ENSTO

# V2G and V2H

## The smart future of vehicle-to-grid and vehicle-to-home

**September 2016**

**Better life.**
With electricity.

# V2G is the future. V2H is here.

V2G enables the flow of power between an electrical system or power grid and electric-powered vehicles, such as BEVs, PHEVs, or FCVs.

Smart charging solutions help the electric vehicle owner communicate with the power grid and manage the flow and cost of electricity.

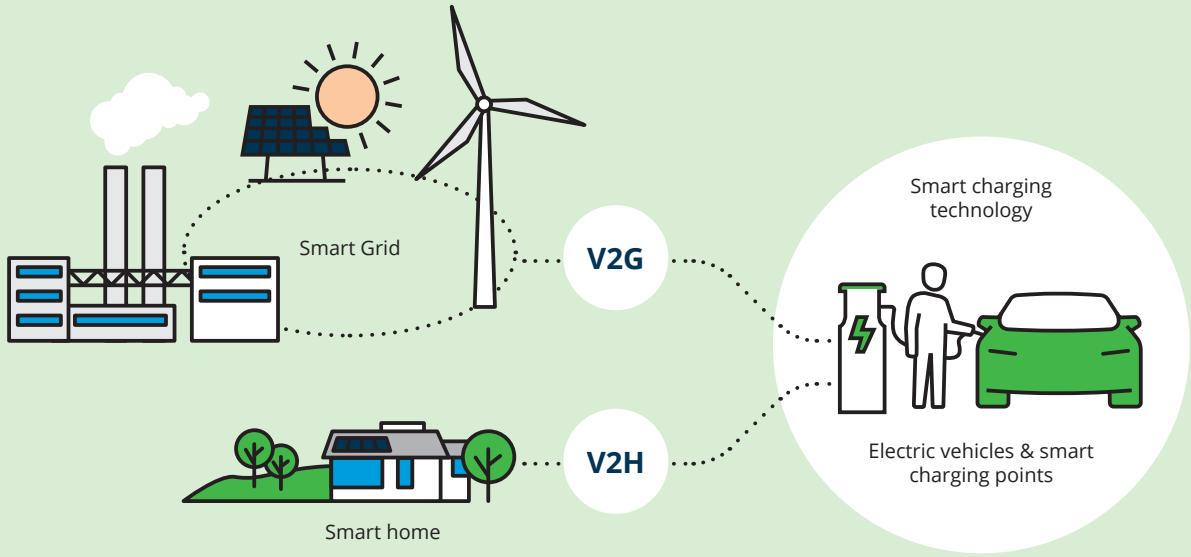
V2G technologies provide demand response services to the power grid. This enhances the efficiency of the system during peak load time and increases the stability of the grid.

The goal of V2G technology is to fully integrate electric vehicles into the power grid, improve the grid's capability to handle renewable power, and make renewable sources even more widely integrated and affordable.

Basic V2H technology is already in the marketplace. The Mitsubishi Outlander PHEV can supply electrical power to a home and can act as an emergency power source, using electricity stored in the vehicle's battery to run appliances in a power outage, at an emergency evacuation site, or at outdoor events.

The Mitsubishi power feeder supplies enough power to meet normal domestic requirements for a day from a fully charged battery, and up to 10 days with a full gas tank.

## Vehicle-to-Grid and Vehicle-to-Home



### The three main types of V2G

1. A hybrid or fuel cell vehicle, which generates power from storable fuel, uses its generator to produce power for a utility at peak electricity usage times. The vehicle serves as a distributed generation system, producing power from conventional fossil fuels, biofuels or hydrogen.

2. A battery-powered or plug-in hybrid vehicle that uses its excess rechargeable battery capacity to provide power to the electric grid in response to peak load demands. These vehicles can then be recharged during off-peak hours at cheaper rates while helping to absorb excess night-time energy generation. Here, the vehicles serve as a distributed battery storage system to buffer power.

3. A solar-powered vehicle that uses its excess charging capacity to provide power to the electric grid when the battery is fully charged. In this case, the vehicle effectively becomes a small renewable energy power station. Such systems have been in use since the 1990s and are routinely used in the case of large solar-powered boats.

## Good to know – useful initialisms

| BEVs | PHEVs | FCVs / FCEVs |
|---|---|---|
| Battery Electric Vehicles | Plug-in Hybrid Electric Vehicles | Fuel Cell Vehicles / Fuel Cell Electric Vehicles |

| V2G | V2H |
|---|---|
| Vehicle-to-Grid | Vehicle-to-Home |

### Vehicle-to-Grid (V2G)

Vehicle-to-Grid is the integration of an electric vehicle into the public power grid. By integrating many electric vehicles the overall stability of the grid can be increased. There is typically some payment to the vehicle owner for these services that offsets vehicle costs.

### Vehicle-to-Home (V2H)

Vehicle-to-Home is the integration of an electric vehicle into a smart energy home. The electric vehicle battery stores energy and intelligently feeds energy back to the home.

# What is the smart grid?

Power grids today primarily move electricity from central power stations to consumers. That is changing. The smart grid will intelligently bring together power generation and distribution assets for the mutual benefit of electricity producers, consumers and the environment.

