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EPIC Strategic Goals Workshop Process Reports

EPIC POLICY + INNOVATION
COORDINATION GROUP

November 2023

1. **Kick-Off Workshop, August 16, 2023**
2. **Equity in RD&D Workshop, August 17, 2023**
3. **Grid Modernization Workshop, September 6-7, 2023**
4. **Built Environment Workshop, September 19, 2023**
5. **New and Emerging Strategies Workshop, September 20, 2023**

EPIC Strategic Goals

Kick-Off Workshop

Report

EPIC POLICY + INNOVATION
COORDINATION GROUP

November 2023

The 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 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 workshop process will collect feedback on measurable program level strategic goals and Administrator level strategic objectives that align with achieving the State's climate goals.

On August 16, 2023, the California Public Utility Commission (CPUC) hosted the EPIC Strategic Goals Kick-Off Workshop, the first workshop in a Strategic Goals Workshop series designed to meet the objectives of this CPUC decision.

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. The Strategic Goals Kick-Off Workshop aimed to introduce the overall purpose of the Strategic Goals Workshop process and identify specific topic areas for subsequent workshop discussions.

More than 170 stakeholders participated in the stakeholder workshop, with speakers identifying critical pathways, and relevant gaps, in achieving the state's energy, climate, and equity policies that could be addressed by ratepayer-funded RD&D. As further detailed in this report, participants highlighted needs for further investments in RD&D around the topics of transportation electrification, customer engagement and affordability, climate resilience, outreach/cooperation with tribes and disadvantage communities, renewable energy integration, and the need to identify low-cost pathways for achieving state goals. The participants also provided suggestions on improvement of EPIC program process and highlighted the importance of coordination and cooperation across projects, entities and funding opportunities and ability to prioritize and conclude/recycle projects quickly.

[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 the PICG to convene the Strategic Goals and Objectives process for 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 workshop was hosted from 10 am – 5 pm and consisted of three panels, 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. CPUC Staff and the PICG Project Coordinator provided an initial introduction to the Workshop process and the purpose of the event.

Opening Remarks: Commissioner Genevieve Shiroma welcomed the participants and outlined the goals and purpose of the workshop series: to discuss gaps, challenges, and opportunities to advance innovation though California's EPIC research, development, and demonstration pathways. The workshop input will help CPUC develop clear and measurable strategic goals and objectives for EPIC 5 that will provide a roadmap to monitor and track progress of EPIC investment and ensure that they align with equity, energy and climate goals

and produce ratepayer benefits. Commissioner Shiroma highlighted the critical role of research and the urgency in the face of the climate challenges that Californians are facing.

Introduction: The PICG Project Coordinator, Andrew Barbeau, and CPUCs Fred Beck introduced the purpose and scope of the Strategic Goals Workshop Process, outlined its proposed process in defining the EPIC strategic Goals and its role in the future Commission proceedings that will determine strategic goals for the EPIC 5 funding cycle. Andrew also introduced the foundation that was laid out in the previous work that PICG did in 2020-2021 to identify policy and innovation partnership areas, highlight critical challenges and timely opportunities for enhanced coordination and to connect RD&D to policy to inform regulatory decisions. CPUC's Fred Beck then introduced the basis for establishing EPIC Strategic Goals and the D23-04-042 directive, the four core elements that the workshop will focus on to help define the strategic goals: critical pathways, key innovation gaps, EPIC's role in addressing them, and desired outcomes of EPIC investments that will help measure their success and contribute to impacts on the achievement of state goals. The questions and comments from the participants also highlighted the following potential additional topics/critical pathways to consider: industrial sector decarbonization; geothermal energy and its linkage with the long-term storage; and customer engagement. Potential critical gaps/hurdles raised included the need to find areas to reduce costs of EV charging infrastructure installation and telematics for home charging in terms of shifting peak demand, as well as a need for improved tools for modelling simulations and better definition of resilience.

Panels: The three panels focused on the following areas:

I. Perspectives on Innovation Needs.

Presenters:

- Leuwam Tesfai, CPUC
- Duncan Callaway, University of California, Berkeley (UC Berkeley)
- Adria Tinnin, TURN
- Peter Miller, NRDC

The panelists provided the perspectives of the of the representatives of CPUC, UC Berkeley, TURN and NRDC, followed by a stakeholder discussion that highlighted the following key challenges/gaps: the need for reduced costs of grid upgrades; pipeline as the missing link for the hydrogen development; the need for more data from the meters, particularly regarding the EV charging; the need to look for opportunities to lower the costs of infrastructure upgrades and potential rates redesign; the concern that the distribution grid will not be able to support the electrification goals and the need to look for ways to improve adoption and marketing of climate technologies; interconnection ties incentives to bring electricity to California.

II. Perspectives from Other Energy RD&D Efforts.

Presenters:

- Gil Bindewald, US Department of Energy (US DOE)
- John Lochner, NYSERDA
- Lisa Epifani, X, The Moonshot Factory
- Brian Young, Washington Department of Commerce

The panelists for this session included perspectives from the US Department of Energy, NYSERDA, X, The Moonshot Factory, and Washington Department of Commerce, followed by a stakeholder discussion that highlighted important takeaways on methods to improve EPIC investment outcomes and impacts. Key topics discussed included: having stakeholders play a key role; making the process more accessible to tribes and local communities; recognizing that topics such as electrification often potentially expand to unexpected topics and areas; the need to prioritize investments to maximize impact; to kill/complete/compose unsuccessful projects fast to pivot to other priorities; to ensure alignment with realities and the regulatory environment; engage the local tribes in the discussions and meet them where they are to maximize participation, at the events like tribes water summit, considering that tribes are also looking for solutions and have access to funding; look for opportunities for regional coordination where there are common obstacles (for example on Hydrogen HUBs or National Offshore Wind Consortium); look for opportunities to work with businesses around testing new technologies, like vehicle-to-grid (V2G); look for ways to collaborate outside of cost share.

III. Perspectives from EPIC Administrators.

Presenters:

- Anthony Ng, California Energy Commission
- Dan Gilani, PG&E
- Tony Johnson, Southern California Edison
- Cynthia Carter, SDG&E

The panelists provided the perspectives of the of the representatives of the California Energy Commission, PG&E, SCE and SDG&E, followed by a stakeholder discussion that highlighted the following key roles of EPIC investment: supporting commercialization and meeting customer needs; looking into a coordinated role of utilities; finding ways to kill/complete/compost unsuccessful projects fast to be able to move on to other areas. Panelists also stressed the need for the research to be relevant in the face of rapidly changing technologies and leverage discussions happening elsewhere to stay

relevant and avoid duplication; sending market signals that bring in private investors looking to co-invest and leverage state investments.

Presentations

The link to each presentation is included in the Appendices to this report.

Attendees

More than 170 individuals participated in the full day workshop, virtually and in person, including CPUC Commissioner Genevieve Shiroma, representatives from the US Department of Energy, the four Administrators of the EPIC Program (California Energy Commission, and the three utilities), as well as RD&D leaders, research institutions, community leaders, technology solution providers, government entities, utilities, non-governmental organizations, and industry.

IV. KEY TAKEAWAYS

Key Gaps and Opportunities

During the workshop, the panelists and participants identified the following key gaps and unique roles/opportunities for EPIC investments:

#1: Customer engagement and affordability, and customer role and experiences with the clean energy transition.

Many stakeholders indicated the need to consider customer engagement and customer perspective/experience as an important factor/gap, or a pathway, to consider. Commissioner Shiroma indicated that it is part of consideration for developing strategies and looking into the cultural and behavioral incentives to ensure customer intake (for example in adopting EVs). Several panelists and participants highlighted that affordability is one of the major barriers that stops electrification, noting that, for example heat pumps are more expensive than gas and existing programs may not be sufficient to incentivize customers, particularly the middle-income customers that do not qualify for the CARE program. Some suggestions also included looking into low-income rates, or capping rate increases with inflation. The panelists and Commissioner Shiroma also highlighted a need to identify ways to help people afford behind the meter initiatives and have no upfront fees. She noted the on-bill financing

as one of the proceedings at the CPUC that she is working on. The utilities also indicated that customer engagement, rather than technology, is a major roadblock and suggested that changing customer psychology to increase adoption will need to be led by CPUC and not utilities. One of the desired outcomes of EPIC investment can potentially be gaining insights, through demonstrations, into understanding customer psychology, the early adopters, and how to help customers understand and adopt the new technologies.

#2: High costs of distribution system upgrades.

Many presenters noted the need to look for cost minimization and to improve efficiency and affordability of existing technology to be able to scale up the upgrades quickly. As an example, participants suggested tweaking existing technology to make it more efficient and affordable, instead of developing new technology. At the same time, other participants suggested also looking for "moonshot" type innovation opportunities that could have groundbreaking impacts and provide tremendous value, or dramatically reduce costs. Participants stressed the need to find ways to lower the costs of infrastructure upgrades, prioritize the ones that are unavoidable, look for RD&D opportunities in reducing utility operational costs, and look for utility coordination and optimization to avoid the upgrades that are avoidable. The customers will not be able to afford the price of how much and how quickly the upgrades are needed to fully electrify.

#3: High costs and slow pace of EV charging installations and limited access for low-income customers.

The participants and panelists indicated that to reach the climate goals the EV charging installation needs to scale up significantly, which might not be achievable without substantially lowering the costs and time of the installation. Participants highlighted the need to fix the market failures and ensure the location of charging infrastructure is where they are most needed, rather than where they are most profitable, so that the changing infrastructure reaches low-income communities. The home charging and telematics for integration, rather than expensive upgrades, multifamily charging and shifting peak demand remain key issues. Lack of coordination in terms of the EV charging technologies creates another frustration for the customers. Testing and demonstrations for the V2G charging and bidirectional operability was suggested as one of the areas for EPIC cooperation with the industry. The EV infrastructure needs to be considered from the perspective of its value to and impacts on the gid and not just as a load.

#4: Climate vulnerability and variability.

Presenters indicated response to weather and climate variability as one of the major gaps and the need to invest in resilience to protect people and economy. Participants recommended thinking of the natural systems, like forests and agriculture, as opportunities. Climate adaptation brings a new topic for tribal representation and cooperation/coordination with the tribes. The participants encouraged engaging tribes and meeting with them locally to ensure maximum participation, at the events attended by tribal members, like the Tribes Water Summit, keeping in mind that tribes are looking for solutions to the same problems and have access to funding.

#5: Limited capacity of distribution system to accommodate electrification and new load with the greater penetration of DER.

Many participants expressed concern over the ability of the distribution system to support the future electrification efforts and the need to expedite building up system capacity. Participants highlighted the need to find cost reductions opportunities, considering the amount of upgrades needed and find ways to reduce the conventional capacity upgrades and prioritize upgrades that are unavoidable.

#6: Forecasting and modelling for renewable heavy portfolios.

Some panelists indicated the need to improve forecasting of resource adequacy by adding different scenarios of higher renewables penetration and extreme weather events. They expressed a need to build a tool to incorporate climate predictions and different electrification scenarios, like different levels of heat pumps adoption. Other participants also indicated the need for tools to help with modeling simulations, and machine learning tools that will invite a path for developing technology to improve modelling.

#7: Understanding realistic realm and role of hydrogen for the California economy.

Several stakeholders inquired into the hydrogen solutions and what role they could play, whether there is research and infrastructure available to support it and highlighted a need to look into permitting and impact on local communities. Participants noted that availability of pipelines and potential leakage impacts need to be evaluated to determine whether hydrogen is a good solution for California. Some participants also expressed concern over using hydrogen to justify the gas infrastructure, because most hydrogen is not currently produced with renewable resources.

#8: Availability of long duration storage, transformers, and other critical equipment and resources, in the future when it's needed.

The panelists identified the long duration storage and availability of lower costs locally built transformers and other critical grid infrastructure as a potential future deadlock. Commissioner Shiroma asked whether there are opportunities for RD&D and find more efficient way to use ratepayer dollars in more innovative ways.

#9: Wildfire mitigation and prevention.

Some panelists indicated that a lot of improvements are still needed for wildfire mitigation and prevention, including improving inspection and analysis, looking into customer impacts in disadvantaged communities, optimizing existing vegetation practices and utilizing broader forest management. Find ways to reduce undergrounding costs and improve lifecycle efficiencies and cost-effective management at service drop.

#10: Transmission infrastructure and regional ties with the broader systems.

The participants also noted a need for better interconnection ties to bring electricity to California, that can be a potential roadblock, and a need to look for mechanisms that can incentivize intertie connections.

#11: Load management across all types of loads to ensure affordability.

Participants described the potential costs of new infrastructure needed to support new transportation and building electrification loads, and the role that load management and load shifting could play in the reduction of otherwise necessary grid investment, and to balance renewable energy resources integrated into the grid.

Process Recommendations

The participants also provided recommendations on approaches and considerations for improving EPIC funding prioritization and coordination:

#1: Maximize value through incremental improvements to existing technology.

Some panelist indicated the potential opportunity in maximizing value and reducing costs though improving existing technologies and looking into ways to improve their efficiency and expand their capabilities with incremental, low-cost changes, rather than only looking to developing new technologies.

#2: Maximize impacts by aligning RD&D investments with the policy tracks.

Panelists from both California and out of state research and development entities highlighted the need to align the RD&D outcomes with the policies to maximize impact and ensure relevance.

#3: Target EPIC investment to the unique areas best suited for government funding.

The panelists suggested that government investment can play a key role in supporting riskier investment that may be overseen by the industries but may have greater community benefits and find ways to connect more closely with the community needs to identify such opportunities. Other participants highlighted that EPIC could play a key role in commercialization and bringing projects to market. CEC also noted that EPIC investments play key role in sending market signals that bring in private investors looking to coinvest and leverage state investments.

#4: Coordinate funding between different entities and projects.

The panelist identified a need to coordinate funding opportunities between different entities to avoid unnecessary overlaps but leverage synergies that can help maximize impacts, in different parts of the project, technology development and different pieces of the whole. Participants highlighted the need to look for opportunities for regional, state, federal, and industry coordination and integration across the projects. One of the suggested areas was to work with businesses around testing new technologies, like V2G integration, operability testing for bi-directional charging, or integration testing. The panelist also suggested testing how systems work together when looking at the digital infrastructure across the board.

#5: Coordinate regionally and integrate federal funding opportunities.

The panelists and participants highlighted a need to look for opportunities for regional coordination where there are common obstacles, for example, on the Hydrogen HUBs or National Offshore Wind Consortium, and look for ways to collaborate beyond the cost share. Participants noted the need to look for the integration of the federal funding incentives under the Inflation Reduction Act (IRA) and Bipartisan Infrastructure Law (BIL) into the EPIC funding considerations. The participants highlighted the need to leverage discussions happening elsewhere to stay relevant and responsive to customer needs and to avoid duplication.

#6: Develop tailored and localized community outreach and engagement.

The panelists and participants highlighted a need to reach the tribes and local disadvantaged communities where they are to ensure their engagement and greater participation. This can ensure better coordination of the local efforts with the broader state projects and ensure EPIC investments are better aligned with the community and tribal needs.

#7: Identify numerical targets for the strategic goals, where possible.

NYSERDA provided examples of the key geothermal drilling costs reduction targets and highlighted the importance of setting clear targets to measure project success.

#8: Think about the big picture.

The panelists highlighted approach strategic planning by taking into consideration the overall objective and the big picture rather than a piecemeal individual actions approach.

#9: Define a benefits framework.

Panelists indicated the importance of defining what the benefits are and developing a benefits framework to measure investment success.

#10: Prioritize funding in the key areas.

The panelists highlighted the importance of identifying key areas to prioritize funding among the many opportunities that exist for RD&D. The panelists expressed the importance of prioritizing the investment for the most impactful projects to maximize value and align the projects with realities, customer needs and regulatory environment.

#11: Allow flexibility in project closures.

Many panelists highlighted the importance of finding ways to close projects quickly that were not on track to achieve the intended results or that were past their useful time (“kill”, “recycle” or “compost”) in order to save unnecessary costs and time and be able to move on to more pressing areas, but also be able to apply their gained learnings to other topics. Some panelists also highlighted the importance of being flexible and open to the potential expansion into new areas that electrification brings to the table, like water integration. Participants also highlighted the need to identify clear paths to production for different RD&D initiatives and pivoting quickly if tested technologies are not ready for it.

#12: Ensure continuous monitoring of progress.

The panelists highlighted the need for continuous monitoring and tracking progress of the initiatives against the broader state goals and roadmaps to ensure that the funding is on track with its strategic goals.

#13: Integrate EPIC success stories into regulatory decisions.

Commissioner Shiroma highlighted the power of success stories from the EPIC projects and the need to think of the ways to brings them into the regulatory decisions to ensure the successful projects are adopted and expanded upon in the regulatory processes and in the full-scale implementation efforts.

V. APPENDICES

Video Recordings:

Workshop video **PT. 1**
Workshop video **PT. 2**

Agenda: **(PDF)**

Presentations:

Andrew Barbeau, EPIC PICG Project Coordinator - Presentation Link
Fred Beck, California Public Utilities Commission - Presentation Link
Leuwam Tesfai, California Public Utilities Commission - Presentation Link
Duncan Callaway, UC Berkeley - Presentation Link
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EPIC Strategic Goals

Equity in RD&D

Workshop

Report

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On August 17, 2023, the California Public Utility Commission (CPUC) hosted an Equity in RD&D Workshop in San Francisco, CA with virtual and in-person participation. It was the second workshop in the Strategic Goals Workshop series designed to meet the objectives of this CPUC decision.

The overall goal of the Strategic Goals Workshop process is to collect stakeholder input on critical pathways, gaps, roles and objectives 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. The Equity in RD&D Workshop aimed to lay the groundwork for how equity should be considered and integrated into RD&D strategic planning.

