High Power Charging becomes practical for everyday use – fast charging at Euro Rastpark service area in Jettingen, Germany

A vital prerequisite for widespread acceptance of electro-mobility is the ability to charge a vehicle in just a few minutes. The results of a research project at a service area along the A8 highway in Germany show that charging in minutes is now possible in real life. The cooled HPC charging system from Phoenix Contact plays an important role in this achievement (Figure 1,lead image).

Figure 1, Lead Image - FastCharge research project at the Jettingen-Scheppach service area on the A8 highway. With HPC, electric cars will become suitable for everyday use thanks to fast charging at electric charging stations

Electric vehicles take too long to charge and they're not really practical for everyday use. Many drivers cite these or similar arguments when the subject of electro-mobility is brought up. For electro-mobility to become convenient enough for everyday use, the electrical and physical limits of all components and systems involved in charging must be explored. For this reason, the FastCharge research project was launched in July 2016. During the project, charging power of up to 450 kW was tested. The goal was that the charging process was as fast and easy-to-use as the tank filling process.

The joint project focused on exploring all aspects of fast charging with the aim of making the necessary technologies practical for everyday use. In addition to increasing charging power levels, the project team also explored the basic principles and processes for operating ultra-

fast charging systems. Plug & Charge, the automated login and billing process that is so important to users, was also included. The three-year project covers all aspects of the charging process and was funded by the Federal Ministry of Transport and Digital Infrastructure. The consortium was led by the BMW Group, and also comprised Allego GmbH, Dr. Ing. h.c. F. Porsche AG, Siemens AG and Phoenix Contact E-Mobility GmbH (Fgure 2).

Figure 2 - The FastCharge project team with charging container, charging stations, and test vehicles from Porsche and BMW: Dr. Markus Göhring (Porsche), Frank Bauer (BMW Group), FastCharge project manager Stephan Elflein (BMW Group), Bernhard Pufal (Allego), Gerhard Oberpertinger (Siemens) and Robert Ewendt (Phoenix Contact)

With the inauguration of this high-tech charging system in Bavarian Jettingen-Scheppach, Germany, on the A8 highway between Ulm and Augsburg in December 2018, the consortium demonstrated that charging times of less than three minutes for the first 100 km of range are possible in real life. It only takes 15 minutes to go from a 10 percent to an 80 percent state of charge (SOC), meaning a nearly fully charged battery.

Charging with test vehicles

This powerful charging infrastructure requires vehicles that can handle these high currents and store them in their batteries. Porsche and BMW provided specifically equipped test vehicles for the FastCharge project. BMW converted an i3 and equipped it with a high-voltage battery with a 57 kWh net capacity. It takes 15 minutes to charge at up to 175 kW. Porsche's modified Panamera takes things even further and has a net battery capacity of

about 90 kWh. The car achieves initial charging power of more than 400 kW, enabling charging times of less than 3 minutes for the first 100 km of range. Both vehicles are equipped with powerful cooling systems to cool the battery during charging.

The higher the voltage and current, the faster the battery charges. But fast charging has some drawbacks. High charging currents produce a lot of heat. The new FastCharge charging infrastructure reaches voltages of up to 920 volts and currents of up to 500 amps, placing heavy demands on all the charging infrastructure components involved, including the battery. To reduce the strain on the components, the systems that transmit energy are cooled.

Low-voltage connection is sufficient for charging station

A charging container, which contains the power electronics for the two charging points in addition to the connection to the public power grid, can deliver 175 kW at one charging point and 450 kW (so far unique) at the other charging point. A low-voltage connection is all that is needed for the charging container. A complex medium-voltage connection is not required. Nevertheless, there is enough power available to simultaneously charge two vehicles at high power. The system with the new charging stations designed by Allego uses Europe's standard Type 2 vehicle connector of the Combined Charging System (CCS) (Figure 3).

Figure 3 - New record: the charging station on the right provides 450 kW and the other one on the left charges at 175 kW

All production electric vehicles with the CCS Type 2 connector can also be charged on both stations because the electronics of the charging infrastructure adjust to the maximum charging power required by the vehicle - making it essentially backwards compatible. The CCS Type 2 charging standard has already been established in Europe and America.

Long range with extremely fast charging times

Depending on the vehicle model, the systems can charge 400 V and 800 V battery systems via the cooled HPC charging cables from Phoenix Contact used in the FastCharge project. Fast charging an electric car is becoming increasingly similar to filling the tank of a conventional car. The advanced charging technology makes it possible to recharge the battery of an electric car at a constant charging current of 500 amps in roughly the same time it takes to have a short coffee break (Figure 4).

Figure 4 - High Power Charging connector from Phoenix Contact: electric vehicles are easily charged in just a few minutes

During the HPC technology development phase already, Phoenix Contact focused on keeping installation time to a minimum. A special cable feed-through was developed that enables the charging cable to be easily mounted to the charging station. As a result, an HPC charging station can be set up almost as quickly as a conventional electric charging station.

The technology is just as user-friendly to maintain as it is to install. In contrast to conventional charging stations, HPCs are equipped with an intelligent fluid cooling system to ensure that the vehicle connector and charging cable do not overheat. The cooling fluid is an environmentally friendly water-glycol mixture that makes the cooling circuit in this semi-open system much easier to maintain than high-maintenance closed cooling systems that use oil cooling.

Sensors in the vehicle connector

Charging cables at public electric charging stations are subject to heavy mechanical strain, for example if they are dropped or driven over. The mating face is subject to the highest strain. Therefore, the HPC connector from Phoenix Contact was designed so that the mating

face frame and power contacts can be replaced quickly. This makes repairs quick and easy, minimising charging station downtime and eliminating the need for costly replacement of the entire charging cable.

There is even more intelligent technology installed inside the vehicle connector: Built-in sensors provide information about the overall status of the HPC connector, its usage and wear, as well as further analytics data. All of this information is stored in the vehicle connector and transmitted to the operator in real time. To ensure safety, the system is constantly monitored for overheating. In addition, the HPC charging cable is CE certified and meets all required standards.

One of the greatest challenges in developing the fast charging vehicle connector was to design the cross section of the charging cable as well as the size and weight of the vehicle connector to be as practical as possible. This problem could only be overcome by developing an intelligent and efficient cooling system, as well as designing a carefully considered cable. Furthermore, the connectors are fitted with silver-plated contacts and a contact carrier that, thanks to its good thermal conductivity, also acts as a heatsink. As a result, a particularly high level of stability and optimum cooling performance are achieved at the same time.

Summary

The FastCharge Euro Rastpark Jettingen project demonstrates that electric vehicles can be used in real life and for long distances. The partners in the consortium complemented each other perfectly with their expertise and technologies during the short project duration, making an important contribution to the acceptance of battery-powered electric vehicles. In the future, it will take only a few minutes, not hours, for drivers to “refuel” an electric car and continue on their way.

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