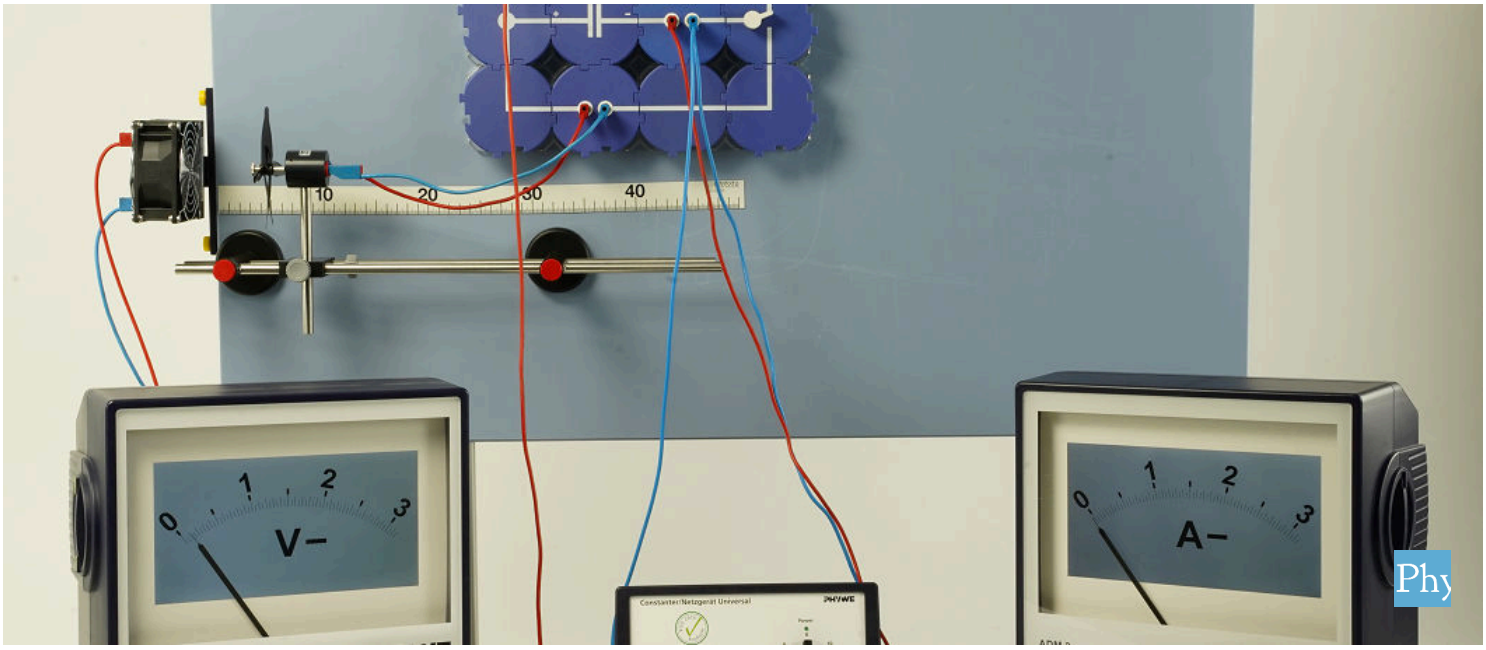
Storage of electrical energy from wind power using a capacitor with ADM3



Storage of electrical energy from wind power with a capacitor

Physics	Energy	Energy forms, conversion & conservation
Physics	Energy	Renewable energies: Wind
Physics	Energy	Energy storage

Difficulty level	Group size	Preparation time	Execution time
medium	1	10 minutes	20 minutes

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Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

