BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking Regarding Transportation Electrification Policy and Infrastructure.

Rulemaking 23-12-008

VEHICLE-GRID INTEGRATION FORUM WORKSHOP REPORT FILED BY SOUTHERN CALIFORNIA EDISON COMPANY (U 338-E), SAN DIEGO GAS & ELECTRIC COMPANY (U 902 E), AND PACIFIC GAS AND ELECTRIC COMPANY (U 39 E)

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Pursuant to Decision (D.) 22-11-040, Ordering Paragraph (OP) 11, issued November 21, 2022, and the *Email Ruling Delaying the Timing of the Vehicle-Grid Integration (VGI) Forums Ordered in D.22-11-040* (Ruling),¹ issued November 13, 2023, San Diego Gas & Electric Company, Southern California Edison Company, and Pacific Gas and Electric Company² hereby file the Vehicle-Grid Integration Forum Workshop Report (Report), dated June 16, 2025.

D.22-11-040 and the Ruling require that the Joint IOUs shall file the Report and distribute the Report to the service lists for other relevant Commission proceedings.³ The VGI Forum Workshop Report is attached.

Respectfully submitted on behalf of the Joint IOUs,

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Dated: June 16, 2025

¹ See generally Rulemaking (R.) 18-12-006, Email Ruling Delaying the Timing of the Vehicle-Grid Integration (VGI) Forums Ordered in D.22-11-040 (filed Nov. 13, 2023) (delayed the VGI Forum until Quarter 1, 2024).

² Pursuant to Commission Rule 1.8(d), counsel for SDG&E confirms that PG&E and SCE have authorized SDG&E to file these comments on behalf of the Joint IOUs.

³ D.22-11-040, pp. 231-32; *see also* Ruling at p. 7.

VEHICLE-GRID INTEGRATION FORUM REPORT

San Diego Gas & Electric Company Southern California Edison Company Pacific Gas and Electric Company

June 16, 2025

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	 LE-GRID INTEGRATION FORUM REPORT

I. <u>Executive Summary</u>

The investor-owned utilities (IOUs)¹ hosted the second annual Vehicle-Grid Integration (VGI) Forum on April 16, 2025, at the California Public Utilities Commission (CPUC) in San Francisco². Attendees included the IOUs, CPUC Energy Division staff, and other regulatory and industry stakeholders. The VGI Forum agenda comprised of four panels:³

- Panel 1 VGI Activities in California
- Panel 2 How Do We Value VGI?
- Panel 3 Crossing the Chasm from Pilot to Programs
- Panel 4 Vehicle-to-Everything (V2X) Standards & Technology

CPUC President Alice Reynolds provided opening remarks for the Forum, highlighting the critical role of California in advancing electric vehicle adoption and VGI strategies, as EVs now account for over 25% of the light-duty market statewide. President Reynolds noted that by leveraging managed charging, dynamic rates, and existing non-ratepayer-funded initiatives, the state aims to maximize grid efficiency, reduce costs, and make EV ownership more affordable and accessible. Current VGI pilots are critical for shaping the future of transportation electrification, with forums like this playing a key role in driving progress.

Panel 1: VGI Activities in California provided an essential summary of VGI activities by the CPUC, CEC, and IOUs, setting the stage for the workshop. The discussion emphasized the importance of VGI in achieving California's electrification and greenhouse gas reduction goals. Panelists highlighted ongoing pilot projects and research initiatives, stressing the need for long-term solutions and increased collaboration among stakeholders to scale VGI effectively. Key themes included identifying high-value services, technological maturity, and scaling mechanisms. The panel underscored the need for strategic initiatives to advance VGI's capabilities, with a focus on affordability, reliability, and customer engagement.

Panel 2: How Do We Value VGI? focused on the qualitative and quantitative mechanisms to value VGI and the challenges in realizing this value. Panelists discussed the roles of rates, managed charging, and V2X technology in determining VGI's value. Key topics included the need for flexible valuation approaches, dynamic hourly rates, and managed charging strategies. The panel emphasized the importance of understanding VGI's value streams, including cost reduction, customer engagement, and grid benefits. Stakeholders highlighted the necessity of automation in residential settings and the potential for subscription-based models. The discussion underscored the importance of developing value assessment

¹ Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE), and San Diego Gas & Electric Company (SDG&E).

² Rulemaking (R.) 23-12-008, Email Ruling Granting Request For Extension of 2024 Vehicle-Grid Integration Forum (filed December 17, 2024).

³ Full agenda available in Attachment A.

methods for the distribution system to enable scalability and reduce long-term infrastructure costs.

Panel 3: Crossing the Chasm from Pilot to Programs addressed barriers to transitioning from limited-scale pilots to full-scale programs. Panelists discussed frameworks to assess VGI maturity and readiness for scaling, focusing on both ratepayer and non-ratepayer funding pathways. Presentations highlighted strategic approaches to advance VGI, emphasizing pilots as strategic investments and the importance of customer acceptance, technology maturity, and regulatory enablement. Key topics included managed charging, dynamic rates, and leveraging funding mechanisms like Low Carbon Fuel Standards (LCFS) credits. The discussion underscored the importance of intentional design, stakeholder alignment, and operational readiness in successfully transitioning from pilot projects to scalable programs.

Panel 4 V2X Standards & Technology focused on the current state of V2X offerings, examining the technical, market, and regulatory barriers to scaling V2X. Presentations covered the status of V2G AC interconnection, bidirectional charging technology, and related standards like UL 1741 SB. Panelists discussed the importance of standardized protocols, streamlined interconnection processes, and collaborative efforts among utilities, manufacturers, and certification bodies. Key topics included the integration of EVs with other DERs, the role of aggregators, and the need for unified communication protocols. The discussion highlighted the rapid evolution of V2G technology and the urgency of formalizing certification processes to support scalable deployment.

II. Background

In November 2022, the CPUC issued Decision (D.) 22-11-040, which ordered the large IOUs, in conjunction with CPUC Energy Division staff (ED Staff), to host an annual VGI Forum with the objective of convening stakeholders to engage in discussion around the established VGI strategic focus areas of 1) rates and demand flexibility programs; 2) technology enablement and 3) planning.⁴ D.22-11-040 also ordered the large IOUs to file a workshop report within 60 days of the VGI Forum to capture the discussion and lessons identified for the record of relevant proceedings.^{5,6}The agenda for the VGI Forum (provided in Attachment A) comprised of four parts:

- Part 1 VGI Activities in California. (45 minutes)
- Part 2 How Do We Value VGI? (90 minutes)
- Part 3 Crossing the Chasm from Pilot to Programs (90 minutes)
- Part 4 V2X Standards & Technology (75 minutes)

⁴ D.22-11-040, p.172.

⁵ *Id. at* Ordering Paragraph (OP) 11.

⁶ The first annual VGI Forum was held on May 21, 2024, and the workshop report can be found in the CPUC's VGI Forum materials (California Public Utilities Commission, 2024), *available at:* https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M532/K262/532262533.PDF.

All presenter slides can be found in Attachment B.

