CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

California Energy Commission

STAFF REPORT

Gas Research and Development Program

Proposed Updated Budget Plan for Fiscal Year 2025–2026

September 2025 | CEC-500-2025-013-REV

California Energy Commission

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ACKNOWLEDGEMENTS

The authors would like to thank the following Energy Research and Development Division staff for leading the research initiatives in the *Gas Research and Development Proposed Budget Plan for Fiscal Year 2025-2026:*

Mithra Moezzi, Ph.D.

Pooya Khodaparast, Ph.D.

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The following Energy Research and Development Division staff contributed valuable support in the development of the *Gas Research and Development Proposed Budget Plan for Fiscal Year 2025-2026*:

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PREFACE

The California Energy Commission (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 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 California Public Utilities Commission (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, lower costs, increase reliability, and improve safety. The research areas address issues that are not adequately addressed by the regulated market.

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

- A focus on the areas of energy efficiency, renewable technologies, conservation, and environmental issues
- Support for state policy
- A reasonable probability of providing benefits to the public
- Consideration of collaboration and cofunding 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 impose 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 2025–2026. The proposed research and development initiatives align with the themes of gas system decommissioning and building decarbonization. The initiatives support state energy policies and goals, with several initiatives directly benefiting under-resourced communities. The proposed research funding for Fiscal Year 2025–2026 is $24 million. The budget plan covers July 1, 2025, through June 30, 2026. The development of 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, distributed generation, renewable generation, networked geothermal, geothermal, energy infrastructure, gas decommissioning, energy-related environmental research, building decarbonization, disadvantaged communities, low-income communities, decarbonization, gas users, energy transition

Please use the following citation for this report:

Horing, Jill and Kaycee Chang. 2025. Energy Research and Development Division. 2025. *Gas Research and Development Program Proposed Budget Plan for Fiscal Year 2025–26.* California Energy Commission. Publication Number: CEC-500-2025-013-REV.

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EXECUTIVE SUMMARY

As California progresses toward its clean energy and climate change goals, the infrastructure, role of the gas sector, and 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~~**an equitable and** cost-effective achievement of the **gas sector transition and** 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 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 interested parties. Key policies, plans, and guidance include Executive Order B-55-18, Assembly Bill (AB) 1279 (Muratsuchi, Chapter 337, Statutes of 2022), Integrated Energy Policy Reports, and CPUC decisions and resolutions, among others.

This proposed Fiscal Year (FY) 2025–2026 Gas R&D Budget Plan includes R&D funding for three initiatives aligned with two themes (Table ES-1). The proposed R&D initiatives serve to support gas decommissioning — retiring portions of California's fossil gas infrastructure to advance decarbonization goals and reduce costs of maintaining and operating the fossil gas system — and building decarbonization **to reduce the use and costs of fossil gas**. Funding for these initiatives is requested from the FY 2025–2026 annual budget of $24 million.

The FY 2025–2026 Gas R&D Budget Plan benefited from input from representatives of the Disadvantaged Communities Advisory Group, environmental justice organizations, and investor-owned utilities; CPUC coordination; and a dedicated public workshop, among other sources of input received on CEC's gas-related R&D efforts.

Table ES-1: Proposed FY 2025–2026 Gas R&D Budget Plan

Investment Theme / Initiative Theme	Initiative Title	Proposed Budget
Environmental and Social Research / Gas Decommissioning	Social Science Research for Gas Decommissioning in the Mid and Long Term	$3,000,000
Gas System Integrity / Gas Decommissioning	Pilot Projects to Advance Gas Decommissioning	$6,000,000
Decarbonization / Building Decarbonization	Networked Geothermal Heat Pumps	$12,600,000
Program Administration		$2,400,000
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 goals, the infrastructure, role of the gas sector, and 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), Senate Bill 100 (De León, Chapter 312, Statutes of 2018), and Senate Bill 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 facilitate 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.[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 the replacement of fossil fuels with renewable energy resources, including renewable and zero-carbon electricity, renewable hydrogen, and biomethane. While these replacements hold significant promise for reducing emissions, further technology development will help improve technology performance and lower costs.

Gas R&D Program Background

The Gas Research and Development (Gas R&D) Program supports the transition of the gas system necessary to achieve 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 by lowering the cost and improving the performance of associated technologies, infrastructure, and services.

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 Program. The CPUC allocates $24 million annually for the CEC's administration of the 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

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.

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.
- Consider opportunities for collaboration and cofunding with other entities, such as federal and local agencies.

In 2006, the California Legislature passed Senate Bill 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 issued resolutions to provide additional guidance for implementing the Gas R&D Program.[5] Chapter 2 describes the CPUC resolutions.

In 2021, the California Legislature passed Assembly Bill 148 (Ting, Chapter 115, Statutes of 2021). This law authorizes the 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 lower energy costs, increase energy efficiency, 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 2024 Annual Report.*[6]

Fiscal Year 2025–2026 Budget Plan Priorities and Development

The proposed Fiscal Year (FY) 2025–26 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 initiatives support gas decommissioning and building decarbonization. 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 public input, as discussed in Chapter 2.

