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V2X Bidirectional Charging:

Policy & Regulatory Solutions for California

Executive Summary

> **"Imagine a future where everyone is driving an electric vehicle – and where that EV serves as a backup power option at home and more broadly as a resource for the grid. Not only is this a huge advancement for electric reliability and climate resiliency, it's yet another advantage of clean-powered EVs, which are so important in our collective battle against climate change."**

PG&E's CEO Patti Pope noted in a May 2023 statement in response to General Motors announcement that all of its EVs will be bidirectional by 2025.[1]

Electric vehicles (EVs) represent a massive energy storage resource for the California grid. Many automobile makers have announced plans to make their EVs bidirectional and numerous charger manufacturers have announced plans to include bidirectional chargers in their product lines.

V2X, including Vehicle-to-Grid (V2G) and Vehicle-to-Building (V2B), developers can't compete with stationary storage given the rich public incentives they receive. Furthermore, existing funding for charging infrastructure is often not accessible for bidirectional charging projects. These and other barriers as discussed in this white paper jeopardize California's leadership in the vehicle grid integration (VGI) space.

Parity with Stationary Storage

Current Barrier

V2X is a form of grid storage yet does not have access to storage incentives and is not currently evaluated as a legitimate grid resource.

Description

Position V2X as comparable to stationary storage with an emphasis on pay for performance. There are three key activities necessary to create parity:

- Launch an incentive program comparable to SGIP for V2X;
- Allow value stacking[2] and direct control by third-party aggregators; and
- Integrate V2X in utility planning processes.

1 See DBusiness Magazine's "General Motors and PG&E Collaborate on EV-to-home Power Pilot" article at https://www.dbusiness.com/daily-news/general-motors-and-pge-collaborate-on-ev-to-home-power-pilot

2 Value stacking means the ability to use a storage asset to provide multiple values such as customer-side values and grid values.

Bidirectional Charging Infrastructure Target

Current Barrier

Bidirectional charging offers significant value to the grid yet state policymakers have not prioritized this technology.

Description

Set an ambitious state goal for the installation of bidirectional EV chargers totaling 3 GW of capacity by 2030 and at least 10 GW by 2040 with direction to state agencies to remove barriers to V2G and enact policies to accelerate investment in bidirectional charging infrastructure.

Make-Ready and EV Charging Infrastructure Funding Access[4]

Current Barrier

California's funding for EV infrastructure does not recognize the value of bidirectional chargers and often disqualifies existing bidirectional charging projects.

Description

Provide access for bidirectional chargers to utility make-ready funding opportunities consistent with unidirectional Level 2 chargers and create a CEC-funded statewide, technology-neutral, rebate for V2G chargers and associated equipment.

Equitable Access to V2X Technology

Current Barrier

V2X technology may be out of reach for most low-income households.

Description

Include incremental funding for equitable community access to V2X technology within all V2X regulatory programs and actions (e.g., additional funding through incentive adders or increased compensation levels).

The four strategies above would collectively support the acceleration of V2X market opportunities in California. Consumers benefit by having the opportunity to generate revenue by providing grid services, thereby reducing the cost barrier for EV adoption. Bidirectional EVs can also provide homes and businesses with backup power during outages, including during the increasingly frequent Public Safety Power Shutoffs (PSPS). Both of these values (grid services revenue and resiliency) will accelerate EV adoption, helping to achieve California's carbon reduction goals while ensuring that the grid has the flexible resources needed to manage the rapid growth in renewable generation anticipated in the next decade.

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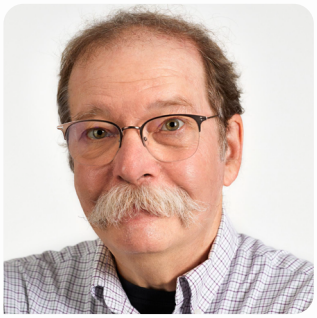
3 This goal is reasonable and would represent a small fraction of the EVs that are anticipated to be sold and the charging infrastructure that is expected to be deployed in California in 2030. For example, PG&E expects to have 3 million EVs in its service territory which would represent 30 GW of capacity if each bidirectional EV was paired with a 10 kW bidirectional charger.

4 Make Ready means all customer and utility side infrastructure (e.g. wiring, panels, trenching, etc. but not the charging station).

Fermata Energy

Table of Contents

A Message from Co-Founders David Slutzky and John Wheeler



We founded Fermata Energy in 2010 with two clear intentions: to accelerate both the adoption of electric vehicles (EVs) and the transition to renewable energy. Fermata Energy's bidirectional charging technology makes it possible for EV owners to earn revenue, increase energy resilience, and combat climate change.

It is no longer a question—EVs will dominate the future new car market with dozens of new models coming to market in the next several years. Further, most automobile manufacturers have announced plans to make their EVs bidirectional. These EVs will represent a massive new power resource for the grid. California expects to have over eight million EVs on the road by 2030. Assuming an average onboard battery of 60 kWh plugged into a 10 kW bidirectional charger, this represents a cumulative 480 GWh of storage capacity and a power resource of 80 GW onboard California's EVs. Putting this into perspective, the highest peak load ever experienced in California was 52 GW for the IOUs (CAISO region).

Fermata Energy's technology unlocks this massive grid resource onboard vehicles that are sitting idle for over 90% of the hours in a day. These mobile energy storage systems will be ubiquitous throughout the utility distribution system and can be controlled precisely and instantaneously using our AI-driven software solution. V2X will represent a new class of grid resource that will usher in an era of unprecedented reliability and resilience even while California transitions to renewable, intermittent resources, including solar and wind power.

The development of the V2X resource faces significant regulatory challenges. Based on Fermata Energy's experience deploying V2X in California and other states, this white paper provides our assessment of the opportunities to improve the policy and regulatory environments to ensure that the potential of V2X is realized in California.

About Fermata Energy

Founded in 2010, Fermata Energy is a leading Vehicle-to-Everything (V2X) bidirectional charging services provider. Fermata Energy designs, supplies, and operates the technologies required to integrate EVs into homes, buildings, and the electric grid. Fermata Energy's V2X platform incorporates CHAdeMO and CCS connectors in a bidirectional charger and management software with the EV and electricity user. Fermata Energy's V2X platform extends the value of an EV and allows the vehicle to act as a dispatchable energy storage resource when the vehicle is not in use. The company's customers today are earning thousands of dollars through Vehicle-to-Grid (V2G) and Vehicle-to-Building (V2B) programs nationwide. The company's bidirectional EV charging system is the first in the world to be certified to a new North American safety Standard, UL 9741, the Standard for Bidirectional Electric Vehicle (EV) Charging System Equipment, and the first to earn approval in the US from a major OEM for battery warranty.

Overview

Extreme weather events, aging infrastructure, and increasing demands from electrification are placing strain on California's electric grid. The California Independent System Operator (CAISO) issued three Energy Emergency Alerts (EEA) in July of 2023 due to higher than anticipated demand driven by extreme heat. In September of 2022, the state experienced some of the hottest temperatures on record creating an historic challenge for grid operators. Grid operators narrowly averted the need for rotating outages like those that occurred on August 14th and 15th in 2020, which left thousands of California households without power during dangerous heat conditions.