III. Workshop Summary

A. Introduction and Objectives

To provide context on VGI and set the tone for the Forum, ED Staff reflected on the journey of VGI and outlined the objectives for the Forum. D.20-12-029 defines VGI as any method of altering the time, charging level, or location at which grid-connected vehicles charge or discharge to optimize their interaction with the electric grid. This definition encompasses all vehicle classes, including light-duty, medium-duty, heavy-duty, and off-road electric vehicles. Staff emphasized that net benefits to ratepayers are central to how the Commission considers VGI. These benefits include increasing electrical grid asset utilization and operational flexibility, avoiding infrastructure upgrades, integrating renewable energy resources, reducing electricity supply costs, and providing reliability services. ED Staff gave an overview of the three VGI strategic focus areas:

- 1) Rates and demand flexibility
- 2) Technology enablement
- 3) VGI and planning⁷

The objective of the annual VGI Forum, as described in D.22-11-040, aims to provide a venue for a comprehensive discussion of VGI topics across multiple proceedings, explore strategic focus areas, facilitate strategic communication, and raise emerging issues. Energy Division further elaborated that VGI objectives include advancing affordability, encouraging third-party innovation, enabling technology adoption, and developing standard inputs for grid planning.

B. VGI Activities in California (Panel 1)

The first session of the Forum aimed to provide essential background information on VGI work areas at the IOUs and CEC, setting the stage for the VGI Forum's discussion. The panel introduced key themes crucial for scaling VGI, highlighting ongoing activities in California that address affordability and reliability, and underscoring the need for strategic initiatives to advance VGI beyond its current capabilities.

Brian Chen, Principal Analyst at PG&E, moderated the panel, which included:

- Aaron Dyer, Senior Manager, Program Design and Development at SCE
- Nick Fiore, Clean Transportation Innovation Manager at SDG&E
- Peter Chen, Supervisor, Energy Research & Development Division at the CEC

⁷ D.22-11-040, at p.172.

1. Stakeholder Presentations

Brian Chen from PG&E opened the panel discussion by posing the question of why VGI is needed. He emphasized VGI's importance as a conduit for achieving California's ambitious electrification and greenhouse gas (GHG) emissions reduction goals, including Governor Newsom's executive order to achieve net zero by 2045,⁸ Senate Bill (SB) 350, which aims to reduce greenhouse gas emissions to 40% below 1990 levels by 2030 and 80% by 2050,⁹ and the California Energy Commission's (CEC) load shift target of 7,000 megawatts by 2030.¹⁰ These initiatives in transportation electrification are crucial for advancing California's decarbonization and electrification objectives. It is essential to ensure that VGI plays a central role in meeting these targets.

PG&E provided insights into current Investor-Owned Utility (IOU) activities in the VGI space, noting that most efforts remain in pilot, research, and design phases, with few projects demonstrating significant customer participation or long-term viability beyond Time-of-Use (TOU) rates and the Emergency Load Reduction Program (ELRP). He pointed out the short-term nature of pilots, which limits the ability to assess customer behavior over extended periods, making it challenging to develop lasting solutions. Additionally, he acknowledged the contributions of non-IOU players, who have been driving innovation in the VGI ecosystem. Despite these efforts, PG&E stressed the need for greater collaboration among stakeholders to fully unlock VGI's potential by integrating insights from diverse players and scaling solutions more effectively.

The presenter concluded the IOU presentation by outlining what is needed to scale VGI. PG&E noted that the current level of maturity across key VGI themes is uneven and still in its early stages. He emphasized that advancing our understanding in each of these themes is essential to developing a strong, compelling value proposition that can support the widespread adoption of VGI. The first theme involves identifying high-value services based on cost savings, efficiency improvements, and customer satisfaction, showing how they can drive affordability and downward rate pressure. The second theme addresses the varying technological maturity levels across different use cases, particularly in Vehicle-to-Everything (V2X) scenarios, and highlights the need for collaboration among OEMs, utilities, and regulators to bring customer-centric solutions to market. The third theme focuses on scaling mechanisms, emphasizing the transition from short-term pilot projects to long-term

⁸ Office of Governor Gavin Newsom, *California Releases World's First Plan to Achieve Net Zero Carbon Pollution*(November 16, 2022) *available at*: <u>https://www.gov.ca.gov/2022/11/16/california-releases-worlds-first-plan-to-achieve-net-zero-carbon-pollution/</u>

⁹ SB Stats. 2015-2016, Ch. 547 (Cal. 2015)

¹⁰ The California Energy Commission adopted a goal to make up to 7,000 megawatts of electricity available through smarter use of existing clean energy resources, aiming to double current levels by 2030 without building new power plants; see CEC, *California Adopts Goal to Make More Electricity Available Through Smarter Use* (May 31, 2023), *available at*: https://www.energy.ca.gov/news/2023-05/california-adopts-goal-make-more-electricity-available-through-smarter-use

programs by leveraging research and development insights, securing funding, and ensuring seamless digital continuity.

PG&E concluded by posing the question of what regulators and utilities need to do to align trends in O&M product offerings, customer acceptance, and funding pathways to scale VGI pilots into full programs while maintaining affordability.

Peter Chen from the CEC followed PG&E and highlighted the collaborative efforts between the CEC and IOUs in the VGI space, showcasing various projects and initiatives aimed at fostering innovation and market movement. He discussed the CEC's role beyond R&D, emphasizing regulations, analysis reports, and standard support as key levers for scaling VGI. He highlighted initiatives like charger grant programs, SB 59 authority for bi-directional capability, and the V2G equipment list. He also illustrated different types of funding efforts, including tech funding for research and development through the CEC's Electric Program Investment Charge (EPIC) program, responsive products with dynamic signals, and the deployment of EV charging automation. Non-ratepayer funded initiatives, such as REDWDS, charter block grants, and solicitations like EnergIIZE, CALeVIP, and Communities in Charge incentive programs, were also discussed, all aiming to foster an ecosystem of innovation and incentivize market movement.

To close his presentation, Peter returned to the three key pillars essential to the successful and large-scale implementation of VGI. He highlighted five key attributes, which align closely with findings from the agency's second AB 2127 Assessment.¹¹

- Access to appropriate value of VGI through rates and program-based options
- Broadly interoperable, reliable, and low-cost products and service offerings
- VGI both enables and benefits from cost-effective and timely grid connection
- VGI performance guides forecasting and planning
- Customers are willing to participate and aware of options

2. Panel Discussion

Panelists began the discussion by addressing the three themes of technology development capabilities, scaling mechanisms, and the value of VGI. They specifically focused on evaluating our performance in these areas, identifying which themes are progressing well and which require more attention.

SCE acknowledged progress in technological development within the VGI space, particularly the increasing role of third-party entities integrating with vehicles through APIs

¹¹ See CEC, Assembly Bill 2127 Second Electric Vehicle Charging Infrastructure Assessment: Assessing Charging Needs to Support Zero-Emission Vehicles in 2030 and 2035 (March 6, 2024), available at: https://www.energy.ca.gov/publications/2024/assembly-bill-2127-second-electric-vehicle-charging-infrastructure-assessment

and direct communication with distributed energy resources (DERs). However, these thirdparty systems still lag in seamless integration with utility platforms, limiting their effectiveness in grid operations. While pilot programs aim to enhance utility-controlled VGI initiatives, they remain relatively small in scale compared to third-party programs that enroll thousands of vehicles, although many of these lack direct utility coordination. The primary challenge is scaling VGI to reliably support hundreds of thousands or millions of electric vehicles as grid-responsive assets. Additionally, stakeholders struggle to determine VGI's broader grid benefits beyond customer cost savings, complicating the valuation framework necessary for scaling. This "chicken-and-egg" dilemma—where scaling requires value clarity, yet value clarity depends on large-scale implementation—underscores the need for stronger collaboration and trust among stakeholders to advance VGI solutions.