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

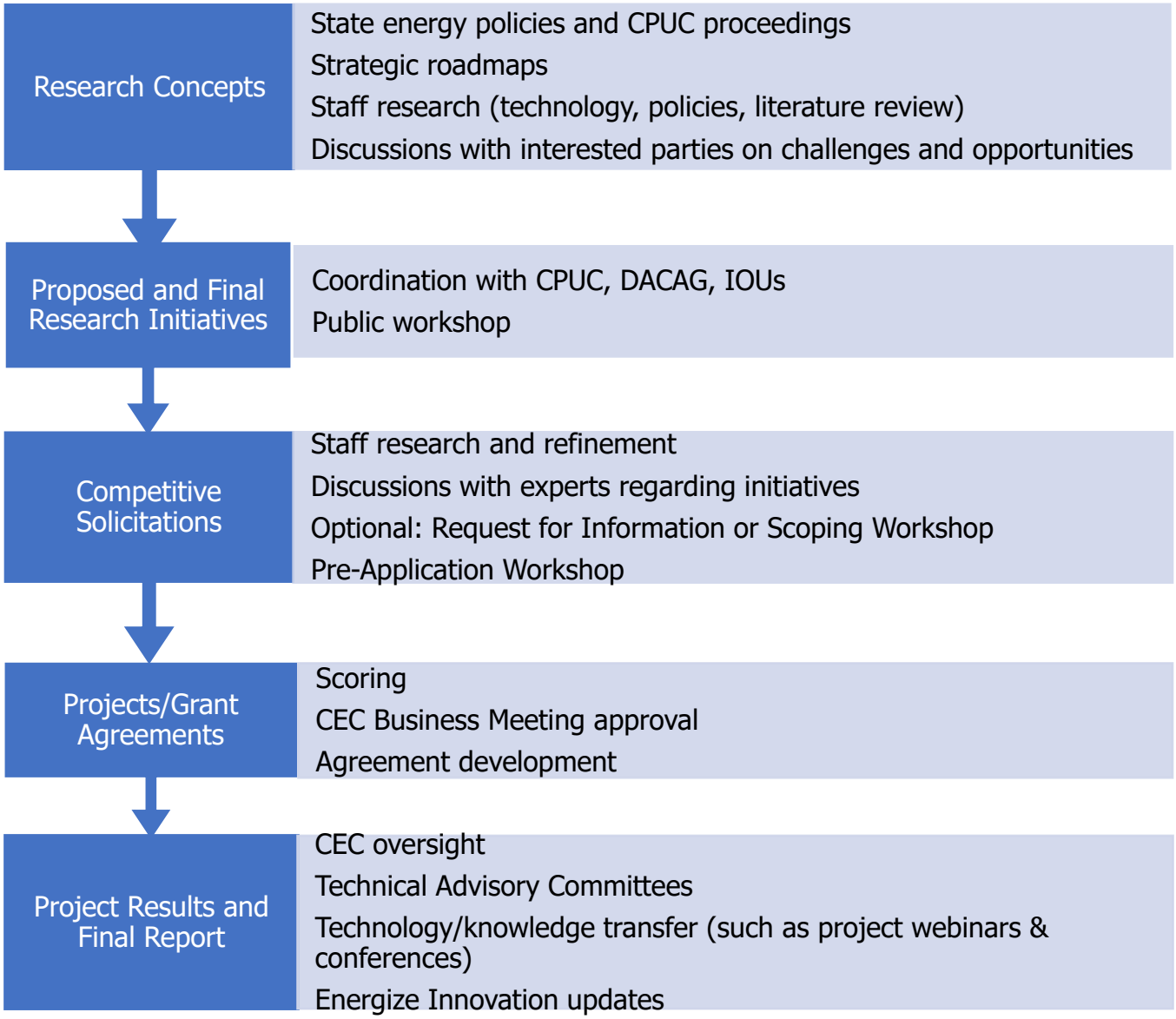
5 California Public Utilities Commission. "Energy Research Development and Deployment," https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/energy-research-development-and-deployment.

6 Once approved for publication, the Gas Research and Development 2024 Annual Report will be available at https://www.energy.ca.gov/programs-and-topics/programs/gas-research-and-development-program

CHAPTER 2:
Developing Gas R&D Initiatives for Fiscal Year 2025–2026

The research initiatives described in Chapter 3 of this report were informed by state policies, plans, and guidance — including in CPUC decisions, as discussed below — as well as the CEC's commitment to diversity and equity, public input, and roadmaps and strategies developed by state agencies, as 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 life cycle of Gas R&D Program activities, is included in Figure 1.

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



Source: CEC staff

CPUC Decision 04-08-10: Supporting State Policy

As delineated 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 Assembly Bill 1279, Muratsuchi, Chapter 337, Statutes of 2022)

and doubling energy efficiency by 2030 (Senate Bill 350, De León, Chapter 547, Statutes of 2015).[7]

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

- Senate Bill 32 (Pavley, Chapter 249, Statutes of 2016), which establishes the state's goal for a 40 percent GHG emissions reduction below 1990 levels by 2030.
- 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.[8]
- The CEC's Integrated Energy Policy Reports (IEPRs) and associated updates, which assess major energy trends facing California's electricity, gas, and transportation fuel sectors and provide policy recommendations.[9]
- 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.[10]

The FY 2025–2026 Gas R&D Budget Plan also specifically addresses the focus areas identified in CPUC Decision 04-08-10, including:

- Conservation and energy efficiency (with an initiative in building decarbonization).
- Environmental issues (including building decarbonization and targeted gas system decommissioning initiatives).