Grid reliability has been an ongoing concern within the state legislature, as demonstrated by the passage of legislation that requires state agencies to jointly produce quarterly electric reliability reports.[5] The February 2023 California Joint Agency Reliability Planning Assessment states:

> "Although the state is experiencing a boom in new project development, challenges remain to achieving the scale and diversity of resources necessary to accomplish the transition. New strategies are needed to increase demand flexibility."[6]

EVs can provide the flexibility the California grid needs both through smart charging (V1G) and bidirectional charging (V2G/V2B).[7] The 8 million EVs that are expected to be on the road in California by 2030 will be the largest distributed energy resource (DER) on the California grid (~8M EVs in 2030 is equal to ~80 GW assuming a 10 kW bidirectional charger). V2G is the most cost-effective and available resource to address the California "Duck Curve" (now "Duck Canyon") challenge.[8]

Figure 1 illustrates conceptually how V2G can help time shift solar production from the daylight hours to the early evening net peak hours. Solar energy production during the day can be stored in the California EV fleet and some solar production can be sent back to the grid during the late afternoon when the sun is setting, thereby reducing the need to ramp up other forms of generation to maintain reliability. Once the net peak is passed, EVs can begin charging during the evening and early morning hours to be ready for the morning commute.

5 See Senate Bill 846 (Dodd, Chapter 239, Statutes of 2022) and Assembly Bill 205 (Committee on Budget, Chapter 61, Statutes of 2022).

6 See February 2023 Joint Agency Reliability Planning Assessment SB 846 Quarterly Report and AB 205 Report available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=248714.

7 Several studies have found that V2G offers significant incremental benefits over V1G including *The value of consumer acceptance of controlled electric vehicle charging in a decarbonizing grid: The case of California* available at https://www.sciencedirect.com/science/article/pii/S0360544221009397/pdfft?md5=eb8b2e97fbc60909c1255bac066376d5&pid=1-s2.0-S0360544221009397-main.pdf. and EPRI *Vehicle-to-Grid: $1 Billion in Annual Grid Benefits?* available at https://eprijournal.com/vehicle-to-grid-1-billion-in-annual-grid-benefits/.

8 See Center for Sustainable Energy V2X as a solution fo the duck curve available at https://centerforcommunityenergy.org/v2x-duck-curve-solution/.

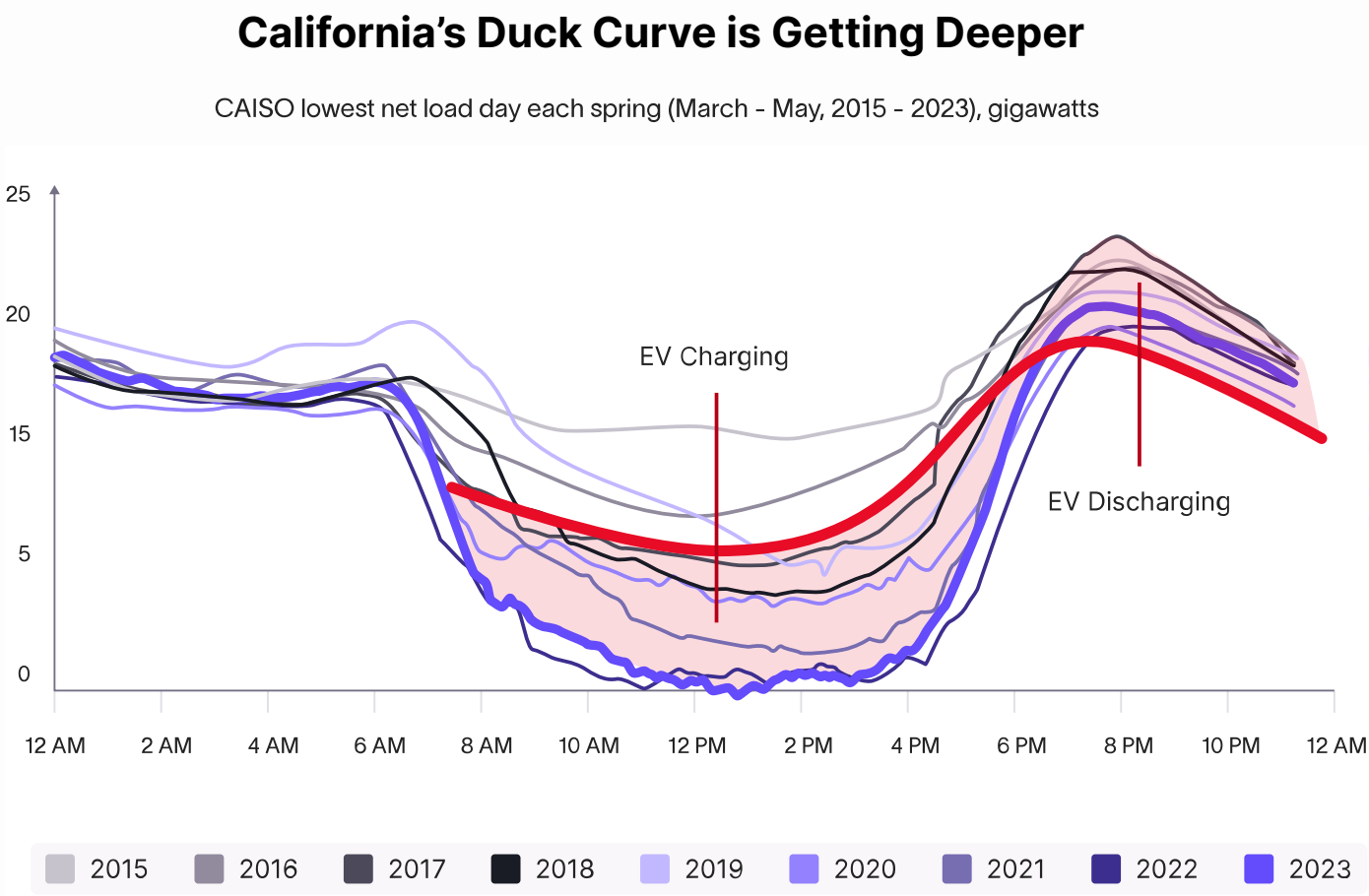


Figure 1. V2X Can Tame California's Infamous Duck Curve

Source: Energy Information Administration, As solar capacity grows, duck curves are getting deeper in California, available at https://www.eia.gov/todayinenergy/detail.php?id=56880#.

While there has been much discussion and some limited pilots of bidirectional charging, significant barriers remain to realizing the gigawatt potential of V2X as a flexibility resource. To support the cost-effective, immediate deployment of EVs using their batteries as mobile energy storage assets and to support critical grid resilience, Fermata Energy recommends four policy and regulatory strategies for V2X bidirectional electric vehicle charging in California, which are described below.

Vehicle-to-Everything (V2X) Overview

Types of V2X

There are different configurations of V2X bidirectional charging. V2X bidirectional charging includes both Vehicle-to-Grid (V2G) and Vehicle-to-Building (V2B) operations. Bidirectional charging can both charge the EV and discharge energy from the vehicle's batteries to provide services to the home, building, or grid. V2B operation can occur during times when the grid is operating by providing customer-side of the meter value, such as customer bill (or "demand charge") management. V2B can also operate during outage conditions by serving as a form of emergency backup power to provide resiliency services.

