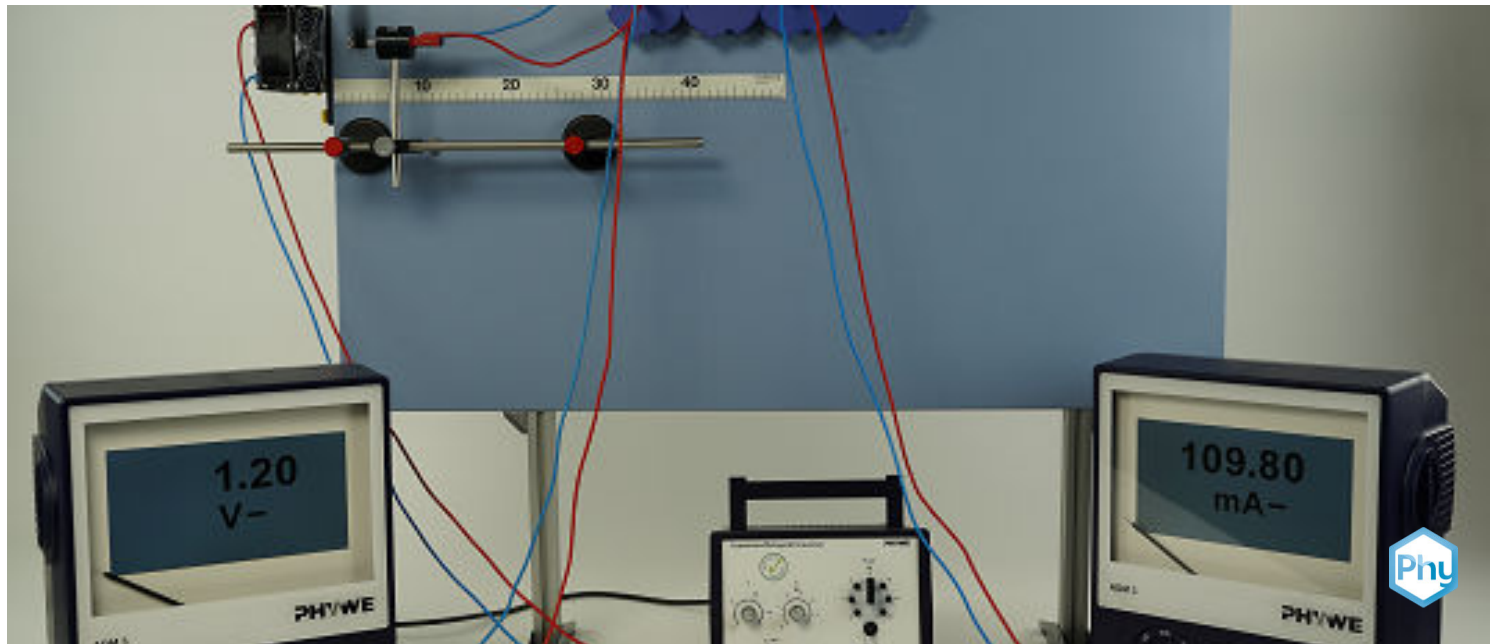


Influence of the number of rotor blades with ADM3



Influence of the number of rotor blades

Physics

Energy

Renewable energies: Wind



Difficulty level

medium



Group size

-



Preparation time

10 minutes



Execution time

20 minutes

This content can also be found online at:



<http://localhost:1337/c/64ae848862a87b00025f2620>

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General information

Application

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Historic windmill with four rotor blades

Influence of the number of rotor blades

In Europe, wind turbines with three rotor blades are currently the industrial standard, whereas four blades used to be common in windmills and even more rotor blades can be found elsewhere.

In addition to the economic aspects such as material costs, there are also technical reasons for using three rotor blades. At the moment when a rotor blade is shaded by the tower, a high load is exerted on the rotor. Therefore, it is favourable if at this moment no rotor blade is at the highest point and thus usually in the strongest wind.

Other information (1/2)

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Prior knowledge



The basics of measuring current and voltage and calculating power from these quantities should be known.

Principle



The flow resistance of the rotor and thus the kinetic energy extracted from the wind increases with the number of rotor blades.

The wind flow from the blower is approximately linear in the near area. With increasing distance, the air flow is distributed in the room and thus the kinetic energy per area decreases.

Other information (2/2)

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Learning



The relationship between power and number of rotor blades as well as between delivered power and the distance between blower and wind turbine should be understood.

Note



The blower may be operated with a maximum voltage of 12 V, otherwise the unit could be irreparably damaged.

Caution when handling the generator. Avoid reaching into the rotating rotor blades.

