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ENERGY RESEARCH AND DEVELOPMENT DIVISION

Staff Report

Gas Research and Development Program

Proposed Budget Plan for Fiscal Year 2024–2025

July 2025 | CEC-500-2024-024

California Energy Commission

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PREFACE

The California Energy Commission's (CEC) Energy Research and Development Division invests in cutting-edge research to support California's energy and greenhouse gas (GHG) reduction goals, such as innovations to advance energy efficiency, renewable integration, clean generation, safe distribution and transmission, environmental protection, and climate resiliency. The Division manages two ratepayer surcharge research funding programs on electric- and gas-related research and development.

In 2000, the California Legislature enacted Assembly Bill 1002 (Wright, Chapter 932, Statutes of 2000), requiring the CPUC to impose a surcharge on gas consumed in California to fund energy efficiency programs and public-interest research and development to benefit gas ratepayers. In 2004, the CPUC issued Decision 04-08-010, designating the CEC as a research fund administrator. The CEC's Gas Research and Development (Gas R&D) Program invests $24 million annually in innovation to support the clean energy transition, increase reliability, lower costs, and improve safety. The research areas address issues that are not adequately provided for by the regulated market.

The CEC is committed to ensuring public participation in its R&D programs, and the research is guided by the following principles:

- Focusing on the areas of energy efficiency, renewable technologies, conservation, and environmental issues.
- Supporting state policy.
- Providing societal benefits.
- Considering collaboration and co-funding opportunities.

For more information about the Energy Research and Development Division, please visit the CEC's research website (www.energy.ca.gov/research/) or contact the Energy Research and Development Division at ERDD@energy.ca.gov.

ABSTRACT

In 2000, the California Legislature enacted Assembly Bill (AB) 1002 (Wright, Chapter 932, Statutes of 2000), requiring the California Public Utilities Commission (CPUC) to add a surcharge on gas consumed in California. These monies funded energy efficiency programs and public interest research and development to benefit gas ratepayers. AB 1002 also required the CPUC to designate an entity to administer the research component of AB 1002. In 2004, the CPUC issued Decision 04-08-010, designating the California Energy Commission (CEC) as a research fund administrator.

This Gas Research and Development Budget Plan describes the CEC's proposed gas research and development initiatives for Fiscal Year 2024–2025. These proposed initiatives align with the themes of gas decommissioning, gas system safety, and renewable generation. The initiatives support state energy policies and goals, with several initiatives directly benefiting under-resourced communities. The proposed research funding for Fiscal Year 2024–2025 is $24 million. The budget plan covers July 1, 2024, through June 30, 2025. The budget plan benefited from input from representatives of the Disadvantaged Communities Advisory Group, investor-owned utilities' gas research and development program administrators, CPUC inter-agency coordination, and a public workshop, among other input received on CEC's gas-related efforts.

The CEC staff appreciates the coordination with CPUC on the proposed research initiatives and CPUC's ongoing support to enable access to needed utility infrastructure data.

Keywords: California Energy Commission, California Public Utilities Commission, gas, climate change, fuel-flexible generation, distributed generation, renewable generation, renewable gas, energy infrastructure, gas decommissioning, gas pipeline integrity, gas storage inspection and monitoring, energy-related environmental research, transportation, building decarbonization, disadvantaged communities, low-income communities, decarbonization, gas users, energy transition, indoor air quality, equipment supply chains

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As California progresses toward its clean energy and climate change mitigation goals, energy infrastructure, the role of the gas sector, and the mix of fuels and use of gas in buildings and in electricity generation will evolve. The California Energy Commission's (CEC) Gas Research and Development (Gas R&D) Program supports this gas sector transition and cost-effective achievement of the state's clean energy and climate goals. Research and development (R&D) investments support reductions in fossil gas consumption to deliver public health, environmental, and gas system safety benefits by advancing the production and use of renewable, low-carbon fuels or alternatives and lowering the cost and improving the performance of associated technologies, infrastructure, and services.

The CEC's Energy Research and Development Division staff develops the Gas R&D Budget Plan based on state energy policies, plans, and guidance; analysis of research gaps; coordination with the California Public Utilities Commission (CPUC) and other agencies; and input from the Disadvantaged Communities Advisory Group, Investor-Owned Utilities, and the public. Key policies, plans, and guidance include Executive Order B-55-18, Assembly Bill (AB) 1279 (Muratsuchi, Chapter 337, Statutes of 2022), Senate Bill (SB) 1221 (Min, Chapter 602, Statutes of 2024), Integrated Energy Policy Reports, and CPUC decisions and resolutions, among others.

This proposed Fiscal Year (FY) 2024–2025 Gas R&D Budget Plan includes R&D funding for three initiatives aligned with three themes (Table ES-1). The proposed R&D serves to support gas decommissioning (retiring portions of California's fossil gas infrastructure to reduce costs and increase other benefits), gas system safety, and renewable generation. Funding for these initiatives is requested from the FY 2024–2025 annual budget of $24 million.

Table ES-1: Proposed FY 2024–25 Gas R&D Budget Plan

Investment Theme/ Initiative Theme	Initiative Title	Proposed Budget
Environmental and Social Research/ Gas Decommissioning	Support Equitable, Safe, and Cost-Effective Decarbonization of California's Gas System	$7,600,000
Gas System Integrity/ Gas System Safety	Innovations for Cost-Effective Operation and Maintenance of Critical Infrastructure During the Gas Transition	$7,815,489
Decarbonization/ Renewable Generation	Fuel-Flexible Distributed Power Generation	$6,000,000
Database Development		$184,511
Program Administration		$2,400,000
TOTAL		$24,000,000
Grand TOTAL		**$24,000,000**

Source: California Energy Commission

CHAPTER 1: Introduction

Gas Sector Transition to Meet Decarbonization Goals

As California progresses toward its clean energy and climate change mitigation goals, energy infrastructure, the role of the gas sector, and the mix of fuels serving demand currently met by fossil gas will evolve. Key policies driving this transition include the Building Energy Efficiency Standards — Title 24 (Energy Code), Appliance Efficiency Regulations — Title 20, Senate Bill (SB) 350 (De León, Chapter 547, Statutes of 2015), SB 100 (De León, Chapter 312, Statutes of 2018), and SB 1221 (Min, Chapter 602, Statutes of 2024), among others. However, fossil gas use remains significant, and transitioning the system will continue to impact many Californians. The California Public Utilities Commission (CPUC) has instituted rulemakings (R.20-01-007, R.24-09-12) to advance decarbonization of the gas system in a way that supports equity, safety, and affordability and addresses reliability challenges, commodity spikes, and other adverse outcomes.[1]

The California Air Resources Board (CARB) published an update in 2022 to its Scoping Plan for achieving carbon neutrality by 2045.[2] The Scoping Plan recognizes the need for decarbonization in every sector and replacement of fossil fuels with renewable energy resources, including renewable and zero-carbon electricity, renewable hydrogen, and biomethane. While both decarbonization and renewable resources hold significant promise for reducing emissions, further technology development will help realize the full benefits of this market transformation via improved performance, accessibility, safety, and lower costs.

Gas R&D Program Background

The Gas Research and Development (Gas R&D) Program supports the gas sector transition and cost-effective achievement of the state's clean energy and climate goals. Research and development (R&D) investments lower the cost and improve the performance of low-carbon gas products, infrastructure, services, and alternatives, supporting reductions in fossil gas consumption; improving technology and system efficiencies; advancing the production and use of renewable, low-carbon fuels; and delivering public health, environmental, and gas system safety benefits.

Recognizing the benefit of gas research to Californians, Assembly Bill (AB) 1002 (Wright, Chapter 932, Statutes of 2000) directed the CPUC to add a surcharge on gas consumed in California to fund R&D specific to the gas system. The 2004 CPUC Decision 04-08-010 designated the California Energy Commission (CEC) as an administrator for the Gas R&D

1 California Public Utilities Commission. Long-Term Gas System Planning Rulemaking, https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M539/K683/539683149.PDF.

2 California Air Resources Board. 2022. "*2022 Scoping Plan for Achieving Carbon Neutrality."* https://ww2.arb.ca.gov/our-work/programs/ab-32-climate-change-scoping-plan/2022-scoping-plan-documents.

Program. The CPUC allocates $24 million annually to this program and defines public interest gas research activities as those "directed towards developing science or technology, the benefits of which accrue to California citizens and are not adequately addressed by competitive or regulated entities."[3] The decision also directs that R&D projects focus on energy efficiency, renewable technologies, conservation, and environmental issues; support state energy policy; offer a reasonable probability of providing benefits to the public; and consider opportunities for collaboration and cofunding with other entities, such as federal and local agencies.

In 2006, the California Legislature passed SB 1250 (Perata, Chapter 512, Statutes of 2006), which further outlines the goal of the Gas R&D Program to "develop, and help bring to market, energy technologies that provide increased environmental benefits, greater system reliability, and lower system costs, and that provide tangible benefits to electric utility customers."[4] In addition to these goals, the CPUC has issued resolutions providing further guidance for implementing the Gas R&D Program.[5] Chapter 2 describes these CPUC resolutions.

In 2021, the California Legislature passed AB 148 (Ting, Chapter 115, Statutes of 2021). This law authorizes continuous appropriation of funds to the CEC for its costs of administering the Gas R&D program. While Gas R&D Program funds do not expire, the CEC strives to encumber these funds within two years and complete projects within a total of six years to align with the original law. The CEC is also required to report to the Legislature on the outcomes, effects, and benefits of the program by October 31 of each year.

The Gas R&D Program has invested in R&D to develop technologies, tools, and strategies that increase energy efficiency, lower costs, reduce air pollutants and greenhouse gas (GHG) emissions, and improve the safety of gas infrastructure. Recent program achievements are included in the *Gas Research and Development 2023 Annual Report.*[6]

Fiscal Year 2024–2025 Budget Plan Priorities and Development

The proposed Fiscal Year (FY) 2024–2025 Gas R&D Budget Plan continues to place emphasis on R&D areas that align with the state's priorities for decarbonization. The proposed R&D serves to support gas decommissioning, gas system safety, and renewable generation. The CEC Energy Research and Development Division (ERDD) staff develops the Gas R&D Budget Plan based on state energy policies, plans, and guidance; analysis of research gaps; coordination with the CPUC and other agencies; and input from the Disadvantaged

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3 California Public Utilities Commission. 2004. "*California Public Utilities Commission Decision 04-08-010*", https://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/39314.PDF.

4 California Code, 2006. "*Public Resources Code Sections 25620-25620.15"* codifies SB 1250, https://codes.findlaw.com/ca/public-resources-code/prc-sect-25620.html.

5 California Public Utility Commission. "*Energy Research Development and Deployment*," https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/energy-research-development-and-deployment.

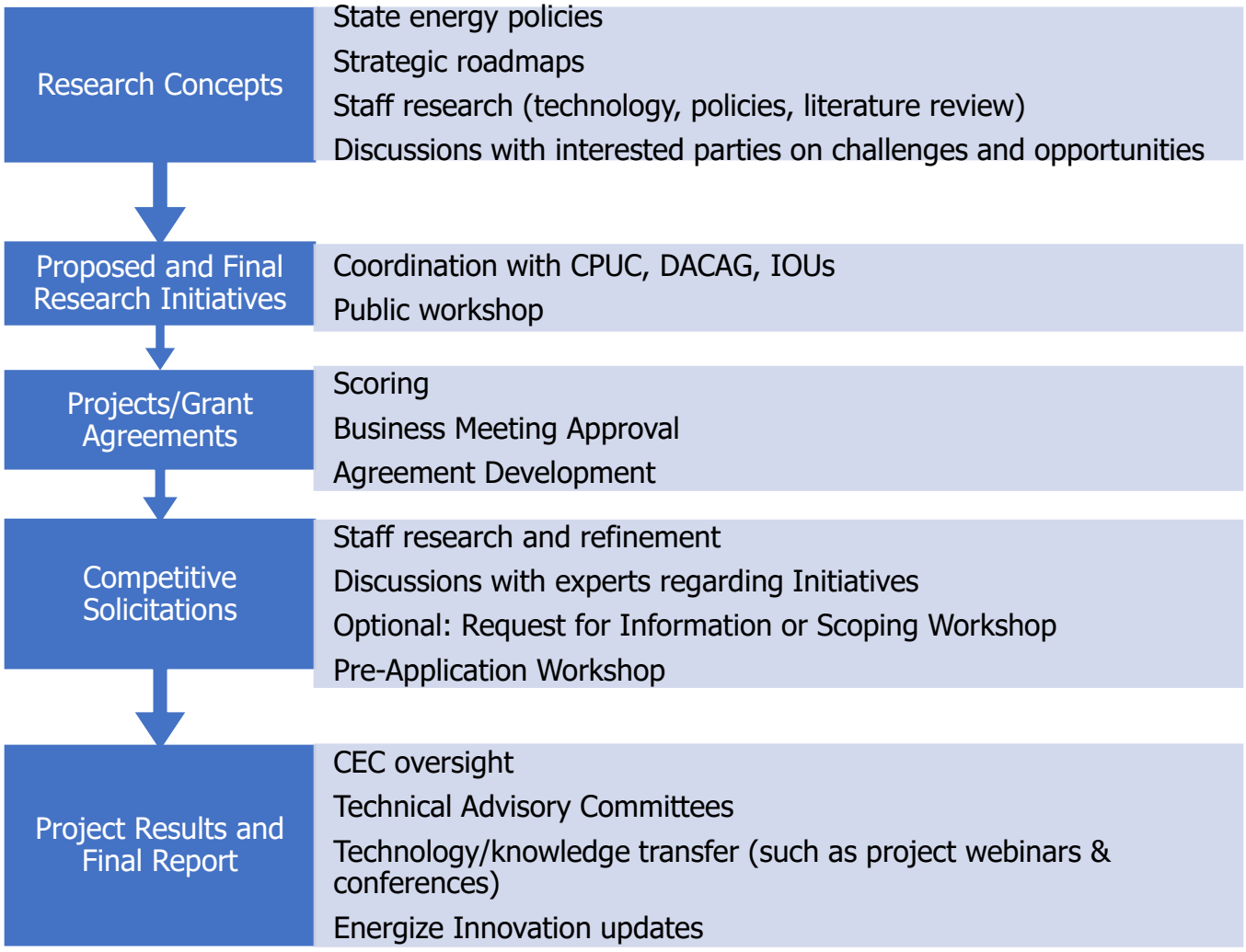
6 O'Hagan, Molly. California Energy Commission. October 2023. "*Gas Research and Development Program 2023 Annual Report*." Publication Number: CEC-500-2023-054, https://www.energy.ca.gov/publications/2023/gas-research-and-development-program-2023-annual-report.

Communities Advisory Group (DACAG), Investor-Owned Utilities (IOUs) and the public, as described in Chapter 2.

CHAPTER 2:
Developing Gas R&D Initiatives for Fiscal Year 2024–2025

The research initiatives described in Chapter 3 of this report were informed by state policies, plans, and guidance — including the CPUC decisions related below — as well as the CEC's commitment to diversity and equity, public input, and state agency roadmaps. All are discussed below and in Appendices A–F. A summary of CEC's process, including how and when interested parties (ranging from interested members of the public to technical experts) can provide input throughout the lifecycle of Gas R&D Program activities, is included in Figure 1.

Figure 1: Summary of Key Input Activities for the CEC Gas R&D Program Grant Solicitation and Agreement Management Process



Source: California Energy Commission Staff

CPUC Decision 04-08-10: Supporting State Policy

As called for in CPUC Decision 04-08-010, issued in 2004, the Gas R&D Program supports state energy policies and goals, such as achieving economywide carbon neutrality by 2045 (Executive Order B-55-18 and AB 1279, Muratsuchi, Chapter 337, Statutes of 2022) and doubling energy efficiency by 2030 (SB 350, De León, Chapter 547, Statutes of 2015).[7,8]

The Gas R&D Program supports several other key energy and climate policies and goals as well, including:

- SB 32 (Pavley, Chapter 249, Statutes of 2016), which established the state's goal for a 40 percent GHG emissions reduction below 1990 levels by 2030.[9]
- CEC Integrated Energy Policy Reports (IEPRs) and associated updates, which assess major energy trends facing California's electricity, gas, and transportation sectors and provide policy recommendations.[10]
- CARB's Climate Change Scoping Plan, which underscores the pivotal role of innovative technologies in improving efficiency, increasing the production of renewable gas, and reducing leakage from gas infrastructure in meeting future climate change targets.[11]
- The CPUC's Long-Term Gas Planning Rulemakings (R.20-01-007, R.24-09-012), which promote decarbonization of the gas system in a way that supports equity, safety, and affordability and addresses reliability challenges, commodity price spikes, and other adverse outcomes.[12]

The FY 2024–2025 Gas R&D Budget Plan also specifically addresses the focus areas identified in CPUC Decision 04-08-10:

- Renewable technologies (with an initiative in the area of renewable distributed power generation), and
- Environmental issues (including building decarbonization, gas system safety, and targeted gas system decommissioning).

Appendix A provides more detail on policies and proceedings relevant to each initiative.

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7 Executive Order B-55-18, *To Archive Carbon Neutrality*, 2018, https://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf, & Assembly Bill 1279, Muratsuchi, *The California Climate Crisis Act, 2022*, https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220AB1279.

8 Senate Bill 350, De León. *Clean Energy and Pollution Reduction Act of 2015*, 2015, https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB350.

9 Senate Bill 32, Pavley. *California Global Warming Solutions Act of 2006,* 2006, https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB32

10 Integrated Energy Policy Report. California Energy Commission. https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report.

11 California Air Resources Board. "*Assembly Bill 32 Climate Change Scoping Plan*," https://ww2.arb.ca.gov/our-work/programs/ab-32-climate-change-scoping-plan.

12 California Public Utilities Commission. Long-Term Gas System Planning Rulemaking.

CPUC Resolution G-3592

The CPUC Resolution G-3592, issued in 2023, required that the FY 2023–2024 Gas R&D Budget Plan allocate $960,000 for CPUC to hire a contractor to evaluate the Gas R&D Program. This funding was allocated from the research funding. The resolution also added seven new administrative requirements for the FY 2023–2024 Budget Plan and beyond. These requirements are summarized below, with more information on how the CEC has addressed them noted in parentheses. In short, the CEC is required to:

1. Engage with and include input from disadvantaged community stakeholders, including the DACAG, to provide input on how to administer the program equitably (documented in Chapters 2 and 3).
2. Offer a presentation of the budget plans to the CPUC commissioners (offer to present the proposed budget plan was sent to Energy Division staff on January 25, 2024).
3. Describe collaborative and cofunding opportunities considered (documented in Chapters 2 and 3).
4. Summarize IOU coordination on the Gas R&D Budget Plan, and provide details on partnerships, costs, and cofunding for projects funded by the Gas R&D Program (documented in Chapters 2 and 3).
5. Provide a detailed cost breakdown of Gas R&D Program administration (documented in Appendix G).
6. Summarize how the Long-Term Gas Research Roadmap, *Recommendations for the Long-Term Gas Research Strategy to Achieve Aggressive Statewide Carbon Neutrality Goals,*[13] was considered in developing the budget plan (documented in Chapters 2 and 3).
7. Identify unspent funds that had been proposed in previous budget plans and use them before using new or additional ratepayer funds (documented in Appendix B).

CPUC Resolution G-3592 will also require the CEC to apply the Electric Program Investment Charge (EPIC) impact analysis framework, once established, to Gas R&D projects and initiatives.

CPUC Resolution G-3584

As directed by CPUC Resolution G-3584, issued in 2021, the CEC considered the AB 3232 (Friedman, Chapter 373, Statutes of 2018) report in developing the Gas R&D Budget Plan, specifically the seven key strategies to decarbonize residential and commercial buildings

13 Webinar recording and presentation on Long-Term Gas Research Strategy Recommendations can be found at: https://www.energy.ca.gov/event/webinar/2022-12/webinar-long-term-gas-research-strategy-recommendations

outlined in the 2021 report *California Building Decarbonization Assessment.*[14] The initiatives in this FY 2024–2025 Gas R&D Budget Plan support several of the recommended strategies.

The "Fuel-Flexible Distributed Power Generation" research initiative supports the second strategy detailed in the report for "Decarbonizing the Electricity Generation System." The initiative proposes using different types and qualities of renewable fuels, such as hydrogen, biomethane, or ammonia, in distributed generation technologies to enable them to be fuel-flexible.[15] The initiative will take a technology-neutral approach that encompasses a range of strategies, from cutting combustion system emissions to expanding the operability of non-combustion systems. This approach seeks to modify or develop energy conversion systems like generators to operate on one or more renewable fuels, thereby expanding the suite of strategies to achieve a cleaner generation system.

The report also includes a strategy referred to as "Decarbonizing the Gas System." While the CEC originally considered a Clean Renewable Hydrogen Distribution research initiative to study the role of hydrogen separation technologies to understand whether and how hydrogen should be used to displace fossil gas in the existing gas system, the CEC ultimately decided not to include this initiative in the FY 2024–2025 Proposed Budget Plan. This decision was based largely on CPUC and public feedback, as summarized in Appendix C.

CPUC Resolution G-3584 further calls for the CEC to consider, when available, the Long-Term Gas Research Roadmap, titled *Recommendations for the Long-Term Gas Research Strategy to Achieve Aggressive Statewide Carbon Neutrality Goals,* which was under development at the time. The final analysis was submitted to the CEC on November 30, 2022, and a public workshop presenting the findings was held December 12, 2022. The roadmap includes recommendations, which are organized around 11 initiatives pertaining to communities, equity, and environment; gas end use; and gas supply chain, including production, transport, and storage. These recommendations have helped guide CEC's Gas R&D planning and inform the investments identified in this budget plan, as described in Chapter 3.

Resolution G-3584 also requires the CEC to review unspent funds to identify research funds from FY 2014–2015 to FY 2022–2023 Gas R&D Budget Plans that were encumbered within two years of budget approval. These funds are identified in Appendix B. Per Resolutions G-3584 and G-3592, the CEC will ensure that for any unspent funds that the CEC has identified and seeks to use for new Gas R&D projects, the CEC will apply this unused funding before any new or additional ratepayer funds are used and will identify the respective research areas for which the CPUC originally authorized the funding.

CPUC Resolution G-3571

CPUC Resolution G-3571, issued in 2020, requires that if the CEC is unable to obtain data it deems necessary to complete any of the projects proposed in the FY 2021–2022 Gas R&D

14 Kenney, Michael, Nicholas Janusch, Ingrid Neumann, and Mike Jaske. California Energy Commission. 2021. "*California Building Decarbonization Assessment*." Publication Number: CEC-400-2021-006-CMF.https://www.energy.ca.gov/publications/2021/california-building-decarbonization-assessment.

15 *Distributed Generation* means producing electricity near the place of use.

Budget Plan, it must first consult with CPUC Energy Division staff overseeing this program before reallocating any funding. To date, the CEC or its project recipients have not encountered data-related obstacles that prevent completion of the projects in the FY 2021–2022 Gas R&D Budget Plan or projects proposed in any subsequent Gas R&D Budget Plan. The CPUC and CEC have an information-sharing agreement to support the Gas R&D Program and ensure that the confidentiality of exchanged information will be maintained.[16] However, should the CEC be unable to obtain needed data, CEC staff will consult with CPUC Energy Division staff before reallocating any funding as required in the CPUC resolution.

The resolution also calls for the CEC to consider "any research gaps that might emerge because of recent budget decreases or reallocations in response to COVID-related economic impacts and potential cofunding opportunities that the Gas R&D program can provide to limit the impact of these gaps on California energy goals." At this time, the CEC is not aware of COVID-related budget decreases or reallocations that may result in research gaps.

For all Gas R&D Budget Plans, CPUC asked that the CEC coordinate with CPUC staff at least three weeks in advance of the CEC's public workshop on the proposed budget plan to help ensure the best possible use of funds across programs. In response, CEC staff provided CPUC staff with summaries of the research initiatives on November 2, 2023, and hosted a staff coordination meeting on November 15, 2023. A summary of this meeting is provided in Appendix C.

The CPUC also included a requirement that, for all Gas R&D Budget Plans, the CEC must post the budget plans publicly on the CEC's website before submitting an approval request to the CPUC and must notify the CPUC of the web address when requesting approval of the plan. The CEC follows this practice, posting Gas R&D Budget Plans to the CEC's website on the page for CEC Energy Research and Development investment plans and annual reports.[17]

For all Gas R&D Budget Plans, the CPUC called for the CEC to distribute the budget plan through the CEC's subscription lists and include the names of the lists served when requesting CPUC's approval of the plan. The resolution also calls for the CEC to consult with CPUC Energy Division staff on which CPUC list serves from ongoing CPUC proceedings the CEC should notice in its proposed plan. Addressing that request for this FY2024-2025 plan, the noticed CEC lists will include "Energy Research and Development;" "PIER Pgm. Residential and Commercial Bldgs. Program Area;" "Developing Regulations, Guidelines, and Policies for Implementing SB 350 and AB 802;" "Renewable Energy Executive Order;" "General Natural Gas and LNG Issues;" and "Disadvantaged Communities Advisory Group." [18]

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16 Available upon request.

17 California Energy Commission. "*Annual Report*," https://www.energy.ca.gov/data-reports/reports/energy-research-and-development-investment-plans-and-annual-reports.

18 California Public Utilities Comission. Listservs include A1704028, A1806015, A1902015, A1907006, A1910012, A1908015, A2106021, A1710008, A1807024, I1911013, R1602007, R1803011, R1804019, R1807006, R1810007, R1812005, R1812006, R1901011, R1211005, R1910005, R1302008, R2001007, R1407002, R2005012, R1503010, R.1901011, R2008020, R1505006, R2011003, and R2409012.

