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next-dimension's comments on the California Assembly Bill 2127 Electric Vehicle Charging Infrastructure Assessment (Staff Report

Additional submitted attachment is included below.

Comments
on the California Assembly Bill 2127
Electric Vehicle Charging Infrastructure Assessment
(Staff Report)

Bjoern E. Christensen
next-dimension
bjoern@nextdimen.com
www.next-dimension.org

TABLE OF CONTENTS

1. INTRODUCTION

My name is Bjoern E. Christensen, and I am the Managing Director of next-dimension. next-dimension is a California based consultancy company focusing on E-Mobility, VGI (V2G) and CO_2 reduction. Prior to founding next-dimension, I served as the Chief Strategy Officer at Nuvve, working closely together with Dr. Willett Kempton, the "father of V2G". In my role at Nuvve, I was a key driver in propelling V2G forward through projects in several different countries, laying the foundation to scale V2G solutions globally. Before Nuvve, I served as President & CEO of Siemens Venture Capital and was responsible for all worldwide open innovation and corporate venture investments made by Siemens AG.

I have spent the last 10 years working on state-of-the-art V2G projects and commercial deployments around the world, including Hong Kong, Denmark, Holland, UK, Japan, USA (PJM), USA (CEC project INVENT), Australia and Namibia (Africa).

I was the key driver in working with United Nations Development Programme (UNDP) to conduct the world's first V2G trial in Africa at the UNDP headquarters in Namibia in 2019. This project serves as a showcase for E-Mobility and VGI (V2G) in Africa, as Africa is the world's fastest growing population and is projected to reach 4 billion people by 2100. UNDP recognized the need to address E-Mobility in Africa if the world should have any chance of reaching the Paris Agreement goals.

2. PREFACE

next-dimension is pleased to have the opportunity to provide comments and feedback on the "California Assembly Bill 2127 Electric Vehicle Charging Infrastructure Assessment (Staff Report)" from January 2021.

In general, we support the report's sound recommendations on the need analysis and roll out scenarios for the charging infrastructure to support the goal of having 5 million ZEVs on the road in 2030.

This document focuses on the role bi-directional (V2G[1]) enabling technology can play in the scenarios. After all an EV battery is a terribly thing to waste for only transportation. A V2G enabled vehicle can be used to support the grid and many other applications as well.

This feedback is based on the author's more than 10 years of V2G project experience and active participation in the worldwide V2G eco system.

V2G is a powerful enabling technology, which we should use and support wisely. Now is the time to intelligently consider how to update the electric grid and to some extent the transport sector for the next generations. V2G will open up for new apps that we don't even know about today just like the internet eventually created the likes of Google and Facebook.

It is up to all the stakeholders to determine which role V2G will play in our future grid. Our goal is to design the resilient, flexible, distributed and efficient electric grid for the next generations, so we better get it right. And we have little time to do it. No more V2G trials are needed, and we need to streamline or remove regulatory barriers for scaling.

[1] V2G is used to denote EV bi-directional power flow (V2L, V2H, V2B, V2G)

Chapter 9 of this document lists the concrete recommendations to CEC on how to make sure that V2G technology will be considered with the right priority it deserves. Some of the recommendations may overlap with the ones made in Chapter 5 of the Assessment Report.

3. THE BIG PICTURE

The Paris agreement foresees that the world keep its temperature rise well under 2-degree Celsius and aiming for 1.5 degree. Since the transportation sector is by far the largest emitter, electrification of the vehicles will play a major role in California meeting its target of carbon neutrality by 2045.

We have learned from the covid emergency that we can indeed react fast. Government (vaccine regulatory approval, lockdown mandates..), business (vaccine production in record time), schools (distant learning) and the general population (work from home, reduce travel, social distancing).

Now California is facing a climate emergency and we have to act rapidly and with greater urgency. Wildfires don't wait for us to get our act together.

Recent years have brought us ample demonstrations of what mother nature can do to our infrastructure. Hurricane Sandy ($70 billion, people without power for 14 days); Paradise fire ($16 billion, 87 people dead) and lately Texas freeze (human damage and cost still unknown).

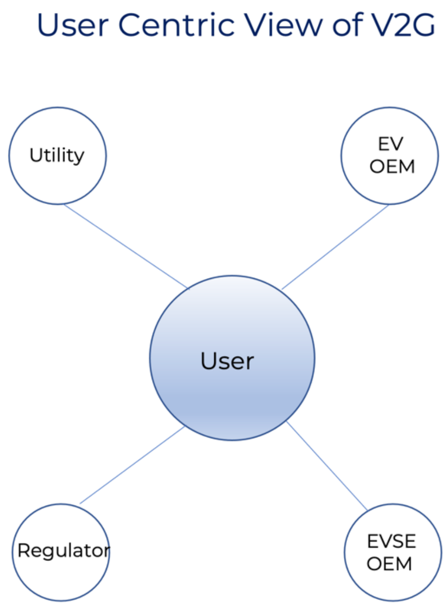
V2G technology can enable more renewable energy in the grid, make it more resilient and lower the cost of EV ownership. It is a well proven technology and product prices are rapidly coming down. What is holding V2G back are not technical barriers but the slow speed of the regulatory regime and resistance from utilities to embrace the new technology. Regulation must not become a bottleneck to fully deploy V2G technology. Wildfires or PSPS events do not wait for us to get ready.

4. USER CENTRIC VIEW

The user perspective is largely absent from the Assessment Report, but it is an important aspect to consider when rolling V2G solutions out.

