

# Merits and Demerits of Vehicle to Grid (V2G) Technology

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**Abstract:** Vehicle to Grid technology is a process in which vehicle can feed the electrical grid during in its rest time. For this, bi-directional charging system comes in to the action. In lower energy demand; period vehicle will store the energy and during peak energy demand; it gives the energy to the grid. But this system has some merits and demerits; this paper is for explaining those advantages and disadvantages of Vehicle to Grid (V2G) system.

**Keywords:** V2G technology, Bi-directional charging, Virtual power plant (VPP), Peak demand, Artificial Intelligence (AI), Demand Side Response (DSR).

## 1. Introduction

We know most of the electric power comes after burning fossil fuels. This process is the cause of greenhouse effect. Currently, all countries started relying on renewable energy sources. The problem with renewable energy sources is that they provide fluctuating energy. The solution for irregular nature of renewable energy is to store the energy so that we can use it whenever we need. The idea coming for storing the energy is Electric vehicle (EV) batteries because of their

higher storing capacity (10kwh, 30kwh, 100kwh etc.). Electric vehicles not only reduce harmful emissions, but can also help stabilize the energy grid through a proven, reliable technology, called Vehicle to Grid (V2G) technology. This idea laid out by California company AC propulsion in early 1990s. V2G technology has bidirectional smart charging system. In this, vehicle can charge from the grid and can feed the grid during peak demand hours. Whenever it can stable the energy supply system but has some demerits.

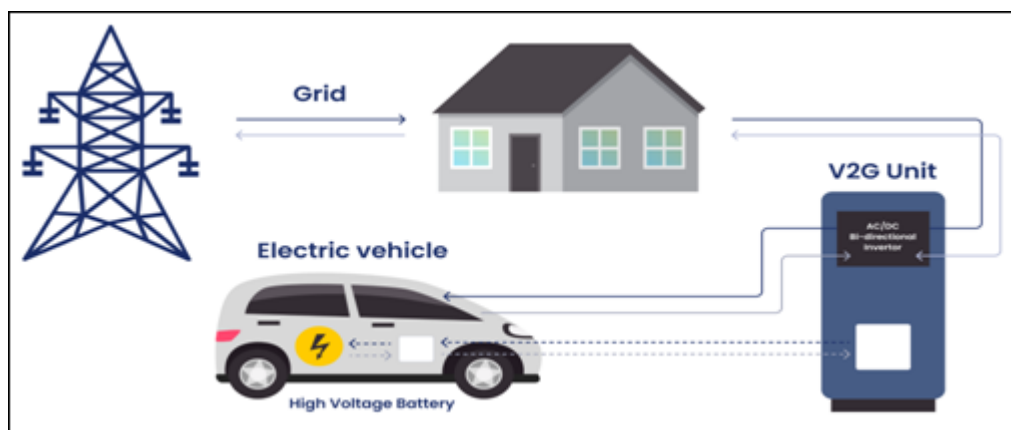


Figure 1

## 2. Bi-directional Charging

This is the key technology on which V2G model is running. Usually we saw one-directional charging technology, but in V2G technology, we need to get the power from the energy source and get back it to the source when it is needed. In off-peak demand time (usually 11pm - 7am), mostly EVs would get charged so they take energy from the grid. Here power is converting from AC to DC so we need a rectifier. That is called one-directional charging. Now, in peak demand hours (mostly 7am - 11pm), EVs can feed with their stored energy. Because here, power is converting from DC to AC so there is a need for an inverter. This two-way flow of energy is called bi-directional charging. It can provide bidirectional flow of energy for many applications like vehicle to building (V2B), vehicle to vehicle (V2V), vehicle to grid (V2G) and vehicle to others (V2X). Advantages of bidirectional charging technology are: save

money on energy use, store power for backups and create a portable power source etc.

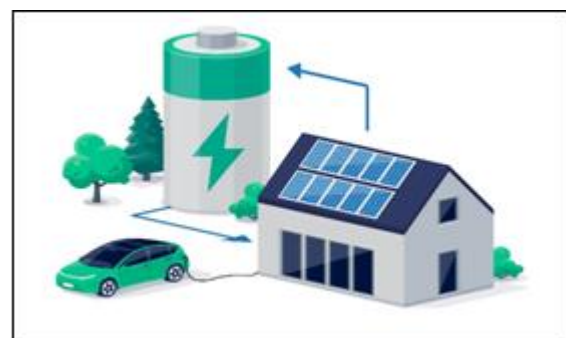


Figure 2

## 3. Virtual power plant (VPP)

A virtual power plant, which is called VPP in short, is a cloud-based power plant. VPP is made by combining

several Heterogeneous Distributed Energy Resources (DER). The purpose of this for enhancing the power generation, trading or selling power in the electricity market and demand side options for load reduction. DER assets would be solar power, electric vehicle chargers, water heaters, thermostats and appliances. VPP has the ability to provide the electricity during peak hours on a short notice. So therefore, it can replace the conventional power plants as it can provide higher efficiency with immediate response, which allows the system to react better during load

fluctuations. The demerits of VPP mainly is that it is a highly complex system so therefore it required high security and complex optimization. Some example of VPP existing countries are United States, Europe and Australia. According to the Pike research (2012), VPP market size is expected to grow from \$1.9 billion in 2022 to \$2.3 billion in 2023 at a compound annual growth rate (CAGR) of more than 22%. The virtual power plant market then expected to reach \$5 billion in 2027 at a CAGR of more than 20%.