CPUC Resolution G-3603

CPUC Resolution G-3603, issued May 9, 2024, directs the CEC to be proactive and specific in articulating its coordination and collaboration with IOUs and other Gas R&D entities in advance of commencing its plan. Likewise, to ensure that research plans are coordinated, consistent, and aligned with CPUC policies and proceedings, the CEC is ordered to coordinate with Energy Division and other CPUC staff. A subsequent section of this chapter, "Coordination and Strategic Partnerships," articulates the CEC's coordination with these and other interested parties.

The resolution also states that, once the EPIC Uniform Impact Analysis framework is approved by the CPUC, the CEC shall use this framework to demonstrate outcomes of achieving its proposed benefits. The guiding principles of the framework have been approved, and their application in this Budget Plan is described in a subsequent section of this chapter, entitled "Foundation Principles for Uniform Impact Analysis."

Equitable Program Administration

The CEC's commitment to diversity and equity shapes the CEC Gas R&D Program. California is a diverse state in its people and geography. The CEC strives to increase opportunities for all Californians through its programs and advance equity through outreach, funding opportunities, and planning. In 2015, the CEC unanimously approved a formal Diversity Policy Resolution, consistent with state and federal law. The resolution seeks to improve fair and equal opportunities for small businesses; women-, disabled veteran-, minority-, and lesbian, gay, bisexual, transgender, and queer (LGBTQ)-owned businesses; and economically disadvantaged and underserved communities to participate in and benefit from CEC programs.[19]

This report uses the term "Environmental and Social Justice (ESJ) communities," defined by the CPUC's ESJ Action Plan 2.0 as predominantly communities of color or low-income communities that are:

- Underrepresented in the policy-setting or decision-making process.
- Subject to a disproportionate impact from one or more environmental hazards.
- Likely to experience disparate implementation of environmental regulations and socioeconomic investments in their communities.

This definition targets "disadvantaged communities," defined as census tracts that score in the top 25 percent of CalEnviroScreen, as well as:

- Those that score within the highest 5 percent of CalEnviroScreen Pollution Burden but do not receive an overall CalEnviroScreen score.
- All tribal lands.

19 Resolution No: 15-0408-3, State Energy Resources Conservation and Development Commission. 2015. "*Resolution 15-0408-3: Resolution Regarding Diversity Policy Statement,"* https://www.energy.ca.gov/media/4163.

- Low-income households (household incomes below 80% of the area median income).
- Low-income census tracts (census tracts where aggregated household incomes are less than 80 percent of area or state median income).[20]

AB 865 (Alejo, Chapter 583, Statutes of 2015) provided additional guidance, requiring the CEC to develop and implement a comprehensive outreach plan to broaden and diversify the applicant pool to CEC programs and track progress toward those objectives. The *2022 IEPR Update* includes adoption of the Justice Access Equity Diversity Inclusion (JAEDI) Framework, which reasserts the CEC's commitment to equity by outlining its vision, values, and best practices to advance equity in its programs.[21] In 2024, the CEC adopted the JAEDI Information Proceeding with the goal of developing a comprehensive JAEDI Action Plan.[22] In the CEC's ERDD, there are designated equity leads who work with the CEC Office of the Public Advisor, Energy Equity, and Tribal Affairs to align the Gas R&D Program and other grant funding efforts with the JAEDI Framework.

One recent example of a CEC outreach effort to support diversity and equity commitments involved staff seeking input on improving the CEC's application and grant management processes to relieve administrative burdens for potential applicants. This improvement is particularly beneficial for smaller entities without prior experience in preparing CEC grant applications or without substantial resources. In collaboration with the CEC grants ombudsman, R&D staff obtains feedback from applicants and works to implement improvements to the grant application process.

Ongoing efforts to support diversity and equity include:

- Leveraging scoring criteria in solicitations to provide preference points for projects that demonstrate benefits to disadvantaged or low-income communities (or both) and tribes. The criteria consider factors such as economic impacts as well as whether access to clean energy would be improved within the community.
- Prioritizing applications with letters of support demonstrating benefits to these communities and tribes.

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[20] CPUC. April 7, 2022. *Environmental & Social Justice Plan, Version 2.0,* https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/news-and-outreach/documents/news-office/key-issues/esj/esj-action-plan-v2jw.pdf. and *CA Disadvantaged Communities Advisory Group Equity Framework, 2024 Update,* https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/infrastructure/disadvantaged-communities/2024-dacag-equity-framework.pdf

[21] Bailey, Stephanie, Jane Berner, David Erne, Noemí Gallardo, Quentin Gee, Akruti Gupta, Heidi Javanbakht, Hilary Poore, John Reid, and Kristen Widdifield. 2023. "*Final 2022 Integrated Energy Policy Report Update*." California Energy Commission. Publication Number: CEC-100-2022-001-CMD, https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2022-integrated-energy-policy-report-update.

[22] CEC. "JAEDI Proceeding Workshop," https://www.energy.ca.gov/event/workshop/2024-09/jaedi-proceeding-workshop.

- Advancing efforts to address energy-related challenges and opportunities in ESJ communities by encouraging residents and interested members to participate in and share perspectives in community meetings on CEC-funded projects.
- Tracking, monitoring, and providing findings in the Gas R&D Annual Report on the participation of California-based entities; women-, minority-, and disabled-veteran-owned businesses; and small businesses as recipients of awards. Since FY 2016–17, the Gas R&D Program has invested an estimated 48 percent of program demonstration funds in projects in a disadvantaged community, low-income community, or both (excluding projects involving combustion). Recent program investments in disadvantaged and low-income communities are included in the *Annual Report*.[23]
- Maintaining the CEC's Empower Innovation platform (EmpowerInnovation.net), which provides an online space for community leaders and clean energy technology innovators to meet and learn from each other and start conversations that lead to effective collaboration. Staff has held "Empower Innovation" events focused on providing how-to technical assistance and navigating grant requirements. Recordings of these events are available to view for free on the platform. Furthermore, staff continues to share information on how to use the Empower Innovation platform at preapplication workshops for Gas R&D Program funding opportunities. These activities serve to help engage a broad set of stakeholders in the Gas R&D Program, including women, minorities, LGBTQ individuals, disabled veterans, and other underrepresented groups.

More information about these and other CEC activities that support equity and diversity is available on the CEC's website (https://www.energy.ca.gov/about/campaigns/equity-and-diversity).

SB 350 (De León, Chapter 547, Statutes of 2015) is a driving policy for advancing equity in California's clean energy transformation. As outlined in SB 350, the CEC co-established the DACAG with the CPUC in 2018 to advise the CEC and the CPUC on ways to help ESJ communities benefit from proposed clean energy and pollution reduction programs, expand access to clean energy technologies, and receive affordable energy services.[24] CEC DACAG liaisons coordinate with the CEC's Office of the Public Advisor, Energy Equity, and Tribal Affairs and with DACAG members to advance energy equity and ensure that program implementation helps meet community needs.

In addition, CEC DACAG liaisons support technical staff in informing funding and focal areas and identifying engagement opportunities with the DACAG. These activities include providing

23 O'Hagan, Molly. October 2023. "*Gas Research and Development Program 2023 Annual Report*." California Energy Commission. Publication Number: CEC-500-2023-054, https://www.energy.ca.gov/publications/2023/gas-research-and-development-program-2023-annual-report.

24 Scavo, Jordan, Suzanne Korosec, Esteban Guerrero, Bill Pennington, and Pamela Doughman. 2016. *"Low-Income Barriers Study, Part A: Overcoming Barriers to Energy Efficiency and Renewables for Low-Income Customers and Small Business Contracting Opportunities in Disadvantaged Communities."* California Energy Commission. Publication Number: CEC-300-2016-009-CMF.

staff updates and presentations on upcoming budget plans, programs, workshops, outreach events, and final reports related to DACAG priority areas in the DACAG monthly newsletter, public meetings, and smaller meetings with DACAG priority area subject matter experts.

CEC staff activities specifically related to CEC's commitment to diversity and equity for the FY 2024–2025 Gas R&D Proposed Budget Plan included:

- Consulting with CEC's Office of the Public Advisor, Energy Equity, and Tribal Affairs and DACAG members to identify relevant ESJ community representatives and effective engagement approaches to seek input on ways to administer the program equitably throughout the plan development and implementation cycles.
- Providing targeted outreach to the DACAG, California Environmental Justice Alliance, Asian Pacific Environmental Network, and the California Energy Research Center (focused on expanding education, training, and demonstration projects in the Central Valley) about the CEC's December 15, 2023, Gas R&D Plan Stakeholders Workshop and offering the opportunity for public comment.
- Requesting public input on how to center equity in the proposed initiatives in the FY 2024–2025 Gas R&D Program.
- Presenting and soliciting feedback on the proposed initiatives within the CEC's Gas R&D Program and proposed equity engagement approach at the DACAG meeting on January 19, 2024. Staff incorporated changes to the Gas R&D Budget Plan based on DACAG input, including removing the clean renewable hydrogen distribution initiative. Periodically meeting with DACAG members to receive recommendations on how to effectively address equity and improve benefits to under-resourced communities and tribes through proposed R&D initiatives.
- Presenting on the updates to the FY 2024-2025 Gas R&D Proposed Budget Plan at the monthly DACAG meeting on January 17, 2025.

CEC staff members additionally held a listening session in October 2024 to invite input from environmental justice and community-based organizations to help guide the FY 2025-2026 budget plan initiatives. Furthermore, per DACAG request at the January 19, 2024, public meeting, staff is coordinating with the CEC Public Advisor's Office to provide the DACAG with more regular updates on ongoing research results and opportunities to provide feedback on future funding efforts. For the FY 2025-2026 Budget Plan, this included earlier engagement with DACAG subject matter experts, an email update on the proposed initiatives, and a presentation to the full DACAG.

Coordination and Strategic Partnerships

CEC staff engage with a variety of interested parties to develop a research portfolio that is responsive to challenges and needs in transitioning the gas sector to a clean energy future. CEC staff initiate discussions with a wide range of experts to understand current challenges, emerging needs, and technology advancements within the gas system. Effective coordination among the CEC, California's gas IOUs, and the CPUC is essential to ensuring that California's ratepayer-funded Gas R&D Program delivers public interest benefits that align with state

energy policies and infrastructure planning, as well as state goals for affordability, reliability, and environmental sustainability. Early and ongoing scoping and coordination help create well-informed research initiatives and establish clear research priorities. A list of engagement activities is provided below, and verbal and written feedback with CEC responses is provided in Appendix D.

After proposed research initiatives are approved by the CPUC, CEC staff conduct in-depth research to focus the future funding areas and develop solicitation requirements. Throughout this process, CEC staff may inquire with various experts and other interested parties, such as those listed below, to explore emerging efforts that may shape future solicitations. However, once solicitations have entered the development phase, the CEC does not collaborate further in crafting grant solicitations to ensure compliance with Public Resources Code Section 25620.5(a), which requires these grant solicitations to be competitively selected and awarded. [25] These measures ensure fairness, transparency, and integrity throughout the solicitation process.

The CEC's coordination and strategic partnerships that support and guide Gas R&D planning are reflected in the following collaborative efforts:

- **IOU coordination**
    - CEC staff participate in regular outreach meetings with IOUs, including:
        - Attending Southern California Gas Company's (SoCalGas) annual public workshop on its Research, Development, and Demonstration (RD&D) plan to provide guidance on research priorities, and meeting SoCalGas subject matter experts on specific research priorities such as hydrogen and transportation.
        - Providing input on Pacific Gas and Electric (PG&E) gas operations and hydrogen-related R&D priorities through meetings with PG&E subject matter experts and attending PG&E's R&D outreach events, such as its Innovation Summit and Pitch Fest. PG&E also recently began developing annual research plans to submit to the CPUC.
        - Since July 2024, attending biweekly meetings with PG&E, SoCalGas, Sempra, and Southwest Gas to coordinate on topics relevant to the Gas R&D Program, including gas system needs, strategic planning, and relevant state energy goals, policies, and proceedings. Examples of outcomes from these biweekly calls include:
            - Proposed alignment of Gas R&D ratepayer benefits between IOUs and the CEC to streamline planning, coordination, and reporting across administrators.

25 Per the Public Utilities Code Section 895(a), the CEC administers the Gas R&D Program under Public Resources Code Sections 25620–25620.15 and evaluates and selects of projects based on merit through a competitive process.

        - Collaboration to organize a joint webinar hosted by SoCalGas titled "Get to Know California's Gas R&D Programs" on February 6, 2025, demonstrating the complementary nature of administrators' distinct portfolios and examples of project partnership.
    - Working with the IOU Gas R&D administrators to hold annual public workshops, starting in 2025, to foster administrator coordination on gas innovation activities to benefit ratepayers and ESJ communities (Per CPUC Resolution G-3603 Ordering Paragraph 4).
  - Coordinating on proposed FY 2024-2025 Budget Plan Initiatives:
    - CEC staff met with PG&E on February 7, 2024, to discuss the Gas System Safety Initiative. Key outcomes include identification of promising research gaps and coordination opportunities to consider when implementing the "Innovations for Cost-Effective Operation and Maintenance of Critical Infrastructure During the Gas Transition" initiative, building on related past and active gas operations R&D supported by PG&E, SoCalGas, and U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety (PHMSA). Example research gaps discussed include technologies that can reduce costs of inspecting and verifying material grade of transmission pipelines and less intrusive underground storage well inspection and continuous monitoring technologies that can provide sufficient data to justify alternative well integrity inspection intervals while ensuring equivalent safety.
    - On April 18 and 29, 2024, CEC staff met with PG&E to share active and forthcoming Gas R&D activities that relate to PG&E's three Gas R&D research focus areas: Operations & Maintenance, Reducing Methane Emissions, and Decarbonizing the Gas System. This included sharing CEC's interest in building on prior projects to improve cost-effectiveness of underground gas storage operations and maintenance, prioritizing gas decommissioning, and exploring research opportunities around thermal networks. CEC staff also shared its best practices around including equity in the implementation of the Gas R&D Program. These best practices included conducting a listening session with environmental justice group representatives, presenting Gas R&D Plans to the DACAG, and designing solicitations to include equity-related scoring criteria or funding carve-outs.
- **CPUC coordination:** CEC staff engage regularly with CPUC Energy Division staff, including by:
  - Hosting a monthly Gas R&D Working Group call with CPUC Energy Division staff. The working group is a venue for CEC and CPUC staff coordination on Gas R&D Program research projects, priorities, and connections with CPUC proceedings. Examples of relevant activities during these calls include:

        - Refining research initiative topics and focus — including pilot projects, social scientific research, and air quality research — germane to fostering a gas transition that aligns with affordability, ratepayer concerns, safety, and public health.
        - Coordinating on data requests to IOUs and associated findings in support of long-term gas planning.
        - Sharing preliminary results from ongoing and recently completed research related to gas system decarbonization to share knowledge and elicit feedback from CPUC.
        - Discussing the potential for the CEC Gas R&D portfolio to support implementation of SB 1221 and CPUC's broader long-term gas planning efforts.
    - Contributing to the 2024 Joint Agency Staff Paper: Progress Towards a Gas Transition,26 including Chapter 8 on Research and Innovation Needs summarizing key research priorities, including those under the Gas R&D Program.
    - Coordinating on Proposed FY 2024-2025 Budget Plan Initiatives:
        - On January 16, 2025, CEC met with subject matter experts from CPUC to discuss the proposed Support Equitable, Safe, and Cost Effective Decarbonization initiative. The discussion strengthened interagency alignment on the initiative goals and clarified the research initiative language.
        - On January 23, 2025, CEC met with subject matter experts from CPUC to clarify the proposed Fuel-Flexible Distributed Power Generation initiative and ensure the goals of the initiative are clearly distinguished from those of IOU research plans.
- **Other governmental agency coordination:** CEC staff participate in regular meetings internally with state and federal agency partners regarding topics related to gas sector challenges. Topics discussed include:
    - Application-driven climate science (led by the National Oceanic Atmospheric Administration).
    - Forest biomass (led by the California Department of Forestry and Fire Protection).
    - Hydrogen hub efforts, including end-use and infrastructure issues (led by Alliance for Renewable Clean Hydrogen Energy Systems [ARCHES], which includes the California Governor's Office of Business and Economic Development [GO-Biz]).

[26] CPUC. February 22, 2024. *2024 Joint Agency Staff Paper: Progress Towards a Gas Transition: A White Paper Supporting the CPUC's Long-Term Gas Planning Rulemaking R.20-01-007,* https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M525/K660/525660391.PDF.

- **Working Group meetings:** To provide a forum for key parties to engage in portfolio-level coordination and relationship-building, CEC staff launched two working groups in 2022. These groups continue to meet approximately quarterly to inform planning for, execution of, and transfer of knowledge from applied research:
    - Climate Data and Analysis Working Group (C-DAWG), which invites industry, research, and state agency staff to participate in technical discussions to advance integration of climate change into planning, research, and operations.
    - Healthy, Equitable Energy Transition (HEET) Working Group, which hosts discussions on analytical approaches, modeling tools, metrics, and demonstration efforts to advance clean energy policy and deployment strategies.
- **Public engagement:** The CEC holds an annual public workshop to solicit feedback on the draft budget plan for that year. The Proposed FY 2024–2025 Gas R&D Budget Plan was presented at a public workshop December 15, 2023. Around 60 people attended the workshop, not including CEC staff, and the CEC received attendee questions and comments during the workshop discussion. The CEC considered and responded to public comments, using them to inform continued initiative and future solicitation development. (See Appendices C and G for a summary of public comments with CEC staff responses and the staff workshop presentation, respectively).

In addition to the above-mentioned engagement that informs Gas R&D budget planning, the CEC also engages a diverse set of parties in R&D implementation. This engagement promotes program accountability, transparency, collaboration, and responsiveness. The CEC relies on strategic partnerships to avoid duplication, build upon previous R&D work, generate new ideas, leverage public and private investments, and ultimately ensure the research portfolio delivers tangible benefits to the state's gas ratepayers. For example, the CEC has an ongoing collaboration with PG&E, San Diego Gas & Electric (SDG&E), and SoCalGas that includes their participation as members of technical advisory committees (TAC), project teams, and demonstration site hosts for CEC-funded Gas R&D projects.

Other efforts include:

- Broadening the use of social media platforms to educate and inform.
- Collaborating with the CEC's Office of the Public Advisor, Energy Equity, and Tribal Affairs to promote grant-funding opportunities.
- Meeting with community leaders, business leaders, and other interested members of the public.
- Distributing R&D informational materials at conferences, meetings, workshops, and public events, including nine events in 2023. (A list of public events is provided in Appendix E.)

Cofunding Opportunities

The CEC leverages cofunding opportunities by either requiring applicants for competitive solicitations to secure match funding (usually 10–20 percent), providing additional scoring

preferences for applications that exceed the minimum match funding requirement, or both. The cumulative match investments and project successes of the program are summarized in the Gas R&D Program Annual Report. As an example, the FY 2021–2022 Budget Plan resulted in competitively awarded projects that catalyzed nearly $8 million in match funds to expand the impact of these projects, effectively increasing the program funding level by 33 percent. A total of $1.5 million of these match funds came from IOUs (such as SoCalGas), $1.23 million from community- or publicly funded entities (for example, the South Coast Air Quality Management District), and $5.1 million from private entities.

Roadmaps and Long-Term Strategies

Roadmaps and long-term strategies are types of planning mechanisms and prioritization tools that help establish a clear link between research and energy policy goals. Research roadmaps define the topic area, significant issues and barriers, data gaps, information needs, research priorities, and potential partnerships. Long-term strategies guide energy system planning by outlining pathways from the current system to future goals. CEC staff and a wide range of energy researchers and consumers participate in developing roadmaps and strategies to gather cutting-edge information that can help determine how to maximize the value of Gas R&D Program investments.[27]

Public feedback during development of these roadmaps helps identify research needs that pertain to the Gas R&D Program. Collaborative thinking about energy solutions that cut across policy boundaries is integral to leveraging research dollars. Bringing gas and electricity parties together helps minimize resource shifting, encourages innovation, and promotes transparency.

For this budget plan, the Gas Decommissioning initiative drew from long-term strategies including the IEPR and the CEC's Gas Decarbonization Order to Institute Informational Proceeding (Gas Decarb OIIP). [28] [29] Both the IEPR and the Gas Decarb OIIP identify the need for long-term gas system planning, pointing to many unknown and evolving energy sector needs related to building decarbonization and gas decommissioning targets. These needs include:

- Coordinating gas system decommissioning with building decarbonization and changing weather patterns.
- Understanding and accounting for gas-electricity system interdependencies.
- Ensuring safe, reliable, and affordable energy for Californians.

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27 Various roadmaps can be found at the Energy Commission's publications database, https://www.energy.ca.gov/energy-rd-reports-n-publications.

28 See the *2021 IEPR* for example, Jones, Melissa, Jennifer Campagna, Catherine Elder, and Stephanie Bailey. 2022. *Final 2021 Integrated Energy Policy Report, Volume III: Decarbonizing the State's Gas System.* California Energy Commission. Publication Number: CEC-100-2021-001-V3, especially pp. 88-90, https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2021-integrated-energy-policy-report.

29 State of California Order No. 22-0309-07,https://efiling.energy.ca.gov/GetDocument.aspx?tn=242287&DocumentContentId=75788.

- Maintaining an adequate gas industry workforce.
- Exploring lower-carbon gas options.
- Mitigating risks to communities, including disadvantaged and lower-income communities.

Similarly, the Fuel-Flexible Distributed Power Generation initiative drew from recommendations in the *2022 IEPR Update* and the *2023 IEPR* to support the research and development of clean renewable hydrogen generation to improve efficiency, address oxides of nitrogen (NO_x) formation, and understand materials impacts, especially at higher blends. [30] [31] This initiative was also motivated by CARB's 2022 Scoping Plan and SB 100 emphasis on the need for adaptable generation systems to decarbonize and eliminate use of fossil fuels.

For example, the anticipated fuel changes ordered under SB 1440 (Hueso, Chapter 739, Statutes of 2018) could lead to a significant increase in biomethane entering the gas pipeline system. With substantial federal investments, particularly from the Infrastructure Investment and Jobs Act for the ARCHES effort and the Inflation Reduction Act for the Clean Hydrogen Production Tax Credit, if these are continued, increased production and use of hydrogen could also occur as the price of clean renewable hydrogen decreases. With these potential changes, the renewable fuel stream of the future might vary in quality, composition, and characteristics to an extent that current generation systems are not capable of handling. Research will be valuable to evolve and adapt these systems.

Beginning in 2021, the CEC managed a contract that developed an analysis on a long-term gas research strategy aligned with California's aggressive carbon neutrality goals. The contractors used a combination of literature review, technology assessments, prioritization methods, and interested party input to produce recommendations for the Gas R&D Program. Interested party input included TAC meetings, several public workshops, and expert interviews.[32] The analysis suggested opportunities for gas-related R&D investment across the gas supply chain and end-use sectors, except utility-scale power generation, spanning opportunities in hydrogen, renewable gas, gas decommissioning, gas safety, carbon capture utilization and storage, health, and equity. The CEC considered this analysis in developing the FY 2024-2025 Budget Plan.

Foundational Principles for Uniform Impact Analysis

The Gas R&D Program, like the EPIC Program, is designed to provide benefits to ratepayers. A uniform impact analysis framework is under development in the CPUC's EPIC proceeding (R

30 Bailey, Stephanie, Jane Berner, David Erne, Noemí Gallardo, Quentin Gee, Akruti Gupta, Heidi Javanbakht, Hilary Poore, John Reid, and Kristen Widdifield. 2023. *Final 2022 Integrated Energy Policy Report*. California Energy Commission. Publication Number: CEC-100-2022- 001-CMF.

31 Bailey, Stephanie, Jennifer Campagna, Mathew Cooper, Quentin Gee, Heidi Javanbakht, and Ben Wender. 2023. *2023 Integrated Energy Policy Report.* California Energy Commission. Publication Number: CEC-100-2023-001-CMF

32 https://www.energy.ca.gov/event/webinar/2022-12/webinar-long-term-gas-research-strategy-recommendations

19-10-005) to demonstrate the realized and potential impacts to electric ratepayers from RD&D investments. CPUC Resolution G-3603 requires that, once this framework is established, the CEC shall demonstrate outcomes of achieving its proposed benefits for all research projects funded by both the EPIC and Gas R&D Programs.

Decision 23-04-042, issued by CPUC on April 28, 2023, included adoption of the following four Foundational Principles for Development of a Uniform Impact Analysis Framework:

- Each project should offer a reasonable probability of providing benefits to ratepayers, and the portfolio as a whole should demonstrably benefit ratepayers.
- If a targeted group of ratepayers benefit from an individual project's output, investments should result in scalable and replicable innovations.
- Accurate and precise project and program impacts reporting is needed to ensure impacts are defensible and not overstated.
- Clear and transparent methods of impacts evaluation are required so other parties can verify results.

The decision emphasizes that benefits should be attributable to the public investment and would not have otherwise occurred and directs the development of methods, metrics, and assumptions in the framework. The CEC is committed to integrating these principles, as well as the framework once adopted, into future Gas R&D planning and reporting.

In addition to outlining these overarching principles, the decision also provides guidance on reporting and determining net impacts of a project; attributing benefits to a project apportioned with respect to reasonable counterfactual scenarios; developing and applying theory-grounded methodologies; articulating and preferentially using a set of common assumptions as applicable across projects; and differentiating among direct, indirect, and induced impacts. These steps support deliberate guidance of research to achieve desired benefits and sustained momentum across the research portfolio. CEC is committed to integrating the principles articulated under D.23-04-042, and the corresponding framework once adopted, into Gas R&D planning, projects, and reporting. The CEC will continue contributing to the refinement of benefit metrics and determinations and applying these as relevant to Gas R&D projects (including adapting the EPIC evaluation areas, as appropriate[22]). CEC will also seek to enhance our processes to track benefits across the short-, mid-, and long term, such as through the consideration of subsequent benefits assessments after projects have completed.