The user wants to make energy simple and personal. He may have a smart home so why can his energy not be smart as well. The user want to be free to use energy when and how much they want and not let the utility determine their lifestyle. In short make energy personal and include home, solar and electric car just as he has his personal computer and laptops. An analogy is the mainframe versus the PC - "a computer on every desk". Use energy without compromise. Users don't care about the grid (except when power goes down at his house). "I have the right to use clean energy as I wish. Take complexity out of energy and don't change my lifestyle drastically." Instead of utilities driving users it should be users and markets driving utilities.

Let's start with the user of the energy. To set the stage this document will take a user centric view of energy instead of a utility point of view.



5. USER REQUIREMENTS

The main user energy requirements can be stated as:

1. Emergency power for energy resilience
2. Go green – use clean renewable energy (reduce CO_2)
3. Reduce home electricity costs (Time-of-Use - TOU)
4. Business want to reduce total electricity cost i.e., for building and EV fleet (Demand Charge)

V2G can serve to satisfy these user requirements as will be detailed in Chapter 7. And what is good for the user is good for the society and should also be good for the utilities.

6. BUILDING ON EXPERIENCES FROM OTHER PROJECTS

6.1 Danish V2G projects

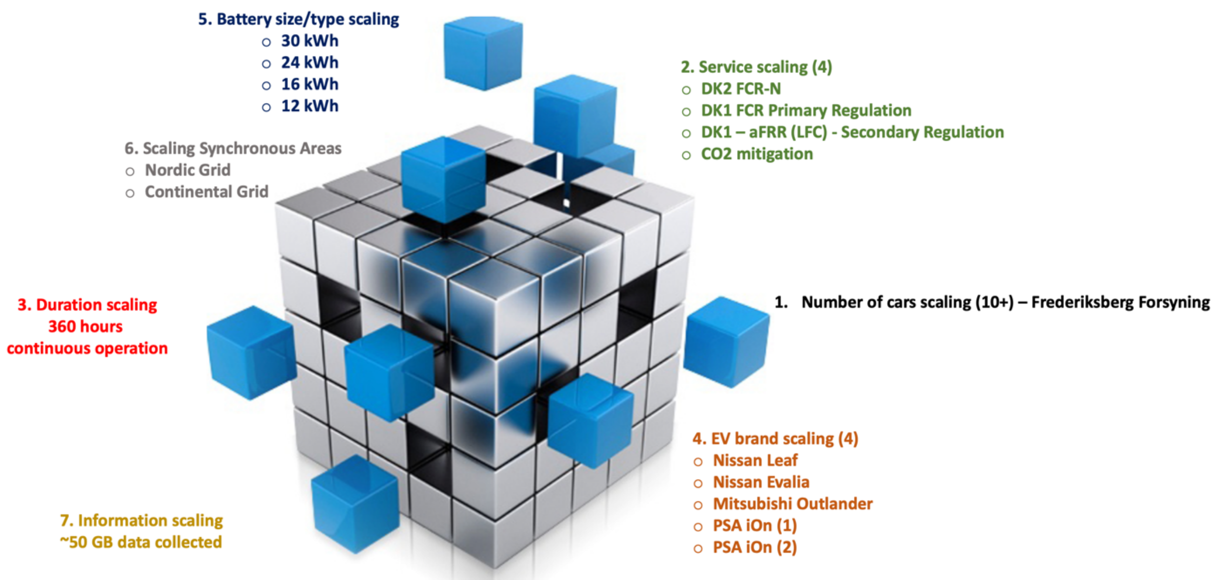
Moving V2G forward it is important that we build on previous experiences from around the world. The following describes two important V2G projects in Denmark led by the Danish Technical University (DTU - https://www.dtu.dk/english) that led to important discoveries about V2G and expanded the knowledge considerable.

The Nikola project in Denmark started in 2015 (https://nikola.droppages.com) with the goal of investigating how electric vehicles can be integrated intelligently in the Danish electric grid.

The Danish grid has a large percentage of renewable wind resources that are placed throughout the country including many off-shore wind farms. Denmark is part of the Nordic Synchronous Region (Sweden, Norway, Finland) and experiences frequent, often longer duration, frequency deviations (from 50 Hz) that need to be contained. This is mainly because of the large penetration of renewables in the Nordic region. Furthermore, Denmark has an open energy market, a transparent and fair market model and a progressive and flexible regulation body. These were the main reasons to conduct the project in Denmark.

Two Nissan e-NV200 (24 kWh) and two Enel bi-directional chargers (10 kW) were aggregated by Nuvve's GIVe V2G aggregator to provide frequency regulation to the Danish TSO Energinet.

The subsequent Parker project started in 2017 (https://parker-project.com/worlds-first-cross-brand-v2g-demonstration-conducted-in-denmark/) and showed the world's first EV cross brand V2G demonstration. Different brand vehicles from Peugeot, Nissan and Mitsubishi were aggregated by the Nuvve aggregator. The project scaled the Nikola configuration from 2 to 10+ EVs to investigate how the V2G solution scaled in different dimension as shown in the picture below. Scaling in 7 dimensions were investigated and showed that the V2G solution was highly scalable.



6.2 Other reports on charging infrastructures outside California

Similar to Chapter 4 of the Electric Vehicle Charging Infrastructure Assessment (Staff Report) a number of similar studies and modeling have been done in other countries.

Denmark

The DTU and Danish EV Alliance have produced a report on charging infrastructure in Denmark with the title "Smart from Start" (Smart From Start - unfortunately only in Danish). The report makes recommendations on how to deploy charging stations to cope with goal of having 700,000 to 1 million EVs on the road in Denmark by 2030. One of the report's main conclusions was to mandate that all chargers installed be capable of supporting future standards via over-the-air software updates.

