GP56-500

Wind Turbine Generator System Specification

Shanghai Ghrepower Green Energy Co., Ltd.

Modification record

Version	Edition in Detail	Author	Edited Date
V1.00	Initial document creation, summarizing specifications system components	ZhouShaojun	2022/05/28
V1.01	Updated general arrangement drawings and tower configurations	ZhouShaojun	2023/04/10
V1.02	Foundation drawing revisions Added maritime transport solutions Modified select turbine parameters	LiaoXueyu	2025/01/14
V2.00	Upgraded turbine performance parameters Expanded tower variants Enhanced transport methodologies	YeYusheng	2025/07/03

Contents

1. Overview of Wind Turbine Generator System

1.1 System Features

- Low-speed permanent magnet generator and direct drive gearless transmission design.
- Active pitch control technology ensures the stability of power output under heavy wind.
- Multiple safety protections such as independent blade pitch, mechanical, electromagnetic brakes and active yawing.
- Equipped with low-speed permanent magnet generator and full-power converter, suitable for multinational grid -tie system.
- Direct 400V to grid and connecting with the nearby load distribution system, which is for self-supply, self-consumption and sufficient electricity input into grid, for efficient energy transmission.
- SCADA remote monitoring system has the features of real-time monitoring, report statistics, fault diagnosis and integrating operation & maintenance management.
- Widely applied for power supply of industrial park, seaport, oil-field, mine, village, expressway service area etc.

1.2 Brief Introduction of Wind Turbine

1.2.1 Overall appearance of WTG

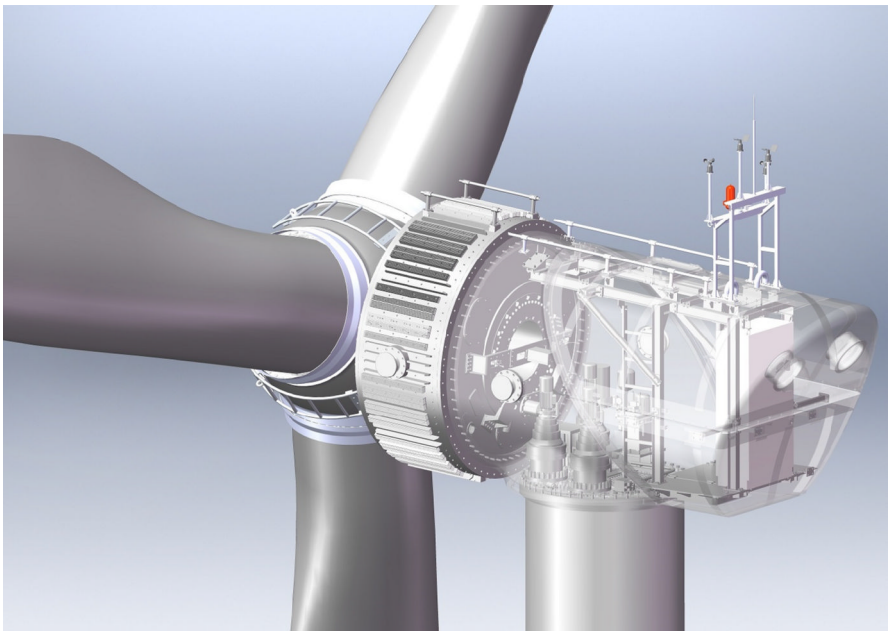
GP56 WTGS outline diagram

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 has three-blade with upwind type which is actively adjusted through pitch mechanism. The blade is made of reinforced fiber glass.

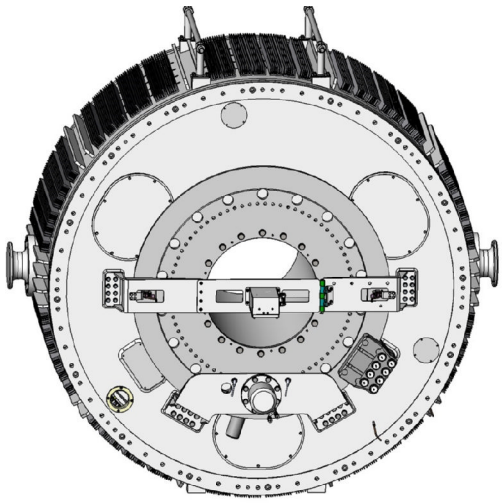
1.2.3 Nacelle

The nacelle is connected with generator and tower, which contains yawing transmission system, damper control system, wind turbine control system, sensors, wind measurement system, aviation warning system, staff passage etc. Please refer to the following figure:



1.2.4 Three-blade independent pitch mechanism

Pitch of WTG adjusts the windward angle of blades, and its main functions are for power adjustment and rotating speed control. It mainly includes hub, pitch reducer, drive motor, pitch controller, angle speed detection device etc. The hub adopts a spherical structure, which has good castability and high strength, which is shown in the left picture below:



1.2.5 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, which is shown on the right picture above.

1.2.6 Yawing system

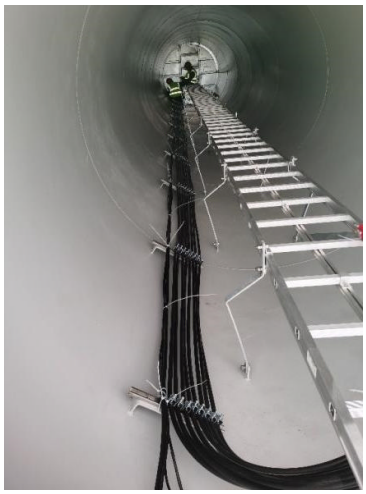
Wind turbine adopts active yawing for wind alignment, which includes three yaws drive devices as yaw angle detection device, twisting detection device and hydraulic brake. Yaw braking is accomplished by yaw reduction motors, which adopts an electromagnetic brake.

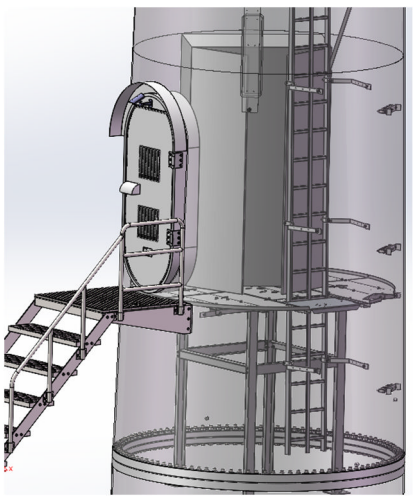
1.2.7 Lubrication system

WTG employs two independent automatic lubrication systems. The yaw bearing and the main shaft at both ends of the generator share one automatic lubrication system located in the nacelle; the three pitch bearings utilize the second automatic lubrication system situated in the hub. Each lubrication point is equipped with a waste oil collection bottle.

