



Erasmus+

Virtual and Intensive Course  
Developing Practical Skills  
of Future Engineers

**VIPSKILLS**  
Erasmus+ 2016-1-PL01-KA203-026152



PROJECT TITLE

Wind Energy  
Laboratory class

OBJECT

The effect on power output of a wind turbine when  
changing the wind speed

NAME AND  
SURNAME

DATE

2018

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Created in 2018



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## 1. Introduction

The power output of a wind turbine varies with wind speed and every wind turbine has a characteristic power performance curve. With such a curve it is possible to predict the energy production of a wind turbine without considering the technical details of its various components. The power curve gives the electrical power output as a function of the hub height wind speed. Figure 1 presents an example of a power curve for a hypothetical wind turbine [1].

The performance of a given wind turbine generator can be related to three key points on the velocity scale:

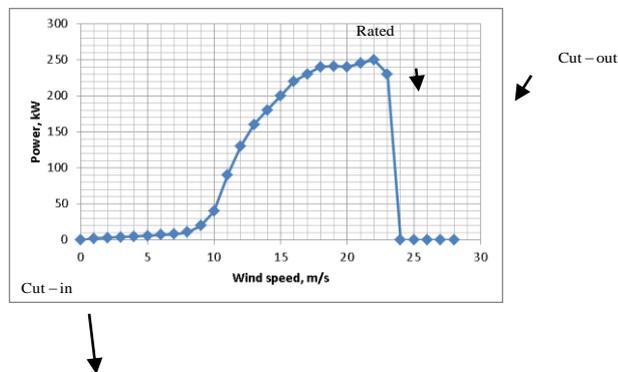
**Cut-in speed:** the minimum wind speed at which the machine will deliver useful power

**Rated wind speed:** the wind speed at which the rated power (generally the maximum power output of the electrical generator) is reached

**Cut-out speed:** the maximum wind speed at which the turbine is allowed to deliver power (usually limited by engineering design and safety constraints)

Power curves for existing machines can normally be obtained from the manufacturer.

The curves are derived from field tests, using standardized testing methods. It is also possible to estimate the approximate shape of the power curve for a given machine. Such a process, however, is by no means a simple task because it involves determination of the power characteristics of the wind turbine rotor and electrical generator, gearbox gear ratios, and component efficiencies [1].



*Rys. 1 Typical wind turbine power curve*



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## 2. Objective

As seen before, one of the factors which has major influence on the available wind power is the speed. For that reason, we will study the influence of this factor in a practical way. It is desired to demonstrate how the speed of the wind influences on the working of the rotor.

## 3. Required elements

### a) required elements

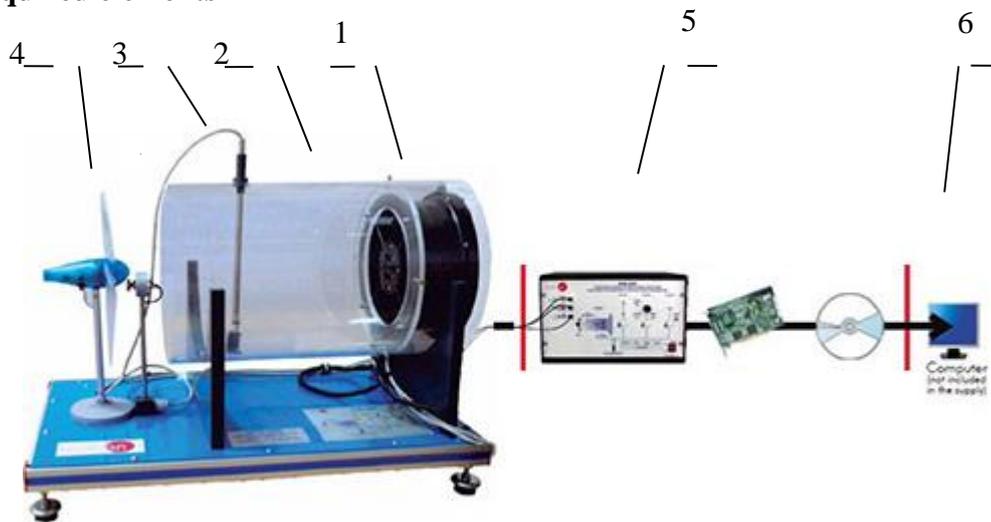


Fig. 2 Required elements: 1-fan, 2-wind tunnel, 3-anemometer, 4- rotor, 5- Control System (SCADA) INIT1, 6 – computer

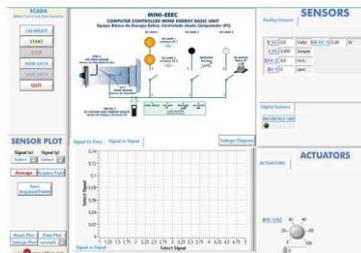


Fig. 3 Control System (SCADA)



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### b) Practical task (fig. 3)

Power changes with air density, the rotor area and the cube of the wind speed. In order to study the power as a function of the wind speed, we will try to keep the density and the area of the rotor constant. We will use a density value of  $1225 \text{ kg/m}^3$ . The fan speed will be changed and, for each fixed speed, every data will be taken: wind speed, rotation speed and power output.

Make sure the fan is turned off before starting the practice. Afterwards, follow the steps described below:

- a. Turn on the main interface.
- b. Put the selector of the DC module to position “engine”.
- c. Turn on the DC module.
- d. Run the SCADA, eeec.exe. Make sure that the PC is connected to main interface via the SCASI cable.
- e. Turn on the fan.
- f. Fix a low fan speed, it will be gradually increased.
- g. Take speed values (40%). Write down the wind speed, rotation speed, and power output of a wind turbine given by the software in the table.
- h. Increase the fan speed.
- i. Repeat steps for: 50%, 60%, 70%, 80%, 90% and 100%.
- j. Write results in table 1.
- k. Turn off the fan.

### c) results and tables

Calculate the average wind speed, the speed of the rotor and the power output of the wind turbine using the following formula:

$$\begin{aligned}v_{\text{avg}} &= \frac{v_1 + v_2}{5}, \\n_{\text{avg}} &= \frac{n_1 + n_2}{5}, \\P_{\text{avg}} &= \frac{P_1 + P_2}{5}.\end{aligned}\tag{1}$$

Put all measured and calculated data into Table 1.

Draw function:  $P=f(v)$ ,  $n=f(v)$

### d) comment:

How does the wind speed influence the captured power ?

How does the wind speed influence the speed wind turbine ?



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Table 1. Results of the experiment.

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Setting						
n%MAX %	v m/s	V <sub>avg</sub> m/s	n rpm	n <sub>avg</sub> rpm	P W	P <sub>avg</sub> W
40						
50						
60						
70						
80						
90						
100						

### Reference list

1. Sathyajith Mathew: Wind Energy Fundamentals, Resource Analysis and Economics
2. [www.edibon.com](http://www.edibon.com)