Germany

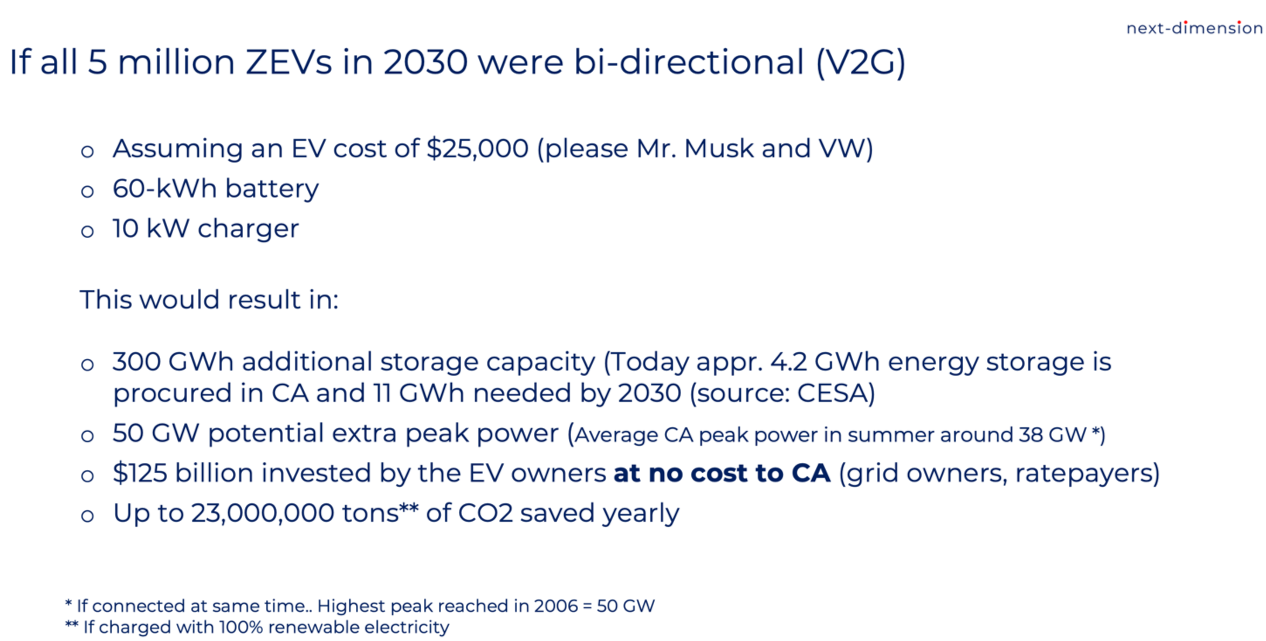
Allgemeiner Deutscher Automobil-Club (ADAC) and Ludwig-Bölkow-Stiftung released a comprehensive study "A coordinated infrastructure for the supply of battery and fuel cell cars in Germany" (*E-Mobility*

Infrastructure Germany). The report models the costs and how to establish a charging infrastructure that can cope with 40 million ZEV by 2050. 3 Scenarios were investigated: 1) 80% BEV (Battery Electric Vehicles) and 20% FCEV (Fuel Cell EV); 2) 20% BEV and 80% FCEV; 3) 50% BEV and 50% FCEV. The report models the charging infrastructure to support the 40 million ZEVs and investigates the need for grid updates in the distribution grid (low and middle voltage) in urban and land districts through Germany.

7. WHAT ROLE CAN V2G PLAY IN 2030 AND BEYOND

7.1 A "what-if" V2G scenario for 2030

V2G EVs can greatly increase the amount of storage in the grid as shown in the figure below. This is at no procurement costs to the grid operator since the EVs (with the battery) have already be paid for by the EV owners. If all vehicles were bi-directional we could add 300 GWh storage capacity to the grid at an investment by the EV owners of $125 billion. As a reference California has today procured 4.2 GWh and 11 GWh are needed by 2030 (source CESA). The V2G EVs could also add additional 50 GW power to the grid[2].



[2] If connected to the grid at the same time. Average CA peak power in summer around 38 GW and maximum peak was reached in 2006 at 50 GW

7.2 A silver bullet V2G use case – The Energy Resilient Vehicle (ERV)

A V2G EV could provide critical emergency power for families and communities to cope with the effects of a Public Safety Power Shutoff (PSPS) wildfire situation in California. School buses provides a good example due to their large batteries and use patterns. The value of this service is hard to define since it is highly dependent on each person's risk tolerance. But a hypothetical PSPS scenario is illustrative.

"Mrs. and Mr. Jones hear on the TV in October 2019 that there may be a proactive power shutoff the next day that may affect the area where they live in their house. The PSPS - PG&E explains - may be necessary because of dry hot weather, strong winds and vegetation that is bone dry from a scorching summer and to avoid that the electric grid ignites wildfires, which have been the case in previous years. The next day after-noon the Jones receives a call from PG&E saying that their area actually will be cut off from power starting at 8pm and that the power outage may last up to 5 days!

