用于天然地基，独立基础，地基承载力设计值应≥110kPa；
3. 本设计基础的室外地面应高于附近地面，否则附近应有排水沟；
4. 本设计基础的抗震设防烈度为Ⅱ级，设计地震分组为第一组，设计基本地震加速度值为0.10g；
5. 本设计基础的抗震设防类别为丙类，场地类别为III类，特征周期为0.35s，土层不液化。

三、施工要求：

1. 本工程基础采用天然地基，独立基础；如基础埋深较深，叠塔时，地基局部处理采用换填法—砂垫层；砂垫层做法如图例；
2. 基础采用C20混凝土，基础下垫层采用C20混凝土，保护层厚度为70mm；
3. 基础和垫层及管架管架施工时应预留，不得后凿；
4. 钢筋：HRB335级，强度为425N/mm<sup>2</sup>级材料；本工程使用的钢筋和钢材，应符合有关国家标准并持证送检；
5. 接地电阻≤4Ω，接地侧与地脚螺栓在同一处（ρ<100Ω·m）；
6. 根据塔架周围的地形、地质情况，选择有设计水准基点和沉降观测点或水准点，满足对风机基础的沉降观测，确保风机基础在风况安全、运行过程中的安全与稳定。

序号	零件代号	名称	规格	长度 (mm)	数量	重量 (kg)	备注
1	Z18.610.152	接地扁钢	-5x40	4000	1	50	Q235A
2	Z18.921.040	地脚螺栓	M36	1600	24	12	289
3	G6/T 6170. M36	螺母	M36		120		
4	G6/T 97.1. 36	垫圈	M36		24		
5	SOC-D-M36-G120	螺栓螺母防松罩	M36		24		
6	Z18.048.070	定位板	±16	Φ1600	2	109	Q235A
7		螺栓 1	Φ20	8000	118	18.5	HRB335
8		螺栓 2	Φ10	12900	5	7.2	HP235
9		螺栓 3	Φ10	12900	8	7.0	HP235
10		螺栓 4	Φ20	7500	60	17.5	HRB335
11		支撑管	Φ20	4000	8	9.5	HP235
12		塔架支撑管	Φ65	23000	1		HP235
13		地脚垫圈	100x100		1		HP235
14		基础垫圈	C30		1	49.0	m <sup>3</sup>
15		垫层垫圈	C20		1	4.0	m <sup>3</sup>
16	Z18.600.054	户外柜支腿			1		
17	Z18.921.024	地脚螺栓			4		热浸锌达克罗 8级
18	G6/T 97.1-2002 16	垫圈			4		
19	G6/T 6170-2015 M16	螺母			4		
20	SOC-D-M16-502	螺栓螺母防松罩	M16		4		

**施工图**

塔架地脚螺栓

地基B (20m)