1.2.8 Tower

Tower mainly plays the role of supporting nacelle, generator and wind rotor. It consists of tower itself, ladder, lighting and ladder safety protection devices. Each floor of tower is equipped with a platform for installation and rest etc.





2. System Technical Parameters

2.1 Parameters of Wind Turbine Generator System

Manufacturer	**Shanghai Ghrepower Green Energy Co., Ltd**
Country of origin	China
Parameter	**Specs**
System model	GP56-500
Device model	FD56-500
Design standard	IEC 61400-1, GB/T 18451.1
Design class	IEC S(A)
Annual average wind speed	6.5m/s
Reference wind speed (Vref,10min)	42.5m/s
Extreme wind speed(3s)	59.5m/s
Design lifespan	20 years
Type	Permanent magnet direct drive, three blades, horizontal axis, upwind
Rotor diameter	56m
Hub height	47.8m (51m optional)
Performance	
Power regulation	Independent Pitch control
Rated power	498kW
Swept area per kilowatt	4.94 m^2/kW
Rated rotation speed	29rpm
Max rotation speed	33rpm
Cut-in wind speed	2.5m/s
Rated wind speed	10.0m/s
Cut-out wind speed	18m/s(10min), 22m/s(10s)
Re-cut-in Condition	Wind speed drops below 95% of the cut-out wind speed value for 10 minutes.
Noise level	<57.5dBA (@80m)
Lightning protection	Blade tip receptors, mid-span receptors, nacelle receptors, etc., are conducted to ground via the down-conductor system. Anemometers and wind vanes have dedicated receptors.

2.2 Component parameters of Wind Turbine

Control system	
Control system	Industrial PLC controller
Inverter type	Full-power On-grid inverter
Monitoring	SCADA Cube
Brake system	
Aerodynamic brake	Active pitch control
Mechanical brake	Mechanical main-shaft brake (hydraulic)
Electromagnetic brake	Electronic dump load control
Rotor blocking	Hydraulically actuated locking pin
Pitch Control System	
Type of pitch	Electric Individual Pitch Control (for Three Blades)
Pitch Max speed	9°/s
Pitch accuracy	≤0.1°
Pitch backup power	Super capacitor
Safety Functions	Emergency pitch-to-feather control; open-loop operation capability during encoder failure
Yawing & untwisting	
Yawing mode	Electric
Untwisting mode	Auto untwisting
Angle of twisting	±1080°(±3 circles)
Generator	
Generator type	Permanent magnet
Drive mode	Direct Drive(gearless)
Rated voltage	400VAC (F class)
Nacelle & generator	23t
Blade	
Blade material	Fiber Reinforced Plastics (FRP)
Blade length	27m
Blade quantity	3
Blade	3*2.4t

Tower	
Surface treatment	Anti-rust painting
Height	46m (49.2 optional)
Tower type	Tubular Steel Tower
Tower	About 42t
Maintenance Access	Internal climbing ladder with inspection platforms at each tower level.
Device position	inverter is deployed at the bottom of tower. Others are placed inside of nacelle.

2.3 Environment Request

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

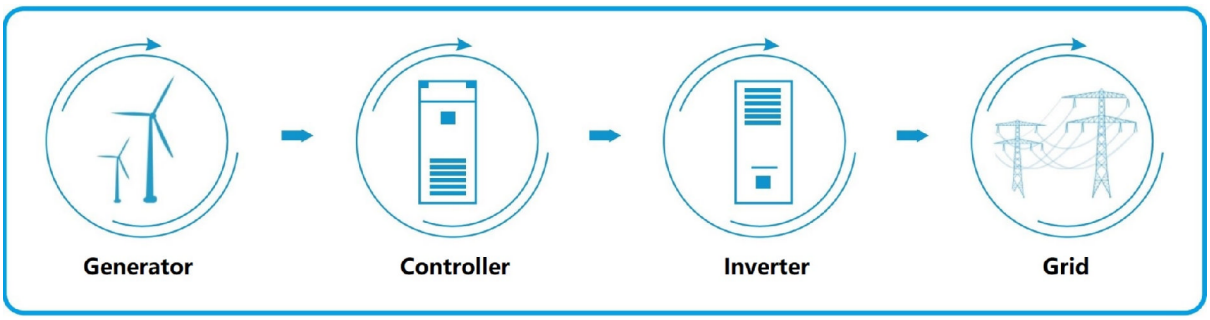
2.4 Grid Connection Request

Grid connection request	
On-grid voltage range	400V±15%, 3P3L
Allowable frequency range	50/60Hz ± 5%
Allowable voltage unbalance	≤3%
Grid connection access standards	Determined according to the standards and requirements of the project location.
Auxiliary power supply	
Voltage and frequency	400V±10%、50/60Hz ± 5%
Normal operation	≤8kW, 3P5L
Standby power	≤1.8kW
PCS standby consumption	≤0.6kW
Interruption duration	≤7 days