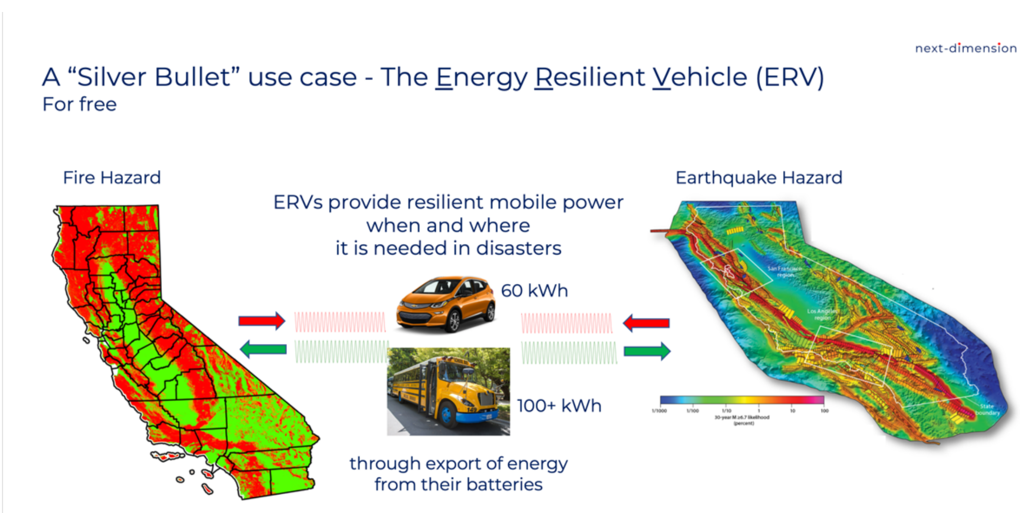
The next day's turns into a nightmare for the Jones. After the first 24 hours the food in the fridge has to be discarded. The same goes for the food in the freezer after 48 hours. Since there is no power to their house and the telephone system is down as are the cell towers Mr. Jones cannot work from home as he normally does and has to commute to his work 2 driving hours away (assuming that his workplace has power). Since he does not want to spend up to 4 hours driving to and from work he decides to book into a hotel close to his workplace.

After a week without power the power returns and the Jones decides to take stock of the costs. The food that was discarded amounts to $500. The hotel costs and meals outside the home to another $400. So, the total cost is in the neighborhood of $900 for this PSPS event, not to mention the discomfort of being without communication and Internet services, no light and heat and security system not working since its battery is empty.

Let's use this hypothetical example to estimate the aggregated costs to the California population living in the PG&E area just focusing on the discarded food cost:

Monetary costs alone: 800,000 households affected @ $500 = 800,000 * 500 = $400 million!

And what about the people relying on grid power for their medical equipment and the old folks' homes, and the lost work income..... And many of these people are economically disadvantaged making the burden even more disproportional."



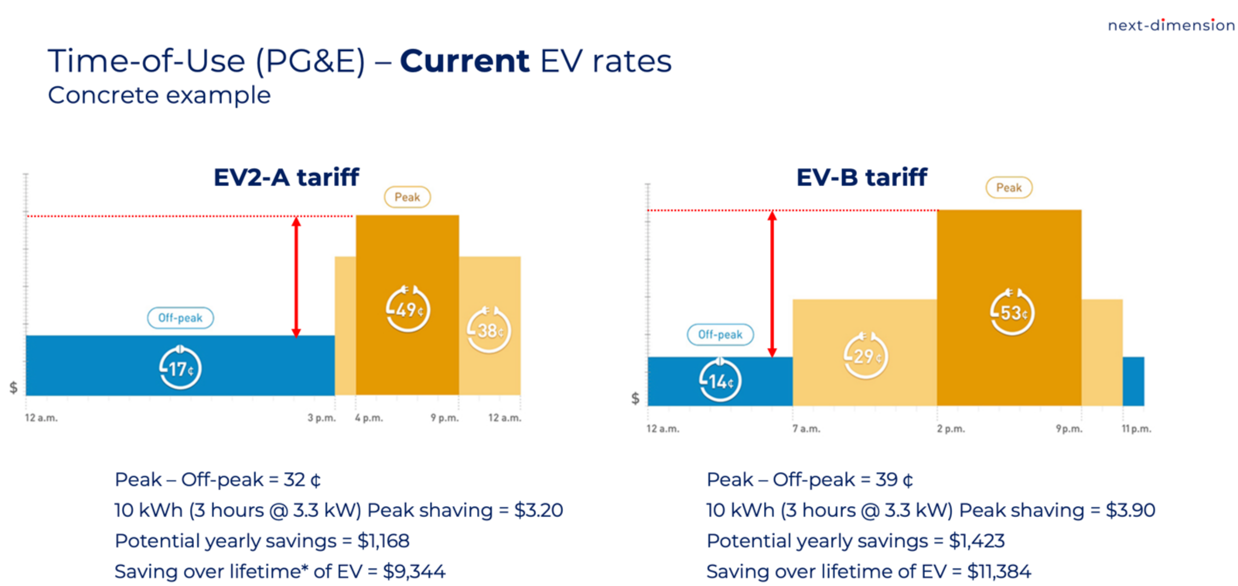
7.3 V2G use case – Grid Services - Frequency Regulation

V2G technology can reduce the cost of ownership for an electric vehicle by earning revenues from participation in ancillary services like frequency regulation. This service becomes more and more important to the grid stability as traditional powerplants are retired and the inertia in the grid decreases leaving the grid more vulnerable to grid disturbances. EVs can react very fast and provide fast frequency regulation in the sub second domain. Nuvve has shown that an EV can earn ~ $1,830 per year by participating in frequency regulation normal services (response time 5 seconds) in Denmark. This would yield a revenue of $14,640 over an 8-year lifetime of the vehicle.

V2G could also deliver valuable services to the Distribution System Operator like: Voltage support, congestion relief, deferral of grid investments. Value varies per DSO.