CEC's current processes align with these principles in several ways, and impact assessment occurs throughout the Gas R&D Program administration process. For example, in the budget planning phase, initiatives are scoped to ensure replicable and scalable benefits to ratepayers, each considering expected outcomes and describing benefits using consistent framing. The anticipated benefits to California ratepayers are described for each initiative and include potential metrics and methods for tracking benefits, derived from CPUC Decision 13-11-025 Attachment 4 (Chapter 3). Consultations with parties - including other Gas R&D administrators, CPUC subject matter experts, and interested members of the public - ensure that initiatives

will enable proposed projects that fill an identified RD&D gap, such that benefits to ratepayers would not otherwise have occurred. Following the approval of a budget plan, the CEC develops competitive solicitations that progress the objectives of the proposed initiatives. Solicitations, which are more specific than initiatives, describe the requirements for impact evaluation that are expected in an application and resulting projects. Applicants are required to identify project performance metrics that demonstrate research or technology advancements by which to measure the project benefits, as well as to provide a description of the proposed project's benefits to Californians. Once a project is underway, grant managers require tracking and reporting of metrics, and project benefits are reported through multiple avenues, including program annual reports, project final reports, and the CEC's Energize Innovation web platform.

In the Gas R&D Program, as with EPIC, the expected impacts, benefits, and benefit assessment methods will differ by the type of project funded. Gas R&D projects can typically be categorized as applied research studies, technology development, or pilot demonstrations. The FY 2023-24 Proposed Budget Plan contains initiatives that span several project types. In the Gas R&D Program, as with EPIC, the expected impacts, benefits, and benefit assessment methods will differ by the type of project funded. Gas R&D projects can typically be categorized as applied research studies, technology development, or pilot demonstrations. The FY 2024-2025 Proposed Budget Plan contains initiatives that will spur several project types.

If approved, the Support Equitable, Safe, and Cost-Effective Decarbonization of California's Gas System initiative in this plan will fund applied research studies. The Innovations for Cost-Effective Operation and Maintenance of Critical Infrastructure During the Gas Transition initiative will fund technology development and applied research studies. The Fuel-Flexible Distributed Power Generation initiative will fund demonstration projects. While pilot demonstrations bring tangible benefits to the targeted community, accompanying research studies can guide site selection and other criteria for demonstrations, as well as assess replicability and scalability of the outcomes. A diverse research portfolio with varying impacts and benefits can enhance the effectiveness of the overall investment plan by preparing for several possible technological, policy, and social futures. Likewise, embedding flexibility in research initiatives further reduces risk and optimizes benefits by enabling responsiveness to emerging policy and technology needs.

As the Uniform Impact Analysis Framework is developed and adopted, the CEC will continue to integrate the framework and principles into planning and program administration processes for all projects.

CHAPTER 3:
Proposed Initiatives for Fiscal Year 2024–2025

Proposed Budget Overview

This proposed FY 2024–2025 Gas R&D Budget Plan includes funding for three initiatives aligned with three program themes (Table 1). The proposed R&D serves to address the following topics:

- Gas decommissioning
- Gas system safety
- Renewable generation

CPUC staff have developed Gas R&D Investment Themes (Environmental and Social Research, Gas System Integrity, and Decarbonization) to improve consistency across Gas R&D administrators and budget plans. Table 1 below reflects both the new Investment Themes and CEC-developed Initiative Themes for the proposed budget plan.

Table 1: Proposed FY 2024–2025 Gas R&D Budget Plan

Investment Theme/ Initiative Theme	Initiative Title	Proposed Budget
Social and Environmental Research/ Gas Decommissioning	Support Equitable, Safe, and Cost-Effective Decarbonization of California's Gas System	$7,600,000
Gas System Integrity/ Gas System Safety	Innovations for Cost-Effective Operation and Maintenance of Critical Infrastructure During the Gas Transition	$7,815,489
Decarbonization/ Renewable Generation	Fuel-Flexible Distributed Power Generation	$6,000,000
Database Development		$184,511
Program Administration		$2,400,000
TOTAL		$24,000,000

Source: California Energy Commission

Proposed Research Initiatives

Initiative Theme: Gas Decommissioning

The tasks of decarbonizing and decommissioning California's gas system confront decades of inertia favoring fossil gas use, complex costs and benefits of conversion, and community and organizational priorities that can misalign with conversion from fossil gas. Overcoming this inertia requires influencing long-evolved societal systems, including going beyond just intervening in decisions, such as homeowner choices when replacing equipment. These societal systems manifest in varied conditions across California's diverse gas customer base, retailers, and contractors and are not easily visible or manageable. In addition to technological innovation, accomplishing gas decommissioning and decarbonization will require a research-based understanding of how ground-level changes in tens of millions of gas end uses can be achieved, and how these shifts can be coordinated with infrastructural changes while meeting safety, resiliency, and energy equity goals.

This initiative supports nimble, rapid research that draws from existing data and fieldwork on ongoing experience and conditions. It is designed to produce insights that help achieve the massive reductions in fossil gas use envisioned to meet state goals, understand the varied

consequences of these efforts, and provide timely, actionable results informing gas decarbonization policy, implementation, planning, and research. It will aim to improve the connection between high-level gas transition planning and pursuit of end-use changes.

Better understanding this bidirectional connection will inform actions and expectations for relevant processes, including:

- Influencing value chains to better favor alternatives to fossil gas end use.
- Anticipating changes in demand patterns and bringing these changes to bear in resource and reliability planning.
- Understanding and managing the impacts of this suite of changes.
- Building a deeper understanding of options for addressing hard-to-electrify gas end uses.

In taking a distributional perspective, rather than one more oriented to averages, research funded under this initiative will also highlight important elements of variability in transition opportunities and effects.[33] Making this variability more visible can foster greater energy equity and build a more systematic ground-level understanding of the technology needs, opportunities, and challenges in decarbonizing the gas system.

Initiative Title: Support Equitable, Safe, and Cost-Effective Decarbonization of California's Gas System

Initiative Description

This initiative advances knowledge critical to effective implementation of gas system decarbonization. It covers all sectors, including the power sector, and adopts three research tenets.

First, the projects under this initiative will emphasize understanding and influencing the micro-conditions of societal gas use and adopting alternatives to gas as relates to the actions needed for equitable, cost-effective decarbonization of California's gas system. The term *micro-conditions* refers to the detailed physical and social interactions, relationships, and contexts that shape decisions and their effects, such as why a contractor may recommend that a homeowner replace fossil gas equipment with similar gas equipment rather than electrify, or what influences the impacts of electrification in any particular location. This perspective thus digs below generalized approaches to support creating an equitable, cost-effective gas transition on the ground. In turn, this can help to build a more precise understanding of the diverse policies, programs, technologies, and communications needed across the state. Specific research projects anticipated under this initiative are outlined in the Expected Initiative Outcomes section below.

33 This perspective is aligned with that outlined in Jasanoff, Sheila 2018. "Just Transitions: A Humble Approach to Global Energy Futures." *Energy Research & Social Science* 35: 11–14. https://doi.org/10.1016/j.erss.2017.11.025.

Second, the initiative focuses on drawing from existing data — including interval meter data on energy use — and from fieldwork that illuminates implications and insights from recent and ongoing experiences in conversion from gas end uses and related gas transition activities. In doing so, the initiative seeks to complement and leverage data, recent research results, and past and emerging experiences pertinent to transitioning from fossil gas.

Third, it stresses that the empirical grounding targeted via this approach will be analyzed and presented in a way that guides ongoing planning, research, investment decisions, and state agency processes, including proceedings, rulemakings, and guidance, more quickly and purposively than a conventional multiyear research cycle requires. Grants funded under this initiative will thus be crafted to accelerate the pace of information transference, be responsive to a rapidly evolving regulatory landscape, and be tuned to near-term usability while maintaining scientific quality and relevance to mid- and longer-term perspectives.

Projects funded under this initiative will include mechanisms to stimulate the nimbleness, customization, and communications required to serve these usability goals. These mechanisms could include: (1) using work authorizations to provide flexibility to address emerging questions and opportunities in a timely manner and with detailed targeting of applicable expertise, versus relying on fully predetermined multiyear scopes of work; (2) agreement language that prioritizes sharing interim results to create dialogues and leverage opportunities to test results; and (3) processes to reduce or avoid acquisition delays for use of key data (e.g. interval meter data for gas and electricity).

Expected Initiative Outcomes

Successful research under this initiative will increase the effectiveness of California's transition from fossil gas use. Success includes developing empirically grounded research approaches that increase the feasibility of gas sector decarbonization and improve the benefits thereof, including by illuminating inequities and possible ways to address them and by anticipating the impacts of electrification on the grid and the gas system. Success also includes contributions to decommissioning planning, such as coordination across disparate R&D and planning topics, to offer a more comprehensive vision of the state's ongoing energy transition and the expected pace of its varied elements. Expected research projects funded under this initiative include at least three projects across the following areas:

- Identifying challenges and development of improvements in equipment value chains toward favoring conversion from gas, such as relates to the decision processes of vendors and of equipment purchasers when replacing gas-powered equipment, supply chain constraints, workforce reskilling needs, technological development needed to improve outcomes and reduce costs, and policy instruments recommendations (such as related to subsidies) to encourage successful conversion from gas. *For example, what changes would make equipment installation contractors more willing to recommend conversion from gas to their residential customers?*
- Discerning lessons learned during the implementation of electrification programs or other electrification efforts, such as within locales that had implemented gas bans or post-disaster rebuilds. This could include examining cases where conversion from gas was

infeasible or protested. *For example, what approaches worked well during locally led electrification efforts, what problems were encountered, and how were exceptions to electrification managed? What can be learned from SB 1221 pilot decommissioning projects and what recommendations and tools can be offered to help improve the success of these pilots?*

- Informing gas demand forecasting and capturing the impacts of gas end use electrification on electricity demand patterns over the long term, shedding light on implications of gas sector decarbonization on energy reliability and resilience, retail electricity prices, and affordability. *For example, how should demand forecasting assumptions and methods be adjusted to better anticipate winter peaks in electricity demand that originate in the electrification of gas space heating?*
- Investigating other interactions between long-term gas planning and electricity system development to create a transition away from gas end uses and from gas-fired power generation – often critical to serving peak net demand – that delivers overall energy reliability at acceptable costs. *For example, what strategies can be used to ensure that electricity customers – including those who convert from gas to electricity – have adequate electricity access including during critical conditions, and what strategic issues related to the operation of gas-fired power generation need to be considered?*
- Synthesizing and communicating evidence of air quality impacts, health implications, and other costs and benefits from converting from fossil gas, including attention to the distribution of these impacts. This work could draw data from a variety of existing resources, e.g., measured data on air exchange rates in homes along with house square footage as collected during home energy upgrade programs, and pollutant concentration data from indoor air quality research. It could then use a combination of data to model impacts. *For example, how do the air quality impacts of conversion from gas vary by location, by occupant characteristics or user practices, and by building conditions?*

These results can be used by parties involved in California's gas system transition, including implementers of end-use conversion from fossil gas, planners requiring better knowledge of expected patterns of gas use change (such as for demand forecasting or safety), regulators and policy makers, and technology developers.

The initiative complements efforts that focus more exclusively on trying to convince end users to convert from fossil gas use by providing information or incentives. Unlike those efforts, this initiative instead draws attention to identifying and targeting systematic issues that impede conversion from fossil gas or retirement of gas infrastructure. It will also help refine transition planning by providing a clearer view of ongoing experiences and related implications, as well as guide technology development by outlining existing technical inadequacies that targeted innovation could help overcome. In addition, funded research will evaluate outcomes and characterize costs and benefits distributionally, supporting R&D, deployment, and policy approaches that help meet energy equity goals and support the realization of anticipated benefits.

Benefits to Californians

Californians benefit from research supported by this initiative because of the focus on providing a strong empirical understanding of effective pathways for achieving end-use changes. This in turn supports assessing costs, benefits, and risks distributionally—that is, for different groups of consumers or other stakeholders. They also benefit from the strategy of leveraging existing data sources and experiences. This approach improves research cost-effectiveness and develops results that reflect real-world contexts. These results will guide CEC's Gas Decarbonization OIIP on Decarbonizing the Gas System (Order 22-0309-7) and CPUC's Long-Term Gas Planning Rulemaking (R. 20-01-007), benefiting all ratepayers.

For each benefit category, the section below gives example benefits and metrics that could be considered, each illustrated for one or more of the project areas described in the Expected Outcomes section above.

Affordability: Supported research will streamline decommissioning planning by systematically analyzing empirical data related to costs, thus reducing risk of costly missteps. Benefits include improved control and prediction of the patterns and pace of electrification and improved information on the impacts of electrification on energy customer bills.

Possible metrics to assess affordability include:

- Effectiveness of information dissemination and adoption of research results, including:
    - Integration of improved information into decommissioning planning and into rate-related policies, yielding potential decommissioning cost reductions and improving energy affordability.

Safety and reliability: Supported research will guide high-level gas transition planning and supporting processes, including the California Energy Demand Forecast and the reliability and resilience planning it shapes. It can also inform tactical elements of system decommissioning based on changing patterns of gas end use and related effects on hydraulics and derating decisions, which affect costs and public safety.

Possible metrics to assess safety and reliability include:

- Improvements in estimating gas and electric demand patterns, including changes to winter peak and its weather sensitivity due to electrification of gas end uses.
- Use of research results in energy forecasts, which could lead to forecast accuracy improvements that support better reliability.

Adaptation: Results will highlight potential difficulties related to energy resilience, costs, or transition effectiveness that the state, industry, and other social groups (such as nongovernmental organizations and communities) can address, along with recommendations for overcoming or mitigating these difficulties.

Possible metrics to assess adaptation include:

- Identification of barriers to conversion and improved strategies for increasing the appeal of electrification of gas end uses and for managing energy resilience vulnerabilities throughout the transition.

- Effectiveness of information dissemination and its integration into program design or policies.
- Mid- and longer-term metrics could capture the integration of this knowledge (e.g., adoption of resilience technologies or operational strategies).

Environmental sustainability: Research will help accelerate conversions of fossil gas end uses to lower carbon alternatives, reducing GHG emissions and other air pollution with accompanying benefits to environmental and human health.
Possible metrics to assess environmental sustainability include:

- Evidence of the effectiveness of information dissemination and use of research results by programs and supply chain actors (e.g., contractors and end consumers).
- Estimation of the indoor air quality improvements, criteria air pollutant reductions, and GHG emissions reductions attributable to the application of improved knowledge.

Equity: By including a focus on patterns of gas use conversions and on variability of related costs, benefits, and risks across populations, research supported by this initiative can identify potential inequitable outcomes (e.g. consumers who rent homes may bear the costs of decommissioning without being able to transition from gas, or reducing energy resilience in areas with weak electricity service) in current and prospective decommissioning practices so they can be better addressed.

Possible metrics to assess equity include:

- Identification of sub-populations at risk of increased inequities in energy costs or energy reliability in a "business-as-usual" transition away from gas.
- Effectiveness of information dissemination and use of research results (e.g., number of information sharing forums, references in regulatory proceedings and policy reports).

Rationale

Because this research is not closely related to profits or to securing market position for specific technologies or economic activities, it is unlikely to be adequately addressed by competitive markets. Due to the scale of the energy transition and the tremendous diversity of energy end users, technologies, businesses, and practices and potential impacts involved, a coordinated portfolio of decommissioning research is required to avoid missteps and to help achieve the balanced approach. This is underscored by the Joint Agency Staff Gas Transition White Paper, which asserts, "State agencies must align the gas system with State priorities and support a

smooth transition to a decarbonized energy system. The challenge lies in balancing many priorities to create a clean, affordable, safe, reliable, and equitable gas system."[34]

The initiative responds to key needs identified in state processes and studies, including:

- The CPUC's Long-Term Gas System Plan Rulemaking R.24-09-012 and its predecessor R.20-01-007, along with the Joint Agency Staff Gas Transition White Paper associated with these rulemakings, all of which recognize the challenge of balancing many priorities in achieving California's decarbonization goals. This initiative takes an integrative and empirical approach in service of finding that balance.
- The CEC's Gas Decarb OIIP, which highlighted the need for long-term gas planning and the risks of unduly burdening disadvantaged and lower-income communities and individuals.
- The CEC's IEPRs, including the Final 2021 Integrated Energy Policy Report, Volume III: Decarbonizing the State's Gas System.[35] That volume emphasizes unknowns in managing safety and reliability in conjunction with local transitions from gas; this initiative will inform that coordination.
- The Guidehouse Long-Term Gas Research Roadmap, which makes recommendations for research[36], like that proposed by this initiative, that is related to communities, equity, and environment in the achievement of state gas decarbonization goals.
- SB 1221 (2024) - Gas Corporations: Ceasing Service: Priority Neighborhood Decarbonization Zones, which requires CPUC to designate priority neighborhood decarbonization zones on the gas distribution system and to facilitate decarbonization of priority neighborhood decarbonization zones. This initiative[37] would support the implementation of SB 1221 in several dimensions, including by informing efficient execution of priority neighborhood decarbonization, contributing to energy resilience for these areas, and assessing and communicating air quality and other local benefits of decarbonization.

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[34] 2024 Joint Agency Staff Paper: Progress Towards a Gas Transition. A White Paper Supporting the CPUC's Long-Term Gas Planning Rulemaking R.20-01-007. https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M525/K660/525660391.PDF. See p. 6.

[35] Jones, Melissa, Jennifer Campagna, Catherine Elder, and Stephanie Bailey. 2022. Final 2021 Integrated Energy Policy Report, Volume III: Decarbonizing the State's Gas System. California Energy Commission. Publication Number: CEC-100-2021-001-V3. https://efiling.energy.ca.gov/GetDocument.aspx?tn=242233

[36] Webinar recording and presentation on Long-Term Gas Research Strategy Recommendations can be found at: https://www.energy.ca.gov/event/webinar/2022-12/webinar-long-term-gas-research-strategy-recommendations

[37] The initiative was originally developed before SB 1221 passed. It was designed to support gas decommissioning pilots, like those subsequently envisioned under SB 1221, as well as longer-term decommissioning and other elements of gas system decarbonization.

The initiative responds to key research gaps and needs identified in coordination with CPUC, IOUs, and other stakeholders, including:

- Conversations with CPUC gas policy branch staff during CEC-CPUC research meetings held in 2022–2024, CPUC's Long-Term Gas Planning Rulemaking documents, feedback during research plan development processes, and specific requests from CPUC Energy Division staff to elaborate on the research proposed by this initiative.
- Coordination with gas utility staff and research organization staff on decommissioning and decarbonization research, including exchanges related to the PG&E Innovation program,[38] and in a CEC scoping workshop and a CEC pre-application workshop on decommissioning and decarbonization research for previously-approved initiatives within CEC's Gas Research program.[39]

Technology and Market Background

The gas energy transition market is at an early stage. There is limited, but growing, experience from which to chart a path toward achieving policy aspirations. Most members of the public are only marginally aware of California's gas transition plans. Only very small decommissioning pilots have been completed in California, and practical concepts related to executing decommissioning are still in development. Crucial uncertainties remain regarding the roles of low-carbon gases and non-pipeline alternatives, and major challenges lie in coordinating gas decommissioning with the reinforcements that are needed in the electricity system to accommodate increased electricity demand with sufficient reliability and resilience.

Projects funded by earlier Gas R&D decommissioning initiatives are continuing to make progress in compiling infrastructure and other geospatial data in guiding planning, assessing air quality impacts of reducing fossil gas use, and analyzing location-specific data to identify promising candidate pilot sites for infrastructure decommissioning. The research on prospective decommissioning pilot sites suggests that implementing conversions of energy equipment from using fossil gas to cleaner alternatives in a manner coordinated with near-term decommissioning of pipeline segments will be challenging. Legacy practices from past energy policy efforts, such as encouraging change in how consumers make energy decisions by providing information and incentives for efficiency, will help but are not adapted to the scale, intensity, or level of coordination required for the gas energy transition envisioned by the state.

In addition, the success of efforts to decarbonize energy end uses at transition scale depends on reliable supply chains for materials, equipment, and appropriately skilled labor, and thus is

[38] See https://www.pge.com/en/about/pge-systems/research-and-development.html?vnt=innovation

[39] Paving the Way for California's Gas Transition (pre-application workshop: https://www.pge.com/en/about/pge-systems/research-and-development.html?vnt=innovation as well as a 2024 scoping workshop).

vulnerable to the challenges of international economic conditions. Plus, society is actively adapting to climate change and the energy stresses it causes, and that process is slow, unpredictable, and ongoing.

These conditions create a need for empirically based assessments illuminating options for paths ahead. These assessments include ways to encourage and support technological change at the end-use level and, in turn, how these changes can effectively be coordinated with infrastructure changes and resource planning; ways to handle hard-to-electrify end uses or situations (such as specific cases with prohibitive conversion costs or special resilience challenges); and the benefits and costs of the gas transition for energy users, energy security, system safety, and resilience overall. Research supported under this initiative will inform these pathways based on ongoing experience in decarbonizing the gas system and by coordinating across disparate components of gas transition research and planning.

Initiative Theme: Gas System Safety

California's gas system provides service to more than 11 million metered customers through an extensive network of nearly 12,000 miles of transmission pipelines and more than 300 underground gas storage wells. [40] [41] While California is working to transition end uses such as buildings and transportation to electricity, maintaining robust storage and transmission infrastructure plays an important role in ensuring system reliability and protecting customers from adverse rate impacts in the electricity and gas sectors. In addition, at this juncture of California's clean energy transition, gas storage wells remain important to provide a stable supply of gas during periods of peak winter demand and continue to fill a critical role in balancing the intermittency of renewable electricity generation.[42]

The urgency of gas system safety becomes even more critical in light of California's aging gas system, which increases the risk of vulnerabilities and potential system failures. Events such as the 2015 Aliso Canyon leak and 2010 San Bruno pipeline explosion are reminders of the importance of prioritizing public safety, public health, and emissions considerations in gas system research and planning. In the aftermath of these major incidents, more stringent safety regulations have been issued by the California Geologic Energy Management Division (CalGEM) and PHMSA, requiring additional tests and inspections to ensure system safety and integrity.

The gas system is becoming increasingly costly to maintain due to aging infrastructure, safety regulations, and decreasing gas usage, the latter of which may also create a gap in cost

40 California Public Utilities Commission. "*Natural Gas and California*," https://www.cpuc.ca.gov/industries-and-topics/natural-gas/natural-gas-and-california.

41 Pipeline and Hazardous Materials Safety Administration. "*Pipeline Mileage and Facilities*," https://www.phmsa.dot.gov/data-and-statistics/pipeline/pipeline-mileage-and-facilities.

42 California Public Utilities Commission. 2023. "*Decision on Phase 2 Issues Regarding Transmission Pipelines and Storage*," https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M521/K892/521892086.PDF.

recovery.[43] To reduce costs during this transition while ensuring safety and reliability, the Gas R&D Program has historically coordinated with gas IOUs and funded research in developing innovative tools and technologies to better assess system vulnerability and prevent damages from geohazards, excavation, corrosion, and other threats. The Gas R&D Program complements research conducted by industry and gas utilities, helping address public safety and affordability issues in the context of achieving the state's climate goals.

Initiative Title: Innovations for Cost-Effective Operation and Maintenance of Critical Infrastructure During the Gas Transition

Initiative Description

This initiative will build on prior CEC research to improve the costs, accuracy, and data quality in operations and maintenance of underground gas storage wells and transmission pipelines by developing strategies and resources, such as continuous monitoring technologies, less intrusive inspection methods, and data management and communication systems. Research conducted under this initiative may include:

- Developing more accurate and reliable monitoring technologies that can detect anomalies in underground storage wells without needing invasive and costly conventional well inspections, thereby improving system safety while minimizing disruptions to operations.
- Optimizing alternative well inspection frequencies by improving data quality and models to estimate degradation trajectory and improving understanding of how inspection techniques may impact well integrity.
- Advancing nondestructive testing methods to verify the material properties of gas pipelines, thus reducing the need for costly excavations or testing methods that disrupt pipeline operations.
- Improving in-line inspection technologies for small-diameter transmission pipelines, which can be particularly challenging to inspect due to size and complex geometry.
- Supporting integration of data management and communication technologies, including asset tracking and traceability, situational awareness systems, and tools supporting documentation and analysis of human factors in managing risk.

Expected Outcomes

Technologies developed under this initiative will support safer and more cost-effective methods of meeting gas system operations and maintenance requirements and inform more optimal prioritization and frequency of inspections. Among the advancements, less intrusive well inspection and monitoring technologies may include fiber optic, acoustic, and electromagnetic sensors that can detect anomalies in mechanical well barriers. Furthermore,

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43 Aas, Dan, Amber Mahone, Zack Subin, Michael Mac Kinnon, Blake Lane, and Snuller Price. Energy and Environmental Economics, Inc. California Energy Commission. "*The Challenge of Retail Gas in California's Low-Carbon Future*." Publication Number: CEC-500-2019-055-F, https://www.ethree.com/wp-content/uploads/2021/06/CEC-500-2019-055-F.pdf.

less intrusive well inspections can reduce costs by improving system capacity and decreasing reliance on redundant infrastructure. Enabling earlier responses to well integrity risks before more major intervention is needed will improve system safety and help to maintain capacity.