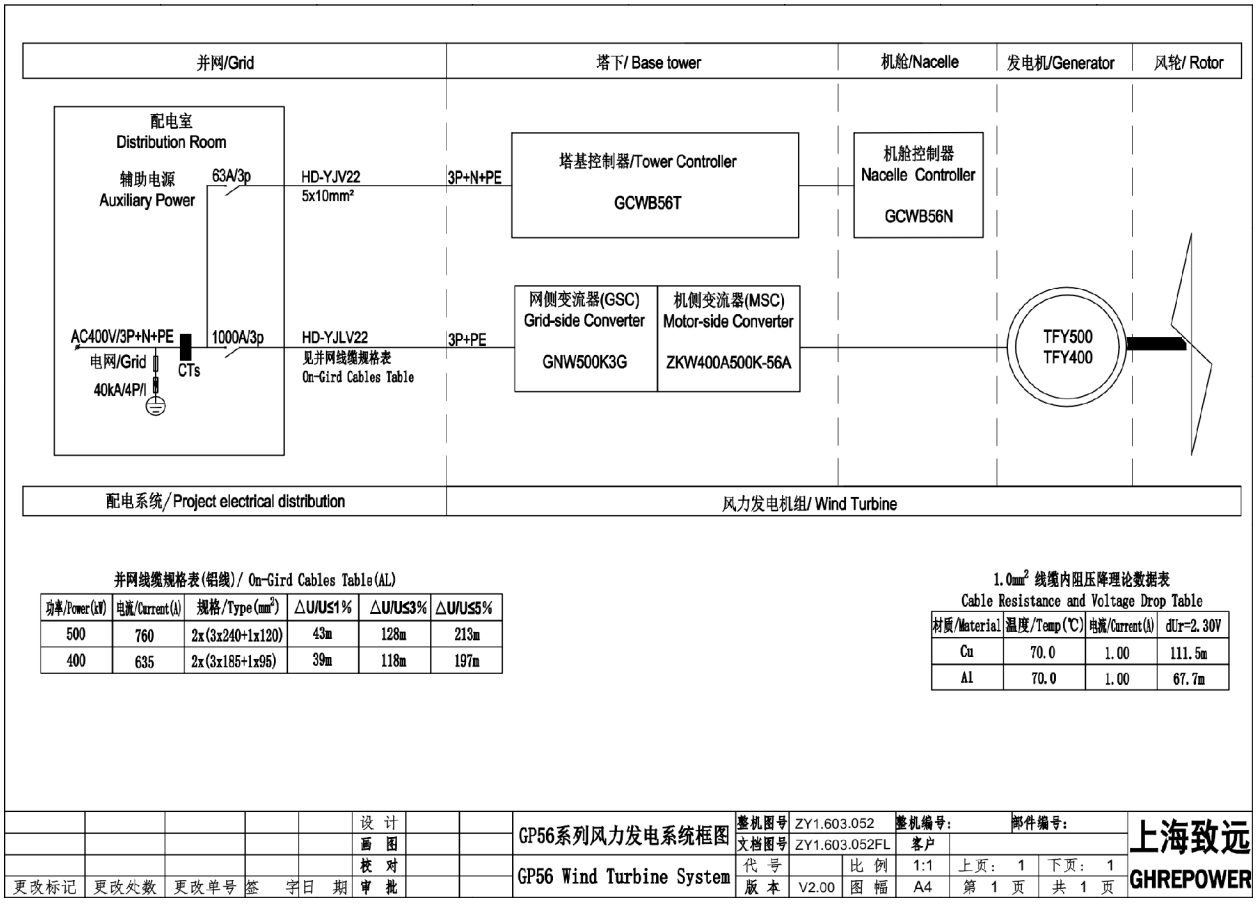
3. System Configuration

3.1 System Connection Diagram

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



3.2 System Electrical Drawing



并网线缆规格表(铝线)/ On-Gird Cables Table(AL)

功率/Power(kW)	电流/Current(A)	规格/Type(mm²)	△U/Us≤1%	△U/Us≤3%	△U/Us≤5%
500	760	2x(3x240+1x120)	43m	128m	213m
400	635	2x(3x185+1x95)	39m	118m	197m

1.0mm² 线缆内阻压降理论数据表
Cable Resistance and Voltage Drop Table

材质/Material	温度/Temp(℃)	电流/Current(A)	dUr=2.30V
Cu	70.0	1.00	111.5m
Al	70.0	1.00	67.7m

					设 计			GP56系列风力发电系统框图	整机图号	ZY1.603.052	整机编号:		部件编号:		上海致远 GHREPOWER
					画 图				文档图号	ZY1.603.052FL	客户				
					校 对			GP56 Wind Turbine System	代 号		比 例	1:1	上页: 1	下页: 1	
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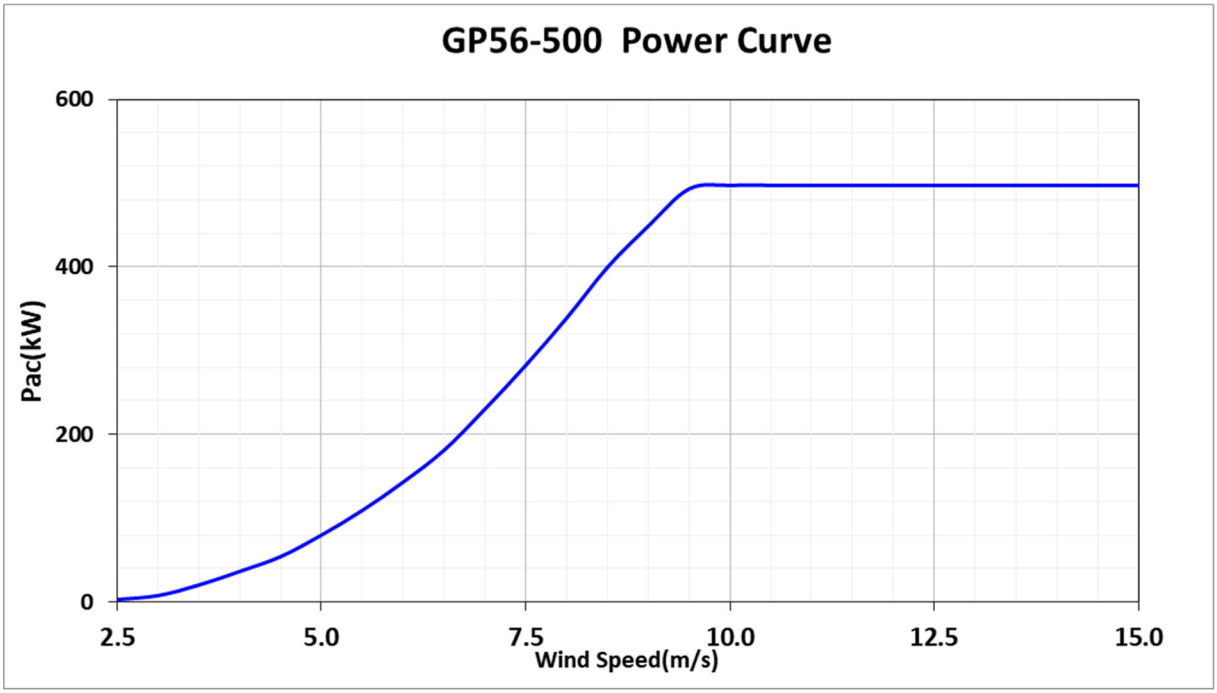
4. Performance