V2G operation entails exporting power through a utility meter to the grid to provide valuable grid services to the distribution utility or grid operator. This is similar to the way in which rooftop solar exports power during the daylight hours. V2G is

different from solar in that the exact time of export is controlled. During peak times, V2G bidirectional charging capacity from multiple sites can be called upon and aggregated into a Virtual Power Plant (VPP) to provide demand response and other grid services.

side of the meter value, reducing a customer's energy bills through demand charge management, time-of-use rate optimization, and increased solar self-consumption. In contrast, parallel V2G operations with export generate revenue through export

Three Types of Bidirectional Charging Configurations

(discharge < site load)

Figure 2. Parallel V2B Operation without Export

(discharge > site load)

Figure 3. Parallel V2G Operations with Export

Emergency Power (Islanded Mode)

Figure 4. Islanded V2B Operation During Grid Outage

There are two common V2X bidirectional charging system configurations during normal grid operations and one during outage conditions.

These three modes of operation provide different value to the EV owner and the power grid. Parallel V2B operation without export creates the customer-compensation from participation in utility programs or other market opportunities. Finally, V2B operation during grid outage (islanded mode) provides resiliency value. While often hard to quantify, the Value of Lost Load (VOL)[9] is one approach that can be used to approximate the value to customers of emergency backup power.

9 The U.S.Department of Energy developed a VOL calculator called the Interruption Cost Estimate (ICE) Calculator for electric reliability planners at utilities, government organizations or other entities that are interested in estimating interruption costs and/or the benefits associated with reliability improvements avallable at https://icecalculator.com/home.

State of V2X Technology

V2X bidirectional charging technology is rapidly evolving for light-, medium- and heavy-duty electric vehicles. The commercially available V2X systems today are based on a direct current (DC) configuration often referred to as V2G DC. This involves exporting DC energy from the EV's battery through a bidirectional DC charger. The bidirectional DC charger has an inverter that converts the DC power from the EV's battery to alternating current (AC), which is what the power grid relies on. V2G DC projects have been interconnected through California's Rule 21 interconnection tariff in multiple locations throughout the state.

While standards for V2G DC are evolving, today's deployments rely on standards-based custom integrations. For example, the Ford F-150 Lightning pickup truck uses a custom CCS solution for V2B.[10] Various V2G electric school bus pilots use DC chargers for V2X with a CCS connector for power and communications. These integrations require proprietary add-ons that are not third-party certified.[11] Reliability issues with V2X bidirectional charging using CCS connectors appear solvable in the next several years.

V2G AC entails the conversion of DC power from the EV battery onboard the vehicle to AC power before it exports to an AC bidirectional charger. AC versions of V2X bidirectional charging are still in the early stages of development.

Most major automobile manufacturers have announced plans to make their EVs bidirectional. In addition, there are numerous charger manufacturers with plans to sell bidirectional chargers in both DC and AC versions. An important obstacle to realizing the potential of bidirectional charging is the standardization of the technology that enables efficient, low-cost, mass adoption. EV communications in the U.S. are too focused on standardizing the charging infrastructure without adequate attention to the impact on the adoption of V2X solutions. Today, this presents a significant barrier to adopting V2X technology at scale.[12]

Benefits of V2X

Today, EVs represent a large battery storage resource. In 2021, the cumulative energy storage capability of EVs was approximately 8 times that of stationary grid-scale batteries installed globally.[13, 14] Bloomberg New Energy Finance (BNEF) data (Figure 5) projects that 90% of all lithium ion batteries manufactured through 2045 will be in EVs. The stationary storage segment will remain a small fraction with EVs having a much larger energy storage capability.

10 California Energy Commission workshop on V2X in July 2022 at 1:40:41 available at https://energy.zoom.us/rec/play/vl4_c7TZJLdfCKXN9LlrRs4hB1HFDgR1Akj_u_gplm7vid8EKvWEyI8rzjmS9Dm71DtHQd6VXSY4W6IB.GTVkITXdN-bie0gv?continueMode=true&_x_zm_rtaid=bL8XjhTSQN2iXUzqqwgj5w.1664313384726.13e9864ead658da7f0c018453007cfee&_x_zm_rhtaid=794

11 CHAdeMO Association letter to CARB, May 31, 2022 available at https://www.arb.ca.gov/lists/com-attach/490-accii2022-UTxRNIQsBQIRZVNk.pdf

12 For more information on these issues see Quality Logic white paper, *Confused about standardizing V2G? You're not alone* available at https://www.qualitylogic.com/knowledge-center/confused-about-standardizing-v2g-youre-not-alone/.

13 Bloomberg Hyperdrive Daily: EVs Feeding the Power Grid available at https://www.bloomberg.com/news/newsletters/2021-04-27/more-evs-are-being-designed-to-push-power-to-the-electrical-grid.

14 See Bloomberg Law https://www.bloomberg.com/news/newsletters/2021-04-27/more-evs-are-being-designed-to-push-power-to-the-electrical-grid available at https://news.bloomberglaw.com/environment-and-energy/electric-vehicles-to-drive-massive-battery-demand-bnef-chart.

