EPIC Strategic Goals

Grid Modernization

Workshop

Report

EPIC POLICY + INNOVATION
COORDINATION GROUP

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California's Electric Program Investment Charge (EPIC) program is funded by California utility customers under the auspices of the California Public Utilities Commission.

This report was completed by The Accelerate Group, a consultant to the California Public Utilities Commission and the Project Coordinator for the EPIC Policy + Innovation Coordination Group. The information herein was collected and summarized by the Project Coordinator, with input from members of the EPIC Policy + Innovation Coordination Group and does not reflect an official position of the California Public Utilities Commission.

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I. EXECUTIVE SUMMARY

In its most recent EPIC decision,[1] the California Public Utility Commission (CPUC) directed that program-wide goals are needed to evaluate the progress of innovation investments and the extent to which investment plan portfolios maximize ratepayer benefits and impacts in achieving California's clean energy and climate goals. As part of that decision, the CPUC directed the establishment of a public workshop process to inform how Strategic Goals and Objectives should be articulated and established by the Commission in its next guidance Decision for the EPIC 5 cycle (2026-2030). The overall goal of the Strategic Goals Workshop process is to collect stakeholder input on critical pathways, gaps, roles and outcomes in achieving the State's climate goals that would be best fulfilled by EPIC's research, development, and demonstration (RD&D) funding, considering its unique role and opportunities.

On September 6-7, 2023, the CPUC hosted the EPIC Strategic Goals Grid Modernization Workshop, which focused on a selection of critical pathways and topic areas related to grid modernization that were discussed in the Kick-Off Workshop, including Transportation Electrification, Distributed Energy Resource Integration, Resiliency, and Reliability.

Almost 200 stakeholders participated in the workshop. Withing the four critical pathways for grid modernization, participants highlighted the following key gaps and opportunities for EPIC research: helping the grid integrate electric vehicles as a resource that can provide services to the grid, such as energy storage and load shifting; enabling the development of critical facility microgrids and community resilience hubs and supporting the deployment of flexible load and grid-supporting Distributed Energy Resources (DER). Participants noted costs of grid upgrades as one of the key obstacles and agreed that microgrids, long-duration energy storage, managed EV charging, Vehicle-to-Grid (V2G), Virtual Power Plants (VPPs) and aggregated DERs can significantly reduce these costs. Participants also identified many opportunities for standardization and improved modelling of existing and new technologies, as well as the data and analysis gaps that EPIC can help address to further California's climate goals.

[1] CPUC Decision (D.)23-04-042

II. BACKGROUND

What is EPIC?

The EPIC program is funded by California utility customers under the auspices of the California Public Utilities Commission.

The Electric Program Investment Charge (EPIC) is a California ratepayer funded program that drives efficient, coordinated investment in new and emerging clean energy solutions. Its mandatory guiding principle is to provide ratepayer benefits, with a mission of investment in innovation to ensure equitable access to safe, affordable, reliable, and environmentally sustainable energy for electricity ratepayers. EPIC invests in a wide range of critical innovation, including building decarbonization, cybersecurity, demand reduction, distributed energy resource integration, energy storage, entrepreneurial ecosystems, grid decarbonization, grid decentralization, grid modernization, grid optimization, grid resiliency and safety, high penetration renewable energy grid integration, industrial and agricultural innovation, smart grid technology, transportation electrification, and wildfire mitigation. From 2012 through 2030, EPIC will have invested nearly $3.4 billion in clean energy technology innovation.

What is the Policy + Innovation Coordination Group?

The California Public Utilities Commission (CPUC) oversees and monitors the implementation of EPIC research, development, and deployment program. For current EPIC funds from investment periods 1 (2012-2014), 2 (2015-2017), 3 (2018-2020), and 4 (2021-2025) there are four program administrators: the California Energy Commission (CEC), Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E). The CEC administers 80% of the funds and the utilities administer 20%.

In Decision 18-10-052, the CPUC established the Policy + Innovation Coordination Group (PICG)—comprised of a Project Coordinator, the four Administrators, and the CPUC—to better align EPIC investments and program execution with CPUC and California energy policy needs. In Decision 23-04-042, the CPUC directed PICG to convene the Strategic Goals and Objectives process to inform Commission guidance on the EPIC 5 funding cycle (2026-2030).

Workshop Process Goals

The Strategic Goals Workshop Process will focus on identifying four core elements:

Pathways:

Set of critical actions necessary to support meeting the State's 2045 zero carbon goals via the most effective strategies and technology innovation.

Gaps:

Key challenges for achieving zero carbon goals and how RD&D should be prioritized to address opportunities and barriers more quickly along critical pathways.

Roles:

The best-positioned stakeholders (ratepayers, state, federal, private sector) to lead innovation investment in addressing identified gaps, including through coordination and collaboration.

Outcomes:

Clear, measurable, and reasonable targets to be used by administrators in developing EPIC portfolios and used in program evaluations to measure impacts of EPIC in supporting achievement of California's 2045 zero carbon goals.

III. WORKSHOP SUMMARY

Agenda

The two-day Workshop was hosted on September 6, 2023, from 1 pm – 5 pm, and on September 7, 2023, from 10 am – 3 pm. The workshop consisted of five roundtables, each followed by stakeholder discussions, inviting questions and comments from the audience in the room and participants connected virtually. CPUC Commissioner Genevieve Shiroma provided opening and closing remarks on both days. The PICG Project Coordinator provided an initial introduction to the Workshop process and the purpose of the event.