Furthermore, the initiative explores nondestructive pipeline material verification and small-diameter in-line inspection such as ultrasonic, radiographic, and electromagnetic devices that can measure wall thickness, detect cracks, and detect corrosion damage in gas pipelines. These technologies will enable more rapid testing of the gas transmission system to help protect vulnerable communities and guide derating and decommissioning decisions.[44] Integration of data management and communication technologies will help operators leverage monitoring and inspection data to optimize operations and maintenance.

Benefits to Californians

As the gas system transitions and end uses are electrified, operations and maintenance of the gas system will remain complex and costly. Development of accurate and reliable technologies for assessing integrity and detecting anomalies in storage wells and transmission lines will help ensure safe, reliable, and affordable operation while minimizing environmental impacts.

Affordability: As gas demand declines to help achieve the state's climate goals, fewer ratepayers will be assigned the costs to maintain the aging gas system. Reducing maintenance costs can help avoid adverse affordability impacts to ratepayers during this transition. This initiative will support innovations for alternative inspection methods that avoid restricting gas system capacity, which can also result in higher costs for ratepayers by reducing supply and requiring system redundancies.

Possible metrics to assess affordability include:

- Operational cost savings, such as avoided costs of manual inspections, reduction of associated infrastructure down time, the reduced need for redundancy to maintain reliability during inspections, or the number of alternative inspection technologies developed or demonstrated.

Safety and reliability: Detecting threats in real time will allow operators to intervene before issues escalate into significant safety concerns. Proactive and targeted responses minimize the risk of equipment failure or other incidents that could disrupt service or result in costly consequences for ratepayers and surrounding communities.

Possible metrics to assess safety and reliability include:

- Number of integrity issues or leaks identified with alternative monitoring and inspection methods.
- Response time to address and/or repair identified threats.
- Extent of monitoring and inspection coverage achievable as compared to current industry standards and practices.

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44 *Derating* means to decrease the capacity or operating limits of an asset due to aging or degradation of the asset, or to extend the asset's useful life.

Adaptation: Considering the interdependencies of the gas and electric sectors, operation and maintenance of transmission pipelines and underground gas storage facilities will continue to play a crucial role in protecting ratepayers from reliability and adverse rate impacts in the gas and electric sectors as California transitions away from fossil gas.

Possible metrics to assess adaptation include:

- Number of infrastructure vulnerabilities detected in high-risk climate zones that could be further affected by climate-related impacts, such as flood, extreme heat, or geohazards.
- Adoption of research results through risk mitigation measures, practices, or policies that are informed by additional monitoring and data-driven insights.

Environmental sustainability: Current pipeline and well inspection methods require systems to be taken offline for inspection, requiring redundant gas infrastructure to remain in operation to maintain capacity. Less intrusive methods will reduce downtime and help minimize the footprint of the gas system. Moreover, early identification of potential issues such as leaks or structural weaknesses can guide prompt mitigation efforts, reducing environmental impacts.

Possible metrics to assess environmental sustainability include:

- Avoided or reduced GHG emissions as a result of 1) early detection of infrastructure anomalies or weaknesses that could result in leaks, or 2) reduced footprint of the gas system resulting from reductions in system redundancies.

Equity: Lowering potential risks to transmission pipelines and underground gas storage facilities is critical for protecting surrounding communities that may be subject to disproportionate impacts from incidents, environmental damage, and the high costs of equipment repairs and disaster recovery. Lowering the costs of risk mitigation helps improve affordability for all ratepayers.

Possible metrics to assess equity include:

- Number of demonstrations that occur within low-income or disadvantaged communities.
- Number of engagements with community-based organizations or other relevant stakeholders.

Rationale

The initiative responds to key needs identified in state processes and studies including:

- CalGEM's Requirements for Underground Gas Storage Projects that went into effect in 2018 and require, in addition to annual noise and temperature logging, well casing wall thickness inspection and pressure testing every 24 months unless an alternative interval is approved by CalGEM.[45] Conventional means of performing well inspections require the well to be shut off and instruments to be lowered into the well to make

45 California Department of Conservation. "*Geologic Energy Management Underground Gas Storage Regulations*," https://www.conservation.ca.gov/calgem/general_information/Pages/UGSRules.aspx.

measurements and detect anomalies. Pressure testing is performed to verify structural integrity. Maintenance plans to meet CalGEM requirements are projected to cost hundreds of millions of dollars through 2030, delay the decommissioning of the Los Medanos storage field in Contra Costa County, and require new wells to be drilled to maintain capacity requirements.[46] In addition, conventional inspections carry safety risks because of human factors, reliability of inspection equipment, and complexity of tasks.[47]

- PHMSA's Mega Rule, which took effect in 2019, that requires pipeline operators to reconfirm maximum allowable operating pressure, verify pipeline material properties, and perform integrity assessments based on criteria such as existing data, location, and operating pressure of the pipeline.[48] These regulations affect more than 1,000 miles of California's transmission pipelines and will be more costly than preceding regulations.[49] CEC staff intend to stay coordinated with PHMSA's Pipeline Safety Research and Development Program and explore opportunities to build off early-stage research funded by PHMSA to accelerate implementation in California. Research is needed to develop more cost-effective methods for meeting the current PHMSA and CalGEM requirements.[50] In addition, data collected could guide future decisions on gas system operation and maintenance requirements. Leveraging public interest research funds for this initiative ensures that findings remain impartial, transparent and closely aligned with the interest of ratepayers and the public. Furthermore, by making the research publicly accessible, the results will be more useful in informing program and policy processes.
- SB 887 (2016) - Natural gas storage wells: This bill was issued in response to the 2015 Aliso Canyon incident, introducing measures to ensure the safety and integrity of gas storage facilities. Research conducted under this initiative could further support the goals and objectives of SB 887 by advancing technologies to enhance early leak detection, well integrity assurance, and risk management.
- Senate Bill 1371 (2014) - Natural gas: leakage abatement: This bill requires the CPUC to determine whether existing practices are effective at reducing methane leaks and promoting public safety, and whether alternative practices may be more effective.

46 CPUC. May 2023. "*Senate Bill 695 Report*," https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/office-of-governmental-affairs-division/reports/2023/2023-sb-695-report---final.pdf.

47 California Department of Conservation. 2022. "*Statutes and Regulations*," https://www.conservation.ca.gov/index/Documents/CALGEM-SR-1%20Web%20Copy.pdf.

48 PHMSA. 2019. "*Pipeline Safety: Safety of Gas Transmission Pipelines: MAOP Reconfirmation, Expansion of Assessment Requirements, and Other Related Amendments*," https://www.federalregister.gov/documents/2019/10/01/2019-20306/pipeline-safety-safety-of-gas-transmission-pipelines-maop-reconfirmation-expansion-of-assessment/.

49 California Public Utilities Commission. 2023. (Table 23). "*Senate Bill 695 Report*," https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/office-of-governmental-affairs-division/reports/2023/2023-sb-695-report---final.pdf.

50 U.S. Department of Transportation. "*Pipeline Research & Development*," https://www.phmsa.dot.gov/research-and-development/pipeline/about-pipeline-research-development

Research funded through this initiative could enable more accurate, real-time detection of methane leaks and can help inform future policies and practices for methane emission management across gas system infrastructure.

The initiative responds to key research gaps and needs identified in coordination with CPUC, IOUs, and other stakeholders, including:

- In 2023, staff from CEC and CalGEM held a series of meetings to discuss ongoing research on underground storage monitoring and inspection technologies; explore future research opportunities, including improving emerging less-intrusive inspection and monitoring technologies to accurately identify anomalies; and better understand factors for determining alternative inspection intervals.
- CEC staff met with PG&E on February 7, 2024, to discuss the Gas System Safety Initiative. Key outcomes included identification of promising research gaps and coordination opportunities to consider when implementing the "Innovations for Cost-Effective Operation and Maintenance of Critical Infrastructure During the Gas Transition" initiative, building on related past and active gas operations R&D supported by PG&E, SoCalGas, and U.S. DOT PHMSA. Example research gaps discussed include technologies that could reduce costs of inspecting and verifying the material grade of transmission pipelines and less intrusive underground storage well inspection and continuous monitoring technologies that could provide sufficient data to justify alternative well integrity inspection intervals while ensuring equivalent safety.
- In response to the December 15, 2023 public workshop, SoCalGas provided comments noting that this is an important initiative and suggested future coordination between staff of SoCalGas and CEC.
- On January 10, 2025, CEC met with CPUC subject matter experts to discuss and respond to feedback about the Gas System Safety research initiative. The CEC team discussed how this initiative aligns with cost effectiveness goals, the value of public research funding in this space, and the importance of coordination with CalGEM both in the development of this initiative and in future initiative refinement through the solicitation development process.

Technology and Market Background

Prior CEC-funded projects have collaborated with PG&E to demonstrate real-time monitoring of underground gas storage wells with the use of fiber optics and less-intrusive inspections with electromagnetic technologies.[51] Building upon this work, advancements in existing and novel real-time monitoring and data management technologies can enable faster intervention and proactive maintenance. By providing operators with accurate, more granular, and timely data about the condition of their assets, they will be better able to identify potential issues before they become major problems or hazards. These data allow for quicker response times when

51 Agreement PIR-19-001. "*All-Optical Multi-Sensor Well Monitoring System to Secure Gas Storage Operations*" and PIR-19-002 "*Electromagnetic and Optical Sensor Technologies for Natural Gas Storage Safety Monitoring*."

needed as well as more proactive maintenance strategies that can help prevent costly repairs or replacements. Real-time monitoring can provide insights into operational performance, which may be used to guide decision making related to future investments and decommissioning, but research is needed to improve data quality and reduce costs.

Less intrusive inspection technologies can reduce the need for conventional well inspections, which are required due to current regulations. Conventional inspections are resource-intensive, requiring the well to be shut off as specialized equipment enters the well to perform a series of tests. Well entries pose significant risks to well integrity because of the potential for equipment failure or human error. Minimizing well entry frequency and using less invasive entry methods are associated with lower operating risks over the life of the well.[52] Less intrusive methods can provide useful information to determine well integrity while reducing or eliminating well shutoff durations, thereby avoiding capacity impacts to the system. Additional research is needed to understand the human factors in well inspection safety, develop less intrusive inspection technology alternatives, and optimize inspection frequency with robust risk assessments.

Nondestructive testing can provide accurate information about the integrity and material properties of transmission pipelines with minimal disruption to gas service.[53] Surface testing such as microindentation can be used to obtain information about yield strength and other mechanical properties of pipeline materials without needing to shut off or remove portions of the pipeline.[54] Inline inspection technologies such as magnetic flux leakage are used to examine pipeline walls without requiring direct access to the full length of the pipeline.[55] Inline inspection can detect subcritical flaws and provide data used in reconfirming maximum allowable operating pressure.[56] Improved inline inspection technologies for small-diameter transmission pipelines can aid in inspecting pipelines that are too narrow or have geometry that is too complex for current in-line inspection technologies. Additional research is needed to improve the versatility, data reliability, and analysis methods of nondestructive testing to reduce the need for more disruptive and destructive testing.

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42 C-FER Technologies. 2020. "*Risk Assessment and Treatment Wells*," https://rosap.ntl.bts.gov/view/dot/56180.

53 *Nondestructive testing* is a group of testing methods that evaluate the properties of a material, component, or system without causing damage.

54 GTI Energy. 2021. "*Validating Non-Destructive Tools for Surface to Bulk Correlations of Yield Strength, Toughness, and Chemistry,"* https://primis.phmsa.dot.gov/matrix/FilGet.rdm?fil=15889&s=59804F6060A24393B2C4804836990D47&c=1.

55 *Magnetic flux leakage* is a nondestructive testing method that uses magnetic fields to detect defects in steel structures.

56 PHMSA. 2019. "Pipeline Safety: Safety of Gas Transmission Pipelines: MAOP Reconfirmation, Expansion of Assessment Requirements, and Other Related Amendments," https://www.federalregister.gov/documents/2019/10/01/2019-20306/pipeline-safety-safety-of-gas-transmission-pipelines-maop-reconfirmation-expansion-of-assessment.

Initiative Theme: Renewable Generation

In 2022, California's power sector generated more than 36 percent of its energy from fossil gas that contributed to nearly 16 percent of the state's GHG emissions.[57] [58] The transition to a cleaner energy system requires adaptable power generation solutions that can remain efficient and reliable. An important component of this transition could be fuel-flexible distributed power generation to bolster resiliency while providing clean energy access to vulnerable communities, especially during extreme weather and grid events.[59] Clean distributed generation aligns with the goals in SB 100 (De León, Chapter 312, Statutes of 2018), which mandates a transition to 100 percent renewable energy and zero-carbon resources by 2045.[60] In line with these goals, California is in a rapidly evolving phase in which increased adoption of renewable gases such as hydrogen, biomethane, or ammonia, are being considered, potentially creating a fluctuation in the mixtures of gas in the fuel stream. Fuel-flexible generation can also help achieve goals under AB 205 (Ting, Chapter 61, Statutes of 2022), which created the Strategic Reliability Reserve to support the state's electric grid reliability for technologies like those proposed in this initiative.[61] [62]

The CEC has funded hydrogen-blended generation research to develop and demonstrate GHG and oxides of nitrogen (NOx) emissions-mitigating technologies in gas-fired systems. In contrast, this initiative focuses on developing combustion and non-combustion generation technologies to be flexible for using either a single renewable fuel or a mix of renewable fuels demonstrated in distributed generation applications. The fuel-flexible technology innovations developed under this initiative would allow for decarbonization strategies that use different fuels based upon the availability and costs of the renewable fuel and the fuel blending infrastructure.

This research initiative complements the distributed generation decarbonization work of IOUs, publicly owned utilities (POUs), and industry that support California's transition to a net-zero-carbon energy future. The CEC shares information pertaining to initiative goals and funded research projects with SoCalGas and PG&E to avoid unnecessary duplication. This coordination and collaboration ensures that funding from the Gas R&D program is strategically applied to areas that are best supported by ratepayer funds. For example, the CEC and SoCalGas have

57 California Energy Commission. 2022. "*2022 Total System Electric Generation*", https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/2022-total-system-electric-generation.

58 California Air Resources Board. 2023. "*Current California GHG Emission Inventory Data*. 2000-2021 GHG Inventory (2023 Edition)." https://ww2.arb.ca.gov/ghg-inventory-data.

59 *Fuel-flexible distributed power generation* means having distributed systems capable of using a wide range of decarbonized fuels and fuel blends.

60 Senate Bill 100. 2018. *Bill Text: CA SB100 | 2017–2018 | Regular Session*, https://legiscan.com/CA/text/SB100/id/1819458.

61 Bill Text: CA AB205 Energy | Chapter 61|. https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220AB205.

62 California Energy Commission. "Distributed Electricity Backup Assets Program," https://www.energy.ca.gov/programs-and-topics/programs/distributed-electricity-backup-assets-program.

collaborated on and co-funded several Gas R&D projects in the past and further collaboration is expected in the future. In particular, the SoCalGas FY 2022-2023 R&D Budget Plan[63] has the following synergistic and non-duplicative R&D initiatives:

- *Clean Generation - Distributed Generation: Hydrogen Integration with Existing Power Generation Technologies*: Projects in this area seek to continue to test and identify pathways for increased levels of hydrogen blending for fuel cell, engine, and turbine-based distributed generation technologies currently operating on natural gas (p. 53).
- *Clean Generation – Integration and Controls: Integration of Low-emissions Backup Generation with Existing Customer Electrical Systems to Provide Energy Resilience*: Projects in this area seek to demonstrate how low-emissions backup generation can be seamlessly integrated with existing customer systems to provide increased resilience. This topic is targeted towards the integration of intermittent/backup generation with existing systems. With the increasing regularity of wildfires (and resulting Public Safety Power Shutoff events), customers and agencies are looking for alternatives to diesel backup generation and clarity on how low-emissions natural gas- or hydrogen-fueled generation technologies can address this need (p. 55).
- *Customer End-Use Applications – Industrial Process Equipment: Hydrogen Blends in Industrial Equipment:* Industrial processes with high energy loads and high-temperature requirements are extremely difficult to electrify. Projects in this area will investigate how hydrogen blends impact the performance of industrial equipment, with a particular focus on NOx emissions (p. 61).

The section on "Expected Outcomes" discusses the comparison between the FY 2022-2023 SoCalGas R&D Budget Plan initiatives and the CEC's proposed initiative.

Initiative Title: Fuel-Flexible Distributed Power Generation

Initiative Description

This initiative will result in development and demonstration projects that can take distributed generation technologies, such as reciprocating engines, gas turbines, linear generators, and

[63] Southern California Gas Company 2022 Research Development and Demonstration Plan in Compliance with Ordering Paragraph 30 of Decision 19-09-051. Tier 3 Advice Letter Submitted to CPUC on June 21, 2021. Link: blob: https://tariffsprd.socalgas.com/0023040e-ea40-4af5-8d63-0acd5a45272a

fuel cells and make them adaptable to the anticipated changing fuel supply. [64] [65] [66] [67] Innovations are needed at the component level up to the system level to ensure that fuel-flexible technologies will meet performance, operability, cost, low-emissions, and decarbonization goals and targets. The intent is to develop cost- and performance-competitive fuel-flexible generation technologies that could eliminate need for fossil-fueled generators including diesel generators. This initiative will require projects and technology/fuel systems to be thoroughly evaluated on the basis of key metrics such as affordability, air quality, GHG and life-cycle emissions, and system performance including flexibility, operability and viability.

Expected Outcomes

Successful projects funded under this initiative will advance the development of clean distributed generation systems to align with California's decarbonization goals while ensuring reliable performance. Outcomes include achieving emission levels below the maximum regulatory thresholds, increasing fuel efficiency, reducing costs, and delivering resilience. Demonstrations may involve either deploying new installations that use electrochemical, thermochemical, or other proven pathways with low emissions without being dependent on emissions control technologies, or modifying existing combustion systems, whereby each demonstration would greatly reduce GHG and criteria pollutants and have other public health impacts.

The inclusion of combustion systems is needed to allow investment in a mixed technology scenario for a decarbonization approach that reduces risk and enables a faster, more cost-effective transition. Modifying existing combustion systems to operate on renewable fuels would enable use of existing engine platforms that could tolerate potential fuel impurities while operating reliably and ensuring low emissions. The intention is to adapt and scale up distributed generation systems to be used as added generation support, and to locate systems carefully and strategically at commercial or industrial sites that avoid negatively impacting disadvantaged or low-income communities.[68] Given the potential scarcity of renewable fuels, potential projects must secure a reliable fuel source. Project outcomes could provide valuable information for the future adoption of technologies as renewable fuels become more widely available.

CEC staff anticipates that research results and technology advancements will benefit diverse sectors, including commercial buildings, industrial operations, utilities, and communities in remote or rural locations, especially those not connected to the grid. Critical infrastructure like

64 *Reciprocating engine* is an engine in which expanding combustion gases move one or more pistons up and down in cylinders.

65 *Gas turbine* is an engine in which expanding combustion gases spin the blades of a turbine.

66 *Linear generator* is a device that uses a low temperature thermochemical reaction to create linear motion that is directly converted into electricity, as defined under Rule 1110.2 of South Coast AQMD. Refer to: https://www.aqmd.gov/docs/default-source/rule-book/reg-xi/r1110_2.pdf?sfvrsn=8

67 *Fuel cell* is a device that uses an electrochemical reaction to directly generate electricity.

68 PSE Healthy Energy. May 2020. "*California Peaker Power Plants,"* https://www.psehealthyenergy.org/wp-content/uploads/2020/03/California.pdf.

data centers, hospitals, microgrids, telecommunications, and others that need to ensure continuous operations, especially during grid outages, are of particular interest as demonstration sites, as these fuel-flexible generation technologies have the potential to replace diesel backup generators and greatly reduce concomitant pollutants.

Projects under this initiative could also leverage other state programs such as those funded through CPUC including the SoCalGas FY 2022-2023 R&D Budget Plan. A comparison of the SoCalGas and CEC initiatives are provided below:

- SoCalGas R&D on *"Clean Generation - Distributed Generation: Hydrogen Integration with Existing Power Generation Technologies."* This SoCalGas R&D initiative is well-aligned with CEC's initiatives from previous budget plans, specifically "Developing and Demonstrating Hydrogen-based Power Generation Systems" in the FY 2021-2022 Gas R&D Budget Plan and "Mitigate Criteria Air Pollutants in Hydrogen-Based Power Generation" in the FY 2022-2023 Gas R&D Budget Plan. Those earlier Gas R&D initiatives resulted in projects focused on developing hydrogen-blended power generation with low GHG and NOx emissions. In contrast, this proposed initiative is focused on technological advancements and demonstrations of fuel-flexible technologies not necessarily limited to hydrogen.
- SoCalGas R&D *on "Clean Generation – Integration and Controls: Integration of Low-emissions Backup Generation with Existing Customer Electrical Systems to Provide Energy Resilience."* The CEC's proposed initiative would complement this SoCalGas initiative. The CEC initiative focuses on long-term clean onsite or distributed power, and is not limited to emergency backup power. The CEC initiative seeks to help critical facilities that have sources of variable renewable fuels to reduce their reliance on grid-supplied electricity. This could lead to lower emissions and lower costs of energy. The SoCalGas initiative is focused on integrated backup generation systems to provide power when grid electricity is not available. It does not indicate which fuels are preferred, not excluding fossil gas as long as the generation system is equipped with advanced emissions controls.
- SoCalGas R&D on *"Customer End-Use Applications – Industrial Process Equipment: Hydrogen Blends in Industrial Equipment."* This SoCalGas initiative is focused on industrial processes with high energy loads and high-temperature requirements that are extremely difficult to electrify. The CEC's proposed initiative is not focused on industrial heat or industrial processes; rather, it is focused on distributed power generation.

Benefits to Californians

Fuel-flexible generation technologies would be designed for consistent operation amid fluctuating availability and types of renewable fuels. The scalability and modularity of these technologies could increase associated adaptability to changing energy needs and lead to reduced costs through mass production or lower design and implementation costs. Projects can optimize capital and operational costs of power generation technologies by diversifying

fuel sources. The ability to switch among different fuel types will allow operation to be optimized with the most cost-effective renewable fuels, especially as the overall costs of renewable fuels decrease by comparison with fossil fuels. This effort also contributes to addressing Goal 2.4 in the CPUC ESJ Action Plan, as it can reduce pollutant impacts in environmental and social justice communities.[69]

Affordability: Optimize capital and operational costs of power generation technologies by enabling fuel diversification, leveraging cost-effective renewable fuels, enhancing efficiency beyond that of traditional fossil gas technologies, minimizing transmission losses, and capitalizing on scalable, modular designs. In addition, distributed generation can reduce transmission losses, which can ultimately contribute to lowered transmission and distribution costs to consumers.

Possible metrics to assess affordability include:

- Cost savings measured by comparing all associated costs, such as capital, operations, and maintenance costs, with the baseline cost.
- Energy savings measured by generation capacity, total generation, and avoided procurement or imports from the grid.
- Avoided fossil gas use estimated based on average fuel consumption of comparable fossil gas fueled baseline technology.
- Deferred transmission and distribution upgrades estimated and described using data and equivalent values from reports and calculators supported by public agencies such as CPUC.

Reliability and integrity: Enhance energy reliability and grid stability by ensuring consistent operation with various renewable fuels, decentralizing power generation to boost resilience, and potentially replacing traditional backup systems used during outages or peak demand to ensure reliable, on-demand power for communities.

Possible metrics to assess reliability include:

- System performance, such as time to ramp up, seamless integration, power quality, generating capacity, availability, and capacity factor.
- Total electricity generated and used onsite or exported to the grid.
- Avoided procurement and centralized generation costs.
- Measured reliability and integrity through consistent performance at varying fuel quality (to demonstrate fuel flexibility).
- Frequency of equipment downtime or power outage, maintenance needs, and duration or time to get back online.

Safety: Increase resilience to equipment failures, unplanned outages, and fuel slip or leaks. In addition, the initiative supports development of safe handling practices for using different

69 California Public Utilities Commission. 2022. "*Environmental & Social Justice Action Plan,"* https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/news-and-outreach/documents/news-office/key-issues/esj/esj-action-plan-v2jw.pdf.

fuel types in the generation system. Projects will be required to develop a safety plan and adhere to strict safety standards. Safety in design, construction, and operation, including protective components, equipment, alerts, or alarm systems, will be integral to projects.

Possible metrics to assess safety include:

- Nature and frequency of critical equipment failures, fuel leakage, and all other emissions, gaseous and otherwise, that are environmental hazards; these could be compared to sets of safety standards, where applicable, and to a similar or comparable system as a baseline.

Adaptation: Enable technologies that can adjust to the different renewable fuel types that may be available as the fuel streams transition from fossil to renewable gases, thereby supporting reduced reliance on centralized power plants and strain on the grid while enabling distributed generation for local use. Technologies will also be well adapted to seamlessly replace and reduce the need for fossil-fueled generation, including backup diesel generators.

Possible metrics to assess adaptation include:

- System performance, such as generating capacity; availability and capacity factor; total electricity generated, used onsite, or exported to the grid; and avoided procurement and centralized generation costs, as compared to existing system performance.

Equity and environmental sustainability: Reduce GHG and criteria pollutant emissions compared to fossil gas generation technologies, particularly when deployed in under-resourced communities that are often disproportionately affected by pollution. Technology and fuel systems deployed through funded projects will be thoroughly evaluated on key environmental parameters and will require that projects are compliant with existing air quality standards. These technologies would reduce reliance on fossil gas and encourage a transition to renewable fuels with ultra-low-to-zero emissions.

Possible metrics to assess equity and environmental safety include:

- Reduction in emissions of criteria air pollution (e.g., NOx and particulate matter), GHG emissions, and lifecycle emissions.
- Number of communities and EJ representatives engaged for input on concerns and education on the benefits of technology.