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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Modern wind turbines

Wind turbine

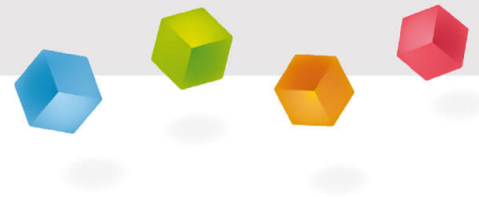
Wind turbines extract kinetic energy from the passing wind through the position of the rotor blades, which is converted into electrical energy by a generator.

Today's wind turbines almost invariably have three rotor blades. Besides economic aspects, the reason for this is the shadowing of the wind by the turbine's tower. If one rotor blade is shaded by the tower, the remaining rotor blades should not be subjected to too much force. With an even number of rotor blades, the opposite blade would be in the strongest wind at the time of shading.

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	Blower, 12V	05750-00	1
7	Generator with metrical thread axis and nut	05751-01	1
8	Rotor, 2 pieces	05752-01	1
9	Clamping holder with 2 clamping possibilit, 0-13 mm,fixing magnet	02151-08	2
10	Sliding mount for optical bench	02151-09	1
11	Support rod, stainless steel, 500 mm	02032-00	2
12	Scale for demonstration board	02153-00	1
13	Clamp on holder	02164-00	1
14	Filament lamps 3.5V/0.2A,E10, 10	06152-03	1
15	Connecting cord, 32 A, 250 mm, yellow	07360-02	1
16	Connecting cord, 32 A, 500 mm, blue	07361-04	1
17	Connecting cord, 32 A, 750 mm, red	07362-01	2
18	Connecting cord, 32 A, 750 mm, blue	07362-04	2
19	G-clamp	02014-01	2

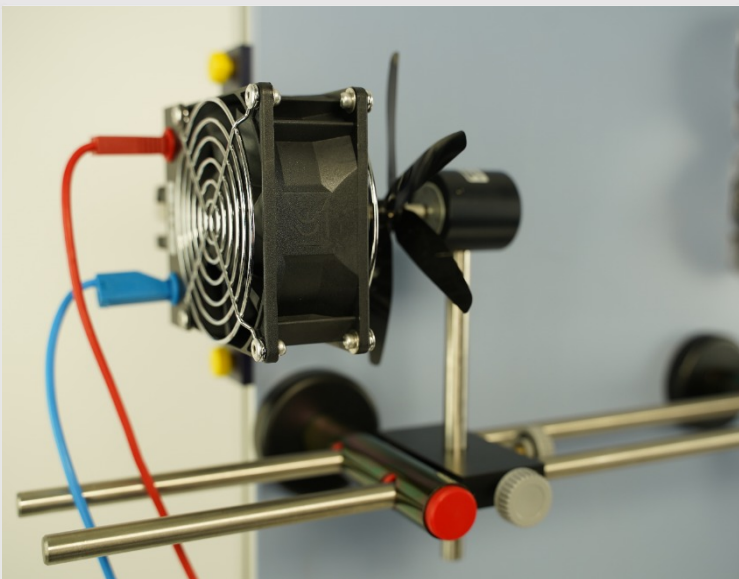
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Setup and procedure

Setup (1/3)

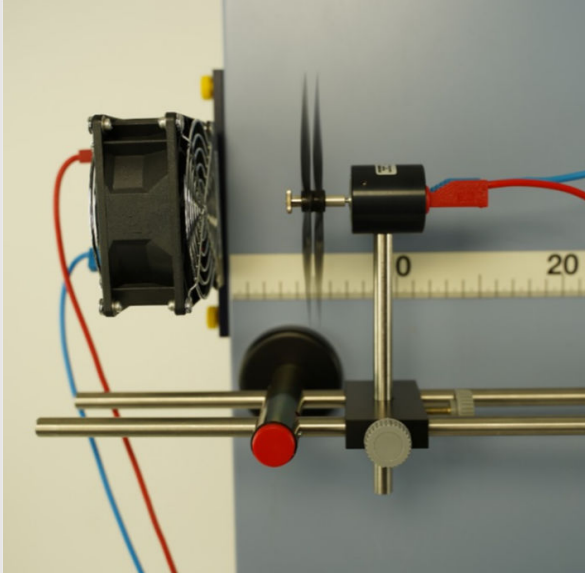
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- On the left side of the board, attach the blower with the bracket (see illustration).
- Align the blower so that it creates a horizontal wind jet along the board.
- Set up a tripod bench for the windmill. Slide the sliding onto the two support rods and guide the rods through the two holes in the clamps.
- Attach the 6 rotor blades to the wind generator.