Opening and Closing Remarks: Commissioner Genevieve Shiroma welcomed the participants and outlined the goals and purpose of the workshop, noting that as a ratepayer funded program, EPIC owes it to the ratepayers that these funds are utilized well, meeting the needs of the low income, tribal and disadvantaged communities through the state. Investing in these communities is crucial to achieving California's 2045 climate goals. The grid is important to ensuring their quality of life, health, and wellbeing. Vulnerable households

across the state have been affected by the outages, and grid infrastructure in those communities needs to be addressed. Commissioner Shiroma noted that grid resiliency is a concern for the Commission, with wildfires, floods, heat storms, cybersecurity, and other threats that California has been experiencing, and needs to be prepared for. The research can help adopt new technologies and best practices for a more resilient grid and protect vulnerable communities from outages. For example, in its microgrid proceeding, the CPUC is looking into investing in low income, disadvantaged and tribal communities that have experienced those burdens. Commissioner Shiroma noted that the current effort is building upon what EPIC has done in the past and she is excited to see EPIC efforts come to fruition on a larger scale. Commissioner Shiroma also introduced and thanked Commissioner John Reynolds and key CPUC judges and Staff involved in this effort. In the closing remarks, Commissioner Shiroma summarized the feedback and key issues raised by the participants and noted the importance of the human condition in research and planning and making distinctions between aspirational and breakthrough solutions.

Roundtables: The roundtables focused on the following four areas:

1. **Transportation Electrification.**

   Presenters:

   - Jack Symington, Los Angeles Cleantech Incubator
   - Phillip Kobernick, Peninsula Clean Energy
   - Rachael Aptowitz, Grid Alternatives
   - Rachel Zook, NUVVE
   - Eric Wood, National Renewable Energy Laboratory (NREL)
   - Rima Oueid, US Department of Energy Office of Technology Transition (US DOE)
   - Damian Inglin, PG&E
   - Rajit Gadh, MOEV

   The speakers presented perspectives of the Los Angeles Cleantech Incubator, Peninsula Clean Energy, Grid Alternatives, NUVVE, NREL, the US DOE, PG&E and MOEV, followed by a stakeholder discussion. During the stakeholder discussion, the participants agreed that California's electric vehicle (EV) targets are realistic, as various studies indicate that there will be sufficient demand to sustain them. Participants noted, however, that supply chain delays, grid connection issues and charging and manufacturing vendors' reluctance to give up their proprietary and vertically integrated solutions in favor of standardized and open access protocols may slow the process down, as the demand outpaces the supply and infrastructure readiness. The presenters expressed a concern of a potential plateau in the EV adoption if these barriers are not reduced. Discussion also focused on the need

to align new electrification loads with renewable energy supply, and streamline interconnection of EV resources, to ensure affordability of EV integration to the electric grid.

2. DER Integration.

Presenters:

- Gabriel Petlin, Masoud Foudeh, and Julian Enis, CPUC
- Rachel McMahon, CA Energy Storage Alliance
- Haresh Kamath, EPRI
- Damian Inglin, Pacific Gas and Electric (PG&E)
- David Carter, Cal Poly Humboldt
- Tom Tansy, SunSpec Alliance
- Michael Colburn, San Diego Gas & Electric (SDG&E)
- Dan Dumovich, GRID Alternatives

The speakers presented perspectives of the CPUC, EPRI, PG&E, SDG&E, Cal Poly Humboldt, SunSpec Alliance, California Energy Storage Alliance and Grid Alternatives, followed by a stakeholder discussion. The stakeholder discussions addressed what EPIC investments should focus on in the Distributed Energy Resource (DER) space, including the role of EPIC in supporting the advancement of flexible load, standardization, and direct benefits to Environmental and Social Justice (ESJ) communities. The discussion included a look at the successful operation of microgrids in grid-stress conditions, the role of aggregated DERs and Virtual Power Plants (VPPs) in reducing costs of grid modernization, and incentives needed to enable customers to offer their DERs as grid resources.

3. Reliability.

Presenters:

- Priya Sreedharan, GridLab
- Miguel Heleno, Lawrence Berkeley National Laboratory (LBNL)
- Marc Costa, The Energy Coalition
- Anthony Johnson, Southern California Edison (SCE)

Participants: The speakers presented perspectives of GridLab, LBNL, The Energy Coalition, and SCE, followed by a stakeholder discussion. During the stakeholder discussions the participants agreed that there are no immediate reliability threats due to high penetration of renewable resources. Participants discussed GridLab's 2022 study

that shows that California's distribution system can be operated reliably at up to 75% reliance on inverter-based resources, with further research necessary to evaluate reliability beyond that and develop a plan for gas retirements. Participants also agreed that frequency control is not a major concern for distribution grid, even at feeder level with high concentration of inverter-based resources. At the same time, voltage control may need to be addressed, utilizing smart inverter capabilities. The participants noted that so far utilities have been generally managing voltage regulation well and are looking into using more DER capabilities for grid balancing. Participants identified data and analysis gaps in this area that EPIC can address to ensure reliability.

4. Resiliency.

Presenters:

- Michael Colburn, San Diego Gas & Electric (SDG&E))
- Anthony Johnson, Southern California Edison (SCE)
- Vipul Gore, Grid Scape
- Gabe Murtaugh, Long Duration Energy Storage Council
- Andrew Coleman, EPRI
- Amee Raval, Asian Pacific Environmental Network
- Olga Hart, Sandia National Laboratory
- J.D. Saucedo, County of Santa Barbara
- Kailash Raman, Form Energy
- Ben McMahan, California Governor's Office of Planning and Research

The last two roundtables focused on Resiliency. Presenters provided perspectives of the SDG&E, Grid Scape, Long Duration Energy Storage Council, SCE, EPRI, Asian Pacific Environmental Network, Sandia National Laboratory, County of Santa Barbara, Form Energy, and California Governor's Office of Planning and Research. Participants discussions that followed highlighted benefits of islanded microgrids and long-duration storage, and highlighted need for standardization of various resources and processes. The stakeholders also discussed timeframes for research and solutions needed and their prioritization. Participants stressed the importance of evaluating research through the lenses of deployment and cost benefits analysis and focusing on cost justifiable solutions and best value approach, including identifying ways to capture non-financial benefits of resilience, and reducing costs through standardized designs and processes.

Presentations

The link to the presentations is included in the Appendices to this report.

Attendees

Almost 200 individuals participated in the two-day workshop, virtually and in person, including CPUC Commissioner Genevieve Shiroma and CPUC Staff, representatives from the US Department of Energy, the four Administrators of the EPIC Program (California Energy Commission, and the three utilities), as well as research institutions, community leaders, technology solution providers, government entities, utilities, non-governmental organizations, and industry.