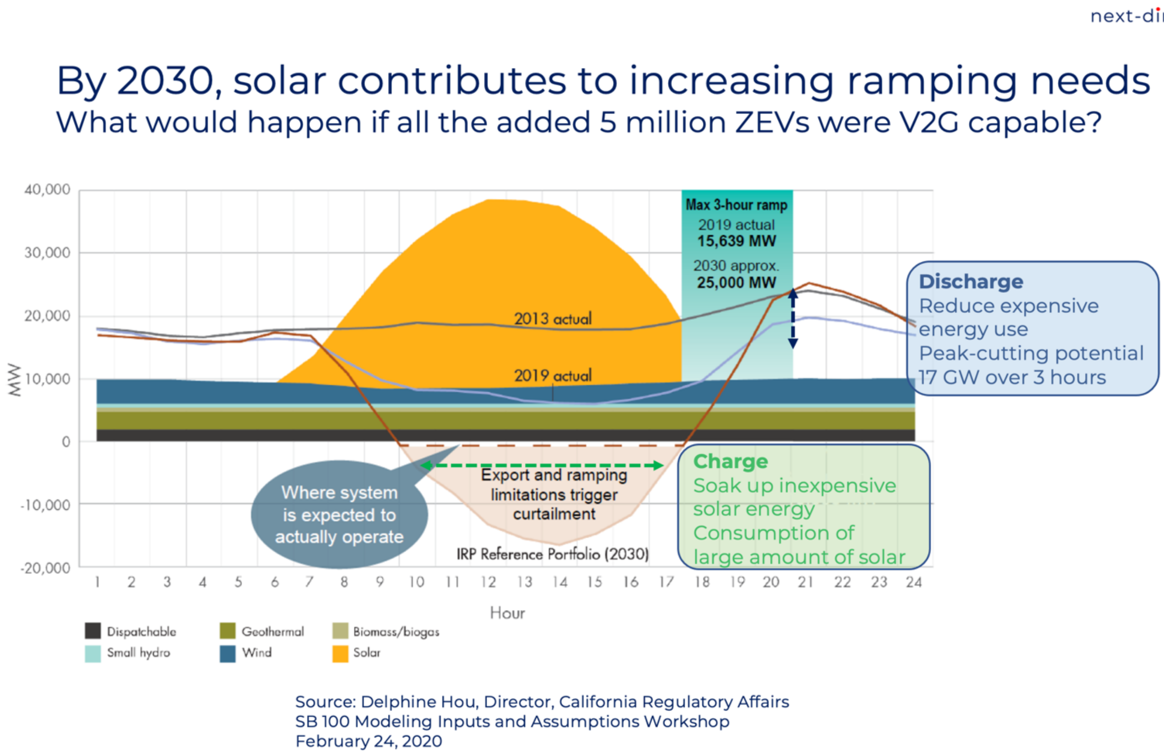
7.4 V2G use case – Time-of-Use

V2G technology can reduce the cost of ownership for an electric vehicle by providing Behind-The-Meter services to reducing energy bills. Charging at daytime (home or work) at low cost and discharging at peak may reduce the energy bill substantially. The arbitrage between peak and off-peak is 0.31 cent (EV2-A tariff) which could amount to an energy savings of more than $9,000 over the lifetime of the EV.



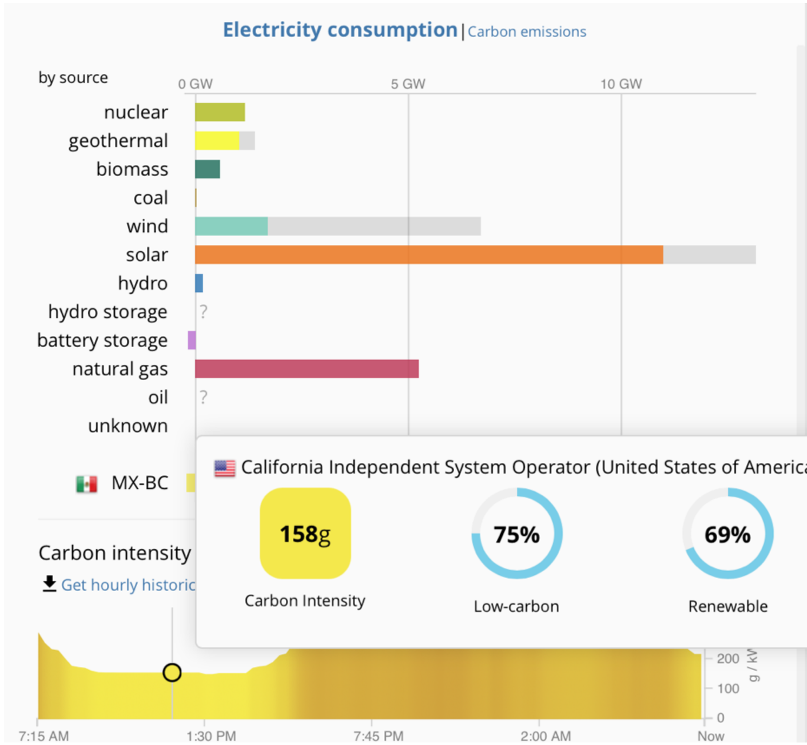
The actions of the users to reduce their electricity bill will also benefits the grid to tame the Duck Curve. V2G[3] technology will also help to absorb the abundant amount of solar power during the day (fill the belly), so it does not have to be curtailed or exported as shown in figure below. It can also significantly bend the neck of the Duck Curve by discharging at peak.

