Wind turbine (توربين الرياح)

Wind turbines convert the kinetic energy from the wind into mechanical power and electrical power.

تقوم توربينات الرياح بتحويل الطاقة الحركية من الريح إلى طاقة ميكانيكية وكهربائية
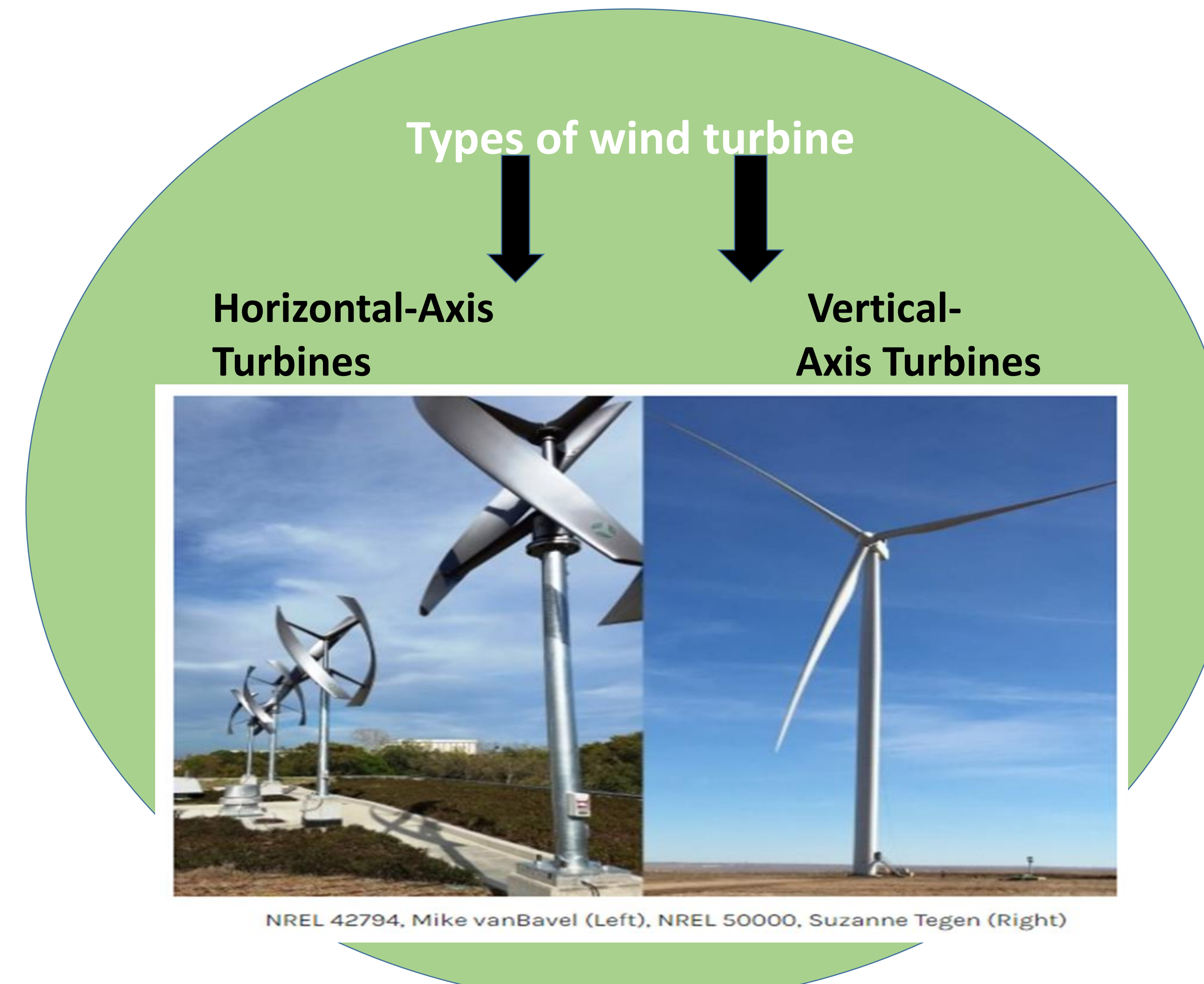
الرياح هي شكل من أشكال الطاقة الشمسية الناجمة عن مزيج من ثلاثة أحداث متزامنة: الشمس تسخين غير متساو في الغلاف الجوي ، وعدم انتظام سطح الأرض ، وتناوب الأرض

Wind is a form of solar energy caused by a combination of three concurrent events:
- The sun unevenly heating the atmosphere
- Irregularities of the earth's surface
- The rotation of the earth.