IV. STAKEHOLDER RECOMMENDATIONS

Workshop participants provided the following recommendations for EPIC funded research opportunities that can address key gaps identified during the workshop:

Key Items of General Consensus

Workshop discussions and presentations highlight the following key areas of consensus among workshop participants:

Critical Pathways:

The discussions focused around the four main pathways of grid modernization identified in the previous workshops: Transportation Electrification, DER Integration, Reliability and Resiliency. No new pathways were suggested during this workshop. Many equity considerations were raised generally and related to specific pathways, that are addressed below.

Key Gaps:

Overall, the participants agreed that the costs of grid modernization and the ability of the grid to sustain the new load from electrification are the main concerns that need to be addressed. The need for increased utilization of customer behind the meter resources to provide grid services, including flexible load and peak load shifting, energy storage, and grid balancing, to reduce the costs of grid upgrades and to sustain the new load, is another key area of general consensus among the participants. The participants overall agree that customer Distributed Energy

Resources (DER), electric vehicle (EV) batteries and charging infrastructure, Vehicle-To-Grid (V2G) and Virtual Power Plant (VPP) resources, if incentivized, utilized, and managed properly, can create valuable opportunities to reduce the grid upgrade investments, offset the new load and align it with renewable generation.

Unique Role of EPIC:

Participants agree overall that as a ratepayer funded resource, EPIC is best suited to fund research that can look into options to maximize ratepayer benefits, particularly for low-income and ESJ customers. Further, participants identified areas where federal investment can drive significant impact and EPIC investments can be focused more on areas where there is a strong nexus to California and ratepayer benefits, and investment may not be made otherwise.

Desired Outcomes & Quantitative Targets:

Stakeholder identified opportunities for quantitative targets in the following areas:

- Getting to a certain percentage of Medium-Heavy Duty Electric Vehicles on the road;
- Achieving a capital cost target for EV charging infrastructure (per kW or type);
- Deploying 7 GW of flexible load by 2030;
- Achieving the retirement of fossil fuel power plants in ESJ communities and statewide by 2030;
- Reducing the number of customers, particularly in ESJ communities, experiencing long-duration outages.

Key Gaps and EPIC Role

Transportation Electrification

Many participants expressed concern that the necessary scale of EV charging infrastructure cannot be reached with the current EV charging installation costs and interconnection delays. Participants noted that within the next six years about 1.4 million chargers will need to be installed to reach the California Energy Commission (CEC) goal of 1.5 million chargers. About 4-6 million chargers will need to be installed within the same time frame, according to California Electric Transportation Coalition (CalETC), to reach California's electrification goals. Participants noted that utilities are paying about $17,000-18,000 per charger, so the required EV charging infrastructure can cost ratepayers more than $100 billion.

To address these gaps, participants suggested that EPIC research can focus on the following:

#1: Gap: Reducing costs of charging installation for multi-family homes.

Many participants noted a need to find solutions for cheaper EV charging installations for low-income customers, particularly in the multi-family housing.

- **Potential Role of EPIC:** One of the suggestions provided was to develop a smart Level 1 charger that is much cheaper to install and can provide massive scaling opportunities. This hardware technology is commercially available, but likely requires integration of data through vehicle telematics. Participants suggested that EPIC funded research can focus on demonstrations for low-cost at-home charging at multi-family homes using Level 1 smart charging outlets with billing and access controls**.**
- **Quantitative targets:** Participants suggested that a target for the EPIC program would be to establish a specific savings or cost target. For example, participants suggested that EPIC could establish a goal to reduce installation costs to under $2,000-3,000 per charging port.

#2: Gap: EV Submetering.

EV submetering was identified by many participants as one of the main gaps for EV and V2G adoption at the multi-family homes. Participants from the EV charging industry noted that incentive programs for connecting EV batteries to the grid, or make-ready infrastructure funding programs, often do not allow for submetering individual components, which forces customers to choose between demand response and V2G programs, creating a distorted picture of lack of customers' interest in V2G.

- **Potential Role of EPIC:** Many participants agreed that research in utilizing bi-directional charging data and EV telematics data for incentive programs and utility billing purposes, particularly in multifamily housing, would provide great value to the customers. EPIC research can help develop a streamlined process and coordination between the utilities and contractors. EPIC research can look into using EV telematics and charging data as a submeter to bill customer based on the EV usage data, with a potential application of discount rates for low-income customers. The presenters noted as an example that some European public charging stations allow people to bring their own chargers, which can enable submetering wherever the customer goes if the charger itself can provide quality data for metering.

#3: Gap: Streamlining interconnection and certification for EVs charging.

Presenters noted that while California updated its interconnection requirements to UL1741 SB, there are currently no bidirectional charging stations with the UL1741 SB certification.

Current interconnection rules and practices provide no separate check boxes for EV batteries and charging and no separate interconnection queue, causing delays in EV infrastructure deployment.

- **Potential Role of EPIC:** Participants recommended EPIC consider research on developing solutions for standardization of EV charging interconnection. For example, EPIC could support the development of an EV specific interconnection standard, similar to solar industry standards, that will expedite the interconnection process and reduce disparities between utility practices and between manufacturers' specifications. EPIC research can also help streamlining certification for inverters and bidirectional charging to align EV manufacturers with the interconnection standards.

#4: Gap: Developing EV ready prewiring requirements for building codes.

Participants noted that a lack of building code requirements for bidirectional EV- and V2G-ready prewiring for new builds increases costs of EV charging installations and building upgrades.

- **Potential Role of EPIC:** EPIC research investment could be focused on supporting the development of EV- and V2G-ready building code requirements that can help significantly reduce costs of upgrades for EV and V2G installations over the next 20 years.

#5: Gap: Identifying efficient incentives for customers and utilities to utilize EVs (load management and V2G) as grid resources.