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

CPUC Resolution G-3592

The CPUC Resolution G-3592, issued in 2023, added seven new administrative requirements for the FY 2023–2024 Budget Plan and beyond. The CEC addressed these requirements, which are summarized below, in the chapters or appendices as noted in parentheses:

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7 California Office of the Governor. September 10, 2018. Executive Order B-55-18 To Archive Carbon Neutrality, https://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf; Assembly Bill 1279, Muratsuchi. 2022. The California Climate Crisis Act, 2022, ; Senate Bill 350, De León. 2015. *Clean Energy and Pollution Reduction Act of 2015,* https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB350.

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

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

10 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.

1. Engage with and include input from disadvantaged community stakeholders, including the Disadvantaged Communities Advisory Group (DACAG), to provide input on how to administer the program equitably (Chapters 2 and 3).
2. Offer a presentation of the budget plans to the CPUC commissioners. (The offer to present the proposed budget plan was made January 22, 2025.)
3. Describe collaborative and cofunding opportunities considered (Chapters 2 and 3).
4. Summarize investor-owned utility (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 (Chapters 2 and 3).
5. Provide a detailed cost breakdown of Gas R&D Program administration (Appendix F).
6. Summarize how the long-term research roadmap, *Recommendations for the Long-Term Gas Research Strategy to Achieve Aggressive Statewide Carbon Neutrality Goals,* was considered in developing the budget plan (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 (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 Assembly Bill 3232 (Friedman, Chapter 373, Statutes of 2018) report in developing the FY 2025–2026 Gas R&D Budget Plan, specifically the seven key strategies to decarbonize residential and commercial buildings (homes and businesses) outlined in the 2021 report *California Building Decarbonization Assessment.*[11] The initiatives in the FY 2025–2026 Gas R&D Budget Plan support several of the recommended strategies.

The Social Science Research for Gas Decommissioning in the Mid and Long Term initiative supports multiple strategies detailed in the report, including "Building End Use Electrification," "Decarbonizing the Gas System," and "Decarbonizing the Electricity Generation System." The initiative will provide analysis, resources, and insights into real-world dynamics of gas use and factors encouraging or dissuading conversion, including to electricity end uses. This initiative would also identify and suggest improvements to coordination gaps between the electricity and gas systems.

The Pilot Projects to Advance Gas Decommissioning research initiative promotes the goals of "Decarbonizing the Gas System" by supporting the transition away from fossil gas. By strategically decommissioning sections of California's gas infrastructure and redirecting

11 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.

investment toward renewable energy alternatives, electrification, or both, this effort aims to lower the overall energy costs and GHG emissions in energy supply and end uses.

The Networked Geothermal Heat Pumps (GHPs) initiative supports the strategy of "Distributed Energy Resources" by assessing the feasibility of networked GHPs to provide neighborhood-scale, clean, efficient, distributed energy for heating and cooling **as well as the goal of "Decarbonizing the Gas System" by supporting the transition away from fossil gas**. Networked geothermal technology is a form of thermal energy network that implements the roughly constant temperature of the bedrock as a source and sink of energy for heat pumps, while balancing the load among a variety of end users in the network, thereby increasing overall thermal efficiency. This initiative aims to investigate the benefits of networked GHPs in the context of California's climate, geology, population, and policy landscape.

CPUC Resolution G-3584 calls for the CEC to consider the long-term research roadmap for gas technology development, titled "Recommendations for the Long-Term Gas Research Strategy to Achieve Aggressive Statewide Carbon Neutrality Goals."[12] 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 analysis includes recommendations, which are organized around 11 initiatives: three under communities, equity, and environment; four under gas end use; and four under gas supply chain, including production, transport, and storage. These recommendations have helped guide Gas R&D planning, including the Fuel Flexible Distributed Generation initiative of the 2024–2025 Plan.

Resolution G-3584 also requires the CEC to review the unspent funds in the Public Interest Energy Research Development and Demonstration Fund CEC subaccount 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 (Appendix B). Per the CPUC's request in Resolution G-3555, issued in 2019, 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.

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 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. However, 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.[13]

12 California Energy Commission. 2022. Webinar on Long-Term Gas Research Strategy Recommendations. https://www.energy.ca.gov/event/webinar/2022-12/webinar-long-term-gas-research-strategy-recommendations

13 Available upon request.

Should the CEC be unable to obtain needed data, the CEC staff will consult with CPUC Energy Division staff before reallocating any funding as required in the CPUC's 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." However, 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, the 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. This additional step helps ensure the best possible use of funds across programs. This year, the CEC provided the CPUC with summaries of the research initiatives on several occasions as described in the section "Coordination and Strategic Partnerships."

The CPUC also included a requirement that, for all Gas R&D Budget Plans, the CEC post the budget plans publicly on the CEC's website before submitting an approval request to the CPUC and notify the CPUC of the web address when requesting approval of the plan. The CEC follows this practice, with Gas R&D Budget Plans posted on the CEC webpage for Energy R&D investment plans and annual reports.[14]

For all Gas R&D Budget Plans, the CPUC called for the CEC to distribute the budget plan through the CEC's email subscription lists and include the names of the lists served when requesting the CPUC's approval of the plan. The resolution also calls for the CEC to consult with CPUC Energy Division staff on which CPUC service lists from ongoing CPUC proceedings the CEC should serve its proposed plan.[15] CEC's email subscription 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."