4.1 GP56-500 Power Curve

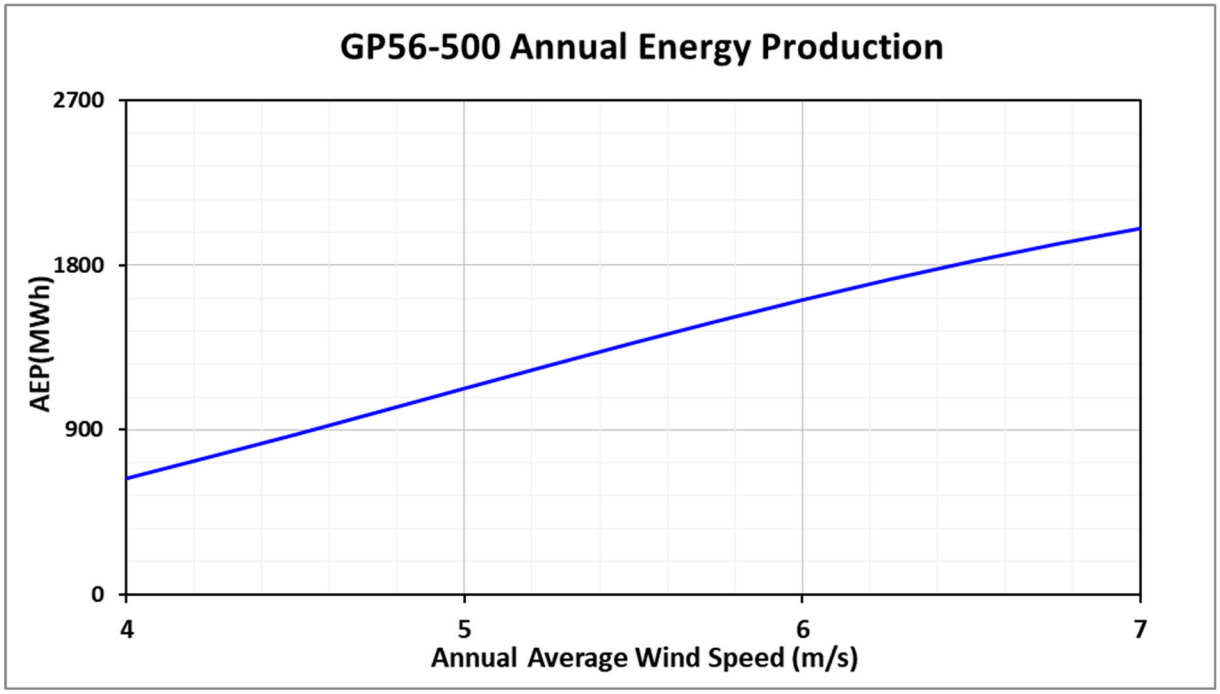


Wind Speed(m/s)	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
Power(kW)	2.4	7.1	19.8	36.1	53.8	79.6	109.2	143.0
Wind Speed(m/s)	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
Power(kW)	181.1	230.4	282.9	339.3	400.2	449.5	494.0	498.0
Wind Speed(m/s)	10.5	11.0	11.5	12.0	13.0	14.0	15.0	16.0
Power(kW)	498.0	498.0	498.0	498.0	498.0	498.0	498.0	……

User instructions for power curve:

1. Data source: The power curve data presented in this table is sourced from third-party testing agencies, based on field measurements of prototype turbines at test sites under standard conditions. The results are based on standard air density (1.225 g/L).
2. Reference standard: IEC 61400-12-1. All data sources provide 10-minute averaged values.
3. Application concern: Once evaluating the site condition, power curve needs to be converted accordingto the actual air density of the site location. For related conversion methods, please refer to IEC 61400-12-1.

4.2 GP56-500 Annual Energy Production

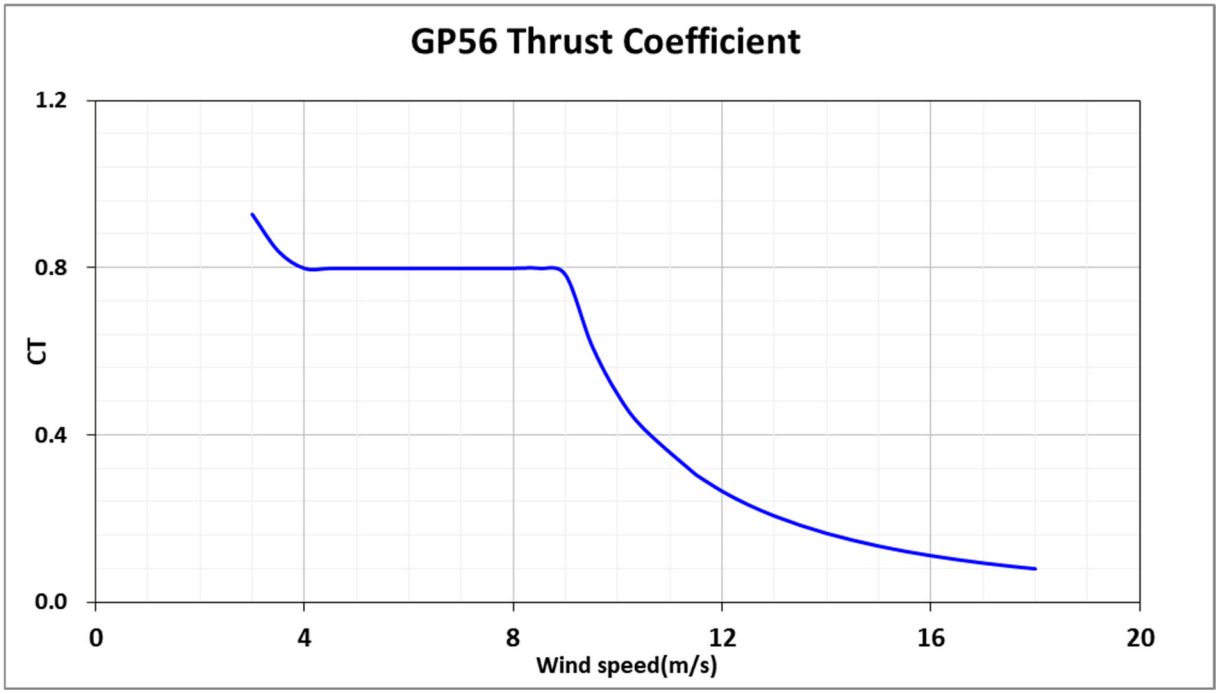


Annual mean wind speed (m/s)	4.0	4.5	5.0	5.5	6.0	6.5	7.0
Annual energy production (MWh)	637	877	1128	1376	1610	1820	2000
Annual equivalent full load hours (h)	1279	1760	2264	2763	3233	3655	4016

User instructions for AEP:

1. Data source: AEP 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.

4.3 Thrust Coefficient



Wind speed (m/s)	Thrust coefficient	Wind speed (m/s)	Thrust coefficient	Wind speed (m/s)	Thrust coefficient	Wind speed (m/s)	Thrust coefficient
3.0	0.927	7.0	0.798	11.0	0.353	15.0	0.135
3.5	0.839	7.5	0.798	11.5	0.305	15.5	0.122
4.0	0.798	8.0	0.798	12.0	0.266	16.0	0.112
4.5	0.798	8.5	0.798	12.5	0.234	16.5	0.102
5.0	0.798	9.0	0.783	13.0	0.207	17.0	0.094
5.5	0.798	9.5	0.615	13.5	0.184	17.5	0.087
6.0	0.798	10.0	0.497	14.0	0.165	18.0	0.080
6.5	0.798	10.5	0.415	14.5	0.149		

Thrust coefficient illustration:

1. Data source: thrust coefficient is a theoretical value obtained by Bladed software based on WTG data simulation.
2. Reference standard: IEC 61400-1, 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. Electrical Control System

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

1. Hardware stability & reliability: PLC-based distributed control system with mature CANopen and EtherCAT buses for system connection.
2. software maturity & completeness: standard wind turbine code library and control strategy with superior performance in efficiency improvement of electricity generation 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 MOPT: combined with real-time air density and dynamically adjust the torque control parameters to ensure MOPT of wind energy Cp.
5. Intelligent yawing strategy: intelligent untwisting and wind-direction strategies balancing 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 IoT 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

Control parameter	
Control system	Industry PLC controller
Pitch Control Algorithm	Dynamic pitch angle optimization control
Power Control Algorithm	Adaptive power curve adjustment
Power Regulation Rate	≤100% P_n/s (rated power per second)
Yaw Control Algorithm	Dynamic adaptive wind alignment
Yawing speed	0.55 °/s
Yawing accuracy	≤1°
Lubrication System	Multi-point automated smart greasing (main shaft, pitch, yaw) with low-grease-level pre-alarm
Hydraulic Control	Executes main shaft braking & yaw braking; equipped with fluid-level monitoring and pre-alarm
Temperature Monitoring	Multi-point surveillance (motors, bearings, nacelle, tower base)
Safety Functions	Multi-layer safety chain design (overspeed/vibration/overtemperature/grid fault protections)
Monitoring & Communication	
Display panel	LCD / Touch Screen
Communication interface	Ethernet (RJ45) (RS485 optional)
Data Management	Event logging, energy yield statistics, operational analytics, fault waveform recording
Remote Monitoring	Ethernet-based data exchange with SCADA systems
External Dispatch	Accepts external commands (power curtailment, start/stop, fault reset)
Self-Consumption Control	
Anti-Backfeed Control	Anti-backfeed control interface (requires additional optional configuration for anti-backfeed protection device)

5.2 On-grid Converter

System model	GP56-500
Generator side parameter	
Generator side voltage range	3 phase 160~460Vac
DC bus voltage range	600 ～ 720Vdc
Brake unit configuration	Built-in control and dump-load resistors
Grid side parameter	
Rated output power	498kW
Rated grid voltage	400V±15%, 3 phase 3 lines
Rated working frequency	50/60Hz ± 5%
Power factor (PF)	>0.99 (0.85L~0.85C adjustable)
Maximum inverter efficiency	≥97%
Harmonic content (THD)	Total current harmonics <5%, harmonics of each order<3% (rated power)
Grid-tie protection function	Over voltage, Undervoltage, Over frequency, Underfrequency, Unbalance protection, etc.
Other grid-tie functions	High/Low Voltage Ride-Through (H/LVRT) Islanding protection.

6. Tower & Foundation

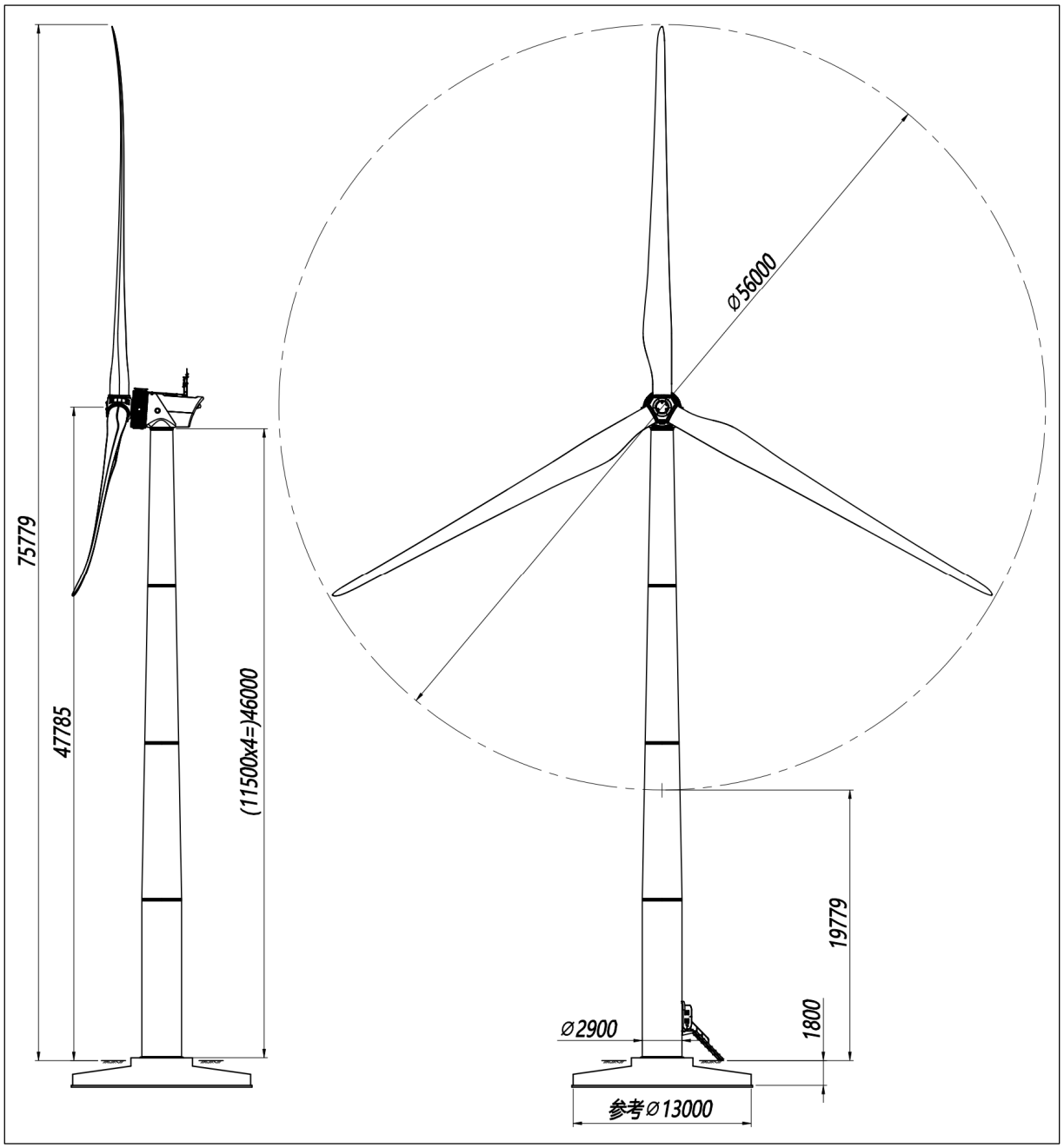
Device model	FD56-500	
Tower model	TF151302-46 (Flat Rack)	TF151302-49
Height	46m	49.2m
Section	4	3
Wall thickness	12mm/14mm/16mm	10mm/12mm/14mm
Weight (Including Accessories)	41.6t	41.3t
First-order frequency	0.612 Hz (36.7rpm)	0.547 Hz (32.8rpm)
Material	Q355ND	
Outside diameter	Top : 1620mm Bottom: 2900mm /3110 mm(flange)	
Surface treatment	Painting	
Dimension (reference)	φ13.0mx1.8m	

