8.4 Storage of energy in a capacitor

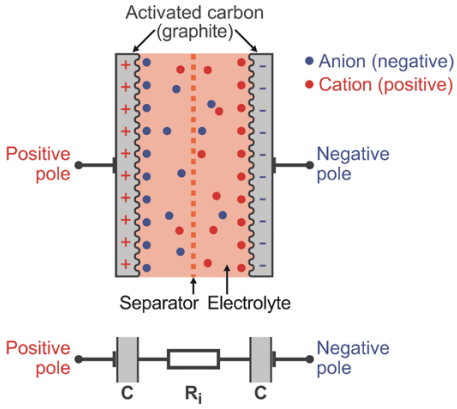
Basic information and collecting ideas

The experiment provides insight into one example of storing renewable energies. If capacitors have been introduced in prior lessons, the Gold Cap also shows the development of electronic components and depicts a further use of capacitors.

Additional information

The Gold Cap is a double-layer capacitor consisting of two layers of activated carbon which are separated by an organic electrolyte.

To charge the capacitor, voltage is applied across the two electrodes. The negative anions of the electrolyte flow to the positively charged electrode and the positive cations flow to the negatively charged electrode. The ion-permeable separator prevents contact between the two electrodes.



The capacity of a capacitor basically depends on the surface area of the electrodes. Due to the extremely large surface area of the porous activated carbon, this type of capacitor has the highest capacity at the lowest volume.

Gold Caps are so-called super-capacitors that have much higher capacitance values than other capacitors, e.g. the electrolytic capacitor you may be familiar with. Gold Cap is a brand name where “cap” is short for capacitor and “gold” is a verbal expression of the high value of the capacitor.

Analysing and reflecting

Students blowing on the motor resemble the function of a wind turbine.

The added energy is stored electrostatically in the capacitor, in the form of electrons. In contrast, batteries store the energy electro-chemically (asin the further research experiment).

When the capacitor discharges (after students stop blowing on the wind turbine), the motor continues to rotate in the same direction since the polarity remains the same.

Doing further research

Caution: Do not disassemble the zinc-iodide cell; it will no longer be functional and irritant chemicals may leak out.

The experiment models a so-called redox flow cell, in which the substances produced during electrolysis (endothermic reaction) are removed from the reaction cell and stored in separate tanks. When energy is required, these substances are used again to produce electrical energy according to the principle of the galvanic cell (exothermic reaction). The following chemical reactions take place during the charging of the zinc-iodide cell:

Doing further research 	Negative pole (cathode): $Zn^{2+} + 2e^- \rightarrow Zn$ Positive pole (anode): $2\ I^- \rightarrow I_2 + 2e^-$ After a short charging time, a brown colouring caused by the produced iodine can be detected at the anode. The deposition of zinc on the cathode is difficult to see. The following chemical reactions take place during discharging of the zinc-iodide cell: Negative pole (anode): $Zn \rightarrow Zn^{2+} + 2e^-$ Positive pole (cathode): $I_2 + 2e^- \rightarrow 2\ I^-$ **Note:** If you charge the zinc-iodide cell very strongly and very often in succession, the brown iodine colour will no longer disappear upon discharge.
Technical and vocational application 	Gold Cap capacitors are used in mobile phones, electronic meters and industrial equipment, for example in trains. Capacitors could also store the braking energy of vehicles, e.g. of bicycles with a battery and an electric motor (so-called electric bikes), and then release the energy again as needed when the cyclist starts pedalling.