Rationale

The initiative responds to key needs identified in state processes and studies, including:

- 2022 Scoping Plan - CARB and SB 100: These statewide strategies emphasize the need for adaptable generation systems to support decarbonization trajectories and help to eliminate use of fossil fuels. This initiative proposes to investigate such systems.
- SB 1440 (2018) – Energy: biomethane: biomethane procurement and CPUC Decision 22-02-025: Fuel changes ordered under SB 1440 resulted in proceedings such as the

2022 CPUC Decision 22-02-025 that are anticipated to cause a significant increase in biomethane entering the gas pipeline system (up to 72.8 billion cubic feet per year by 2030) to help achieve a 40 percent reduction in methane emissions.[70,71] This initiative helps to prepare for and inform the anticipated increase in biomethane.

- The *2022 IEPR Update* recommended expanding SB 100 analyses to evaluate increased hydrogen use to decarbonize fossil gas-fired generation, as well as promote new economic opportunities such as green ammonia.[72] [73] Recommendations in the *Draft 2023 IEPR* highlighted the need for continued research and development on clean and renewable hydrogen generation to improve efficiency, address NO_x formation, and understand materials impacts, especially at higher blends,[74] which this initiative will help to do.
- SB 1383 (2016) – Short-lived climate pollutants: methane: This bill requires reductions in statewide emissions of methane by 40 percent, hydrofluorocarbon gases by 40 percent, and anthropogenic black carbon by 50 percent below 2013 levels by 2030. Innovative fuel-flexible and low emissions generation technologies could reduce methane emissions and help meet the mandates of SB 1383 through possible widescale deployment of power generation technologies that use methane produced by organic wastes in digesters and landfills.
- SB 1369 (2018) – Energy: green electrolytic hydrogen: This policy requires CPUC, CEC, and CARB to consider green electrolytic hydrogen for energy storage and other potential uses. Projects funded by this initiative could provide options and facilities for using green hydrogen.
- The Guidehouse analysis, Long-Term Gas Research Roadmap*,* identified challenges in using renewable fuels that may vary in quality, composition, and characteristics. Other challenges included the use of renewable fuels in distributed generation applications, such as those in remote areas, where electrification may not always be suitable or affordable and fuel-flexible generation options may be needed to fit demands. This initiative seeks to ensure that existing fossil gas-fired technologies are quickly and effectively modified or replaced, in alignment with Governor Gavin Newsom's 2022

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70 Senate Bill 1440. Hueso. 2018. "*Bill Text: CA SB-1440 Energy: biomethane: biomethane procurement,"* |https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB1440.

71 California Public Utilities Commission. 2022. "*Order Instituting Rulemaking to Adopt Biomethane Standards and Requirements, Pipeline Open Access Rules, and Related Enforcement Provisions."* docs.cpuc.ca.gov/PublishedDocs/Published/G000/M454/K335/454335009.PDF.

72 California Energy Commission Staff. 2023. *Final 2022 Integrated Energy Policy Report Update*. Publication Number: CEC-100-2022-001- CMF, https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2022-integrated-energy-policy-report-update.

73 *Green ammonia* also known as renewable ammonia, is a form of ammonia that is produced using renewable energy sources.

74 California Energy Commission Staff. 2023. *Draft 2023 Integrated Energy Policy Report*. Publication Number: CEC-100-2023-001-CMD, https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2023-integrated-energy-policy-report.

letter requesting state agencies to plan for no new fossil gas-fired plants to meet long-term energy goals. [75]

The initiative responds to key research gaps and needs identified in coordination with CPUC, IOUs, and other stakeholders, including:

- Comments provided by SoCalGas in response to the public workshop on December 15, 2023, which were generally supportive of the proposed initiative and noted by CEC staff:
    - Stating that NOx emissions control is a technical priority for fuel-flexible distributed generation; provided examples for pursuing retrofittable solutions for combustion-based technologies such as microturbines and reciprocating engines and noted the possibility, through the initiative, of creating microgrids capable of delivering resilient and decarbonized power.
    - Advocating for the retrofit of existing combustion technologies to accommodate hydrogen blends in the near term and expect more non-combustion technologies in the medium term.
    - Stating that, given the absence of private sector investment, the CEC is well positioned to support hydrogen blending infrastructure. Requested CEC consider outreach to a university program looking at advancing microturbines and combustors for different blends of hydrogen and encouraged CEC staff to share learnings, best practices, and requirements that demonstrate improved equity engagement.
- Participation in meetings, including an interview in April 2024 with PG&E R&D staff to exchange information and provide input on the most relevant research focus areas, critical knowledge gaps and potentials, regulations on the horizon, emerging technology and trends to explore, and strategies to increase equity components of projects.
- Regular participation in SoCalGas annual public workshop on its RD&D plan to provide feedback and inform research priorities. CEC staff also co-organized and participated in a joint webinar in February 2025 with SoCalGas that discussed California's Gas R&D programs.
- Participation in interagency Wood Utilization Working Group under the Governor's Task Force on Wildfire and Forest Resiliency, highlighting potential for renewable fuels from forest waste and potential use for flexible power generation.
- Participation in regular meetings related to hydrogen efforts led by ARCHES and GO-Biz.
- Participation in regular engagement with CPUC Energy Division staff, such as coordination in November and December 2023 and on the monthly Gas R&D Working Group call, to discuss research projects and priorities. Staff also coordinated with CPUC subject matter experts in January 2025 to clarify and respond to questions related to the proposed fuel-flexible distributed power generation initiative.

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75 Office of the Governor. 2022. "*Letter from Governor Gavin Newsom to CARB Chair Liane Randolph.*" https://www.gov.ca.gov/wp-content/uploads/2022/07/07.22.2022-Governors-Letter-to-CARB.pdf?emrc=1054d6

IOUs such as SoCalGas and SDG&E are investing in research demonstrations for producing, transporting, storing, and blending for various end uses and have plans for using clean hydrogen in their generation portfolios.[76] [77] POUs, such as Los Angeles Department of Water and Power (LADWP), intend to have their generating station units run on 100 percent green hydrogen by 2035.[78] For ammonia, international companies are investing in end uses, such as Japan's largest power generation company, Japan's Energy for a New Era (JERA), which is partnering with Mitsubishi to establish a 100 percent ammonia power plant.[79] Renewable ammonia and renewable methanol are more nascent compared to renewable hydrogen and biomethane but show potential for use either directly in gas turbines or as a pathway to produce renewable hydrogen.[80]

Furthermore, there is emerging interest in both renewable ammonia and renewable methanol for industrial operations, such as chemical manufacturing, and backup power due to easier storage compared to hydrogen. Industries are generally risk-averse, and CEC's support in continuing the development of power generation technologies can help reduce associated risks. Therefore, with policy and industry drivers in action, there is a clear need for investing in fuel-flexible technology innovations.

While renewable fuel blends will impact the performance and associated emissions of a technology, which is a specific concern raised by the DACAG, this initiative aims to introduce new installations that use electrochemical, thermochemical, or other proven pathways, with very low emissions even without being dependent on emissions control technologies or modifying existing combustion systems, potentially helping to improve local air quality and public health.

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76 SoCalGas. *"Angeles Link: Shaping the Future With Clean Renewable Hydrogen,"* https://www.socalgas.com/sustainability/hydrogen/angeles-link.

77 SDGE. "*Hydrogen Innovations,"* https://www.sdge.com/more-information/environment/sustainability-approach/hydrogen-innovation.

78 LADWP. "*Scattergood Generating Station Units 1 and 2 Green Hydrogen-Ready Modernization Project*," https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-power/a-p-projects/a-p-p-scattergoodmodernization?_adf.ctrl-state=17iye60ga_4&_afrLoop=921049590252480

79 JERA. *"Jurong Port, Mitsubishi Heavy Industries Asia Pacific and JERA Asia come together… to explore establishing an ammonia direct combustion power plant. The project aims to accomplish the twin goals of supplying green electricity and developing an ammonia bunk,"* https://www.jera.co.jp/en/news/information/20220819_961.

80 IEA for the G20. Japan. June 2019. "*The Future of Hydrogen."* https://iea.blob.core.windows.net/assets/9e3a3493-b9a6-4b7d-b499-7ca48e357561/The_Future_of_Hydrogen.pdf.

Fairley, Peter. IEEE Spectrum. October 31, 2023. "*Backing Up the Power Grid With Green Methanol."* https://spectrum.ieee.org/methanol-energy-storage.

Technology and Market Background

Existing power generation technologies are not designed to operate with flexible fuel blends and cannot readily withstand changes to fuel inputs. Taking a technology-neutral approach could enable a quicker and more cost-effective decarbonization transition. Innovation options could include developing new sensors and controls, modifying fuel handling systems, and refashioning combustor hardware to handle a variety of operations, such as steady-state and transient operations, to investigate fully the performance and emissions impacts under different modes.[81]

While efforts exist to introduce renewable fuels in power generation technologies, the goal of this initiative is to enable a broader array of renewable fuel types, including mixes, than presently deployed. For hydrogen, the CEC is funding projects focused on combustion-based power generation systems that can use a steady volumetric percentage of higher blends of hydrogen and demonstrate low NO_x and GHG emissions.[82] The U.S. Department of Energy awarded several projects nationally to develop equipment capable of using low-carbon fuels like hydrogen and hydrogen blends with a specific focus on industrial decarbonization.[83] However, as these projects would not solely use renewable fuels, research is needed on a wide range of generation technologies that can more adequately adapt to California's anticipated fuel changes and climate commitments.

For biomethane, companies such as Motoren- und Turbinen-Union (MTU), Jenbacher, Caterpillar, and 2G-Energy are developing new biogas-capable generation systems.[84] [85] [86] [87] However, the focus of this initiative is different from that of the industry developers, as it seeks to support modifications on existing gas-fired generation systems. For ammonia, companies like General Electric (GE) see the need for multi-year investments to develop ammonia-capable gas turbines that meet critical operational and safety requirements.[88] To leverage such ongoing work and address the remaining research gaps, this initiative looks at

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81 *Steady-state Operations* assumes that the system does not change over time, while *Transient Operations* considers the changes that occur over time.

82 California Energy Commission. 2023. "*GFO-22-504 — Hydrogen Blending and Lower Oxides of Nitrogen Emissions in Gas-Fired Generation (HyBLOX).*", https://www.energy.ca.gov/solicitations/2023-01/gfo-22-504-hydrogen-blending-and-lower-oxides-nitrogen-emissions-gas-fired.

83 Office of Energy Efficiency & Renewable Energy. *" Funding Selections: FY23 Industrial Efficiency and Decarbonization Multi-Topic FOA, "*https://www.energy.gov/eere/iedo/funding-selections-fy23-industrial-efficiency-and-decarbonization-multi-topic-foa.

84 MTU. "*The New Biogas Systems mtu Series 4000,"* https://www.mtu-solutions.com/na/en/applications/power-generation/power-generation-products/gas-generator-sets/biogas-generator-sets.html.

85 Jenbacher. "*Biogas: Turning Biogas Into Heat and Power,"* https://www.jenbacher.com/en/energy-solutions/energy-sources/biogas.

86 CAT. *"Higher Efficiency, Lower Cost, Renewable Energy,"* https://www.cat.com/en_US/by-industry/electric-power/electric-power-industries/biogas-higher-efficiency.html.

87 2G. "*Biogas,"* https://www.2g-energy.com/products/biogas.

88 GE. *"Ammonia as a Power Generation Fuel,"* https://www.ge.com/content/dam/gepower-new/global/en_US/images/gas-new-site/future-of-energy/GEA34985-ammonia-power-gen.pdf.

the innovation space more broadly across fuels and power generation systems and will require ultra-low to zero-GHG emissions and criteria pollutants, such as NO_x and CO, be demonstrated.

Equity Benefits of Proposed Initiatives

The CEC applies the DACAG Equity Framework[89] to help guide its R&D investments toward equity. Table 2 shows the application of the DACAG Equity Framework in CEC Gas R&D initiatives by illustrating the potential direct and indirect benefits of the initiatives. The framework outlines the key principles of equity for state investments and interventions, including (1) health and safety, (2) access and education, (3) financial benefits, and (4) economic development. (See Appendix E for definitions of these principles.) A fifth principle, consumer protection, is not applicable to the Gas R&D Program and is not included in the table. Direct impacts are expected as a direct result of project implementation, whereas indirect impacts are expected from research and technology innovation advancements more broadly.

Table 2: FY 2024–2025 Gas R&D Plan Equity Framework Matrix

#	R&D Topic	Health and Safety	Access and Education	Financial Benefits	Economic Development
1	Gas Decommissioning	Indirect Benefits	Indirect Benefits	Indirect Benefits	Indirect Benefits
2	Gas System Safety	Direct Benefits	Indirect Benefits	Indirect Benefits	Indirect Benefits
3	Renewable Generation	Direct Benefits	Direct Benefits	Indirect Benefits	Direct Benefits

Source: California Energy Commission

Next Steps

Upon review and approval of the Gas R&D Budget Plan by the CPUC, CEC staff will begin conducting additional research scoping, which may include, but is not limited to, hosting public workshops, conducting literature reviews, and engaging with interested parties to further develop these initiatives into competitive grant solicitations.[90] A public preapplication workshop will be held for each solicitation to discuss and clarify the purpose, eligibility, project requirements, and scoring criteria with potential applicants. CEC staff will present selected projects for approval at CEC business meetings. Project summaries are maintained on CEC's

89 California Energy Commission. 2018. Disadvantaged Communities Advisory Group Equity.

90 California Energy Commission. *"Solicitations,"* https://www.energy.ca.gov/funding-opportunities/solicitations.

Energize Innovation website, and final reports for completed projects are published on CEC's publication website.[91,92]

91 Energize Innovation. California Energy Commission. *"Project Showcase,"* https://www.energizeinnovation.fund/projects.

92 California Energy Commission. *"Energy Commission Publications,"* https://www.energy.ca.gov/resources/publications/energy-commission-publications.

LIST OF ACRONYMS

Acronym	Spelled-Out Terms
AB	Assembly Bill
ARCHES	Alliance for Renewable Clean Hydrogen Energy Systems
ARPA-E	Advanced Research Projects Agency–Energy
CalGEM	California Geologic Energy Management Division
CALSEED	California Sustainable Energy Entrepreneur Development
CARB	California Air Resources Board
CEC	California Energy Commission
CO	Carbon monoxide
COVID	Coronavirus disease
CCA	Community choice aggregator
CPUC	California Public Utilities Commission
DACAG	Disadvantaged Communities Advisory Group
DOE	U.S. Department of Energy
Energy Code	Building Energy Efficiency Standards – Title 24
EPIC	Electric Program Investment Charge
ERDD	Energy Research and Development Division
FOA	Funding opportunity announcements
FY	Fiscal year
Gas Decarb OIIP	CEC's Gas Decarbonization Order to Institute Informational Proceeding
Gas R&D	Gas research and development
GFO	Grant funding opportunity
GHG	Greenhouse gas
GO-Biz	The Governor's Office of Business and Economic Development
IEPR	Integrated Energy Policy Report
IOU	Investor-owned utility
JAEDI	Justice Access Equity Diversity Inclusion

Acronym	Spelled-Out Terms
LADWP	Los Angeles Department of Water and Power
LGBTQ	Lesbian, gay, bisexual, transgender, and queer
LNG	Liquified natural gas
Long-Term Gas Research Roadmap	Long-Term Technological Research and Development Strategy to Meet Aggressive Statewide Decarbonization Goals
NOx	Oxides of nitrogen
PHMSA	Pipeline and Hazardous Materials Safety Administration
PIER	Public Interest Energy Research
PG&E	Pacific Gas and Electric
POU	Publicly owned utility
R&D	Research and development
R&D Program	Public Interest Research, Development, and Demonstration Program
SB	Senate Bill
SDG&E	San Diego Gas & Electric
SoCalGas	Southern California Gas Company
TAC(s)	Technical Advisory Committee/Committees
US DOT	United States Department of Transportation

GLOSSARY

For additional information on commonly used energy terminology, see the following industry glossary links:

- California Air Resources Board Glossary, available at https://ww2.arb.ca.gov/about/glossary
- California Energy Commission Energy Glossary, available at https://www.energy.ca.gov/resources/energy-glossary
- California Public Utilities Commission Glossary of Acronyms and Other Frequently Used Terms, available at https://www.cpuc.ca.gov/glossary/

California Native American Tribes: Per Public Resources Code, § 21073: "California Native American Tribe means a Native American Tribe located in California that is on the contact list maintained by the Native American Heritage Commission." The Native American Heritage Commission maintains a list of contacts among California Native American tribes for Chapter 905 of the Statutes of 2004 and the California Environmental Quality Act.[93]

Carbon capture utilization and storage: The capturing carbon dioxide, either from a concentrated stream or from the atmosphere, then containing it for further use or storage.

Carbon dioxide (CO2): A naturally occurring gas, CO_2, also referred to as carbon, is also a by-product of burning fossil fuels (such as oil, gas, and coal), burning biomass, land-use changes, and industrial processes (for example, cement production). It is the principal anthropogenic greenhouse gas (GHG) that affects the Earth's radiative balance. It is the reference gas against which other GHGs are measured and therefore has a global warming potential of 1.

Carbon neutrality: Carbon dioxide and other GHG emissions generated by sources such as transportation, power plants, and industrial processes must be less than or equal to the amount of carbon dioxide that is stored, both in natural sinks such as forests and mechanical sequestration such as carbon capture and sequestration. Executive Order B-55-18 established a target for California to achieve carbon neutrality by 2045 and maintain net negative emissions thereafter. For more information, see the CARB Carbon Neutrality web page.

Climate: Climate is the average course or condition of the weather at a place, usually over a period of years, as exhibited by temperature, wind velocity, and precipitation. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. Climate in a wider sense is the state, including a statistical description, of the climate system.

Climate change: Climate change refers to a change in the state of the climate that can be identified (for example, by using statistical tests) by changes in the mean or variability (or

93 CEC. Tribal Consultation Policy. February 2024. https://www.energy.ca.gov/publications/2024/california-energy-commission-tribal-consultation-policy.

both) of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic (human-induced) changes in the composition of the atmosphere or in land use. *Anthropogenic climate change* is defined by the human impact on Earth's climate, while natural climate changes are the natural climate cycles that have been and continue to occur throughout Earth's history. Anthropogenic climate change is directly linked to the amount of fossil fuel burning, aerosol releases, and land alteration from agriculture and deforestation.

Decarbonization: The process by which countries, individuals, or other entities aim to reduce or achieve zero fossil carbon emissions. This process typically refers to a reduction of the carbon emissions associated with electricity, industry, and transport. Decarbonization involves increasing the share of no- or low-carbon energy sources (renewables such as solar and wind) and decreasing the use of fossil fuels.

Decommissioning: Retiring portions of fossil gas infrastructure to reduce the costs and environmental impact of maintaining and operating the fossil gas system.

Demand flexibility: The ability of customers to reduce or increase load in response to grid conditions, usually through a proxy price signal or system operator or utility signal and facilitated by automation.

Disadvantaged community: Disadvantaged communities refer to the areas throughout California that most suffer from a combination of economic, health, and environmental burdens. These burdens include poverty, high unemployment, air and water pollution, presence of hazardous wastes, as well as high incidence of asthma and heart disease. One way that the state identifies these areas is by collecting and analyzing information from communities all over the state. CalEnviroScreen, an analytical tool created by the California Environmental Protection Agency, combines different types of census tract-specific information into a score to determine which communities are the most burdened or "disadvantaged." For more information, see the California Office of Environmental Health Hazard Assessment's CalEnviroScreen Web page.

Disadvantaged Communities Advisory Group (DACAG): The Clean Energy and Pollution Reduction Act of 2015 (also known as Senate Bill [SB] 350) called upon the CPUC to help improve air quality and economic conditions in disadvantaged communities by, for example, changing the way the state plans the development and future operations of power plants and rethinking the location of clean energy technologies to benefit burdened communities. In addition, SB 350 required the CPUC and the CEC to create a group representing disadvantaged communities to advise the agencies in understanding how energy programs impact these communities and could be improved to benefit these communities. For more information, see the CEC and CPUC DACAG web pages.[94]

94 California Energy Commission. "Disadvantaged Communities Advisory Group (DACAG)," https://www.energy.ca.gov/about/campaigns/equity-and-diversity/disadvantaged-communities-advisory-group.

Distributed energy resource(s) (DER): Distributed energy resources are any resource with a first point of interconnection of a utility distribution company or metered subsystem.

Distributed energy resources include:

- Demand response, which has the potential to be used as a low-GHG, low-cost, price-responsive option to help integrate renewable energy and provide grid stabilizing services, especially when several distributed energy resources are used in combination and opportunities to earn income make the investment worthwhile.
- Distributed renewable energy generation, primarily rooftop photovoltaic energy systems.
- Vehicle-grid integration, or all the ways plug-in electric vehicles can provide services to the grid, including coordinating the timing of vehicle charging with grid conditions.
- Energy storage in the electric power sector to capture electricity or heat for use later to help manage fluctuations in supply and demand.

Electric Program Investment Charge (EPIC): The CEC's EPIC invests in scientific and technological research to accelerate the transformation of the electricity sector to meet the state's energy and climate goals. Investments of about $150 million annually support research and development in renewable energy, energy storage, electric system resilience, and electric technologies for buildings, businesses, and transportation. For more information, see the CEC EPIC web page and the CPUC Energy Research, Development, and Deployment web page.

End use: Final applications for which energy is ultimately used, such as heating, power generation, or transportation or a combination.

Environmental and Social Justice (ESJ) Communities: Term defined by CPUC's ESJ Action Plan 2.0 as predominantly communities of color or low-income communities that are underrepresented in the policy setting or decision-making process, subject to a disproportionate impact from one or more environmental hazards, and are likely to experience disparate implementation of environmental regulations and socioeconomic investments in their communities. This definition targets Disadvantaged Communities, defined as census tracts that score in the top 25 percent of CalEnviroScreen 3.0, all tribal lands, low-income households, and low-income census tracts.

Energy efficiency: Energy efficiency means adapting technology to meet consumer needs while using less energy. The CEC adopts energy efficiency standards for appliances and buildings, which reduces air pollution and saves consumers money. The CPUC regulates ratepayer-funded energy efficiency programs and works with the investor-owned utilities, other program administrators, and vendors to develop programs and measures to transform technology markets within California using ratepayer funds. For more information, see the CEC Energy Efficiency web page and the CPUC Energy Efficiency web page.

Equity (energy equity): Energy equity is the principle of fairness in burden sharing and is a basis for understanding how the impacts and responses to climate change, including costs and benefits, are distributed in and by society in more or less equal ways. It is often aligned with

ideas of equality, fairness, and justice and applied with respect to equity in the responsibility for, and distribution of, climate impacts and policies across society, generations, and gender, and in the sense of who participates and controls the processes of decision-making.

Gas end uses: Final applications of gas for energy use, such as heating, power generation, or transportation, or a combination.

Greenhouse gas (GHG): GHGs are those gaseous constituents of the atmosphere, natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself, and clouds. This property causes the greenhouse effect. Water vapor, carbon dioxide, nitrous oxide, methane, and ozone are the primary GHGs in the Earth's atmosphere. Moreover, there several entirely human-made GHGs in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside carbon dioxide, nitrous oxide, and methane, the Kyoto Protocol deals with the GHGs sulfur hexafluoride, HFCs, and perfluorocarbons. In response to Assembly Bill 32 (California Global Warming Solutions Act of 2006), the definition of GHGs defined in Health and Safety Code Section 38505 includes nitrogen trifluoride in addition to those defined under the Montreal and Kyoto Protocols.

Investor-owned utility (IOU): Investor-owned utilities (IOUs) provide transmission and distribution services to all electric customers in their service territory. The utilities also provide generation service for "bundled" customers, while "unbundled" customers receive electric generation service from an alternate provider, such as a community choice aggregator (CCA). California has three large IOUs offering electricity service: Pacific Gas and Electric, Southern California Edison, and San Diego Gas & Electric.

Low-income communities: Communities within California census tracts with median household incomes at or below either of the following levels: 1) 80 percent of the statewide median income or 2) the applicable low-income threshold listed in the state income limits updated by the Department of Housing and Community Development and filed with the Office of Administrative Law under subdivision (c) of Section 50093 of the Health and Safety Code.

Methane: Methane, also known as CH_4, is one of the six GHGs to be mitigated under the Kyoto Protocol and is the major component of natural gas. Emissions also occur as a result of dairy and livestock operations and disposal of organics in landfills, and the management of these organics represents a major mitigation option. Methane is a short-lived climate pollutant. Unlike carbon dioxide, which lasts for about 100 years in the atmosphere, reductions of methane can create a relatively quick reduction in global warming.

Sustainability: A dynamic process that guarantees the persistence of natural and human systems equitably.

Utility: An organization supplying the community with electricity, gas, water, or sewerage.