Moreover, the resolution asks that, for all Gas R&D Budget Plans, the CEC consult with the CPUC to allow the option of presenting the budget plan to the CPUC commissioners during a CPUC commissioner committee meeting. (The offer to present the proposed budget plan was made January 22, 2025.) This request was revised via CPUC Resolution G-3592, and the CEC responded accordingly.

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14 California Energy Commission. "Energy Research and Development Investment Plans and Annual Reports," https://www.energy.ca.gov/data-reports/reports/energy-research-and-development-investment-plans-and-annual-reports.

15 California Public Utilities Comission. Service lists 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 are updated as needed in consultation with CPUC Energy Division.

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 the 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 the CPUC 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, "Foundational Principles for Uniform Impact Analysis."

Equitable Program Administration

The CEC's commitment to diversity and equity shapes the 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 advances 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.[16]

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.
- Low-income households (household incomes below 80% of the area median income).

16 California Energy Commission. 2015. *Resolution 15-0408-3: Resolution Regarding Diversity Policy Statement,* https://www.energy.ca.gov/sites/default/files/2020-07/diversity_policy_resolution_ada.pdf.

- Low-income census tracts (census tracts where aggregated household incomes are less than 80 percent of area or state median income).[17]

Assembly Bill 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.[18] In 2024, the CEC adopted the JAEDI Informational Proceeding with the goal of developing a comprehensive JAEDI Action Plan.[19] In the ERDD, there are designated equity leads who work with the CEC's 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.

A recent example of a CEC outreach effort to support diversity and equity commitments includes input sought on improving the CEC's application and grant management processes to reduce administrative burdens for potential applicants. These improvements may be particularly beneficial for smaller entities without prior experience in preparing CEC grant applications or without substantial resources or risk capacity or both. In collaboration with the CEC grants ombudsman, ERDD staff obtains feedback from applicants and works to improve the grant application process.

Examples of 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 criterion considers factors such as economic impacts, as well as improving access to clean energy within the community. Applications with letters of support demonstrating benefits to these communities and tribes are also considered.
- Continuing to advance efforts to address energy-related challenges and opportunities in ESJ communities by encouraging residents and interested members to participate and share perspectives in community meetings on CEC-funded projects.
- Continuing to track, monitor, and provide findings in the Gas R&D Annual Report on the participation of California-based entities; women-, minority-, and disabled-veteran-

17 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.

18 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.

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

owned businesses; and small businesses as recipients of awards. Since FY 2016–2017, the Gas R&D Program has invested about 48 percent of research funds in demonstration projects (excluding combustion projects) in a disadvantaged community, low-income community, or both, with the aim to bring benefits to those communities. Recent program investments in disadvantaged and low-income communities are included in the *Gas Research and Development 2024 Annual Report*.[20]

- Maintaining the CEC's Empower Innovation platform (EmpowerInnovation.net) 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 help engage a broad set of interested parties 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).

Senate Bill 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. The DACAG advises 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.[21] 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 outreach opportunities with the DACAG. These activities include providing staff updates and presentations on upcoming budget plans, programs, workshops, outreach events, and final reports related to the group's priority areas in the DACAG monthly newsletter, public meetings, and smaller meetings with DACAG priority area subject matter experts (SMEs).

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20 Once published, the *Gas Research and Development 2024 Annual Report* will be available at https://www.energy.ca.gov/programs-and-topics/programs/gas-research-and-development-program.

21 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, https://efiling.energy.ca.gov/getdocument.aspx?tn=214830.

CEC staff activities specifically related to CEC's commitment to diversity and equity for the FY 2025–2026 Gas R&D Proposed Budget Plan include:

- Routinely 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.
- Requesting comments to elicit public input on how to center equity in the proposed initiatives in the 2025–2026 Gas R&D Program following the February 7, 2025, public workshop.
- Briefing DACAG SMEs on the initial list of proposed initiatives August 19, 2024. The finalized initiatives were selected with consideration of DACAG SME input**, including removal of an initiative that did not have support from the DACAG SMEs**, and a follow-up email to DACAG members about the selected initiatives was sent October 16, 2024.
- Presenting and soliciting feedback on the proposed initiatives of the Gas R&D Program and the proposed equity engagement approach at the DACAG meeting January 17, 2025. Staff incorporated changes to the Gas R&D Plan informed by DACAG input.
- Presenting and soliciting feedback on the proposed initiatives of the Gas R&D Program at an environmental justice roundtable October 11, 2024, with representatives from seven organizations. Input from the roundtable was incorporated into initiative development and will be considered in future budget plans. See Appendix D for a summary of feedback and CEC responses.