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General information

Application

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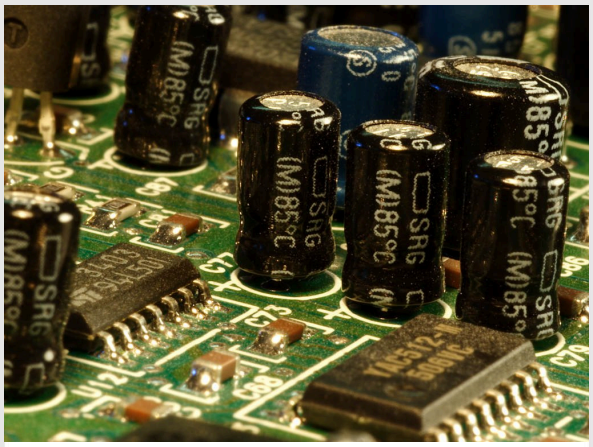

Capacitors on a circuit board

Storage of electrical energy from

Wind energy with a capacitor

Electrical energy can be stored with the help of capacitors.

Compared to batteries with chemical storage media, capacitors have the great advantage of being able to release the stored electrical energy more directly, since energy does not have to be converted. Especially at higher voltages, capacitors provide a time advantage.

This experiment shows how a capacitor affects a wind generator. In addition, the relationship between charging time and running time is measured with a motor.

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Other information

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Previous

The basic operation of capacitors as storage devices for electrical energy should be known for this experiment.

Principle

If DC voltage is applied to the capacitor, the electrons flow and the capacitor charges. As soon as the applied voltage and the capacitor have the same voltage, no more current flows.

In the first part of the experiment, it is shown how the installation of a capacitor affects a system consisting of a wind generator and motor. In a second part of the experiment, it is then measured how different charging times affect the running time of the motor.

Other information (2/2)

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Learning

Students understand the relationship between motor run time and capacitor charge time.

Note

The blower may be operated with a maximum voltage of 12 V. Be careful when handling the generator. Do not reach into the rotating rotor blades.

Pre-shift when handling the generator. Do not reach into the rotating rotor blades.

The capacitor should be connected to the voltage source so that the current is positive when charging and negative when discharging.

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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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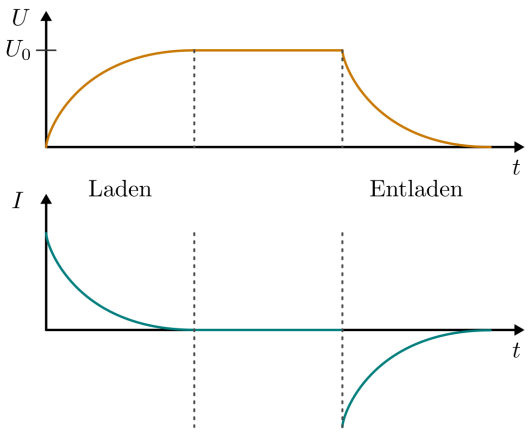

Capacitor during charging and discharging

- When a DC voltage is applied to a capacitor, the electrons flow and the capacitor charges.
- As soon as the applied voltage and the capacitor have the same voltage, no more current flows. The capacitor is charged.
- If a load is now connected, the field strength of the electric field decreases and with it the capacitor voltage.
- A discharge current flows in the opposite direction to the charging current.

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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 DC: 0...18 V, 0...5 A / AC: 2/4/6/8/10/12/15 V, 5 A	13504-93	1
4	Connector, straight, module DB	09401-01	2
5	Connector, angled, module DB	09401-02	4
6	Connector, T-shaped, module DB	09401-03	2
7	Connector interrupted, module DB	09401-04	2
8	Junction, module DB	09401-10	2
9	Switch, change-over, module DB	09402-02	1
10	Motor with indicating disc, 5 V, module DB	09469-00	1
11	Blower, 12V	05750-00	1
12	Generator with metrical thread axis and nut	05751-01	1
13	Rotor, 2 pieces	05752-01	1
14	Clamping holder with 2 clamping possibilit, 0-13 mm,fixing magnet	02151-08	2
15	Sliding mount for optical bench	02151-09	1
16	Support rod, stainless steel, 500 mm	02032-00	2
17	Clamp on holder	02164-00	1
18	Capacitor (gold cap), 1F, DB	09450-10	1
19	Connecting cord, 32 A, 250 mm, red	07360-01	2
20	Connecting cord, 32 A, 250 mm, blue	07360-04	2
21	Connecting cord, 32 A, 250 mm, yellow	07360-02	1
22	Connecting cord, 32 A, 500 mm, blue	07361-04	1
23	Connecting cord, 32 A, 750 mm, red	07362-01	1
24	Connecting cord, 32 A, 750 mm, blue	07362-04	1