Almost 130 stakeholders participated in the workshop, with speakers identifying critical pathways, and relevant gaps, related to key areas of focus, including: education and training, technical assistance and outreach, early engagement and sustained involvement with tribes and disadvantaged communities in decision making processes, meeting tribes and communities where they are at, developing clear and measurable metrics, following the roadmap for the equity framework implementation, developing a clear understanding of benefits, involving tribes and communities in evaluating those benefits.

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

II. BACKGROUND

What is EPIC?

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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 the PICG to convene the Strategic Goals and Objectives process for 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 Workshop was hosted from 9 am – 1 pm and consisted of three panels, each followed by stakeholder discussions inviting questions and comments from the audience in the room and participants connected virtually, with the opening and closing remarks from the CPUC Commissioner Genevieve Shiroma and an initial introduction by the CPUC Staff.

Opening and Closing Remarks: Commissioner Genevieve Shiroma welcomed the participants and highlighted that EPIC investment plans and programs must ensure rate payer benefits in form of equitable access to safe, affordable, reliable, and environmentally sustainable energy for electricity ratepayers. The Commissioner also noted that in a recent decision, the CPUC directed EPIC Administrators to align their EPIC investment plans with CPUC's Environmental and Social Justice Action Plan and the federal Justice40 initiative. The decision requires Administrators to achieve 40% of the benefits in low income and disadvantaged communities and to engage with environmental and justice communities

before developing their plans. She indicated that EPIC could go a long way to correct the historical injustices towards communities of color, native American communities, and environmental and social justice communities. In the closing remarks, Commissioner Shiroma specified that RD&D investments intending to benefit low-income and disadvantaged communities are looking not only for the location of the projects but also the accrual of benefits to the disadvantage communities. She mentioned that the Commission tasked the utilities in other programs (e.g., wildfire mitigation) to strengthen partnerships with community-based organizations and tribal members to serve as liaisons in sharing information with the communities on what is available to them. The Commission also requires that utilities provide grants to tribes/tribal members to ensure that tribes know about the programs they qualify for. She also stressed the importance of learning how community-based organizations can play a key role with EPIC. In concussion, Commissioner Shiroma stressed importance of looking not just at data but also at stories where EPIC was successful, in uplifting communities, reducing GHG emissions, proving advances, or health improvements. Commissioner Shiroma noted that there might be opportunities to look for at brownfields, for example, to identify opportunities to cleanup those sites with clean energy.

Introduction: EJ Action Plan and Tribal Engagement Level Setting. Before the panels, the CPUC Staff, Amanda Krantz and Kenneth Holbrook, introduced the CPUC's Environmental and Social Justice (ESJ) Action Plan and Tribal Consultation Plan that serve as a framework to integrate environmental and social justice and tribal consultations and considerations. Amanda outlined the goals of the ESJ Action Plan and noted recent CPUC decision that requires EPIC Administrators to allocated at least 25% of technology demonstration and deployment (TD&D) funds toward projects located and benefiting disadvantaged communities and at least 10% of TD&D funds towards projects benefiting low-income communities. Amanda noted that the feedback from this workshop process will help determine how to continue achieving the EPIC ESJ Action Plan through the next EPIC funding cycle. Kenneth outlined the goals for tribal engagement and consultation and provided examples of some recent projects and success stories.

Panels: The three panels focused on the following areas:

I. **How Equity is Incorporated into EPIC Portfolios.**

Presenters:

- Cynthia Carter, San Diego Gas & Electric (SDG&E)
- Dan Gilani, Pacific Gas and Electric (PG&E)
- Anthony Ng, California Energy Commission (CEC)

- Aaron Renfro, Southern California Edison (SCE)

The panelists provided perspectives of the CEC, PG&E, SCE and SDG&E, and outlined EPIC Administrators' approach to incorporating equity into their EPIC plans and portfolios, their outreach efforts and provided examples of projects located in or benefiting disadvantaged communities. The panelists also provided examples of how outreach and coordination helped adjust/improve the projects and what their approaches are for engaging more experts from tribal communities in their workforce (field projects, pilots, supplier diversity processes, partnership with colleges and support to energy entrepreneurs). The stakeholder discussion that followed highlighted the need to focus more on the customer psychology and provide more education, training and outreach to the communities to help them understand EPIC funding opportunities and priorities. The discussions also focused on the need to evaluate how to better engage tribal communities in the demonstrations, the need to locate more workshops and events in the tribal communities and have two-way meaningful conversations with tribes on RD&D ideas and potential testing in tribal communities.

II. Equity Frameworks and Principals.

Presenters:

- Sneha Ayyagari, Greenlining Institute
- Andres Ramirez, People for Mobility Justice
- Anuj Desai, Southern California Edison (SCE)
- James Strange, US Department of Energy (US DOE)

The panelists provided perspectives of the Greenlining Institute, People for Mobility Justice, SCE and US DOE. The panelists discussed the Equity Framework developed by the Disadvantages Communities Advisory Group (DACAG) and highlighted a need for a clear roadmap for how to implement it. They highlighted the need for more outreach and guidance to eliminate barriers to funding and better engagement with the communities through the project selection and evaluation process. The panelists used CalSEED as an example of successful application of the equity framework to EPIC investments that lead to increased engagement of women and people from underrepresented ethnic or racial groups, but noted that more could be done, particularly to improve tracking of demographic information during the outreach process. SCE also discussed their Climate Adaptation Vulnerability Assessment and the community engagement and outreach efforts during its development. Some of

the lessons learned from the process included the importance of paid engagements of community leaders to be part of designing solutions, and then lead engagement and outreach; flexibility to meet people and organizations where they are at and taking time to bring them up to speed; as well as customization/adjustment to specifics of each group. US DOE also discussed the Justice40 Initiative, Community Benefit Plans and key measurements and scoring approaches. The 8 benefits that US DOE is looking for to see in the disadvantaged communities are: decrease in energy burden and environmental exposures and increases in jobs and training, creation of enterprises, energy democracy, low-income capital, energy resilience, and clean energy access and adoption. Some of the suggestions for the EPIC improvement included: standardization of benefits and maps; leveraging data (quantifiable, measurable and trackable); and identifying where the benefits are occurring.

III. Equity Benefits in RD&D.

Presenters:

- Daniel Coffee, University of California, Los Angeles (UCLA)
- Walker Wieland, California's Office of Environmental Health Hazard Assessment (OEHHA)
- Eddie Price, San Diego Urban Sustainability Coalition (SDUSC)
- Holmes Hummel, Stanford University
- Thomas Steirer, Alliance for Tribal Clean Energy

The panelists provided perspectives of UCLA, OEHHA, SDUSC, Stanford University and Alliance for Tribal Clean Energy. The panelists discussed various screening tools, including CalEnviroScreen, and provided recommendations on layering them with localized data. The panelists also discussed various metrics, matrixes and policy frameworks that can be used by EPIC Administrators to evaluate the projects. The panelists also discussed unique challenges of the tribes and the need to recognize their energy sovereignty.

Presentations

The link to each presentation is included in the Appendices to this report.

Attendees

Almost 130 individuals participated in the full day workshop, virtually and in person, including CPUC Commissioner Genevieve Shiroma, representatives from the US Department of Energy, the four Administrators of the EPIC Program (California Energy Commission, and the 3 utilities), as well as RD&D leaders, research institutions, community leaders, technology solution providers, government entities, utilities, non-governmental organizations, and industry.

IV. KEY TAKEAWAYS

During the workshop, the panelists and participants identified the following key gaps and unique roles/opportunities for EPIC investments:

Measurable Metrics

#1: Clear roadmap on how to implement and track Equity Framework.

Many participants complimented the DACAG Equity Framework but noted that a clear tracking and roadmap are necessary for its implementation, with clear and measurable goals, processes, and tracking metrics. Participants suggested requiring funding grantees to set specific and measurable goals that are realistic and achievable and track inclusivity and equity impacts. The proposed tracking metrics included: health and safety impacts on the community (e.g., Does the projects result in some measurable changes?); access and education (including access to funding opportunities); financial benefits (Is the impact positive or negative? Are there cost savings, incentives, financial benefits? What is the impact on rates?); economic development (including jobs pipeline, training, workforce development); consumer protection (such as protection from predatory practices). They also highlighted the need to make as much of the information about projects' narratives, outcomes, progress and tracking data publicly available, particularly on how the program goals account for equity considerations, how the projects are progressing in achieving those equity goals, how the implementation has impacted disadvantaged communities, what are the anticipated community benefits. Participants noted that having this publicly available data will improve transparency and accountability of EPIC funding in terms of its impacts on disadvantaged and ESJ communities. The US DOE also echoed the need for measurable and trackable data, and identifying where the benefits are occurring. Many participants agreed

that some traditional metrics (e.g., enrollment numbers) might not be indicative of actual impacts on people's lives and more targeted measurements are necessary (e.g., thermal comfort). Panelists suggested a wide range of metrics and matrixes that can be used as an example for developing project evaluation criteria and tracking metrics. Some participants also suggested agency coordination on the metric development, such as using the California Office of Data and Innovation (https://innovation.ca.gov) standards for equity progress data collection, or following the California Racial Equity Commission (https://www.nextgenpolicy.org/priorities/racial-equity-commission) work on developing standards of practice for state government. Another example following San Diego Energy Equity Center (https://sdeecvp.com) that addresses equity and inequities from the community perspective. Participants noted that, for example, it uses the "community of concern" term, rather than "disadvantaged community."

#2: More clarity on definition of energy equity and benefits to disadvantaged communities and tracking demographic impacts.

Many participants highlighted that it is not enough to simply locate the projects in disadvantaged communities, as it can sometimes even harm them by causing displacement, and housing affordability issues. They noted that it is important to understand what the actual impact in those communities is. The panelists indicated a need for a clear definition of energy equity in funding criteria and how it differs from the benefits to ratepayers overall. They noted that there must be a collective understanding of what equity means and how to measure it. Participant noted that equity needs are regionally diverse, what fits one community will not work for the other. They noted that some EPIC programs (e.g., CalSEED) developed their own definition with feedback from community partners. Participants suggested extending that guidance more broadly across the full portfolio of EPIC projects. Participants also suggested involving disadvantaged communities in defining what benefits should be delivered to their communities and evaluating whether these benefits have been delivered. Participants suggested that providing more publicly available data on the community benefits – that are measurable and real or anticipated - of each project in the EPIC's project database will help track and evaluate their progress and keep grantees accountable. Some participants suggested that a better ability to track demographic information, such as race, veteran status, or gender identity, during the outreach process will help evaluating program success in delivering social benefits and help the entities implementing projects keep track of the impacts of their outreach efforts across a broader range of underrepresented groups. Participants argued that EPIC reporting on equity and demographic metrics should be connected with Justice40 reporting and should require using community benefit plans or similar tools in the assessment of applications.

#3: Standardization of benefits and maps and streamlining metrics tracking.

Some panelist suggested streamlining the tracking, if there are synergies between federal and state approaches, so there is less for the applicants to track. The US DOE also suggested standardization of benefits and maps across the projects and agencies and layering the federal and state tools, starting with the federal Climate and Economic Justice Screening Tool (available at geoplatform.gov) and then adding more specifics from the state and local tools, where appropriate. Participants note that the federal and state/local tools overlap in 70-80% of cases.

#4: On the ground engagement.

Some participants stressed that while screening tools are very helpful, they may not be adequate to provide the details of specific neighborhoods and the on-the-ground engagement is necessary to collect that data to inform programs and policy goals.

Training, Education, and Technical Assistance

#1: Overarching need for more accessible information, training and education on programs and funding opportunities.

Many stakeholders highlighted the need for more outreach, training, and education for tribal and disadvantaged communities on funding opportunities, to level the playing field. To help tribal and disadvantaged communities explore and use opportunities, they may require help understanding and navigating these opportunities. Participants highlighted the need to train applicants on priorities and goals, and what is considered as “innovation.” They also stressed the need for better coordination with science and technology education programs to build a pipeline of innovators. They also stressed that key information on the programs and funding opportunities should be translated into multiple languages.

#2: Technical assistance for communities and community groups.

The participants noted that it is important to provide technical assistance, including for the community-based groups, and create pathways for underrepresented groups to receive clean energy innovation funding. They may not be in a position to apply even if they know about the programs or may not know which programs can be a good fit, or what they can qualify for. Participants suggested that some existing available technical assistance programs could be integrated across different opportunities.

#3: Streamline the application and verification process.

Some participants highlighted the need to simplify and streamline the application and verification processes around similar topics (e.g., income verification) to make it easy for communities to apply to and qualify for multiple opportunities at once (for example through a standardized portal for end consumers).

Community and Tribal Outreach

#1: More integrated engagement of local communities through the process.

The panelist highlighted the need to enable better integration and coordination with the local communities though the entire process, including them in goals setting, processes definition, implementation, and evaluation. The panelists suggested co-creation of projects and pilots with paid community groups; including impacted communities in projects evaluation process and ensuring early on partnerships to align the goals of the projects with the actual community needs. The panelists also suggested evaluating EPIC programs in consultations with the Disadvantages Communities Advisory Group (DACAG). It was also highlighted that the engagement must be continuous, not come and go with each project, and develop sustainable continuous partnerships.

#2: Formula allocations to communities.

One of the suggestions was to make direct formula allocations to the communities and have the communities define their own needs and design and implement their solutions, have community plans developed by the communities.

#3: Higher allocations to disadvantaged communities.

Several participants indicated that the 25% +10% TDD and 40% Justice40 allocations might not be enough to address the historic injustices and to have meaningful impact. A higher allocation would be more equitable (e.g., 60% or 100%). For example, the allocations can focus exclusively on disadvantaged communities for the first few years to level the playing field. It is important to do an analysis of the historical perspective on how the investments were directed and allocated in the past and what % was historically invested in the disadvantaged communities. Many participants agreed that Justice40 requirements should be considered a floor and not a ceiling.

#4: Meet tribes and disadvantaged communities where they are at.

Engaging tribes and disadvantaged communities locally at their convenient location and times, e.g., hosting workshops at their localities, at the times that work for them (e.g., evenings) was raised by many participants as a key to better and more efficient outreach and engagement. Some other suggestions included right sizing the outreach, paid engagements of community leaders to lead the engagement and outreach and customization/adjustment to specifics of each group. Keeping in mind digital divide when hosting virtual outreach opportunities.

#5: Understand and recognize tribes' unique challenges.

The panelist indicated that tribes should be recognized for their energy sovereignty and should be treated separately from other disadvantaged communities. ECE resolution committing to tribal energy sovereignty might be an inspiration for the EPIC. The impact of the outages on the tribes may be more profound, considering the rural and remote location of the tribes, cutting people from access to medical assistants, education and basic necessities (e.g., fresh food). The most remote tribes are often the first to lose power and the last to be reconnected, so even the most basic metrics, like duration and frequency of outages, may be more important to them.

#6: Evaluate ways to engage tribal members in workforce development.

The participants expressed a need to evaluate how to better engage tribal communities in workforce development, particularly through the pilots, field demonstrations etc.

#7: Look for opportunities to involve tribes in testing.

Commissioner Shiroma invited EPIC Administrators to think of ways to involve tribes in pilots and investigate opportunities for testing within tribes, if they are interest, and look for testing and demonstrations, from lab scale to pilot scale, and have two-way meaningful consultations with the tribes on potential ideas and opportunities for projects and pilots.

Equitable and Safe Access to Technology

#1: Enable better access to established technology and enable collaboration between the communities and industry.

The panelists indicated that EPIC funding should be directed to fund opportunities for collaboration between companies that increase access in disadvantaged communities to

existing technology in addition to new technologies (e.g., software that will reduce costs or increase community ownership; hardware that will make solar more accessible to renters). The panelists suggested providing resources for community-based organizations and companies to work together as it will improve collaboration and provide new solutions for the communities. Some participants also suggested that EPIC should provide resources for collaboration among companies so that they could provide more holistic and comprehensive community solutions that are more affordable (for example have a collaboration of companies in the EV space to design solutions for the community on all stages of the EV lifecycle, including charging, energy storage and battery recycling). Participants noted that this will also help reduce fatigue in the community of being approached by too many companies.

#2: Consumer protection.

The participants indicated a need to think of consumer protection measures to ensure the disadvantaged communities are not taken advantage of and become victims of predatory and fraudulent behaviors in the clean tech adoption processes or funding applications. Is there a potential for standardized contract language? Are there translations available?

#3: Remove administrative and financial barriers and split incentives.

The participants indicated many administrative and financial burdens to funding. Participants noted that many programs provide benefits in the long run, or after the fact, but do not cover the upfront costs and or demand complicated paperwork and verification processes that exclude the most vulnerable populations that needs these programs the most. Participants noted that it is also important to keep in mind the potential split incentives between landowner and renters where the renters may be unable to access some of the programs, such as energy efficiency, even though these programs could benefit them the most. Participants suggested that programs specifically targeted to renters, such as Comprehensive Affordable Multifamily Retrofits program, could help address this barrier. Participants also suggested investing more resources in creating pathways for underrepresented groups to receive funding, for example by partnering with science and technology education programs or other programs.