Coordination and Strategic Partnerships

CEC staff engages 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 initiates discussions with a wide range of experts to understand current challenges, emerging needs, and technology advancements within the gas system. Further, 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 reliability and environmental sustainability. This 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 conducts in-depth research to refine initiatives and develop proposed 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. Once solicitations have entered the development phase, the CEC does not collaborate in crafting grant solicitations **with external entities outside of a public forum** to ensure compliance with Public Resources Code Section 25620.5(a), which requires these grant solicitations to be

competitively selected and awarded.[22] 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 participates in regular outreach meetings with IOUs, including:
    - Attending Southern California Gas Company's (SoCalGas) annual public workshop on its annual research, development, and demonstration (RD&D) plan to provide guidance on research priorities, and meeting with SoCalGas SMEs on specific research priorities, such as hydrogen and transportation.
    - Providing input on Pacific Gas and Electric's (PG&E) gas operations and hydrogen-related R&D priorities through meeting with PG&E SMEs 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 planning and reporting among IOUs and the CEC to streamline coordination across administrators.
        - 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 administrators to hold annual public workshops, starting in 2025, to foster greater administrator coordination on gas innovation activities to benefit ratepayers and ESJ communities (Per CPUC Resolution G-3603 Ordering Paragraph 4).
    - Coordinating on proposed 2025-2026 Budget Plan Initiatives by coordinating briefings:
        - On August 12, 2024, CEC staff met with representatives from SoCalGas, PG&E, and Southwest Gas to gather feedback on the initial set of potential initiatives. The CEC answered clarifying questions, heard the IOUs' perspectives on research needs that helped guide the selection and

22 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.

preparation of the proposed initiatives**, and ensured duplication of proposed research across administrators would be avoided**. Following these meetings, SoCalGas and PG&E also provided written comments that are summarized in Appendix D.

- On October 9, 2024, CEC staff met with representatives from SoCalGas, Sempra, and PG&E to gather additional feedback on the selected proposed initiatives included in the Proposed FY 2025–2026 Budget Plan.

- **CPUC coordination:** CEC staff engages 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:
    - Discussions to refine 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.
    - Coordination on data requests to IOUs and associated findings in support of long-term gas planning.
    - Sharing of preliminary results from ongoing and recently completed research related to gas system decarbonization to share knowledge and elicit feedback from the CPUC.
    - Ongoing discussion regarding the potential for the CEC Gas R&D portfolio to support implementation of SB 1221 and the CPUC's broader long-term gas planning.
  - Contributing to the *2024 Joint Agency Staff Paper: Progress Towards a Gas Transition,*[23] including Chapter 8 on "Research and Innovation Needs," summarizing key research priorities, which includes priorities under the Gas R&D Program.
  - Soliciting early and ongoing feedback on proposed FY 2025–2026 Budget Plan initiatives from CPUC SMEs, with the first briefing July 24, 2024. Subsequent updates were provided at monthly CEC-CPUC Gas R&D Working Group meetings on August 27 and October 29, 2024. Additional coordination calls took place to discuss initiatives on September 9 and November 22, 2024.
- **Other governmental agency coordination:** CEC staff participates in regular meetings internally with state and federal agency partners regarding topics related to gas sector challenges. Topics discussed include:

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23 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.

    - Application-driven climate science (led by the National Oceanic Atmospheric Administration).
    - Forest biomass (led by the California Department of Forestry and Fire Protection [CAL FIRE]).
    - Hydrogen hub efforts, including end-use and infrastructure issues (led by Alliance for Renewable Clean Hydrogen Energy Systems which includes the California Governor's Office of Business and Economic Development.)
- **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 **periodically**~~roughly quarterly~~ to guide planning for, execution of, and transfer of knowledge from applied research:
    - The Climate Data and Analysis Working Group invites industry, research, and state agency staff to participate in technical discussions to advance integration of climate change into planning, research, and operations.
    - The Healthy, Equitable Energy Transition Working Group 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 that year. The Proposed FY 2025–2026 Gas R&D Budget Plan was presented at a public workshop on February 7, 2025. Approximately 70 people attended the workshop, not including CEC staff, and the CEC received around 30 attendee questions and comments during the workshop discussion. The CEC considered and responded to public comments associated with budget plan development. (See Appendices C and D for the workshop presentation and a summary of public comments and CEC responses, respectively.)

Beyond the above-mentioned engagement that guides Gas R&D budget planning, the CEC also engages a diverse set of parties in Gas 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 ongoing collaboration with PG&E, San Diego Gas & Electric (SDG&E), and SoCalGas that includes their participation as members of technical advisory committees (TACs), project team members, and demonstration site hosts.

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 to a broad audience.
- 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. (A list of public events is provided in Appendix C.)

Cofunding Opportunities

The CEC leverages cofunding opportunities by requiring applicants for competitive solicitations to secure match funding (usually 10 to 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 bringing in 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-funded 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.[24]

Public feedback during development of these roadmaps and strategies 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 research initiatives proposed drew from long-term strategies such as IEPRs and the CEC's Gas Decarbonization Order to Institute Informational Proceeding (Gas Decarb OIIP).[25] Both IEPRs and the Gas Decarb OIIP highlight the need for long-term gas system planning, refering to many unknowns and evolving energy sector needs related to building decarbonization and gas decommissioning targets. Planning needs include:

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

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

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

In 2024, CPUC, CEC, and CARB developed the *2024 Joint Agency Staff Paper: Progress Towards a Gas Transition* in support of the CPUC's Long-Term Gas Planning Rulemaking (R.20-01-007).[26] This report sets the stage for interagency coordination to develop strategic plans for reducing fossil gas demand and planning for the future of the pipeline system. The report acknowledges the need for thoughtful planning for the transition away from gas to achieve California's climate goals while reducing rate and bill impacts, ensuring safe and reliable operation of the gas system, supporting public health, prioritizing disadvantaged communities, and advancing opportunities for the affected gas workforce. The report outlines key considerations and strategies and highlights networked geothermal as one such approach. The report informed the three initiatives proposed in the FY 2025–2026 Gas R&D Budget Plan.