Setup (2/3)

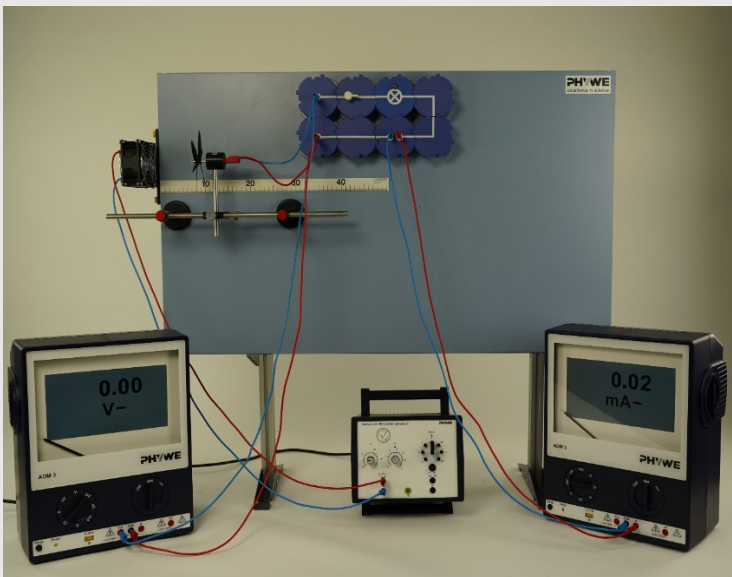
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- Place the bench on the board and align it horizontally.
- The distance between the wind generator and the fan should initially be 5 cm.
- If necessary, correct the distance of the blower to the panel and adjust the height of the generator by moving it in the sliding.
- Place the scale horizontally on the adhesive board at the height of the rotor.

Setup (3/3)

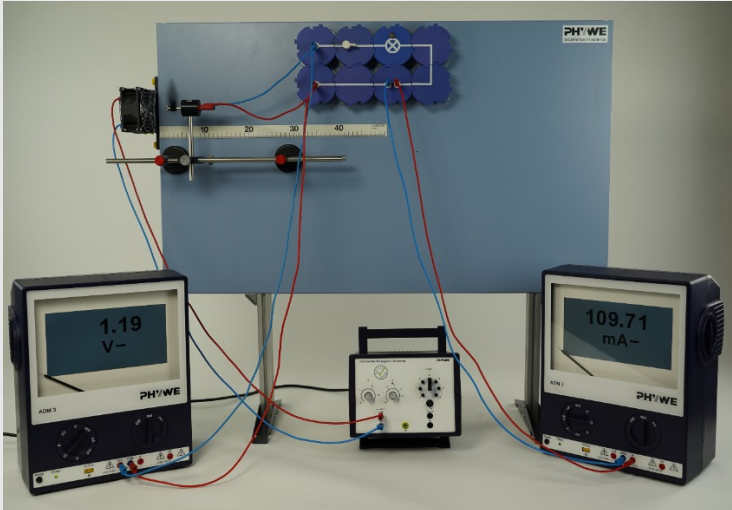
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- Set up the circuit with the 3.5 V filament lamps.
- Align the blower so that it creates a horizontal wind jet along the board.
- Connect the blower to the DC output of the power supply.
- The power supply is switched off.

Procedure (1/2)

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Experiment part 1: Wind turbine with 6 rotor blades

- Set the power supply to 0 V and switch it on.
- Set a voltage of 12 V.
- Measure current and voltage.
- Increase the distance between the wind turbine and the blower by 5 cm.
- Repeat the last two steps until a distance of 40 cm is reached.
- Note down the measurement data in the chart in the evaluation.

Procedure (2/2)

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Experiment part 2: Wind turbine with 3 rotor blades

- Remove three of the six rotor blades from the wind generator and bring the wind turbine back to a distance of 5 cm from the blower.
- Set the power supply to 12 V again and repeat the measurement with three rotor blades.
- Note down the measurement data in the chart in the evaluation.
- Set the power supply to 0 V and switch it off.

Evaluation (1/4)

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Experiment part 1: Wind turbine with 6 rotor blades:

Distance [cm]	5	10	15	20	25	30	35	40
Current I								
Voltage U								
Power P								

Evaluation (2/4)

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Experiment part 2: Wind turbine with 3 rotor blades:

Distance [cm]	5	10	15	20	25	30	35	40
Current I								
Voltage U								
Power P								

Evaluation (3/4)

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Both power curves decrease with increasing distance,

However, this does not happen linearly.

this happens linearly.

Evaluation (4/4)

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Drag the words into the correct boxes!

It can be seen that with only 3 rotor blades less than 20 % of the power of the wind turbine with is achieved. The power is significantly smaller with a because this reduces the area on which the wind power can act. Furthermore, with six rotor blades, the blades are so close together in the middle that the air flowing past one blade hits . As the distance increases, the decreases. Due to the lower rotation of the blades, less is generated in the generator.

lower number of rotors

wind speed

6 rotor blades

electrical power

another rotor blade

✓ Check

Slide

Score / Total

Slide 16: Power curves and rotor blades

0/3

Slide 17: Power, rotors and wind speed

0/5

Total score



Show solutions



Repeat



Export text