Cordence WORLDWIDE

Smart Sustainable Transport Electric Vehicles – a "Killer App" for Utilities?

A Cordence Perspective

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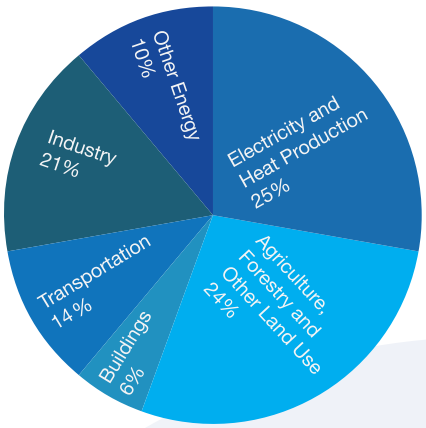
Electric Vehicles – More than Green Transportation

Traditional combustion engine vehicles account for about 14% of the world's greenhouse gas emissions[1], and dating back to the days of Henry Ford and the Model T, they have had a virtual monopoly on the automobile market.

Now after many years of fits and starts, the Electric Vehicle (EV) market is showing signs of coming into its own. Electric vehicles use energy stored in rechargeable batteries, which are recharged by common household electricity. Unlike a hybrid car—which is fueled by gasoline and uses a battery and motor to improve efficiency—an electric car is powered exclusively by electricity.

Global Greenhouse Gas Emissions by Economic Sector



In this paper, we will talk not only about the current state of the EV market and what is driving its growth, but will explore why EVs could become the "killer app" for utilities as a source of load growth and as an important tool for managing the grid.

The advance of the EV market is happening with both a push from policy makers and a pull from the market, as evidenced by:

- A growing infrastructure of public charging stations being put in place often primed with government and private support. In the US, the number of charging stations grew from 500 in 2008 to 16,000 in 2016, and in 2016, the US Federal Highway Administration announced that it was creating 48 national electric-vehicle (EV) charging corridors on nearly 25,000 miles of highways in 35 U.S. states [2].

- The cost of lithium ion batteries (which power EVs) has seen a 75% decrease over the past 10 years, and at the same time the density of batteries is rising[3], and Tesla has recently announced even bolder price reductions.

- Governments are putting in place incentives for the purchase and use of electric vehicles, such as the exemption from paying road taxes in the Netherlands and funding toward purchase costs of EVs in California.

- Tesla, is bringing excitement to the EV market with a stylish new car entrant – the Model S - that is changing the dialogue from buying for the sake of being green to buying for aesthetics and performance as well. When else has a new car unveiling generated long lines at show rooms?

1 Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, IPPC 2014

2 U.S., 35 states to boost electric vehicle charging network, Reuters, November 3, 2016

3 Report: Global EV Outlook 2016 - Beyond One Million Electric Cars, Electric Vehicles Institute, 2016

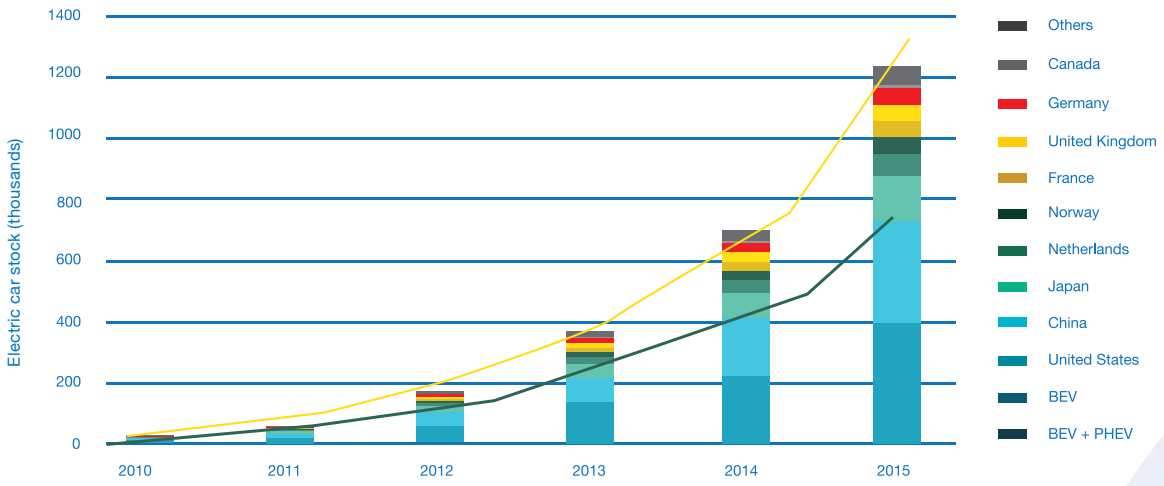
When we talk about Electric Vehicles we mean two classes: Plug-in Hybrid Electric Vehicles (PHEVs) and Battery Electric Vehicles (BEVs). Both have the capability to plug into the power grid and in this way they can both charge and discharge their power to and from the grid.