Additionally, 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 contactors 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.[27] The analysis suggests 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 2025–2026 Budget Plan.

Foundational Principles for Uniform Impact Analysis

The Gas R&D Program, similarly to EPIC, is designed to provide benefits to ratepayers. A uniform impact analysis framework is under development in the CPUC's EPIC proceeding (R 19-10-005) to demonstrate the realized and potential impacts to electric ratepayers from R&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 EPIC and the Gas R&D program.

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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.*

27 CEC. December 12, 2022. "Workshop on Long-Term Gas Research Strategy Recommendations," https://www.energy.ca.gov/event/webinar/2022-12/webinar-long-term-gas-research-strategy-recommendations.

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:

1. Each project should offer a reasonable probability of providing benefits to ratepayers, and the portfolio as a whole should demonstrably benefit ratepayers.
2. If a targeted group of ratepayers benefits from an individual project's output, investments should result in scalable and replicable innovations.
3. Accurate and precise project and program impacts reporting is needed to ensure impacts are defensible and not overstated.
4. Lastly, 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 Gas R&D planning and reporting.

In addition to outlining these overarching principles, the decision 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 apply 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.

The CEC's processes are in alignment with these principles in several ways, and impact assessment occurs throughout the Gas R&D Program administration process. In the budget planning phase, initiatives are scoped to ensure replicable and scalable benefits to ratepayers, each considering expected outcomes and describing benefits using a 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 R&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 advance the objectives of the proposed initiatives. Solicitations, which are more specific than

initiatives, may describe the requirements for impact evaluation that are expected in applications and any 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 provide a description of the proposed benefits of the project 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 2025–2026 Proposed Budget Plan contains initiatives that span several project types.

The Social Science Research for Gas Decommissioning in the Mid and Long Term initiative will fund applied research studies. The Pilot Projects to Advance Gas Decommissioning Pilots initiative will fund pilot demonstrations. The Networked Geothermal Heat Pumps initiative proposes two phases: the first will fund a research study, and, based on the findings, the second phase 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 being responsive 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 2025–2026

Proposed Budget Overview

This proposed FY 2025–2026 Gas R&D Budget Plan includes funding for three initiatives aligned with two research themes (Table 1). The proposed R&D initiatives serve to address the following themes:

- Gas system decommissioning
- Building decarbonization

Themes represent the overarching topical areas of study under which the research initiatives fall. Multiple initiatives may be proposed under a theme. Initiatives provide more detail on the proposed research area and example activities within the scope of the themes.

Table 1: Proposed FY 2025–2026 Gas R&D Budget Plan

Investment Theme / Initiative Theme	**Initiative Title**	**Proposed Budget**
Environmental and Social Research / Gas Decommissioning	Social Science Research for Gas Decommissioning in the Mid and Long Term	$3,000,000
Gas System Safety / Gas Decommissioning	Pilot Projects to Advance Gas Decommissioning	$6,000,000
Decarbonization / Building Decarbonization	Networked Geothermal Heat Pumps	$12,600,000
Program Administration		$2,400,000
TOTAL		$24,000,000

Source: California Energy Commission

Proposed Research Initiatives

Initiative Theme: Gas System Decommissioning

California's climate policies such as Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006)[28] and Assembly Bill 1279 (Muratsuchi, Chapter 337, Statutes of 2022)[29] are driving the state to reduce GHG emissions. Despite significant progress toward a clean energy economy — including surpassing 60 percent clean electricity on the grid — California remains the country's second-largest consumer of fossil gas, which was also the largest source of GHG emissions from in-state electricity generation.[30] The long legacy of fossil gas in California presents substantial social, technological, political, and economic challenges to achieving the transition to cleaner energy resources.

Gas system decarbonization and decommissioning are critical to the effective pursuit of a decarbonized energy system in California. California's vision for gas decommissioning, which **prioritizes**~~involves~~ transitioning away from aging and high-maintenance portions of gas infrastructure in areas where there are viable renewable energy alternatives, such as electrification, could offer a path to achieve the state's decarbonization goals. Recognizing the importance of retiring California's aging gas infrastructure, recent legislation, SB 1221,[31] sets a regulatory requirement for public utilities to provide maps of priority neighborhood decarbonization zones, detailing potential gas distribution line replacement projects.

Much of California's gas system, which consists of 11 million meters of transmission and distribution pipeline, is approaching its end-of-service life.[32] By 2045, it is estimated that $43 billion in maintenance costs will be needed to ensure gas delivery safety and infrastructure integrity, minimize gas commodity price spikes, and meet the gas utilities' regulatory requirements to provide safe and reliable gas services under the current obligation to serve.[33]

According to the 2024 Gas Report, California is expected to experience a steady decline in gas demand between 2024 and 2040 due to energy efficiency, building electrification, and climate

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28 California Air Resources Board. December 2022. *2022 Scoping Plan for Achieving Carbon Neutrality*.

29 California Legislative Information AB-1279 The California Climate Crisis Act, 2021–2022.

30 U.S. Energy Information Administration. "Frequently Asked Questions," https://www.eia.gov/tools/faqs/faq.php?id=46&t=8. California Energy Commission, "Supply and Demand of Natural Gas in California, https://www.energy.ca.gov/data-reports/energy-almanac/californias-natural-gas-market/supply-and-demand-natural-gas-california#:~:text=Nearly%2045%20percent%20of%20the,90%20percent%20of%20its%20natural.