While DER resources can bring great value to the grid, customer preferences for how and when they want to use their owned resources may conflict with how these resources need to perform to bring maximum value to the grid. Compensating EVs (for load management and V2G performance) as a grid resource can help create new revenue streams for customers to shift customer behavior and for vendors and suppliers to ensure the sustainable supply of EVs and chargers.

- **Potential Role of EPIC:** EPIC research can identify efficient incentives and develop personalized approaches for compensating EVs (for load management and V2G performance) for the services they can provide, including energy, capacity, ancillary services, congestion relief, or reducing air pollution in ESJ areas. The research can also investigate incentives for utilities for effective use of DERs as grid resources and as non-wires solutions. The research could focus on non-technical aspects, like the customer psychology and social behavior, to answer the questions of how to incentivize the right behaviors and technologies, what

incentives are most effective and whether existing programs exclude participation of people that can benefit the most. For example, stakeholders noted that while there are some existing V2G programs, they are nowhere near the scale that is needed and are not fully accessible to some customers, like multi-family housing residents.

#6: Gap: Exploring direct load control with managed EV charging to provide load flexibility and alignment with renewable generation.

Participants suggested that using EV batteries can potentially provide 10x times the energy storage the grid might need to sustain the future load from electrification, in comparison to standalone stationary batteries. In addition, they provide greater environmental sustainability benefit of saving raw materials because the EV batteries use the same materials as stationary batteries in manufacturing but provide both mobility and energy benefits. Managed smart charging for the medium- and heavy-duty fleets and residential charging was identified by many participants as one of the key areas that can benefit from additional research. Managed charging can help shape operations of EV fleets in a way that shifts peak load, reduces fleet owners' demand charges, and increases EV battery life. It can also align the EV charging with the times when renewable generation is powering the grid to ensure greater decarbonization results.

- **Potential Role of EPIC:** Participants suggested that EPIC research can study the role of EV batteries and V2Gs as flexible load and grid resources, and study potential coordination between transportation and energy networks for coordinated planning and forecasting. EPIC research can investigate the potential for replicating the successful models of direct load control in air conditioning and water heating and consider ways to deploy it at scale. The research can test various scenarios, including control by the aggregators and utilities. The research can help develop local heatmaps for the EV load, considering that while the electrification targets and forecasts are developed on a national or regional levels, the EV charging will be mostly a local problem and utilities will need to manage concentration locally. Presenters suggested that EPIC programs could study predictive analytics of the EV charging applied to the real time load and renewable generation. For example, it can build upon the NREL's Electric Vehicle Infrastructure–Projection (EVI-Pro) program and take it to the next level. Presenters noted that one of the pending NREL research projects is focused on increasing spatial granularity of the load forecasts coming from the EVI-Pro for the improved planning. It is aimed at enabling utilities to have public data that can

be shared with customers and charging providers to guide the proactive discussions on distribution upgrades and interconnection.

- **Quantitative targets:** Participants noted that the state has established a goal to deploy 7 GW of flexible load by 2030.

#7: Gap: Standardizing communication protocols and interoperability of EV charging and telematics.

Many participants agreed that residential smart at-home and managed EV fleet charging can be incredibly impactful when scaled. Telematics-based load shaping from residential charging can provide submetering for multifamily buildings, can help avoid grid upgrades and provide renewable energy alignment. It also provides great charging data: what behind-the-meter charging looks like on the grid, who is using Level 1 vs Level 2 chargers, what is the load shifting potential, what does it mean for how much capacity people have at their homes for future building electrification. However, lack of standardized communication protocols and EV manufacturers proprietary systems and vertically integrated solutions do not allow interoperability across the industry and limit customer choice. One of the presenters noted that Open Charge Point Protocol (OCPP) compliance may not be enough for transit agencies because they cannot demand access to OCPP enabled chargers.

- **Potential Role of EPIC:** Participants noted that EPIC-funded research could help develop standardized communication protocols for EV charging and telematics, accuracy testing, and communications improvements for automakers and charging vendors to make sure that all cars can do this out of the gate in a standardized approach to allow for aggregation.

#8: Gap: Discounted EV charging at multi-family housing and subsidized public charging.

Many participants stressed that low-income renters are left out of the energy transition and need access to affordable charging that is scalable. Home charging is often the least expensive option for electric vehicle charging, as public charging is typically 2-3 times more expensive than home charging and does not provide access to any low-income or discounted rates. However, at-home charging is an extremely limited option for renters.

- **Potential Role of EPIC:** Participants suggested that the EPIC portfolio could include research on potential options for discounted charging rates at public charging stations and in multi-family housing to benefit low-income customers.

#9: Gap: Charging affordability for small fleets of Medium/Heavy Duty vehicles.

Participants highlighted a need to find solutions for HMD public charging that can be affordable for small fleets and can support their operations patterns. Participants noted that HMD vehicle charging is lagging 10-15 years behind the light duty vehicles infrastructure. There are no public fast-charging options for HMD vehicles yet. The presenters noted that while it is expected that most of the HMD charging will be done through a slow charging infrastructure at depots, the research shows that most of HMD vehicles in the US today are part of very small fleets of about 5 vehicles of less. These vehicles are expected to be the next wave of HMD EV rollout. They may be relying mostly on public fast charging and would need to find solutions to optimize charging costs. Research into such solutions will need to consider the regional scale of HMD vehicle rollout, and local grid and ratepayer impacts.

- **Potential Role of EPIC:** EPIC Research could investigate options for affordable public charging for small fleets, and, in particular, focus on approaches to encourage fleet owners to spread the load of HMD charging across the grid, to avoid local congestion and reduce required grid upgrades, thus lowering ratepayer burdens of paying for such upgrades.

#10: Gap: More compact and readily deployable infrastructure.

Stakeholders raised a concern that the footprint of the onsite equipment needed for EV fleet charging, including switchgear and transformers, is a big concern for the fleet operators that maximize every inch of their property.

- **Potential Role of EPIC:** Participants suggested that EPIC research could explore more compact and more readily deployable infrastructure for the smaller EV fleets.

#11: Equity: Ensuring ESJ communities benefit from transportation electrification.