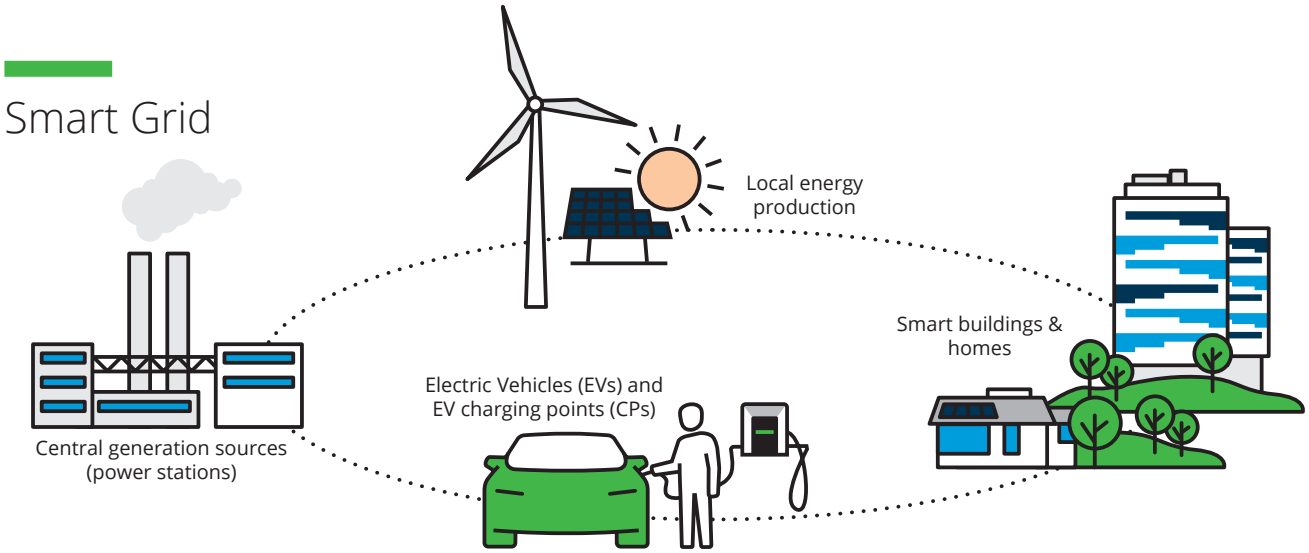
### Key components are:

1. Central generation sources (power stations)
2. Local intermittent renewable power generation sources (solar, wind etc.)
3. Smart buildings and homes
4. Electric Vehicles (EVs) and EV charging points (CPs)

The smart grids of the future will unify all these assets in a single system with the benefits of more efficient energy use and reduced emissions.

### Far more efficient use of available resources

Smart grids even out demand spikes, also known as peak load levelling. Smart grids use the resource mix more efficiently. They better integrate and balance all the available resources, including wind and solar power, as well as power fed back into the grid from electric vehicles and other sources.




"...when the electricity comes from a lot of different places, when consumers are producers, and when it's cloudy and the wind stops blowing, the grid has to get a bit wiser. Among other things, it has to be able to predict at what time everyone wants to charge their cars, and how to solve this on a freezing cold January night."

**Fortum, The Smart Grid**

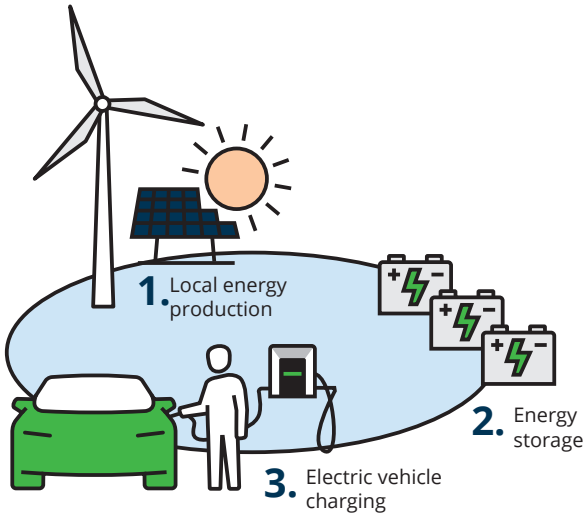
"The smart integration of electric vehicles to the grid will radically change the energy landscape, so that EV owners can actively contribute to the stability of their national grid and support renewable energy sources."

**Nissan**

"A smart grid is defined as the over-laying of a unified communications and control system onto the existing power delivery infrastructure to provide the right information to the right entity at the right time."

**Global Smart Grid Federation**

# The smart energy triple play of the future




The smart energy triple play

EVs are not the only fast growing area of the energy sector. The solar industry is booming. Businesses and private citizens are installing solar panels on their roofs with the aim of becoming independent from the energy grid, while saving money and reducing emissions. Total independence from the grid is still some way off for most but local production is becoming substantial in many areas.

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### The US solar power market will double in size in 2016

GTM Research shows that the US solar power market will grow 119% this year according to the latest U.S. Solar Market Insight Report, published in conjunction with the Solar Energy Industries Association (SEIA).