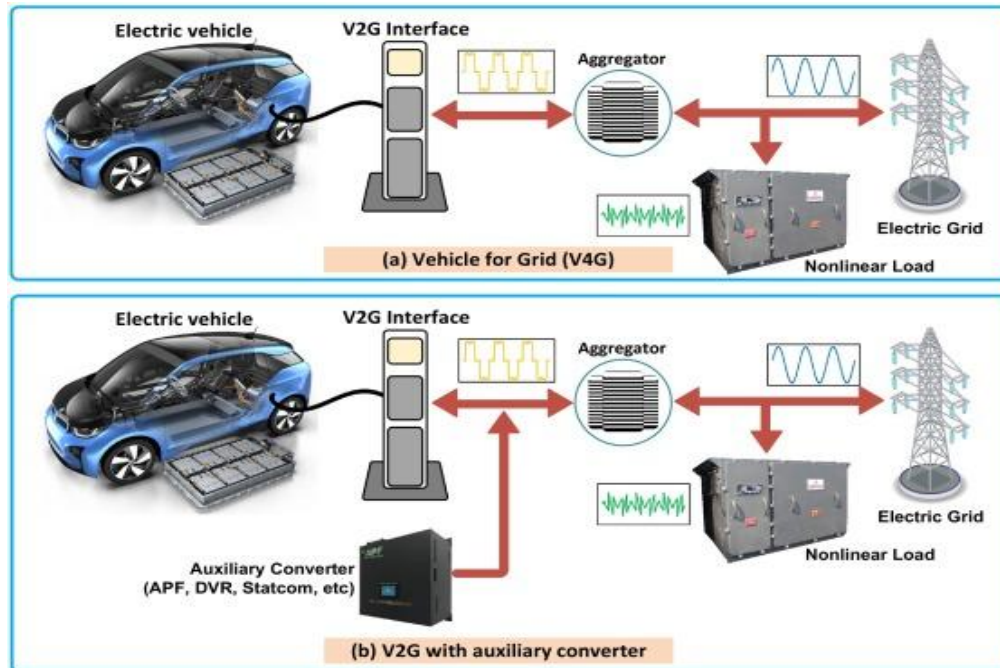


Figure 3

#### 4. Why are we using EVs battery pack for storing the energy?

As we know electric batteries have huge battery packs, these have high storing capacity as well. For example, one EV can provide three or four days electricity for a family home. Therefore, we found EVs battery packs for storing the energy. Normally, an EV has high - energy capacity like 10kwh, 30kwh and 100kwh. The quality of the EV battery is much better than a conventional battery because of using lithium material. A normal car spends a huge part of its life at the home or in the office. Therefore, we have enough space capacity and time for alternate use of their energy. A good advantage with EVs is that EVs already have good inverter DC to AC with frequency control. Bidirectional technology has already been adapted in electric vehicles. Electricity charging rate varies according to time, which are cheap at night and high during the day. Generally, Vehicles use to charge at night and stand in the office parking during the day. This gives a great opportunity of using energy on peak demand time. During peak demand, EVs will feed the grid by giving a small part of their storing energy in the battery packs and can make money by providing this service, so overall cost of EV will decrease.

Due to charging and discharging cycle of battery, life of the vehicle might be affected. But it is much better than rapid charging and discharging. So therefore, battery capacity will

not decrease but overall life of the battery will decrease. Overcome from this problem, Tesla is working on millions miles battery technology. According to Tesla's 2021 impact report, this battery is designed to last the life of the vehicle. Which the company estimates as roughly 200, 000 miles in the U. S. and 150, 000 miles in Europe. We can assume the results that means vehicles chassis will spoilage but battery not.

According to the research, battery loss its capacity when it getting rapid charging or discharging. But in V2G technology, vehicle gives slightly slow power supply to the grid so therefore Vehicles battery will not loss its capacity although loss its lifespan. These are some factors due to which we have used Electric Vehicle batteries as an energy stores.

#### 5. Merits of V2G technology

- This technology allows batteries from multiple vehicles to be combined into a virtual power plant (VPP). This combined energy can be sold on energy markets, or be used to provide as grid services during peak times that helps stabilize the grid and prevent blackouts.
- V2G technology saves fleet owners money by charging vehicle when electricity rates are low (usually at night) and can even power a building with low cost energy stored in the EV batteries.