SDG&E reinforced SCE's points on customer scalability and technology maturity, highlighting rapid advancements in hardware and software while emphasizing successful pilot projects like the school bus V2X initiative, which provided site-level benefits but faced challenges in compensation for exported energy. While school buses were identified as an optimal early use case due to their predictable duty cycles, expanding VGI to municipal fleets, commercial users, and residential customers introduced new complexities requiring targeted outreach, education, and messaging. Ongoing pilots, including a collaboration with Toyota and the EPIC initiative, which integrates V2X with solar and battery storage for wildfire resilience, have demonstrated progress in interconnection and interoperability. However, SDG&E emphasized the need for more straightforward value propositions, broader customer engagement, and seamless integration with utility planning tools, like DERMS, to support the large-scale deployment of VGI solutions.

The CEC highlighted recent advancements in understanding the value and technological enablement of VGI, primarily through its technology funding initiatives. Ongoing projects and upcoming results will help clarify VGI's potential, with efforts under EPIC supporting Vehicleto-Building (V2B) demonstrations that explore backup power and demand flexibility across various commercial vehicle use cases. A recent EPIC solicitation targeted electric vehicles and distributed energy resources, focusing on improving VGI modeling techniques, reducing bidirectional charging costs, and developing innovative metering solutions. The speaker emphasized leveraging pilot results to guide scalable deployment and market readiness, underscoring CEC's unique role in fostering favorable conditions for VGI adoption. Looking ahead, the CEC plans to shape its next five-year investment strategy prioritizing transportation electrification, and calling for stronger coordination among EPIC administrators, including IOUs, as well as aligning innovation efforts through programs like BUILD.

The discussion then explored the CEC's role in scaling VGI beyond early-stage R&D, including regulatory levels, analysis, standard-setting, and incentive programs. CEC highlighted efforts such as grant programs, minimum equipment standards, and the potential use of SB 59 authority to require bi-directional capabilities in vehicles. During the discussion, CEC noted that they are also exploring resources, such as the V2G Equipment

List, to support interconnection and enhance product transparency for customers, aiming to bridge the gap between pilot projects and broader market deployment.

To discuss customer engagement, stakeholders stressed the importance of educating customers about VGI, noting that information often comes from inconsistent and fragmented sources. In response, SDG&E has expanded its Transportation Electrification Advisory Services (TEAS) to better support customers in evaluating options, such as total cost of ownership and return on investment. SDG&E also prioritized simplifying and clarifying the interconnection processes coordinating across teams to ensure customers had a more seamless and transparent experience as pilot projects began to scale beyond one-off, utility-led efforts.

SDG&E views its role as enabling customers to pursue the electrification options that best suit their unique use cases by simplifying processes and providing clear, supportive guidance. The utility focused on making deployment as seamless as possible, particularly around interconnection, while helping customers evaluate potential value. SDG&E also recognized the need to support early adopters—who often pursue complex, cutting-edge installations—with a higher-touch experience, then use those learnings to shape broader rollout strategies.

SCE echoed SDG&E's comments, concluding that while utilities excel in grid planning, safety, and reliability, they may not be best positioned to manage customer-device relationships directly. Instead, their role should be to integrate customer-owned devices—like EVs and heat pumps—into system operations in a way that respects customer preferences and partnerships with third parties, such as automakers, while ensuring those devices contribute to meeting grid needs.

3. Q&A Section

Stakeholders raised concerns about the slow progress in scaling VGI initiatives, noting the need for breakthroughs to meet 2030 climate goals. SDG&E emphasized the importance of enhancing the value proposition for customers and reducing the costs associated with VGI technologies. Stakeholders also emphasized the importance of utilities simplifying interconnection processes and supporting customer adoption. SCE echoed these sentiments, underscoring the importance of using existing tools effectively and understanding the holistic value of VGI. Stakeholders also mentioned PG&E's working group focused on resource adequacy for VGI, which invites participation to address cost-effectiveness and valuation challenges.

The CEC discussed its vision for the Charging Interoperability and Collaboration Yard ("Charge Yard") solicitation, which aims to establish an open and neutral resource for industry collaboration, knowledge sharing, and interoperability testing of electric vehicle

charging equipment.¹² CEC staff also highlighted partnerships with stakeholders on various projects focused on managed charging and grid dispatch approaches. SCE mentioned the integration of Advanced Distribution Management Systems (ADMS) and DERMS in their development roadmap, emphasizing the importance of streamlining interconnection processes.

SDG&E highlighted its integrated test facility in Escondido, which supports EV and charger testing, and emphasized the importance of sharing insights statewide and nationally to accelerate VGI adoption. Stakeholders underscored the need to simplify customer processes, enabling users to evaluate the potential value of technologies and ensuring a seamless deployment experience. Stakeholders agreed that early adopters are more engaged and excited about new technologies, requiring tailored support and messaging. As VGI scales toward mass market adoption, communication strategies must evolve to address different customer segments. Panelists agreed that maintaining a pulse on market trends and continuously updating educational materials and outreach efforts is essential. Collaboration and ongoing improvement were identified as key to achieving scalability.

C. How do we Value VGI? (Panel 2)

In Part 2 of the panel discussion, the focus was on the qualitative and quantitative value of VGI, and the challenges in realizing this value. The discussion explored the different roles that rates, managed charging, and V2X (vehicle-to-everything) play, and their implications for VGI value.

Danielle Weizman, Clean Transportation Business Development Manager at SDG&E, moderated the panel, which included representatives from various sectors of the energy ecosystem:

- Achintya Madduri, Senior Retail Rates Analyst at the CPUC
- Phillip Kobernick, Associate Director of Energy Programs at Peninsula Clean Energy
- Russell Vare, Vice President of Vehicle-Grid Integration at The Mobility House
- Mathias Bell, Vice President of Policy and Regulatory Affairs at WeaveGrid
- Dan Fletcher, Head of Ecosystems at Dcbel
- David Almeida, Senior Manager of Clean Energy Transportation Strategy at PG&E

Each panelist introduced their role and background, providing diverse perspectives from regulation, program design, customer-facing technologies, and utility operations.

