

Power 400 - High Power Charging System with Battery Buffer

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Abstract

In the R&D project Power 400 a battery buffered 400kW fast charging station will be developed, constructed and tested in real life environment within three years.

The aim is to reduce charging times for electric cars to well below ten minutes while reducing the load of powerful charging systems on the electric power grid by means of battery buffers that can even stabilize the power grid. Hence Power 400 is of great importance for both the energy as well as the mobility transition. For the system tests a test stand with a mobile high power battery will be developed, as electric cars up to now cannot be charged with charging power rates of more than 100 kW.

1 Goals

For the energy and the mobility transition it is essential to reduce charging times for cars to below ten minutes and for buses and trains to reasonable times. While charging of cars will take place most of the time at home over night or at work during the working hours, it is important for the acceptance of electric cars that long range trips will not suffer from long charging breaks. Furthermore, due to the much higher capacity of batteries in buses and trains, without high power charging these will not be suitable for real life conditions.

The public power grid limits the available power in most areas to about 100 kW. It would be very expensive to increase this limit, that, on the other hand, would not be used most of the time. In order to overcome this problem, a battery buffer will be charged continuously with a power of up to 100 kW, and will enable one or more simultaneous charging processes with an overall power of 400 kW and more.

A further focus is on developing a battery technology that enables rapid charging while not reducing battery life and safety. This is important for use in electric cars, but also in charging systems.

2 Preceding development

2.1 DC 100 fast charging system FE alpha

A 100 kW DC charging system was developed and successfully tested on several electric cars including a BMW i3 owned by Netz L beck GmbH. Features:

- modular construction
- remotely maintainable
- communication interfaces
- input 230/400V (standard power grid)
- output 0 – 1000 V
- 100 kW DC on CCS or CHAdeMO
- 22 kW AC charging mode 3 type 2



Figure 1 DC research fast charging system FE alpha

The experience gathered in the development and construction of FE alpha helps in developing the Power 400 charging system, as many parts of it are up-scaled versions of their counterparts in FE alpha.

2.2 AC 22 wall box

A 22 kW AC wall box was developed and optimized.

3 Layout of the Power 400 system

The planned general layout of the Power 400 system with its components, power currents and communication paths is shown in figure 2. All components will fit in a standard ten feet container for future purposes like production of a small series.

Power currents and communication channels

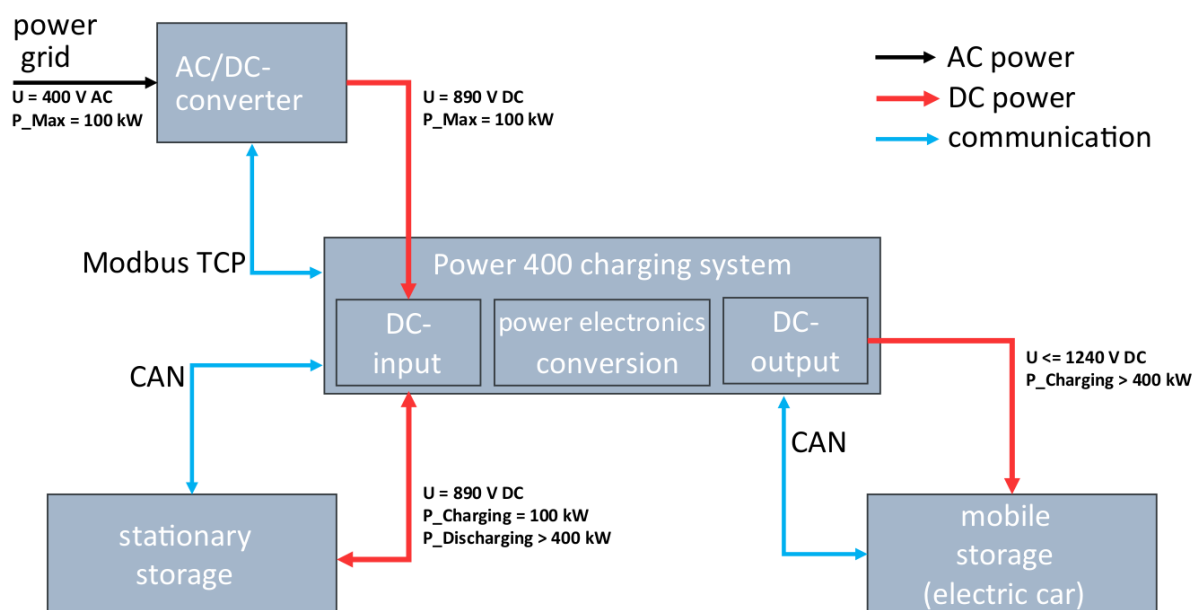


Figure 2 Power currents and communication channels in the Power 400 charging system