While hybrid cars, like the popular Toyota Prius, have a lower carbon footprint than traditional combustion engine vehicles, hybrids do not "plug in" into the grid, and therefore do not draw power from the electrical distribution system nor can they act as a service to better manage the grid. As shown below, the global stock of this Electric Vehicle category is growing rapidly.

In 2015, the stock of Electric Vehicles topped 1,000,000 cars for the first time with some countries such as Norway and the Netherlands leading the way in per capita ownership [4]. After a couple of sluggish years, the EV market in the US grew by 36% - much of this driven by Tesla (the Model S was the top selling EV in 2016 in the US).

Tesla, Model S

Evolution of the global electric car stock, 2010-15



Note: the EV stock shown here is primarily estimated on the basis of cumulative sales since 2015.
Sources: IEA analysis based on EVI country submissions, complemented by EAFO (2016), IHS Polk (2014), MarkLines (2016), ACEA (2016a), EEA (2015) and IA-HEV (2015)

4 Report: Global EV Outlook 2016 - Beyond One Million Electric Cars, Electric Vehicles Institute, 2016

Electric cars (battery electric and plug-in hybrid), market share by country, 2005-15

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Canada							0.0%	0.1%	0.2%	0.3%	0.4%
China						0.0%	0.0%	0.1%	0.1%	0.4%	1.0%
France							0.1%	0.3%	0.5%	0.7%	1.2%
Germany							0.1%	0.1%	0.2%	0.4%	0.7%
India						0.0%	0.0%	0.1%	0.0%	0.0%	0.1%
Italy								0.0%	0.1%	0.1%	0.1%
Japan					0.0%	0.1%	0.4%	0.5%	0.6%	0.7%	0.6%
Korea							0.0%	0.1%	0.1%	0.1%	0.2%
Netherlands						0.0%	0.2%	1.0%	2.5%	3.9%	9.7%
Norway				0.2%	0.1%	0.3%	1.5%	3.2%	5.8%	13.7%	23.3%
Portugal							0.1%	0.1%	0.2%	0.2%	0.7%
South Africa											0.1%
Spain							0.1%	0.1%	0.1%	0.2%	0.2%
Sweden							0.1%	0.3%	0.5%	1.4%	2.4%
United Kingdom							0.1%	0.1%	0.2%	0.6%	1.0%
United States						0.0%	0.1%	0.4%	0.6%	0.7%	0.7%
Others*							0.0%	0.1%	0.1%	0.3%	0.7%
Total**				0.0%	0.0%	0.0%	0.1%	0.2%	0.3%	0.5%	0.9%

*Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Iceland, Ireland, Latvia, Lichtenstein, Lithuania, Luxembourg, Malta, Poland, Romania, Slovak Republic, Slovenia, Switzerland, Turkey