¹² See CEC, *GFO-24-609 – Charging Interoperability and Collaboration Yard ("Charge Yard")* (March 14, 2025), at pp. 7–40, *available at:* https://www.energy.ca.gov/solicitations/2025-03/gfo-24-609-charging-interoperability-and-collaboration-yard-charge-yard

1. Stakeholder Presentations

a. Ongoing Planning and Market Integration

Panel moderator Danielle Weizman led a discussion on the classification of EVs, EV supply equipment, and VGI as DERs, emphasizing the importance of understanding their distinct traits to assess their value accurately. She outlined two key valuation markets: wholesale, managed by the California Independent System Operator (CAISO), through energy markets and transmission planning, and retail, governed by the CPUC through rates. While retail valuation focuses on the cost to serve benefits to ratepayers, and consumer participation, the perceived value can differ from the actual service value, requiring careful program design and incentives. Since most customers are not in the energy sector, engagement often depends on financial motivation. Danielle emphasized the importance of flexibility in valuation approaches to promote broader adoption while avoiding rigid frameworks.

b. Regulatory Roadmap for Dynamic Hourly Rates

CPUC presenter Achintya Madduri discussed key principles of rate design and demand flexibility, emphasizing that utility rates must fairly recover authorized revenue requirements while minimizing cost shifts among customers. The CPUC supports demand flexibility by aligning rates with real-time costs, enabling customers to adjust their usage and reduce long-term infrastructure needs. The CalFUSE framework was introduced, promoting dynamic pricing through transparent real-time rates, capacity pricing, rate reform, and bi-directional pricing for exported energy.¹³ They clarified that dynamic pricing should apply to both bundled and unbundled customers, and that incentives must be cost-based to prevent inequitable cost shifts. A slide illustrated that only a portion of residential rates could be influenced by customer behavior, underscoring the balance between incentivizing flexibility and ensuring utilities recover costs. The Commission's overarching message stressed economic efficiency, fair cost distribution, and the need for regulatory guidance to support evolving rate designs.

c. EV Managed Charging

Peninsula Clean Energy (PCE) shared two key insights, highlighting challenges with residential managed charging and the potential for simpler strategies to enhance VGI. A yearlong pilot using telematics-based managed charging with monthly financial incentives resulted in low enrollment and participation, primarily among individuals who were already optimizing their charging habits. While the pilot did not significantly reduce the evening load,

¹³ See CEC, Assembly Bill 2127 Second Electric Vehicle Charging Infrastructure Assessment: Assessing Charging Needs to Support Zero-Emission Vehicles in 2030 and 2035 (March 6, 2024), available at: https://www.energy.ca.gov/publications/2024/assembly-bill-2127-second-electric-vehicle-charging-infrastructure-assessment, and CEC, EV Specific Rates and CPUC Energy Division CalFUSE Staff Proposal (July 26, 2022) at p. 12, available at:

https://efiling.energy.ca.gov/GetDocument.aspx?tn=244215&DocumentContentId=78139.

it successfully mitigated the midnight demand surge when many EVs began charging simultaneously, providing benefits to distribution utilities. PCE emphasized that accelerating EV adoption alongside smarter load management may be a more effective approach to realizing VGI benefits. They also shared a study revealing that Level 2 home charging is less common than expected, with many early adopters instead relying on basic Level 1 outlets. PCE proposed a right-sizing residential charging infrastructure, particularly for multi-family properties, to limit peak impact by design, suggesting that simpler charging strategies could offer a more practical path forward.

d. VGI Value Streams

The Mobility House emphasized a customer-centric approach to VGI, focusing on cost reduction and engagement. In Europe, a hybrid energy rate was introduced that rewarded EV drivers with a "flexibility bonus" for shifting charging to lower-cost periods, leveraging smart telematics-based charging to aggregate load flexibility and pass financial benefits to users. In France, they launched a bidirectional charging program with Renault, enabling customers to earn up to €50 per month by providing grid services. For fleet customers, the emphasis was on reducing upfront infrastructure costs through automated load management and flexible interconnection, with ongoing savings driven by demand charge management, time-of-use optimization, and additional value streams like vehicle-to-grid services and backup power.

e. How do we Value VGI?

WeaveGrid outlined its focus on managed EV charging and VGI, emphasizing collaboration with utilities and automakers to develop software beyond telematics integrations. The presentation noted that EVs are personal vehicles, not just grid resources, and policies should prioritize the driver's experience, affordability, and sustained adoption. In addressing grid impacts, WeaveGrid highlighted that unmanaged residential EV charging can significantly stress distribution feeders, even if it doesn't coincide with broader system peaks. Traditional tools like TOU rates and demand response programs help manage systemwide demand but may exacerbate localized grid challenges. They argued that simple strategies like staggered charge times may reduce coincident peaks but can inadvertently create new non-coincident peaks, thereby driving up infrastructure costs. Given that EVs are typically plugged in for about ten hours but require only two hours of charging, WeaveGrid advocated for refined, location-aware charging strategies to optimize grid performance while maintaining affordability as EV adoption grows.

f. How to Value VGI

The Dcbel presentation focused on unlocking VGI value in the residential sector by emphasizing distributed intelligence and systems capable of communicating with both DERs and utility pricing structures. While homeowners seek costly features like dual EV charging, blackout power, and backup capabilities, monetizing VGI services could offset expenses and make advanced home energy setups more accessible. A key theme was situational awareness, stressing the need for real-time data and intuitive user portals to build trust in VGI systems. To address scalability across various utility jurisdictions, Dcbel proposed partnering with regional aggregators to unify programs despite differing rules and rates. They highlighted that DERs, including EVs and home batteries, can enhance grid flexibility and reduce infrastructure costs if properly coordinated.

To conclude, they categorized three types of DERs: bidirectional EVs, stationary home batteries, and unidirectional EVs. They demonstrated that with proper standards and interconnection, integrating other household devices like heat pumps and water heaters could further strengthen grid resilience. Ultimately, Dcbel emphasized that these distributed resources offer substantial energy capacity and can play a significant role in managing growing grid demand.

2. Panel Discussion

The moderator began the panel discussion by addressing potential savings from VGI use cases such as managed charging or V2X. They questioned whether the added costs of involving third parties, including aggregators, service providers, and charging network operators, would negate those savings, and who should be responsible for covering these costs.

Stakeholders explained that for VGI to work at scale, especially in residential settings, the process needed to be at least semi-automatic, if not fully automatic since most users wouldn't manually manage energy usage for small savings. They emphasized that some automation could be achieved through software. Their approach enabled more engaged users to access advanced features through the app while basic functionality operated automatically. They also suggested a subscription-based model, where users paid a vendor for bundled services rather than individually for each feature.

PG&E emphasized the importance of understanding the value provided through VGI and how to allocate that value across customers, third parties, and the utility. They noted that while value assessment mechanisms exist at the wholesale market level, the local distribution system lacks comparable tools. PG&E cited its ambitious VGI goal of having 550 MW of flexible EV load under management by 2030 and stressed the need for understanding the value of VGI—in particular distribution value— to understand impacts on affordability. Additionally, PG&E noted that a more robust integration of VGI into the utility planning process and operations is critical to realizing actual value.

ED staff highlighted that existing utility processes, notably General Rate Case (GRC) proceedings, already offer mechanisms to assess value at the distribution level. Stakeholders noted that utilities regularly calculate avoidable or marginal costs on a component-by-component basis, such as avoiding the need for additional distribution capacity or secondary grid upgrades. These values are typically annualized and attributed

per kilowatt of avoided load. While the system may not be perfect, established methods allocate costs and revenue across customer classes based on their contribution to system costs. ED staff rejected the claim that there is no existing process to assess value at the distribution level, citing the distribution cost component within the Avoided Cost Calculator (ACC), which can be leveraged to evaluate the value of VGI.¹⁴

Stakeholders noted that established frameworks like California's Standard Practice Manual could guide the evaluation of participant costs and total resource costs. They emphasized that affordability should be a central focus, and VGI should be viewed not just as a clean energy tool but as a strategy for reducing long-term revenue requirements. They also highlighted the importance of bottom-up approaches, acknowledging that while system constraints vary by location, investments must be seen as reasonable and prudent. Ultimately, they argued that if VGI could lower costs systemwide, it could put downward pressure on rates, making it a more affordable solution for all.