APPENDICES: A-G

- Appendix A: Policies Supported by FY 2024-25 Gas R&D Program Initiative Themes
- Appendix B: CPUC Resolution G-3584 Funding Encumbrance — Unspent Funds
- Appendix C: Public Comment and CEC Responses
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- Appendix E: FY 2024-2025 Gas R&D Plan Equity Framework Topic Definitions
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- Appendix G: Gas R&D Stakeholders Workshop Presentation

APPENDIX A:
Policies Supported by FY 2024-2025 Gas R&D Program Initiative Themes

Policies Supported by Gas System Decommissioning Theme

- California Public Utilities Commission (CPUC) Long-Term Gas Planning Rulemakings (R.20-01-007, R.24-09-012) establish policies, processes, and rules to ensure safe and reliable gas systems in California and to perform long-term gas system planning. The *2024 Joint Agency Staff Paper: Progress Towards a Gas Transition* (2024) outlines interagency coordination to develop strategic plans for reducing fossil gas demand and planning for the future of the gas system.
- Senate Bill 887 (Pavley, Chapter 673, Statutes of 2016) issued requirements to ensure the safety and integrity of gas storage facilities.
- Senate Bill 1371 (Leno, Chapter 525, Statutes of 2014) requires the CPUC to determine whether existing practices are effective at reducing methane leaks and promoting public safety, and whether alternative practices may be more effective.
- CPUC Order Instituting Investigation I1702002 under Senate Bill 380 (Pavley, Chapter 14, Statutes of 2016) determines the feasibility of minimizing or eliminating the use of the Aliso Canyon gas storage facility in Los Angeles County while maintaining energy and electric reliability for the region.
- CPUC Adaptation Rulemaking (R.18-04-019) considers strategies to integrate climate change adaptation considerations into CPUC proceedings, beginning with (Phase 1) gas and electric utilities.
- Assembly Bill 3232 (Friedman, Chapter 373, Statutes of 2018) directed CEC to develop a *California Building Decarbonization Assessment* (2021), which provides a framework to tackle the challenges in developing a path toward reducing greenhouse gas emissions associated with California's buildings.
- The *Final 2021 Integrated Energy Policy Report Volume III: Decarbonizing the State's Gas System* (Chapter 6) outlines factors affecting the reduction or retirement of gas assets and the need for long-term gas planning, including a comprehensive assessment of the overall needs of the gas system within the long-term context of climate goals as well as with respect to weather impacts of climate change.
- Assembly Bill 1496 (Thurmond, Chapter 604, Statutes of 2015) requires the state to monitor methane hotspots.

- CARB's Short-Lived Climate Pollutant Reduction Strategy recommends actions to reduce emissions of short-lived climate pollutants, including from dairies, organics disposal, and wastewater.
- SB 1221 (Min, Chapter 602, Statutes of 2024) requires CPUC to designate priority neighborhood decarbonization zones on the gas distribution system and to establish a voluntary program to facilitate the cost-effective decarbonization of priority neighborhood decarbonization zones, not to exceed 30 pilot projects across the state.
- SB 350 (De León, Chapter 547, Statutes of 2015) is a driving policy for advancing equity in California's clean energy transformation. As outlined in SB 350, the CEC co-established the Disadvantaged Communities Advisory Group (DACAG) with the CPUC to advise the CEC and the CPUC on ways to help Environmental and Social Justice (ESJ) communities benefit from proposed clean energy and pollution reduction programs, expand access to clean energy technologies, and receive affordable energy services.

Policies Supported by Gas System Safety Theme

- Senate Bill 887 (Pavley, Chapter 673, Statutes of 2016) requires the operator of a gas storage well, before January 1, 2018, to have commenced a mechanical integrity testing regime specified by the Division of Oil, Gas, and Geothermal Resources in the California's Department of Conservation and would require the division to promulgate regulations that establish standards for all gas storage wells. It also requires the division to determine by regulation what constitutes a reportable leak from a gas storage well and the timeframe for reporting those leaks, as specified.
- Senate Bill 1371 (Leno, Chapter 525, Statutes of 2014)requires reporting and mitigation of emissions from CPUC-regulated gas pipeline facilities. The bill requires gas corporations to file a report summarizing utility leak management practices, a list of new gas leaks by grade, a list of open leaks that are being monitored or are scheduled to be repaired, and a best estimate of gas loss due to leaks.
- Senate Bill 1383 (Lara, Chapter 395, Statutes of 2016) sets targets for statewide reductions in short-lived climate pollutant emissions, including a reduction in methane emissions by 40 percent below 2013 levels by 2030.
- Assembly Bill 1496 (Thurmond, Chapter 604, Statutes of 2015) requires CARB to undertake monitoring and measurements of high emission methane "hot spots," life-cycle greenhouse gas emissions analysis of gas produced and imported into California, and review and assess the atmospheric reactivity of methane as a precursor to the formation of photochemical oxidant.

Policies Supported by Renewable Generation Theme

- Senate Bill 1383 (Lara, Chapter 395, Statutes of 2016) requires reductions in statewide emissions of methane by 40 percent, hydrofluorocarbon gases by 40 percent, and anthropogenic black carbon by 50 percent below 2013 levels by 2030.
- Senate Bill 100 (De León, Chapter 312, Statutes of 2018) requires 60 percent of retail sales of electricity be generated from eligible renewable energy resources by 2030 and all retail sales of electricity be renewable or zero-carbon by 2045.
- Senate Bill 1369 (Skinner, Chapter 567, Statues of 2018) requires the consideration of green electrolytic hydrogen as a form of energy storage and of other potential uses of green electrolytic hydrogen.
- Senate Bill 1075 (Skinner, Chapter 363, Statutes of 2022) mandates that a comprehensive report on hydrogen be posted to CARB's website by June 1, 2024, to include specified information on the deployment, development, and use of hydrogen across all sectors as a key part of achieving California's climate, air quality, and energy goals.
- Assembly Bill 205 (Ting, Chapter 61, Statues of 2022) created the Strategic Reliability Reserve to support the state's electric grid reliability and required the CEC to implement and administer the Distributed Electricity Backup Assets Program to incentivize the construction of cleaner and more efficient distributed energy assets.
- Environmental & Social Justice Action Plan Version 2.0 by the California Public Utilities Commission establishes both a commitment to furthering principles of environmental and social justice and an operating framework with which to integrate environmental and social justice considerations throughout the agency's work.
- 2022 Scoping Plan for Achieving Carbon Neutrality by the California Air Resources Board lays out a plan to achieve carbon neutrality by 2045 and identifies renewable hydrogen produced through electrolysis or from biomethane as an alternative to fossil fuels in the transportation, buildings, industry, and electricity sectors.
- CPUC Rulemaking Decision 22-02-025 February 24, 2022: Implementation of Senate Bill 1440. This decision establishes a biomethane procurement program for California's four large gas utilities that is designed to help achieve the state's short-lived climate pollutant (SLCP) goals, which call for a 40 percent reduction in methane and other SLCPs by 2030.
- CPUC Rulemaking Decision 22-12-057 December 15, 2022: This decision directs California's four large gas utilities to propose system testing on the effects of hydrogen blended into methane at concentrations ranging from 0.1 percent to 20 percent. It further establishes safety thresholds for hydrogen content in biomethane and makes modifications to existing biomethane-related reporting requirements.

APPENDIX B:
CPUC Resolution G-3484 Funding Encumbrance – Unspent Funds

Per the CPUC's request in Resolution G-3592 and consistent with Resolution G-3484, Appendix B shows the research funds from FY 2014–2015 to FY 2023-2024 Gas R&D Program budget plans *encumbered and unspent as of January 2025*. Each budget plan approved by CPUC describes estimated allocations of funding among the Gas R&D research areas.

The CEC's Gas R&D program budget process allocates funding to CPUC-approved research areas/initiatives that are subsequently acted upon by developing specific projects selected through competitive solicitations. Encumbered funds refer to funds that are committed to a specific project that has been approved at a Business Meeting and for which the agreement package has been executed (signed by both parties). Funds Unspent refers to funds that have not been encumbered to an executed agreement (contract or grant), or previously encumbered funds that become unencumbered because the agreement has been canceled or due to other reasons. Following CPUC's request in Resolution G-3555, the CEC will ensure that for any use of encumbered and unspent funds that the CEC requests for new projects, the request will identify the respective research areas for which the CPUC originally authorized the funding.

Proposed FY 2023-2024 Gas R&D Budget Plan Funds Encumbered as of January 2025

Initiative Theme	CPUC FY 2023-24 Budget Plan ($M)	Total FY 2023-24 Funds Encumbered ($M)	Total FY 2023-24 Funds Unspent* ($M)
Building Decarbonization: Air Pollutant Exposure Assessment in California	7.00	2.00	5.00
Building Decarbonization: Networked Geothermal District Heating Study	5.64	0.00	5.64
Targeted Gas System Decommissioning	8.00	0.00	8.00
Comprehensive Programmatic Evaluation, Under G-3592	.960	0.00	.960
TOTAL	**21.60**	**2**	**19.60**

Amounts shown in table are in millions and rounded to the nearest $10,000.

Source: California Energy Commission

**FY 2023-24 Gas R&D Budget Plan was submitted to the CPUC on June 1, 2023, and is pending approval.*

Proposed FY 2023-2024 Gas R&D Supplemental Budget Plan Funds Encumbered as of January 2025

Initiative Theme	Total FY 2023-24 Budget Plan ($M)	Total FY 2023-24 Funds Encumbered ($M)	Total FY 2023-24 Funds Unspent* ($M)
Building Decarbonization: Air Pollutant Exposure Assessment in California Residences	0.00	0.00	0.00
Building Decarbonization: Networked Geothermal District Heating Study	2.41	0.00	2.41
Targeted Gas System Decommissioning	4.13	0.00	4.13
Comprehensive Programmatic Evaluation, Under G-3592	0.00	0.00	0.00
TOTAL	**6.54**	**0**	**6.54**

Amounts shown in table are in millions and rounded to the nearest $10,000.

Source: California Energy Commission

**FY 2023-24 Gas R&D Budget Plan was submitted to the CPUC on June 1, 2023, and is pending approval.*

FY 2022-2023 Gas R&D Budget Plan Funds Encumbered as of January 2025

Initiative Theme	CPUC FY 2022-23 Approved Budget Plan ($M)	FY 2022-23 Current Budget Plan ($M)*	Total FY 2022-23 Funds Encumbered ($M)	Total FY 2022-23 Funds Unspent ($M)	Actual or Anticipated Solicitation Release or Encumbrance
Targeted Gas System Decommissioning	3.50	4.10	0.70	3.40	$3.4M Anticipated Solicitation to be Released FY 2025
Decarbonization of Gas End Uses	13.00	13.00	11.1	1.90	$1.9M Anticipated Solicitation to be Released in FY 2025
Energy Efficiency	1.50	1.50	1.50	0	
Gas Pipeline Safety and Integrity	0	3.00	2.99	0.007	*Unspent Funds for an Anticipated Supplemental Plan $7,772*
Entrepreneur Development	3.60	0.00	0	0.00	
TOTAL	**21.60**	**21.60**	**16.30**	**5.30**	

Amounts shown in table are in millions and rounded to the nearest $10,000.

Source: California Energy Commission

**FY 2022-23 Gas R&D Budget Plan, approved March 16, 2023, in part, by CPUC Resolution G-3592. CPUC modified the $3.6 million budget for Entrepreneur Development (CalSEED Initiative) and directed the CEC to submit a new proposal for reallocating the $3.6 million via a Tier 2 Advice Letter. CPUC approved CEC's request to reallocate $600,000 to Targeted Gas System Decommissioning and $3,000,000 to Gas Pipeline Safety and Integrity.*

FY 2021-2022 Gas R&D Budget Plan Funds Encumbered as of January 2025

Initiative Theme	CPUC FY 2021-22 Approved Budget Plan ($M)	FY 2021-22 Current Budget Plan ($M)	Total FY 2021-22 Funds Encumbered ($M)	Total FY 2021-22 Funds Unspent ($M)
Energy Efficiency	6.10	6.10	6.10	0
Renewable Energy and Advanced Generation	4.00	4.00	4.00	0
Gas Infrastructure Safety and Integrity	4.00	4.00	4.00	0
Energy-Related Environmental Research	3.50	3.50	3.50	0
Transportation	4.00	4.00	4.00	0
TOTAL	**21.60**	**21.60**	**21.60**	**0**

Amounts shown in table are in millions and rounded to the nearest $10,000.

Source: California Energy Commission

FY 2020-2021 Gas R&D Budget Plan Funds Encumbered as of January 2025

Initiative Theme	CPUC FY 2020-21 Approved Budget Plan ($M)	FY 2020-21 Current Budget Plan ($M)	Total FY 2020-21 Funds Encumbered ($M)	Total FY 2020-21 Funds Unspent ($M)	Actual or Anticipated Solicitation Release or Encumbrance
Energy Efficiency	3.00	3.00	1.77	1.23	$1.23m of remaining funds included in the Proposed FY 2023-24 Gas R&D Supplemental Budget Plan – Building Decarbonization
Renewable Energy and AdvancedGeneration	4.00	4.00	4.00	0	
Gas Infrastructure Safety and Integrity	9.10	9.10	9.10	0	
Energy-Related EnvironmentalResearch	1.50	1.50	1.50	0	
Transportation	4.00	4.00	4.00	0	
TOTAL	**21.60**	**21.60**	**20.37**	**1.23**	

Amounts shown in table are in millions and rounded to the nearest $10,000.

Source: California Energy Commission

FY 2019-2020 Gas R&D Supplemental Budget Plan Funds Encumbered as of January 2025

Initiative Theme	CPUC FY 2019-20 Approved Supplemental Budget Plan ($M)	CPUC FY 2019-20 Supplemental Current Budget Plan ($M)	CPUC FY 2019-20 SupplementalFunds Encumbered ($M)	CPUC FY 2019-20 SupplementalFunds Unspent ($M)
Energy Efficiency	1.00	1.00	1.00	0
Renewable Energy and AdvancedGeneration	0	0	0	0
Gas Infrastructure Safety and Integrity	2.00	2.00	2.00	0
Energy-Related Environmental Research	2.00	2.00	2.00	0
Transportation	0	0	0	0
Gas Small Grant Program	2.29	2.29	2.29	0
TOTAL	**7.29**	**7.29**	**7.29**	**0**

Amounts shown in table are in millions and rounded to the nearest $10,000.

Source: California Energy Commission

FY 2019-2020 Gas R&D Budget Plan Funds Encumbered as of January 2025

Initiative Theme	CPUC FY 2019-20 Approved Budget Plan ($M)	FY 2019-20 Current Budget Plan ($M)*	Total FY 2019-20 Funds Encumbered ($M)	Total FY 2019-20 Funds Unspent ($M)
Energy Efficiency	9.00	9.63	9.63	0
Renewable Energyand Advanced Generation	3.00	2.89	2.89	0
Gas Infrastructure Safety and Integrity	2.00	1.58	1.58	0
Transportation	6.60	6.50	6.50	0
Gas Strategic Plan (Cross-Cutting)	1.00	1.00	1.00	0
TOTAL	**21.60**	**21.60**	**21.6**	**0**

Amounts shown in table are in millions and rounded to the nearest $10,000.

Source: California Energy Commission

**The CEC reallocated $630,000 from the Renewable Energy and Advanced Generation, Gas Infrastructure Safety and Integrity and Transportation research areas to Energy Efficiency due to strong proposals in high-priority research areas.*

FY 2018-2019 Gas R&D Budget Plan Funds Encumbered as of January 2025

Initiative Theme	CPUC FY 2018-19 Approved Budget Plan ($M)	FY 2018-19 Current Budget Plan ($M)*	Total FY 2018-19 Funds Encumbered ($M)	Total FY 2018-19 Funds Unspent ($M)
Energy Efficiency	6.00	9.32	9.32	0
Renewable Energyand Advanced Generation	3.00	0	0	0
Gas Infrastructure Safety and Integrity	5.60	5.60	5.60	0
Energy-Related Environmental Research	3.00	4.36	4.36	0
Transportation	4.00	2.31	2.31	0
TOTAL	**21.60**	**21.60**	**21.60**	**0**

Amounts shown in table are in millions and rounded to the nearest $10,000.

Source: California Energy Commission

**The CEC reallocated $3.32M from the Renewable Energy and Advanced Generation and Transportation research areas to Energy Efficiency due to strong proposals in high-priority research areas. The CEC reallocated $1.36M from the Renewable Energy and Advanced Generation research area to Energy-Related Environmental Research due to strong proposals in high-priority research areas.*

FY 2017-2018 Gas R&D Budget Plan Funds Encumbered as of January 2025

Initiative Theme	CPUC FY 2017-18 Approved Budget Plan ($M)	FY 2017-18 Current Budget Plan ($M)*	Total FY 2017-18 Funds Encumbered ($M)	Total FY 2017-18 Funds Unspent($M)	Actual or Anticipated Solicitation Release or Encumbrance
Energy Efficiency	6.60	4.57	4.57	0	
Renewable Energy and Advanced Generation	4.00	4.00	4.00	0	
Gas Infrastructure Safety and Integrity	5.00	5.82	5.82	0	
Energy-Related Environmental Research	3.00	3.46	3.46	0	
Transportation	3.00	3.75	2.89	.87	*Unspent Funds for an Anticipated Supplemental Plan $865,642*
TOTAL	**21.60**	**21.60**	**20.73**	**.87**	

Amounts shown in table are in millions and rounded to the nearest $10,000.

Source: California Energy Commission

**The CEC reallocated $2.03M from Energy Efficiency to Gas Infrastructure Safety and Integrity, Transportation, Energy-Related Environmental Research areas due to strong proposals in high-priority research areas.*

FY 2016-2017 Gas R&D Supplemental Budget Plan Funds Encumbered as of January 2025

Initiative Theme	CPUC FY 2016-17 Supplemental Approved Budget Plan ($M)	FY 2016-17 Supplemental Current Budget Plan ($M)*	Total FY 2016-17 Supplemental Funds Encumbered ($M)	Total FY 2016-17 Supplemental Funds Unspent ($M)
Energy Efficiency	.91	0	0	0
Renewable Energy andAdvanced Generation	0	0	0	0
Gas Infrastructure Safety and Integrity	1.70	2.61	2.61	0
Energy-Related Environmental Research	2.70	2.70	2.70	0
Transportation	0	0	0	0
TOTAL	**5.31**	**5.31**	**5.31**	**0**

Amounts shown in table are in millions and rounded to the nearest $10,000.

Source: California Energy Commission

**The CEC reallocated $.91M from Energy Efficiency to Gas Infrastructure Safety and Integrity research area due to strong proposals in high-priority research areas.*

FY 2016-2017 Gas R&D Budget Plan Funds Encumbered as of January 2025

Initiative Theme	CPUC FY 2016-17 Approved Budget Plan ($M)	FY 2016-17 Current Budget Plan ($M)*	Total FY 2016-17 Funds Encumbered ($M)	Total FY 2016-17 Funds Unspent ($M)	Actual or Anticipated Solicitation Release or Encumbrance
Energy Efficiency	7.10	5.20	4.03	1.18	$1.18M from terminated projects included in Proposed FY 2023-24 Supplemental Budget Plan – Building Decarbonization
Renewable Energyand Advanced Generation	4.40	5.02	5.02		
Gas Infrastructure Safety and Integrity	4.00	3.87	3.87		
Energy-Related Environmental Research	2.60	2.69	2.69		
Transportation	3.50	4.82	2.19	2.63	$2.63M from terminated projects included in the Proposed FY 2023-34 Gas R&D Supplemental Budget Plan – Targeted Gas System Decommissioning
TOTAL	**21.60**	**21.60**	**17.79**	**3.81**	

Amounts shown in table are in millions and rounded to the nearest $10,000.

Source: California Energy Commission

**The CEC reallocated $1.9M from Energy Efficiency to Renewable Energy and Advanced Generation, Energy-Related Environmental Research, and Transportation research areas due to strong proposals in high-priority research areas. The CEC reallocated $.13M from Gas Infrastructure Safety and Integrity to Renewable Energy and Advanced Generation research area due to strong proposals in high-priority research areas.*

FY 2015-2016 Gas R&D Supplemental Budget Plan Funds Encumbered as of January 2025

Initiative Theme	CPUC FY 2015-16 Supplemental Approved Budget Plan ($M)	FY 2015-16 Supplemental Current Budget Plan ($M)	Total FY 2015-16 Supplemental Funds Encumbered* ($M)	Total FY 2015-16 Supplemental Funds Unspent ($M)
Energy Efficiency	0	0	0	0
Renewable Energy andAdvanced Generation	0	0	0	0
Gas Infrastructure Safety and Integrity	1.50	1.50	1.50	0
Energy-Related Environmental Research	2.10	2.10	2.10	0
Transportation	0	0	0	0
TOTAL	**3.60**	**3.60**	**3.60**	**0**

Amounts shown in table are in millions and rounded to the nearest $10,000.

Source: California Energy Commission

**In Resolution G-3507 (June 25, 2015), the CPUC directed the CEC to prioritize gas research and development projects on climate change, drought, and gas safety. The CEC funded high-priority research areas when strong research proposals were received.*

FY 2015-2016 Gas R&D Budget Plan Funds Encumbered as of January 2025

Initiative Theme	CPUC FY 2015-16 Approved Budget Plan ($M)	FY 2015-16 Current Budget Plan ($M)	Total FY 2015-16 Funds Encumbered ($M)	Total FY 2015-16 Funds Unspent ($M)	Actual or Anticipated Solicitation Release or Encumbrance
Energy Efficiency	7.10	7.10	7.10	0	
Renewable Energy and Advanced Generation	5.80	5.80	4.62	1.18	$1.18M included in FY 2019-2020 Supplemental Budget Plan
Gas Infrastructure Safety and Integrity	1.00	1.00	1.00	0	
Energy-Related Environmental Research	3.30	3.30	3.30	0	
Transportation	4.40	4.40	2.90	1.50	$1.5M included in FY 2023-2024 Supplemental Budget Plan
TOTAL	**21.60**	**21.60**	**18.91**	**2.68**	

Amounts shown in table are in millions and rounded to the nearest $10,000.

Source: California Energy Commission

FY 2014-2015 Gas R&D Budget Plan Funds Encumbered as of January 2025

Initiative Theme	CPUC FY 2014-15 Approved Budget Plan ($M)	FY 2014-15 Current Budget Plan ($M)*	Total FY 2014-15 Funds Encumbered ($M)	Total FY 2014-15 Funds Unspent ($M)
Energy Efficiency	8.60	7.48	7.48	0
Renewable Energy and Advanced Generation	3.50	2.48	2.48	0
Gas Infrastructure Safety and Integrity	2.50	4.68	4.68	0
Energy-Related Environmental Research	3.00	3.62	3.62	0
Transportation	4.00	3.34	3.34	0
TOTAL	**21.60**	**21.60**	**21.60**	**0**

Amounts shown in table are in millions and rounded to the nearest $10,000.

Source: California Energy Commission

**The CEC reallocated funds from Energy Efficiency ($1.12M). Renewable Energy and Advanced Generation ($1.02M), and Transportation ($0.66M) research areas to Gas Infrastructure Safety and Integrity ($2.18M) and Energy-Related Environmental Research ($0.62M) research areas due to strong proposals in high-priority research areas.*

APPENDIX C
Public Comment and CEC Responses

The California Energy Commission (CEC) appreciates the comments and questions received during and in response to a public workshop, the coordination meeting with California Public Utilities Commission (CPUC) staff, and meeting with the Disadvantaged Communities Advisory Group (DACAG) representatives on proposed initiatives for the fiscal year (FY) 2024-2025 Gas Research and Development (Gas R&D) Program Budget Plan. The engagement events to support the development of this Budget Plan included the following:

- On November 15, 2023, CEC staff held coordination meetings with CPUC staff.
- On December 7, 2023, CEC staff presented the proposed budget plan to CPUC Commissioner Douglas. Comments were not directed to the initiatives and therefore are not summarized below.
- On December 15, 2023, CEC staff held a public workshop and invited written public comments on the proposed research initiatives.
- On January 19, 2024, CEC staff met the full DACAG to present the proposed budget plan.
- On January 10, 16, and 23, 2025, CEC staff held additional coordination meetings with CPUC staff.

Based on feedback received through this process and current funding priorities, CEC staff did not include the proposed initiative on Clean Renewable Hydrogen Distribution: Hydrogen Separation in the FY 2024-2025 Gas R&D Program Budget Plan and redirected the associated funds. For a summary of this proposed initiative, please see Appendix D. In response to Resolution G-3603, CEC proposed shifting the Geothermal District Heating Study to the FY 2023-2024 Gas R&D Program Budget Plan. Comments on this initiative are included in both Budget Plan appendices for completeness.

A summary of the comments provided and CEC staff responses for each are provided in the following sections:

CPUC Staff Coordination Meeting Comment Summary and CEC Responses

The CEC presented the proposed FY 2024-2025 Gas R&D Program Budget Plan to representatives of the CPUC's Energy Division and Safety and Enforcement Division at a meeting on Nov 15, 2023. At the meeting, CEC staff presented five proposed initiatives for the FY 2024-2025 Gas R&D Program Budget Plan. The CEC appreciates the helpful questions and comments from CPUC staff during the coordination meeting. Below is a summary of CPUC staff comments and CEC staff responses organized by initiative.

Gas Decommissioning: Support Equitable, Safe, and Cost-Effective Decarbonization of California's Gas System

- CPUC staff commented that equipment replacement experiences under local fossil gas bans could provide useful empirical information about potential problems and opportunities for improvement in electrification processes.
    - CEC staff agreed and provided information on jurisdictions within the state that had adopted building codes aimed at reducing reliance on gas.
- CPUC staff commented that Berkeley's gas ban had been overturned.
    - CEC staff provided several references on legal decisions related to gas bans in the state, namely concerning the ruling of the United States Court of Appeals for the Ninth Circuit that the City of Berkeley could not regulate the quantity of gas used.
- CPUC staff requested clarification on the schedule and process for gas decommissioning research, particularly how it aligns with decommissioning pilot research in northern and southern California under CEC grants to Energy + Environmental Economics, Inc. (E3) and RAND, respectively.
    - CEC staff outlined two overarching visions: one addressing the schedule and perspective for research that has been proposed in the draft initiative, and the other focusing on translating research findings from the aforementioned decommissioning pilot grants into actual pilot implementation. Regarding the latter, decisions on how to proceed should stem from findings of the two projects, including assessment by the CEC grant managers, as well as from potential funding availability and opportunities for collaboration with gas investor-owned utilities (IOUs).