- V2G technology generates revenue for vehicle's owner and reduces the overall cost of owning an electric vehicle by putting their batteries to use when parked and not being driven.
- This technology accelerating the adoption of EVs and helping integrate renewable energy into the electric grid. This would further reduce the greenhouse effect.
- V2G technology gives you the opportunity to use your energy in your way. It reduces the everyone's reliance on the energy companies. For example, you can fit a solar panel and use the V2G technology for your home, in this way your home would become a private mini power station.
- In V2G technology, Demand Side Response (DSR) is a programme, which has the purpose of balancing the use of energy around the country. It's a responsibility of DSR to setup the smart meters that will indicate the homeowners to control and reduce their energy use. On the macro level, businesses and large public sector organisations are being encouraged to save energy costs by reducing carbon footprints and adopt new technologies, which use less power consumption.
- By using V2G technology, any electric vehicle owner can make money by giving the energy to the grid during peak hours.
- V2G supports in balancing the grid and smoothly integrating renewables, it enables utilities to become less dependent from fossil fuel power plants. V2G technology helps utilities in reaching their sustainability targets.
- V2G solutions are expected to become a financially feature for utilities; they have a clear incentive to encourage consumers to take part. Consumers will be rewarded if they make their battery available to the utility to be used for V2G. This will result in a lower total cost of ownership.
- Fleet owners can make money with their fleet by putting back to the grid and reduce their energy costs by being more active in consuming the energy. While the stored energy can be used in case of a power outage, continuous operation is guaranteed.
- Additionally, costs to electric ratepayers are further reduced by limiting congestion on existing distribution infrastructure, reducing the need to build new fossil generation resources, and avoiding costly distribution system upgrades.
- Electric vehicles get the energy for charging from the sustainable sources of power generation. V2G chargers enable utility to provide voltage support services and its regulation to the grid.
- V2G enables electric vehicles to act as energy storage systems. Charging when grid frequency is rising and discharging when frequency is dropping. V2G chargers can respond with milliseconds, well within the grid operator limits.
- In off peak hours, vehicle starts charging for the purpose of load levelling and in demand peak hours it starts feeding the power grid for the purpose of load shaving. In this way, V2G technology works for the clean balancing of demand and supply of energy.

## 6. Demerits of V2G technology

- As we use bidirectional charging in V2G technology, due to more number of charging and discharging cycles this impact on the lifespan of EV battery.
- For V2G technology, a bidirectional charger is required. This type of charger is not widely use in EVs. Additional V2G connection required a special connection with grid it means that not all consumers or businesses can use this technology.
- This technology is newly in the market and rarely used so therefore vehicles owners should think about pros and cons of this technology before participating in this technology.
- In V2G technology, we need to install good smart meters, which are not easily available and need to work on the Electrical Safety because V2G works in a collective form of vehicles. If any fault occur in the system, it can affect all the vehicles and grid too.
- If we want smart working of V2G technology, there is need to use Artificial Intelligence (AI) with this technology. This AI will monitor the pattern of energy using by the consumer so that it can ready for the upcoming tasks. By using AI, it will become more complex.
- Electric Vehicles use the energy from the renewable sources but our reliability is more on the fossil fuels so we should need to develop infrastructure for renewable energy sources and it will take time.
- For V2G operation, Virtual Power Plant (VPP) is a basic need. These VPP has a very complex structure so therefore this will be a challenging part about making VPP.
- In V2G technology, vehicle owner can make money by selling its vehicles energy to the grid. If grid pays more money to vehicles owner for selling the energy so on the other hand the price of consuming the electricity will definitely arise. Therefore, government have to make rules and regulations about these tariffs.
- V2G technology required a big charging infrastructure. A reliable charging infrastructure will take many years of time to develop. To setup charging stations will be a big challenge for any country.
- This technology needs a huge amount of investment because of its dynamic structure. Many poor countries cannot afford this amount of investment.

## 7. Conclusion

Vehicle to grid technology has both pros and cons. As we studied above vehicles, owner can make by selling their vehicles energy to grid but they bear the reduction in vehicles battery lifespan. Vehicles manufacturers may be wary of warranty issues that could arise from this technology. V2G technology provides the idea to stabilize the grid and prevent blackouts. It can fulfil the peak demand however; it may strain the grid if many EVs plugged in at once. Ultimately, V2G technology is a promising but still emerging technology that has potential benefits and risks both. In future, V2G technology has many benefits for all countries, but it will take time to make this technology. To run this technology smoothly and successfully, tools like AI

(Artificial Intelligence) and machine learning will be required and government have to make law, rules and regulations which will need to be changed from time to time which would be a huge task. The essence is that this technology has many benefits, but it would have to face many barriers.

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