PG&E acknowledged that while there are existing valuation frameworks, they were developed primarily to assess system-level value and lack granularity for the emerging use case of distribution deferral value.

ED staff concluded the discussion by emphasizing their concern about affordability, noting that California has some of the highest electricity rates in the country. They stressed that their top priority is to identify strategies to reduce rates for all customers and made clear that any VGI efforts undertaken would not result in increased costs for ratepayers.

3. Question & Answer (Q&A) Section

A stakeholder opened the Q&A session by asking how customers could make informed, near-term investment decisions, such as upgrading to V2G technology, without clear visibility into future value or returns, as opposed to cheaper unidirectional solutions.

SDG&E emphasized the importance of customer relationships, noting that establishing an initial connection is crucial for achieving company goals. They shared that fostering positive experiences during pilot programs and nurturing ongoing relationships are essential as new use cases and opportunities emerge. However, SDG&E acknowledged the challenges in encouraging customer participation in innovative opportunities, especially when incentives are one-directional.

In response, the ED staff stated that it had authorized ambitious rate pilots, signaling a strong commitment to innovation. They explained that these pilots were mechanisms to begin swift implementation, even as the regulatory framework was still being developed. They added that success was not contingent on proving pilot outcomes before proceeding but on

¹⁴ In D.24-04-010, the Commission approved funding for Energy Division to conduct a study on avoided transmission and distribution costs. Per that decision, the results of the study should be completed in time to be incorporated into the 2026 ACC update in the R.22-11-013 proceeding.

launching early and learning in parallel. ED staff also highlighted efforts to support widespread participation in optional rates once they become available, demonstrating the Commission's active intent to advance these mechanisms.

Stakeholders shifted the discussion to address an audience question about the need for greater urgency from the Commission in moving beyond small pilot programs to engage the millions of EVs expected on California roads within a few years. They emphasized the importance of involving OEMs, who possess rich customer data and have direct relationships with drivers. Stakeholders encouraged panelists to explain how they were working with OEMs to target and engage with appropriate participants.

SDG&E highlighted that partnership with OEMs, such as GM and Toyota, had already been established through various company pilots. They emphasized the importance of automakers as key partners, citing their rapid scalability and ability to drive technological innovation. This is especially crucial as these companies aggressively pursue electrification to stay competitive on a global scale.

WeaveGrid responded by advocating for an omnichannel approach that includes both OEMs and utilities. They emphasized the importance of well-justified value propositions and scalable pilot programs. Without scalability, WeaveGrid argued that OEMs may be hesitant to invest in the necessary IT upgrades for broader implementation.

D. Crossing the Chasm from Pilots to Programs (Panel 3)

Part three of the panel discussion addressed key barriers hindering the transition from limited-scale pilots and studies to full-scale programs.

Blake Heidenreich, Strategic Advisor, Program Design & Development at SCE moderated the panel, which included representatives from various sectors of the energy ecosystem:

- Danielle Weizman, Business Development Manager, Clean Transportation at SDG&E
- Amy Costadone, Principal Product Manager at PG&E
- Jacqueline Piero, US Head of Policy at The Mobility House
- Casey Donahue, CEO and Founder at Optiwatt

SCE noted that many in the room likely shared the same North Star: decarbonization and providing reliable, affordable, and equitable energy to customers, even if their approaches differed. Acknowledging that the industry had tested many ideas without always reaching scale, he framed the discussion around how to take the next step toward broader implementation.

The presenters explored frameworks and considerations to assess VGI maturity and readiness for scaling, focusing on both ratepayer and non-ratepayer funding pathways.

4. Panelist Presentations

a. Scaling Pilots to Programs

SDG&E began its presentation by emphasizing that the company views VGI pilots as strategic investments rather than mere expenditures. Further, it is explained that these pilots are designed with targeted outcomes and future scalability in mind. High-priority use cases were selected by assessing market readiness, technology maturity, and potential value streams. The speaker shared that each pilot is crafted with a clear understanding of its goals, funding sources, and eventual path to scale.

SDG&E explained that the company treats VGI pilots as steppingstones to broader adoption, with mechanisms in place to modify, continue, or expand them based on learnings. The team at SDG&E evaluates which technologies are ready for commercial scale and identifies the appropriate regulatory and funding pathways, considering cost-benefit analyses and equitable design for ratepayers.

The company's key pilot areas include managed charging (through a CEC REDWDS Grant), resiliency and V2X applications (under EPIC 4), and a dynamic rate pilot that aligns with broader regulatory initiatives. In evaluating scalability, SDG&E employed two primary pathways: the Low Carbon Fuel Standard (LCFS) via Tier 2 advice letters and traditional application mechanisms. The speaker explained that these pathways enable program expansion, with a focus on non-ratepayer funding where possible. However, SDG&E argued that the policy appetite and value proposition for ratepayer-funded expansion remains an open consideration. The optimal mechanism to scale depends heavily on the specific use case and its alignment with regulatory, market, and customer needs.

b. VGI Scaling Pilots to Programs – PG&E

PG&E began its presentation by highlighting the growing constraints on local grid infrastructure in areas with high EV penetration, emphasizing the urgency of solutions like managed charging. PG&E has implemented both residential and commercial EV-specific rates and piloted dynamic pricing through programs such as its V2X pilot. Additionally, its EV Charge Manager pilot currently has over 6,000 participating vehicles in high EV adoption areas, exploring how managed charging can alleviate strain on service transformers.

The company applied a four-part framework to scale EV programs: quantifying grid value, evaluating technology maturity, simplifying customer experience, and ensuring regulatory enablement. PG&E found that 90% of EVs were on some form of TOU rate and as a result, the peak load reduction was modest as TOU rates already encourage charging at off-peak hours. PG&E believes that managed charging shows promise in addressing distribution-level constraints.

PG&E considered V1G technology mature and ready to scale, while V2G faced higher costs and integration challenges. To support broader adoption, PG&E acknowledged the need for upgrades to its billing system, seamless customer registration processes, and clearer interconnection pathways.

The speaker concluded the presentation by emphasizing the importance of customer acceptance, noting that PG&E conducted research to assess the effectiveness of its pilots. Regulatory enablement remained a critical factor, with the utility considering both LCFS funding and standalone applications for scaling, while acknowledging the complexity and limitations of each approach.

c. The Mobility House

The Mobility House opened its presentation by introducing the company, a 15-year-old firm founded in Europe with extensive experience in optimizing fleet operations and managing capital costs. This includes thousands of fleet deployments and both V1G and V2G initiatives. Over the past five years, the company has expanded into the U.S., continuing its work, particularly in California.

In Europe, The Mobility House directly participated in wholesale energy markets, enabling greater value capture and integration opportunities for EVs. However, in California, regulatory structures limit these benefits. They noted that while California utilities have made efforts to reflect wholesale pricing through rates and programs, incorporating third-party aggregators, as successfully demonstrated in deregulated markets abroad, could further enhance customer value and market efficiency.