Gas System Safety: Innovations for Cost-Effective Operation & Maintenance of Critical Infrastructure During the Gas Transition

- CPUC staff highlighted the significant expenses associated with adhering to California Department of Conservation Geologic Energy Management Division (CalGEM) testing regulations and a desire to streamline these tests, making them less time-consuming, costly, and intrusive.
    - CEC staff emphasized that this initiative would advance technologies and methods, including continuous monitoring, non-intrusive inspection, and non-destructive testing, to lower the costs of maintaining the safety, integrity, and reliability of gas storage facilities and transmission pipelines.
- CPUC staff sought clarification on how continuous monitoring and non-intrusive inspection technologies would influence decisions regarding derating and decommissioning.
    - CEC staff highlighted that the decision to decommission a pipeline depends on its condition and usage. If a pipeline is in poor condition and not used, decommissioning may be appropriate. Conversely, if a pipeline is actively

used but in poor health, repair may be warranted. Access to continuous and detailed data on usage, conditions, and degradation trends of gas infrastructure can significantly aid in making these decisions. CEC has previously supported initiatives using fiber optic sensors for continuous monitoring of underground gas storage wells and intends to expand these efforts.

- CPUC staff inquired about the publication status of the study conducted by Southern California Gas Company (SoCalGas) as part of its methane leak abatement plan with Lawrence Berkeley National Lab and CEC.
    - CEC staff indicated that the final report for this study is still awaiting publication. The project is anticipated to conclude by mid-2024, with the final report expected to be published around that time.
- CPUC staff requested an explanation of how non-intrusive well inspections could lower costs to ratepayers by avoiding the expenses associated with intrusive inspections and subsequent reductions in system capacity.
    - CEC staff outlined that current storage well inspection procedures necessitate shutting down wells for inspection, rendering them unusable for gas injection or withdrawal during that period. Consequently, maintaining capacity requires additional wells. Moreover, capacity reductions resulting from inspections might prolong the service life of older wells or necessitate the creation of new ones. Non-intrusive testing, however, would mitigate operational disruptions, minimize storage well downtime, and diminish the necessity for extra wells. This approach effectively reduces both equipment and operation and maintenance costs.
- CPUC staff requested an explanation of how non-intrusive well inspections can avoid safety risks compared to intrusive well inspections.
    - CEC staff responded that conventional well inspections require opening the well, inserting instruments, and removing large components for inspection, all of which pose risks of accidental damage to the equipment. Non-intrusive methods, on the other hand, minimize the need to open wells for inspections, thereby reducing associated safety hazards. CEC clarified that this initiative is currently focused solely on transmission pipelines, excluding distribution pipelines.

Renewable Generation: Fuel-Flexible Distributed Power Generation

- CPUC sought clarification on how the prime movers fit with retrofits, specifically on developing more fuel-based power generation in light of the state's long-term policy goals to transition away from fossil fuels wherever feasible.
    - CEC staff explained that prime movers can be modified or designed to operate on a single renewable fuel or mix of renewable fuels such as biomethane, hydrogen, or ammonia. While policies like Assembly Bill 205

incentivize cleaner and more efficient distributed energy assets, they do not account for adapting these systems to evolving renewable fuel supplies, which this initiative aims to address. Furthermore, the initiative aligns with the California Air Resources Board's 2022 Scoping Plan and Senate Bill 100, which emphasize the need for an adaptable generation system to withstand decarbonization treads, policies, and increasing electric demand while eliminating fossil fuels. This initiative aims to fulfill that need by promoting the development of renewable fuel-based power generation.

- CPUC sought clarity regarding the extent to which the end target of the initiative would involve new power plants or make use of existing equipment.
    - CEC staff clarified and edited the initiative title and scope to focus on distributed generation. In addition, CEC staff is considering limiting new installations to use electrochemical, thermochemical, or other proven pathways, with very low emissions even without being dependent on emissions control technologies and allowing modifications to existing combustion resources, to avoid investing in new combustion demonstrations.
- CPUC inquired about the need for public funding for this initiative, as the electric generation industry is looking at alternatives to fossil gas generation.
    - Based on literature review and prior experience with industrial grant recipients and project partners, CEC staff found industries are generally risk averse. CEC's support in continuing the development of power generation technologies can help reduce the risk. In addition, CEC staff posed the question to stakeholders, to which entities responded as summarized below, supporting the need for public funds.
- CPUC inquired about the potential to fund research to explore biomethane cost reductions.
    - CEC staff appreciate this suggestion and may consider it in a future Gas R&D initiative.

Clean Renewable Hydrogen Distribution: Hydrogen Separation

- CPUC requested clarification on the intended definition of hydrogen in the scope of the initiative.
    - CEC staff clarified that the initiative intends to align with CPUC's interim definition established for clean renewable hydrogen in D.22-15-057.[95]
- CPUC requested clarification on the range of hydrogen blend percentages that the initiative would focus on, considering D.22-15-057 ordered the Joint Gas Utilities to

95 California Public Utilities Commission. Decision D.22-12-057 - Decision Directing Biomethane Reporting and Directing Pilot Projects To Further Evaluate And Establish Pipeline Injection Standards For Clean Renewable Hydrogen. December 2022. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M500/K055/500055657.PDF

submit applications for hydrogen blending pilot programs to test hydrogen blends up to 20 percent by volume.

  - CEC staff clarified that the initiative intends to focus on hydrogen separation technologies that could be used with a future blended gas stream. CEC staff revised the initiative to target applicability to blends of three to 20 percent by volume.

- CPUC staff raised concerns about committing research on hydrogen separation before more foundational questions are answered regarding the costs and expected role of hydrogen blending.

  - CEC staff responded that research on hydrogen separation can inform understanding of potential costs and mitigation strategies that could apply to a systemwide blending scenario.

Building Decarbonization: Networked Geothermal District Heating Study

- CPUC staff asked for clarity on the connection between networked geothermal district heating and its impact on gas ratepayers.

  - CEC staff highlighted that this initiative approach offers gas ratepayers a clear pathway toward decarbonization. Additionally, it presents an opportunity to leverage the skills and expertise of the existing gas workforce.

- CPUC staff sought clarification on the rationale for bypassing ground source heat pumps.

  - CEC staff clarified that typical ground source heat pumps require significant land space, and many do not achieve sufficiently high temperatures. The study is not bypassing ground source heat pumps but rather focusing on "expensive/hard to electrify building types" for which conventional ground source heat pumps may not be sufficient.

DACAG Meeting Comment Summary and CEC Responses

The CEC presented the proposed FY 2024-2025 Gas R&D Program Budget Plan to representatives of the DACAG at a meeting on January 19, 2024. At the meeting, CEC staff presented an overview of the Gas R&D Program and development process and summaries of the five proposed initiatives included in the proposed FY 2024-2025 Gas R&D budget plan. The CEC appreciates the helpful questions and comments from DACAG members on the proposed FY 2024-2025 Gas R&D budget plan. Below is a summary of DACAG member comments and CEC staff responses organized by initiative:

Gas Decommissioning: Support Equitable, Safe, and Cost-Effective Decarbonization of California's Gas System

- No comment

Gas System Safety: Innovations for Cost-Effective Operation & Maintenance of Critical Infrastructure During the Gas Transition

- DACAG Members sought clarification regarding the development of technologies and approaches that may become inappropriate if hydrogen blending were to occur.
    - CEC staff clarified that previous funded research initiatives include projects aimed at evaluating the risks associated with hydrogen blending. Notably, a project with University of California, Los Angeles in partnership with Pacific Gas & Electric and SoCalGas is developing a quantitative risk assessment of hydrogen blending and will evaluate potential risk mitigation measures. This ongoing study is anticipated to yield valuable insights. Additionally, a recently approved FY22-23 Gas R&D Budget Plan initiative is set to investigate the potential introduction of hydrogen to gas storage facilities, emphasizing the need for understanding special inspection or monitoring measures tailored to such systems if used to store hydrogen in the future.
- DACAG members sought clarity on exploration of gas inspection technologies, particularly focusing on inspections for hydrogen and storage, and expressed concerns regarding potential embrittlement issues.
    - CEC staff clarified that the initiative would center on improving safety and affordability of existing gas infrastructure. CPUC staff clarified that the overarching aim is to mitigate the expenses associated with maintaining the current gas system amidst escalating regulatory demands, thereby alleviating potential rate impacts.
    - CEC staff will advocate prioritizing infrastructure in disadvantaged communities during implementation and progress with testing out inspection technologies in gas system safety efforts.
- DACAG members sought clarity on whether methane emissions are included in the research initiative, suggesting a discussion on both hydrogen and fugitive methane emissions.
    - CEC staff clarified that the FY23-24 Gas R&D Budget Plan includes an initiative on this topic pending CPUC approval. CEC staff also discussed the portfolio of active Gas R&D Program projects focusing on methane emissions, particularly highlighting two efforts: 1) studying behind-the-meter methane emissions in residential settings with an emphasis on multifamily homes and 2) monitoring regional multi-tiered methane emissions associated with production, processing, and distribution in the San Joaquin Valley.

Renewable Generation: Fuel-Flexible Distributed Power Generation

- No comment

Clean Renewable Hydrogen Distribution: Hydrogen Separation

- DACAG members sought clarification on the types of gas streams being considered for hydrogen separation.
    - CEC staff clarified that hydrogen separation technology would be applicable to blended gas streams that may be present in a future gas pipeline system. CEC staff also clarified current progress in CPUC's Renewable Gas Proceeding, including forthcoming gas utility hydrogen blending pilot proposals to test blends up to 20 percent in isolated segments of the gas system. Findings from the pilots and other research will inform future policy decisions on broader deployment of hydrogen blends.
- DACAG members sought clarification on whether the hydrogen blend percentage referenced was by volume or energy.
    - CEC staff confirmed that the three to 20 percent blend is by volume. Higher hydrogen blends facilitate more efficient hydrogen recovery. Yet, this comes with trade-offs such as the need to upgrade infrastructure.
- DACAG members stated they have concerns with hydrogen blending and recommended directing hydrogen towards the hardest to decarbonize sectors of the economy like industrial feedstocks, aviation, and marine shipping.
    - As noted above, due to stakeholder concerns with hydrogen blending in pipelines, CEC decided to not include this initiative in the FY2024-2025 Gas R&D Budget Plan.

Building Decarbonization: Networked Geothermal District Heating Study

- DACAG members expressed enthusiasm for networked geothermal district heating. They emphasized the importance of exploring energy efficiency measures alongside supply-side solutions.

Public Workshop Comments and CEC Staff Responses

The CEC appreciates the thoughtful and helpful comments from stakeholders received in response to CEC's December 15, 2023, Gas R&D Workshop, where staff presented proposed initiatives for the FY 2024-2025 Gas R&D Program Budget Plan. The CEC requested comments at the December 15, 2023, workshop and via notifications on the CEC website, subscription lists, and docket. A summary of the written comments and CEC's responses is provided below. Please note that for brevity, footnotes included in public comments are not included in this summary.

Public Workshop and Written Public Comment Summary and CEC Responses

Gas Decommissioning: Support Equitable, Safe, and Cost-Effective Decarbonization of California's Gas System

- SoCalGas Comment: Suggested consideration of pipeline blending of renewable gas as an alternative decarbonization pathway.
    - CEC Response: Pipeline blending of renewable gas is anticipated to be a possible gas system decarbonization pathway that could be considered under this initiative.

Gas System Safety: Innovations for Cost-Effective Operation and Maintenance of Critical Infrastructure During the Gas Transition

- CPUC Comment: Very interested in well inspection practices that don't hamper operations of the wells to serve their purpose in mitigating price fluctuations in gas markets.
    - CEC Response: The gas system safety initiative is responsive to the challenges with meeting CalGEM regulations described in CPUC's 2023 Senate Bill 695 Report, including higher operations and maintenance costs, reduced system capacities, and retention of older wells due to downtime caused by well inspections required at a standard two-year interval.[96] This initiative supports the development of technologies and methods for less intrusive well inspections to reduce well downtime and maintain system capacity, as well as continuous monitoring to support early detection of anomalies before they escalate into significant safety concerns. This research may also inform policies related to alternative inspection intervals by providing useful data about well integrity without requiring frequent conventional inspections.
- SoCalGas Comment: Important initiative; suggest coordination with SoCalGas; noted SoCalGas' existing pipeline inspection technology and related research.
    - CEC Response: CEC staff recognize the value of leveraging work done by SoCalGas and others in this space. Research developed and conducted under this initiative will incorporate input from IOUs relative to current practices and technologies, research needs, and challenges with pipeline inspection and material verification.

Renewable Generation: Fuel-Flexible Distributed Power Generation

Public Workshop Comments Received:

- CPUC Staff Comment: Interested in applications for utilizing woody biomass, particularly in off-grid or mountainous areas with limited access to the grid. Is this

96 CPUC. 2023. Senate Bill 695 Report. https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/office-of-governmental-affairs-division/reports/2023/2023-sb-695-report final.pdf

going to be for types of processes that have reduced local pollution, such as sulfur oxides (SOx) and oxides of nitrogen (NOx)? Is this strictly combustion or non-combustion as well?

  - CEC Response: The fuel-flexible initiative is focused on using renewable gases (such as hydrogen, biomethane, or ammonia) in distributed generation technologies in demonstrations located at commercial or industrial sites that may be in remote or rural locations, especially those not connected to the grid. Technologies could be either combustion, such as reciprocating engines and gas turbines, or technologies that use electrochemical, thermochemical, or other proven pathways, with very low emissions even without being dependent on emissions control technologies, such as linear generators and fuel cells. Critical infrastructure – like data centers, hospitals, microgrids, telecommunications, academic/research institutions, and others – that need to ensure continuous operations, especially during grid outages, are of particular interest, as these technologies have the potential to replace diesel backup generators. All demonstrations must reduce greenhouse gases and criteria pollutant emissions compared to fossil-fueled generation technologies.

- SoCalGas Comment: Noted existing project on hydrogen-methane blends for fuel cell applications; offered tours of their hydrogen home demo. Question about the CPUC decision that supported research into blended fuels. Gaps not addressed by the private sector are for field demonstrations of blended fuels and the fuel supply. Recommend outreach to UC Irvine's advanced power and energy programs with Vince McDonald, who is looking at microturbines and changing the combustors for different engines and turbines to accommodate different blends of hydrogen.
  - CEC Response: The CPUC decisions regarding blending targets are in Decision 22-02-025 (February 24, 2022), which sets biomethane targets for utilities, and Decision 22-12-057 (December 15, 2022), which directs utilities to test effects of hydrogen blends up to 20 percent. Please see written public comment no. 5 for CEC's response to the need for funding investments for large quantities of hydrogen blending projects. CEC staff appreciate the recommendation on contacting other stakeholders for information on hydrogen generation.
- SoCalGas Comment: From a research perspective, what are you hearing from the communities around better centering research projects in under-resourced communities or in Environmental and Social Justice communities? Are there any specific actions or procedures being added to your program that you could share with us today?
  - CEC Response: Staff has received feedback from the DACAG regarding the EPIC Program to consider not investing in combustion projects in under-resourced communities. However, staff is working to better understand how that feedback may influence the Gas R&D Program by researching and engaging with DACAG and other stakeholders, such as other environmental

justice organizations and environmental groups. Generally, staff is seeking to take their feedback into account during investment planning and throughout the process of developing solicitations, prioritizing equity in investments.

- SoCalGas Comment: Want to encourage CEC staff to share learnings, best practices, and requirements from the CPUC, the U.S. Department of Energy, and other funding agencies to demonstrate improved equity engagement.
    - CEC Response: CEC staff support open communication on sharing best practices to incorporate environmental justice principles in research investments and will work with the CEC's Public Advisor's Office to facilitate this.
- CPUC Staff Comment: Related to the fuel-flexible generation initiative, how is CEC addressing concerns about combustion technologies from the DACAG?
    - CEC Response: There is a CEC-wide effort to expand outreach specifically to communities and community-based organizations around the combustion concern. For example, there was a presentation on January 19, 2024, to the DACAG on the 2024-25 Gas R&D Budget Plan. Currently, with the help of the CEC's Public Advisor's Office, staff is working to better understand the concern and consider applying feedback within this Gas R&D initiative. For example, in the fuel-flexible initiative, staff is considering limiting new installations to use electrochemical, thermochemical, or other proven pathways, with very low emissions even without being dependent on emissions control technologies and allowing modifications to existing combustion resources, to avoid investing in new combustion demonstrations.
- Tour Engine Comment: CEC has the HyBLOX grant opportunity (GFO-22-504[97]); does CEC have any other program with Federal cost share?
    - CEC Response: The Gas R&D Program is on an annual cadence. In the 2023-24 budget plan, there is an initiative to allow federal cost share. That budget plan is still under evaluation by CPUC. CEC also has a separate funding program called the Clean Hydrogen Program,[98] with a different funding source, that does include federal cost share.

Written Public Comments Received:

Q1: How can equity considerations be centered in the fuel-flexible initiative?

- Mainspring Comment: Equity can be centered in a number of ways; first, siting projects in low-income, disadvantaged, and rural communities, as well as communities that have historically faced outsized impacts from fires and public

97 California Energy Commission. GFO-22-504 – Hydrogen Blending and Lower Oxides of Nitrogen Emissions in Gas-Fired Generation (HyBLOX). https://www.energy.ca.gov/solicitations/2023-01/gfo-22-504-hydrogen-blending-and-lower-oxides-nitrogen-emissions-gas-fired

98 California Energy Commission. Clean Hydrogen Program. https://www.energy.ca.gov/programs-and-topics/programs/clean-hydrogen-program

safety power shutoff events, empowers these communities through increased resilience and reduced emissions. Second, equity can be centered by ensuring that some component of this program focuses on accelerating deployment of charging infrastructure for medium- and heavy-duty (MDHD) electric vehicles (EVs). Deploying fuel flexible generation, including linear generators, to rapidly energize EV charging stations enables immediate charging of EVs by operating as grid-independent microgrids before utility interconnection, and then serving as clean fuel-powered resilience and flexible load after utility interconnection takes place.

  - CEC Response: Staff concur with the suggestion to have equity as the central focus of the initiative. For the project siting suggestion for using a non-combustion technology in frontline communities, CEC staff concluded that this suggestion would be aligned with addressing the combustion concerns from the DACAG. Taking this approach would help to ensure the project sites in the communities would not have any adverse emissions impacts. Staff will take this into consideration during solicitation development. Having strong application requirements or target metrics for demonstrating the renewable fuel-flexible generation would allow for more direct ratepayer benefits to be quantified.

Q2: How would project siting and/or a community benefits plan help address equity considerations?

- Mainspring Comment: Similar to Mainspring's response to the previous question posed in the R&D workshop materials, siting projects to alleviate the challenges frontline communities face is particularly valuable. This is true not only for residents, but also for the critical infrastructure communities rely on – such as medical facilities, cold storage facilities, data centers, and others that represent commercial and industrial applications where high levels of reliability are of paramount importance. These facilities and the communities they serve cannot afford long-duration outages. As such, a project siting or community benefits plan should incorporate not only the benefits of increased resilience and improved air quality, but also the continuity value of essential services to those communities.
  - CEC Response: Staff concur with siting the clean renewable fuel-flexible generation projects in frontline communities and at critical infrastructure facilities that offer crucial services and cannot sustain any long duration outages. Regarding the suggestions for the community benefits plan, staff also acknowledge the importance of having clean, reliable, fuel-flexible generation to support these essential services in the communities. In response, staff will consider these approaches for incorporation during solicitation development.

Q3: What are the most promising innovations, applications, and technology priorities for fuel-flexible distributed generation?

- Mainspring Comment: Linear generators have strong potential to provide grid benefits in the near-, medium-, and long-term for a number of reasons....

dispatchable, able to quickly ramp up/down ... being fuel flexible ...are highly cost-effective as they can operate on, and readily switch between, hydrogen, ammonia, biogas, natural gas, and propane. ... Finally, by virtue of their modular size (20.5' x 8.5' x 9.5'), linear generators are space- and land-efficient.... The applications for which linear generators provide benefits are broad. ...deployed linear generators across a number of locations in California, including units sited at logistics facilities, grocery stores, wastewater treatment plants, and landfills – and continues to expand the number of units in service.

    - CEC Response: Thank you for highlighting the dispatchable, fuel-flexible, and modular capabilities of linear generators, enabling them to be used in a wide range of applications, including load reduction to the grid. This supports staff's considerations for the innovations and application areas needing support for fuel-flexible generation initiative.

- SoCalGas Comment: A technical priority for fuel-flexible distributed generation is NOx emission control. One specific example of this priority involves pursuing retrofittable solutions for fielded microturbines. Supported by SoCalGas RD&D, ongoing hydrogen blending research at University of California, Irvine seeks to investigate the impact of various parameters on NOx emissions in microturbines. Fuel-flexible distributed generation holds promise as another innovative solution to decarbonize the current gas grid. This initiative highlights the possibility of utilizing existing gas infrastructure by blending hydrogen with electrolyzer and fuel cell technology, thereby creating microgrids capable of delivering resilient and decarbonized power. Another promising innovation on the horizon involves zero-emission stationary generators. With the backing of SoCalGas RD&D, Noble Thermodynamic Systems is spearheading the development of a retrofit for existing stationary engine reciprocating engine plants.

    - CEC Response: CEC staff concur that NOx emissions control is a technical priority and appreciates the examples provided for pursuing retrofittable solutions for combustion-based technologies such as microturbines and reciprocating engines. Thank you for the explanation of a promising application for decarbonizing the gas grid from the example of the Caltech project for long-duration clean energy storage and dispatchable power generation. This supports staff's considerations for taking a technology-neutral approach that includes both combustion and non-combustion technologies.

Q4: To what extent are you seeing combustion vs. non-combustion technologies as part of fuel-flexible distributed generation in the near- and medium-term?

- Mainspring Comment: Non-combustion generation technologies are key to fuel-flexible distributed generation resources – which itself are an important tool for rapidly adding meaningful capacity to California's grid while simultaneously reducing criteria pollutants and lowering carbon emissions.

- SoCalGas Comment: SoCalGas believes a viable near-term strategy is to retrofit existing combustion technologies to accommodate blends of hydrogen in the fuel supply. In the medium-term, we expect more non-combustion technologies to become available (e.g., fuel cells).
    - CEC Response to both Comments: CEC staff appreciate the different perspectives regarding the timeframe for combustion and non-combustion technologies used in fuel-flexible distributed generation. These technologies may play a crucial role in facilitating our transition towards decarbonization and in response, staff will continue considering a technology-neutral approach under this initiative.

Q5: What gaps are there from private sector investment for advancing fuel-flexible generation that are best addressed by the state?

- Mainspring Comment: Projects in the biogas sector (especially landfills, dairies, and wastewater treatment facilities) are particularly important in demonstrating the value of locally-sited fuel-flexible clean dispatchable generation for a number of reasons produce much more fuel than can be used onsite (which is often flared when unused); capital intensive and ineligible for state incentives (e.g. the Self Generation Incentive Program ("SGIP")); require strong revenue source to offset high capital costs. However, power generated from many biogas facilities, especially landfills, does not produce enough revenue to be economically competitive relative to other Low-Carbon Fuel Standard-eligible projects, which drives investment interest away. Market-based Power Purchase Agreements ("PPA") alone are insufficient to achieve investor return requirements variability in the content of biogenic fuels can vary depending on the source (e.g., landfill, dairy, wastewater treatment), further reinforcing the need for fuel-flexible generation in this important segment state investment to accelerate deployment of charging infrastructure for medium- and heavy-duty vehicles using fuel-flexible distributed power generation is an area that can materially help to meet the state's climate and energy goals – which disproportionately improves air quality for disadvantaged communities by reducing diesel particulates.
    - CEC Response: This initiative is focused on fuel-flexible distributed generation targeted for critical infrastructure, particularly data centers, hospitals, microgrids, telecommunications, academic/research institutions, and others, that need to ensure continuous operations, especially during grid outages. However, staff may consider this suggestion in a future Gas R&D initiative.
- SoCalGas Comment: Large-scale field demonstrations require that the infrastructure accept large amounts of trucked-in hydrogen and the infrastructure to blend that hydrogen with natural gas. Given the absence of private sector investment in this area, the CEC is well positioned to provide the hydrogen blending infrastructure and to provide funding for the large quantities of hydrogen required for these projects.
    - CEC Response: CEC staff welcome the feedback expressing the need for public investment in hydrogen blending infrastructure and for the large

quantities of hydrogen needed for these projects. Staff will investigate these suggestions and will take them into perspective during the fuel-flexible solicitation development.

Clean Renewable Hydrogen Distribution: Hydrogen Separation
Public Workshop Comments Received:

- SoCalGas Comment: SoCalGas asked for clarification on how CEC staff is planning to determine end uses. SoCalGas recommended that CEC staff consider that certain end uses may have different gas quality and pressure requirements. For example, fuel cells would require highly pure hydrogen. A variety of hydrogen separation technologies should be explored for a variety of end uses.
    - CEC Response: The technoeconomic analysis portion of the initiative intends to evaluate feasibility and cost-effectiveness of applying hydrogen separation technologies to various end uses. CEC staff agree that gas quality requirements will differ by end use.
- SoCalGas Comment: SoCalGas previously funded a project with HyET to demonstrate and de-risk electrochemical hydrogen separation technologies at a small scale and recommended coordination and collaboration with CEC. For example, CEC can complement SoCalGas' research by targeting larger scale demonstrations. Electrochemical hydrogen separation can also be used as compression, which is important for improving reliability of fuel cell electric vehicle refueling stations that currently rely on mechanical compressors. SoCalGas also has an active project with UC Riverside to evaluate impacts of hydrogen blends on compressed natural gas (CNG) engines to address manufacturer concerns. SoCalGas recommended that this research be conducted now to inform future policy decisions.
    - CEC Response: CEC staff have connected previously with SoCalGas on the HyET project and welcome other opportunities to collaborate on and complement research funded by SoCalGas.
- GTI Energy Comment: This is an important R&D area that pairs well with the Fuel-Flexible Distributed Power Generation initiative. Where de-blending occurs, there may be a hydrogen-rich gas as an output that can be used by on-site generation technology that accepts a wide range of gas quality.
    - CEC Response: CEC staff concur that hydrogen de-blending could be used to supply hydrogen-rich gas to fuel-flexible distributed power generation end uses.
- CPUC Comment: CPUC asked for clarification on how this research will connect with the Hydrogen Roadmap and Strategic Plan funded under CEC's EPIC Program.
    - CEC Response: CEC staff offered to connect offline to provide a more detailed explanation of the scope of the EPIC-funded Hydrogen Roadmap and Strategic Plan projects.