31 California Legislative Information. 2024. SB 1221: Gas corporations: ceasing service: priority neighborhood decarbonization zones,https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202320240SB1221.

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

33 Smillie, Sean, Daniel Alberga, Aryeh Gold-Parker, and Dan Aas. (Energy and Environmental Economics, Inc. [E3]). June 2024. Fact Sheet. "Avoiding Gas Distribution Pipeline Replacement Through Targeted Electrification in California," https://www.ethree.com/wp-content/uploads/2024/06/Gas-Decommissioning-Fact-Sheet-2024-06-18.pdf.

change.[34] Without planning, this decline in gas demand could result in increased gas rates for those who remain on the gas system and **may be**~~are~~ least able to electrify. Decommissioning gas infrastructure and services presents a complex and multifaceted challenge ~~in addition to~~ **that encompasses** technical feasibility, ~~involving~~ **evolving** energy regulations and policies, innovative technologies, adaptation **strategies**, and economics.

In alignment with CPUC guidance and proceedings, research on gas decommissioning continues to be a focal point of CEC's Gas R&D Program, and the resulting gas decommissioning research portfolio has supported legislative and regulatory efforts to advance the gas transition. The CEC's gas decommissioning research portfolio has included extensive cost-benefit analyses to delineate long-term, policy-compliant trajectories for the gas system; pre-pilot studies done in partnership with IOUs to establish basic planning parameters; and ongoing research to advance data-driven approaches for gas system transitions. Below is a summary of the progression of the portfolio of gas decommissioning research projects and initiatives to date:

- **In 2020, E3 completed an economic modeling study[35] that concluded that, compared to decarbonizing at the pipeline, building electrification was a lower cost, lower risk option for achieving overall GHG emission reductions. The study emphasized that a transition away from gas should be closely managed to control adverse consequences to gas system affordability, safety, and equity (funded by Gas R&D FY 2015-16 Budget Plan).**
- **Subsequent to the above economic modeling study, two pre-pilot studies, one led by E3 in Northern California and one by RAND in Southern California, scoped the potential for gas-to-electricity conversions in select communities and sought to identify barriers and community interest.[36] Among other findings, these studies found that, while some community members were interested in electrification, many were not convinced that electrification was an appealing alternative to gas (funded by Gas R&D Budget Plans from FY 2019-20 and FY 2020-21).**
- **The 2020 E3 economic modeling study noted above led to funding the** ***Mindful Decommissioning: A Data-driven Tool for Prioritizing Strategic Gas***

34 California Gas and Electricity Utilities. 2024. *2024 California Gas Report*, https://www.socalgas.com/sites/default/files/2024-08/2024-California-Gas-Report-Final.pdf.

35 Aas, Dan, Amber Mahone, Zack Subin, Michael Mac Kinnon, Blake Lane, and Snuller Price. 2020. *The Challenge of Retail Gas in California's Low-Carbon Future: Technology Options, Customer Costs and Public Health Benefits of Reducing Natural Gas Use*. California Energy Commission. Publication Number: CEC-500-2019-055-F.

36 For the E3 project, see Gold-Parker, Aryeh, Claire Halbrook, Helen Mejia, Allison Lopez, Fangxing Liu, Jared Landsman, and Amber Mahone. 2024. *An Analytical Framework for Targeted Electrification and Strategic Gas Decommissioning: Identifying Potential Pilot Sites in Northern California's East Bay Region*. California Energy Commission. Publication Number: CEC-500-2024-073 . For a summary of the RAND project, see Strategic Pathways and Analytics for Tactical Decommissioning of Portions of Natural Gas Infrastructure in Southern California | CEC; the final report is forthcoming.

Asset Decommissioning **project initiated in 2022.[37] The tool being developed in this project relies on extensive collaboration between CPUC and CEC staff to obtain data on gas distribution infrastructure and conditions from R.20.01.07, and combines these with socioeconomic data to produce a map-based tool to help screen for promising decommissioning sites (funded by Gas R&D FY 2020-21 Budget Plan).**

- **An active solicitation titled *Paving the Way to California's Gas Transition* is expected to fund research on gas decommissioning in rural and tribal areas—a topic that was a DACAG research recommendation—and use fieldwork to assess practical aspects of converting gas end uses (funded by Gas R&D Budget Plans from FY 2021-22 and FY 2022-23).**
- **Subsequent Proposed Budget Plans, including FY 23-24, FY 24-25, and the current plan, continue to develop gas decommissioning research proposals that would support and develop decommissioning pilots in the field, such as via SB 1221 and conduct targeted, pragmatic studies. These studies would draw on empirical data to inform key challenges in gas decommissioning, including supporting successful conversions from gas end uses, assessing the short- and long-term impacts of those conversions for consumers and the state, and contributing to critical transition planning. If the Proposed Budget Plans are approved, the resulting solicitations and funded research projects will be intentionally and strategically designed to mutually support and build on, rather than overlap with, past and ongoing studies.**

This budget plan includes two complementary initiatives addressing gas decommissioning. The first initiative focuses on gas end-use conversion and decommissioning, funding broadly social sciences-centered research to support an effective, equitable, and affordable transition away from gas over the next few decades. The second initiative focuses on pilot projects to demonstrate gas decommissioning in neighborhoods, which may include areas identified in SB 1221's decommissioning zonal maps. These pilots will ~~include~~ **aim to** develop~~ing~~ and test~~ing~~ processes to achieve conversion of existing gas uses in ~~these~~ neighborhoods and inform~~ing~~ the safe and environmentally sound decommissioning of local gas infrastructure. Research supported by these two initiatives will be designed to mutually inform each other as applicable.