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 (crane 25 tons), the production and binding of embedded parts, formwork cutting and supporting, foundation pit pouring (C35), and foundation maintenance will take at least 20 days.

Foundation layout diagram

6.1 46m Tower

6.1.1 Overall appearance diagram(46m)



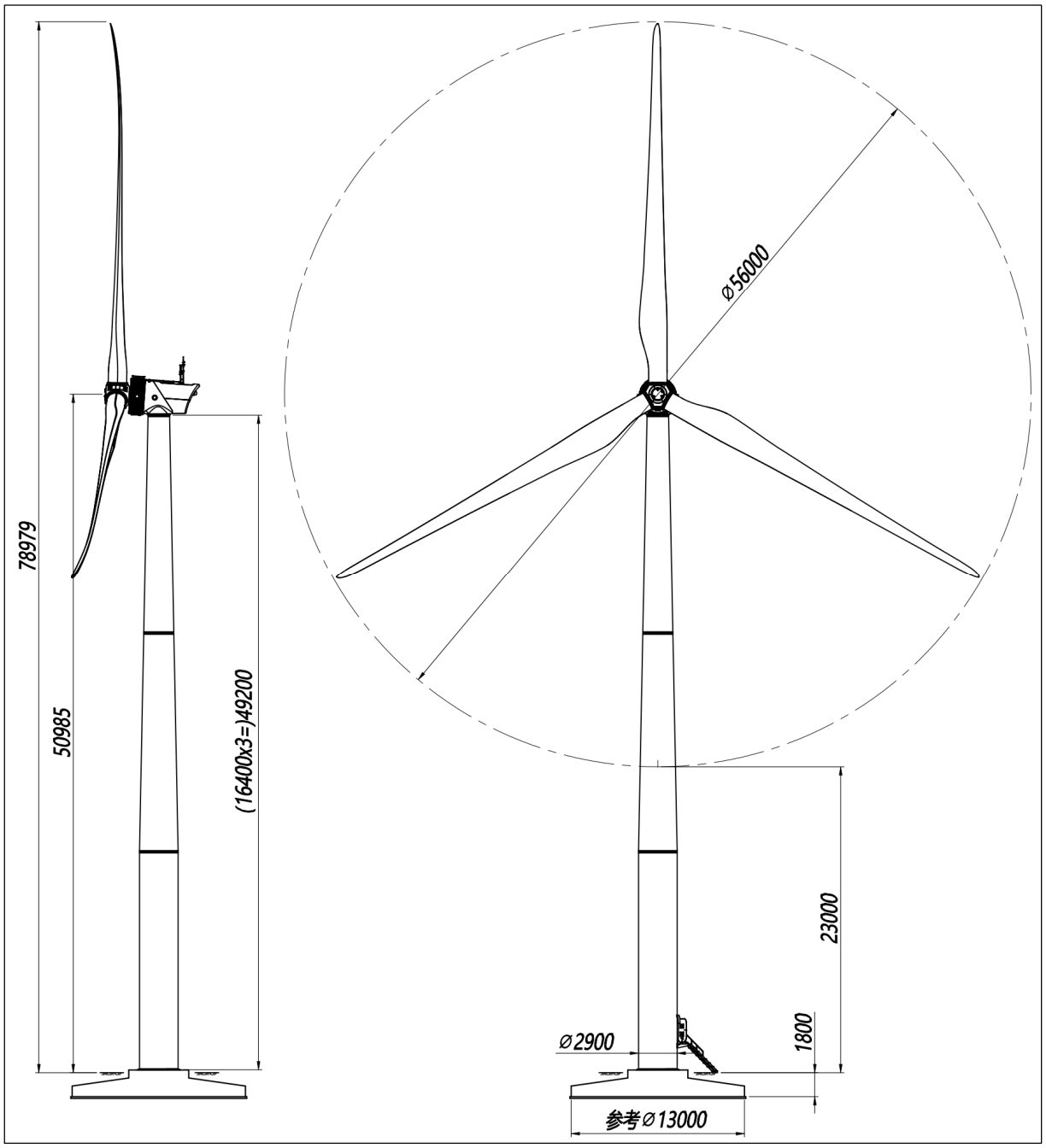
6.1.2 Foundation load(46m)

Load case	Tower Mxy [kNm]	Tower Mz [kNm]	Tower Fxy [kN]	Tower Fz [kN]	Safety factor	Notes
Normal run load case	4910	431	123	-730	1.00	Pn=498kW
Ultimate load case	13729	-386.7	349.4	-742.1	1.10	Ve=59.5m/s

Remarks: Loads include safety factors.