The company emphasized that successful scaling of VGI requires innovative thinking around customer access and utility collaboration, though they acknowledged uncertainty in how this would take shape. They highlighted a Massachusetts pilot as a promising model – a fast, multifaceted effort that integrated interconnection, customer recruitment, and operations while producing deliverables and a roadmap for the state. The Mobility House concluded its presentation by stressing that pilots should be designed as launchpads for commercial operations rather than isolated experiments and should be structured with scalability and implementation in mind.

d. Optiwatt

Optiwatt began its presentation by sharing how the company initially started as a personal project to automate off-peak EV charging for the founder's Tesla, eventually evolving into a full-scale platform. Over time, the company grew significantly, managing 80,000 EVs and 25,000 smart thermostats and supporting over 10 DR programs in California. Notably, Optiwatt scaled the REDWDS grant program to 12,000 EVs in just nine months, providing incentives to only 1% of participants and proving its ability to scale without large payouts.

Optiwatt focused on addressing two main challenges: cost-effectiveness and scale. The company emphasized that reducing customer acquisition costs was just as critical as increasing grid value. Acquisition costs varied from \$7 to \$300 per customer, influenced mainly by enrollment design, channel strategy, and geographic targeting. Optiwatt discovered that streamlining the onboarding process and removing friction, such as manual meter input or account verification, drastically reduced costs.

The company advocated stacking value beyond just incentives to drive adoption. It proposed combining incentive programs into a single customer-friendly offering to enhance participation. Optiwatt also emphasized the need to avoid vendor lock-in and to allow open participation across multiple platforms—OEM apps, utility portals, smart home systems, and third-party aggregators—so customers could enroll through the channels they already used.

Optiwatt concluded that incentives alone may be insufficient to engage most customers. Instead, it recommended bundling benefits, enabling multiple program participation, and simplifying user experience to drive scale, lower acquisition costs, and generate meaningful insights quickly for future grid integration.

5. Panel Discussion

The central theme of the discussion focused on the distinction between pilots and programs and the challenges of "crossing the chasm" from one to the other. Panelists reflected on the current state of EV and DER initiatives, noting that while many efforts were still in the pilot phase, the goal was to evolve these into full-scale, sustainable programs.

Panelists debated the key differences between pilots, which are typically exploratory, smallscale, and temporary, and programs, which are designed for scale, permanence, and integration into broader utility operations. They emphasized the need for more precise definitions and transition strategies, questioning whether existing initiatives had achieved the maturity required for program status or remained in development.

The discussion revealed a shared recognition that a successful transition from pilot to program would require intentional design, stakeholder alignment, and operational readiness, along with lessons learned from existing pilot experiences.

From SDG&E's perspective, the key distinction between a pilot and a program is that a pilot aims to learn something specific, often related to testing value, capability, or outcome. SDG&E acknowledged that the current environment is still in the pilot phase, with efforts focused on incentivizing V1G and broader EV adoption. They emphasized the need to prioritize investments in areas with the highest incremental value rather than spreading resources thinly across numerous pilots. SDG&E advocated for targeted, high-potential pilots designed with scalability in mind to better unlock the full potential of EVs—beyond simple charging, toward flexible grid services. PG&E echoed SDG&E's sentiment on pilot scalability efforts, adding that scalability requires supporting multiple channels and vendors, significant IT infrastructure upgrades, and simplified customer enrollment processes. They noted that requiring details like service agreement IDs posed a significant barrier. PG&E also emphasized the importance of identifying different models to support growth without over-investing while still enabling broad ecosystem participation.

Optiwatt concluded the discussion by highlighting that a business model focused on acquiring and enrolling customers cannot be sustained if programs remain short-term pilots. Long-term programs provide vendors with the certainty needed to invest in customer acquisition and integration, ensuring that the economics and participation remain viable over a five to ten-year period.

Stakeholders shifted the discussion towards the potential for federal funding, particularly through the White House, to support the transition from short-term pilot initiatives to long-term, programmatic efforts. They highlighted how quickly priorities and funding guidance can change and asked the panelists what they would advocate for to secure sustained funding through 2030 or 2045.

SDG&E highlighted the advantage of LCFS funding in reducing financial pressure on ratepayers while supporting EV adoption and incentivizing VGI. Both parties view pilots as "on-ramps" to programs, which should gradually phase out subsidies to ensure equity. SDG&E emphasized leveraging LCFS to avoid cost shifting and provide tangible benefits for ratepayers, planning to refine rate designs over time to maintain equity across customer classes and usage periods.

SCE echoed SDG&E's sentiment, emphasizing that LCFS funding is a valuable tool to help jump-start initial EV and VGI projects. They acknowledged that as deployment progressed and more data became available, it would be possible to better assess that value and then determine appropriate long-term funding sources beyond LCFS. Optiwatt shared that there are two potential pricing pathways: either utilities directly expose their costs through dynamic rates, or they maintain simple, customer-friendly rates while collaboratively managing load with vendors to optimize outcomes.

Overall, stakeholders emphasized the importance of partnerships with service providers and aggregators, stating that relationships had increased efficiency in both customer acquisition and long-term DER operations. They also underlined the importance of establishing a regulatory framework that supports reliable aggregator participation rather than relying on utilities to find cooperative partners.

Finally, stakeholders advocated for a technology-neutral approach to valuing grid flexibility. They noted that Europe and Massachusetts have begun prioritizing flexible resources, even if not EV-specific, as critical assets for grid planning through 2030 and 2045. Stakeholders collectively closed the discussion by emphasizing the importance of integrating EVs within the broader DER landscape while recognizing that EVs are not uniquely separate from other DERs. They noted that EV-specific rates remain essential but should not be the sole focus. Instead, stakeholders advocated for recognizing value streams like export compensation and other flexible grid services that could benefit customers regardless of their base rate.

They also acknowledged that customers' energy decisions were based on total operational cost, not just EV ownership, and thus, programs should reflect a holistic energy approach. Stakeholders noted that while California's rate design is complex, there is international interest in its step-curved model, suggesting opportunities to explore how EVs can support grid flexibility more effectively.

To conclude, stakeholders underscored the need for alignment with broader regulatory proceedings, such as the High DER OIR (R.21-06-017), which addressed the operationalization of smart inverters, distribution system operator models, and DER market integration.¹⁵ Ultimately, efforts should align with systemic goals to avoid duplicative work while ensuring that DERs, including EVs, can contribute value in a scalable and customercentric manner.

6. Q&A Section

A stakeholder raised a question about the current barriers preventing utilities from offering compensation programs to all customers, particularly school districts interested in investing in electric buses but lacking access to such incentives. He inquired why these programs are not universally available, what specific obstacles exist, and what regulatory changes utilities would need to implement to support broader adoption.

SDG&E acknowledged that operating in a regulated environment poses significant challenges, particularly with fast-evolving technologies that necessitate pilot programs. They emphasized the complexity and time-consuming nature of navigating regulatory frameworks, including seeking approvals, meeting target settings, and undergoing measurement and evaluation. SDG&E further noted that while these requirements ensure value, equity, and prudence, they limit the utility's ability to respond swiftly to emerging opportunities. They highlighted that launching a pilot could take one to two years for approval and another two years to implement, which conflicts with the urgency of meeting 2030 climate goals.

PG&E responded by highlighting that the current regulatory process, which can be a multiyear process from application to program implementation, hinders responsiveness to

¹⁵ R.21-06-017, Order Instituting Rulemaking to Modernize the Electric Grid for a High Distributed Energy Resources Future(issued July 2, 2021).

emerging technologies. They suggested exploring a more flexible, staged approval process that would allow for incremental learning and funding adjustments, potentially improving the timeline and effectiveness of scaling new programs.