V. APPENDICES

Video Recordings:

Workshop video **PT. 1**

Workshop video **PT. 2**

Agenda: (**PDF**)

Presentations:

Introduction: Andrew Barbeau, EPIC PICG Project Coordinator (no slides)

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

EJ Action Plan and Tribal Engagement Level Setting

Amanda Krantz, California Public Utilities Commission - Presentation Link

Ken Holbrook, California Public Utilities Commission - Presentation Link

How Equity is Incorporated into EPIC Portfolios

Cynthia Carter, San Diego Gas & Electric - Presentation Link

Dan Gilani, Pacific Gas and Electric - Presentation Link

Aaron Renfro, Southern California Edison - Presentation Link

Anthony Ng - California Energy Commission Presentation Link

Equity Frameworks and Principals

Sneha Ayyagari, The Greenlining Institute - Presentation Link

Andres Ramirez, People for Mobility Justice - Presentation Link

Anuj Desai, Southern California Edison - Presentation Link

James Strange, US Department of Energy - Presentation Link

Equity Benefits in RD&D

Daniel Coffee, UCLA - Presentation Link

Walker Wieland, CalEnviroScreen (OEHHA) - Presentation Link

Eddie Price, San Diego Urban Sustainability Coalition (no slides)

Holmes Hummel, Stanford University - Presentation Link

Thomas Steirer, Alliance for Tribal Clean Energy (no slides)

EPIC Strategic Goals

Grid Modernization

Workshop

Report

EPIC POLICY + INNOVATION
COORDINATION GROUP

November 2023

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

EPIC Strategic Goals

Built Environment

Workshop

Report

EPIC POLICY + INNOVATION
COORDINATION GROUP

November 2023

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 19, 2023, the CPUC hosted the EPIC Strategic Goals Built Environment 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 Customer Focused Solutions, Building Decarbonization, Electrification, and the Coordinated Role of Gas.

One hundred and twenty stakeholders participated in the workshop. Within the critical pathways for built environment, participants highlighted the following key gaps and opportunities for EPIC research: greater demand flexibility from electrified buildings; phasing out gas infrastructure in a planned manner on a larger scale, like neighborhood level; studying customer behavior and identifying cost reduction opportunities to enable greater clean appliances adoption, retrofits and greater demand flexibility; and scaling up electrification and retrofits efforts though standardization of interconnection, technology, data sharing, and permitting requirements. Participants noted that EPIC can play a key role in deploying technologies at greater scale, coordinating various programs to enable greater synergies and data sharing, and targeting most vulnerable neighborhoods in the most polluted areas.

[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 Workshop was hosted on September 19, 2023, from 10 am – 4:15 pm and consisted of two roundtables. The stakeholder discussions following each roundtable welcomed questions and comments from the audience in the room and participants connected virtually. CPUC Commissioner Genevieve Shiroma provided opening and closing remarks. 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 workshop participants and outlined workshop goals. The Commissioner noted that California is experiencing a big paradigm shift from gas to all electric buildings, employing new technologies, such as heat pumps and induction stoves. The Commissioner noted that research can play an important role in making home appliances more efficient and strengthening electric grid to sustain the increased load from building electrification. She

stressed the importance of the input from the workshop stakeholders in defining goals and strategies for EPIC funded research to help California reach its decarbonization goals. In the closing remarks, Commissioner Shiroma noted the importance of finding synergies through EPIC and other proceedings. Commissioner Shiroma thanked the participants and noted that she is very inspired by the workshop discussions.

Roundtables: The two roundtables focused on the following areas:

I. Customer Focused Solutions.

Presenters:

- Elden Hawkes Jr., U.S. Small Business Administration Office of Innovation and Technology (SBA)
- Ethan Elkind, University of California (UC), Berkeley
- Michael Colvin, Environmental Defense Fund (EDF)
- Carmen Best, Recurve
- Joe Desmond, California Efficiency + Demand Management Council (CEDMC)
- Jared Langevin, Lawrence Berkeley National Laboratory (LBNL)
- Brett Webster, Rocky Mountain Institute (RMI)

During the roundtable, a presentation from SBA outlined federal funding available under the SBA America's SeedFund Program for small American innovative manufacturing businesses. UC Berkeley presented findings from their recent "Building Towards Decarbonization" report and "The Future of California Consumer Energy Finance" report, noting that an incentive-based approach proved to be ineffective, and more financing solutions are needed to support retrofits and building decarbonization. Recurve discussed research data transparency and tracking and suggested focusing EPIC research on data-driven tools, like the CPUC Distributed Energy Resources (DER) Avoided Cost Calculator, which can provide valuable data to inform customer, grid operator, and industry decisions. CEDMC discussed barriers to smart devices adoption and areas where EPIC research can be most valuable in addressing those barriers. LBNL discussed findings from the LBNL/Brattle Group "Buildings 2050" study on scenarios of building and grid decarbonization on a national level, noting that the US buildings sector can reduce up to 90% of carbon emissions by 2050 through energy efficiency, flexible load and decarbonization of electric supply. RMI presented findings from their REALIZE Initiative on building retrofit acceleration through standardized solutions. The presenters also discussed approaches to ensure electrification affordability and the importance of developing Energy Burden targets for California. They noted that Energy Burden, Air Quality, and Building Safety metrics need to be incorporated into all programs to measure their success in bringing real benefits to customers. Stakeholder discussion following the presentation identified key targets that can be potential strategic goals for EPIC

portfolio. Participants also discussed the unique role of EPIC and highlighted several areas where EPIC can play a key role, including deploying technologies at scale, targeting most vulnerable communities, enabling seamless data sharing, and coordinating between programs, platforms, and policies for grater synergies.

II. Building Decarbonization, Electrification, and the Coordinated Role of Gas.

Presenters:

- Beckie Menten, Building Decarbonization Coalition (BDC)
- Zach Lou, California Green New Deal Coalition (CA GND)
- Andrew Brooks, Association for Energy Affordability (AEA)
- Jacques de Chalendar, Stanford University
- Kelly Lyndon, San Diego 350 Climate Action (SD 350)
- Daniel Hamilton, City of Oakland
- Theo Caretto, Communities for a Better Environment (CBE)
- Peter Chen, California Energy Commission (CEC)
- Mark Toney, The Utility Reform Network (TURN)

During the roundtable, BDC discussed a neighborhood decarbonization approach to transition neighborhoods off the gas infrastructure and opportunities presented by neighborhood-scale geothermal networks. CA GND discussed findings of their recent Report on equitable building decarbonization, noting that decarbonization is also a housing issue in California, where housing stock is one of the oldest and deteriorated in the country, and where 46% homes are occupied by renters. CA GND also shared findings from the California Housing Partnership report that shows that the need for affordable housing is much greater than available affordable housing. The naturally occurring affordable housing is shown to represent about a third of California's affordable housing. CA GND noted that typically it is affordable because of its poor and unsafe conditions. Building decarbonization improves building conditions and can lead to decreased availability of naturally occurring affordable housing. BDC and AEA discussed key barriers to multi-family housing decarbonization projects that can benefit from EPIC research, including developing more renter-ready appliances, like cook stove and water heater appliances with integrated batteries, and looking into panel optimization and smart panels to remove the need for upgrades to building electric wiring. Stanford's presentation discussed the RD&D needs in commercial building electrification, noting that 92% of the energy load comes from medium to large commercial buildings that are above 5,000 sq.f., like schools, hotels, supermarkets, and offices, even though they only constitute 50% of the buildings in the US. The Stanford presenter mentioned that 40% of commercial floor space has building automation systems

for heating or cooling and only 22% of the buildings have programmable thermostats, with only 6% internet connected thermostats. SD 350 highlighted metrics and gaps for supporting building electrification with equity in mind, noting the need to keep electricity cheaper than gas, aligning utility incentives with decarbonization goals, and setting simple trackable key metrics, like target cost per kWh. The City of Oakland presenter highlighted the need to simplify building codes to ease interconnection and contractors' ability to follow their requirements. He also focused on the need for strategic planning and mapping out transmission and distribution constraints to help cities align their strategic planning with existing system conditions. CBE discussed opportunities and challenges for hydrogen use, noting that over 90% of hydrogen today is produced from fossil fuel resources and can extend the lifespan of polluting resources, which perpetuates the disproportionate negative impacts on low-income and Environmental and Social Justice (ESJ) communities. CBE also noted that hydrogen use has unclear benefits for ratepayers and can increase infrastructure costs. The CEC discussed programs for commercialization of clean hydrogen for industrial decarbonization, noting that 20% of state emissions come from industry. The CEC further noted that decarbonizing high heat processes provides the best opportunities for clean hydrogen, like cement, glass, metal, and electronics manufacturing. The CEC noted that no clean hydrogen production facilities are currently present in California due to the high costs of clean hydrogen production. TURN noted that power should be treated as an essential human right and discussed how to protect captive customers. TURN recommended funding an independent study on gas system decommissioning. TURN also called on the Commission to freeze funding for hydrogen research until 100% clean hydrogen can be guaranteed, and instead called for a focus on geothermal heat pump technology that is 44% more effective in reducing emissions and energy use. In the stakeholder discussions following the presentations, participants discussed using the neighborhood-scale decarbonization approach in EPIC strategic goals and streamlining interconnection and permitting by enabling a better visibility into the transmission and distribution grid infrastructure capacity and constraints. Participants also discussed opportunities to reduce costs of geothermal resources and approaches to decommission or reuse gas pipeline systems.

Presentations

The link to each presentation is included in the Appendix to this report.

Attendees

One hundred and twenty individuals participated in the workshop, virtually and in person, including CPUC Commissioner Genevieve Shiroma and CPUC Staff, representatives from the US Small Business Administration (SBA) Office of Innovation and Technology, the four Administrators of the EPIC Program (California Energy Commission (CEC), 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 highlighted the following key areas of consensus among workshop participants:

Critical Pathways:

The discussions focused on the three main pathways of built environment and electrification, identified in the previous workshops: Customer Focused Solutions, Building Decarbonization and Electrification, and Coordinated Role of Gas. 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 enabling greater demand flexibility from residential and commercial buildings is a key to unlocking the potential of electrified buildings to reduce and delay grid upgrades and significantly reduce costs of decarbonization and transition to 100% clean energy grid. Understanding customer behavior in technology adoption and demand flexibility, how customers react to signals and incentives and what motivates them was noted as a key gap that can benefit the most from EPIC research. Participants also agreed that the scale of electrification and retrofits that is needed to reach California climate goals cannot be achieved with available state funding, and it is crucial to find ways to significantly reduce costs and find synergies between programs and private and federal funding to be able to scale up. Participants agreed overall that EPIC can play a key role in

streamlining and reducing costs of installation, interconnection, and permitting by helping standardize interconnection, technology, retrofits, building codes and data sharing requirements, and enable more efficient planning through enabling greater data access and visibility into the transmission and distribution systems conditions.

Unique Role of EPIC:

Participants agreed overall that, as a ratepayer-funded resource, EPIC is best suited to fund research on the following: 1) reducing financial burden of energy bills (Energy Burden) for California communities; 2) achieving a rate of building decarbonization retrofits at the scale that is needed for economy-wide decarbonization; 3) rapidly expanding capacity of flexible load needed for California's grid balancing needs; 4) larger scale targeting and demonstrations, like neighborhood-scale approach in gas phase out, retrofits and appliances adoption; 5) targeting the most vulnerable populations, particularly in the most polluted areas; 6) enabling seamless data flow and sharing between various platforms, programs, and entities; and 7) coordinating between different programs to understand how to fit them together to complement each other and provide holistic wrap-around benefits for customers and communities.

Desired Outcomes & Quantitative Targets:

Stakeholders identified opportunities for quantitative targets in the following areas:

- **Flexible Load:** Deploy 7 GW of flexible load by 2030, including VPPs, and relying on energy efficiency, load shifting, and electrification to provide 50% of building emission reductions;
- **Retrofits:** Increase rate of retrofits to 3% annually and 3.6% for affordable housing, and greatly reducing retrofit costs, including reducing costs of geothermal heat pumps installation, to about $20,000 per home;
- **Energy Burden:** Reduce Energy Burden for low-income customer to the EPIC identified numbers, but overall, much greater than the current 9% and closer to the national average of 3%, and keep electricity bills lower than gas bills;
- **Air Quality:** Improve air quality in most polluted areas through retrofits and electrification efforts by targeting these areas first;
- **Safety:** Increase the number of safe and code compliant buildings through retrofit efforts.

Other potential targets suggestions included:

- cost to go down to $X per kWh;
- % of all buildings electrified;
- % of buildings using distributed solar; and
- % of gas pipeline miles decommissioned.

Desired Outcomes and Targets

Specific suggestions of the potential targets for EPIC research suggested during this workshop included the following:

#1: Target: Flexible Load and Load Shifting.

- **7 GW of flexible load by 2030**: LBNL noted that about 200 GW, or about 15-20%, of flexible load is needed nationally, according to LBNL modelling and NREL's Electrification Futures studies, to relieve grid constraints. LBNL noted that not all this flexible load has to be dispatchable, because energy efficiency and load shifting can play a critical role as well. For California, CEDMC noted that CEC recently published its recommended target of 7,000 MW of load shifting by 2030, in line with California Senate Bill 846 that sets load shifting mandates for California. CEC estimated load shifting capability in 2022 at 3,100 to 3,600 MW, which totals about 3,400 to 3,900 MW of new load shifting by 2030.
- **X number of VPPs by 2030**: Recurve noted that US Department of Energy Loan Programs Office (USDOE LPO) released its Pathways to Commercial Liftoff Reports which estimates energy consumption in the US to double or triple within the next 10 years and estimate a target of 80-160 GW of virtual power plants (VPPs) by 2030 nationwide, triple of the current adoption rate. California could develop a state-specific target of that national goal.
- **Capturing additional margin from energy efficiency opportunities**: Recurve noted that over the course of a year, their market access program for summer reliability solutions was able to capture 38% more than the existing energy efficiency portfolio in system value. Recurve noted that this shows that there is a lot of potential available that can be captured with the right price signals to optimize the load.
- **50% of California's buildings emissions reduction target to come from building efficiency, electrification, and demand flexibility and cut costs of grid decarbonization by one third**: LBNL noted that buildings have high potential to serve as a demand side resource, since buildings consume about ¾ of electricity nationally. LBNL noted that there are three types of building solutions: 1) reducing building demand through energy efficient equipment and building envelopes; 2) building demand flexibility through shedding, shifting and reshaping buildings electric loads and behind the meter resources; and 3) buildings end use electrification through converting fossil fired cooking and water/air heating and cooling to electric use. In addition, decarbonization of the electricity generation powering the grid reduces buildings' overall carbon footprint as well. Most studies highlight that

building electrification paired with decarbonization of electric supply are key to reach net zero emissions by 2050. However, LBNL/Brattle Group "Buildings 2050" study noted that, from the energy savings and emission reduction perspective, parallel improvements in demand side efficiency and flexibility are as critical as energy efficiency and electrification. This is particularly relevant in the near term, while the grid is still decarbonizing its energy supply. The "Buildings 2050" study shows that 92% of building emissions can be reduced nationally by 2050, with almost 50% of that attributed to demand side efficiency and electrification, and the other half to electric supply decarbonization. Building efficiency and demand flexibility can avoid up to ⅓ of the costs of grid upgrades, amounting to more than $100 billion nationally by 2050. Increased building efficiency and flexibility can also further reduce costs by reducing existing buildings' load to make room for new load from electrification.

#2: Target: Retrofits.

- **3% retrofit rate for residential and 2% for commercial buildings, and 3.6% for affordable housing:** RMI noted that to meet California's climate goals the retrofit rate must increase 3 to 5 times. According to the UC Berkeley presenter, California has about 14 million existing residences, including homes and units in multifamily homes. Many will need retrofits. RMI presented the Advance Building Collaborative's Market Guidance Report that shows that for California's 4.3 million units of multi-family building stock, about ¾, totaling almost 3 million units, will need an all equipment swap out; while about ¼, which totals about 1 million units, will need equipment swaps paired with light touch envelope. A smaller fraction of buildings, about 82 thousand units, require more aggressive envelope upgrades. Only about 220 thousand units do not require upgrades now. LBNL also noted that their research suggests a target of 3% retrofit rate for residential and 2% for commercial buildings by 2030 nationwide under the best-case scenarios, which is about 4 million homes nationally, representing about 3.3 to 3.4 times increase to current rates. RMI noted that for California's affordable housing of 1.3 million units of natural affordable and 0.5 mil of subsidized housing they estimate a target retrofit rate to be 3.6% a year, or about 45,000 units a year.
- **Decrease retrofit costs, mandate geothermal heat pumps for new build, and reduce costs for retrofits to $20,000 per home:** UC Berkeley noted that the current level of available funding is not sufficient to support the required scale of retrofits. For example, it took GoGreen Financing over the last six years and cost $55 million to issue 3,000 residential retrofit loans. However, about $26 billion will need to be invested through 2030 under the CEC "moderate electrification scenario." About $150

billion investment is needed by 2030 for space and water conditioning, according to the BDC estimates. Several participants, including BDC, AEA, and TURN, highlighted the high potential of ground-based geothermal heat pump technology, particularly if deployed on a neighborhood or district level scale. While it can be cheaper if mandated as a default for new built homes and neighborhoods, to compete with the air heat pumps technology in the retrofit projects, the geothermal heat pumps installation costs will need to be reduced to approximately $15,000-$20,000 per home.

#3: Target: Energy Burden.

- **Achieve an X% Energy Burden level for low-income customers:** Many participants, including EDF and UC Berkeley, noted that Energy Burden shall be used across all EPIC programs as a metric for affordability. EDF noted that the US DOE indicates that a typical residential customers' energy burden is approximately 3% of their total income. For low-income customers, the number triples, at approximately 9%. EPIC can help develop Energy Burden targets for California residential and low-income customers that brings it closer to the 3% national average. This metric will help track affordability of EPIC's building decarbonization efforts and their success in making it affordable. CA GND noted the importance of looking at this holistically and systemically with housing affordability and availability and other considerations in mind.
- **Lower electric bills to compete with gas:** Many participants agreed that electrification efforts will not succeed if electricity is more expensive than gas. Participants called for creative ratemaking ideas, including profit share, regulatory asset treatment, utility incentives, redirecting gas upgrades investments to fund electrification, making rates more progressive, or think of using income tax system that is more progressive, to ensure that electric bills stay lower than gas bills. TURN also noted that electric bills increase should be capped at the rate of inflation.