**The total market share is calculated for all the countries covered above

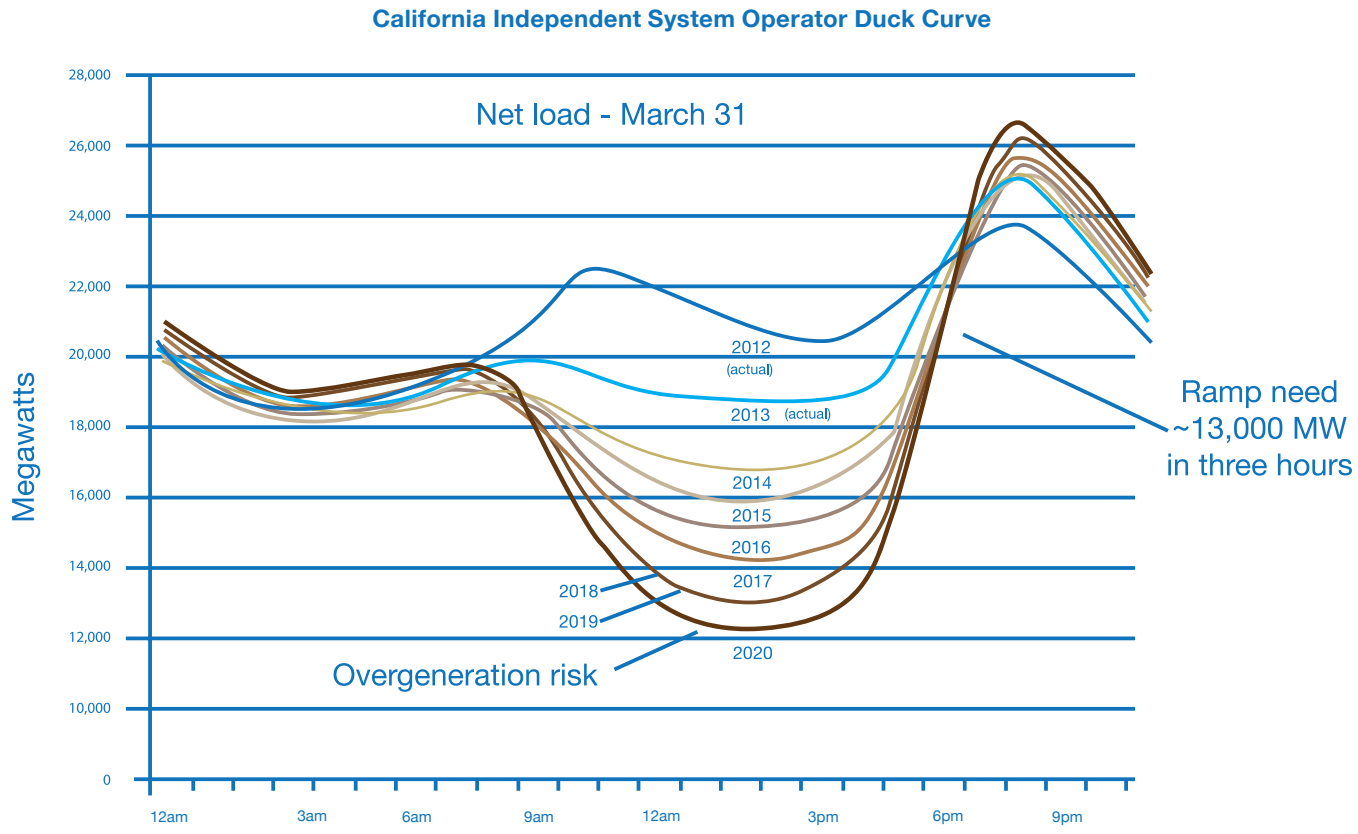
Electric Vehicles – More than Just Transportation

Grid operators are eyeing the rise of EVs with more than just an academic eye

EVs may put some stress on electrical distribution equipment in neighborhoods with high EV penetration, but more importantly EVs mean a growth market in an electric industry that has been anemic since the 2008 recession, and EVs may be a potential secret weapon to manage the grid of the 21st century.

As of February 2017, more than 580,000 EVs have been sold in the United States, representing approximately one terawatt-hour (TWh) of annual electricity consumption. According to Bloomberg New Energy Finance, EV power consumption is projected to increase to approximately 33 TWh annually by 2025, and 551 TWh by 2040. (Source: Bloomberg New Energy Finance) To understand why, let's consider what's happened on the grid over the past 5-15 years. One significant change is that we are seeing a much higher degree of penetration of renewable energy connected to the grid. Whether you are driving through the mountains of Galicia Spain, wheat lands in the US Pacific Northwest or near the coast of China, you will see the expanse of wind turbines that are providing more and more of the world's electricity. And in countries like Germany, there has been a tremendous build out with solar power topping 40,000MW of nameplate capacity. It seems that everywhere you look 'renewable energy' is becoming a reality.

But while wind and solar provide carbon-free power, these energy sources are intermittent and produce at the whims of weather and turning of the earth. In the middle of the day, a region may have more solar power generated than needed, and when the sun goes down there may not be enough electricity as people arrive home from work and turn on appliances and energy demand ramps up sharply. California is already experiencing this phenomenon with the now famous Duck Curve as shown here.