ZY4.135.162

上海致远绿色能源股份有限公司

图例

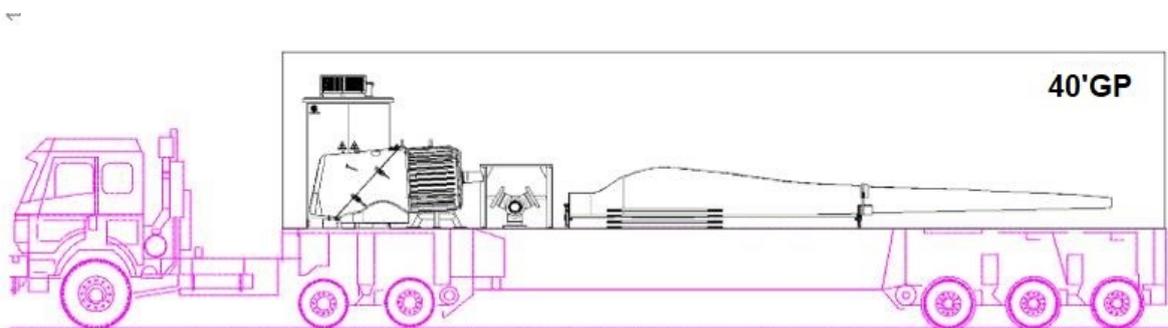
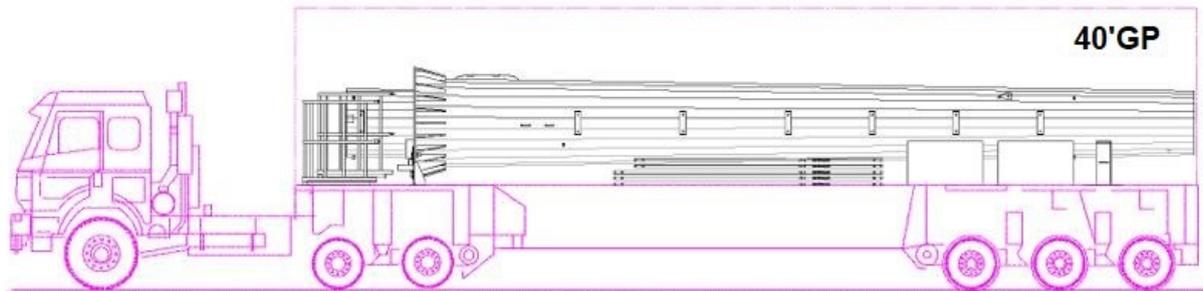
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Confidential

## 7 Wind turbine transportation

The main components of WTGS are listed and the loading diagram as follows:

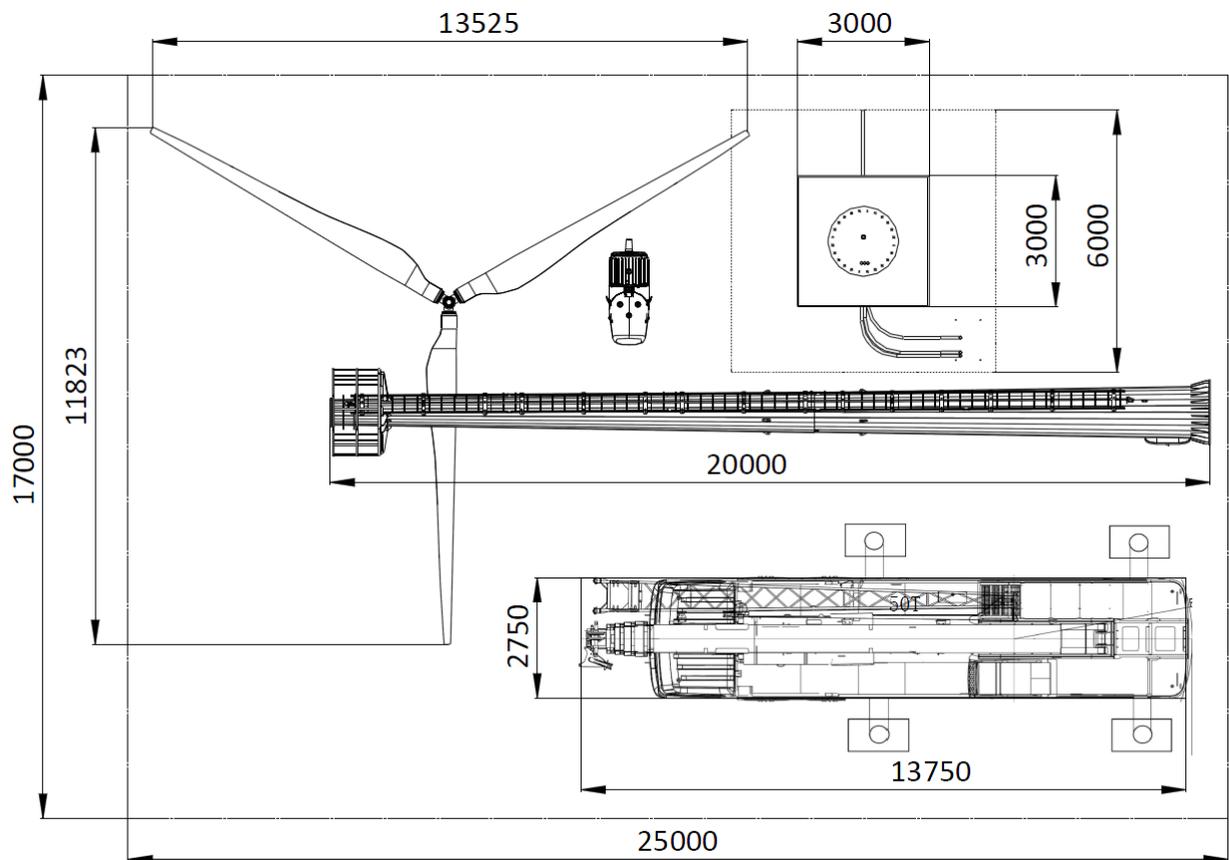
No.↵	Name ↵	Weight (t) ↵	Dimension (m) ↵	Vehicle↵	No.↵
1↵	20m tower (tube, ladder, inspection rack) ↵	5.8↵	11380*1500*1600↵	40'GP↵	1↵
2↵	Anchor bolt, positioning plate, outdoor cabinet mounting ↵	0.7↵	Bulk packing↵	40'GP↵	1↵
3↵	Wind turbine nacelle ↵	3.0↵	2560*1170*1790↵		
4↵	Wheel hub lightning protection assembly↵	0.3↵	768*678*580↵		
5↵	Integrated outdoor control cabinet (box) ↵	0.8↵	1170*870*2250↵		
6↵	Blade installation mounting↵	0.08↵	898*778*729↵		
7↵	Blade (1 set) ↵	0.8↵	7580*1150*855↵		