90% of Batteries Manufactured through 2030 will be in EVs

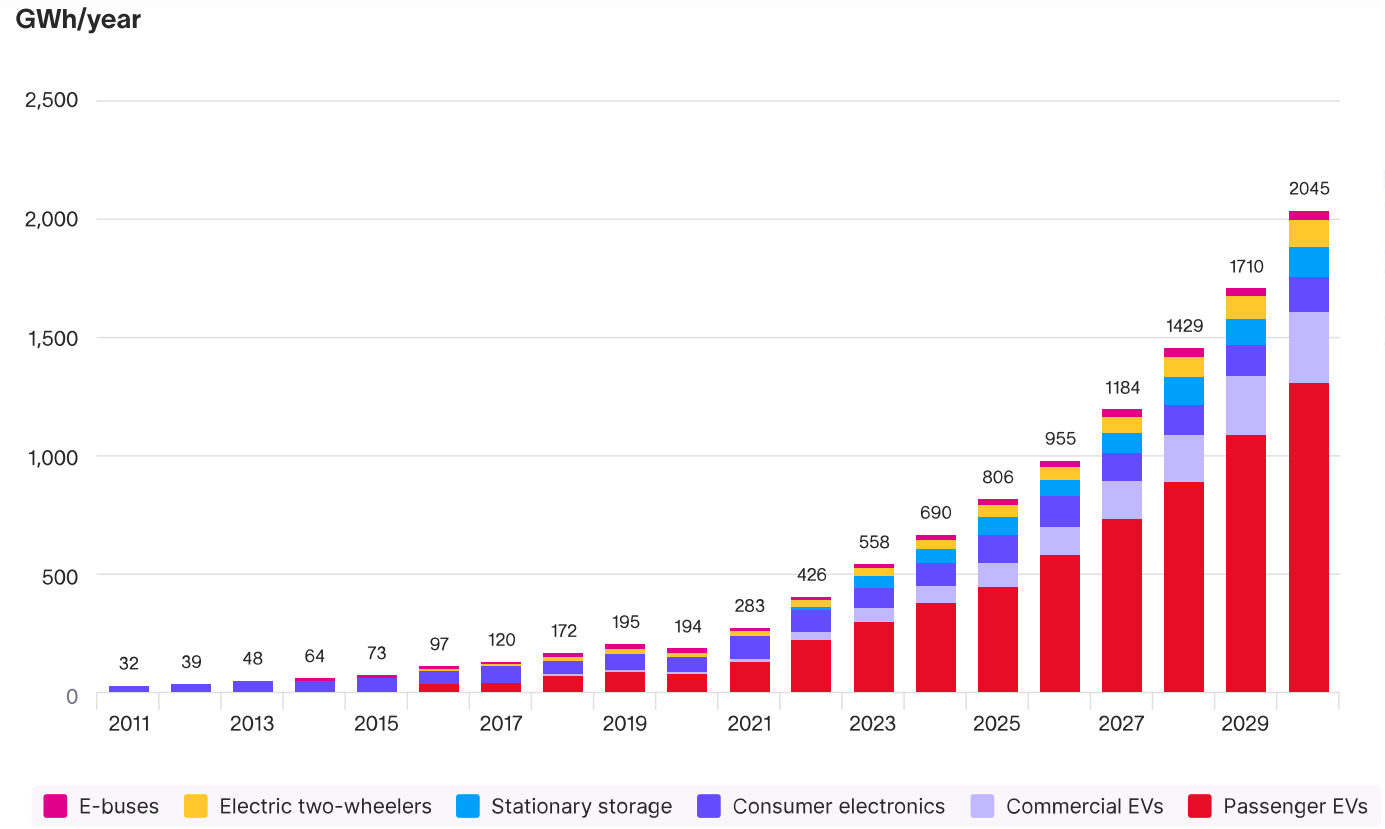


Figure 5. EV Energy Storage vs. Stationary Battery Resources

Source: Bloomberg New Energy Finance, Electric Vehicles to Drive Massive Battery Demand: BNEF Chart available at https://news.bloomberglaw.com/environment-and-energy/electric-vehicles-to-drive-massive-battery-demand-bnef-chart

V2X technology unlocks the vast potential of EVs to be used as grid assets providing value to utilities, regulators, and consumers. V2X bidirectional charging is a win-win-win investment. Table 1 summarizes the key benefits of V2X.

Key Benefits of Bidirectional Charging and V2X

Benefit	Description
Supports Achievement of Climate Goals	Just like stationary storage, V2X bidirectional charging platforms can reduce carbon and criteria pollutant emissions from generators by shifting electricity consumption to the cleanest hours of the day and removing the need for dirty thermal peaker electricity generation. Batteries can absorb excess renewable generation, reducing the curtailment of wind and solar and then releasing that energy back to homes and businesses when needed. V2X, however, is more cost-effective than stationary storage, as ratepayers don't have to pay for the purchase of the EV battery and can help the transition to renewable energy (see Figure 1).
Provides Valuable Grid Services	With V2X bidirectional charging, utilities gain a large new flexibility resource that can provide the same grid services that stationary energy storage projects provide today. V2X can play an important role in addressing California's solar "Duck Curve" challenge, reducing the early morning and late afternoon ramping requirements.
Lower Vehicle Ownership Costs	EV owners can earn money by selling electricity back to the grid (V2G) and reduce energy costs through customer-side bill management (V2B), significantly cutting the cost of vehicle ownership. Reducing the cost of owning an EV will help to accelerate EV adoption.
Increase Community and Household Resiliency	V2X bidirectional charging cost-effectively supports grid resilience. During blackouts and Public Safety Power Shutoffs, EV owners with bidirectional chargers can power their homes, businesses, and critical infrastructure. The energy in an EV can power a typical home for three or more days. Using EVs as a source of backup power also avoids emissions from gasoline- or diesel-based generators.
California Ratepayers	EV adoption has already been shown to significantly benefit utility ratepayers, and V2X technology can further those benefits. A 2018 Electric Power Research Institute study projects $1 billion in annual ratepayer benefits if 50% of chargers were V2X bidirectional charging capable.[15] Bidirectional charging technology also improves driver economics, which would drive further EV adoption and even greater ratepayer benefits.

Table 1

The 2021 California Preferred System Plan approved by the CPUC calls for 13.6 GW of new energy storage by 2032 to support the integration of renewables.[16] Today, the state has 6.6 GW of battery storage capacity on the grid.[17] V2X bidirectional charging, with supportive policies, can provide many thousands of MW by 2032 to help California meet its energy storage needs at lower cost relative to stationary storage. V2X serves as a hedge against the likelihood that stationary storage deployments will be delayed due to supply chain issues. Battery material suppliers will prioritize EVs over stationary storage as it represents a much larger market for their products.

15 See The Electric Power Research Institute, Vehicle-to-Grid: $1 Billion in Annual Grid Benefits? Available at https://eprijournal.com/vehicle-to-grid-1-billion-in-annual-grid-benefits/#:~:text=V2G%20technology%20can%20provide%20%241,peak%20shaving%20and%20ramping%20support.

16 See California Public Utilities Commission, Energy Storage Procurement Study available at https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/energy-storage/2023-05-31_lumen_energy-storage-procurement-study-report.pdf.

17 See California Energy Commission, California Sees Unprecedented Growth in Energy Storage, A Key Component in the State's Clean Energy Transition available at https://www.energy.ca.gov/news/2023-10/california-sees-unprecedented-growth-energy-storage-key-component-states-clean.

Barriers to V2X Bidirectional Charging

The adoption of V2X technology holds immense promise for revolutionizing California's transportation and electricity sectors. However, significant barriers and challenges need to be addressed to unlock its full potential.

One of the primary challenges lies in the absence of long-term visionary goals and commercialization policies akin to those that have driven the growth of renewable power generation. Similar to Renewable Energy Portfolio Standards, V2X technology needs ambitious targets set by policymakers to stimulate innovation and attract investments. V2X should be integrated into utility planning processes whereby V2X is compared alongside traditional resources used to meet California's future energy needs. Integrating V2X into grid planning will help regulators and stakeholders better understand the role that V2X can play in meeting the state reliability goals and can act as a basis to determine bidirectional charging capacity goals over time.

The California State Legislature recognized the need to adopt an energy storage target with the passage of Assembly Bill (AB) 2514 in 2010.[18] In 2013, the California Public Utilities Commission (CPUC) issued Decision (D.13-10-040) to comply with AB 2514, which established a 1,325 megawatts (MW) energy storage target by 2020.[19] From 2018 to 2023, battery storage capacity in California increased from 500 MW to more than 6,600 MW, far exceeding the initial goal established in D.13-10-040.[20]

Another critical issue is the inequity V2X technology faces in comparison to stationary energy storage solutions. Today, stationary energy storage receives strong policy support in California, while V2X energy storage receives almost none, even though it is more cost-effective for ratepayers. Stationary storage benefits from access to incentives through the Self Generation Incentive Program (SGIP) that are not available to V2X projects. Rectifying this imbalance and establishing parity in terms of incentives between stationary storage and V2X, given its potential cost-effectiveness for ratepayers, is imperative. Policymakers should explore avenues for leveling the playing field and ensuring that V2X receives the support it deserves.

Another barrier to V2X adoption is the higher upfront costs associated with V2X bidirectional chargers compared to their unidirectional counterparts. This disparity can discourage consumers from embracing V2X technology. To mitigate this, policymakers and industry stakeholders should explore ways to make V2X chargers more affordable and accessible, perhaps through subsidies or incentives, ensuring that cost doesn't become a barrier to adoption.