This is where EVs come in

Since electric vehicles can connect to the grid in what is known as Vehicle-to-Grid (V2G), electric have a variety of services that they can provide. With the right pricing structures in place:

- An EV owner can respond to a price signal to charge their vehicle when power is abundant and electricity prices are low (mid-day hours or the belly of the duck shown above).
- Conversely, an EV owner can opt to not charge their car during a peak time when prices are high and there is stress on the system (the neck of the duck in the early evening when net load spikes).

Utilities are not ignoring this opportunity, as it doesn't take a lot of math to imagine a fleet of 20,000 EVs that provide 20 Megawatts of power reduction or injection to the system. This is the equivalent of the amount of power consumed by 25,000 homes. Utilities are testing this idea of V2G. Pacific Gas & Electric (PG&E), for example, is piloting the use of EVs for V2G services with BMW in a program called BMW ChargeForward. For an incentive payment, consumers allow PG&E and BMW to modify their charging time. The initial test group of 100 customers reported a 92% satisfaction rate with the program.

For V2G to become a reality a number of conditions will need to be in place:

- Scale – the EV market must continue to grow.
- Technology infrastructure needs to be built.
- Rates & policies need to provide incentives.
- Consumers need to feel it's worth it to participate.

In each of the areas, we are seeing car manufacturers, policy makers, innovators and consumers come together with a common goal of making EV more than just a hobby car.

Opportunity for an Industry under Siege

It's still early in the game, but V2G is an example of a way in which utilities can succeed in the 21st century.

Today, utilities are under siege: there is competition from new entrants who sell power directly to large commercial buyers like data centers, technology giants like Google are entering the home and offering to help people manage their power, and millions of consumers are becoming "prosumers" generating their own solar power (and when combined with a home battery, consumers may perceive less need from their local utility). The risk is that utilities go the way of the land line telephone companies.

- V2G could help increase sales in an industry that in many parts of the world has been flat or growing at less than 1% for years. Note – battery charging consumes more power than tall the other appliances in a typical home.

- V2G could also mean a new way for utilities to connect with consumers. The utility, with its "wires and meter infrastructure" and traditional customer relationship, is in a unique position to help the consumer by offering incentives to charge or discharge their EV storage during times of need, or facilitating charging infrastructure at home.

Cordence Worldwide Helps Clients Integrate New Resources like Electric Vehicles

Around the globe, Cordence Worldwide, management consulting partners aret helping energy companies and automobile manufacturers think of new ways to bring value to their customers, including the convergence of electricity and new devices, like electric cars.

In the United States, Cordence Worldwide Partner, North Highland, assisted the nation's largest investor-owned utility (IOU) to form an Electric Vehicle team within its Smart Energy department. One of the initial goals of the Electric Vehicle team was to develop a feasible strategy and approach that would enable this IOU to support the impending electric vehicle growth. North Highland partnered with the Director of Electric Vehicles to develop the electric vehicle strategy. Together with the client, a three-pronged strategy addressing the utility-to-consumer, utility-to-business, and utility-to-government components was developed.

Elsewhere, Cordence Member firms have assisted a very large government electric utility (more than 20GW of nameplate capacity) devise its strategy to integrate new "demand side" devices coming on the grid including battery storage. Knowing that the utility operators have high standards to "keep the lights on" for their customers, Cordence Member firms worked with the client to lay out a proof of concept model that would bring confidence to power and transmission operators. Success measures were set across key criteria including: (see figure on the next page).

The team piloted demonstrations (two that were national award winners) that showed how demand side devices could help smooth the sharp ramps of wind that could go from 4500MW to 0 MW in less than an hour, or inject stored battery energy into the grid during cold winter mornings and afternoons when extra generation sources are needed. In this case, Cordence/ North Highland built and demonstrated a portfolio of more than 150MW of demand side resources and helped the client see the promise of a greener future.

Customer Acceptance (Are end-customers open to participating on the grid?)	✓
Reliability (Can we count on the resource when needed?)	✓
Cost Effectiveness (Cost relative to other generation resources?)	✓
Operationally Feasible (Can we measure what is happening with the new resource?)	✓
Availability (Is the resource at a scale to be meaningful to the grid and in the right locations?)	✓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