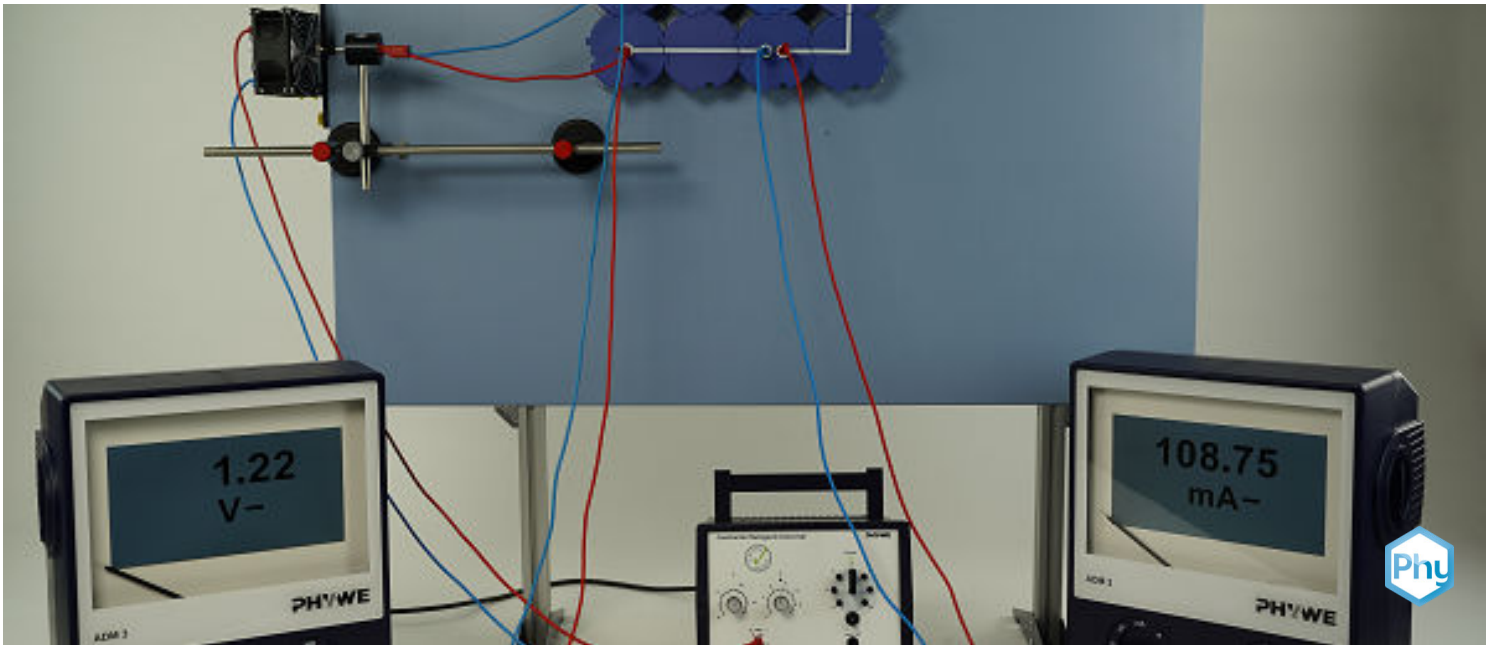
Electrical Energy from Wind Power - Influence of Wind Speed, Wind Direction and Load with ADM3



Electrical energy from wind power - influence of wind speed and load

Physics > Energy > Renewable energies: Wind

Difficulty level	Group size	Preparation time	Execution time
hard	-	10 minutes	20 minutes

This content can also be found online at:

http://localhost:1337/c/64ac143dec34c90002f3ef31

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General information

Application

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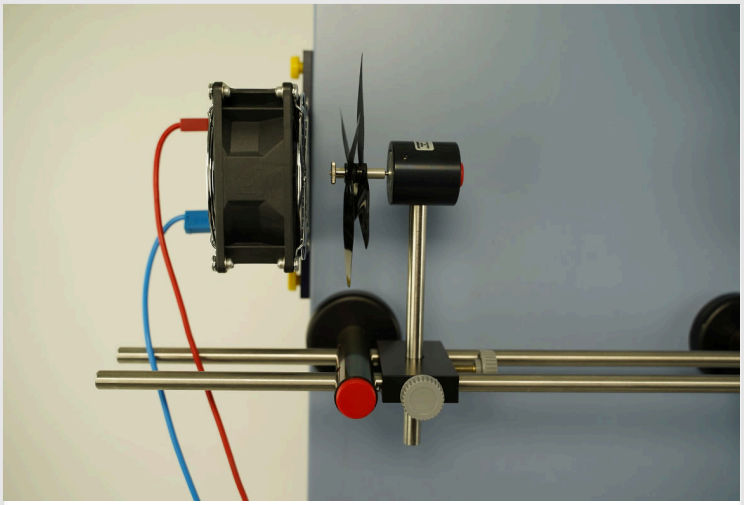

Experimental setup - wind turbine

Electrical energy from wind power - Influence of windspeed and load

Wind turbines convert the kinetic energy contained in the flow of the wind into electrical energy. Wind turbines are automatically guided by the direction of the wind in order to optimise their performance.

In this experiment, the electrical energy generated causes a filament lamp integrated in the circuit to light up. The dependence of the power emitted on the wind speed and the load can be observed.

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Other information (1/2)

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Prior knowledge

The basics of measuring current and voltage should be known, as well as how to calculate the power from these values.

Principle

Wind causes the rotors to turn, which in turn drive a generator. This generator converts the mechanical energy into electrical energy.

This experiment looks at how the generator behaves under different loads and how changes affect the electrical measured variables.

Other information (2/2)

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Note

The pupils recognise the relationship between wind speed and power output using a model of a wind turbine.

Task

The blower may be operated with a maximum voltage of 12 V, otherwise the motor could be destroyed.

Pre-shift when handling the generator. Avoid reaching into the rotating rotor blades.

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Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

For H and P phrases, please refer to the safety data sheet of the respective chemical.

Theory

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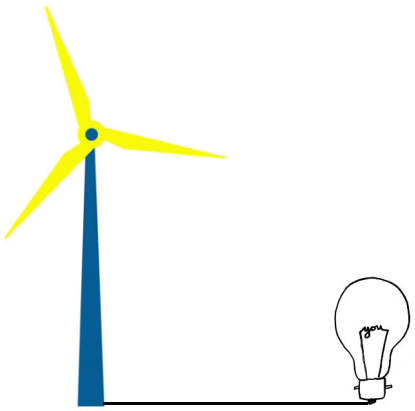
Wind power

How does a wind turbine work?



- Wind turbines use wind energy to generate electricity.
- The kinetic energy of the wind drives the wind turbines.
- By using a generator, the kinetic energy can be converted into electrical energy.
- Wind turbines typically have 3 rotor blades for best efficiency.
- The power output is calculated with $P = U \cdot I$

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Equipment

Position	Material	Item No.	Quantity
1	PHYWE Demo Physics board with stand	02150-00	1
2	PHYWE Demo Multimeter ADM 3: current, voltage, resistance, temperature	13840-00	2
3	PHYWE Power supply, universal, analog display DC: 18 V, 5 A / AC: 15 V, 5 A	13503-93	1
4	Junction, module DB	09401-10	2
5	Socket for incandescent lamp E10 ,module DB	09404-00	1
6	Switch on/off, module DB	09402-01	1
7	Blower, 12V	05750-00	1
8	Generator with metrical thread axis and nut	05751-01	1
9	Rotor, 2 pieces	05752-01	1
10	Clamping holder with 2 clamping possibilit, 0-13 mm,fixing magnet	02151-08	2
11	Sliding mount for optical bench	02151-09	1
12	Support rod, stainless steel, 500 mm	02032-00	2
13	Clamp on holder	02164-00	1
14	Filament lamps 1.5V/0.15A,E10,10 pieces	06150-03	1
15	Filament lamps 4V/0.04A, E10, 10	06154-03	1
16	Filament lamps 3.5V/0.2A,E10, 10	06152-03	1
17	Connecting cord, 32 A, 250 mm, yellow	07360-02	1
18	Connecting cord, 32 A, 500 mm, blue	07361-04	1
19	Connecting cord, 32 A, 750 mm, red	07362-01	2
20	Connecting cord, 32 A, 750 mm, blue	07362-04	2
21	G-clamp	02014-01	2

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Setup and procedure

Setup (1/3)