#4: Target: Air Quality.

- **Improve local air quality in most polluted areas**: Many participants noted that, to help target and map out program deployment to prioritize communities that need help the most, all customer-facing programs must include non-energy benefit metrics, such as health, indoor and outdoor air quality, and thermal comfort. This can help target the most polluted areas for low carbon and efficiency upgrades and retrofits to lower energy consumption and displace gas infrastructure buildout with decarbonization solutions that also improve local air quality. EDF stressed that

integrating non-energy benefits, like air quality, into program metrics can provide opportunities for creative rate design solutions. EDF also noted the importance of broadening the definition of "clean" to include both lower carbon footprint and improved local air quality as a critical project outcome.

#5. Target: Building Safety.

- **Increased number of code compliant buildings**: Many participants noted that California's building stock contains a lot of very old buildings, many of which are not up to code. While California has the most aggressive energy requirements in building codes in the country, no adequate funding is designated to bring California's buildings up to those codes. DBC noted that the State and about 75% of Local Building Codes emphasize some form of "electric preferred" or "all-electric" construction. EDF recommended using code compliance as a proxy for the safety metric.

#6. Target: Simple Key Metrics.

Participants also recommended setting simple trackable key metrics, like:

- Cost per kWh;
- % of all-electric buildings;
- % of buildings using distributed solar; and
- % of gas pipeline miles decommissioned.

Unique Role of EPIC

This workshop included additional discussion on EPIC's overall unique role in addressing gaps in pathways. Many participants agreed that, overall, these are the key areas where EPIC has a unique role to play in built environment electrification:

#1: Role: Larger scale deployment and demonstrations.

Many participants suggested that a unique role of EPIC as a ratepayer funded program can be to work on a larger scale, focus on communities and neighborhoods, and use modelling and data analytics to identify key target locations where customers can benefit from deployment the most. For example, this may include areas that have higher quantities of aging gas infrastructure or communities in higher air pollution or weather impact zones. EPIC research can identify how to incentivize and deploy projects at a larger scale, instead of the individual customer level. BDC and RMI noted that the neighborhood-scale approach can provide helpful demonstrations and lessons learned. This approach can also help with aggregation and coordination with gas infrastructure decommissioning, where valuable

lessons can be derived from hard-to-electrify buildings and transitioning entire neighborhoods off of gas service. These lessons can help with scalability and aggregation when expanding programs to more neighborhoods. EPIC can use demonstrations at larger scale as proof of concept by working through different challenges and developing solutions for them. Similarly, RMI suggested research on deploying a larger portfolio of projects at once, e.g., 1,000 or 5,000 buildings, to test benefits and cost savings potential of large-scale deployment. This can help design more sustainable large-scale programs, like utility programs. The Stanford presenter also suggested that larger scale deployment by switching appliances all at once, together, instead of one at a time, at a house, commercial building, and neighborhood level, can provide substantial cost savings. The City of Oakland presenter also noted that deploying equitable solutions at a larger scale can help understand how to target RD&D for the most vulnerable and most impactful areas.

#2: Role: Targeting and reaching the most vulnerable populations.

Many presenters also agreed that one of the key areas where EPIC could help the most with building decarbonization is by targeting areas of the state with the greatest air pollution. They noted that EPIC decarbonization efforts should layer carbon reduction and energy savings targets with local air quality improvement targets when prioritizing program deployment locations. UC Berkeley noted that EPIC research could focus on low carbon appliances and building envelopes, which can help customers in vulnerable populations save money and improve indoor air quality. EDF suggested that EPIC target areas with poor air quality that are also due for gas infrastructure upgrades and deploy decarbonization efforts there to displace gas infrastructure upgrades and, thus, achieve both lower energy bills and improved local air quality.

#3: Role: Develop Energy Burden targets for California.

Many presenters noted that EPIC could play a key role in answering the question of: What is the right level of Energy Burden for California? What number is appropriate for residential, low-income, and other vulnerable customers in the built environment decarbonization efforts? EPIC research could help inform the affordability proceedings and other regulatory and decision-making processes in adopting these metrics and incorporating them across various programs.

#4: Role: Fitting pieces of the puzzle together.

Many presenters suggested that to get to scale all measures discussed in this workshop, including supply side optimization, customer adoption, demand flexibility, gas decommissioning, and financing, need to be stacked together and EPIC's key role in this can

be to identify the order of operations on how to stack different policy goals and measures to fit together. For example, participants suggested coordinating efforts with the Market Transformation Authority on commercialization of technologies that come out of EPIC, coordinating with Advanced Building Construction Collaborative and building departments on retrofit efforts, coordinating with fire authorities on decommissioning gas infrastructure in fire hazard zones, and working with federal programs to find synergies and costs sharing opportunities.

#5: Role: Enable seamless data sharing.

Many participants suggested that EPIC can play a key role in improving data access and data sharing to ensure seamless data flow between consumers, utilities, and aggregators and between different databases and platforms. Participants suggested that EPIC can help navigate how to get different systems and databases across different utilities to export and import data in the right way, how to utilize time series data, and how to ensure access to information with customer privacy protected. For example, AEA noted that utilities have kW draw data for each building, each transformer, and each service drop from that transformer. The National Electric Code allows using 12 months of utility KW draw data to determine buildings' available electrical capacity. Utilities, however, provide this data only to buildings that pay demand charges. AEA noted that having this data will streamline processes as it will demonstrate that NEC calculations for the load of the building overestimate what the total load actually is and may potentially help avoid building upgrades.

Key Gaps

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

Customer Focused Solutions

Many presenters highlighted that the incentive-based approaches had not worked as expected, particularly for low-income and moderate-income customers, to get to the necessary scale of building decarbonization. The main causes of consumer resistance identified during the workshop included: lack of capital to invest in needed upgrades, lack of time to look for electrification and decarbonization solutions, particularly in emergency replacement situations, and lack of knowledge about available incentive programs and technologies. In general, participants noted that electrification and decarbonization are not within customers' priorities when they look to invest in home upgrades. Another barrier

noted is that many upgrades typically happen in emergency situations, when customers look for the cheapest and quickest solutions and do not have time to investigate cleaner and more efficient alternatives. Contractors that come to perform home upgrades are often not aware of decarbonization solutions and are not trained to sell and install them. Customers that are interested in decarbonization solutions are often dissuaded by complicated incentive programs that are not easy to navigate. Also, customers are often confused by mixed messages that come from political resistance to gas phase-out and related lawsuits.

#1: Gap: Understand customer behavior.

Many participants noted the importance of enabling greater demand flexibility from buildings, including from heating and cooling, light, refrigeration and the EVs and industrial facilities, to support faster and cheaper grid decarbonization. Participants stressed that EPIC could play a key role in studying customer behavior to understand and remove constraints on technology adoption and demand flexibility and improve modelling and forecasting to better account for demand flexibility potential.

- **Potential Role of EPIC:** CDEMC and BDC recommended studying customer behavior and how customers make decisions in adopting electrification and decarbonization solutions, what makes them excited or holds them back, particularly in low-income and ESJ communities, as well as the customer's ability to take on additional debt. CDEMC noted a recent pilot that is studying how people make investment decisions. This study identified 19 criteria, in addition to utility bill reduction, that drive customer decisions. Participants suggested that EPIC could help understand decision making factors and how they differ between customer groups.
- **Potential Role of EPIC:** LBNL suggested that EPIC can be most valuable in identifying behavioral constraints to demand flexibility and ways to balance the need for automation versus customer desire to retain some controls over their energy use. EPIC research can test various key drivers of customer electrification adoption and response to signals in various scenarios of demand flexibility, including small commercial and residential buildings, and energy intensive commercial facilities, like hospitals.
- **Potential Role of EPIC:** LBNL suggested that EPIC research on customer behavior and response to various price and operational signals could be integrated into grid modelling and forecasting. The research can also help improve linkage between grid planning and building modelling to help utilities understand the implications of higher deployment of demand side resources. It could help design technologies and incentives attractive to consumers.

#2: Gap: Incorporate Energy Burden, Air Quality, and Safety metrics into all customer facing decarbonization programs.

Participants noted that all decarbonization efforts must lead to improved Affordability, Clean Energy, and Safety as key indicators of their success.

- **Potential Role of EPIC:** EDF and others suggested that EPIC research could help develop Energy Burden, Air Quality, and Safety targets and metrics and facilitate incorporating them into all decarbonization programs across all utilities and state agencies. EPIC could also help identify how to align utility and customer incentives and reward utilities for effective management and coordination of programs that improve these metrics.

#3: Gap: Improve customer education and outreach.

- **Potential Role of EPIC:** UC Berkeley and CDEMC suggested that EPIC programs could help educate customers and the broader public on decarbonization appliances and retrofits that can help improve indoor air quality and reduce energy bills. UC Berkeley noted, in particular, that EPIC should increase support to community-based organizations that are on the ground in vulnerable communities and can provide customer education, outreach, and technical assistance. These organizations can also help with demonstration projects in the community, considering that adoption of clean energy technology is often a very social and culture-based experience. Often, seeing neighbors adopt decarbonization appliances and receive energy savings and health benefits can help scale up the adoption efforts in the community. BDC recommended studying how customers prefer to receive information and to identify trusted messengers. For example, BDC noted that their survey identified chefs as one of the most trusted voices in the communities and, as a result, started a "Cheffluencer" training program to train chefs on induction technology and demonstrations. The City of Oakland noted examples of the Oakland Eco Block project implementation where working with the communities and designing solutions around community needs lead to greater enrollment and overall project success.

#4: Gap: Develop smart technology workforce and contractor training.

- **Potential Role of EPIC:** UC Berkeley, BDC, CDEMC, SD 350 and many other presenters recommended that EPIC focus on workforce development for smart clean technology installation and maintenance. EPIC could help develop education and training for contractors that are the first point of contact, particularly for emergency repairs, on available appliances, technologies, and incentives. CDEMC suggested that EPIC could

help identify potential sites, organizations, and colleges that can host training programs.

#5: Gap: Financing and simplified access to incentives and programs.

Many presenters highlighted the need for additional financing and easy to access incentives to support customer decarbonization and electrification efforts.

- **Potential Role of EPIC:** To overcome customer resistance, many participants recommended developing a public facing one-stop-shop for decarbonization incentives and financing opportunities so that consumers could understand how to access them. For low-income customers and low-income building owners this resource needs to have human assistance available to help guide them, and not just be an internet-based resource. BDC recommended developing streamlined incentive programs that are stackable with other programs and are easy to access for customers and contractors. BDC noted that easy installation programs for customers that cannot afford upfront costs and affordable financing for customers with low credit scores are also needed. CDEMC suggested that EPIC could help simplify enrollment in the smart device adoption programs to make them easy for customers to sign up and leave, including through automatic enrolment and opt out options.

#6: Gap: Smart rate-design to keep electricity cheaper than gas.

Many participants noted that rate design must ensure that all electric buildings are affordable, and that electricity is cheaper than gas to ensure continuous switching.

- **Potential Role of EPIC:** Participants suggested that EPIC could help navigate potential solutions to advise ratemaking. BDC suggested looking for innovative smart rate design options. SD 350 suggested investigating ways to eliminate or cover utility cost increases in electrification, for example, by tariffed on-bill financing. EDF suggested looking into profit sharing and regulatory asset treatment options.

Buildings Decarbonization and Electrification

Many participants agreed that state funding may not be sufficient to get to the electrification and retrofit scale necessary to reach California's climate goals. One of the key challenges in electrifying multi-family housing is building electric infrastructure upgrades, which can prevent projects from going forward or reduce their scope significantly. Inconsistent standards, interconnection delays and outdated building codes, lack of visibility into the utility systems, and transmission availability further prevent effective design and integration of best suited solutions.

#1: Gap: Leverage private capital to scale up retrofits and decarbonization.

Many participants highlighted a need for innovative solutions to leverage private funding to support state's building decarbonization efforts.

- **Potential Role of EPIC:** Participants noted that EPIC research and demonstrations could build up a factual database for legislators and regulators to adopt solutions and mandates to leverage private funding. For example, one of the solutions suggested by UC Berkeley and EDF was to redirect funding from the gas infrastructure upgrades into helping customers adopt low carbon appliances. The UC Berkely presenter also suggested partnering with larger banks and establishing public private partnerships to leverage public funding that could encourage more private lenders to step in. Another suggestion was to create a microloan marketplace for appliances to ensure that funding is available when needed for urgent repairs and other upgrades. UC Berkeley also suggested leveraging data sharing and smart meter data to identify in advance customer equipment that might need to be replaced soon and inform customers on potential low carbon solutions for these replacements. Another suggestion was to establish a legislative mandate for energy audits and retrofits at the point of sale or lease, similar to the United Kingdom's and New York City's mandates for commercial buildings. This allows customers moving in to understand the carbon and energy footprint of the building.

#2. Gap: Develop more renter ready solutions.

Many participants recommended that EPIC could help develop renter ready solutions that can plug into 120V outlets and help electrify buildings without significant electrical upgrades.

- **Potential Role of EPIC:** AEA and BDC named several technology research opportunities where EPIC could help fully electrify and disconnect houses, particularly multi-family units, from gas services, including:
    - Providing field trials for emerging technologies, such as cooking appliances, domestic hot water and HVAC appliances, with integrated batteries, that allows appliances to plug into 120V outlets on shared circuits. AEA noted that these appliances monitor grid voltages and can adjust and switch off if needed and will be critical to fully disconnect buildings from gas lines.
    - Studying smart panels and addressing fundamental structural challenges with virtual net energy metering (V-NEM) that prevents the use of battery storage and looking into service panel optimization to accommodate more 120V products.

- Testing performance of large central heat pumped hot water systems in extreme climate zones and developing commercial heat pump dryer solutions, lack of which prevents full electrification of multi-family buildings.
- Studying pump chillers that can be used as drop-in replacements for chillers paired with gas boilers for multifamily buildings. Also studying the potential application and performance of the alternative low-global-warming-potential refrigerants that are highly flammable.
- Testing multi-family whole building air leakage.
- Studying combined multi-family mechanical systems.

#3: Gap: Accelerate smart technology adoption.

Participants stressed that smart devices, including grid edge computers, submetering, batteries, smart appliances, etc., face many challenges that must be addressed to accelerate their adoption, including a lack of standardized approaches to data sharing and interconnection.

- **Potential Role of EPIC:** As one of the potential pathways to improve smart device adoption, CDEMC suggested that EPIC continue its work on standardization in coordination with its regional partnerships and with grid operators. This can streamline technology, data, and interconnection standards and codes and can enable technology commercialization and expansion into wholesale markets. Wide enablement of smart devices requires consistency on how these devices are valued on a wholesale market when aggregated. The need for research to help ease interconnection and permitting was also echoed by the City of Okland.
- **Potential Role of EPIC:** CDEMC suggested research into integrating various technologies into utility planning processes and incentive programs and simplifying program enrollment processes.
- **Potential Role of EPIC:** Other areas suggested by CDEMC where EPIC can contribute the most in accelerating smart technology adoption include:
  1) Studying alternative approaches to metering for example, exploring and validating the modified proxy demand resource methodology.
  2) Developing uniform cybersecurity best practices for smart devices.
  3) Developing common open source modeling tools, including data sets, predictive models, and measurement methods that can help engineers predict and manage performance. For example, these tools can help identify and develop new dynamic baselines for load shifting in response to different conditions, like price.

4) Accelerating research, development, and adoption of the distribution system reliability standards and requirements to make it more transparent and easier for new market entrants to understand these standards and navigate different markets.
5) Developing a total system benefits metrics. For example, this may include looking at Pacific Northwest Natural Lab research that starts with the desired "grid of the future" and works backwards to identify the key elements and the order and timeline of issues to be addressed. The research then identifies steps to transition to the "grid of the future" efficiently, in an open and accessible way, and necessary metrics, including certification, standardized reporting, or service level agreements.

#4: Gap: Develop energy performance metric.

- **Potential Role of EPIC:** Participants recommended developing an energy performance metric, for example in air and water heating, to help lower demand and bill impacts of heating electrification and make new high efficiency technologies more affordable and accessible to low-income communities. This can help close the gap in customer adoption of heat pumps and similar technologies and make them more attractive to consumers and more competitive with other technologies.

#5: Gap: Accelerate retrofits through standardized retrofit packages.

Presenters noted that to meet California's climate goals, the retrofit rate must increase 3 to 5 times. RMI shared findings from the REALIZE Initiative that created standardized packages that streamline and standardize retrofit design and delivery. Standardized packages streamline: a) project identification and eligibility through building typology; b) procurement through bulk purchasing; and c) delivery through systematized contractor training. RMI noted that standardized project typology can enable demand aggregation at scale. RMI noted that financing solutions are needed to fund or subsidize the initial cohorts of these projects, and that the Inflation Reduction Act may potentially provide some support but not all that is needed. RMI currently has 4 pilot projects in California and 4 in Massachusetts.

- **Potential Role of EPIC:** RMI suggested that retrofits standardization that accommodates buildings' unique needs through common typologies can provide a solution for scaling up retrofits rate. RMI noted the following key RD&D areas for EPIC to consider that can help accelerate this approach:
    - Setting up a full-suite one-stop-shop solution provider for retrofits that can deliver assessment, design, financing, installation and, potentially, manufacturing.

- Delivering contractor training and workforce development for these retrofits that ensure diversity and inclusivity and engagement of BIPOC and woman-owned businesses and labor organizations with diverse networks.
- Developing innovative solutions for air sealing since current solutions are either very manual or disruptive.
- Developing solutions for retrofit wall panels that pair structural and seismic retrofits with zero-carbon technologies. This may include prefabricated exterior panel products that can provide structural repairs and energy efficiency, or climate-smart wood solutions that can provide alignment with multiple state agencies programs.

