Smart charging keeps power grid from overloading

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Smart charging electric cars with a dynamic price mechanism may play an important part to help keep the power grid from overloading. For her PDEng at Twente University, Marieke van Amstel from ElaadNL and

Enexis Netbeheer designed a model to render power demand and supply more flexible. This will eliminate the biggest risk of overloading the power grid. Grid operators must be able to intervene if necessary and have cars charge more slowly in case of an overload risk.

Last week, Marieke van Amstel successfully defended her thesis (Professional doctorate in Engineering) titled Flexibility System Design for Electric Vehicles. Performing Congestion Management for the DSO, in Arnhem, the Netherlands. She created a system design for flexibility in the power grid for power grid operator Enexis and ElaadNL, the knowledge and innovation centre for smart charging electric vehicles. She based her design on an analysis of the impact of different types of smart charging on power grid usage using a computer simulation of a district in the Dutch city of Den Bosch.

Examining smart charging variants

A range of smart charging methods is available. Price stimuli may often play a part, for instance. There is already an energy market that makes charging attractive in lower priced time windows. And in ongoing experiments, market parties are paid for the level of flexibility they offer in power demand. In other smart charging tests, the management of charging stations is adjusted to deliver less power during peak hours, and more during off-peak hours. Researchers are also examining the scenario in which the grid operator transmits a direct control signal that causes electric cars to charge more slowly if there is a risk of a power grid overload. The study compares nine scenarios in an agent-based simulation model for a district in Den Bosch featuring a variety of residential types and charging options. The simulation assumes the power mix that is expected in the year 2030, with 80 per cent of all households owning an electric car.

Smart charging with dynamic profiles reduces peak loads

Among other things, the simulation demonstrates that smart charging with static profiles should be discouraged. For instance, if you do not allow electric vehicles to be charged between 17:00 and 19:00 to reduce the load during peak hours, a new and even higher peak results at the end of that time window. All of the cars plugged in before 19:00 will start charging simultaneously at 19:00. Dynamic profiles, based on a market for instance, do result in a peak load reduction.

Van Amstel wants to add a control mechanism for power grid operators to prevent overloading. A flexible capacity contract would be one possible option. The capacity contract allows regional power grid operators to implement capacity limits when the power grid is at risk of an overload. A signal is then sent to flexible devices, such as charging stations for electric vehicles, so they consume less power temporarily. The simulation shows that intervention is required only incidentally if the market operates adequately.

Opportunities and challenges for the power grid

The rise of electric vehicles may present both a challenge and an opportunity in power grid management. If many vehicles are charged simultaneously in a single district, this may lead to high (or excessive) demands on the power grid in the future. The peak demand of a modern electric car is comparable to that of ten households. Smart charging solves this problem, resulting in more efficient usage of the grid. Deployment of smart technology will mean that cars charge mainly outside peak hours. In this way, electric cars can improve flexibility in power demand, enabling greater contributions of solar and wind power to the grid. Traditionally, supply is adjusted to demand (power stations are required to produce more power during peak demand), but now demand can also be adjusted to supply. This is a good thing for an energy system that increasingly generates power from sustainable sources. Using smart charging, electric vehicles will be able to charge

faster at the moments of high solar or wind power generation.

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