

Exercise: Fixed speed Wind turbine of 300 kW

Let's consider a fixed speed wind turbine of **300 kW** with the following parameters:

- Blades **diameter (2R) : 28 m**
- Nominal wind speed **V: 14 m/s**
- Nominal rotational speed of the turbine rotor ***N*_{turbine} : 43 rpm**
- Gearbox multiplication ratio : **35**

In addition, the air density is **1.225 kg/m³**.

- 1) What parameters should be taken into account when choosing and installing a wind turbine ?
- 2) Calculate the value of the wind turbine's **power coefficient Cp** at the nominal operating point.
- 3) Calculate the specific speed $\lambda = \frac{R \times \Omega}{v}$ of the wind turbine. Conclude about the wind turbine type (rapid or slow). (Ω : Nominal rotational speed of the turbine rotor in rad/s).
- 4) What is the rated speed **N** of the generator rotor?

Correction:

1) The parameters that must be taken into account when choosing and installing a wind turbine are:

- Instantaneous wind velocity at the cube in generated power;
- Instantaneous air density, which is also involved in generated power, but at factor 1;
- Rotor area, which also intervenes at factor 1 in generated power.

2)

$$C_p = \frac{P}{\frac{1}{2} \times \rho \times S \times V^3} = \frac{300 \times 10^3}{0.5 \times 1.225 \times \pi \times R^2 \times 14^3} = 0.290$$

Only 29% of wind energy is recovered.

$$3) \Omega = \frac{43 \times 2\pi}{60} = 4.5 \text{ rd/s}$$

$$\lambda = \frac{R \times \Omega}{V} = \frac{14 \times 4.5}{14} = 4.5 > 3 ; \text{ so it is a fast wind turbine.}$$

4) The ratio of the multiplier is 35 and the nominal rotational speed of the rotor used is: 43 rpm. The nominal speed of the desired generator is thus: $N = 35 \times 43 = 1505\text{rpm}$.