Additionally, the misalignment in the design of make-ready programs to support bidirectional charging and V2X technology poses challenges. Consumers making EV charging infrastructure decisions may default to unidirectional charging given the incremental cost of bidirectional charging and the lack of a clear value proposition. To maximize the technology's potential, programs should be technology-neutral and adaptable to various V2X applications. Different types of V2X, such as V2G and V2B, have unique requirements, and program design should reflect these distinctions. Clarity in distinguishing between V2X and unidirectional charging programs is crucial to prevent confusion and ensure that V2X's specific needs are met.

18 See AB 2514, Skinner, Energy storage systems, Available at http://www.leginfo.ca.gov/pub/09-10/bill/asm/ab_2501-2550/ab_2514_bill_20100929_chaptered.html.

19 See California Public Utilities Commission Decision D.13-10-040 https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M079/K533/79533378.PDF.

20 See California Energy Commission, California Energy Storage System Survey, available at https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/california-energy-storage-system-survey#:~:text=From%202018%20to%202023%2C%20battery,will%20be%20needed%20by%202045.

Addressing these barriers requires collaborative efforts among policymakers, utility companies, automakers, and technology developers. By setting visionary goals, rectifying policy imbalances, streamlining approval processes, and making V2X technology more affordable and adaptable, California can pave the way for its widespread adoption. To this end, Fermata Energy offers concrete regulatory and policy recommendations in the next section of this white paper.

V2X Policy Recommendations

The Executive Summary above provides a brief introduction to Fermata Energy's policy priorities to advance the V2X market opportunity in California. California has a complex and multi-agency regulatory landscape. Fermata Energy's policy recommendations promote collaboration across California's energy and environmental agencies including the California Energy Commission (CEC), California Public Utilities Commission (CPUC), and California Air Resources Board (CARB).

The top policy priority is to create parity between V2X storage and stationary storage with regard to incentives. Today, V2X is unable to compete with stationary storage given the significant subsidies provided through the self-generation incentive program (SGIP), which are not available for V2X storage. Next, additional details are provided on this and Fermata Energy's other V2X policy priorities.

Parity with Stationary Storage

Ensuring parity between V2X technology and stationary storage is critical and will allow EVs to displace stationary storage at a lower cost relative to stationary storage, thereby reducing the cost of meeting California's decarbonization goals.

To bridge the gap between V2X and stationary storage, California should consider implementing incentives for V2X technology akin to or as part of the Self-Generation Incentive Program (SGIP). These incentives should be designed to acknowledge the unique capabilities and constraints of V2X. While stationary storage serves as a consistent energy source, V2X's mobile nature can be leveraged to address specific grid needs and dynamic energy demands. Therefore, incentives should be carefully tailored to reward V2X's flexibility, its ability to provide grid services in real-time, and the benefits it brings to grid resilience. By offering incentives that reflect these distinctions, California can encourage V2X adoption while recognizing its distinct value proposition.

Similar to SGIP, V2X projects should receive both an upfront incentive and on-going payments based on performance. The energy storage capacity eligible for incentives would not include the EV's full rated energy storage capacity. It would be adjusted to reflect the amount of energy storage that would typically be available for export. In addition, more of the incentive for V2X could be allocated over time based on performance. The existing SGIP program allocates 50% of the funding upfront and 50% over five years with some performance requirements.

For V2X to be on par with stationary storage, it should be allowed to stack multiple values the way stationary storage can today. This includes being able to provide savings for customers through smart energy bill management and generate revenue from utility programs and/or dynamic rates with export compensation. Finally, the emerging Virtual Power Plant (VPP) concept should be encouraged, promoting the role of third-party aggregators to manage multiple EV fleets and present them as grid resources similar to what companies like Tesla and Sunova are doing with customer-side battery storage and solar.[21]

21 See Tesla, Join the Tesla Virtual Power Plant available at https://www.tesla.com/support/energy/tesla-virtual-power-plant-pge and Sunova Energy, Sunova Grid Services available at https://www.sunnova.com/grid-services.

Integrating V2X technology into utility planning processes is instrumental in positioning it alongside stationary storage and other traditional resources. Utilities should consider V2X as an integral component of their grid planning and expansion strategies. This includes evaluating V2X as a distributed energy resource and incorporating it into load management and capacity planning. By embracing V2X as part of the grid infrastructure, utilities can harness its mobile nature to address peak energy demands, grid congestion, and emergency response. This integrated approach not only maximizes V2X's potential but also optimizes grid operations, ultimately enhancing energy resilience and minimizing grid investments.

By adopting these strategies, California can position V2X as a complementary and comparable technology to stationary storage, recognizing its unique attributes while ensuring its contributions to a more sustainable and resilient energy system are valued and rewarded appropriately. This approach encourages V2X adoption, fosters innovation, and drives the state's transition towards a cleaner and more reliable energy future.

Bidirectional Charging Infrastructure Target

To propel the adoption of V2X technology and chart a course for a sustainable energy future, California should establish bold, long-term goals for V2X bidirectional charging infrastructure. Much like the Million Solar Roofs Initiative and stationary storage targets, these goals should be codified through Executive Orders or legislation.

The bidirectional charging infrastructure target should apply to use cases that are conducive to V2X operations including, residential charging and private fleets. The target should exclude public access fast charging infrastructure from meeting the bidirectional infrastructure capacity target. Public access fast charging is not conducive to long dwell times and V2X operations. This use case serves primarily as a source of fast charging for EV owners traveling long distances and thus should be excluded from being eligible to meet the bidirectional charging capacity target.

Fermata Energy recommends targeting the installation of bidirectional EV chargers with a combined nameplate capacity of 3 gigawatts (GW) by 2030, and an even more ambitious 10 GW by 2040. These targets should be driven by the collective efforts of the California Public Utilities Commission (CPUC), California Air Resources Board (CARB), California Energy Commission (CEC), California Independent System Operator (CAISO), and the Governor's Office of Business and Economic Development (GO-Biz), with the CPUC taking the lead to develop an action plan with clear deadlines.

Frontline and priority communities should be given top priority to ensure that the benefits of V2X technology are equitably distributed across the state (see policy recommendations below). V2X offers the opportunity to reduce the use of peaker power plants that we know are inefficient, polluting, and predominantly located in disadvantaged communities.

Make-Ready and EV Charging Infrastructure Funding Access

Bidirectional charging infrastructure is often ineligible for existing utility make-ready and EV charging infrastructure funding that unidirectional chargers can access, for the reasons discussed below. It is also important to note that while make-ready programs vary by utility, they often offer funding to offset both electric vehicle supply equipment (EVSE) installation costs and the purchase of the EVSE. While the site preparation/ installation costs for a bidirectional charger are comparable to that of unidirectional (e.g., V1G) EVSE, without access to make-ready funding, bidirectional EVSE are at a major disadvantage. V2X bidirectional chargers tend to be somewhat

more expensive compared to conventional V1G EVSE, yet often cannot access make-ready equipment rebates. This further widens the cost gap between bidirectional charging and unidirectional charging, which can discourage consumers from choosing V2X technology.

V2X technology is ineligible for many make-ready programs because of misaligned program design and restrictive program requirements that do not take into account the unique needs, technology configurations, and use cases of bidirectional charging technology. Most utilities also maintain approved product lists (APLs) to prequalify EVSE software and hardware for utility make-ready funding. Unfortunately, these APLs subject bidirectional charging hardware and software to the same requirements for V1G unidirectional chargers, which often results in the automatic disqualification of bidirectional charging technology from any incentives.