- **Potential Role of EPIC:** RMI also suggested coordinating retrofit RD&D with the Advanced Building Construction Collaborative and other research programs to amplify investment and leverage parallel programs, including tapping into federal funding opportunities with EPIC providing cost share.

#6: Gap: Remove building codes restrictions and coordinate with building departments.

Participants noted that building codes often restrict integration of some technologies on shared circuits, even if there is enough electrical capacity in the building. AEA noted that, for example, Packaged Thermal Air Conditioner (PTAC) requires a separate circuit because the Building Codes treat heat pumps as a permanently installed appliance. Air conditioners, on the other hand, are treated as a temporarily installed appliance that can be plugged into shared circuits.

- **Potential Role of EPIC:** AEA noted that it is critical to remove the need for a dedicated circuit for such technology, particularly in multi-family housing, to avoid running multiple additional service lines. EPIC could help coordinate efforts in updating Building Codes to accommodate needs of multi-family housing electrification. EPIC could also help coordinate with the building departments and technology developers, for example, on using smart panel technology to avoid service upgrades and provide demonstrations to get building departments more accustomed to these new proven technologies. The City of Oakland also echoed the need to simplify codes, so it is easier for contractors to follow them and implement various technologies.

#7: Gap: More stress test and experiment-based research for commercial buildings.

Presenters suggested adopting an "experiments first" instead of a "model-first" approach, or, at least, place more emphasis on real world experimentation in RD&D efforts. This is particularly relevant in studying commercial buildings electrification to expedite the transition from planning to implementing solutions. This approach can help generate more data sets for different variations and conditions. For example, Stanford research that adopted this approach identified high efficiency potential from even the smallest temperature adjustments in commercial buildings.

- **Potential Role of EPIC:** The Stanford presenter suggested that EPIC can help generalize this type of experimentation and data driven approach to scale up decarbonization efforts.

#8: Gap: More data-driven and feedback-loop focused research results.

Recurve noted that while California has many demand flexibility and clean energy programs, it is hard to understand what they are delivering and how they are achieving reported results because they lack transparent tracking mechanisms. The energy sector is very data rich, with Advanced Metering Infrastructure (AMI) data and various program models. But many of those models are not as data driven as they need to be.

- **Potential Role of EPIC:** Recurve called for EPIC to ensure that research data is fully available and that programs have embedded measurement verification and analytics that can create feedback loops as the research is progressing, rather than having feedback at the very end of the project. Instead of static reports and fixed savings estimates, or fixed estimates of what the impacts are, it is more valuable to have dynamic feedback loops, where every opportunity and impact of demand flexibility intervention that is being tested can have an actual positive impact on resource planning. Recurve noted that an embedded measurement tracking and verification framework can deliver meaningful results to customers and grid operators. Data-driven models, as opposed to incentive-only models, have the added benefit of providing visibility into potential long term cash flows and return on investments of various technologies to inform and attract private investments. Among the examples of successful data-driven models, Recurve noted the CPUC Distributed Energy Avoided Costs Calculator (ACC) used in the CPUC demand flexibility proceeding (Rulemaking 22-07-005) and the requirement to measure at the meter in the CPUC energy efficiency programs. Recurve noted that the ACC provides a valuable baseline for avoided cost of energy reductions from energy efficiency and demand response programs but can also include any

specific elements, like carbon reduction, localized grid value, and demographic value to calibrate the base value to any specific needs. It provides an opportunity to target various customers and identify those that can benefit or suffer negative impacts from electrification programs, like increased energy bills. Another example is the use of a common measurement and a verification software platform in the market access program. This provides innovators with consistent visibility into the impacts of each project. LBNL also noted that one of the key values of EPIC research is generating missing data that can support future programs and program design. LBNL provided an example of another ratepayer funded program, Tech Clean California, that generated cost data for electrification projects. EPIC could leverage this to keep the barriers to entry low and attract more innovative partners into EPIC programs. This can translate to high impact interventions that provide grid and customer benefits.

#9: Gap: Demonstrate buildings' load flexibility potential in reducing building infrastructure investments.

Presenters noted that the biggest sources for cost savings in large commercial building electrification are the avoided infrastructure investments. Building owners could significantly reduce their capital investments if these buildings are designed to rely on smaller energy infrastructure and load flexibility management, instead of large energy infrastructure.

- **Potential Role of EPIC:** The Stanford presenter suggested that EPIC could help research the physical and behavioral sides of flexible demand management. EPIC could also conduct demonstrations to prove operational efficiency of demand management and build trust around relying on a smaller energy system in commercial buildings with flexible demand capabilities. The Stanford presenter suggested starting with larger buildings of above 5,000 sq. ft. because they have higher emission and energy reduction potential – these buildings are responsible for approximately 92% of building emissions in the US.

#10: Gap: Develop low-cost automation and sensing solutions for commercial buildings.

The Stanford presenter noted the potential value of sensors and automation in decarbonizing commercial buildings. As an example, distributed sensor technology can reveal zone-by-zone energy intensity and flexibility in different rooms and allows for greater efficiency by adjusting heating and cooling in specific zones, rather than the entire room or building.

- **Potential Role of EPIC:** The Stanford presenter suggested funding research on solutions that can make automation and sensing cheaper for commercial buildings. These solutions need to be compatible with legacy systems, need to shorten the hardware and software stack, and need to modernize data management practices to enable scaling up decarbonization efforts.

#11: Gap: Measure unpredictability of commercial buildings demand response.

- **Potential Role of EPIC:** The Stanford presenter recommended evaluating commercial buildings soft and hard energy efficiency and flexibility to measure deviation ranges in buildings' demand response performance. Measured deviations from performance requirements can help grid operators estimate how they can deploy and rely on the buildings' load flexibility services.

#12: Gap: Enable advanced strategic grid planning to help cities and municipalities design their resources more effectively.

The City of Oakland presenter noted that the lack of advanced planning for grid needs and strategic vision of two-way power issues, like vehicle-to-grid or building-to-grid, prevents cities from developing strategies that can support overall electrification efforts. This presenter noted that many interconnection delays could be avoided if there was more visibility into distribution and transmission systems. Resources could be planned accordingly on the local level with all the constraints on those systems taken into consideration.

- **Potential Role of EPIC:** The City of Oakland presenter suggested that EPIC RD&D in this area, in coordination with California Independent System Operator (CAISO), can help inform planning and mapping out where the transmission and distribution problems are, and where there are limitations on transformers, so that cities can design effectively around actual system conditions. AEA also noted that this is a national issue and California can take a lead on this. AEA noted that this is also a permitting and approval issue, particularly when the building owner submits applications to the utilities to add new load, whereas visibility into the grid infrastructure and capacity will streamline a lot of processes by enabling more accurate design and planning.

Coordinated Role of Gas

Participants noted a general concern that customers that are not participating in electrification will be shouldering a greater burden for gas infrastructure upgrades.

Wealthier customers are typically the early adopters of electrification, leaving behind vulnerable populations to carry the increased costs of the gas system. Electrification and building decarbonization programs must be deployed with vulnerable populations in mind. Built environment decarbonization will increase electric usage and electric bills but will displace gas usage, which can create opportunities for innovative ratemaking approaches.

#1: Gap: Displace gas upgrades with efficiency and electrification programs.

Many participants suggested looking into a planned transition for existing gas infrastructure and ways to redirect investments going into upgrades of natural gas infrastructure, that California is trying to phase out, to fund decarbonization efforts as non-pipeline alternatives.

- **Potential Role of EPIC:** Participants suggested that EPIC could investigate options to use electrification, building decarbonization, weatherization, energy efficiency and energy retrofits as the non-pipeline alternatives to displace gas system investments. EPIC could identify areas of the state where gas infrastructure will soon require upgrades and use this approach to retire gas assets instead of upgrading them. Participants highlighted the value of a neighborhood decarbonization approach in utility planning, focused on neighborhoods that need gas upgrades, and redirecting gas upgrades funding to pay for neighborhood-wide electrification. EPIC could help investigate how to coordinate and share data between the utilities across various efficiency, retrofit, and electrification programs, and use these programs as non-pipeline alternatives to displace gas upgrade investments. EPIC could also help navigate how to target these programs with an equity and affordability lens using Energy Burden as a metric. Further, EPIC could investigate how to deploy these programs together and at a neighborhood scale and how to reward utilities for effective management, whether through shared savings mechanisms or some regulatory asset treatment approach, etc.

#2: Gap: Utilize geothermal technology.

Participants suggested looking into using neighborhood or district geothermal networks to switch entire neighborhoods from gas to geothermal heating and cooling and provide opportunities for workforce development.

- **Potential Role of EPIC:** BDC noted that EPIC could help develop targets for California on the necessary scale of the geothermal resources. BDC also noted that California is far behind other states, including New York and Massachusetts, that are already piloting these technologies and getting mandates on targets in front of legislators. EPIC could help test how thermal networks perform in

California (particularly in hot climate zones) and their potential to reduce building load on the grid. EPIC could also help demonstrate potential to reduce water consumption.

- **Potential Role of EPIC:** TURN recommended that EPIC devote funding to advance geothermal heat pump technology. TURN noted that these ground-based heat pumps consume less electricity that results in lower bills and 44% less energy consumption and emissions than air source heat pumps, according to the US Environmental Protection Agency. TURN also noted that the upfront costs of this technology are higher due to drilling, digging, and necessary pipeline infrastructure. EPIC funding could support the development of new digging and drilling techniques that could bring down the costs of installation and retrofit and develop plans to require this technology as a standard for new developments. TURN also named examples of major projects that use geothermal heat pump technology, including the George Lucas Museum and the Los Angeles city-wide project. AEA and BDC echoed the value of mandating this technology for new developments but noted that it can be too expensive for retrofit projects, where air heat pumps are much cheaper, at about $15,000-20,000 per home. Participants agreed that this number can serve as a potential goal for cost reduction for the geothermal heat pump technology for retrofits.

#3: Gap: Fund independent studies on gas decommissioning.

- **Potential Role of EPIC:** TURN recommended that EPIC fund independent studies on how to close and decommission natural gas facilities and develop strategies and a realistic timeline to decommission gas infrastructure as quickly as possible. The City of Oakland speaker noted that gas pipeline rapture poses significant risks for wildfires, particularly in seismic active zones, like Oakland hillsides, and there may be place for coordination of the gas decommissioning and wildfire prevention efforts in those areas, particularly in residential areas, to get multiple benefits and share the costs.
- **Potential role of EPIC:** SD 350 suggested that EPIC could look into system level strategies to reduce ratepayer costs from gas system upgrades, to avoid new gas infrastructure investments and to retire gas infrastructure early. Some suggested research areas include studying opportunities for early retirement of fossil fuel resources through incentives, developing approaches to limit hydrogen to hard-to-electrify uses, and studying approaches to use alternative delivery options to avoid infrastructure upgrades. SD 350 also noted that EPIC could also help with neighborhood and city-wide demonstration projects on gas asset retirement.

#4: Gap: Commercial use of clean hydrogen.

CEC noted the importance of setting safeguards around hydrogen. TURN, on the other hand, recommended that EPIC freeze funding for hydrogen research until clean hydrogen is guaranteed, noting that it is extremely hard to produce because it requires zero emissions though the entire production process. TURN also noted that hydrogen produced with average grid electricity is 65% more carbon intensive than diesel fuel.

- **Potential Role of EPIC:** TURN highlighted the importance of ensuring that hydrogen is produced with a zero-emission footprint and called for EPIC to develop standards to ensure that RD&D funding is only available for 100% clean hydrogen. CBE also emphasized the need to set clear boundaries on what sources of energy can qualify to produce clean hydrogen. CBE recommended that EPIC research help set the scope of hydrogen use as narrow as possible to ensure that when it is being deployed it is not taking place of potential electrification solutions. CBE also noted the need for more clarity on what is required to retrofit the gas system for hydrogen use. The CEC also noted that further research is needed around clean hydrogen use, including understanding the optimal ways to use hydrogen and consider environmental concerns, what safeguards need to be in place, what the important uses are, and how the infrastructure could scale up to support this use. The CEC presenter noted that the CEC is funding an independent study to answer many of those questions, and EPIC could play an important role in researching these issues further.

Equity Considerations

Many participants noted a concern that the most vulnerable customers may end up left behind in the grid decarbonization process while having to pay higher energy bills as they often lack funding, knowledge, and opportunities to be the early adopters of the energy efficiency and low carbon solutions.

#1: Gap: Make building decarbonization technologies more affordable.

Participants noted a shift in building decarbonization RD&D from making technology more efficient to making it more affordable to expedite its adoption but noted that more research is needed in this regard.

- **Potential Role of EPIC:** LBNL suggested that EPIC focus on solutions to significantly reduce costs of higher performing technologies that are entering the market today to make them affordable and accessible to customers and communities that have not traditionally benefited from building technology investments, like the multi-family housing renters.

#2: Gap: Incorporate tenant protections.

CA GND noted that 46% of homes in California are occupied by renters and decarbonization efforts must include tenant protections to avoid higher rent burdens, evictions, and loss of available affordable housing.

- **Potential Role of EPIC:** Participants suggested that EPIC could help develop standards and practices on incorporating tenant protections into decarbonization programs. EPIC could also develop incentives for landlords to drive uptake without sacrificing tenant protections. CA GND suggested that EPIC could help develop approaches to prioritizing housing solutions that are permanently affordable, like community land trusts, and develop strategies to target deed-restricted affordable housing, as opposed to naturally occurring affordable housing.

#3: Gap: Provide whole-home approach in low-income retrofits.

- **Potential Role of EPIC:** Participants suggested that decarbonization and retrofit projects in low-income neighborhoods must be performed in a whole-home approach, with the decarbonization technologies paired with remediations for home safety, energy efficiency, and renewable energy supply. This can reduce the costs of implementation and provide wholistic customer benefits, including energy savings, health, safety, and overall wellbeing.

#4: Gap: Community involvement in hydrogen discussions.

Participants noted concern that a commercial use of hydrogen has a potential to increase infrastructure investments, placing financial burdens on low-income ratepayers while also extending the life of the fossil fuel resources that pollute disadvantaged and ESJ communities. Most vulnerable communities are excluded from the discussions and decision-making process on hydrogen adoption.

- **Potential Role of EPIC:** CBE stressed a need for processes to ensure community participation in hydrogen decision making that allows for community self-determination and protection from perpetuation of “sacrifice zones” in disadvantaged communities that historically hosted gas and fossil infrastructure. There should also be just workforce transition to ensure that jobs are available to the community members and not just outsiders.

Process Recommendations

#1: State and Federal research funding coordination.

Participants suggested coordinating EPIC programs with available federal funding to supplement EPIC funded research and commercialization efforts. EPIC could look for federal funding opportunities to coordinate with EPIC resources to support commercialization, particularly within market-driven federal programs that are more open ended and can support projects in state-identified priority areas.

- **Aim for matching funds and open-ended programs:** SBA noted that federal agencies will typically give a lot of weight to the state's identified priority areas, particularly if supported by matching state funding. As an example, some of the U.S. SBA America's SeedFund programs support small innovative manufacturing and market facilitation in various areas, including cybersecurity, climate science, and clean energy. Typically, SBA's market-driven programs look to invest in technologies to solve problems through commercial marketplace across multiple federal agencies, including the US Department of Energy, US Department of Agriculture, and the US Environmental Protection Agency. These programs are usually more open-ended, without any specific targeted technology, and rely on the applicants to prove how their technology fits into each federal agency's profile and strategic goals.
- **Aim for comparable commercialization timeline**: SBA presenter noted that a US Department of Agriculture survey showed that companies that were successful in commercialization took an average of five years from Phase I award, which is a proof-of-concept stage, to commercialization, and about three years from Phase I to Phase II, which is focused on technology development. The U.S. SBA presenter noted that majority of programs set aside dedicated funding for the Phase I winners to support their future development and these funds are typically available for five years, even if the project was originally market for 1 year funding, before being de-obligated and sent back to the Department of Treasury.

V. APPENDICES

Video Recordings:

Workshop video **Part 1**
Workshop video **Part 2**

Agenda: PDF

Presentations:

Opening remarks: Commissioner Genevieve Shiroma, California Public Utilities Commission (no slides)
Andrew Barbeau, EPIC Policy + Innovation Coordination Group Project Coordinator (no slides)

Roundtable: Customer Focused Solutions.

Elden Hawkes Jr., SBA Office of Innovation and Technology - Presentation Link
Ethan Elkind, UC Berkeley - Presentation Link
Michael Colvin, Environmental Defense Fund (no slides)
Carmen Best, Recurve (no slides)
Joe Desmond, CA Efficiency + Demand Management Council (no slides)
Jared Langevin, Lawrence Berkeley National Laboratory - Presentation Link
Brett Webster, RMI - Presentation Link

Roundtable: Building Decarbonization, Electrification, and the Coordinated Role of Gas

Beckie Menten, Building Decarbonization Coalition (no slides)
Zach Lou, California Green New Deal Coalition - Presentation Link
Andrew Brooks, Association for Energy Affordability (no slides)
Jacques de Chalendar, Stanford - Presentation Link
Kelly Lyndon, San Diego 350 Climate Action – Presentation Link
Daniel Hamilton, City of Oakland - Presentation Link
Theo Caretto, Communities for a Better Environment - Presentation Link
Peter Chen, California Energy Commission - Presentation Link
Mark Toney, The Utility Reform Network (no slides)

EPIC Strategic Goals

New and Emerging Strategies

Workshop

Report

EPIC POLICY + INNOVATION
COORDINATION GROUP

November 2023

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 20, 2023, the CPUC hosted the EPIC Strategic Goals New and Emerging Strategies Workshop, which focused on a selection of critical pathways and topic areas identified in the Kick-Off Workshop, including Offshore Wind, Geothermal, Green Hydrogen, Biomass, Carbon Sequestration and Role of Artificial Intelligence (AI).