SCE acknowledged that while regulatory processes exist for valid reasons, the urgency of today's challenges demands faster action. They emphasized that historical timelines should not set the pace for future progress and suggested that it is possible to move more swiftly and effectively, much like past large-scale infrastructure projects. SCE advocated rethinking traditional approaches to achieve better, faster outcomes that meet the pressing needs of the present.

Attendees raised questions about the challenges of valuing and quantifying the benefits of distribution infrastructure and emerging technologies. They pointed out that assessing costeffectiveness is challenging due to limited participation, high upfront costs, and the complexity of defining value across different use cases, including resiliency, customer experience, and system-level benefits. They emphasized that the perceived value varies depending on who receives the benefit, whether it's individual customers or the broader grid.

Stakeholders emphasized the importance of pilot programs for data collection, testing incentive designs, evaluating customer behavior, and guiding future program design. They supported a growth mindset that prioritizes scalable, iterative development over striving for perfection from the start.

In response to an attendee's question, the panelists discussed the potential of transitioning from a traditional customer acquisition model to an opt-out approach for scaling participation and maximizing the value of VGI. Stakeholders collectively agreed that opt-out models historically lead to higher participation rates than opt-in models, making them more effective for program expansion. They also underscored the critical role of OEMs in enabling opt-out functionality.

Utilities cited limitations in customer data as a barrier to automatic enrollment, underscoring the need for OEM coordination at the point of sales. Concerns were raised about the risks associated with automatic enrollment without customer commitment, particularly in sensitive use cases like congestion management or emergencies. There was consensus on preserving customer choice through a range of participation options. Some proposed linking managed charging enrollments to incentive or rebate program conditions to ensure a seamless, non-disruptive experience.

Overall, stakeholders supported exploring opt-out models while emphasizing the importance of OEM collaboration, effective risk management, and preserving customer autonomy.

E. V2X Standards & Technology (Panel 4)

Panel 4 focused on the current state of V2X offerings, examining the technical, market, and regulatory barriers to scaling V2X. Additionally, an in-depth discussion on V2G AC progress, including emerging trends and existing barriers, took center stage.

Zach Woogen, Executive Director at Vehicle Grid Integration Council, moderated the panel, which included representatives from various sectors of the energy ecosystem:

- Jose Aliaga-Caro, Utility Engineer, Energy Division Interconnections and Distribution Engineering at California Public Utility Commission
- John Holmes, Sustainability Business Development, American Honda Motor Company, Inc.
- Ari Naggar, Manager, Residential Energy Products, at Tesla
- Scott Picco, Principal Engineer, Distributed Energy Resources, EV Power Export, and Power Control Systems at UL Solutions
- Tim Zgonena, Principal Engineer, Energy and Industrial Automation at UL Solutions.

1. Presentations

a. CPUC Interconnection and Distribution Engineering

The Energy Division presented the current state of the interconnection process for V2G systems, highlighting the status of V2G DC interconnection. They noted that these systems can operate in either unidirectional or bidirectional modes. Bidirectional systems must comply with Rule 21 interconnection and all applicable requirements, ¹⁶ including UL 1741 and Supplement B.¹⁷ However, systems participating in the Emergency Load Reduction Program (ELRP) may be certified under UL 1741 alone.

ED Staff discussed the V2G AC interconnection. In 2020, the Commission introduced a temporary pilot pathway for interconnecting V2G AC systems, allowing the use of relays or other agreed-upon methods due to the absence of permanent standards. In December 2023, during the Smart Inverter Working Group, UL Solutions presented its Quickstart Interoperability and Key Performance (QIKP) process to streamline and accelerate the testing and certification of V2G AC systems leveraging existing standards.

¹⁶ See CEC, *Electric Rule 21: Generating Facility Interconnections, available at:* <u>https://www.cpuc.ca.gov/rule21/</u>

¹⁷ See Press Release, UL Solutions, Issues First Certification to UL 9741 and UL 1741 SA for an AI-Driven Vehicle-to-Grid Compliant EV Charger to Fermata Energy (October 11, 2023), available at:

https://www.ul.com/news/ul-solutions-issues-first-certification-ul-9741-and-ul-1741-sa-ai-driven-vehicle-grid

ED staff presented an overview of the CPUC Resolution (Res.) E-5315,¹⁸ adopted in August 2024, which extended the V2G AC interconnection Pilot and initiated its transition to a permanent process through modifications to Rule 21. This action was designed to ensure continuity between the pilot's conclusion and the establishment of a long-term interconnection framework. The Commission acknowledged that the industry would need time to certify new standards and included language to provide that flexibility, referencing earlier findings by the subgroup, which identified gaps in existing standards. The Commission committed to reconvening the subgroup once updated standards were available, to assess their adequacy for permanent interconnection.

In March 2025, utilities submitted an update indicating that relevant standards for V2G AC interconnection were expected to be published by the third quarter of 2025. At that point, the subgroup would be reconvened to evaluate the standards and assist in drafting appropriate Rule 21 language. The presentation concluded with an overview of two potential interconnection processes: one using UL 1741 Supplement SC (expected by July 2025) and another using UL's QIKP process, which is currently available but has not yet been implemented.

b. VGIC

The Vehicle Grid Integration Council provided an overview of bi-directional charging technology, commonly referred to as V2G (Vehicle-to-Grid) and V2H (Vehicle-to-Home), highlighting their growing relevance and current market status.

The presentation aimed to demystify technical concepts, acronyms, and policy pathways critical to advancing the V2X market. VGIC outlined three primary bidirectional charging configurations: parallel operation without export, parallel operation with export, and islanded operation. VGIC distinguished between AC systems (which use onboard inverters) and DC systems (which rely on offboard inverters). Most current products use DC configurations, which tend to be more expensive due to the need for additional equipment. Certified products currently available on the market include the Nissan Leaf with Fermata Energy chargers (UL 1741 SA certified) and Tesla's AC-based solution, approved under the 2020 AC pilot. New offerings from BMW, GM, Lucid, and others are expected soon.

VGIC noted that all-electric school buses seeking CARB HVIP funding in California are now required to be bidirectionally capable, a significant factor driving their deployment. However, barriers to scaling bi-directional charging were discussed, including high interconnection application fees (up to \$800), a lack of streamlined permitting, and limited tracking and reporting mechanisms in Rule 21 filings. The speaker emphasized the need for regulatory updates and streamlined interconnection pathways to accelerate market growth and unlock the full potential of V2X technologies.

¹⁸ Res. E-5315 (August 26, 2024).

c. UL Solutions

UL Solutions delivered a technical overview of key standards governing bidirectional electric vehicle (EV) power export systems, starting with foundational standards such as UL 2202 for DC chargers and UL 2594 for Level 2 AC equipment, before shifting its focus to UL 9741, which addresses bidirectional EV charging systems explicitly. This standard integrates the functions of both the EV charger and grid-interactive inverter to meet utility interconnection requirements and local grid codes. The speaker traced the evolution of UL 9741 from its initial development in 2014 for military applications to its 2021 update and the joint publication of UL 9741/CSA C22.2 No. 348 in 2023, which formalized its binational scope.