Operation

- When the wind flows across the blade, the air pressure on one side of the blade decreases.
- The difference in air pressure across the two sides of the blade creates both lift and drag.
- The force of the lift is stronger than the drag and this causes the rotor to spin.
- The rotor is connected to the generator, either directly (if it's a direct drive turbine) or through a shaft and a series of gears (a gearbox) that speed up the rotation and allow for a physically smaller generator.
- This translation of aerodynamic force to rotation of a generator creates electricity.

Types of wind turbine

Horizontal-Axis Turbines

Vertical-Axis Turbines

NREL 42794, Mike vanBavel (Left), NREL 50000, Suzanne Tegen (Right)

عندما تتدفق الرياح عبر النصل ، ينخفض ضغط الهواء على أحد جانبي الشفرة. يؤدي الاختلاف في ضغط الهواء عبر جانبي الشفرة إلى كل من الرفع والسحب. قوة المصعد أقوى من السحب وهذا يسبب دوران الدوار. يتصل الدوار بالمولد ، إما مباشرة (إذا كان توربين محرك مباشر) أو من خلال رمح وسلسلة من التروس (علبة تروس) تسرع الدوران وتسمح بمولد أصغر جسديًا. هذه الترجمة من القوة الديناميكية الهوائية لتدوير مولد كهربائي يخلق الكهرباء

The maximum theoretical power output P is:

$$P = \frac{16}{27}\frac{1}{2}\rho v^3 A = \frac{8}{27}\rho v^3 A,$$

the effective area of the disk is A, and the wind velocity v , ρ is the air density.