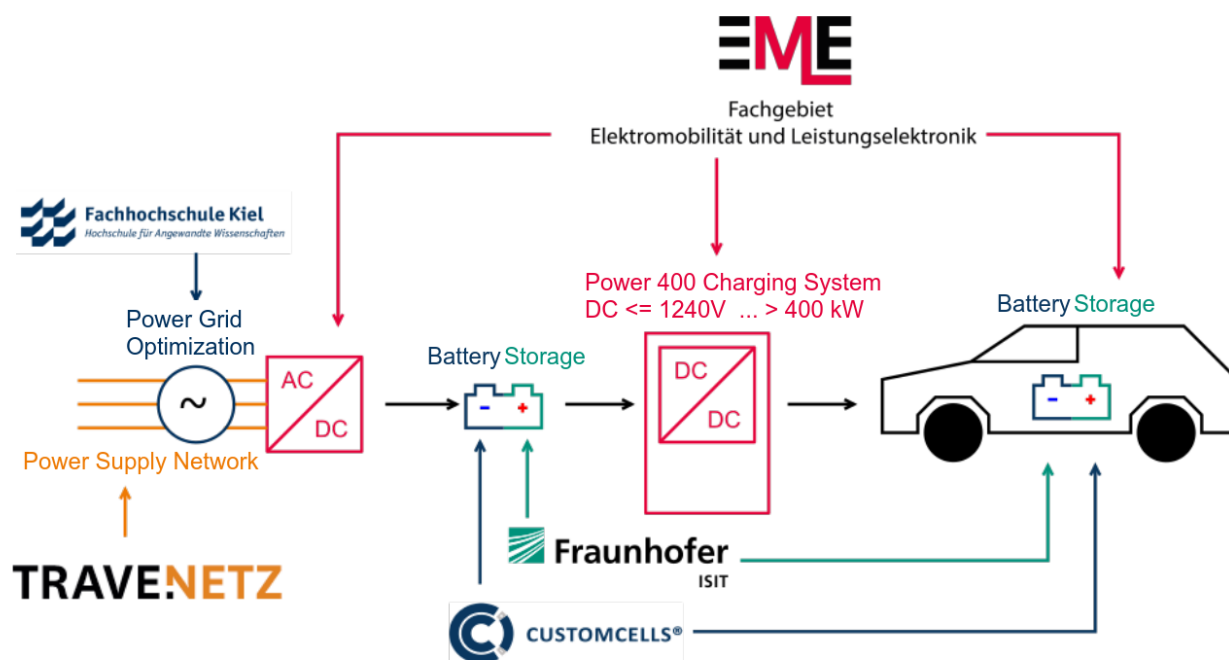


Figure 3 Project partners and tasks

4 Partners and tasks

An overview of the project partners is shown in figure 3 and listed below.

4.1 Fachgebiet Elektromobilität & Leistungselektronik der Technischen Hochschule Lübeck

We are developing and constructing the central system of Power 400 and integrating it with the external systems, i.e. AC/DC converter and stationary battery storage, to the complete Power 400 system.

4.2 TraveNetz GmbH

After construction and successful testing we will build up the complete Power 400 system in a separate building at the company TraveNetz GmbH, which is the general power grid provider for the Lübeck region. There it will be tested under real life conditions.

4.3 Fraunhofer Institute for Silicon Technology (ISiT)

4.4 CustomCells Itzehoe GmbH

Both, Fraunhofer ISiT and CustomCells, provide research and development of the stationary and mobile batteries.

4.5 Institut für Elektrische Energietechnik an der Fachhochschule Kiel

This institute will evaluate the effects of high power charging systems like the Power 400 system on connection points in urban power grids regarding stabilization of harmonic frequency distortion and power load. The aim is to identify possible connection points and to minimize the costs of network integration.

5 Project funding

The research project Power 400 is funded by the European Union and the federal country Schleswig-Holstein with 2.5 Million Euro. We, the „Fachgebiet Leistungselektronik & Elektromobilität“, will receive a share of 1.3 Million Euro.

6 About us

The “Fachgebiet Elektromobilität & Leistungselektronik - EMLE” (Department of Electromobility & Power Electronics) of the “Technische Hochschule Lübeck” (Technical University of Applied Sciences Lübeck) was founded in July 2012 by Professor Dr. Roland Tiedemann as “Forschungsgruppe Erneuerbare Energien & eMobilität” (Research Group Renewable Energies and E-mobility) in order to investigate and solve the technical and legal aspects of the energy and mobility transition. The goal is an environmental friendly power generation based on renewable energy sources like wind and solar power, and a mobility concept based on electromobility

and efficient and sustainable use of resources. Electromobility is a perfect counterpart to renewable energies, as it uses the “fuel” produced by wind and solar power.

Members are Professor Tiedemann, three full time development engineers and seven student or science assistants. Furthermore, there are several associated partners, e.g. a lawyer and an university professor.

7 Future plans and related projects

7.1 Off grid charging systems

As the Power 400 charging system already has an integrated battery buffer, it is a perfect companion for a wind turbine or solar power plant to operate without connection to the public power grid. Dependent on the relation of generated power to required charging power and required availability of charging power, it can be combined with an electrolyzer and fuel cells or diesel generators. Moreover, an electrolyzer could serve a hydrogen filling station.