Ninety-seven stakeholders participated in the workshop. Within the critical pathways for emerging strategies, participants highlighted the following key gaps and opportunities for EPIC research: developing strategies and equity guideposts for wind and solar supplements to reach the last 10% of the 100% carbon free grid; developing strategies and targets for CO_2 removal; developing California targets for offshore wind, geothermal and renewable hydrogen technologies; performing resource availability studies, particularly for geothermal resources; performing demonstrations and testing and streamlining permitting for geothermal, offshore wind, geothermal, renewable hydrogen, biomass and AI integration; funding cost reduction research in California specific areas and areas not funded elsewhere that have high cost reduction potential, like geothermal exploration and drilling efficiency; identifying best uses for green hydrogen and understanding hydrogen leakage and local pollution impacts and mitigation; and studying impacts of all of these technologies on Environmental and Social Justice (ESJ) communities and developing guideposts and filters to avoid projects that harm them.

[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 Workshop was hosted on September 20, 2023, from 1 pm – 4:45 pm and consisted of two roundtables. The stakeholder discussions following each roundtable welcomed questions and comments from the audience in the room and participants connected virtually. CPUC Commissioner Genevieve Shiroma provided opening and closing remarks. 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 workshop participants and outlined workshop goals. The Commissioner noted that she is looking forward to hearing from the participants on the range of strategies for the net zero future and how EPIC can ensure benefits to disadvantaged, tribal and low-income communities. The Commissioner reminded participants that their comments along with the CPUC Staff proposal will contribute to a proposed CPUC decision on establishing EPIC research goals

and strategies. Commissioner Shiroma noted the importance of looking at local air pollution and developing guideposts discussed by presenters to ensure that no harmful projects are funded. Commissioner Shiroma also asked presenters to supply more details on the referenced research projects that fund combustion technologies and invited CEJA to submit source information for closer consideration. The Commissioner also asked about fuel cell technology and how it should be considered, if at all. The Commissioner thanked speakers for sharing their expertise, as well as Commissioner John Reynolds, CPUC Administrative Law Judges, CPUC Legal Staff, and CPUC Energy Division Staff who have been working on these proceedings and workshop series to ensure that EPIC funding achieves California goals and benefits disadvantaged, low-income and tribal communities.

Roundtables: The two roundtables focused on the following:

I. Strategies for a Net Zero Future (1)

Presenters:

- Brian Sergi, National Renewable Energy Laboratory (NREL)
- Sarah Baker, Lawrence Livermore National Laboratory (LLNL)
- Jill Haizlip, Geologica Geothermal Group (GGG)
- Alexis Sutterman, California Environmental Justice Alliance (CEJA)
- Tim Yoder, Pacific Northwest National Laboratory (PNNL)

During the roundtable, NREL shared findings from recent studies[2] on achieving the last 10% of a 100% carbon free grid and listed data gaps and research needs to identify the most effective and cost-beneficial solutions for California. LLNL discussed its recent study "Getting to Neutral"[3] that looks at a portfolio of approaches to carbon removal to reach California's carbon free energy goals and highlighted that biomass gasification through thermo-chemical conversion into hydrogen, paired with carbon storage, was identified as a viable technology for California. GGG discussed California's research needs for geothermal technologies, noting California's potential and current use of geothermal energy. GGG explained that the two current uses for geothermal resources are electricity generation, measured as MegaWatt-electric (or MWe) or heating, measured as MegaWatt-thermal (or MWth). CEJA

[2] NREL, On the Road to 100% Clean Electricity: Six Potential Strategies to Break Through Last Few Percent, September 09, 2022. https://www.cell.com/action/showPdf?pii=S2542-4351%2822%2900405-6

[3] LLNL, Getting to Neutral: Options for Negative Carbon Emissions in California, January 30, 2020. https://livermorelabfoundation.org/2019/12/19/getting-to-neutral/

outlined environmental justice concerns with new and emerging technologies, noting that CEJA views the energy transition as a way to also redistribute power and benefits among the communities historically affected by fossil fuel generation. CEJA highlighted equity considerations for EPIC to consider in the EPIC funded projects, in particular prioritizing the most vulnerable communities and ensuring that ESJ communities benefit from, and are not harmed by, the clean energy transition. PNNL discussed the role of artificial intelligence (AI) in the energy transition and noted various areas where AI is applied today, including modeling and forecasting, distributed energy resources (DERs) and load flexibility integration, and affordability solutions. During the stakeholder discussions after the presentations, participants discussed potential targets and timelines for innovation and EPIC's role in advancing discussed technologies and strategies. Participants also discussed equity safeguards, incentives, and concerns related to these technologies. One of the questions from the audience was on the availability of wave energy analysis and its potential for California. CPUC Staff Fredric Beck answered the question noting work conducted by the United States Department of Energy (US DOE), including resource maps and wildlife impacts, and pointed to the DOE website for further information.

II. Strategies for a Net Zero Future (2)

Presenters:

- Kori Groenveld, National Offshore Wind Research & Development Consortium (NOWRDC)
- Walter Musial, NREL
- Jeffrey Reed, University of California, Irvine (UCI)
- Woody Hastings, The Climate Center (TCC)
- Ari Eisenstadt, California Environmental Justice Alliance (CEJA)

During the roundtable, NOWRDC and NREL discussed key RD&D needs for offshore wind technology, particularly floating structures, including the modeling, engineering, environmental sustainability, and infrastructure research gaps. NOWRDC noted that among seven research areas it funds, the two major areas are floating offshore wind and transmission and grid stability. NOWRDC research goals are established in its Research and Development Roadmaps that NOWRDC develops every three years —the last one published

in 2023.[4] NOWRDC noted that it is working with the California Energy Commission (CEC) on the California/NOWRDC offshore wind initiative in which the CEC approved $5 million for competitive solicitation in the spring and summer of 2024 to fund RD&D projects. NOWRDC noted that they are now in the process of identifying research priorities through a stakeholder process and invited anyone interested to provide feedback into that process. NREL discussed its modeling of offshore wind costs, performance, and weather forecasts, and noted several data gaps that need to be filled to adjust this modeling to California-specific needs, particularly in weather predictions. UCI shared findings from the 2020 Renewable Hydrogen Roadmap for California,[5] a report developed for the CEC. UCI discussed the potential portfolio of hydrogen technologies viable to produce renewable hydrogen for California. TCC highlighted a need for a formal definition of "green hydrogen" and discussed the role of state funded RD&D for this technology. TCC noted that the first solar hydrogen demonstration project took place in 1995 under the White House Technology Reinvestment grant, which included a 40kW solar array electrolyzing water on site to produce hydrogen for utility pickup trucks at the Xerox El Segundo campus. This project was part of a program to convert WWII technologies for civil use since the project used nuclear submarine electrolyzers. CEJA discussed equity considerations in the clean energy transition, noting that EPIC should consider a full suite of pollutants that affect ESJ communities in its decarbonization programs. CEJA raised concern over using hydrogen combustion and Carbon Capture and Storage (CCS) or Carbon Capture, Utilization, and Storage (CCUS) to extend the life of fossil fuel technologies in contradiction with California climate goals. Instead, CEJA recommends a focus on proven technologies that benefit ESJ communities, such as demand response, energy efficiency, and DER. CEJA stressed the need to develop filters for harmful projects, like hydrogen combustion, CCS, or dairy digesters. In the stakeholder discussion after the presentations, participants discussed potential targets for hydrogen and offshore wind and EPIC's role in cost reduction research. Many participants noted that EPIC research should not duplicate federal- and private- funded research efforts or focus on areas where cost savings can come from market scale up and process

[4] NOWRDC, Research and Development Roadmap 4.0, April 2023, available at https://nationaloffshorewind.org/wp-content/uploads/NOWRDC-Research-Development-Roadmap-4.0.pdf

[5] UCI, Roadmap for the Deployment and Buildout of Renewable Hydrogen Production Plants in California, Final Project Report prepared for the California Energy Commission, Clean Transportation Program, June 2020, available at http://www.nfcrc.uci.edu/PDF_White_Papers/Roadmap_Renewable_Hydrogen_Production-UCI_APEP-CEC.pdf

automation. Instead, participants recommended focusing on gaps that remain unfunded that can drive down costs. Participants also suggested EPIC could help identify best uses for hydrogen in hard-to-electrify industries or in the "best fit for least cost" scenarios. Participants also discussed the potential role of fuel cell research, in response to a question posed by Commissioner Shiroma, noting the potential use of fuel cells to provide peak load support and displace diesel backup generators, if green electrolytic hydrogen is adopted. Participants further discussed specific needs and a possible EPIC role in hydrogen leak detection, clarifying that the focus should be on hydrogen-designated pipelines, rather than hydrogen-gas blending in the gas pipeline infrastructure, that many participants oppose.

Presentations

The link to each presentation is included in the Appendices to this report.

Attendees

Ninety-seven individuals participated in the workshop, virtually and in person, including CPUC Commissioner Genevieve Shiroma and CPUC Staff, representatives from the EPIC Program Administrators (California Energy Commission (CEC), 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 highlighted the following key areas of consensus among workshop participants:

Critical Pathways:

The discussions focused on the main pathways of Emerging Strategies, identified in the previous workshops: Offshore Wind, Green Hydrogen, Geothermal, Biomass, Carbon Capture and Storage and Artificial Intelligence (AI). The two new potential pathways discussed were Wave Energy and Fuel Cells. No recommendations were

made by the participants on Wave Energy. On Fuel Cells, CEJA noted that if California adopts a green hydrogen solution, fuel cells may play a role to displace diesel backup generators and provide peaking load but stressed that only green hydrogen —not combustion or biogas as a feedstock — should be considered in any scenarios. Many equity considerations were raised generally and related to specific pathways that are addressed below.

Key Gaps:

Overall, the participants agreed that California needs to map out key technologies to prioritize reaching its climate goals by 2045, including options to decarbonize the last 10% of the grid, and remove CO_2 from the atmosphere. Offshore wind and geothermal resources overall appear to have general support from workshop participants and no opposition was raised during the workshop, particularly with respect to research data and modeling gaps and research needs. The participants overall also agree on the potential value of green hydrogen for hard-to-electrify industries. Participants' general area of disagreement was the use of CCS technologies and hydrogen. Most advocacy groups, including CEJA and TCC, oppose the use of CCS as well as any hydrogen, other than green hydrogen produced through electrolysis from renewable energy resources, and oppose any technology that involves combustion, biogas and biodigesters. They also urged narrowing the use of green hydrogen to limited industries that are hard to electrify. Research institutions and groups, including LLNL, UCI, and NREL, noted the value of CCS, direct air capture and various hydrogen technologies, with proper controls, to achieve the necessary scale of decarbonization to reach California's climate goals. LLNL noted that renewable hydrogen produced from biomass and biogas that does not involve combustion could be considered carbon and air pollution neutral or even negative, as it uses basically no electricity from the grid, prevents flaring, and removes carbon and other pollutants from the atmosphere by capturing biomass and biogas carbon and other air pollutants that would otherwise be released into the atmosphere. Participants raised no specific objections or concerns with respect to the utilization of the AI, except for the potential carbon footprint and cybersecurity concerns. The PNNL presenter noted that these concerns may be removed in the future with the decarbonization of the grid and more cybersecurity research.

Unique Role of EPIC:

Participants agreed overall that, as a ratepayer funded resource, EPIC is best suited to fund research on the following: 1) developing strategies to supplement wind and solar to get the last 10% of the CO_2 off the grid to reach 100% clean energy goal; 2) evaluating resource availability, particularly for geothermal and offshore wind, and

mapping out biomass availability for renewable hydrogen that does not involve combustion; 3) streamlining permitting processes for geothermal, biomass and other technologies, particularly on the environmental impact assessment requirements and coordination; 4) funding technology gaps research that has high cost reduction potential that is not funded elsewhere; and 5) performing system analytic and review based studies.

Desired Outcomes and Quantitative Targets:

Participants identified opportunities for the following quantifiable targets:

- **Renewables.** A certain capacity (X MW) of wind and solar installed by 2045;
- **Geothermal.** A certain capacity (X Gwe and Y GWth) of geothermal electricity and heating installed by 2045;
- **Hydrogen.** 4 billion kg of renewable hydrogen produced by 2050;
- **Reducing the Cost of Green Hydrogen.** $3/kg cost of green hydrogen by early 2030s without subsidies;
- **CO_2.** 125 mil metric tons of removed CO_2 per year by 2045 and/or a certain quantity of removed CO_2 per year from Biomass Gasification and/or Biogas Carbon Capture and Storage by 2045.

Participants, however, disagreed on whether hydrogen and biomass related technologies should be considered carbon free and suitable for EPIC funding without particular safeguards in place to prevent negative impacts on ESJ communities.

Desired Outcomes and Targets

Specific suggestions of the potential targets for EPIC research suggested during this workshop included the following:

#1: Target: Wind and Solar.

- **X MW of wind and solar by 2045**: NREL's recently published study "Getting to 100%: Six Strategies for the Last 10%"[6] shows that accelerating wind and solar generation deployment can result in high levels of decarbonization at relatively low costs. Yet

[6] NREL, On the Road to 100% Clean Electricity: Six Potential Strategies to Break Through Last Few Percent, September 09, 2022, available at https://www.cell.com/action/showPdf?pii=S2542-4351%2822%2900405-6

NREL acknowledges that removing the last portion of carbon on the grid is more challenging because the seasonality of these resources does not always align with the grid load and relying on a 100% weather dependent system can pose many risks and challenges.

#2: Target: Geothermal.

- **X GWe geothermal electricity and X GWth of geothermal heating installed by 2045:** GGG notes that the US DOE 2019 GeoVision Study[7] indicates that, with current technology, the U.S. has the potential to increase use of geothermal power by 26 times to achieve 60 GW of geothermal power generation by 2050. In 2023 US DOE updated its projections to 90 GW by 2050.[8] GGG noted that, currently, U.S. geothermal installed capacity is at 3,800 MWe, 71% of which is operating in California, totaling 2,800 MWe. California also has more than 25% of the world's geothermal capacity, and about 50 years of extensive geothermal experience and expertise in exploration, field development, and operation of a variety of geothermal systems. GGG also noted that there is great potential for increasing the amount of geothermal electricity in California, since approximately 6% of California power already comes from geothermal energy (this is larger than in any other country). However, GGG believes that approximately 40% of California geothermal resources are yet to be identified. GGG also noted that it takes about 7-18 years to permit a new geothermal project; therefore, to get to necessary scale, deployment needs to start as soon as possible.

#3: Target: Renewable and Green Hydrogen.

- **4 billion kg of renewable hydrogen by 2050:** UCI noted that the Renewable Hydrogen Roadmap for California[9] estimates the renewable hydrogen demand by 2050 to reach about 4 billion kg statewide and can come from the two technologies

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[7] US DOE Geothermal Technologies Office, GeoVision: Harnessing the Heat Beneath Our Feet (2019), available at https://www.energy.gov/sites/default/files/2019/06/f63/GeoVision-full-report-opt.pdf

[8] US DOE NREL, Enhanced Geothermal Shot Analysis, January 2023, available at https://www.energy.gov/eere/articles/doe-analysis-highlights-opportunities-expand-clean-affordable-geothermal-power

[9] UCI, Roadmap for the Deployment and Buildout of Renewable Hydrogen Production Plants in California, Final Project Report prepared for the California Energy Commission, Clean Transportation Program, June 2020, available at http://www.nfcrc.uci.edu/PDF_White_Papers/Roadmap_Renewable_Hydrogen_Production-UCI_APEP-CEC.pdf

identified as most viable for California: thermochemical conversion from biomass and electrolysis from renewable energy.

- **$3/kg cost of green hydrogen by early 2030's:** UCI noted that the US DOE's Hydrogen Shot[10] program aims to reduce costs of hydrogen production to $1/kg by 2030. UCI notes that this goal is very ambitious, and a $2/kg cost is more realistic. UCI notes that, judging from the current deployment economics in different sectors, by the 2030s, economic adoption can be achieved without subsidies at $3/kg cost, and $2/kg for industrial hydrogen. UCI noted that the base case forecast for green hydrogen from electrolysis is below $15 per Giga Joule (GJ) by the early 2030s and below $15 per GJ by the mid-2030s for bio hydrogen.

#4: Target: Biomass.

- **125 MT of removed CO_2 per year by 2045:** LLNL states that its studies indicate that 125 million metric tons (Mt or MT) of CO_2 removal per year is needed to achieve California's 2045 zero emissions goals. According to an LLNL study, this goal can be reached by a combination of technologies that average at $60 per ton.
- **X MT removed CO_2 per year from Biomass Gasification and/or Biogas Carbon Capture and Storage by 2045:** LLNL recommended that EPIC should set goals for deployment rate of these technologies to help achieve California's decarbonization goals. LLNL states its research shows that Gasification of Waste to fuel, like hydrogen, paired with CO_2 storage and Biogas CO_2 Capture at Dairy, Landfill and Wastewater Treatment facilities paired with storage are shown to be the impactful solutions that can provide significant CO_2 removal at the lowest costs. LLNL estimates that these technologies can deliver about 84 Mt of carbon removal per year at $29-$64 per ton. However, LLNL notes that to achieve the 125 Mt per year, these technologies will have to be supplemented with about 16 Mt of CO_2 removal from Direct Air Capture, at $193-198 per ton, and about 25 Mt of CO_2 removal from natural and land CO_2 absorption, at about $11 per ton.