The speaker outlined five key system configurations from UL 9741, including vehicle-to-load (V2L), home backup (V2H), grid-tied V2G, and multi-mode systems supporting both V2H and V2G. He emphasized how UL 9741 works in tandem with UL 1741 SB and IEEE 1547 to address critical safety and grid compliance concerns, including electric shock, fire hazards, and interoperability.

UL Solutions focused on developing standards to ensure the safe and reliable integration of EVs into the electric grid through bidirectional power export. Recognizing the utility preference for third-party certification, the presenter introduced UL 1741 SC, a supplement bridging the gap between the automotive industry's self-certification model and the strict certification expectations of utilities. This supplement aims to align EV export equipment with existing distributed energy standards, ensuring mutual trust in grid compatibility and safety.

A key part of the effort involves establishing a bidirectional EV Supply Equipment (EVSE) system that communicates with the vehicle using the SAE J3072 protocol. This protocol authorizes export limits through real-time utility signals, ensuring safe and coordinated interaction with the grid. The presentation emphasized that the utility interface for bidirectional EV systems is modeled after traditional DERs, utilizing familiar communication protocols to support monitoring and control. This collaborative effort spanning EV manufacturers, utilities, inverter companies, and certification bodies, has made significant progress in aligning the needs of the transportation and energy sectors to enable safe, bidirectional EV-grid integration.

d. Honda Automotive

Honda's presentation emphasized its commitment to achieving "Triple Zero" goals—carbon neutrality, resource circularity, and clean energy solutions by 2050. Bidirectional grid integration was highlighted as a key enabler of these objectives. While communication protocols are essential for enabling interaction between EVs and the electric grid, panelists noted that harmonizing these protocols to ensure safety, utility, and interoperability remains a significant challenge. The presentation spotlighted common transaction frameworks developed through the Smart Inverter Operationalization Working Group, which prioritize use cases such as price-based optimization, demand response, load flexibility, and export limit enforcement. Limiting EV exports during grid oversupply events was identified as a critical yet often overlooked functionality.

Honda emphasized the importance of integrating EVs with other DERs, such as solar, storage, and water heaters, through a local control model. However, the lack of formal standards for this integration presents challenges for coordinated household energy management.

On a broader scale, aggregators were described as essential for managing DERs on a larger scale. Explaining that these entities must interface with systems like SCADA and DERMS using communication protocols that are available but not yet fully harmonized. Honda advocated for unifying DER and bidirectional grid integration (BGI) communications under a single protocol, noting that IEEE 2030.5 and OCPP 2.1 are functionally similar but currently incompatible. This misalignment is particularly relevant given that IEEE 1547 specifies IEEE 2030.5 for DER interconnection.

To address these inconsistencies, Honda recommended adopting IEEE 2030.5 as the unified protocol and called for stronger industry engagement with standards development organizations such as SAE International, which is actively updating EV-specific standards like SAE J2847/2 and J2847/3 for DC and AC V2G applications, respectively.

Finally, Honda encouraged participation in standards task forces and referenced resources such as SAE's task list and a global standards guidebook published by EPRI, which is available for free download.

e. Tesla

Tesla shared its vision and product architecture for V2G integration, focusing on scalability, affordability, and accessibility. The company introduced its PowerShare platform, which enables bidirectional power flow using the vehicle's onboard inverter. This approach eliminates the need for costly off-board equipment and supports multiple use cases, including vehicle-to-load (V2L), vehicle-to-vehicle (V2V), and complete home backup. The presenter announced that the Cybertruck is the first vehicle to offer this functionality, with a broader rollout expected across other models in 2025.¹⁹

Tesla emphasized the increasing role of EVs in home energy ecosystems, particularly as residential electricity demand rises due to the electrification of appliances and HVAC

¹⁹ See Electrek, *Tesla gives an update on Powershare: Cybertruck powering your house* (October 16, 2024), *available at:* <u>https://electrek.co/2024/10/16/tesla-gives-an-update-on-powershare-cybertruck-powering-your-house/</u>

systems. The company positions EVs as a critical source of distributed energy storage, complementing its stationary products like Powerwall and Megapack.

Tesla's PowerShare platform enables customers to participate in energy arbitrage and grid services by leveraging the vehicle's onboard inverter, which supports AC-coupled bidirectional charging. This architecture eliminates the need for costly off-board equipment, reducing system costs by an estimated 40–50% compared to DC-based V2G solutions. The system includes a PowerShare Gateway for site control, a universal wall connector, and disconnection equipment. Tesla Cybertruck is the first vehicle in its lineup to support PowerShare functionality. It can deliver up to 11.5 kW of power, which Tesla claims is sufficient to support 95% of homes, equivalent to the output of approximately nine Powerwalls. The company also addressed technical and regulatory considerations, noting that V2G operation requires certification to standards such as UL 1741 SB and the use of a secure communication protocol. A stationary controller governs grid interaction, ensuring vehicles are discharged of energy under approved configurations. Tesla concluded by urging the industry to support standardized certification, simplify program participation, and reduce equipment costs to make V2G scalable. The company also called on utilities to allow EVs to participate in existing distributed energy resource programs without imposing unnecessary barriers.

2. Panel Discussion

During the panel discussion, the presenter reflected on how rapidly the V2G technology conversation has evolved, noting that just six months to a year ago, certification standards like UL 1741 were not yet part of the dialogue. With that context, the presenter posed two key questions to the panel. First, they asked about the next steps for the 1741 SB Certification Requirement Decision (CRD) pathway. Second, they inquired about the future of the EVSE certification pathway.

UL shared that it had received detailed feedback from four to five members of the Standards Committee on the 1741 SB draft. They are currently consolidating comments into a final version, which is expected to be completed within the week.

ED staff emphasized that V2G technology is already proven and operational in laboratory environments, indicating that no significant technical barriers remain. The primary challenge lies in formalizing the certification process. ED assured the panelists that the committee is diligently working to finalize Rule 21 activities, and once standards are published, regulatory progress can move quickly.

The moderator concluded by highlighting California's significant investment in advancing V2G standards through agencies like the CEC, CPUC, and EPIC funding. However, he noted that Maryland may soon surpass California in formally adopting V2G regulations for both DC and AC pathways, with AC incorporating both the UL 1741-SC and UL 1741-FE CRD. The

VGIC representative used this development to underscore a sense of urgency for California to accelerate its efforts.

3. Q&A Section

During the Q&A session, an attendee asked whether Tesla's claim that AC architecture is approximately 40-50% less expensive than DC aligns with the experiences of other panelists. The same suggested that, if accurate, AC cost advantage could potentially represent the logical future for V2G. The attendee also inquired about the potential drawbacks of using AC over DC for V2G applications.

Panelists acknowledged both the advantages and limitations of AC architecture. From the user perspective, AC offers convenience, as vehicles with onboard inverters can connect to standard Level 2 chargers and discharge without needing specialized infrastructure. However, panelists explained that utilities face planning difficulties due to the unpredictability of vehicle locations and the amount of power they can provide. Current interconnection rules require fixed locations, and enabling roaming discharge would demand new communication protocols and permitting framework.

The UL 1741-SC certification pathway helps address this issue by allowing certified vehicles to discharge from multiple approved sites. Panelists emphasized that the core issue is not AC vs. DC but rather the need for more mature standards and improved interoperability. Overall, stakeholders supported deploying existing systems to build experience while standards continued to evolve.