Participants noted that many ESJ communities and customers are left behind in the transportation electrification efforts, either because no affordable EV options are available to them or because their neighborhoods or living arrangements do not support affordable EV charging. Many participants provided examples of other programs that can contribute to the ESJ community participation in the transportation electrification efforts, including EV ride share, electric bikes, EV public transit. Participants noted that EPIC research must look for solutions that provide direct benefits of transportation electrification to the ESJ customers, including EV ownership, public transit options and prioritization of ESJ communities for pollution reduction efforts.

DER Integration

#1: Gap: Scaling up flexible load and optimizing DER utilization to provide greater value to the grid.

Participants agreed that customer distributed energy resources must be utilized as flexible load and for grid services on a much larger scale to help reduce costs of grid modernization and offset the increasing load from electrification. Participants agreed that many customer-sited DER resources and VPPs have capabilities that create valuable opportunities to enable greater integration of clean energy and provide more resilience. Participants highlighted studies that showed that adding storage on the distribution system can significantly reduce the risk costs of outages. For example, an LBNL study for utility ComEd showed that 1.1MWh of battery storage combined with some additional grid investment can reduce the risk cost (CvaR) of outages from $2.6 billion to $10million.

- **Potential Role of EPIC:** Utilities representatives indicated that research would help with utilizing Distribution Energy Resources Management System (DERMS) and understanding ways to optimize the use of DERs as grid resources in a way that both ensures grid reliability and accommodates customer needs, on daily and seasonal basis. EPIC research can help develop an approach on how to value DER resources in routine events or their risk mitigation capabilities during grid stress events. The research can evaluate DER value in different scenarios: based on various combinations of infrastructure and operational characteristics of the distribution grid, presence of other DERs and utility assets, and operational ability of the distribution system to leverage DERs.
- **Potential Role of EPIC:** Some participants also suggested looking into utilizing eastern facing solar PVs for winter morning peaks.
- **Potential Role of EPIC:** Stakeholders also agreed that EPIC funded research is best suited to look into effective incentives for customers to offer their DERs as grid resources and for utilities to utilize DER as non-wires solutions. EPIC research can focus on customer psychology and social behavior to help navigate beast practices and what worked and did not work in the past.
- **Quantitative targets:** Participants noted that the state has established a goal to deploy 7 GW of flexible load by 2030.

#2: Gap: Streamlining DER Interconnection.

Participants noted that the majority of DERs do not require system upgrades to interconnect and there is a huge potential to streamline the interconnection process. Delays in interconnection create difficult obstacles for customers in deploying DERs.

- **Potential Role of EPIC:** Participants suggested EPIC could support evaluating options for a streamlined process for interconnection and panel upgrades for those resources, including evaluating potential notification only or instant interconnection options for both behind and in front of the meter customer technologies as well as beyond net-metered systems, like standalone storage. Participants noted that while there are some pilots, they are narrow and scattered. Participants also support the integration capacity analysis (ICA) in DER interconnection process but note that it needs refinement over time based on research and analysis. The utility representatives also highlighted that research could help figure out how to consider various things at the same time in the interconnection process. Because the utilities do not control where DERs go, EPIC research can help develop an approach to utilize interconnection process to incentivize DERs to locate in the places that maximize social benefits, avoid upgrades and align it with the climate goals, wildfire mitigation and other policies.

#3: Gap: Standardizing DER interconnection and communications.

Standardization was raised by many participants as a way to reduce costs and streamline deployment of DER. One of the EPIC success stories mentioned by participants was the DERMS guide in IEEE that is based on the work done in EPIC 1 and 2 that won the IEEE Best Standard of the Year award.

- **Potential Role of EPIC:** Participants recommended that EPIC-funded research focus on standardization of various technologies, including microgrids, installations and interconnection of DERs, communication protocols for DER equipment, and cybersecurity. Further, EPIC research could be leveraged to support upgrading grid equipment life expectancy under climate adaptation scenarios, including stronger winds and increased heat and humidity that prevents equipment from cooling down at night. While IEEE, UL and others develop national design standards, the implementation standards will need to be developed with local differences in mind, and EPIC can be a good fit to develop those implementation standards.

#4: Gap: Mechanisms for operating a DER market at a local level.

Participants noted that the market for renewable resources and DERs is usually considered at the locational marginal price (LMP) level, a higher-level geography that is primarily focused

on wholesale market transactions. Participants identified the opportunity for DERs to provide services to the distribution system, which would be at a level below LMP nodes. However, Participants identified a need to explore creating these more localized markets for DERs to enable greater penetration of DERs and reduced costs for renewable energy integration. Participants noted that there are challenges for such an approach, considering that there is no balancing authority on the distribution system and there are situations where there are local constraints that may be in conflict with CAISO or wholesale market needs.

- **Potential Role of EPIC:** Participants noted that an important area for EPIC research is investigating how to create market signals for DERs at the distribution system level, leveraging market structures and grid operations to manage congestion on the local level and avoid installing additional infrastructure.

#5: Gap: Mandated open access protocols and open data.

Many participants stressed the need for open standards and an open application programming interface (open API) for aggregators' software to be able to communicate with DER and appliance hardware from different vendors and manufacturers. A lot of DER interfaces are proprietary. To be able to utilize smart managed changing and DER coordination and aggregation, data access and bidirectional flow between devices, customer, utilities, and aggregators is a key gap that needs to be addressed by the researchers and regulators. Stakeholders note that the customer must win, and that vendors need to be open and comfortable with standardized open access protocols instead of proprietary software. Participants noted that non-utility aggregators will also need access to the Demand Side Grid Support (DSGS) programs to aggregate DER assets for wholesale markets.

- **Potential Role of EPIC:** EPIC research can help support the development of open data and open access protocols and requirements for DER resources, and help coordinate their adoption with the manufacturers, utilities, and aggregators.

#6: Equity: Ensuring ESJ communities benefit from DER deployment.