[10] US DOE NREL, Enhanced Geothermal Shot Analysis, January 2023, available at https://www.energy.gov/eere/articles/doe-analysis-highlights-opportunities-expand-clean-affordable-geothermal-power

Unique Role of EPIC

This workshop included specific additional discussion on the unique role of EPIC in addressing gaps in pathways. Many participants agreed that, overall, these are the key areas where EPIC has a unique role to play:

#1: Role: Strategies and Equity Guideposts for getting to 100% carbon free grid.

NREL suggested that EPIC can help develop strategies to supplement wind and solar generation to get to 100% carbon free grid. The NREL study "Getting to 100%: Six Strategies for the Last 10%"[11] noted that most of grid decarbonization can be achieved through wind and solar generation but the last portion needs to be supplemented by other resources to ensure reliability and less dependence on seasonality of the wind and solar resources. NREL studied the following six scenarios: 1) adding more wind and solar and energy storage; 2) adding other renewable resources, like biomass, geothermal, and hydrogen resources; 3) adding nuclear and fossil fuel resources with carbon capture; 4) adding seasonal storage, like hydrogen; 5) adding CO_2 removal with direct air capture and bioenergy + carbon capture and storage (BECCS); and 6) adding demand side resources. NREL suggested that EPIC research of these scenarios and other scenarios of supplementing wind and solar generation can help fill the data gaps on costs savings and costs certainty potential of each scenario, demand response constraints and reliability, and other factors, to help inform grid and resource planning. CEJA noted that EPIC needs more guideposts to ensure that the solutions deployed to get to 100% clean energy, particularly in decarbonizing the last 10%, do not negatively impact ESJ communities. CEJA notes that it would be helpful to know what the suite of options are for California to be able to create a matrix to analyze these options and create filters, beyond cost effectiveness, that consider social value impacts to communities. For example, when looking at the wind/solar + storage option discussed by NREL, CEJA noted that it would advocate for prioritizing DERs first and looking for ways to optimize and site DERs to provide the greatest value, before deploying these larger scale solutions. CEJA asserts this would minimize land use and deliver more local community benefits. LLNL noted that an example of considering equity is the reporting practice that US DOE is beginning to

[11] NREL, On the Road to 100% Clean Electricity: Six Potential Strategies to Break Through Last Few Percent, September 09, 2022, available at https://www.cell.com/action/showPdf?pii=S2542-4351%2822%2900405-6

implement in carbon removal projects. This practice requires community feedback on the information, measurements, and reporting verification that the community wants to see. GGG also noted that having general guideposts for all projects will help to measure and evaluate projects and can also help expedite permitting (particularly for geothermal projects).

#2: Role: Resource availability studies.

GGG noted that it is important for California and EPIC, as ratepayer funded program, to evaluate and map out available resources, particularly the geothermal and biomass resources, because California can benefit from utilizing the potential of these resources and technology. Surveying available resources and developing priority or ranking for these resources can help to reduce costs of exploration and sourcing and help to reach the needed scale.

#3: Role: Demonstrations and testing.

Most participants, particularly the research institutions (LLNL, PNNL, UCI, NREL, and GGG) agree that EPIC can play a key role in demonstrations and testing to help bring research from the labs to the market as quickly as possible. Demonstrations could help build trust and show value proposition, identify gaps, and provide a roadmap for others in deploying these technologies. Demonstrations could also improve technology understanding among stakeholders and generate support for these technologies which will streamline their permitting process.

#4: Role: Streamlining permitting processes.

GGG noted that EPIC could play a key role in streamlining the permitting process for many resources, including green hydrogen, biomass, and geothermal energy. GGG suggested that EPIC could help with coordination and collaboration between different agencies in the Environmental Impact Review (EIR) and Studies (EIS) processes. GGG noted that National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) requirements often overlap, and EPIC could help coordinate and identify who the lead agencies are and provide clarity on those requirements for geothermal projects. NEPA and CEQA reviews are noted as typical areas that significantly complicate and delay permitting process. GGG noted that geothermal projects take, on average, approximately 7 years to get through the permitting process if there are no complications, and about 18 years if a more complex NEPA/CEQA process is required. LLNL also noted that it can take 35 years to get from the lab demonstrations to production for biomass and hydrogen projects. Participants agreed that EPIC's support with collaboration and demonstrations could improve public

awareness and greatly reduce permitting delays by improving understanding of the green hydrogen, geothermal, and biomass energy technologies among key stakeholders.

#5: Role: Funding unfunded or California-specific research gaps.

Many participants agreed that EPIC funding should not be used for research that is duplicative of federally and privately funded research. For example, participants noted that research on hydrogen cost reduction may not be an efficient use of ratepayer funds, because a majority of cost reductions will come from federal and private research and the scaling up and automation of the hydrogen market. Instead, NOWRDC and NREL suggested that EPIC could identify remaining gaps that can drive costs down but are not funded elsewhere, or research California-centric issues and define California targets for different resources, such as offshore wind.

#6: Role: System analytic and review studies.

UCI recommended that EPIC fund system analytic- and review-based studies such as NOx emission impacts of hydrogen blending in turbines and other debated areas of hydrogen production. These areas could benefit from neutral and properly charted research.

Key Gaps

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

Offshore Wind

NOWRDC noted that RD&D has the potential to advance technoeconomic solutions to engineering, environmental and policy challenges. NOWRDC runs competitive solicitations to fund projects that can respond to those challenges. NOWRDC research has a design feedback process that incorporates industry input and guidance along the entire project development process, from fundamental science to deployment, to ensure that solutions are useful to the industry and deployable in the future. RD&D in offshore wind is focused on solutions that are safer, higher performing, lower cost, and have the potential to accelerate project development timelines. RD&D near term impacts, including narrowing down viable technology offerings, often result in standardization of manufacturing and development practices that yield cost savings inherent in economies of scale.

#1: Gap: Floating offshore wind research needs.

NOWRDC noted that RD&D needs for offshore wind, particularly for floating offshore wind technology, are focused in three main categories: 1) floating platform engineering; 2) environmental sustainability and ocean co-use; and 3) infrastructure and supply chain. NOWRDC noted that floating offshore wind borrows a lot of technology solutions from oil and gas exploration. NOWRDC asserts that this technology needs to be adjusted for offshore wind, which has more dynamic loads, is more spread-out and has smaller units, requiring more efficient and cost-effective design.

- **Potential Role of EPIC:** NOWRDC listed a number of RD&D needs for floating offshore wind technology, highlighting the following:
    - Design and engineering:
        - Testing four main floating platform technologies available today to identify the most cost-efficient approach that is best fit for California.
        - Designing California-specific solutions that mitigate extreme earthquake loads.
    - Environmental stability and ocean co-use:
        - Developing solutions that lower impact on offshore environment and other ocean users.
    - Infrastructure and supply chain:
        - Since California infrastructure requires a lot of traditional infrastructure, RD&D can help identify alternative infrastructure upgrade designs that are higher performing, cost effective, and built for California-specific floating offshore wind needs.
    - Transmission:
        - Optimizing performance to reduce transmission needs, by designing higher performing and lower cost profiles- for example higher capacity dynamic power cables or shared landfall design - to have more efficient onshore land redevelopment and avoid having radio transmission connection in every project.

#2: Gap: Offshore wind modeling needs.

NREL noted that its offshore wind modeling research is currently focusing on cost modeling tools, wind and waves modeling, single turbine and full -pant performance and loads, mooring systems, and grid integration and reliability, and noted gaps in these areas where additional research is needed.

- **Potential Role of EPIC:** NREL highlighted the following data and research gaps that can feed into improved modeling for offshore wind:
    - Cost modeling: On the cost modeling side, NREL is developing models to evaluate actual cost of energy for the whole system and future cost predictions. NREL is doing this by looking into individual turbines, plant level and project lifecycle, analyzing various cost data sets from the industry, and bottom-up estimates of material, labor, and other costs. NREL suggested that further research is needed on higher resolution of temporal scale of cost reduction, to answer questions such as: What costs are going to be like in 2030, including for different components? What are the tradeoffs between cost reduction opportunities in turbine standardization, upscaling and mass production versus the costs of new infrastructure needed to support these new turbines? NREL noted that further research is needed to extrapolate these data inputs for the full-scale floating wind plants, that currently have not matured beyond pilot stage.
    - Weather Research and Forecasting (WRF): NREL uses WRF model for wind and extreme weather modeling with California CA20 dataset, that has best validations available in 2020, including California ocean surface buoys, four coastal radars and three floating lidars in the Mid-Atlantic. NREL notes, however, that there are not enough datapoints for validation. For example, the standard setup used on the East Coast and Hawaii doesn't work for California. To trust these models, more research is needed to understand the physics causing the California wind bias in WRF. Further data and research are also needed to better understand the physics and the coupled wind/wave models as well as extreme weather events.
    - Multi-Fidelity Performance and Loads Models: NREL tests technology through two levels (individual turbine and full-plant level) and multi-fidelity modeling (with low to high fidelity scenarios). NREL uses the open-source tool OpenFAST, which has been tested over time, and NREL trusts and finds accurate, as a primary engineering tool to develop 80% of full-scale floating wind prototypes. NREL notes that further research is needed into the accurate behavior of floating systems and deeper water and steep slope mooring.
    - NREL noted that validation of the modeling results with field data is needed in all areas.

- NREL noted that grid modeling and capacity expansion tools also need more research, particularly with the congestion issues in California. Currently, the best resources are on the North Coast and are stranded right now. More research could go into delivering these resources to load centers in the Bay Area and potentially integrating with the interregional grid with Oregon and resources that are North of Del Norte.

Geothermal Energy

GGG noted that geothermal energy can contribute to low carbon energy generation, heating and cooling, and other direct uses of heat. It is low carbon but not carbon free. GGG notes that California has more than 25% of the world's geothermal capacity, with the two world largest known geothermal developments: steam-dominated in The Geysers, at about 800 MW, and liquid-dominated in Salton See area at about 500 MW, both trying to expand their capacity in the near future. Further, GGG stated that California has approximately 50 years of extensive geothermal experience and expertise in exploration, field development, and operation of a variety of geothermal systems. California hosts 11 operating geothermal fields ranging from less than 1 MW in Wendel/Amedee area to 820 MW in The Geysers. California also has a large research capacity in both technological and market research, due to the National Labs potential, like LLNL. GGG noted that the main challenges that prevent expedited development of this sector are: 1) location constraints, as geothermal resources need to be converted into electricity or heat at the site where it is present; 2) technological challenges —exploration is high risk and enhanced geothermal system (EGS) power conversion technologies remain unproven; 3) capital cost constraints, with high initial upfront costs due to drilling but good long-term returns; 4) permitting delays, due to varying state and local regulations and unpredictable permitting timelines.

#1: Gap: Develop detailed survey of California's geothermal resources.

GGG believes that approximately 40% of California's geothermal resources are not identified yet. GGG noted that the last review and documentation was performed in the 2000s. GGG notes that, due to advances in technology, a wider range of resources could be potentially used now.

- **Potential Role of EPIC:** GGG noted that a new and more detailed review of California's geothermal resources is needed to increase development and reduce costs of exploration and resource characterization. GGG noted that this area is important for California and EPIC research because California can benefit from utilizing the potential of this technology, and it is important to explore available resources and develop resources prioritization or ranking.

#2: Gap: Improve exploration and drilling efficiency.

GGG noted that there are many technological gaps that require more research to lower costs of geothermal energy resources. GGG stated that exploration techniques and methodologies are the biggest gaps.

- **Potential Role of EPIC:** GGG noted the need for more research to improve exploration, assessment, production, and management of geothermal resources. GGG noted that research is needed to improve techniques and methodologies of exploration, to reduce drilling costs, and to improve the currently low success of drilling. GGG noted that this technology is not ready to be deployed at scale yet and, to get to scale of producing enough MWs, research must focus on improving drilling, exploration, and validating and improving power conversion on the enhanced geothermal system (EGS) technologies. Considering that permitting takes on average 7 to 18 years, GGG notes this as an urgent need to meet 2045 goals.

#3: Gap: Identify incentives to make geothermal projects economically viable.

GGG noted that another area that needs research is in mapping out the credits and incentives that geothermal projects could use to become more economically attractive.

- **Potential Role of EPIC:** GGG suggested looking at power purchase agreements (PPAs) and credits or payments that geothermal electric generation projects can receive for the benefit they can provide to the grid. Geothermal electric generation can stabilize the grid and reduce congestion through baseload and flexible power.

Green Hydrogen

UCI introduced its report published in 2020 for CEC on the “Renewable Hydrogen Roadmap for California” (“Roadmap”), which discusses a potential portfolio of renewable hydrogen technologies and analyzes demand across various sectors, different production options, and supply chain constrains. The Roadmap analyses renewable hydrogen produced with the following key technologies:

1) electrolysis and artificial photosynthesis using renewable resources;

2) thermo-chemical conversion of biomass that either produces biomass or renewable natural gas (RNG), with the RNG then further converted into hydrogen through reformation; and

3) anaerobic digestion of biomass that produces RNG that is then reformed into hydrogen.

Carbon capture, utilization, and storage (CCUS) technologies are not included in the Roadmap scope.

UCI stated that its Roadmap analyzes both methane and hydrogen technologies and finds renewable hydrogen from electrolysis and thermo-chemical conversion to be the two primary pathways for California for renewable hydrogen, with equal share for each in the California portfolio. UCI finds that both technologies have an abundant supply potential and relatively mature technology. Anaerobic digestion only has approximately one-tenth of the resource potential of the other two technologies. The Roadmap estimates about 4 billion kg statewide renewable hydrogen demand from these two technologies by 2050. The Roadmap analyzes renewable hydrogen impacts from its point of production to its points of use, including production, processing, storage, transportation, and end use. The Roadmap further finds that many of the logistical steps have issues that need to be addressed with further research. UCI noted that while some local production options are available that eliminate many of the steps, like storage and transportation, these are limited cases as hydrogen production requires large land plots. UCI concluded that the most economically viable option for renewable hydrogen at scale to reach California's climate goals is producing hydrogen from electrolysis from wind and solar at high renewable resource availability areas, such as the desert, and transporting it to the end user. UCI stated that this approach, however, requires further research into many of the steps in hydrogen logistics to address potential issues and impacts of these steps.

#1: Key Role: Demonstration and deployment and policy and regulations.

UCI noted that EPIC can be most valuable in the field demonstration, validation, and measurement of things like leakage, California-specific techno-economic and lifecycle analysis, and system planning for optimal deployment. UCI also noted that policy and regulations are currently more critical than technology research in advancing green hydrogen technology.

#2: Key Role and Equity Consideration: Model impact of hydrogen on ESJ communities.

CEJA noted that EPIC research should not focus on developing new technologies for hydrogen combustion, but on modeling hydrogen's health impacts on ESJ communities. This includes hydrogen combustion, storage, transportation, and the full life cycle of its infrastructure.

#3: Gap: Adopt unified definition of "green hydrogen."

TCC discussed that there are multiple definitions of green hydrogen that come from different stakeholders, which integrate various requirements, like "no fossil" and "electrolytic" or "no polluting feedstocks."

- **Potential role of EPIC:** TCC suggested that the first step in green hydrogen advancement should be developing a formal and unified definition of "Green Hydrogen."

#4: Gap: Make green hydrogen production cheaper.

UCI listed key technology gaps that need further research on the hydrogen production side, including electrolyzer cost reduction opportunities. This is particularly relevant regarding the precious metals content in the catalysts that drive costs up and pose supply issues in the long-term. TCC noted that capital costs of proton exchange membrane electrolyzer system went down over 90% since 2001 according to the US DOE. Many participants agreed, however, that further cost savings may potentially come from industry automation and scaling up and the federal and private research in this field, so it may not be a good use of ratepayer funds for EPIC to fund any duplicative research.

- **Potential Role of EPIC:** TCC highlighted that a key role for ratepayer funded RD&D is to address the question of how to develop and deploy a green hydrogen economy without repeating past mistakes and avoiding negative impacts on ESJ communities and the environment.
- **Potential Role of EPIC:** TCC suggested that, since green hydrogen production is currently nearly non-existent, ratepayer funded RD&D should prioritize production, not deployment. TCC stated that RD&D can help address the problems with electrolytic hydrogen production, such as leakage, water use efficiency, energy resource shifting, and high costs. TCC asserts that research should focus on the 3 pillars of hydrogen production: 1) Electrolyzers powered by new sources of zero-emissions electricity; 2) Directly supplying produced energy into the same distribution circuit where the electrolyzers are connected; and 3) Do so at the same time when the generators are running, with hourly matching of production and supply. TCC recommended that if EPIC funds research on the deployment side, it should focus on local hydrogen production to avoid transportation costs and risks, as it is easier and cheaper to move electrons than hydrogen. EPIC could study financial and technological risks of the green hydrogen deployment scenarios where hydrogen production and end uses are co-located. TCC and CEJA argued that technologies with hydrogen combustion for electricity generation should be avoided.

#5: Gap: Identify the best use for green hydrogen.

Many participants noted that hydrogen use should be limited to hard-to-electrify areas and industries to ensure that it is not displacing more environmentally beneficial technology alternatives.

- **Potential Role of EPIC:** TCC recommended that EPIC evaluate the best potential green hydrogen end uses by narrowing down the hard-to-electrify sectors that cannot be addressed by other technologies. This research should assess social impacts, potential GHG emissions, cost, and energy efficiency of using hydrogen as compared to alternatives, such as electrification, as well as associated health, safety, environmental, and climate risks. UCI recommended utilizing the "least cost best fit" approach, including environmental impacts in the cost analysis, so that hydrogen can be considered for areas that can potentially be electrified but where the cost of electrification is too high to be viable.

#6: Gap: Better hydrogen storage and transportation opportunities.

UCI noted that geological storage and hydrogen pipelines are the key areas for research, as these solutions are most cost economical (approximately 5 times cheaper than other options, such as vehicle transportation).

