Solution sheet Model 3/4/5 – Wind turbines

Topic task

1. In addition to wind speed, the efficiency of a wind turbine depends on a) the work angle (the angle by which the rotor blades are turned in relation to the rotational axis). In our model with flat blade surfaces, a work angle of approx. 30 degrees will be most favourable.
   b) in our model (flat blade surfaces) from the area of the rotor blades
   c) the amount of bearing friction. Rotors, gears or generators can never be 100 percent efficient, because heat loss occurs due to bearing friction or friction between air molecules.
   The power it delivers should not be confused with the individual effectiveness of a wind power generator, which describes the efficiency itself. The rotor type and design of the rotor blades play an important role here, among other factors. To achieve optimal performance, the design of the rotor blades must be adapted to the different wind conditions.
2. The power of a wind turbine is dependent on the wind and wind speed, air density and efficiency of the system. First the power of the wind is calculated, and then it is multiplied by the efficiency of the system.
3. To calculate the maximum possible current generation for a year, you must multiply the power of a wind turbine by the number of hours per year. Result: The wind turbine outputs 6 gigawatt hours. This is 6,000 megawatt hours, or 6,000,000 kilowatt hours. This could supply approx. 1714 households for one year.
4. Wind atlas. The wind atlas is an important instrument for planners, project managers and approval authorities to identify suitable locations for wind energy. When determining how suitable locations are for wind turbines, the windiness of the area also plays a role.
5. a) Advantages:
   - There are no emissions of harmful gases such as carbon dioxide, nitrogen oxide and sulphur dioxide as with conventional power generation.
   - Expensive imported raw materials (coal, oil) are eliminated
   - The actual space used is minimal in comparison to other power generation plants
   b) Disadvantages
   - Wind cannot be stored. It must be converted immediately into electricity.
   - The wind does not always blow at the expected strength.
   - Animals, particularly birds, can be hit by wind turbines.

Experimental task 1

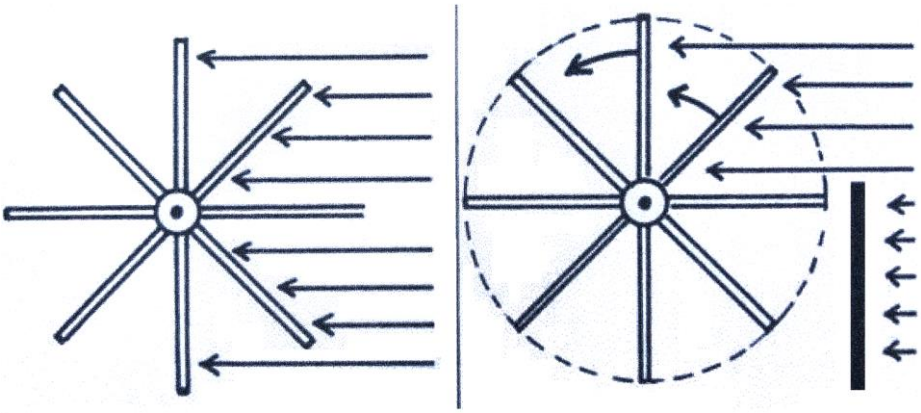
1. The wind does not always have to be blowing at top speed to evaluate the economic efficiency of a wind turbine. Wind turbines are designed and used so as to work with different wind speeds and directions. They are assigned to

wind classes. A wind turbine which turns continuously can deliver more electricity per year in some circumstances than a system which is designed for very strong winds, but must be switched off frequently to avoid storm damage. The wind speed at which a wind turbine automatically shuts off is called the shut-off speed.

2. Yes, the surface area of the rotor blades does influence the effectiveness of the wind turbine.

Experimental task 2

1. The wind hitting the rotor from the side makes it turn faster. Moving air exercises the same force on all bodies it hits. Rotational movement can only occur if the thrusts on two opposing blades or shovels are unequal.



2. Model 4 starts to turn earlier. It requires less wind force to generate energy. This is why vertical wind turbines are used at lower wind speeds and close to the ground.

Experimental task 3

1. The effectiveness of a wind turbine depends primarily on the optimal aerodynamic design of the rotor blades. The rotor is at the start of the functional chain of a wind power plant.