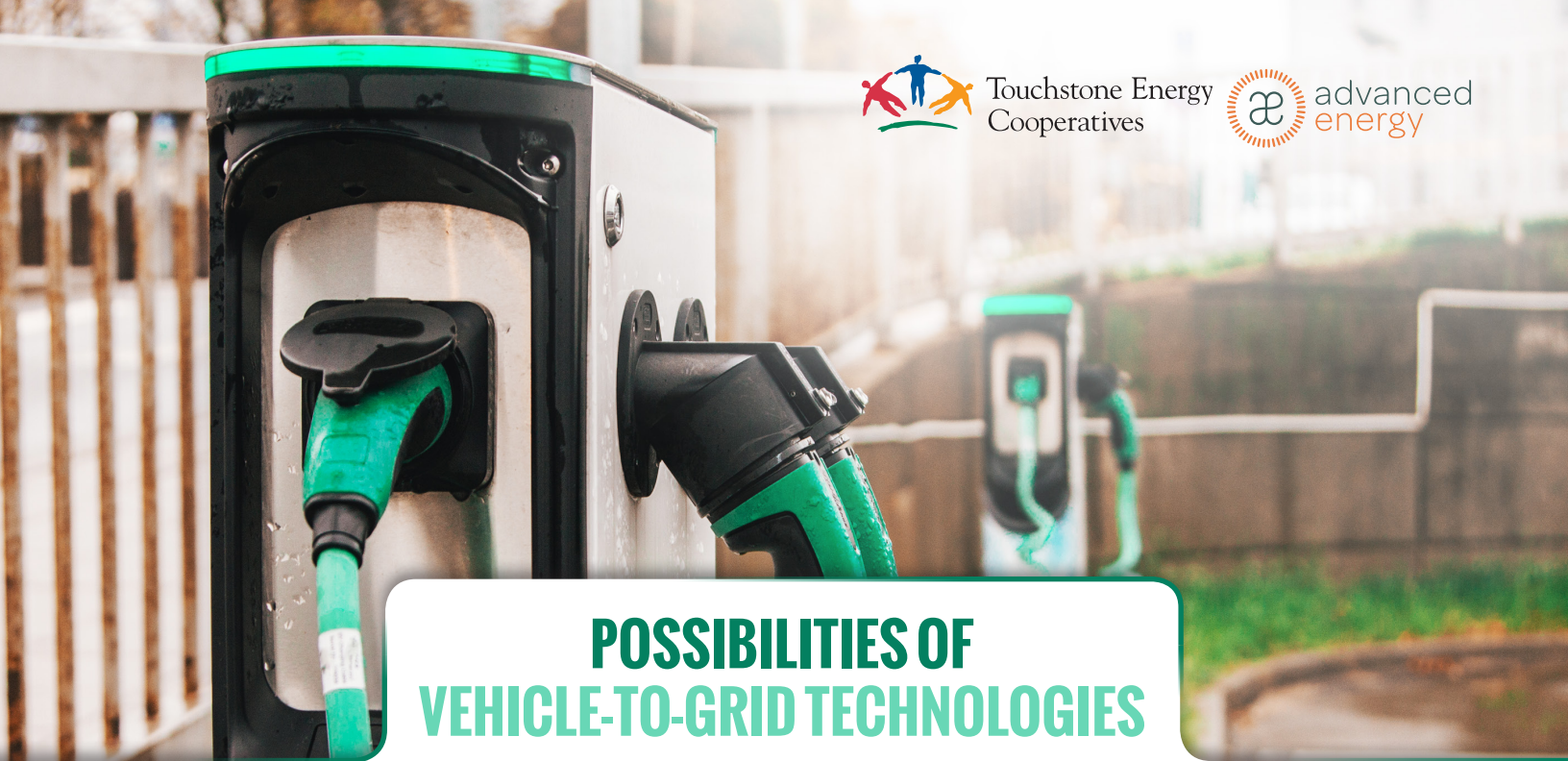


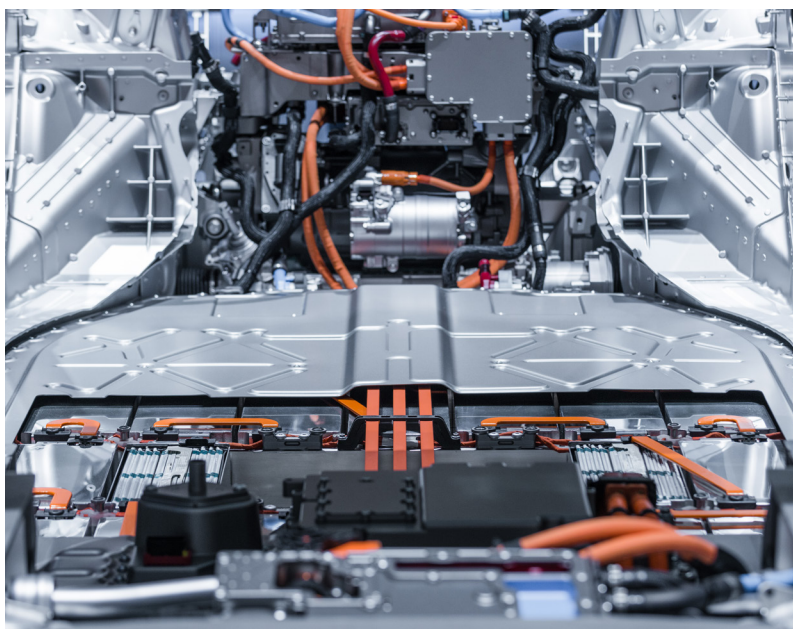


POSSIBILITIES OF VEHICLE-TO-GRID TECHNOLOGIES

When we think of an electric vehicle (EV), we might envision a car receiving power from the electric grid before driving off. Along the way, its battery will deplete, so it will need to be plugged in to charge again. In other words, there is a one-way relationship between the electric grid and EV: the car gets electricity from the grid so it can drive.

But what if the relationship could be bidirectional? What if, when plugged in and parked (which cars are most of the time), EVs could communicate with the grid and act as spare batteries. Not only would they be receiving power to charge, but also supplying it back. This idea - known as vehicle-to-grid (V2G) - is currently being explored in laboratories and pilot programs across the world. And don't worry, you won't come back to a car with a completely dead battery - with many cars being used at the same time, the amount of power taken from any one car would likely be small. You may even be compensated for power your vehicle supplies.

This setup almost sounds too good to be true, and the possibilities of V2G are vast. For example, EVs could be charged with solar energy during the day, and then send excess power back to the grid later, when energy demand is high and solar sources unavailable. Ultimately, V2G technology could help stabilize the electric grid, as well as add value to EVs by giving them an additional use.



Nissan is one vehicle manufacturer that has begun to explore these possibilities and has over 100 cars throughout Europe engaged in V2G trials. Nissan allied with Enel, an Italian utility, and Nuve, a California-based energy technologies and smart grid company, for a project in Denmark. This ongoing effort is using 10 V2G charging units with electric Nissan vans so that the vehicles can both receive and provide energy when parked. EV fleet operators have earned more than \$1,500 for the power they supplied to the grid. A similar collaboration between Nissan and Enel is happening in Italy, and Nuve, with the success of the project in Denmark, is getting a V2G program underway with the University of California San Diego and support from the California Energy Commission. Here, Nuve's V2G charging platforms will be added to 50 EV chargers at the university.

Other V2G efforts have cropped up across the U.S. over the past few years as well. For example, starting with the Los Angeles Air Force Base, the U.S. Air Force has been using a fleet of EVs to run a V2G project at various pilot installations. The goal is to evaluate the technology and possible challenges to larger-scale implementation. Likewise, NRG Energy has worked with the University of Delaware to form eV2g, a collaboration looking to assess V2G capabilities with commercial fleet vehicles.