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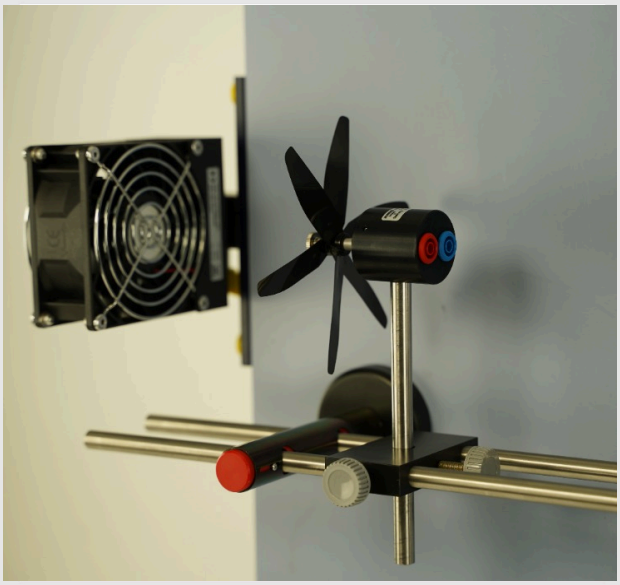

- On the left side of the board attach the fan with the clamping holder (see illustration).
- Blower the fan so that it creates a horizontal wind jet along the board.
- Set up a tripod bench for the windmill. Slide the glider onto the two support rods and guide the support rods through the two holes in the clamps.

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Setup (2/3)

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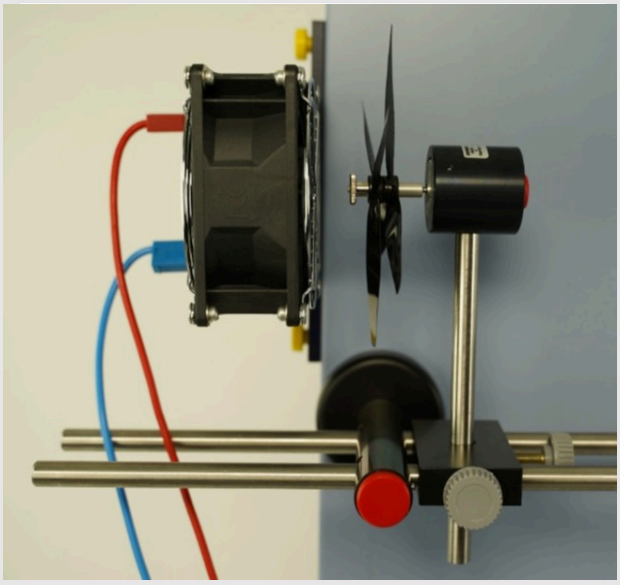

- Place the stand bench against the board and alignit horizontally.
- Attach the 6 rotor blades to the wind generator. For a good result, point the dull side of the rotor blades away from the wind.
- Place the wind generator in the hole of the slinding.
- The distance between the wind generator and the fan should be approx. 5 cm.

Setup (3/3)

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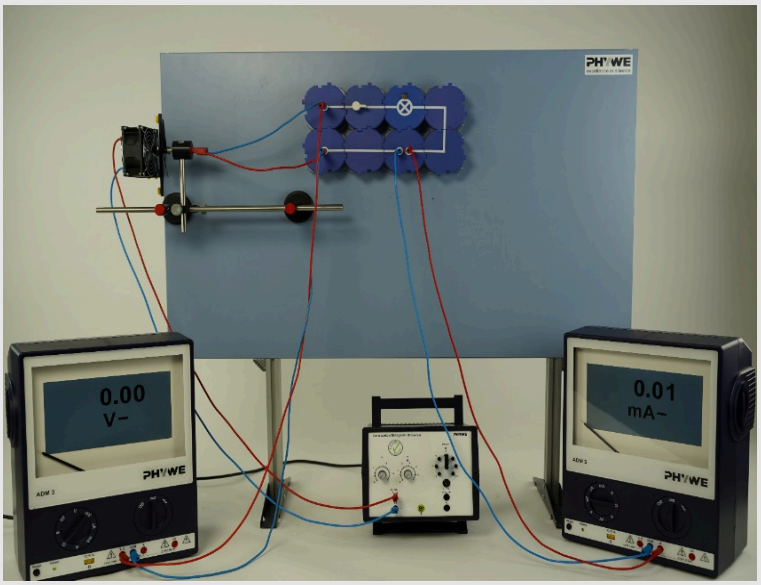

- If necessary, correct the distance of the blower to the board and adjust the height of the generator by moving it in the sliding.
- Set up the lamp circuit according to the illustration with the 1.5 V filament lamps. The switch is closed.
- Connect the Blower to the DC output of the power supply unit.
- The power supply unit is switched off.