## 8 Hoisting request

In order to ensure the hoisting time, tower hoisting and wind rotor assembly are carried out simultaneously. The requirements for the site are very strict. It is necessary to ensure that there is space for placement and installation of components. The flat area of the site should be wider to facilitate the layout of hoisting installation. The tower needs to be placed in a flat area 18 meters long and 6 meters wide, and the blades need to be placed in a flat area 15 meters long and 15 meters wide for assembly of the wind wheel.

The road needs to ensure the passage of 13-meter flatbed vehicles. The turning radius is greater than 15m. The geology must not be soft, otherwise it needs to be paved with sand and gravel.



**The list of main tool requirements for each stage of hoisting is as follows:**

No.	Name	Specs	Qty	Time	Function
1	Crane	25T	1 unit	1 day	Unloading, blade Assembly & separate tower
2	Crane	50T	1 unit	1 day	Tower assembly, hoisting, wind turbine & wind rotor hoisting

## 9 SCADA remote monitoring

Remote monitoring system CUBE3.0 with system functions & features:

- Data transmission: data connection and interaction can be carried out through wired/wireless networks and access method is flexible and convenient.
- Real-time monitoring: log on the web page anytime & anywhere to observe and analyze real-time operation status.
- Data logging: record various operation information, meteorological, grid data, electricity generation and other types of data.
- Report analysis: statistics of each monitoring quantity and fault records can be made by day, month and year and reports can be generated.
- Failure alarm: failure information can be notified to operation and maintenance personnel in a timely manner by pre-classifying various types of failures.
- Operation & maintenance management: record each operation & maintenance information and provide operation and maintenance status reminders according to maintenance requirements.
- Safety and reliability: the server is built on a third-party cloud platform, which the network service is safe and reliable.



**Add: No. 58, Tongju Rd, Songjiang District, Shanghai City, China Tele:**  
**0086-21-37832332**  
**Fax: 0086-21-37832356**  
**E-mail: info@ghrepower.com**  
**Web: www.ghrepower.com**