- **Potential Role of EPIC:** UCI noted that one of the key and timely research areas is understanding the feasibility of underground hydrogen storage in depleted oil and gas reservoirs. UCI notes that hydrogen is most commonly stored in salt caverns, particularly on the Gulf Coast where there is significant deployment of hydrogen pipelines. UCI noted that some experts estimate that it may take approximately 15 years to gather knowledge on the oil and gas reservoir storage viability, but California climate goals call for much more expedited results and recommends that this research is elevated to the top of the timeline on the priority list.
- **Potential Role of EPIC:** UCI noted liquefaction and cryogenic technologies, particularly the efficiency and boil-off issues, as key areas for research — particularly if hydrogen is used to fuel vehicles and industry, where the potential penalty on smaller users and negative environmental impacts if anything goes wrong will be too high. UCI notes that these technologies should also be prioritized, as they could play an important role in the supply chain within the next 5 to 10 years.

#7: Gap: Understand hydrogen leakage and air pollution risks.

UCI, TCC, and other participants noted the high importance of avoiding hydrogen leakage and understanding the potential environmental impacts of hydrogen lifecycle, such as GHG and local air pollutants emission.

- **Potential Role of EPIC:** UCI stressed the importance of understanding hydrogen leakage detection and mitigation, from production to end use, to avoid global warming impacts of hydrogen emitted or leaked through the process. TCC, UCI, and other participants further clarified that the focus should be on the hydrogen designated pipelines, rather than gas pipelines that blend gas with hydrogen, since this technology has high opposition among many stakeholders. UCI asserted that leakage is one of the key areas that needs further research, but EPIC will need to identify where it could fit best to not duplicate any federal research efforts. UCI noted that the Pipeline Research Council International (PRCI) performed a hydrogen "state of the art" and "gap analysis" study and EPIC could perform a similar type of analysis from California perspective. Further, UCI stated that EPIC could also develop a survey on the available data and conduct field validations, instead of basic science research. TCC noted that leakage becomes a more crucial issue with a scaled deployment, particularly in residential areas, as more potential risks arise. TCC noted that industries that use hydrogen have deployed comprehensive detection and monitoring systems to ensure they avoid any potential disasters.
- **Potential Role of EPIC:** UCI also noted the need for further research to understand NOx impacts and reduction approaches in hydrogen combustion applications, such as industrial heat and power generation. UCI noted that current research indicates that NOx from these uses can be reduced below the current gas emission levels, but further research is required to explore this.

#8: Gap: Market facilitation.

UCI asserted the need to study market falsifications to enable successful business models of renewable hydrogen production.

- **Potential Role of EPIC:** UCI highlighted following areas that need further research:
    - Consistent policy and adequate subsidies in the launching and scaling up phases.
    - Environmental goals-based subsidies, such carbon intensity or NOx reduction.
    - Time-matching, deliverability, and additionality provisions.
    - Regulatory framework and market rules for hydrogen pipelines and hydrogen blending in the natural gas system.
    - Rates for grid delivered power to electrolyzer that reflect the cost-to-serve, including grid benefits.
    - Establish market rules allowing electrolyzer operators to procure electricity from wholesale generators.

#9: Gap: Reduce ratepayer burdens from infrastructure investments.

Many participants also highlighted the need to identify approaches to pay for green hydrogen infrastructure equitably.

- **Potential Role of EPIC:** Many participants noted that EPIC could evaluate what role green hydrogen should play in advancing an equity-centered, resilient, decentralized, democratized, and decarbonized energy grid, and what role ESJ communities should play in paying for green hydrogen infrastructure. UCI recommended that subsidies from ratepayers and taxpayers that support the launch and scaling of infrastructure be provided based on the long-term costs and benefits of the technology. UCI noted that this should also include the cost of externalities and be commensurate with subsidies provided to "similarly situated" technologies and pathways.

#10: Gap: Optimize variable resources through green hydrogen.

- **Potential Role of EPIC:** TCC recommended that EPIC research could help evaluate how green hydrogen can optimize variable resources and harness curtailed solar and wind. EPIC could help evaluate the viability of business models in harnessing curtailed power.

Biomass

LLNL's study "Getting to Neutral" shows that California needs 125 Mt of CO_2 removal per year to reach its climate goals. This LLNL study identified that biomass solutions could be the most impactful, removing the most carbon at the lowest cost. LLNL found that the two leading technologies in its study are:

1) Thermo-chemical gasification of waste, including municipal, agricultural, and forest to convert into fuels, like hydrogen, paired with biogas CO_2 storage; and

2) Capture and Storage of Biogas CO_2 from dairies, landfills and wastewater treatment facilities.

Another recent study conducted by LLNL, called "Carbon Negative by 2030,"[12] shows that California is suitable for biomass and CO_2 storage projects due to the availability of both biomass and storage resources. LLNL finds that there are approximately 58 million tons of

[12] LLNL, Carbon Negative by 2030: CO_2 Removal Options for an Early Corporate Buyer, February, 2022, available at https://www-gs.llnl.gov/content/assets/docs/energy/LLNL-MSFT-CarbonRemoval_Final_28Feb22.pdf

waste biomass available across California, including municipal, agricultural, forest, and other waste. However, supply chain and logistics, including sourcing, siting, and offtake, pose the greatest barriers for these technologies.

#1: Gap: Set biomass gasification targets for California.

LLNL asserted that thermo-chemical gasification of waste biomass, particularly municipal, agricultural, and forest waste, to produce hydrogen is one of the options that has the highest carbon removal capacity at lowest cost per ton of CO_2. LLNL considers hydrogen generation from waste biomass paired with CO_2 storage to be a leading technology for California in removing CO_2. LLNL stated that this technology can generate about 4 million tons of hydrogen a year and help California reach its hydrogen goals. However, this technology poses a logistical challenge, particularly with sourcing a stable and long-term biomass supply. LLNL finds that the high upfront costs of facilities to get to economies of scales poses high investment risks as well: these facilities process approximately 2,000-5,000 tons of biomass per day and requires approximately $500 million of capital investment, so it is important that there is a reliable long-term supply of biomass upfront that can last for 20 years to catalyze the capital investment.

- **Potential Role of EPIC:** LLNL noted that research in biomass hydrogen production is needed to identify potential cost reduction opportunities, incentives, and risk reductions in the supply chain to make this technology economically viable.
- **Potential Role of EPIC:** LLNL noted that modular deployment and large-scale demonstration are the areas that can benefit from additional research as well. While LLNL finds gasification to be a proven technology, for other feedstocks, since feedstock variability and unique biomass attributes pose some technical risks to the facilities, it finds that mid-scale demonstrations could help to identify these risks and opportunities to reduce risks of project failure due to complications from biomass attributes and variability. LLNL further finds that research on potential opportunities to deploy modular units that can scale up easier, cheaper, and requires a lower capital investment.
- **Potential Role of EPIC:** LLNL recommended that EPIC can help identify the potential deployment rates needed to reach California's climate goals as well as opportunities to reduce costs of production and incentives for the industry to invest in this technology. LLNL considers this technology to be not just carbon neutral but carbon negative as it does not draw significant grid electricity and removes CO_2 from the atmosphere. LLNL noted that EPIC can play a key role in providing demonstrations on the emissions profile and carbon removal potential

of this technology. EPIC can also help to address community concerns by demonstrating the effectiveness of pollution controls that work best.

#2: Gap: Set biogas carbon capture and storage targets for California.

LLNL identified capture and storage of biogas CO_2, particularly at dairies, landfills and wastewater treatment facilities, as a viable near-term biomass carbon removal technology to supplement biomass gasification and storage. LLNL finds that this technology does not have sourcing challenges, like biomass gasification, since biomass is already present and there is a constant supply of it at the facilities where this technology is deployed. LLNL stated that carbon capture and storage of biogas CO2 reduces the carbon intensity of the produced renewable natural gas and that this technology helps avoid flaring when the CO_2 from biogas is captured and stored underground. LLNL finds that the main barrier to implementation is the small scale: the sources of biogas are small scale, typically farm scale or treatment facility scale, but the CO_2 capture technologies are usually available on the large scale to be economical (such as a power plant level), so the biogas needs to be collected from several small sources, which poses a technical and logistical challenge.

- **Potential Role of EPIC:** LLNL asserted that research is needed to identify cost reduction opportunities and incentives for the industry. LLNL recommended that EPIC could help identify potential deployment rates for capture and storage of biogas CO_2 for California to support its climate goals and help solve the logistical and technical issues in small scale carbon capture from biogas resources.

Carbon Capture and Sequestration (CCS)

#1: Gap: Understand CCS role in low-cost solutions for 100% clean grid.

NREL suggested that EPIC can further research strategies to achieve California's goal of a 100% carbon free grid, continuing from an NREL recent study.[13]

- **Potential Role of EPIC:** NREL suggested that EPIC can perform further studies into various scenarios of how CCS, direct air capture and BECCS can be used to achieve 100% clean electricity and to identify the most effective and low-cost solutions for California.

[13] NREL, On the Road to 100% Clean Electricity: Six Potential Strategies to Break Through Last Few Percent, September 09, 2022, available at https://www.cell.com/action/showPdf?pii=S2542-4351%2822%2900405-6

#2: Gap: Direct air capture research opportunities.

LLNL finds that direct air carbon capture and storage can deliver about 16 Mt of CO_2 a year at approximately $193-$198 per ton to supplement natural and biomass-based carbon removal solutions. LLNL asserted that California has areas that provide opportunities for direct air capture and can supply jobs for the reduced fossil fuel industry. LLNL also noted that CCS demand currently exceeds the supply and the market is paying high prices, with costs varying from $1200/ton for ocean electrochemical to $112/ton for biomass, with the $550/ton average price. LLNL stated that the Boston Consulting Group estimates a global demand of about 70-230 Mt CO_2/yr in 2030-2040 with direct air capture prices estimated to be at about $230/ton in 2030 and $200/ton in 2040. LLNL noted that the direct air capture industry grew substantially in the last 2 years reaching $2 billion and is projected to reach $45 billion globally by 2045, with North America's share of the global market estimated at about 36%. LLNL stated its research shows that California can take a lead in the nation's CO_2 removal effort as it has great potential, particularly due to the agricultural, forest, and municipal waste supply and geologic storage availability.

- **Potential Role of EPIC:** LLNL noted the following research opportunities for direct air capture research include: 1) improving sorbents durability, since the costs decline with the increased sorbents lifetime; and 2) adjusting design to local and seasonal conditions, to accommodate large temperature swings in the Central Valley, since the systems operate differently at different temperatures and humidity levels. LLNL noted that EPIC can play a key role in providing demonstrations on the emissions and carbon removal potential of this technology and what controls work best to address community concerns.

#3: Equity Considerations: Identify CCS cost to society.

- **Potential Role of EPIC:** CEJA asserted that EPIC research should not focus on trying to improve CCS and CCUS capture rates, but rather on finding the appropriate metrics necessary to illustrate its true cost to society, and finding ways to ensure that CCS isn't necessary.

Artificial Intelligence (AI)

PNNL noted that AI and machine learning have been utilized in the energy industry for some time, including in DER integration, decarbonization road-mapping and impact analysis, energy efficiency, energy equity and environmental justice, forecasting and system planning, and grid reliability and resilience.

#1: Gap: Demonstrations and data analytics.

PNNL highlighted that the biggest gaps in using AI for the clean energy transition are data availability and quality to enable greater analysis and more accurate models and predictions. Trustworthiness and validation, bias, and unforeseen events, as well as data privacy and security, are the other key concerns and gaps in this sector. PNNL noted that stakeholders often call for regulations and standards, particularly related to critical infrastructure systems, as well as data privacy and security. PNNL noted that research and demonstrations are critical in the AI space, especially because technology changes rapidly. PNNL stated there is significant AI research currently being undertaken, particularly in physics models with machine learning methods to increase interpretability and transparency of different models. PNNL suggested that more research is needed to help improve modeling in grid planning.

- **Potential Role of EPIC:** PNNL asserted that more demonstrations are needed to take AI research from the labs, including national labs of ratepayer funded programs like EPIC, to the industry as quickly as possible. PNNL noted that demonstrations are also needed to build trust and demonstrate value propositions, identify gaps, and provide a roadmap for others to deploy AI technologies. PNNL noted that one of the roles EPIC can play in this area is providing demonstrations on how to apply available AI tools to the areas important to California and on how to use AI to manage and analyze large data sets. PNNL confirmed, in reply to the CPUC Staff' question, that cybersecurity and carbon footprint of AI technology are potential concerns but noted that a lot of research is under way on cybersecurity measures.

#2: Gap: Applying AI to track impacts on ESJ communities.

- **Potential Role of EPIC:** PNNL asserted that AI can be applied effectively in affordability analyses to support equity impact assessment and inform regulatory decisions. PNNL noted an example of a project at PNNL that applies AI to enable a framework that evaluates equity. The project identified inconsistent tracking for ESJ communities, with only snapshots of information of census years. PNNL stated its project is building a framework to connect the timelines between these snapshots and fill the information gaps with stakeholder feedback and research. This will enable PNNL to track the evolution of these ESJ communities and impacts on them over the long term.

Equity Considerations

#1: Gap: Improve participation of ESJ communities in project selection.

CEJA noted concern over the track record of EPIC funds going towards harmful combustion-based projects in ESJ communities with very little benefit to those communities.

- **Potential Role of EPIC:** CEJA recommended creating a more transparent and community-driven process for project selection. Particularly, involving ESJ stakeholders early in the project selection process.

#2: Gap: Improve ESJ communities' access to green economy.

CEJA asserted that more investment is needed to improve access to green economy solutions in ESJ communities, as these communities face greater and different barriers and burdens.

- **Potential Role of EPIC:** CEJA recommended that EPIC develop strategies on how to bring the benefits of and improve access to the green economy solutions, such as community solar and storage, resilience centers, demand response, energy efficiency, and DERs. CEJA notes that these solutions should be designed around community-specific barriers. CEJA also recommended that EPIC consider innovations that will help ESJ households participate in demand-side programs and to account for the typical constraints in those communities, such as poor internet access, limited ability to shift load, and limited availability of smart technologies. EPIC should also consider affordability, such as how ESJ communities are protected from increased bills. Overall, EPIC should consider what benefits of the energy transition ESJ communities should receive.
- **Potential Role of EPIC:** CEJA recommended that EPIC develop a holistic approach to delivering benefits to ESJ communities, including healthy homes, community resilience hubs, community based renewable generation and energy storage, demand flexibility, energy efficiency. CEJA recommended that EPIC could help develop more community resilience centers, microgrids, and solar + storage projects for ESJ communities to increase community resiliency. CEJA noted that EPIC should think about where to site resiliency projects so that they reach the most vulnerable communities that are the most impacted by extreme weather events.

#3: Gap: Prioritizing the most vulnerable communities.

- **Potential Role of EPIC:** CEJA recommended implementing a targeted investment approach in ESJ communities by prioritizing investments for communities with the least resources and who are most vulnerable to impacts of climate change. CEJA

recommended retiring fossil fuel infrastructure and providing backup generation in areas with high levels of air pollution to improve local air quality.

#4: Gap: Prioritize clean energy investment to retire gas.

CEJA noted that hydrogen combustion and CCS have potential to harm ESJ communities given the existing location of gas plants and that EPIC funding to support such technologies is inappropriate and could have negative impacts on these communities.

- **Potential Role of EPIC:** CEJA noted that over $3 billion investment can be more meaningfully be used to advance locationally targeted, clean, distributed solutions to meet reliability, while benefiting ESJ communities.

#5: Gap: Develop filters to avoid harmful projects.

CEJA raised a concern that EPIC continues to fund combustion research projects in ESJ communities, noting that of the $43 million in EPIC funding allocated to combustion projects, $41 million funded projects located in ESJ communities, primarily focused on dairy digester gas. Commissioner Shiroma asked CEJA to supply more details on these referred projects and invited them to submit source information for further consideration.

- **Potential Role of EPIC:** CEJA recommended EPIC take stock of how much funding went towards benefiting ESJ communities and create a filter for “bad projects” that perpetuate more harm to the ESJ communities. CEJA suggested that harmful projects, such as hydrogen combustion, CCS, and dairy digesters, can be avoided by using appropriate filters, such as the White House Justice 40 Guide. CEJA recommended that sufficient filters, paired with strong social cost-benefit accounting, can help identify beneficial projects and prevent harmful projects. CEJA also stressed that EPIC funding should not be used for combustion projects, particularly in the ESJ communities, or any projects that increase or maintain criteria pollutants emissions and GHG emissions in ESJ communities. CEJA argued that EPIC must measure the full spectrum of impacts of new technologies, such as hydrogen and CCS, and quantify the harms; this can inform future project selection.

V. APPENDICES

Video Recordings:

Workshop video recording

Agenda: PDF

Presentations:

Opening remarks: Commissioner Genevieve Shiroma, California Public Utilities Commission (no slides)
Andrew Barbeau, EPIC Policy + Innovation Coordination Group Project Coordinator (no slides)

Roundtable: Strategies for a Net Zero Future (1):

Brian Sergi, National Renewable Energy Laboratory - Presentation Link

Sarah Baker, Lawrence Livermore National Laboratory - Presentation Link

Jill Haizlip, Geologica Geothermal Group - Presentation Link

Alexis Sutterman, California Environmental Justice Alliance - Presentation Link

Tim Yoder, Pacific Northwest National Laboratory - Presentation Link

Roundtable: Strategies for a Net Zero Future (2):

Kori Groenveld, National Offshore Wind Research & Development Consortium - Presentation Link

Walter Musial, National Renewable Energy Laboratory - Presentation Link

Jeffrey Reed, UC Irvine - Presentation Link

Woody Hastings, The Climate Center - Presentation Link

Ari Eisenstadt, California Environmental Justice Alliance - Presentation Link

(End of Attachment B)