

PÖYRY POINT OF VIEW - JANUARY 2018

# EV charging challenging the grid



# How to tackle the impact of high-power EV charging on the Swedish power grid

In June 2017, Sweden passed a new Climate Act, legally binding the country to become carbon neutral by 2045. While the power sector is close to reaching the target, more effort is required in the transportation sector. In the past years, electrification has gained considerable interest worldwide.

## ELECTRIC VEHICLES IN HIGH DEMAND

The electric vehicles global stock has grown exponentially, with Sweden being among the top 10 nations in terms of sales volume. In order to meet the growing power demand, and to target range anxiety<sup>1</sup>, major players are planning to install high-power chargers, with a rated power of up to 350 kW. Unpredictability and high power demand of these systems could considerably overload the grid, consequently affecting its stability. Coupling charging stations with stationary storage systems offers a solution which could alleviate the stress on the grid, as well as lower ownership costs. In less than a decade, the automotive sector underwent an incredible shift towards electrification. Thanks to the drop in battery prices, electric vehicles passed from



<sup>1</sup> Range anxiety is the fear that drivers experience from knowing that their battery could run out of charge and strand them far from a recharging station.

being just a concept to a real product, which is set to ultimately replace the internal combustion engine. During 2016, the global stock of EVs rose to 2 million units, having passed 1 million in 2015. Among their fleets, nearly all car manufacturers now offer at least one full electric model. Some have even announced the intention to stop selling non-electric vehicles: starting from 2019, all Volvo cars will be either hybrid or electric, while Smart intends to shift towards full electric.

## POLICIES ADVANCING TRANSFORMATION

Several European countries issued plans to ban fossil fuel cars by mid-century, the latest

being UK and France. More importantly, China, the world's second biggest economy, announced in September 2017 that similar measures could be taken. Sweden is not lagging behind. Its new Climate Act legally binds the country to become carbon neutral by 2045 and, as of August 2017, it is the third country in terms of market share for EVs, globally. The country has seen an exponential growth in its EV stock, which now stands at more than 40 000 units. The vast majority of charging currently takes place at home and thus, to encourage widespread adoption of EVs, public – and fast – charging is essential.

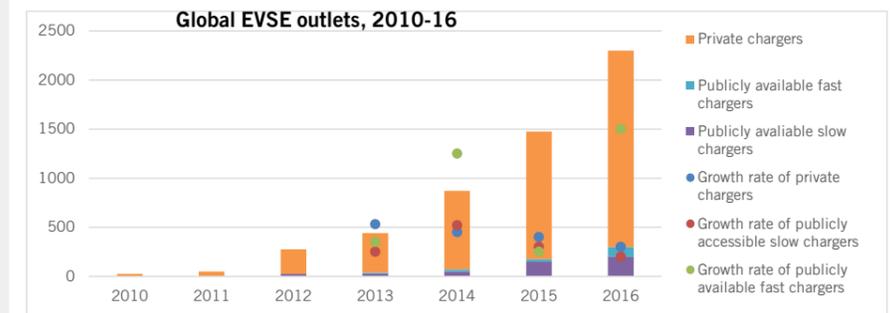
## PUBLIC FAST CHARGING IN DEMAND

In some niche markets (such as taxis and commercial fleets), public fast charging is fundamental to normal business operation and this has led several companies to enter the market. Apart from Tesla, which offers the service to its customers only, Clever, Vattenfall and Fortum Charge & Drive are active in the Swedish territory with fast chargers. In general, the industry's trend is to install more and more powerful systems, to emulate the customer experience of conventional refuelling stations. (Further insight available from our Point of View on "EVs - Who's in charge" - available from [www.poyry.com/insights](http://www.poyry.com/insights)).



# Unpredictability could affect grid operations

Electric cars still outnumber public charging stations by more than six to one, indicating that most drivers rely primarily on private charging stations. Nevertheless, publicly accessible infrastructure is growing to support the emerging EV market, especially publicly accessible fast chargers.



Note: Private chargers in this figure are estimated assuming that each electric car is coupled with a private charger.  
 Sources: IEA analysis based on EVI country submissions, completed by EAFO (2017a).  
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## SHORTER CHARGING TIMES = HIGHER COSTS

Several studies point out that unpredictability and high charging power of fast chargers could severely affect grid operations. In some cases, distribution operators (DSOs) might not even have enough capacity to accommodate such a demand. For example, in the Stockholm area, where the grid is highly utilised, there is a concrete risk of congestion and, consequently, charging stations might not be allowed to connect to the network. By law, distribution operators are obliged to permit connection; however, they can postpone due to a capacity shortage, until the system gets upgraded. In the area of the

Swedish capital, Vattenfall and Ellevio are collaborating to improve current infrastructure. It must be stated, however, that system renewal is a cumbersome process, which may require several years to be finalised. Such an extended period could prevent the investment being done, consequently jeopardising businesses and affecting EV owners.