DESIGN AND CONSTRUCTION OF 5 kW WIND TURBINE

In Tripoli, the wind power density is about 258 W/m^2 (data from GLOBAL WIND ATLAS MEAN WIND POWER DENSITY MAP LEBANON)
- Area of swept surface =32.84 m^2
- Radius of blades =3.23 m
- Therefore, the height of tower should be between 1.5X to 3X the rotor radius, then between 4.85 &9.7m.
- The speed of wind is between 6.0 m/s (13.4mph) / 6.4m/s (14.3mph).
- λ(TSR)=4*pi/number of blades
- rpm = 60 * V * TSR / (Pi * D)
- Number of rotation per minute =77
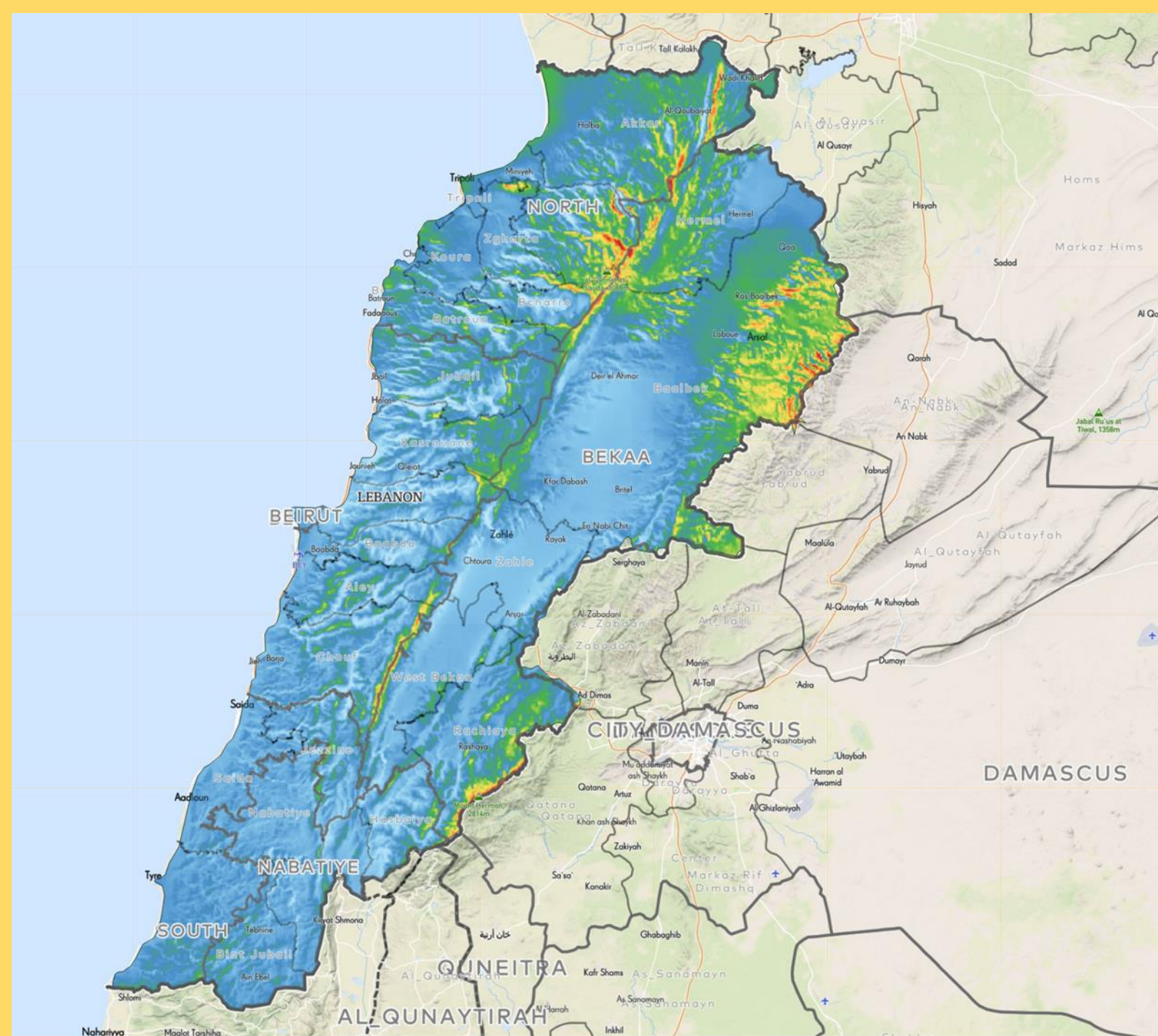
The wind power density, measured in watts per square meter, indicates how much energy is available at the site for conversion by a wind turbine (by meter of swept area of blades)
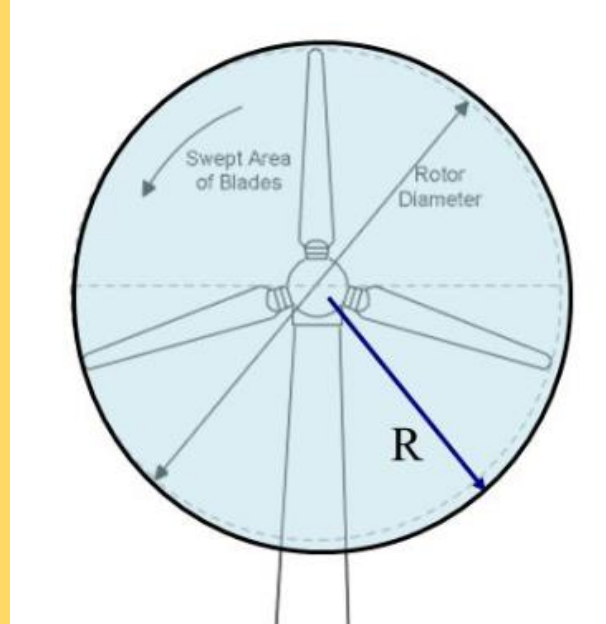
Wind turbine components