Oftentimes, bidirectional charging projects are doubly disadvantaged because they do not qualify for rebates for the purchase of EVSE in addition to being ineligible for funding to offset installation costs. For example, Southern California Edison (SCE) requires that all charging equipment installed under their make-ready programs, including their Charging Station Rebate, Charging Infrastructure and Rebate, and New Construction Rebate Programs must be selected from their APL.The Charging Infrastructure and Rebate Program, for commercial customers with light duty EVs, funds utility and customer-side of the meter distribution infrastructure upgrades as depicted on the left in Figure 6 and also provides rebates for the purchase and installation of qualifying charging equipment. Some make-ready funding programs do not cover customer-side infrastructure investments for bidirectional charging equipment and upgrades (see right side of Figure 6). A customer or project developer that wishes to purchase a bidirectional charger not listed on SCE's APL will not be able to access funding for infrastructure upgrades or rebates for the installation and purchase of their bidirectional EVSE.

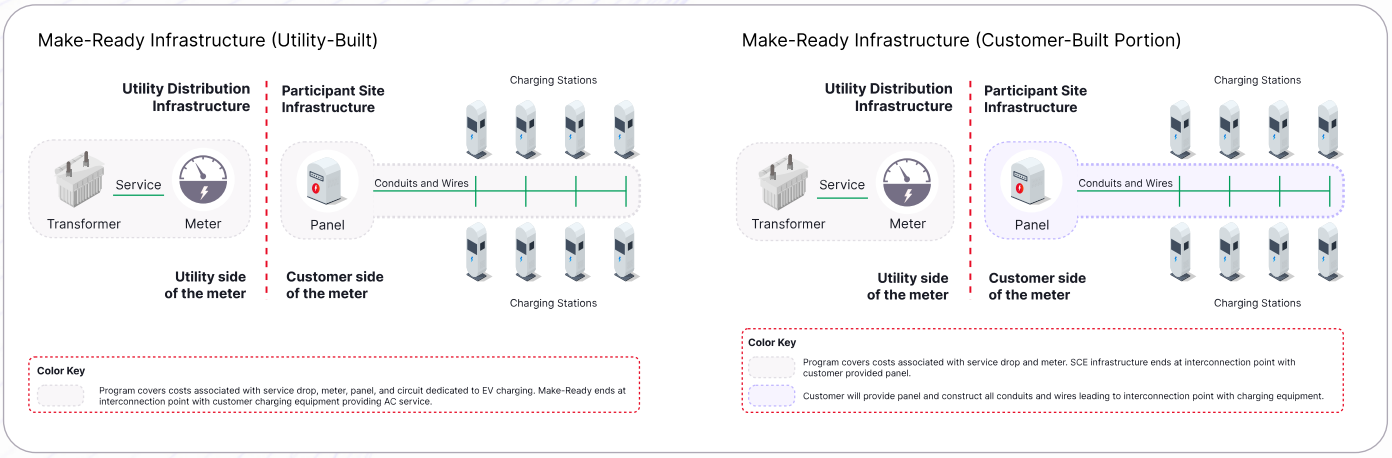


Figure 6. Make-Ready Funding: Utility- vs. Customer-Side Infrastructure

Adapted from SCE's Quick Reference Guide for Charging Infrastructure and Rebate and Turn-Key Installation

To rectify the above imbalance, we urge the CEC, CPUC, and CA investor owned utilities (IOU's) to consider broad incentive designs that enable EV owners and fleet owners to access new and emerging technologies, and that empower low- and middle-income (LMI) and environmental justice (EJ) drivers who may not be able to afford EV charging without incentives. We recommend that the CEC establish a CEC-funded statewide, technology-neutral, rebate for V2X chargers and associated equipment, similar to CALeVIP but for bidirectional chargers (not used for public access fast charging).

To ensure access to utility make-ready funding opportunities consistent with unidirectional chargers, CA utilities should remove these three common limitations in make-ready programs:

1. Exclusion of low power bidirectional DC chargers: Expand the definition of Level 2 (L2) charging to include DC up to 50kW so that emerging V2X chargers can be included in make-ready incentive programs and listed on utility APL used to qualify make-ready eligible chargers.

2. Exclusion of Behind the Meter (BTM) installations: Make-ready programs, CALeVIP incentives, and charger rebates should not be limited to separately metered chargers on new service drops, which limits opportunities for bidirectional use cases such as V2B customer bill management and V2B back-up power.[22] BTM make-ready programs (e.g., customer-side of the meter programs) and charger rebates should not be limited to separately-metered EVSE. These programs should allow facility accounts or linked[23] accounts to qualify and/or use submetering.

3. Restricting make-ready funding to "publicly accessible" EVSE. Many states, including California, New York, and Massachusetts, have allocated make-ready funding for infrastructure upgrades to integrate EVSEs into utility infrastructure. However, these states narrowly define "public access" that precludes spending make-ready funding on V2X projects. Specifically, Fermata Energy has attempted to access make-ready funding for infrastructure upgrades to enable V2X deployment for multi-unit dwellings in underserved neighborhoods to enable LMI and EJ drivers to access V2X revenue that can substantially reduce the total cost of EV ownership.

Given the nature of V2X today, the EVSE will primarily be occupied by the V2X-enabled vehicle to opportunistically provide V2X services when the EV is parked. Because the EVSE is occupied when the EV is not being driven, it is not considered "public" and thus does not qualify for make-ready funding. Additional restrictions are often applied requiring "shared" access versus assigned parking, which can preclude V2X services. The EVSE is providing a public service by enabling V2X discharge of the EV battery to provide grid services and backup power. V2X EVSE provides considerable public value during power outages compared to unidirectional EVSE because it can enable the discharge of a bidirectional EV to the grid or a building. It is essential to consider how make-ready funding can be applied to V2X applications because many underserved neighborhoods could benefit from infrastructure upgrades and have historically been more vulnerable to power outages.

Per SB 676 by Senator Bradford (PU Code 740.16), California should allow all types of vehicle-grid (VGI) integration technology and ensure that all types of VGI technology can be eligible for VGI program funding, pilots, rates, and incentives. Fermata Energy believes that SB 676 was correct in stating that VGI should be technology neutral (i.e., "electric vehicle grid integration strategies shall not require the use of any specific technology),[24] as there are many different

22 For example, https://www.sce.com/sites/default/files/custom-files/PDF_Files/Quick_Reference_Guide_No_CSR_Final_01.24.2024.pdf

23 See CaleVIP, What are the EV charger requirements? Available at https://calevip.org/faq/what-are-ev-charger-requirements-0.

24 PUC Section 740.16 at (b)2.https://law.justia.com/codes/california/2022/code-puc/division-1/part-1/chapter-4/article-2/section-740-16/

types of VGI (including V2G, V2B and V1G), many different use cases, different types of power flow and connectors, different communication pathways and standards, and different communication mediums. Unfortunately, SB 676 did not apply to all state agencies, and the CPUC has not followed the directive to be technology neutral regarding VGI in its August 2022 ruling in the Submetering Decision.[25] This 2019 California law applies to more than just V2X by covering all types of managed charging/ V1G.[26] Based on this, we recommend that state agencies commercialize VGI by allowing all of the different grid service values it can provide as well as all of the different business models and technologies to qualify for funding, including EV, VGI, and V2G rates, programs, pilots and incentives. For example, on business models, VGI technology should be able to participate in all types of demand response, including traditional demand response programs, utility-controlled demand response programs, and automated, aggregator-controlled demand response programs. This approach favors outcomes rather than technologies or strategies. If non-vehicles technologies (e.g. stationary storage) have been commercialized with substantial compensation from grid service values, then managed charging should be similarly nurtured. At this stage, California cannot afford to pick winners and losers with VGI or V2G technology.