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Procedure (1/2)

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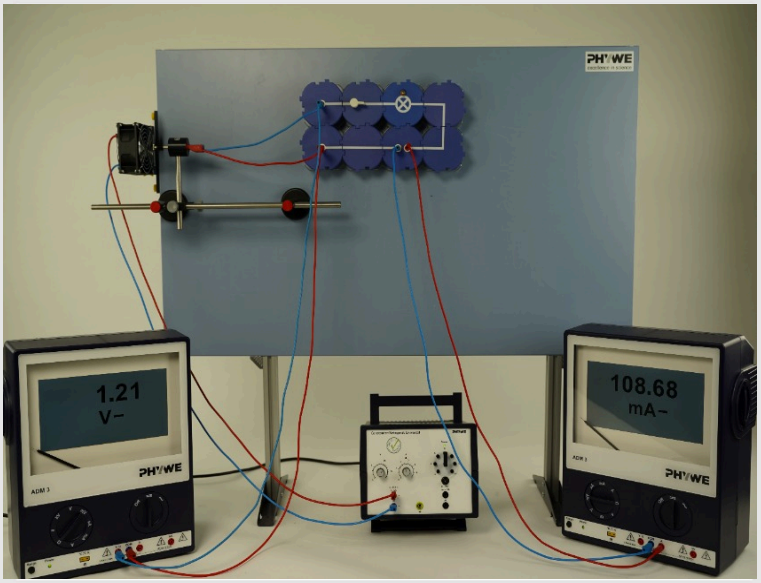

1st part of the experiment: change the windspeed

- Set the voltage on the power supply unit to 0 V.
- Switch on the power supply unit.
- Very slow increase the voltage at the power supply unit to 12 V.
- Observing the brightness of the filament lamps.

Procedure (2/2)

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Test part 2. change of load

- Note the current and voltage for each measurement. Calculate the power. Enter the values in the chart on the next slide.

1.5 V filament lamps

- Wait for about 15 seconds.
- Open the switch in the circuit, listening for the sound of the wind generator.

3.5 V filament lamps

- Replace the 1.5 V filament lamps with the 3.5 V filament lamps.
- Close the switch. Wait 15 seconds and open the switch again.

4 V filament lamps

- Replace the 3.5 V filament lamps with the 4 V filament lamps.
- Wait 15 seconds. Switch off the mains unit.

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Evaluation (1/2)

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Determined values:

Lamps	1.5V	3.5V	4V
Current I			
Voltage U			
Power P			

Observation

When the wind speed increases, the power of the wind generator increases and the filament lamos shine brighter, but do not reach their full brightness.

If the circuit is interrupted, the power goes down to zero, the speed of the wind generator increases and it can be clearly heard that it becomes louder.

\If the wind turbine is not blown from the front but from the side, the power output decreases significantly at larger angles.

Evaluation (2/2)

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From the specified data of the incandescent lamps for voltage and current, their rated wattages can be calculated (see chart), at which the incandescent lamps would shine brightly.

	U	I	$P = U \cdot I$	$R = \frac{U}{I}$
1,5-V-Glühlampe	1,5 V	0,15 A	0,225 W	10 Ω
3,5-V-Glühlampe	3,5 V	0,2 A	0,7 W	17,5 Ω
4-V-Glühlampe	4 V	0,04 A	0,16 W	100 Ω

Drag the words into the correct boxes!

Comparing nominal and measured power values shows that the _____ with the filament lamps connected cannot deliver enough _____ and therefore they do not shine brightly. The different lamps have different _____. With the load, the _____ and thus the volume of the wind turbine changes.

wind generator | speed | power | resistances

Check

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Slide	Score / Total
Slide 15: Observations at the wind turbine	0/4

Total score 0 / 4

Show solutions | Repeat | Export text

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