[3] V1G can also absorb solar energy but cannot discharge later at peak

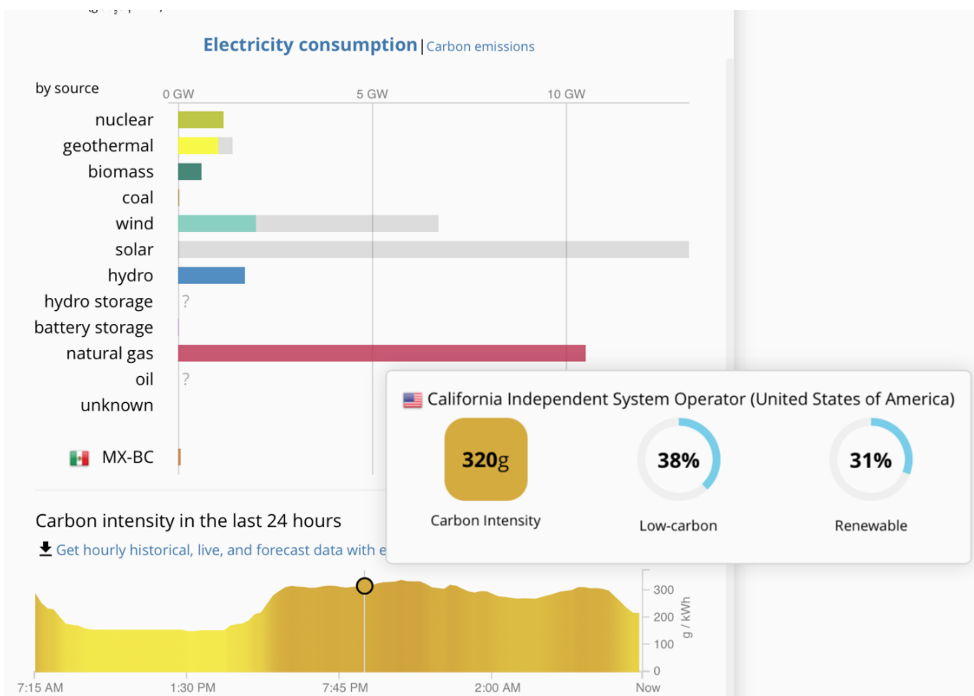


7.5 V2G use case - CO_2 reduction

V2G technology will also help reduce the carbon emission by charging solar energy during the day and discharging between 6pm and 9pm in the peak period with high CO_2 emission. In California the typical CO_2 emission per kWh during the daytime is 158 gram and at peak time 320 gram (see figures below). A difference of 162 gram/kWh. If 10 kWh were discharged in peak time (3.3 kW over 3 hours) the CO_2 savings would amount to 1.62 kg CO_2 saved, 591 kg per year and 4,730 kg over an 8-year lifetime of the EV.



California Electricity Consumption – 12pm (Source Electricitymap)



California Electricity Consumption – 8:30pm (Source Electricitymap)

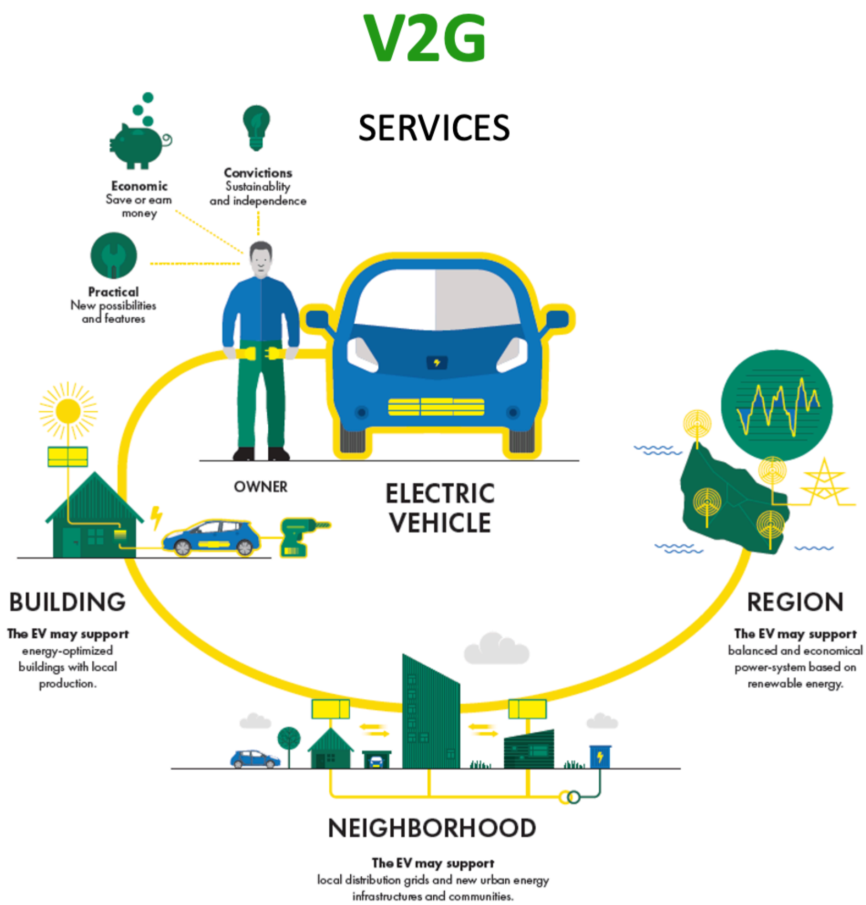
7.6 Demand Charge reduction

A considerable part of a company's monthly electricity bill is from Demand Charges. By using V2G vehicles to lower the daily peak consumption (measured over every 15 minutes interval) the electricity bill can be substantially lowered. A 10-kW reduction of peak could yield a savings of $400/month @ 6 months = $2,400/year * 8 = $19,200 over lifetime of the EV (highly dependent on grid operator tariffs, building load profile and number of EVs in fleet).

7.7 V2G service taxonomy

The user buys an EV for transport. If the vehicle is V2G capable the user can choose to offer V2G services to 1) his house/building; 2) the community; 3) to the grid (region). If the grid operators want to take advantage of this battery capacity they must offer easy to understand and competitive tariffs so they can compete with applications for the house/building (Behind-the-Meter - BTM). BTM services will generally have fewer regulatory burdens than grid services which put additional pressure on streamlining the regulations (like with solar[4]) and offer fair and competitive rates for V2G services.