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Structure and implementation

Set-up (1/3)

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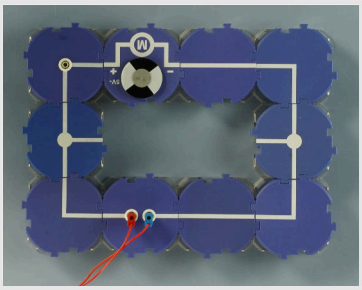

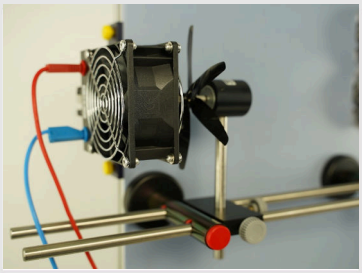

Experiment part 1: Qualitative experiment

- Set up the circuit according to the illustration, but first without the capacitor. Pay attention to the polarity of the motor.
- On the left side of the panel, carefully screw the sleeve onto the support and hold the fan in it.
- Orient the blower to create a horizontal wind stream along the bottom half of the panel.

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Set-up (2/3)

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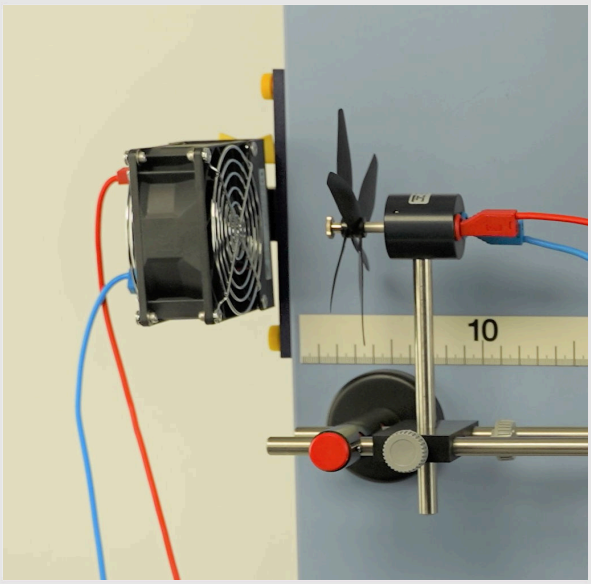

- Set up a "tripod bench" for the windmill: Place the two clamps on the table. Slide the glider onto the two stand rods and guide the rods through the two holes in the clamps.
- Place the stand bench against the board and align it horizontally.
- Attach the 6 rotor blades to the wind generator.
- Place the wind generator in the hole of the glider.
- The distance between wind generator and fan should be 5 cm

Set-up (3/3)

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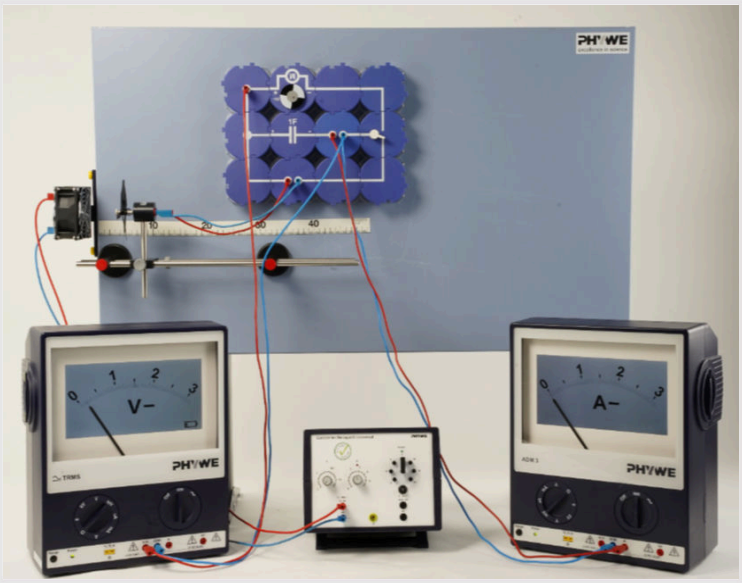