## THE SOLUTION: DSOS AND CUSTOMER PERSPECTIVE

Decreasing battery costs offer an interesting solution: coupling charging stations with an appropriately sized energy storage system.

This approach could result in several potential benefits, both for the charging station owners as well as the distribution operators. The latter could profit from a flatter and more predictable demand profile, which would consequently ease operations. The flexibility provided by the implementation of storage may also defer the need of infrastructure upgrade. In fact, reacting to pricing signals, the system could store electricity during low demand periods and avoid consumption at peak times, thus avoiding congestion and diminishing the stress on the electrical equipment. DSOs cannot legally own and operate storage devices, which

should be run by the charging station owner. In turn, charging stations that take advantage of storage devices could be granted connection, while conventional systems not. On the other hand, the system could help charging station owners to decrease costs. Depending on the adopted control strategy, the battery management system could react to pricing signals and purchase electricity when cheaper. Even more significant is the effect on distribution tariffs. These kinds of systems are characterised by high power demand for a short period, randomly distributed during the day. For this sort of

load patterns, demand charges – a monthly fee applied for the maximum hourly average power withdrawal of a given month – might become considerably high. Batteries can reduce the peak demand of the station, thus cutting down demand charges. The utilisation of batteries also affects the rated size of the equipment. Lowering peak consumption makes it possible to reduce the initial investment for the equipment, i.e., cables, converter, and transformer. It must be stated, however, that this aspect is secondary in respect to electricity pricing.



The German automotive corporation Daimler announced it would create a network of high-power charging (up to 350 kW) extended throughout Europe. Within the Nordic countries, Fortum C&D reported that it would start the construction of a similar corridor, connecting Oslo, Stockholm, and Helsinki.

# EU directives will be the drivers

## OUR ANALYSIS

According to our analysis, coupling storage systems with Swedish fast chargers cost effectively could already be possible. More specifically, for highly used units, such as the ones located in major cities or close to the Norwegian border. Projections show that, with future scenarios of charging demand and electricity pricing, these systems will become more and more convenient to install. It must be stated, however, that the system's sizing is a crucial and complex process, for which several factors must be taken into account. Among these, battery price and performance, charging load and electricity tariffs. All of these parameters should be included in a mathematical model, before making a final assessment.

### Did you know ...

China is the largest market for EVs with over two times more units sold than in the USA.

Ref: International Energy Agency; Global EV outlook 2017

## FURTHER OPPORTUNITIES

Soon, implementing a battery could become even more convenient. In some cases it might also create new revenue streams for its operator, consequently boosting the system's profitability. As of today, no widespread demand response programmes, nor the possibility of offering ancillary grid services are in place in Sweden. However, EU directives are going in this direction. The "Clean Energy for All Europeans" package presented by the European Commission in late 2016 addresses the integration of EVs and storage systems into the electrical grid. Specifically, it suggests the introduction of better pricing signals, as well as the use of a demand response programme, as alternative measures to an infrastructure upgrade for tackling grid congestion. Upon its approval, DSOs in Europe will need to issue reports presenting the implemented actions regularly. Such a step would undoubtedly boost the battery market.

Local energy storage also offers the possibility of integrating the power demand with locally produced renewable energy, if the location permits it. It might seem unreasonable, but Tesla's CEO Elon Musk recently announced that, in the long term, most Superchargers would be off-grid, powered by the combination of PV panels and batteries. Apart from energy savings, which strongly depend on the particular case, such a measure improves the image of the business.

## MAIN TAKEAWAYS

- In some cases, the implementation of the battery might be already more convenient respect to the non-storage option. In the future, with battery price reduction and tailored electricity tariffs, the profitability of these systems will further increase. According to data from Pöry in 2017, prices for battery generation units will fall below \$ 150/kWh by 2020 and below the threshold of \$ 100/kWh by 2028.<sup>2</sup>
- It is hard to precisely predict how the energy demand will evolve since both technical developments and behavioral factors contribute to it. Thus, the initial battery rating might be not sufficient for the entire lifespan of the installation. Nevertheless, storage systems can be easily scaled up, responding to circumstances variations.
- A tailored modelling analysis is essential before making a final decision on the exact rating of the equipment. Currently, the most important element to consider when planning the installation of an energy storage system is the distribution tariff, in particular, demand charge. A high share of it in the total costs is the primary driver for a cost-effective implementation of such a device.
- However, as previously stated, if demand response programmes will be implemented, the possibilities of storage will become even higher. Swedish DSOs are currently examining new pricing schemes, which will enable batteries to provide different services, other than peak shaving.

## CONCLUSION

Coupling batteries with fast charging stations is a viable and efficient solution to tackle the integration of these high-power systems into the Swedish electrical grid. As well as allowing charging stations to connect to networks facing occasional congestion, it can also save the owner money. Following EU directives, Sweden is likely to implement tariffs which will further boost the profitability of such a system. Together with other initiatives, it can help the country to move a step further towards its ambitious goal of becoming one of world's first carbon-neutral nations.

<sup>2</sup> The reported prices refer to generation batteries.



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