1-Foundation,
2-Connection to the electric grid,
3-Tower (tubular steel ,concrete, or steel lattice.,),
4-Access ladder,
5-Wind orientation control (Yaw control),
6-Nacelle (),
7-Generator,
8-Anemometer + wind vane (Measures the wind speed and transmits wind speed data to the controller,),
9-Electric or Mechanical Brake (Stops the rotor mechanically, electrically, or hydraulically, in emergencies.),
10-Gearbox,
11-Rotor blade (fiberglass),
12-Blade pitch control (Turns blades out of the wind to control the rotor speed, and to keep the rotor from turning in winds that are too high or too low to produce electricity),
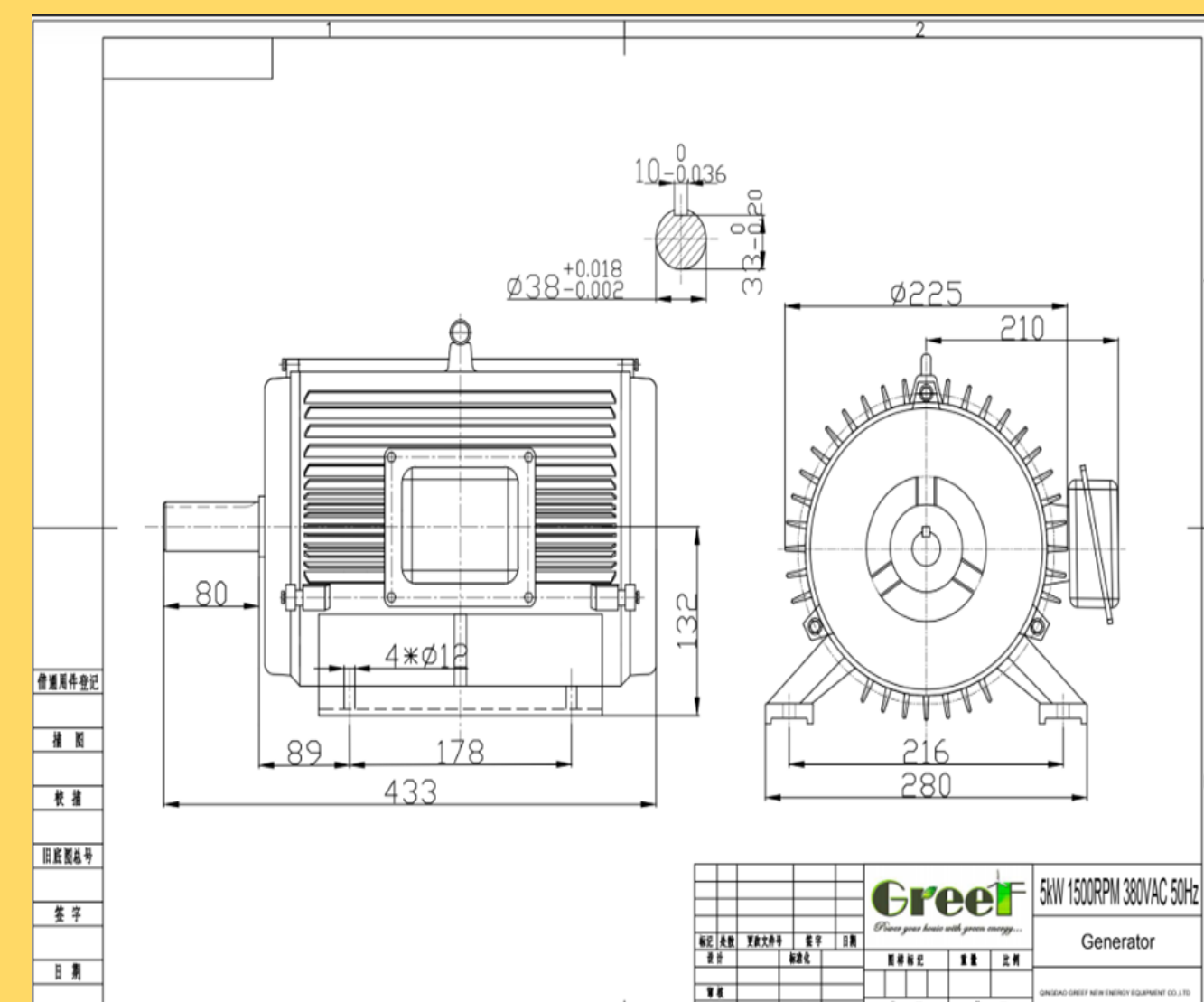13-Rotor hub (with welded sheet steel, cast iron, forged steel).