At least for demonstration and educational purposes we plan to integrate a diesel generator or methanol fuel cell into the Power 400 system.

7.2 Decentralised Energy Supply

With the growth of renewable energy sources like wind and solar power and biomass, decentralised energy supply becomes a possible solution for houses and residential areas. While in industrial countries this can stabilize the public power grid and help to avoid energy transport losses and reduce or even avoid the cost of power grid extension, in developing countries it might even be the only available solution.

The principle of decentralised energy supply for a detached house is shown in figure 4.

The energy is generated by solar panels and a small wind turbine and stored in the central battery system.

Fuel cells or diesel generators can assure energy supply, also a connection to the public power grid. Moreover, this connection can feed power into the public power grid.

The power of the central battery system is converted to conventional 230/400 Volt AC current and drives all devices in the house like stove, washing machine, TV, radio etc. and a heat pump to heat the house.

The electric car can be charged and also act as an additional battery buffer, if enabled for bidirectional charging.

With the already installed solar power system on the roof of our laboratory, a diesel generator and a battery we are building a small system to show the principles of decentralised energy supply for demonstration and educational purposes.

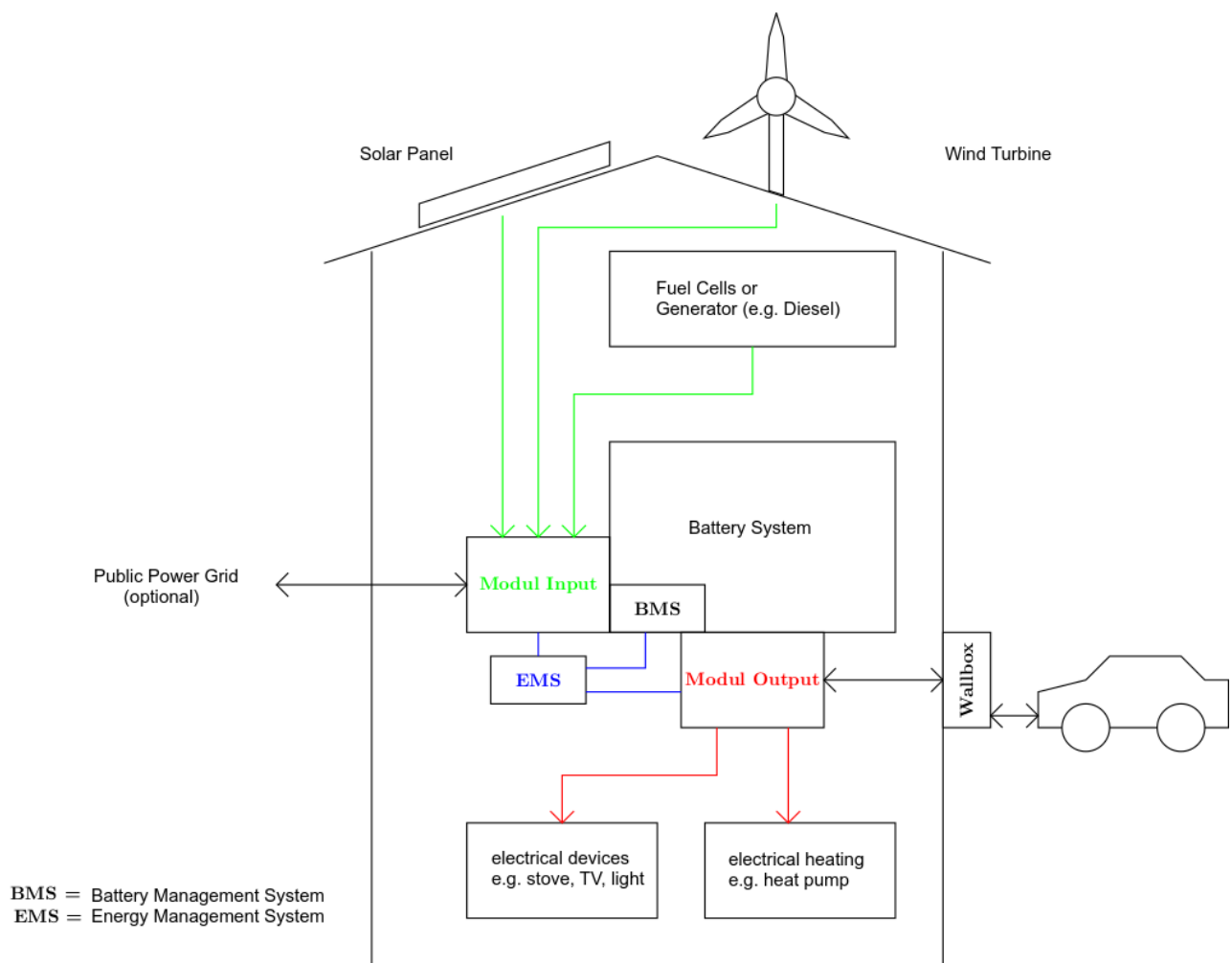


Figure 4 House with decentralised energy supply

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