Experiment part 2: Quantitative experiment

- Set up the circuit according to the illustration.
- Pay attention to the polarity of the capacitor.
- The changeover switch closes the respective circuit.

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Implementation (1/4)

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Experimental setup - without capacitor

Experiment part 1: Qualitative experiment

- Switch on the power supply and set a voltage of 12 V (without capacitor).
- After some time, switch off the power supply and observe the motor.
- Insert the capacitor into the circuit.
- Repeat the test while observing the motor.

Implementation (2/4)

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capacitor charging

Experiment part 1: Quantitative experiment - Charging

- Switch on the power supply unit and set a voltage of 12 V.
- To measure the current and voltage, the circuit should be adjusted accordingly.
- Flip the switch and charge the capacitor.
- After 30 seconds, stop recording the measured values and note the electrical work in the table in the

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Implementation (3/4)

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Discharging the capacitor

Experiment part 1: Quantitative experiment - discharging

- The lamp stays off.
- Flip the switch (discharge capacitor) and observe the motor.
- Calculate and note the electrical work. (Maximum voltage, current and discharge time).

Procedure (4/4)

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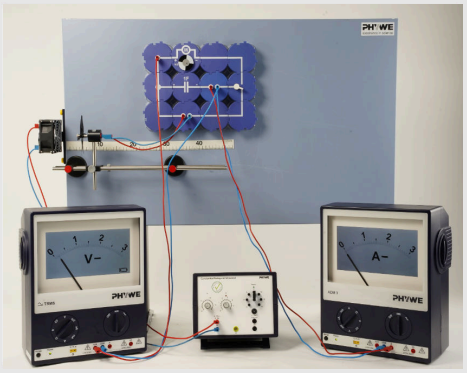
- Repeat the experiment with a charging time of the capacitor of 60 seconds and then with 120 seconds.
- Record all the results in the table on the next page.



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Evaluation (1/3)

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If the charging time is longer, the motor will run longer.

○ True ○ False

Check

Determined values:

	30s	60s	120s
Charging time			
Runtime			
Electr. work (loading)			
Elecr. work (discharged)			

Evaluation (2/3)

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Experiment part 1: Qualitative experiment

The capacitor in the circuit is connected _____ to the motor. This _____ the current through the motor and makes it run a little slower. As long as the wind generator is running, the capacitor is _____. When the power supply is turned off, the capacitor _____, causing current to flow through the motors in the wind generator and in the brick. The motors run until the capacitor voltage reaches the _____ of a motor. The small motor in the module runs longer because it only needs a very _____ voltage to operate.

reduces
small
parallel
charged
minimum voltage
discharges

Check

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Evaluation (3/3)

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Experiment part 2: Quantitative experiment

The ratio between the running time of the motor and the charging time of the capacitor gets worse the _____ the capacitor is charged. If the charging time is extended by e.g. 30s, not as much additional _____ is stored as in the first 30s. The electrical work done when discharging is significantly _____ than when charging the capacitor. This is because a capacitor has relatively large _____, e.g. due to natural discharge. Losses also occur due to the motor in the form of _____.

losses | longer | lower | friction | energy

Check

Slide	Score / Total
Slide 16: Loading time	0/1
Slide 17: Charging and discharging the capacitor	0/6
Slide 18: Saturation of the capacitor	0/5

Total score 0 / 12

Show solutions | Repeat | Export text

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