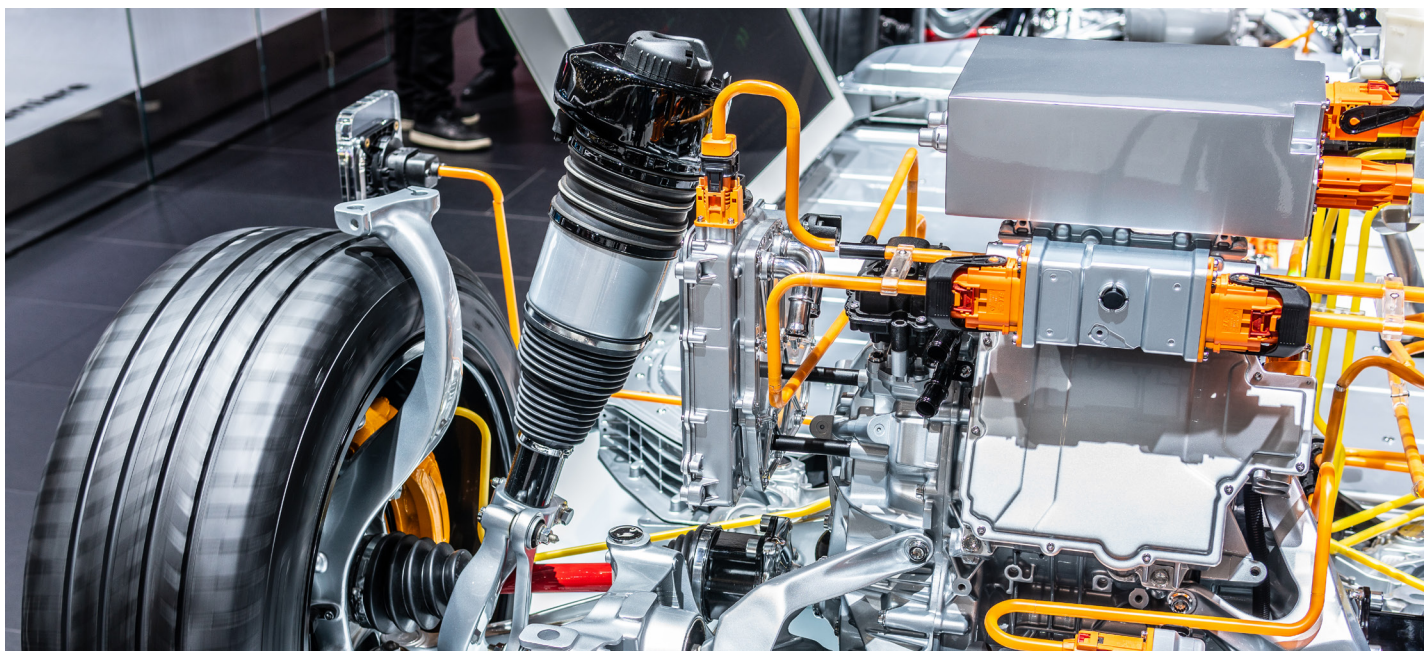
One concern with V2G is the possibility that it could harm EV batteries. The thought is that the frequent cycling (i.e., switching between charging and discharging) required for V2G could degrade batteries more quickly. One recent study, though, revealed that degradation is not necessarily a guarantee, and that under some circumstances battery performance could actually be improved.

Along with V2G, a number of complementary vehicle-grid technologies are being explored. One is vehicle-to-home (V2H), in which an EV battery supplies an individual home with power. This system could be particularly useful for reducing the effect of peak periods or acting as a backup generator in emergencies. Furthermore, with smart charging and demand response, vehicle charging is managed so that it occurs when demand is lower.

Avista Utilities and Greenlots in Washington state are currently running a pilot to examine these possibilities using home, workplace and public charging. The hope is to understand how larger EV penetration might be able to effectively interact with the existing grid to reduce costs and improve reliability.

Pacific Gas and Electric Company and BMW also completed their own investigation into smart charging and demand response. In their pilot, which consisted of about 100 BMW i3 drivers, PG&E dispatched 209 demand response events totaling 19,500 kilowatt-hours to BMW during periods of high demand. BMW in turn reached out to certain vehicles for up to one hour delayed charging. Drivers earned an incentive for participating but could opt out of specific events. As additional support, BMW incorporated a solar-powered energy storage system made up of “second life” EV batteries.

The future of V2G and related technologies is exciting, especially with the continued growth of EVs. With additional trials, the next few years should shed more light on the potential and possibilities of these systems. If they work on a large scale, the grid might have a new tool to support its energy balancing act: a giant battery made up of thousands of EVs.



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