[4] SCE Implemented standards and processes to scale 1,000 solar installations per month in 2-3 days approval process. Source: Forbes California has already scaled solar to more than 1.2 million installations



Source: The Parker project, Denmark

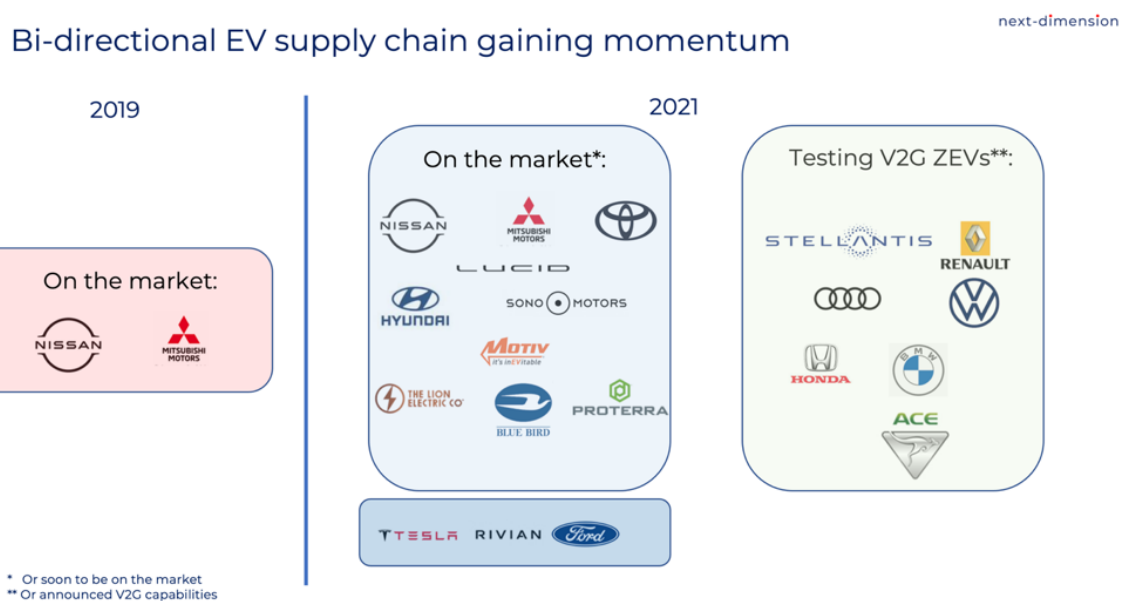
8. CURRENT STATUS OF V2G

8.1 V2G technology is here and now and has been proven in many project and commercial deployments.

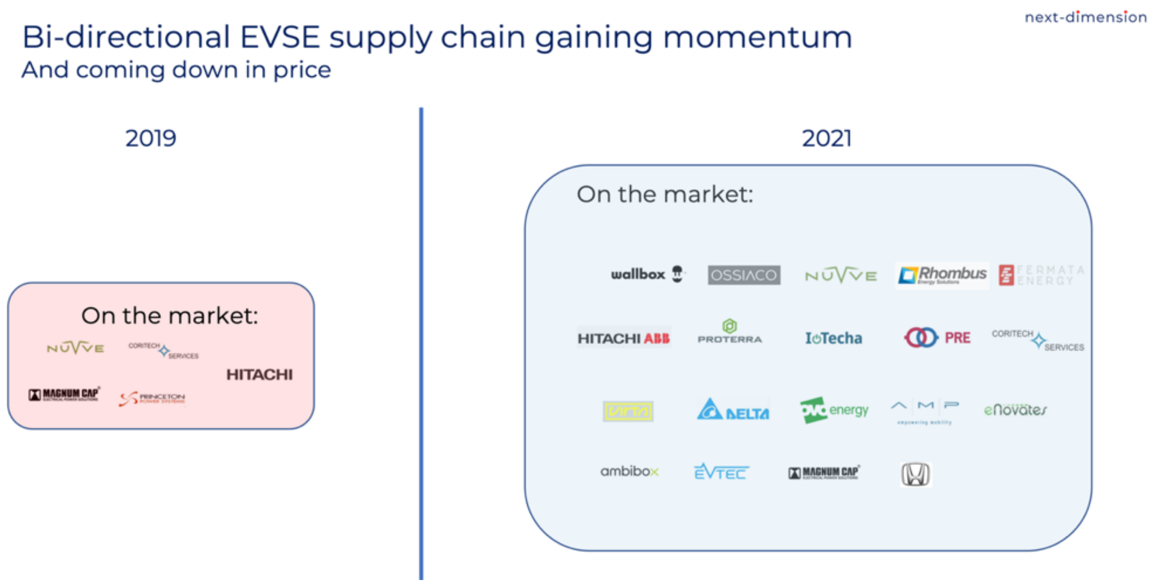
Nuvve has successfully operated a commercial V2G operation at a utility in Frederiksberg, Denmark since September 6, 2016, a period of more than 4 years. The V2G solution aggregates via a Nuvve aggregator a fleet of 10 Nissan e-NV200 (24 kWh) connected to 10 kW Enel bidirectional chargers providing frequency regulation (every second) to the Danish TSO, Energinet. The V2G installation operates 118 hours per week (14 hours daily and 2X24 hours weekends). It has logged more than 250,000 EV hours of successful V2G operation.

8.2 The V2G supply chain is rapidly growing

In 2019 there were only two automotive OEMs with bi-directional capabilities now there are more than a dozen and even more preparing to launch V2G vehicles.