### German "Energiewende" policy to boost renewables reaches a turning point

On May 8th, 2016, German solar, wind, hydro and biomass plants supplied about 55 GW of the 63 GW being consumed (87%). German electricity prices turned negative. Some consumers were paid to use electricity for periods, with prices dropping as low as minus €50 per megawatt-hour.

In 2015, Denmark's wind farms supplied 140% of demand, while the UK had no coal-fired power stations meeting electricity demand for about four hours on May 10th as a result of plant breakdowns.

### How can you better utilize your energy production?

There are several ways that you can better utilize your own energy production when it is not used for your own consumption at the time of production. New technologies mean you can participate in utilities' virtual power plant programs, build you own local storage capabilities and utilize your electric vehicle battery for local production and storage.

# What does this mean for EV charging points at home, at work and in public?

For the success of the smart grid it is vital to have intelligent electric vehicle charging stations that can communicate with the smart grid.

EV charging stations need to be remotely managed, they need to be ready for bi-directional V2G and they need to be in use now.

Our electric vehicle charging infrastructure is being built now. If we invest now in "dumb" chargers that cannot communicate and that do not have V2G capabilities, these devices will need to be replaced to meet the needs of the smart grid. Investing in legacy chargers is also a massive waste of energy and defeats the object of developing sustainable smart charging infrastructure.

### Is a "dumb" charger worth it?

If a residential charging station today has no communications capabilities it cannot be easily integrated with, for example, solar panel controllers or smart home applications. These kinds of integrations shorten the payback time of solar panel systems, and drastically reduce power consumption from the grid when EV charging takes place during peak solar energy production.

### Renewable production is rising but unpredictable

Our entire energy system is facing huge challenges but there are many opportunities. The roll out of renewable energy production is substantially reducing $CO_2$ emissions. Unfortunately wind and solar energy production is unpredictable. There are times when production exceeds consumption and then there are situations when production is very low. This volatility has a direct impact on energy costs and availability. As energy systems become more reliant on renewables, the risk to system stability and possible black outs will increase.

### Integrate EV charging and the smart grid

One way to control consumption is to utilize EV batteries and charging. When there is a surplus of energy, EVs can be given incentives to charge. And when consumption is likely to exceed production, charging is stopped, reduced or energy is taken from the battery.

According to a study by Rocky Mountain Institute, if every light vehicle in the US became an EV, total US electricity demand would increase by about 25%. However, this could be done without increasing peak demand and it could reduce the unit cost of electricity by eliminating the need to invest in peak capacity.

### V2G has the potential to transform electricity consumption

- Let's take an example country with 100,000 EVs, each with an average battery size of 50 kWh
- Let's assume 60% of the EVs are connected to a smart charger and 1/3 of the EVs are charging with an average power of 10 kW
- Then the maximum storage capacity of all the connected EVs is 3,000 MWh
- When these EVs stop charging, consumption immediately decreases by 200 MW
- Bi-directional V2G would enable these EVs to provide 600 MW of energy to the smart grid

### Is this a realistic projection for V2G?

Norway is a country with less than 5 million people but already has over 100,000 electric vehicles on the road. If Norway could fully implement smart grid, smart charger and bi-directional V2G technology, this incredible energy return would be possible today.

The utility companies are making the grid smarter. We need to make sure that all EV chargers are smart chargers so that we can realise this potential.

# What does V2G mean for business decision-makers?

In order to build a successful renewable energy system and successful smart energy business it is important to invest in the right charging station infrastructure.

EV charging stations need to be smart. They need to be connected with remote management capabilities, and they need to be V2G-ready.

There are two key ways smart EV chargers can support the energy system:

- Firstly, EV chargers can provide data to energy companies about how much charging is occurring at a specific moment, which can then be stopped, reduced or increased, depending on the status of energy production across the grid.
- Secondly, smart EV chargers can be equipped with V2G and V2H-enabling hardware. This can enable energy companies to utilise EV battery capacity to do peak levelling and increase system stability.

**Invest only in future-proof hardware, open architecture and advanced connectivity**

Bi-directional V2G charging is still in its infancy, particularly with AC charging, as electric vehicle manufacturers are slow to release their roadmaps. Therefore, EV charging solution buyers should carefully consider how new chargers will be able to adapt to the demands of V2G and the smart grid in future.

We believe that V2G and V2H have a bright future and will significantly impact how societies generate and consume electricity. Together, we are becoming smarter about electricity use and we are getting smarter about the business. That change is all around us. We aim to stay at the forefront of that change.

If you have any questions about V2G, V2H or smart charging, please get in touch.

**www.ensto.com**

**Checklist for EV charging solution buyers**

When choosing an EV charging solution vendor or EV charging points, buyers should look for:

- Modular designs that are easy to upgrade
- Strong remote management capabilities
- Advanced connectivity options
- Flexible systems integration options
- Dynamic load balancing capabilities

**Ensto** is a leading expert in developing and manufacturing high quality charging products and services for electric vehicles, with operations in over 20 countries. Our focus is to support the development of sustainable electric mobility with energy efficient services and reliable, Smart Grid friendly products.

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