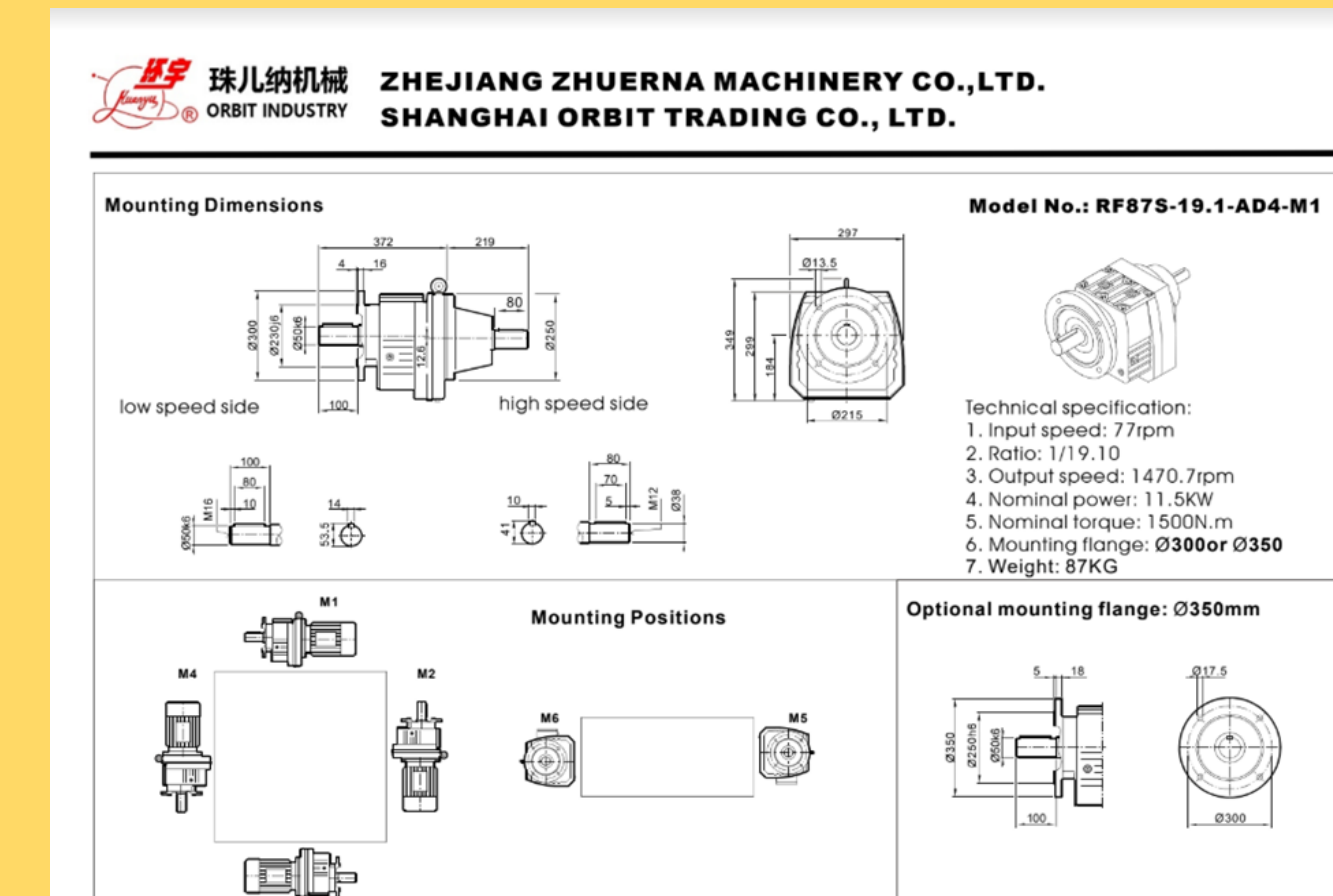1-Blades :
- Nb:3
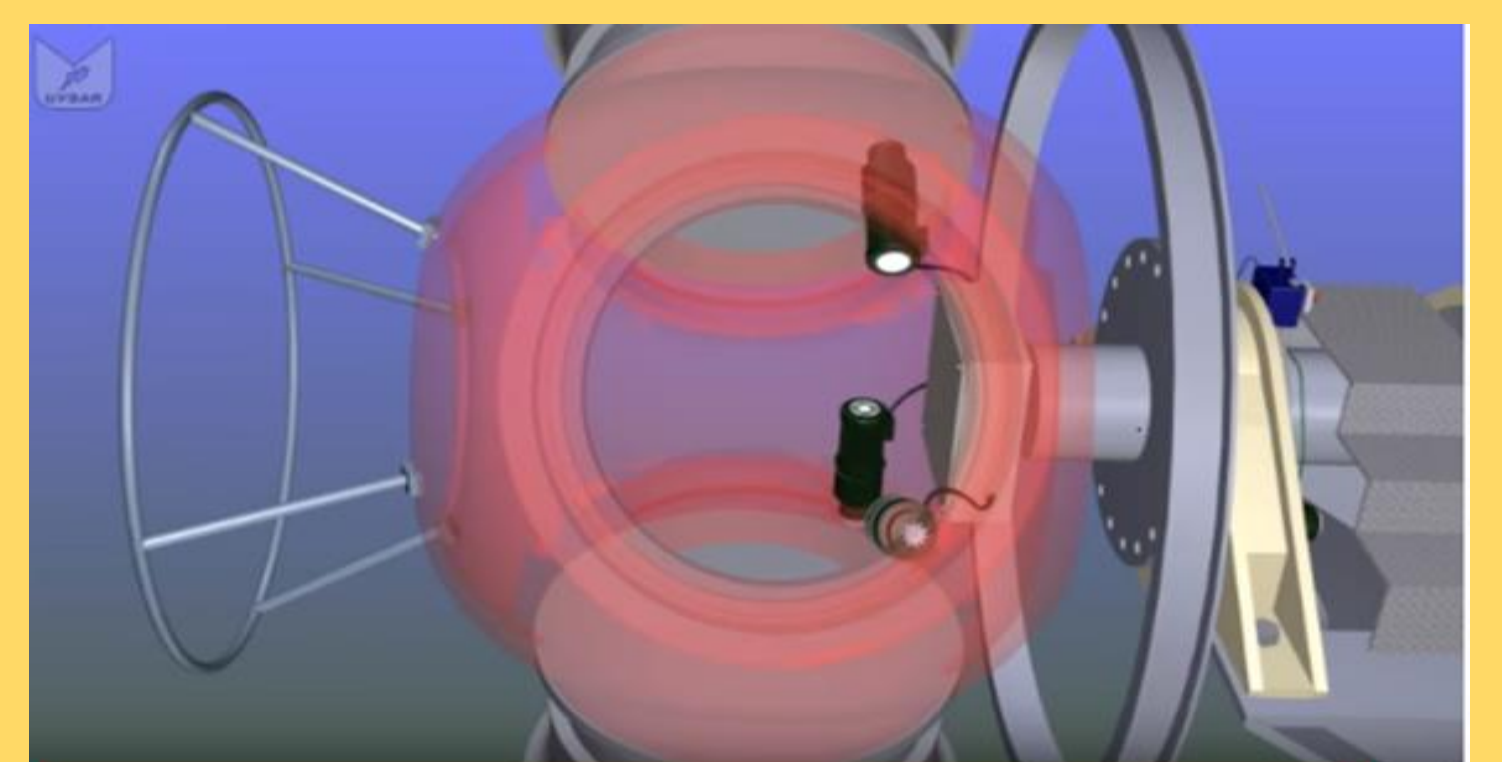- length:3.2 m
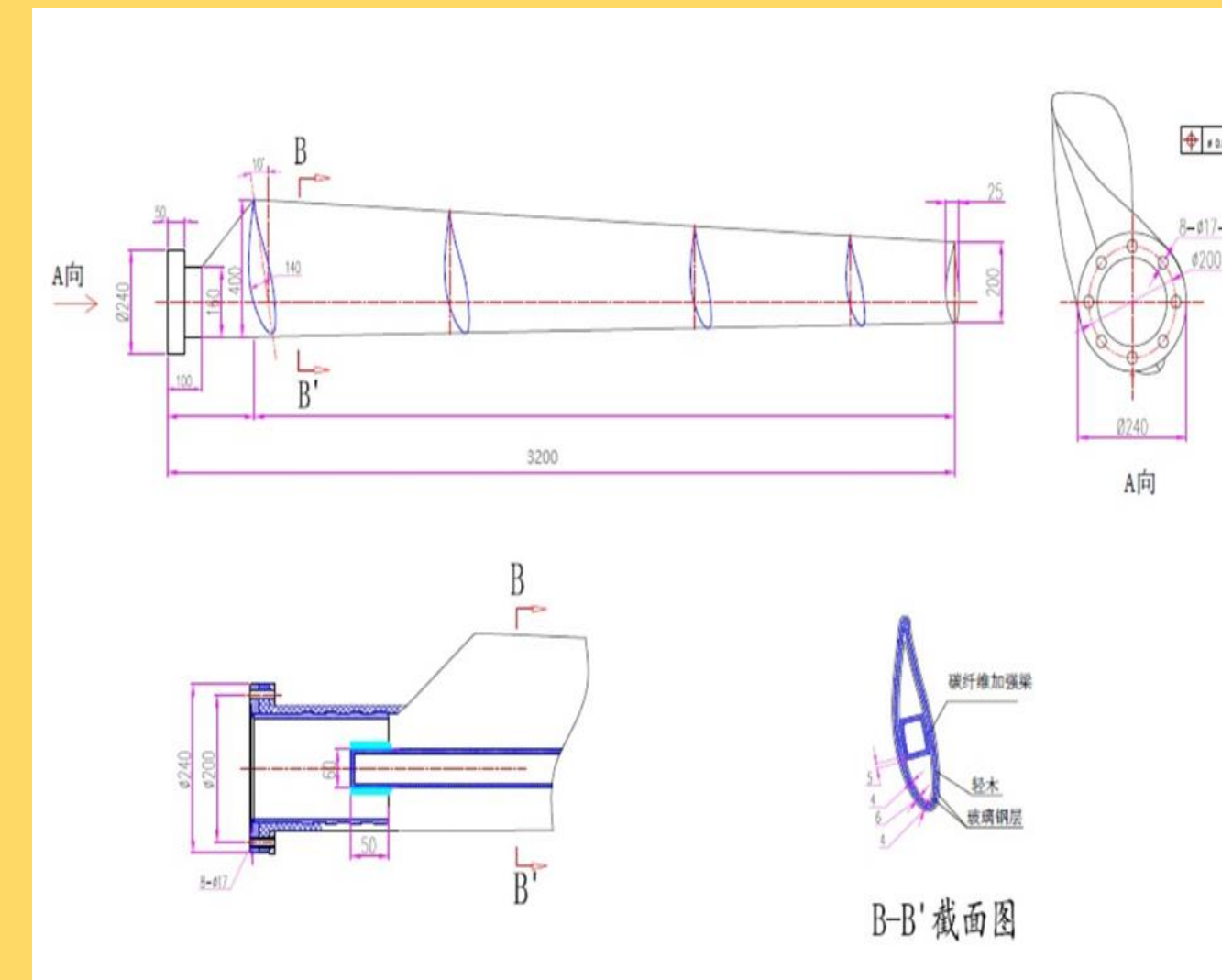