Written Public Comments Received

Q1: Should this research be pursued in the near term? Or wait for clearer policy direction regarding hydrogen blending on a broader scale?

- SoCalGas Comment: This type of research is needed today to help the State meet its pressing goals of carbon neutrality by 2045, as well as Senate Bill 100 and Senate Bill 32. In fact, conducting the research can help to inform the regulators setting policies, analyzing possible scenarios that are economically and technically feasible. R&D helps to inform more robust policymaking and better policy decisions.
    - CEC Response: CEC staff appreciate this feedback and will consider it amongst others to determine prioritization of this initiative.

Q3: Is there additional demand for this technology, aside from the use cases discussed in previous slides?

- SoCalGas Comment: Electrochemical hydrogen separation can also be used for hydrogen compression, for example at a hydrogen fueling station with on-site electrolysis. Solid state compression could improve fueling station reliability. Some natural gas customers use methane as a feedstock for chemical production processes. These customers are known as "feedstock customers," and often cannot utilize hydrogen in their operations. These customers would benefit from deblending upstream from their meters. Also, consider distributed power generation using hydrogen fuel cell power generators. These units could use hydrogen de-blended from the pipeline to produce zero emissions (greenhouse gas and NOx) power for microgrids or backup power applications.
    - CEC Response: CEC staff appreciate this feedback and concur that hydrogen separation technologies are applicable to these use cases.

Q4: What are some resources that can help further inform this research initiative?

- SoCalGas Comment: The CEC can refer to SoCalGas's HyET demonstration, which field tested a technology that can simultaneously separate and compress hydrogen from a blend of hydrogen and natural gas. At scale, the technology would allow hydrogen to easily be transported via the natural gas pipeline system, then extracted and compressed at fueling stations that provide hydrogen for fuel cell electric vehicles (FCEVs). HyET's technology can be designed to achieve simultaneous purification and deblending (from mixtures of nitrogen (N2), hydrocarbons (CxHy), and trace amounts of carbon monoxide and carbon dioxide) and compression of hydrogen, up to >900 bar. The SoCalGas RD&D demonstration ran for approximately 9 months and tested a variety of blending percentages (2 to 20 percent hydrogen in methane) at a flow capacity of 10 kilograms (kg) of hydrogen per day operating at an approximately 6000 pounds per square inch gauge (PSIG). Depending on blend level, extraction typically consumed 4 to 8 kilowatt hours (kWh) per kg hydrogen, and compression consumed 2 to 8 kWh per kg hydrogen. HyET and Baker Hughes also have a collaboration to combine HyET's electrochemical hydrogen compression technology with Baker Hughes' compression

technology across a variety of pressure applications to grow and accelerate the hydrogen market. The insights and experiences gained by SoCalGas RD&D through these demonstrations can be used to inform future research and projects.

  - CEC Response: CEC staff appreciate the background and technical metrics provided on HyET and Baker Hughes' hydrogen separation and compression technologies. CEC staff have connected previously with SoCalGas on the HyET project and welcome other opportunities to collaborate on and complement research funded by SoCalGas.

Q5: What are some promising innovations that can further improve separation efficiency, durability, and performance with low hydrogen concentrations?

- SoCalGas Comment: SoCalGas RD&D is supporting a project, directed by Caltech researchers, and funded by Advanced Research Projects Agency - Energy (ARPA-E), that seeks to develop a hybrid electrochemical/catalytic approach for direct generation of high-pressure hydrogen. Caltech's proposed system has the potential to reach <$2 per kg of hydrogen produced and compressed at 700 bar using renewable energy sources. The proposed catalytic compression is estimated to require lower capital expenditures and operating expenses and has much better scalability than incumbent technologies. The team estimates a cost of $0.19 per kg hydrogen for compression to 700 bars, representing a >80 percent reduction compared with state-of-the-art.
  - CEC Response: CEC staff appreciate the background and technical metrics provided on SoCalGas' and ARPA-E's project to develop Caltech's catalytic compression technology.
- Aven Alliance Comment: My name is Karmel Graham, and I am the Founder of the Aven Alliance. We are a nonprofit that consults in the clean energy space. I am also the Director of Product Management for Great Plains Analytical Services (GPAS), which is an emissions testing company headquartered in Oklahoma. Both the Aven Alliance and GPAS are making strides to move clean hydrogen energy forward, yet we've noticed that there is a lack of resources and incentives for hydrogen equipment maintenance and hydrogen gas leak repair. New state and federal rules/guidelines must be created to incorporate this very critical element of the value chain. There is also the need for new tooling and testing equipment to be developed, as everything currently available is not suitable for hydrogen detection. I ask that this be a consideration and focal point in plans moving forward.
  - CEC Response: The FY2023-24 Gas R&D Budget Plan includes a proposed initiative for Gas Leakage Mitigation, inclusive of research on hydrogen leakage detection and mitigation technologies. That budget plan is still under evaluation by CPUC.

Building Decarbonization Networked Geothermal District Heating Study

- SoCalGas comment: There were issues in the Imperial Valley where there's a tremendous amount of geothermal power generation, but they were suffering from decreasing capacity over time.
    - CEC Response: Anticipated performance degradation is a common occurrence in geothermal wells over time. One potential strategy to address this is oversizing the project and factoring in a percentage decrease to ensure the required heating capacity remains available throughout the project's lifespan. Additionally, the district heating system can be complemented by heat pumps or other technologies on exceptionally cold days, with geothermal heating serving as the primary heating source for the majority of the time. Furthermore, it's important to note that the capacity requirements for power generation may differ from those of the proposed district heating system. Thus, the heating system may not encounter the same challenges as the power generation aspect. In developing a future solicitation, CEC staff will consider evaluations of the estimated life span of the well and anticipated performance degradation, so stakeholders can understand the long-term impacts of the project.
- SoCalGas Comment: In response to Q2: What are the major obstacles that prevent wider adoption of geothermal heating in California? The two major obstacles that prevent wider adoption of geothermal heating in California are brine production and seismic concerns. Geothermal wells often produce brine contaminated with materials that are potentially toxic (e.g., heavy metals) and costly to dispose of. Drilling to geothermal depths in populated areas could raise seismic concerns.
    - CEC Response: In the context of brine, geothermal power necessitates separating non-condensable elements from steam to safeguard turbine blades from damage or reduce maintenance on heat exchangers due to the high flow rates. In geothermal heating systems, the steam or hot water is passed through a heat exchanger and then re-injected into the ground. Some losses occur in this loop, and the brine may be diluted with treated wastewater. The CEC staff don't expect the brine waste volume to be as high as that generated by power generation processes. However, CEC staff will consider including in the solicitation(s) to closely monitor and assess the environmental impact of brine disposal to ensure responsible management practices. Addressing seismic concerns is crucial in the community engagement strategy for such projects. This is similar to large-scale endeavors in populated areas, like driving piles for sizable buildings, as these also require community engagement to minimize disruptions. As part of the study, researching existing gas wells—including those in urban areas or near fault lines with similar seismic concerns—is essential. This research allows for the incorporation of lessons learned from past drilling experiences into the current project planning. Since the drilling is relatively less deep, the potential impact may be minimal. However, as part of the study, this concern will be

investigated to ensure a comprehensive understanding of any potential effects.

- SoCalGas Comment: In response to Q2: What type of business models (e.g., gas utilities) could best leverage these (>120 degrees F) geothermal heating resources? Gas utilities are already positioned to provide fuel for heating purposes (customers are billed per therm of energy delivered). Utilities are also skilled at deploying, maintaining, and operating large infrastructure projects and would be well-positioned to provide this type of product.
    - CEC Response: CEC staff appreciate this feedback and concur that gas utilities could have a positive impact on geothermal district heating.

Additional CPUC Staff Coordination Meeting Comment Summary and CEC Responses

On January 10, 2025, CEC met with CPUC subject matter experts to respond to feedback about the Gas System Safety research initiative. On January 16, 2025, CEC met with subject matter experts from CPUC to discuss the proposed Support Equitable, Safe, and Cost Effective Decarbonization initiative, building from brief written feedback the CPUC provided to the CEC on December 23, 2025. The conversations helped to deepen interagency alignment on the initiative goals and clarified the focus areas of the research initiatives. On January 23, 2025, CEC met with subject matter experts from CPUC to make clarifications regarding the proposed Fuel-Flexible Distributed Power Generation initiative and help to ensure the goals of the initiative are clearly distinguished from that of IOU research plans. Comments from CPUC staff and CEC responses from each of these meetings are summarized below.

Gas System Safety: Innovations for Cost-Effective Operation & Maintenance of Critical Infrastructure During the Gas Transition

- CPUC staff comment: This initiative should discuss why ratepayers should fund these activities rather than utilities, since both will benefit. Ensure clear and public reporting of results.
    - CEC Response: Investing in this research through the Gas R&D Program helps to ensure the work remains impartial, transparent, and aligned with the interest of ratepayers and the public. As a sister agency to CPUC and CalGEM, the CEC is also uniquely positioned to invest in research that aligns with state policy and their needs as regulators. Additionally, CEC staff anticipate the utilities will play a valuable role in this research as they have previously in similar efforts. Utilities could potentially serve as project partners, provide match funding, and support field demonstrations. All project results will be made publicly available. In addition to a published final report, project recipients will be required to establish a technical advisory committee and develop a technology transfer plan identifying how the team will make project

information available. This could include potential outreach to key parties, utilities, and regulatory agencies, among others.

- CPUC staff comment: If this relates to CalGEM requirements, have you coordinated with CalGEM about it?
    - CEC Response: CEC staff have coordinated with CalGEM on past research projects to develop and demonstrate underground gas storage well monitoring and inspection technologies as well as in the development of this proposed initiative. CEC staff met with CalGEM staff in 2023 to share information about the Gas R&D Program, better understand their current framework for well testing requirements and intervals, and learn about their interest in exploring specific factors that may contribute to extending well testing intervals. CalGEM staff noted that the agency's regulation is intended to be technology agnostic and that they are open to better understanding the effectiveness of emerging technologies in identifying anomalies. If this initiative is approved, CEC staff will continue to engage with CalGEM staff to scope the solicitation and to ensure the research aligns with state interests and needs as feasible.

Gas Decommissioning: Support Equitable, Safe, and Cost-Effective Decarbonization of California's Gas System

- CPUC staff expressed that this initiative contained many good but diverse topics and requested additional detail. They also noted that it may be difficult to find appropriate bidders for solicitations funded under this initiative. CPUC suggested there could be former IOU employees who possess the needed expertise to support these research needs.
    - CEC staff affirmed CPUC's concern about the difficulties of reaching bidders with the expertise for some of the research envisioned under this initiative. CEC noted that staff are attuned to this challenge and to an overall need to grow the research industry pool to accommodate transition research needs. CEC also noted that staff will continue to explore mechanisms (e.g., contract versus grant funding) and options to secure interest from potential bidders who could assemble suitable research teams. CEC requested CPUC staff provide further input on prioritizing focus areas under this initiative.
- CPUC staff commented on coordinating with long-term gas proceedings to clarify the types and timeframes of information that can be garnered from this effort. They gave examples of outstanding questions on existing hurdles to decarbonization activities (e.g., replacing gas stoves with lower-carbon alternatives) for which research illuminating complexities and pathways forward would be useful. CPUC noted that they are not up-to-date on the types of research already occurring on these topics.
    - CEC staff affirmed the intent that research funded under this initiative would be coordinated with CPUC gas proceedings. They also commented that

research approaches supporting these topics are being actively developed, noting that data collection applicable in social sciences diverges from that typical in technical disciplines, in turn requiring innovation, including in characterizing what collected data may represent.

- CPUC staff suggested research and characterization of health impacts and associated costs related to transitioning away from gas to electricity, such as air pollutant exposure from indoor gas combustion, and how these vary by case. For example, modeling could reveal how health impacts vary by the size of the premises. CPUC also noted that some communities subject to frequent Public Safety Power Shutoffs or other outage events might rely heavily on gas stoves for cooking during those outages.
    - CEC staff noted their appreciation for these suggestions and concurred on the importance of understanding the diversity—across different communities and instances—of air quality and other impacts of a transition away from gas. Staff noted that research findings on these topics could support both communication efforts and the identification and development of technological advances that improve the marketability and functionality of conversion from gas (e.g., battery backup systems for operability of electric appliances during outages). In response to this feedback, initiative leads incorporated an example research question in the initiative description that could be further scoped in the solicitation phase (see Chapter 3, page 27).

Renewable Generation: Fuel-Flexible Distributed Power Generation

- CPUC staff comment: Need justification on why this should be funded through public investment. We have concerns over IOUs trying to increase investment in delivery before understanding/solidifying the source of the renewable fuels.
    - CEC Response: The CEC Gas R&D funding stream is the best funding source, because it comes from gas ratepayers who will be affected by the policy plans. SoCalGas and SDG&E are investing in clean hydrogen R&D for producing, transporting, storing, and blending for various generation uses.
- CPUC staff comments: Consider the Renewable Order Instituting Rulemaking (OIR), including findings that existing gas pipelines cannot carry hydrogen above a certain percentage. This initiative should not attempt to build out comprehensive renewable generation and distribution capacity but could explore creating/locating hydrogen-related hubs, potentially at industrial sites/substations.
    - CEC Response: Anticipated fuel changes drive the need to address power generation technology readiness. Using various renewable fuels shows consideration of the Renewable Gas OIR and would complement the CPUC's rulings on the procurement of biomethane/renewable gas. The 2022 CPUC Hydrogen Blending study states that up to 5% hydrogen blend is safe and

recommends doing key activities to support demonstrations, R&D, planning, and engagement to study hydrogen blending at higher percentages.

- CPUC staff comment: Are you referring to a portfolio of technologies or a single technology? This should demonstrate first why such technologies would be an improvement over existing non-emitting BTM generation or generation-plus-storage technologies (e.g., solar-plus-storage).
    - CEC Response: This initiative proposes to study distributed generation technologies including reciprocating engines, gas turbines, linear generators, and fuel cells, to make them adaptable to the anticipated changing fuel supply. It would also support the development of using renewable fuels in these technologies as an improvement over current fossil-based generation. The initiative may consider the necessary technology to complement existing clean BTM generation, addressing its limitation (e.g., supply and capacity) and resulting in overall system improvement.
- CPUC staff comment: An interesting outcome would be the social benefits of phasing out diesel backup generators. How this could replace diesel back-up generators – need to identify the gap that this is filling and justify the funding level.
    - CEC Response: According to a 2022 M.Cubed report,[99] the diesel backup generator population is growing and accounts for almost 90% of backup generators. Cleaner systems would reduce negative health effects related to emissions from diesel fuel. This initiative would support cleaner options during Public Safety Power Shutoff events and developing technologies that could complement plans in related programs, such as the Distributed Electricity Backup Assets program. The 4-6 Technology Readiness Level range for the proposed $6M funding could support about 3 to 4 projects for component and full system innovations to ensure fuel-flexible technologies meet expected performance, operability, cost, low-emission, and decarbonization goals and targets.
- CPUC staff comment: This could be a pilot project to demonstrate the usefulness and the cost effectiveness and reliability of this technology/identify use cases to reduce risks to the buyer for adopting the technology. The state policy general direction seems to be towards pipeline injection as opposed to electricity production.
    - CEC Response: The Technology Readiness Level range includes pilot demonstrations to make generation systems adaptable to the anticipated

99 M.Cubed, 2022. "Back-up Generator Populations in Bay Area, South Coast Continue to Grow; San Diego Home to a Significant Number of Generators, Mostly Diesel Power." chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M500/K762/500762070.PDF

change in fuel supply, regardless of renewable fuel sources. We propose focusing on the generation use case, because nearly 45% of the fossil gas burned in California is used for electricity generation. The goal is to help bolster resiliency while providing clean energy access to vulnerable communities, especially during extreme weather and grid events.

- CPUC staff comment: Could be best to just require non-combustion technologies to be used or at least considered in applications (for example, any renewable gas bids coming into the Renewable Gas Standard requesting permission to use on-site electricity production based on combustion would be required to submit costs of production with a linear generator/fuel cell alongside their bid that includes combustion).
    - CEC Response: This initiative aims to be inclusive of a portfolio of distributed generation technologies. It is intentional when referring to linear generators by not implying that a linear generator is a "non-combustion" technology like a fuel cell. Any technology demonstrations under this research initiative would need to greatly reduce GHG and criteria pollutant emissions.
- CPUC staff comment: There is mention of industrial applications; it seems like it would be for high-heat applications, not generation? Discuss and refine specific use cases for this demonstration based on the amount of funding ($6 million). What is the source of hydrogen for these applications? It seems like the most cost-effective CO2/short-lived climate pollutant abatement approach would be carbon-negative renewable gas.
    - CEC Response: Applications include commercial buildings, industrial operations, utilities, and communities in remote or rural locations, especially those not connected to the grid. CEC is also considering critical infrastructures, as fuel-flexible generation technologies have the potential to replace diesel backup generators. Heat applications could be supported as an enhancing feature. The initiative does not address the sourcing of the renewable fuels. We expect the program initiative to be competitive and favorable to sources that are cost-effective and have the lowest carbon intensity.
- CPUC Staff Comment: Tech transfer and scaling/market transformation over time should be discussed, and the objective could focus on investigating linear generators, fuel cells, and combustion and comparing the three in terms of cost, operations and maintenance, and applicability. With use case(s) in mind, how would this initiative improve/maintain affordability?
    - CEC Response: Technology transfer and scaling capabilities are typically included in CEC solicitation requirements and would be considered during review and scoring. CEC solicitations require proposals to compare their proposed technology/innovation to any incumbent and competing technologies across several metrics including costs, emissions, efficiency, and others. If CPUC staff are interested, the CEC Solicitation Manager could invite

a CPUC subject matter expert to be a reviewer during the proposal evaluation process. Affordability would be improved through enabling fuel diversification, leveraging cost-effective renewable fuels, and enhancing efficiency.

- CPUC staff comment: This initiative description should discuss and differentiate the research from that approved in SoCalGas' FY 2022-2023 Gas R&D Budget plan.
    - CEC Response: The initiative description includes a summary of related SoCalGas R&D initiatives and how they complement the research proposed by CEC Gas R&D Program.

APPENDIX D
List of 2023 Gas R&D Events

January 2023:

- Pre-Application Workshop: Hydrogen Blending and Lower Oxides of Nitrogen Emissions in Gas-Fired Generation (HyBLOX) - GFO-22-504

September 2023:

- IEPR Commissioner Workshop on the Potential Growth of Hydrogen (presentation on hydrogen research portfolio, including Gas R&D Program projects)
- EPIC Policy + Innovation Coordination Group – Strategic Goals Built Environment Workshop (presentation on hydrogen for industrial decarbonization, including Gas R&D Program projects)
- Climate Data Analysis Working Group (C-DAWG) Presentation on Historical Weather Observation Platform (developed under PIR-19-006)

October 2023:

- Presentation on "Advanced Quantification of Methane Emissions Using UAV Curtain Flux Method and Comparison with Flux Chamber Method" at EREF Summit on Quantification of Landfill Emissions (PIR-19-009)
- Presentation on the AB 100 Seismic Safety and Earthquake Preparedness Activities Report to the Seismic Safety Commission, including overviews of related Gas R&D Program projects to improve gas pipeline geohazard risk mitigation (PIR-18-002, PIR-18-003, PIR-23-004)

November 2023:

- Pre-Application Workshop: Quantifying Exposures to Indoor Air Pollutants in Multifamily Homes that Cook with Gas or Alternatives (GFO-23-501)

December 2023:

- Staff Workshop to Discuss Proposed Gas Research Initiatives for FY 2024-25
- Meeting of the California Energy Commission's Healthy, Equitable Energy Transition (HEET) Working Group, covering the theme "Understanding Air Quality and Equity Impacts of Clean Energy Interventions Using Models and Measurements"

APPENDIX E
FY 2024-2025 Gas R&D Plan Equity Framework Topic Definitions

The FY 2024-25 Gas R&D Budget Plan includes the application of the Disadvantaged Communities Advisory Group (DACAG) Equity Framework. The five key equity principles have been adapted to apply to the Gas R&D Program and Electric Program Investment Charge (EPIC Program).

Health and Safety

CEC will direct investments to optimize the health and well-being of California's most vulnerable communities by advancing clean energy technologies that lead to health benefits and positive impacts, build resiliency, address climate change vulnerabilities, and reduce climate and air-quality-related healthcare costs. For example, advancements in building envelopes and low-carbon cooling technologies will reduce exposure to climate change impacts such as wildfire and extreme heat. Disadvantaged communities will benefit from reduced emissions from advancements in transportation electrification, as well as innovations in load flexibility that can reduce and eliminate the need to run fossil fuel-powered peaker plants.

Access and Education

Accessibility is the extent to which cleantech products and services are usable and available to people from the widest range of backgrounds and capabilities. The CEC strives to remove barriers to clean energy technology adoption, as identified in the SB 350 Barriers Report and by relevant stakeholders. This is accomplished through technology demonstration and deployment (TDD) in under-resourced communities, addressing community priorities, supporting relationship-building and partnerships among diverse members of the public, ensuring meaningful community engagement with community-based organizations as key project partners, and investing in diverse businesses. CEC will address access and education through projects and program administration by (1) enhancing inclusivity by focusing on targeted outreach, meaningful engagement, and knowledge dissemination; (2) ensuring that technologies are applicable to community interests and responsive to local needs; and (3) supporting the sharing of culturally relevant and sensitive project information and educational materials for participating communities. Tracking and evaluating progress of such efforts will ensure that these interventions are successful.

Financial Benefits

CEC investments will lead to technological advancements that lead to financial benefits and cost savings while considering affordability and rate impacts. For example, improved energy efficiency and load flexibility will result in electric bill savings; advancements in

energy resilience from energy storage technologies will help reduce financial impacts to businesses facing grid reliability issues; and manufacturing advancements will reduce the costs and accelerate the scaling of clean energy technologies. In addition, CEC EPIC and Gas R&D funding has a solid history of expanding community investment by attracting significant additional public and private funding and building capacity for future clean energy project developments and affordability and other benefits. CEC Gas R&D and EPIC investments will prioritize financial benefits in under-resourced communities to improve energy equity.

Economic Development

CEC investments will support economic development by:

- Funding applicants committed to diversity, equity, and inclusion.
- Investing in manufacturing, entrepreneurship, job creation, and training that support workforce development pathways to high-quality careers in California.
- Encouraging hiring for low-income, disadvantaged, and under-represented populations (including women, re-entry, veterans, and environmental justice communities, among many others).
- Supporting small and diverse business development and contracting.

For example, through support of the Entrepreneurial Ecosystem, the CEC seeks to grow the Gas R&D and EPIC-related talent pool and provide critical support at all stages of the technology development pipeline to accelerate and expand clean energy benefits. TDD projects and manufacturing initiatives support job growth, on-the job training, and workforce development and include opportunities in regions facing high rates of unemployment and underemployment.

Consumer Protection

As a technology R&D program, the Gas R&D program does not directly address consumer protection in any initiative; thus, consumer protection was not included in the Equity Matrix (Table 2). Rather, through investments that work to advance clean energy technologies, the Gas R&D program is supporting consumer protection by demonstrating, de-risking, scaling, and accelerating the affordability, accessibility, and other benefits from the adoption of emerging clean energy technologies.

Direct and Indirect Benefits

Direct impacts are expected as a direct result of project implementation. For example, occupant health benefits are expected from indoor air quality improvements from TDD projects that include electrification of gas appliances. Similarly, economic development benefits are expected from geothermal energy projects that hire local workers and support workforce development.

Indirect impacts are expected more broadly outside of project implementation. For example, indirect health benefits are expected from a project that funds the technological

advancements of an induction cooktop that will improve indoor air quality at later stages of development.

APPENDIX F
Estimated Administrative Costs

Based on analyses conducted on FY 2023-2024 Gas R&D Program administration, an estimated breakdown of Gas R&D Program administration costs is provided below. The FY 2022-2023 Gas R&D Program administration continues to provide the cost basis, as it is the most recent plan that has been fully approved. As subsequent plans are approved, this analysis will be updated.

Program Administrative Cost Budget Item	Fiscal Year 2024-2025 ($)
Investment Plan Development	$229,669
Project Planning and Initiation	$504,031
Project Oversight and Governance	$695,214
Stakeholder Communication, Engagement, and Outreach	$116,697
Regulatory Support Compliance	$229,669
Internal Management Coordination	$76,970
Program and Process Coordination and Improvement	$63,121
Administrative Activities	$81,565
Supervision and Personnel	$271,928
Training and Development	$131,136
Total	**$2,400,000**

APPENDIX G
Gas R&D Stakeholders Workshop Presentation

Please see: https://www.energy.ca.gov/event/workshop/2023-12/fy-2024-25-gas-rd-budget-plan-workshop.