Participants noted that many ESJ communities and customers are often left behind in the DER integration efforts. Participants noted that EPIC research must look for solutions that provide direct benefits to the ESJ customers, such as DER ownership, pollution reduction, community participation and leadership in project design and implementation, education and workforce development, non-energy benefits, like health, habitability, and thermal comfort. They stressed the importance of ensuring that the projects avoid causing unintended consequences, like costly operation and maintenance, predatory loans, gentrification, increased rent etc.

#7: Equity: Local buy-in and engagement.

Participants noted the importance of getting local buy-in through demonstration projects and early engagement of local low-income and ESJ community partners. The participants stressed that the closer the project gets to demonstration, the more localized project partners should be. Working with local entities for the RD&D demonstrations can provide many benefits and ensure local and sector buy-in, for example engaging city and municipal agencies on county or city-wide Virtual Power Plants projects. Communicating the DER benefits to low-income and ESJ customers requires a simplified message that can be delivered by local partners. Participants shared their experience that showed that some deployments can be more successful if focused on the facilities that are used most often as public gathering places, like critical facilities and community centers. The presenter noted as an example an EPIC funded project for renewable mobile batteries application, where deployment at local community facilities proved more effective and beneficial than at individual residences. Also, presenters noted that demonstration projects need to think of long-term funding solutions for the community after the end of the pilots, to ensure continuous operation and further adoption. Community choice aggregators (CCAs) can engage programmatically and be a pathway to revenue in ESJ and other communities in terms of VPPs and DERMS platforms and load management and forecasting.

Reliability

#1: Gap: Improved modeling and load forecasting.

Many participants agreed that modeling tools and planning processes need significant improvement to help achieve decarbonization goals. Many participants noted that conventional modelling understates the variability of weather conditions by sampling specific time slots. It also undermines the seasonal variability and how it can utilize DER and EV capabilities. This results in greater uncertainty on the output of renewable generation, and often an overbuilt and inefficiently used grid infrastructure, creating affordability concerns.

- **Potential Role of EPIC:** EPIC research can help develop modelling and forecasting capabilities that consider additional weather patterns, interregional coordination, geographically diverse resource data and technology cost uncertainties. Another participant suggested including roundtrip modelling with a tighter loop between capacity expansion and resource adequacy testing. Recommendations from participants included implementing 8760-hour optimization horizon in capacity

expansion planning, modeling a wide range of weather years and extreme weather events, and utilizing weather-correlated load and renewable profiles.

- **Potential Role of EPIC:** Participants further identified some of the data gaps that EPIC research can help fill, including:
    - lack of DER tracking data, to have visibility into where DER resources are on the grid and enable DER coordination;
    - lack of all-electric load profiles for planning and forecasting and avoided cost calculator;
    - lack of granular market characterization that can inform energy efficiency potential and can represent load curves for Integrated Resource Planning; and
    - lack of distribution grid interventions data that can identify when something will help or hurt the grid.

  Additional analysis needed includes:
    - assessing clean portfolios against additional sets of weather data, generator outages, and assessing grid stability;
    - potential for muti-measure Integrated Demand Die Management (IDSM) VPP needs and accommodating multiple uses that may be conflicting;
    - power conditioning from behind the meter exports and evaluating if all power coming from inverter is the same, or does it need conditioning and ancillary services;
    - stochastic modeling of dispatch availability to get more resource adequacy and planning for DERs that are not centrally managed;
    - cascading impact analysis to see what other critical resources will be affected when the grid goes down, like telecommunications, emergency response, fire, life and safety, similar to the analysis done by the County of Los Angeles; and
    - societal objectives-based design, noting the example of Australia that does total system architecture with the societal benefits in mind, and societal interventions beyond rate structures.
- **Potential Role of EPIC:** Participants suggested looking at existing data streams and data overlays from other agencies, including emergency response agencies. Many participants agreed that centralization of data sources will improve accessing existing data and interpreting it. EPIC research can help explore what resources are available, help various stakeholders navigate where to find data and how to interpret it.

#2: Gap: Cybersecurity standardization.

Participants identified cybersecurity as one of the key gaps for reliable DER integration. As millions of new DER devices come online, many foreign manufactured, no standard protocols apply to them and there is no DER monitoring by grid operators for cybersecurity. One key issue identified by participants is that the grid needs to continue allowing communications even in the event of attack.

- **Potential Role of EPIC:** Participants suggested EPIC research can help answer questions of how much encryption of communications is necessary for substations and various grid facilities and how to share and update encryption keys on all the devices. Participants noted that circuits in the field are the most physically vulnerable equipment and have minimum cybersecurity and noted that research in this area is critical to protect the grid. EPIC-funded projects can provide demonstrations around encryption key sharing and updates and can look into different commercial cybersecurity applications in other industries, like banks, and how they differ from utilities. Standardization and unification of various cybersecurity standards for the DER vendors and operators can help provide a clear understanding of what is required of various vendors and improve compliance.

#3: Gap: Exploring non-wires alternatives.

Participants noted that sporadic integration of DERs, V2Gs and VPPs on the first-come-first-served basis is inefficient and increases costs of grid upgrades. Utilities highlighted the importance of exploring non-wires alternatives and finding ways to use existing wires and infrastructure to save costs and avoid replacing equipment.

- **Potential Role of EPIC:** EPIC research can help find ways to integrate DERs, V2G and VPPs into the grid in a more organized and planned way that can help optimize the use of existing infrastructure to avoid some distribution-system investments.

#4: Gap: Granular gas retirement study.

A presenter noted the lack of a granular gas retirement plan to meet California climate goals reliably. The roundtable included a presentation of GridLab's 2022 study of Reliably Reaching California's Clean Electricity Targets, which zonal modeling for gas retirements needed to achieve California's climate goals in an accelerated timeline (85% by 2030). Further, a Form Energy study found that 2GW of long duration and 2GW of short duration storage can effectively displace gas capacity within LA basin disadvantaged communities.

- **Potential Role of EPIC:** Participants suggested that one of the potential research areas for EPIC investment may be building upon the decarbonization research that has been conducted at a zonal level to identify local congestion areas more granularly

and help develop a plan for reliability resources to support gas retirements. EPIC research can help identify those targets for California and identify resources needed to facilitate California gas retirements.