6.2 49m Tower

6.2.1 Overall appearance diagram(49m)

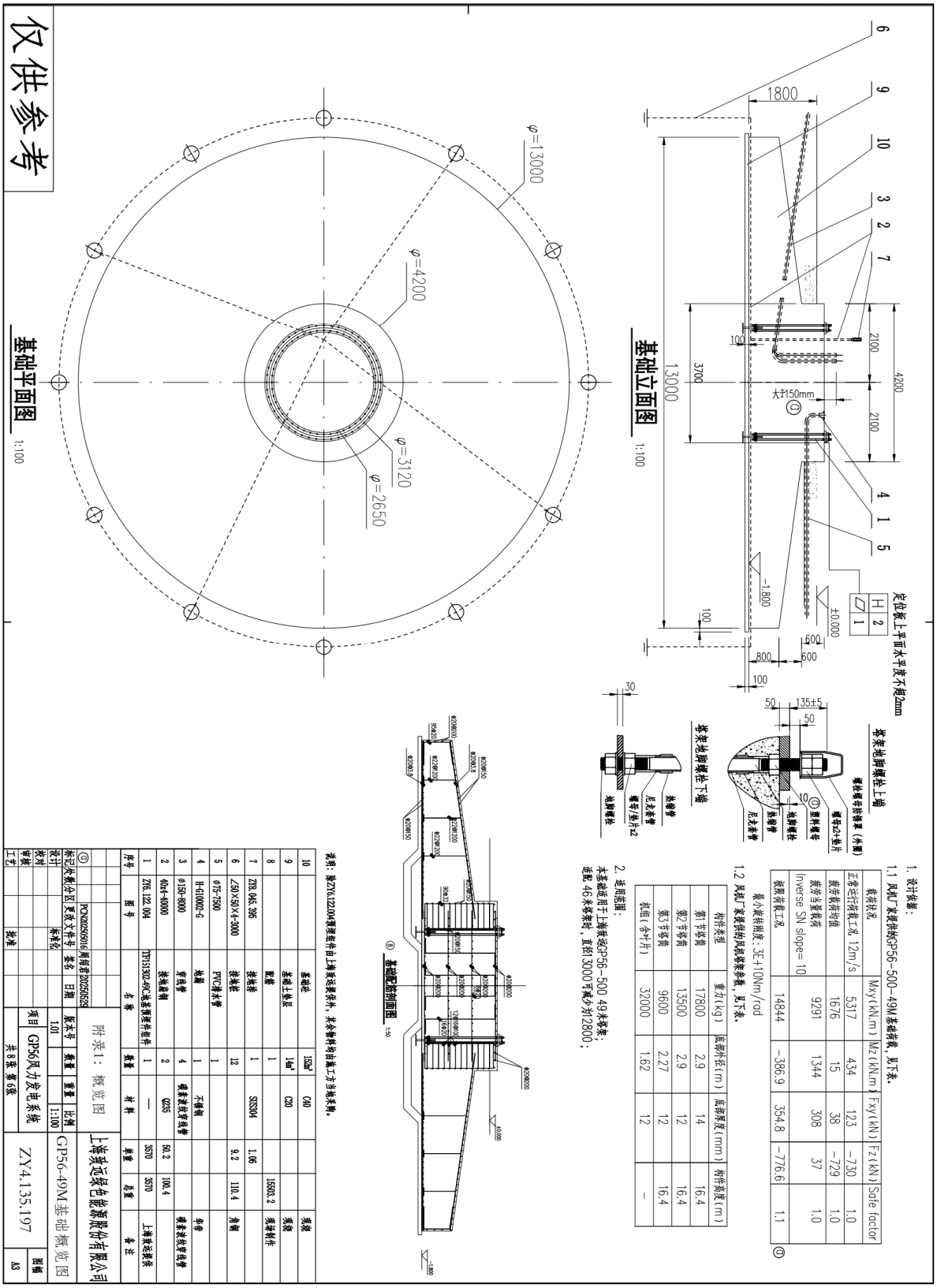


6.2.2 Foundation load(49m)

Load case	Tower Mxy [kNm]	Tower Mz [kNm]	Tower Fxy [kN]	Tower Fz [kN]	Safety factor	Notes
Normal run load case	5317	434	123	-730	1.00	Pn=498kW
Ultimate load case	14844	-386.9	354.8	-776.6	1.10	Ve=59.5m/s

Remarks: safety factor for load are included.

6.3 Reference foundation



载荷状况	Mxy(kN.m)	Mz(kN.m)	Fxy(kN)	Fz(kN)	Safe factor
正常运行载荷工况 12m/s	5317	434	123	-730	1.0
最大载荷均值	1676	15	38	-729	1.0
疲劳当量载荷 Inverse SN slope= 10	9291	1344	308	37	1.0
极限载荷工况	14844	-386.9	354.8	-776.6	1.1

最小发电刚度：3E+10Nm/rad

构件类型	重力(kg)	底部外径(m)	底部厚度(mm)	搭接长度(m)
第1节塔筒	17800	2.9	14	16.4
第2节塔筒	13500	2.9	12	16.4
第3节塔筒	9600	2.27	12	16.4
机组（含叶片）	32000	1.62	12	-

序号	图号	名称	材料	数量	单重	总重	备注
10		基础化	C40	132m³			现浇
9		基础上垫层	C20	1.9m³			现浇
8		配筋		1		156000.2	现场制作
7	ZTB.045.306	接地排	SUS304	1	1.06		
6	∠50×50×4-3000	接地排		12	9.2	110.4	点焊
5	φ75-7500	PVC套水管		1			
4	H-610002-G	地脚		1			专供
3	φ150-8000	塔筒法兰	不锈钢	1			螺栓紧固专线专用
2	40x4-40000	接地扁钢	Q235	2	50.2	100.4	
1	ZZ6.122.004	TZT13320-49C塔筒预埋件组件	—	1	3570	3570	上海致远绿色

