How EVs could help to support the future grid and what possible impacts this vehicle-to-grid technology might have

Our energy infrastructure is changing, and we need new ways to produce renewable energy. But did you know that we also need new strategies to operate the grid? Research is now looking at the possibility to operate the grid with the support of electric vehicles as vertically integrated resources.

Why in the whole world could it take so long to transform our energy production to be renewable? We have solar, we have wind! Let's just go! Right? As the energy industry has come far in developing technologies to produce renewable energy, we might not have come as far in adjusting the ways in which we operate the grid to a more sustainable fashion. The development of smart grids has highlighted this topic, but we also need to find replacements for the components that maintain the grid and relieve us from blackouts. This is where the electric vehicles (EVs) come into the picture and could be a part of the solution.

At all times in the grid the power consumption has to equal the power production. Some fluctuations are okay, but what if it varies to much? Well, I hope you charged your phone, because we would experience a power outage. The balance in the grid is measured by the frequency and we control it through frequency regulation. Historically, the frequency has been controlled by large power generators in the grid. If you don't live in for example Norway with a huge supply of hydropower the stakes are high that these generators run on fossil fuels. These generators are also pretty good at keeping the frequency robust towards changes in the consumption and production balance. When we now would like to transit to renewables, this has led to an interesting change – the frequency will be more sensitive. And if we don't want a blackout every now and then we need to do something about it. So, let's be smart and do something so that we can proceed to integrate solar, wind and other renewables.

Some years ago, researchers realized that electric vehicles are energy resources that are only used a minor part of the day. Think about that! Maybe you drive to work and back home. Go out for a couple of errands. The rest of the day your car is a battery – an energy resource – that is just standing there. So, researchers came up with the idea to perform frequency regulation with EVs. For this bidirectional charging is necessary and would allow your car to be integrated to the grid as a vehicle-to-grid (V2G) solution. The project behind this article is associated with the Parker project, which aims to validate that EVs can support the grid by becoming vertically integrated resources in the grid. Based in Copenhagen, the project has one of the World's first commercial EV fleets to perform frequency regulation. The EV fleet consists of 10 EVs, which can each charge 10 kW – which makes it a 100 kW vertically integrated 'mini-power-plant'. The fleet has also given research within this field something that is lacking – real world data to validate and develop the V2G technology.

To be able to apply this technology, to upscale and further develop it we need to know how it affects the grid. The study behind this article has looked at how the EV fleet affects the electrical system around it and at how it would affect total power demand. Additionally, it also investigated if we could stretch the system limitations slightly to have more of these frequency regulating EVs in the grid.

In the study regarding the power demand (the load profiles) the EV fleet load was compared to the load in a system at Bornholm. All EVs are scheduled to be fully charged at the same time in the morning and thus, a morning peak load appeared when scaling up the EV fleet. This could possibly be solved through smarter scheduling and optimizing the charging of the vehicles. Additionally, the peak load in the afternoon became larger and wider. However, this could be solved through only performing the type of frequency regulation that discharge the battery. This is an easy applicable strategy because most of the cars have energy left in their batteries when they return to the charging station in the afternoon. Since this means that power is transported from the car to the grid this would result in lowering the peak load instead.

Traditionally, grids have been oversized due to an uncertainty and thus the study found that if there is capacity left in a system this V2G technology could be a promising candidate to perform frequency regulation. However, if the system limitations would be violated grid upgrades might be required and this would cost both economically and environmentally. But there are ways to stretch the limits slightly if one would like to scale up the EV fleet or placing it in a weaker grid. Whereas the active power is the type of power you use to charge your phone, reactive power would not help you with that but instead affect variables that in turn affect the system limitations. Through reactive power compensation it was discovered that the system limitations could be stretched a bit. Meaning, that the EV fleet could grow or also be implemented in somewhat weaker grids.

So, could we go on and invest in hundreds of these EV fleets jointly operating as one large battery to support our grid? Could you in the future come home and plug in your EV and now that it would do something good by just standing there? Well, yes maybe. But most probably this research needs a bit more of attention first.

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