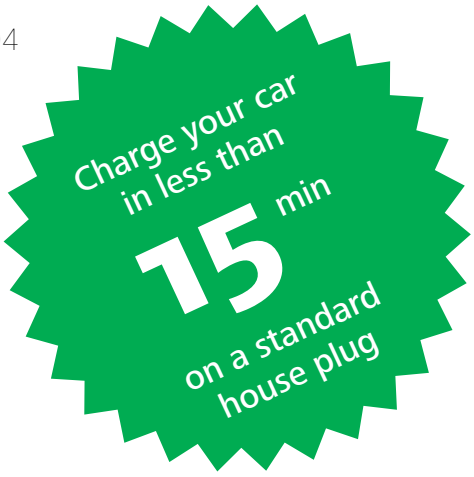

High voltage for e-cars

Charging your electric car in only five minutes – a new charging system should make the unimaginable possible. And it still works without any expensive infrastructure, merely with your run-of-the-mill industrial socket

TEXT: Anemone Seger / PICTURES: Empa / ILLUSTRATION: iStockphoto

On average, an electric car needs to be hooked up to a household socket for seven to eight hours before its battery is fully charged. At a rapid charging station like CHAdeMO or the Tesla Supercharger, it only takes 15 to 30 minutes, depending on the car. Filling up in five minutes, however, – which owners of conventional cars with combustion engines take for granted – has been wishful thinking for drivers of electric cars up to now. But this could be about to change.

Empa teamed up with ETH Zurich, EPF Lausanne and the Bern University of Applied Sciences in a project funded by CCEM (the ETH Domain's Competence Center for Energy and Mobility) and swisselectric research to develop a new charging station termed UFCEV (for "Ultra-Fast Charging of Electric Vehicles"). "Our charging station is essentially a giant battery. It is charged slowly and dispenses the power very rapidly," explains project leader Donat Adams, who conducts research on the reliability and safety of lithiumion batteries at Empa. The new technique should finally make the dream of fully recharging an empty electric car in just five minutes come true. The charging system doesn't require any expensive infrastructure from electricity companies and works with any common 230-volt socket with a 16-amp fuse.

» **UFCEV**
Ultrafast Charging
of Electric Vehicles»

One step ahead of today's electric cars

As the UFCEV charging station weighs one and a half tons and is still sup-posed to be mobile, the researchers incorporated it in a car trailer. It takes about an hour to charge on a common industrial socket. Inside the charging station, a converter converts the alternating current into direct current for the 15 battery elements. These consist of several lithium iron phosphate batteries – for two reasons: firstly, they carry no fire hazard; secondly, they are long-lasting. The researchers estimate that the batteries themselves will still be usable in 20 years. An integrated ventilation system uses air to cool the battery elements as they heat up when in operation. During the discharging process, a voltage converter regulates the power output to any electric car that is hooked up to the system.

Although the UFCEV charging station was up and running in late January, this doesn't mean that five-minute charging will be possible as of now. This is because the batteries in today's electric cars are not capable of taking up the power in such a short period of time as the UFCEV charging station releases it. "During the charging process, the roughly 1.5-ton battery elements in the UFCEV charging station heat up by around seven degrees. The batteries in electric cars are a lot smaller. If the car battery were to be charged within five minutes, it would heat up by around 50 degrees or more and go bust," explains Adams. In other words, the UFCEV charging station requires suitable car batteries to exploit its full potential.

Charging current connection	Data	Charging time for electric car
Household socket Switzerland	230 V and 10 A	7 – 8 hours
Industrial socket Switzerland	230 V and 16 A	4 hours
Rapid charging stations (e.g. CHAdeMO or Tesla Supercharger)	Up to 500 V and 200	15 – 30 minutes
UFCEV-charging station	Up to 700 V and 390 A	5 minutes

Charging station and back-up battery

But until that day comes, the UFCEV charging station won't be standing idle. It can already be used as a "normal" rapid charging station as the researchers can tune it via the voltage converter so that it dispenses its charge in around 20 minutes – the maximum current car batteries can withstand. And as Adams, who also teaches energy storage at EPF Lausanne, adds: "We're also looking into other areas of application. For instance, the UFCEV charging station can also be used as a back-up battery and thus stabilize the power grid." This means that differences between the supply and demand can be compensated by charging the station(s) whenever surplus electricity is available and discharging it again when electricity is required on the grid on short notice. //

Empa scientist Donat Adams (sitting) and Patrick Haldi from Bern University of Applied Sciences mount batteries and power electronics into the UFCEV-trailer.