- **Quantitative Targets:** Retiring 100% of fossil plants in ESJ or disadvantaged communities as quickly as possible, and 85% statewide by 2030.

#5: Gap: Omnidirectionality of distribution grid.

Utilities representatives indicated that distribution system is now becoming omnidirectional, even though it was built for unidirectional operation. Distribution grid circuits that have intermediate transformers, that are generally stepdown transformers, can create issues in maintaining correct customer voltage, particularly in spring and fall seasons in times of extreme reverse power flow with high generation and low demand, for example on the days with clear sky and cold temperature.

- **Potential Role of EPIC:** Presenters noted that distribution system infrastructure includes lower voltage distribution circuits of 5kV and below and noted that there must be concerted effort to gradually transition overtime to higher voltage lines of 12kV and above. EPIC research can help navigate cost effective options for such transition.

Resiliency

#1: Gap: Long-duration storage, battery size, weight, and energy density.

Stakeholders stressed that a more resilient grid would benefit from long duration storage and more efficient batteries at lower costs, further enabling the grid to be powered by renewable resources at all times of the day. Participants noted that long-duration storage is not currently supported by the market as there is not a sufficient arbitrage opportunity, and the market is not able to optimize long duration storage due to the 24hr planning horizon. Market improvements will be needed to value long-duration properly, including by looking at extreme weather effect risks.

- **Potential Role of EPIC:** Presenters noted that while there is a good amount of federal funding dedicated to this area, more research is still needed. Presenters noted that EPIC research must address two main questions: 1) how much storage is necessary, and 2) how to satisfy that need. The research must ensure safe, reliable, economically viable, environmentally responsible, and innovative storage. The technology will need to be tested for all these attributes before selecting any individual solutions. The

research data and demonstrations will help inform energy storage planning and operations.

- **Potential Role of EPIC:** An alternative or complementary approach suggested was to research the use of EV batteries as a cheaper grid storage resource through V2G and V2X.
- **Quantitative Targets:** Participants noted that setting specific targets for long-duration storage early can reduce overall costs. Long-duration storage procurement mandates in Integrated Resource Planning, such as for x amount of y-hour duration storage, like lithium ion 4-hr duration storage mandates, can bring actual investments from the utilities to bring storage to the grid and will help develop markets over time. EPIC research can support potential market reforms with modelling and data on what those mandates should be.

#2: Gap: Islanded microgrids as a grid resource.

The participants highlighted that successful operation of microgrids in islanded mode can provide resilience and reliability to the grid and local communities during extreme weather events and outages, particularly in remote grid edge communities. SDG&E provided an example of the Shelter Valley microgrid in the remote grid-edge community of Shelter Valley that is subject to often power shutoffs. Presenters also noted that microgrid applications have proven to be critical in emergency response scenarios, for example by the successful long-duration operation of SDG&E's Ramona microgrid during wildfire events. Microgrids were able to perform well and effectively go on and off grid during extreme grid stress events. Presenters discussed the Redwood Coast Airport Microgrid as an example. Participants noted that islanded microgrids need to have black start capability to be able to commence operations quickly and safely. Presenters also noted that household-level microgrids are starting to develop, for example by Tesla, New World Connect DER, and others, that can isolate the homes in case of outages, feed energy back into the grid and provide additional safety to the utility crew working on the outages. They are typically installed behind the utility revenue meter and owned by the customers.

- **Potential Role of EPIC:** Presenters noted that EPIC research can help evaluate voltage regulation in 100% inverter-based islanded microgrids and facilitate standardization to streamline and reduce costs of microgrids deployment. In particular, one of the presenters suggested to focus EPIC efforts on the following:
    1) product standardization, for example, develop standards for modular products that can be tested in the factory to reduce the need to test in the field;

2) design standardization, for example, developing a standard for cookie cutter design with the same components to streamline the microgrid permitting in different cities;
3) process standardization for microgrid installation process; and
4) interconnection standardization.

- **Quantitative Targets:** Participants did not identify any existing state goals or projections for microgrid deployment.

#3: Gap: Investing in community infrastructure and resilience hubs.

Many participants stressed the importance of investing in community infrastructure and places where people spend most time in their community, like churches, schools, libraries, hospitals, and community centers. Supporting these facilities can help build a more resilient and sustainable community in the long term. Participants noted that resilience hubs are crucial for community resilience and can provide access to cooling, fresh food, device charging, and medication in case of storms. They can also help demonstrate benefits of DERs to the community members and increase DER adoption in the community.

- **Potential Role of EPIC:** EPIC Research can help navigate options to increase investments in the resilience hubs and community infrastructure to increase resilience of local communities to extreme weather events. Participants noted that there is an increased interest in quantitative equity and resilience metrics and a real desire to apply them to planning. Participants suggested that EPIC could help design targets for the equity and resilience metrics to understand what the results of these metrics are telling us: What is a good social burden score? Is there a universal standard of living for resilience and equity? Should there be a bottom line for resilience and equity? What should trigger actions? Existing work on resilience could be extended to equity, or in understanding tradeoffs between costs and benefits of resilience investments. EPIC could help answer the question of how to help decision makers prioritize resilience and equity and have an integrated planning approach to look at resilience and equity at the same time, as well as how to rank reliability projects vs equity projects. There is also a need to find a way to validate these metrics in between critical reliability events.

Equity Considerations

#1: Equity: Needs-based prioritization of low-income participants.

Stakeholders suggested that in the projects that involve low-income and ESJ communities, it is important to prioritize participants who can benefit the most from the cost savings, instead of the first-come-first-served approach. Participants noted the need to incorporate options for progressive financial support to ensure that everyone can participate equitably.

#2: Equity: Preventing unintended consequences of RD&D projects in low-income communities.

Participants stressed the importance of having a right balance of involving low-income and ESJ communities in RD&D projects and avoiding unintended negative consequences in these communities. They stressed the importance of ensuring that the projects provide benefits to these communities and are fully supported when the technologies are tested and after that, to avoid predatory loans, green gentrification, displacement and other unintended consequences.