4-ANEMOMETER (+WIND VANE)
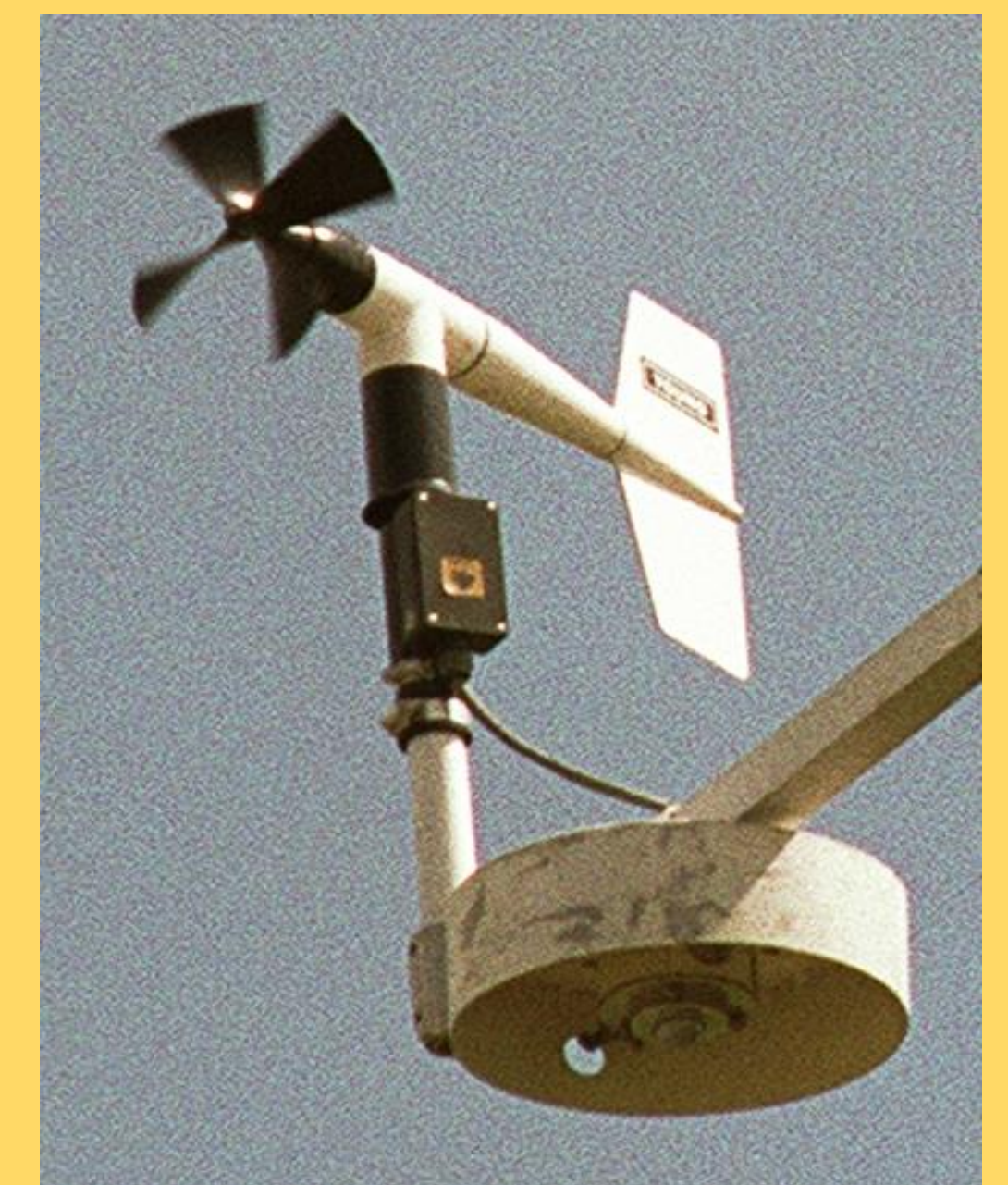
2-Generator: 5KW

5- BRAKS

3-Gearbox (SPEED UP)

6-rotor hub

Parts	Price ($)	Suppliers
Wind turbine	2000-3500	Ouyad.com
Blades	50-400	www.aerofp.com/GREEF NEW ENERGY
Generator 5 kw/1500rpm	900	GREEF NEW ENERGY
Flange hub	190	GREEF NEW ENERGY
Gear box	100-300	Orbitindustry.com

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