项目	GP56风力发电系统	版本号	1.01	比例	1:100
共8张 第6张		重量		重量	

标记	处数	分区	更改文件号	签名	日期	标准化
①			PCN20250610	周锦君	20250626	

附录1：概览图

设计			
校对			
审核			
工艺			
批准			

上海致远绿色能源股份有限公司		
GP56-49M基础概览图		
ZY4.135.197	图幅	A3

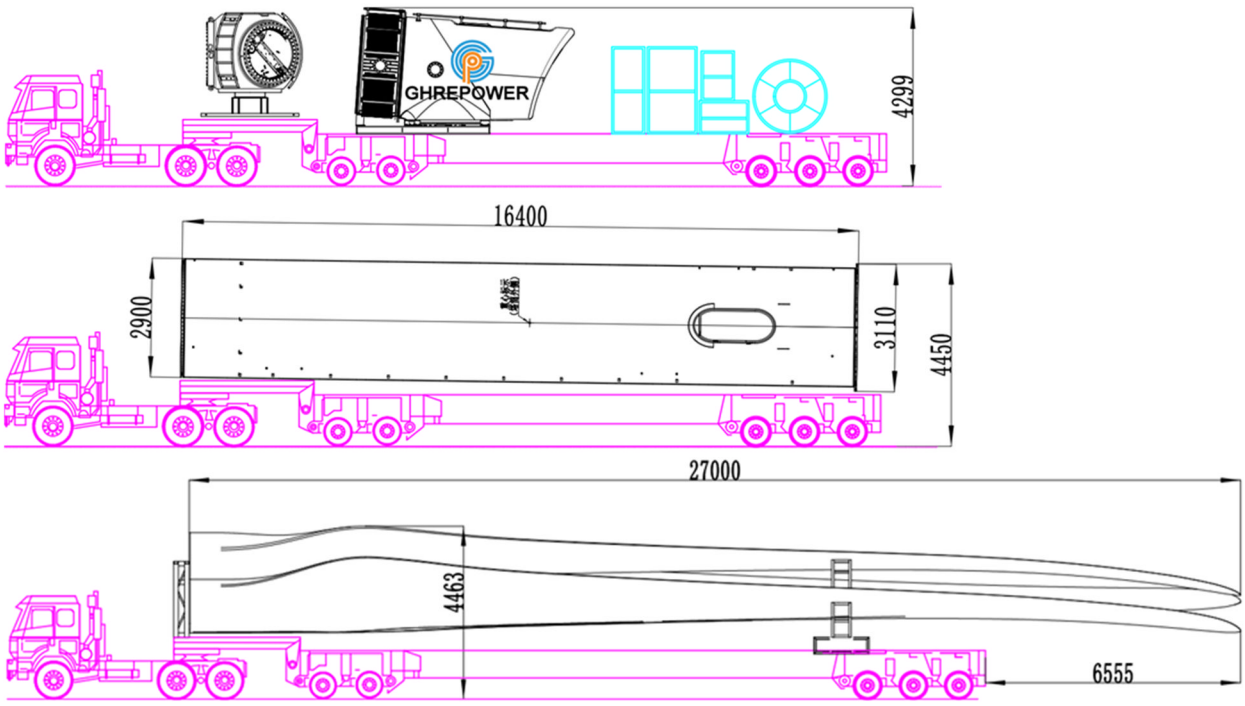
Due to minor load variations between the 46m and 49m tower configurations, this foundation drawing serves as a reference. Site-specific detailed design shall be executed accounting for: Geological conditions, Seismic zone classification, Meteorological factors.

7. Wind Turbine Transportation

7.1 Land Transportation

The main components of WTGS are listed and the loading diagram as follows, Take the 49m tower configuration as an example, The loading diagram is as follows :

No.	Item	Weight (t)	Dimension (m)	Vehicle	number of vehicles
1	Ground cage - positioning plate	0.58	3.21*1.35*0.40	ordinary vehicle	1
	Ground cage - foundation bolt	2.96	2.20*1.50*0.60		
	Ground Cage - Accessories	0.30	2.50*1.00*1.00		
2	Hub	5.5	2.40*2.40*2.20	17.5m platform lorry	1
	Nacelle	23.0	5.70*3.20*3.20		
	Tower base controller	0.03	0.96*0.65*0.44		
	Motor-side Converter	0.34	0.96*0.76*2.24		
	Grid-side Converter	0.65	1.10*0.80*2.30		
	Nacelle installation accessories	0.36	1.20*0.60*0.60		
	Engineering cables	/	Loose parts		
3	Tower (upper/middle/lower)	9.5 13.3 17.6	16.50*2.30*2.30 16.50*2.90*2.90 16.50*3.20*3.20	17.5m platform lorry	3
4	Blade	7.5	27.40*3.00*2.90	21m platform lorry	1



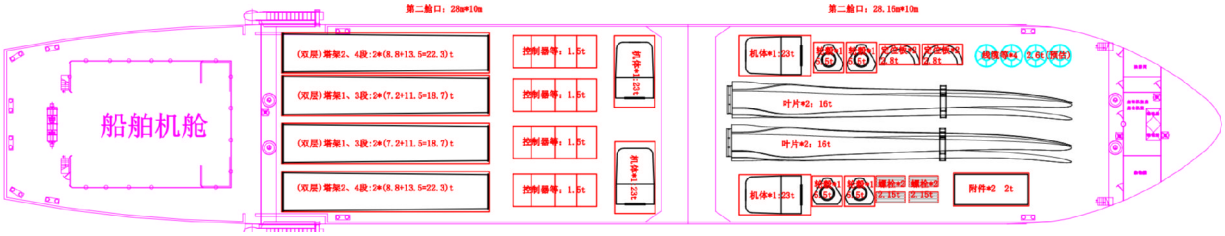
7.2 Maritime Transport Solutions

Due to the fact that the blades and tower are ultra-long and overweight components, and need to arrive at the project installation site at the same time as the body, controller, rectifier, and other components, and considering transportation costs and unit efficiency, it is generally recommended to transport 4 sets of wind turbines by charter ship and choose bulk carriers for loading. The sea freight plan for other quantities of units or more detailed requirements shall be formulated according to specific contract requirements.

Overseas Standard Configuration: 46m height Tower (4 segments), Segment 1 nested with Segment 3, Segment 2 nested with Segment 4, The loading diagram is as follows：

No.	Item	Weight (t)	Dimension (m)	Shipping method	number of Flat racks
1	Ground cage - positioning plate	0.58	3.21*1.35*0.40	20 foot general cabinet	1
	Ground cage - foundation bolt	2.96	2.20*1.50*0.60		
	Ground Cage - Accessories	0.30	2.50*1.00*1.00		
2	Hub	5.5	2.40*2.40*2.20	20 foot general cabinet	1
	Tower base controller	0.03	0.96*0.65*0.44		
	Motor-side Converter	0.34	0.96*0.76*2.24		
	Grid-side Converter	0.65	1.10*0.80*2.30		
	Nacelle installation accessories	0.36	1.20*0.60*0.60		
	Engineering cables	/	Loose parts		
3	Nacelle & generator	23.0	5.70*3.20*3.20	Flat racks or bulk carriers	1
4	46m Tower (4 segments)	7.0/11.5 8.5/13.7	S1&S3:11.65*2.50*2.50 S2&S4:11.65*3.10*3.10		2
5	Blade	8.0	27.4*3.01*2.88	bulk carriers	1

Schematic diagram of 4 sets of unit compartments (tower and blade stacking on 2 layers):



Schematic diagram of physical fixation:


Nacelle


Tower


Blade


Hub

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 of 20 meters long and 10 meters wide, and the blades need to be placed in a flat area of 50 meters long and 40 meters wide for assembly of the wind wheel.

The road needs to ensure the passage of 17.5meter flatbed vehicles. The turning radius is greater than 20 meter. 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	75T	1 unit	2 days	Unloading and blade assembly
2	Crane	260T	1 unit	2 days	Tower & wind rotor assembly

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.

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