#3: Equity: One-stop-shop and wrap-around approach.

Many participants indicated the importance of coordinating and stacking resources across various programs from different agencies, including federal, state, local and private resources, to complement each other and provide a comprehensive, one-stop-shop and wrapped around support for the customers. This will help avoid duplication and complement different programs so that less rate-payer funding is needed. Participants suggested designing community outreach events to promote multiple opportunities at once to reduce outreach fatigue in the community of being contacted too often by too many actors. Ensuring access to both established and new technologies to provide holistic solutions to the communities was another important factor stressed by some participants. As an example, participants suggested that for a multi-family housing that is getting an EV charging installed, the property can also be evaluated for solar panels installation and building decarbonization. Participants also recommended that private market sector and private funding should be used as much as possible to expand the programs instead of using ratepayer funding as a fall back.

#4: Equity: Better marketing of program benefits.

Participants highlighted a need to improve the marketing of program benefits to the customers that can benefit from them. As an example, the participants noted the negative

experience of low sign in for the medical baseline program due to lack of customers' understanding of the program benefits.

Process Recommendations

Workshop participants' recommendations on developing targets and outcomes for EPIC funded research included the following:

#1: Set measurable targets and evaluation criteria.

Stakeholders stressed the need to set clear and measurable targets for the EPIC funded programs and EPIC portfolio overall to enable a transparent evaluation of their results. Los Angeles Cleantech Incubator provided examples of the measurable targets they set for the LA Transportation Electrification Partnership to achieve an additional 25% in climate and air pollution reduction in LA by the 2028 Olympics (TEP 2028). Those included the following numerical targets to be achieved by 2028: 84,000 EV chargers; 30% light-duty private EVs; 100% of shared cars; 100% of Metro and LADOT local transit; 1 or more commuter rail lines; all disadvantaged neighborhoods with low walk score to have Light Electric Vehicles hubs; and electric short-haul and vertical take-off and landing for aerial transit. The TEP 2028 also included numerical targets for goods movement and qualitative targets for energy-transportation nexus.

Stakeholders through the workshop focused on the following targets for the four pathways:

- Getting to a certain percentage of Medium-Heavy Duty Electric Vehicles on the road;
- Achieving a capital cost target for EV charging infrastructure (per kW or type);
- Deploying 7 GW of flexible load by 2030;
- Reducing the number of customers, particularly in ESJ communities, experiencing long-duration outages.

#2: Set visible localized benefits.

Stakeholders stressed the need to set measurable targets with localized, ratepayer-centric results so that communities can see benefits in money and energy saved. In addition to broader environmental benefits, fleet owners need to understand and see savings and benefits: the sooner they can see how electrification can save them money, the sooner they will want to transition to EV fleets. Project targets can also focus on removing specific obstacles in medium- and heavy-duty EV fleet adoption in ESJ communities.

#3: Commitments on pilots/demonstrations next steps.

Participants also stressed the importance of setting clear success criteria and next steps for the pilots and demonstrations when they are being developed so it is clear to the participants what happens if the pilot or demonstration is successful and what the next phase and next steps will be to scale up. Participants noted that industry and stakeholders will benefit greatly from some commitment to what happens after a successful demonstration.

#4: Prioritizing research on long-term solutions and commercialization.

Stakeholders noted that EPIC programs should focus research and demonstrations on long-term big picture solutions rather than immediate and short-term solutions and focus on problem statements where research can inform more permanent solutions. Some participants also suggested that since California and EPIC have a lot of innovation success stories, EPIC research can focus on taking those to scale and commercialization, which can provide most value for money for the ratepayers, comparing to investing in new research and technologies.

V. APPENDICES

Video Recordings:

Workshop video **Day 1**
Workshop video **Day 2**

Agenda: (PDF)

Presentations:

September 6

Opening remarks: Commissioner Genevieve Shiroma, California Public Utilities Commission (no slides)

Transportation Electrification Roundtable
Jack Symington, Los Angeles Cleantech Incubator - Presentation Link
Phillip Kobernick, Peninsula Clean Energy - Presentation Link
Rachael Aptowitz, Grid Alternatives - Presentation Link
Rachel Zook, NUVVE (no slides)
Eric Wood, NREL (no slides)
Rima Oueid, DOE Office of Technology Transition - Presentation Link

Damian Inglin, PG&E (no slides)
Rajit Gadh, MOEV - Presentation Link

DER Integration Roundtable
Gabriel Petlin, Masoud Foudeh, and Julian Enis, California Public Utilities Commission - Presentation Link
Haresh Kamath, EPRI - Presentation Link
Damian Inglin, PG&E (no slides)
David Carter, Cal Poly Humboldt - Presentation Link
Tom Tansy, SunSpec Alliance - Presentation Link
Michael Colburn, SDG&E (no slides)
Rachel McMahon, CA Energy Storage Alliance - Presentation Link
Dan Dumovich, GRID Alternatives (no slides)

September 7

Opening remarks: Commissioner Genevieve Shiroma, California Public Utilities Commission (no slides)

Reliability Roundtable
Priya Sreedharan, GridLab - Presentation Link
Miguel Heleno, LBNL - Presentation Link
Marc Costa, The Energy Coalition - Presentation Link
Anthony Johnson, Southern California Edison (no slides)

Resiliency Roundtable 1
Michael Colburn, SDG&E (no slides)
Vipul Gore, Grid Scape (no slides)
Gabe Murtaugh, Long Duration Energy Storage Council - Presentation Link
Anthony Johnson, Southern California Edison (no slides)

Resiliency Roundtable 2
Andrew Coleman, EPRI - Presentation Link
Amee Raval, Asian Pacific Environmental Network (no slides)
Olga Hart, Sandia National Laboratory (no slides)
J.D. Saucedo, County of Santa Barbara - Presentation Link
Kailash Raman, Form Energy - Presentation Link
Ben McMahan, CA Governor's Office of Planning and Research - Presentation Link