Furthermore, V2G and V2B compete with other technologies that provide all or part of the same services, but they cannot compete when California agencies do not allow them to or only financially reward their competitors, which is unfortunately common. Two examples include the Self Generation Incentive Program (SGIP), which funds stationary storage but not V2X, and the storage procurement mandate, which does not encourage V2X deployments.

Equitable Access to V2X Technology

Promoting equitable access to V2X technology is essential for ensuring that the benefits of this innovation reach all communities, including those that have been historically underrepresented in the transition to clean energy technologies. To achieve this, incentive programs can be designed to provide additional benefits or "adders" for low- and moderate-income (LMI) individuals and communities. By creating incentives that prioritize accessibility and inclusion, policymakers can help bridge the gap and ensure that the advantages of V2X technology are shared broadly across California's diverse population.

Frontline and priority populations, a large percentage of which overlap with disadvantaged communities (DAC)-designated areas, stand to benefit most from this technology, so it is appropriate to direct increased incentive funding toward these communities:

- Many disadvantaged communities cannot afford personal transportation, let alone EVs.
- Low-income options for cars are often limited to old vehicles, which while being less expensive to purchase, are not dependable and often end up costing more to service and repair than drivers can afford.

Bidirectional EVs can provide an affordable, reliable, and safe personal transportation option for LMI communities, particularly renters, and can offer an alternative to public transportation. California's priority and frontline communities face an acute need for reliable, low-cost, and effective stationary storage. SGIP sets an important precedent for

25 See Ordering Paragraph 6 (on pp. 44-45): "All direct current conductive EVSE deployed on or after July 1, 2023, for light-duty use cases in ratepayer-funded, or utility-administered, behind-the-meter transportation electrification infrastructure programs must be equipped with a Combined Charge System connector;" See OP 6 on page 44/45.

26 DECISION ADOPTING PLUG-IN ELECTRIC VEHICLE SUBMETERING PROTOCOL AND ELECTRIC VEHICLE SUPPLY EQUIPMENT COMMUNICATION PROTOCOLS (Aug 4, 2021), Ordering Paragraph 6, pages 44-45. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M496/K419/496419890.PDF

directing increased incentive funding for energy storage projects to low-income ratepayers through SGIP's Equity budget category and Equity Resilience budget. The Equity budget category was created to help make energy storage solutions more affordable for low-income, indigenous and underrepresented communities. The Equity Resiliency budget provides incentives for residential and nonresidential storage systems for low-income, vulnerable customers in High Fire-Threat Districts and those impacted by Public Safety Power Shutoff events.

To support LMI customer adoption of V2X technology, all low-income multi-family housing developments should include bidirectional charging infrastructure. The charging infrastructure should be able to be linked to the utility account for an individual tenant to support customer-side value creation in the form of customer bill management and demand response revenue. This infrastructure should explicitly qualify for both utility-side and customer-side make-ready funding and should not be subject to public accessibility requirements, as some Multi-Family EVSE incentive programs currently require. While the EV is parked, it can provide energy storage services to the building and grid. When not needed for V2X services, the EV can be reserved and driven by tenants. Although the EV and charger would only be used by residents, the charger would still be providing a significant public benefit by enabling access to clean, reliable transportation, while also providing the energy storage services and electric bill savings/V2X revenue to the residents of these affordable housing buildings. Therefore, a requirement that these bidirectional charging stations be accessible to the general public, not just residents of these affordable housing buildings, is an onerous and unnecessary restriction.

V2X charging technology is the most cost effective form of storage for ratepayers. Directing additional incentive funding toward LMI communities will help ensure that this technology is adopted quickly and at scale in communities that cannot afford expensive stationary storage and at a net benefit to ratepayers. Because stationary storage systems remain expensive, their batteries are often limited in size.[27,28] An EV, however, can provide several times the energy storage of these stationary systems and can be remotely charged to be driven back to the owner's home or workplace. For example, an off- board 7 kW bidirectional DC EVSE is estimated to cost $5,000-$7,000 (purchase and installed price) compared to a more typical level 2 AC charging station ($600-1,500).[29] While this is a premium compared to a normal charging station, it is still far less than a comparable home storage system. It is very expensive to purchase storage to deploy at a home or business. In addition to the cost effectiveness of V2X systems versus stationary storage, V2X technology helps offset the total cost of ownership (TCO) of EVs by making clean transportation more affordable for average drivers.

LMI communities are also an important share of the total addressable market for the EV OEMs and the bidirectional charging industry. For the bidirectional charging industry to grow and scale, LMI communities need access to this technology. Without expanded market access, bidirectional charging technology risks remaining a niche part of the EV charging industry, as opposed to a mainstream energy storage and e-mobility solution. Moreover, utilities cannot deploy bidirectional charging technologies at scale if they are not also deployed in LMI communities. Incentives and rebate programs can help ensure that V2X technology is accessible for all utility ratepayers.

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27 See IRENA (2019) Innovation landscape brief: Behind-the-meter batteries, International Renewable Energy Agency, Abu Dhabi, which states "Typically, residential consumers' batteries can reach 5 kW/13.5 kilowatt-hours (kWh)." available at https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_BTM_Batteries_2019.pdf

28 See National Renewable Laboratory, Annual Technology Baseline–Residential Battery Storage available at https://atb.nrel.gov/electricity/2022/residential_battery_storage

29 See electrek, Wallbox Quasar 2 bidirectional V2H CCS-combo DC charger announced, turns EVs into huge Powerwall, which states "The Wallbox Quasar, a bidirectional DC charger for home use, is expected to retail for $4,000" available at https://electrek.co/2022/01/03/wallbox-quasar-2-bidirectional-v2h-ccs-combo-dc-charger-announced-turns-evs-into-huge-powerwall/.

Next Steps

In the journey towards realizing the full potential of V2X technology, the above recommendations offer a roadmap for California policymakers. Ensuring parity with stationary storage, setting ambitious goals, allowing bidirectional charging to access make-ready and EV charging infrastructure funding, and promoting equitable access are the foundational steps needed to drive V2X technology into the mainstream.

By acting on these recommendations, California can position itself once again as a leader in sustainable transportation and energy, benefiting both the environment and its residents. These actions will not only enhance grid reliability and reduce greenhouse gas emissions, but also create economic opportunities and a more equitable energy future for all.

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APPENDIX

Detailed Policy Recommendations

Processes

- Streamline utility V2X bidirectional charging interconnection processes.
- Create a centralized and approved V2X bidirectional charging product and platform list (preferably national) to be eligible for program funding. Ensure clear eligibility requirements to reduce confusion for V2X technology vendors.
- Adopt standardized customer meter data platforms so that customers can readily share their interval energy usage data with V2X bidirectional charging providers and other DER management solutions; Green Button[30] and Utilidata[31] are two such solutions.
- Accelerate development of new or updated codes and standards including SAE J3400, SAE-J3072, IEEE 2030.13, UL 1741-SC and -SD, Sunspec IEEE 2030.5 Profile for SAE-J3072, and others that are needed for the different types of V2X.
- Given the fact that no bidirectional chargers have achieved UL1741-SB certification, it is critical to extend the bidirectional charger UL1741-SB waiver beyond the Emergency Load Reduction Program to all VGI pilots and dynamic rate offerings with export compensation.