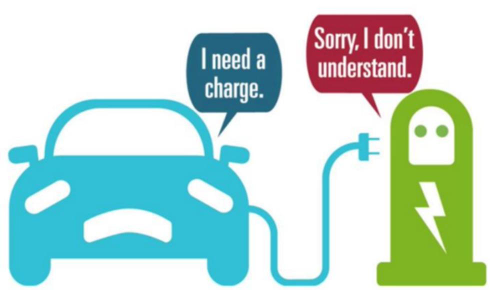


The supply chain for bi-directional EVSE is also expanding rapidly. The equipment prices are coming down fast both for bidirectional DC and AC chargers. The latter approaching the cost of a unidirectional charger.



8.3 International standards or de-facto standards

Standardization of equipment and protocols are essential in order to bring the cost down and scale to meet California's goals of 5 million ZEV on the road by 2030.



International standards are just around the corner (end 2021) and they support both AC and DC V2G. CCS (Combined Charging System) and IEEE 15118-20 and OCPP, and IEEE 2030.5 are almost there and there are already pre-versions in the market. When the standards are finally released the EVs, and the chargers can be updated via the air.

8.3.1 Cooperation with the CharIn group

The Charin organization consists of more than 200 members to promote the worldwide standardization of chargers and protocols. Practically all the world's important car manufacturers and EVSE manufacturers are members of CharIn.

Their vision is: Developing and establishing the Combined Charging System (CCS) as the global standard for charging battery powered electric vehicles.

Their mission:

- Expanding the global network by integrating companies on each level of the defined value chain to support and promote CCS
- Drafting requirements to accelerate the evolution of charging related standards
- Defining a certification system for all manufacturers implementing CCS in their products

It is recommended that a formal relationship is established between the California Energy Commission and CharIn to cooperate on promoting and enabling CCS and IEC 15118 standards in California.

The figure below shows some of the members of CharIn.

8.4 Value of V1G vs V2G

The value of V2G was shown to be 7 – 13 times higher than V1G (Smart Charging) for Frequency Regulation in Denmark in the Nikola V2G project (Nikola Project – V1G vs V2G Value). In general, V2G provides more value due to its capability to both charge and discharge and being a distributed resource.

9. RECOMMENDATIONS TO CEC

next-dimension fully agrees and supports the V2G recommendations put forward in Chapter 5 of the "California Assembly Bill 2127 Electric Vehicle Charging Infrastructure Assessment (Staff Report). In addition to and partly overlapping with we have the following recommendations to ensure that V2G will become an integral and important part of the planning and recommendation activities of the CEC.

1. Streamline safety certification of V2G solutions from beginning to end (EV, EVSE, ATS[5])
2. Leverage experience gained with solar panels[6] for V2G as described in Chapter 5 of the assessment report
3. Streamline the interconnection process for both DC and AC V2G[7]
4. Establish fair and attractive tariffs for V2G use cases
5. Adopt international standards protocols CCS, IEC 15118, OCPP as described in Chapter 5 of the assessment report
6. Mandate that chargers installed now can be upgraded to latest standards via over the air software update (no hardware changes) to avoid stranded assets
7. Establish education programs to inform public about advantages of V2G
8. Provide grants to incentivize workplace charging to align charging with daytime clean sun power
9. Provide incentives for V2G enabled EVs and EVSEs to get market to critical mass
10. Establish a partnership with CharIn to promote CCS and IEC 15118 standards in California
11. No more V2G trials – it is time to scale

[5] Automatic Transfer Switch
[6] California scaled solar to more than 1.2 million installations
[7] SCE Implemented standards and processes to scale 1,000 solar installations per month in 2-3 days approval process. Source: Forbes

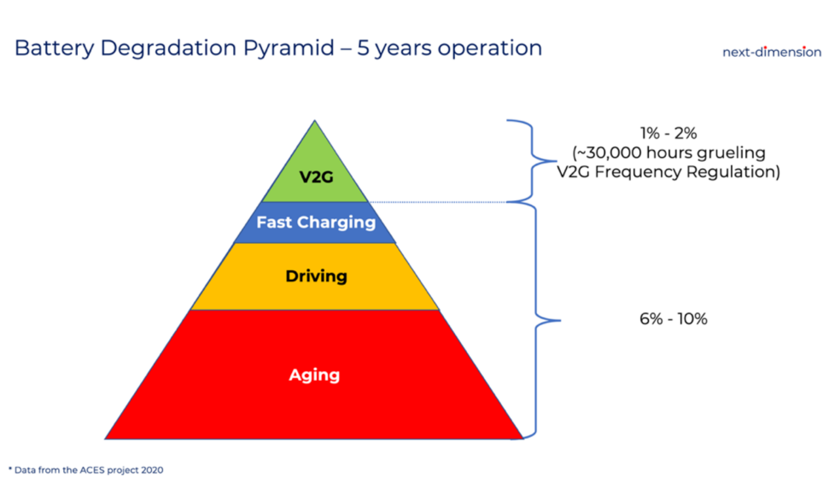
10. V2G PERCEPTIONS VS FACTS

Most non-experts do not understand what V2G technology is about, and a number of common negative perceptions exists. During my 10 years of working with V2G I have encountered mainly 2 issues that need to be addressed up front:

10.1 V2G degrades the battery

Nuvve has successfully operated a commercial V2G operation at a utility in Frederiksberg logging ~250,000 fleet hours of V2G operation with little V2G battery degradation. The figure below shows the battery degradation after 5 years (Source: Battery Degradation).

The largest degradation (6%-10%) is from battery aging followed by driving (acceleration, braking, cruising) and fast charging. Only a minor degradation (1% - 2%) is from heavy duty V2G operation. These results published as part of the Across Continents EV Services (ACES) project in Denmark with Danish Technical University and Nissan Corporate Research.



The battery degradation from V2G has also been shown to be low in the joint study by Honda and University of Delaware (Honda V2G Study)

10.2 Battery warranty

Nissan has been providing battery warranty for V2G use since a number years and other OEMs are following.