Market Design

Agnostic Battery Programs

- Battery support programs should be agnostic as to whether the battery is stationary or mobile. Specifying battery types is economically inefficient, adding complexity for ratepayers in selecting rates and other incentives to participate in and precluding the grid from accessing batteries onboard EVs. Unlike stationary storage projects, charging stations are often required to be separately metered as a funding requirement. Thus, behind-the-meter make-ready programs and charger rebates should not be limited to separately-metered electric vehicle supply equipment. We recommend allowing facility accounts or linked[32] accounts to qualify and/or use submetering.[33]

Dual Participation

- EV owners can provide everyday value by responding to time-of-use rates (TOU) and capacity needs by discharging batteries for demand response (DR) during critical periods for the grid. Work with regulators and ISO/RTOs to coordinate signals for coincident peaks so that customers are not excluded from DR if they are part of an everyday TOU rate.

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30 See U.S. Department of Energy Open Energy Data available at https://www.energy.gov/data/green-button.

31 See Utilidata company information available at https://utilidata.com/

32 See CaleVIP program information, What are the EV charger requirements? available at https://calevip.org/faq/what-are-ev-charger-requirements.

33 See Southern California Edison's Charge Ready Reference Guide for Charging Infrastructure Rebate and Turn-Key Installation available at https://www.sce.com/sites/default/files/custom-files/PDF_Files/Quick_Reference_Guide_No_CSR_Final_01.24.2024.pdf.

Pay for Performance

- Eliminate requirement for physical "permanence" (e.g., in the Self-Generation Incentive Program) and use a pay for performance system instead. Demand response should always be measured on discharge per sub-metered load in the EVSE or EV telematics, and not on a rolling 10-day baseline. A rolling 10-day baseline erodes ratepayer incentive to provide everyday grid value by discharging and charging a battery or EV in response to a grid signal.

Spatial/Locational-Based Rates

- Utilities, ISO/RTOs, and regulators have made considerable progress in designing temporal rates. However, utilities should expand upon existing temporal rates by working with regulators and ISO/RTOs to design pricing signals that incentivize EVs to provide battery services in specific locations based on time of day, week, and season. These temporal rate designs would leverage a major benefit of V2X bidirectional charging—that it is a mobile, swappable battery asset. The battery can be available at a particular time of day in the location that it is most needed, and a discharged EV can be replaced or "swapped" with a fully charged EV.

Capture Battery Value with Innovative Designs for Grid Firming or Balancing at the Distribution Network Level

- As customers adopt more behind-the-meter inverter-based DERs, increased use of batteries (including V2X bidirectional charging) can provide much-needed frequency regulation services. However, utilities have not fully considered the value of this service to the grid and should develop more innovative rate designs that reflect the true value of battery storage and V2X bidirectional charging for grid balancing.

Topics Specific to the CAISO, CPUC, and California Utilities

- Behind the meter make-ready programs, CALeVIP incentives, and charger rebates should not be limited to separately metered chargers on new service drops, which limits opportunities for bidirectional use cases such as V2B (vehicle-to-building) customer bill management and V2B back-up power.[34] Allow facility accounts or linked accounts[35] to qualify and/or use submetering.
- Increase compensation for V2X bidirectional charging exports to be on par with other programs across the country so that California remains the national leader in V2X programs. For example, Connected Solutions, a pay for performance, distribution level demand response program offered by Eversource, Unitil, UIL, and National Grid in RI and MA, offers $200/kW to $400/kW to small batteries such as those that can be

34 For example see See Southern California Edison's Charge Ready Reference Guide for Charging Infrastructure Rebate and Turn-Key Installation available at https://www.sce.com/sites/default/files/evcharging/Quick_Reference_Guide_No_CSR_Final.pdf.

35 This is when the customer account for the parking lot chargers and the other customer account for the building are linked and effectively work as one account for bill management and back-up power.

leveraged by V2X for grid services. Connected Solutions is also technology neutral and penalty free.[36]

- Allow third party aggregators to directly control bidirectional and unidirectional managed charging as well as other strategies and technologies for VGI per SB 676's prohibition on picking a VGI technology.
- Create as many VGI value streams as possible as soon as possible and do not place limits on value stacking.
- Create V2X bidirectional charging programs that cover all types of V2X (see technology status section above). V2X bidirectional charging programs should be year-round (not seasonal) and include all types of V2X configurations (e.g., vehicle-to-building, low-power DC, AC V2G) and remain technology agnostic, supporting CHAdeMO and CCS connectors, various types of communication, DC and AC versions of V2X bidirectional charging.
- Avoid strict CPUC rules on duplication so that VGI pilots and other load management programs can coexist (e.g., SB 676 pilots should allow California ratepayers to participate if they are also participants in the Emergency Load Reduction Program).
- V2G exports should be able to exceed site load.
- Develop pay-for-performance programs to prevent siloing of rules for Net Energy Metering stationary storage, V2X bidirectional charging, managed charging, water heaters, etc. and establish baseline metrics that can be used to readily compare all DERs including V2X bidirectional charging.
- Include V2X in proceedings on UNIDE (OIR to Advance Demand Flexibility (R.22-07-005)), High-DER Rulemaking (R.21-06-017), and Financing OIR (Clean Energy Financing OIR (R.20-08-022)) at CPUC and the load management standard rulemaking at the CEC.
- Revise regulations of meter accuracy and align accuracy rules (4+ agencies regulating accuracy in a state). This will reduce conflicting meter accuracy, aggregator requirements, and onerous data reporting between agencies.

Policies and Incentives for Technology Adoption

- Work with policymakers to allow bidirectional chargers to earn Low Carbon Fuel Standards (LCFS) credits for the electricity dispensed for mobility. This requires netting out the energy used for V2X from the total energy dispensed through the EV charger.
- Create temporary V2X bidirectional charging equipment incentives that mirror rebate, tax credit, incentive, and purchase requirement programs created to commercialize stationary storage and solar such as California's SGIP or various state-level solar and battery energy storage capacity procurement mandates. V2X incentives can be offered as an expansion of existing energy storage commercialization programs or as standalone commercialization programs.
- Ensure that there is coordination among different agencies on the program design and eligibility requirements for V2X bidirectional charging rebates and compensation in order to avoid confusion and duplication for customers. Strive towards creating a seamless experience for customers applying for V2X incentives or enrolling into V2X programs.
- Expand the definition of Level 2 (L2) charging to include DC up to 50kW so that emerging V2X chargers can be included in make-ready incentive programs.
- Share lessons learned, value streams, and best practices from pilots and programs and continue to expand more use cases. Enhance communications and messaging efforts.

36 See National Grid Massachusetts' Program Materials for ConnectedSolutions for Commercial/Industrial Customers 2021 available at https://www.nationalgridus.com/media/pdfs/bus-ways-to-save/connectedsolutions-ciprogrammaterials.pdf.