Initiative Title: Social Science Research for Gas Decommissioning in the Mid and Long Term

Initiative Description

The *2024 Joint Agency Staff Paper: Progress Towards a Gas Transition*[38] calls for social scientific research on a range of decommissioning innovation and development needs,

[37] See Mindful Decommissioning: A Data-Driven Tool for Prioritizing Strategic Gas Asset Decommissioning | CEC for project summary and updates.

38 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.*

including for building and zonal electrification. This initiative responds to that call by applying expertise and methods to support achieving technological and societal changes consistent with California's gas system transition goals. Funded research would build a bridge from recent ~~experience on~~ gas system decarbonization **activities** — such as pilot gas decommissioning projects[39] and ongoing building electrification efforts[40] — to mid-term and longer-term efforts to support a successful transition from fossil gas. The initiative expands on decommissioning research themes introduced in the proposed FY 2024–2025 Gas Research Plan and coordinates with evolving research on decarbonization pathways.

This initiative will create a portfolio of research that investigates societal elements of the technological change required for and resulting from gas decarbonization and decommissioning. It seeks to create productive conversations across industry parties and produce output that captures information that is typically inaccessible, such as project or informal experience that otherwise would not be formally reported. Projects will also draw insights from past energy technology transitions and market transformations, such as the transition from incandescent to fluorescent to light-emitting-diode (LED) lamps. Potential projects include:

- Collecting and synthesizing data on gas user and supply chain actor contexts and attitudes pertinent to gas system decarbonization, decommissioning, and end-use conversion, formatting research outputs to be easily used by planners and policy makers. For instance, research outputs could include **integration of novel data into** a map-based tool serving location-specific sociological, demographic, market, technical, and infrastructural data relevant to questions about receptivity, needs, capacity, and overall suitability for gas decommissioning.
- Identifying and refining approaches to support electrification and understand frictions preventing or slowing the adoption. These could draw from a range of possibilities, such as:
    - Experience in jurisdictions that had enacted limits on gas use.
    - Identification of technology innovation needs that could make electrification more appealing or better performing.
    - User-centered evaluation of outcomes of electrification.

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39 For example, see the Gas Research and Development Program projects "Strategic Pathways and Analytics for Tactical Decommissioning of Portions of Natural Gas Infrastructure in Southern California" (https://www.energizeinnovation.fund/projects/strategic-pathways-and-analytics-tactical-decommissioning-portions-natural-gas-0) and "Strategic Pathways and Analytics for Tactical Decommissioning of Portions of Natural Gas Infrastructure in Northern California" (https://www.energizeinnovation.fund/projects/strategic-pathways-and-analytics-tactical-decommissioning-portions-natural-gas), both of which develop frameworks to identify opportunities for gas decommissioning based on infrastructural and community data.

40 This includes, for example, voluntary individual electrification projects (such as a household replacing some or all of their gas-fueled equipment with electric counterparts) as well as those primarily driven by government or utility programs such as California's Equitable Building Decarbonization Program (https://www.energy.ca.gov/programs-and-topics/programs/equitable-building-decarbonization-program).

- Producing tools to estimate changes in gas and electricity costs, whether for individual consumers or planners and researchers to assess affordability and equity implications of conversion under different scenarios.
- Investigating hard-to-decarbonize gas end uses outside the building sector, including gas-fired electricity generation and industrial applications.

Additional potential topical areas include research guiding energy infrastructural and resilience planning. Examples include coordinating changes in gas-use patterns with gas system operations and safety, anticipating impacts of gas end-use electrification on electricity demand patterns, converting hard-to-electrify gas end uses in the industrial and commercial sectors, analyzing sociotechnical issues concerning the role of renewable fuels, and managing the transitional role of gas-fired power plants.

Expected Outcomes

Projects will provide data, resources, and results guiding government programs and policy; easing the transition away from fossil gas dependency; identifying utility and technology developer activities that could aid this transition; and providing supply chain, communications, tools, and community development recommendations that could help enable the transition. Research pursued under this initiative will support the creation of compelling, actionable societal pathways for transitioning away from fossil gas use. Orienting to the use of more empirical data will improve utilities' ability to maintain reliable energy services, energy system safety, and energy affordability, and it will enable more equitable outcomes as a result. Results will generate knowledge, motivate conversations across siloes, and identify technological and policy innovation needs that foster a positive transition away from dependency on fossil gas.

Benefits to Californians

Californians will benefit from research supported by this initiative because of the focus on providing a strong empirical understanding of effective pathways to gas system decarbonization. This strong empirical understanding supports successful achievement of, and social adaptability to, gas system decarbonization, together with assessing costs, benefits, and risks for different groups of consumers and other interested parties. Californians will also benefit from the strategy of leveraging existing data sources and experiences, improving research cost-effectiveness. Results can help inform CEC's Gas Decarbonization OIIP (Order 22-0309-7) and CPUC's Long-Term Gas Planning Rulemaking (R. 20-01-007), benefiting all ratepayers. **The EPIC Program's Uniform Impact Analysis Foundational Principles will be used to demonstrate outcomes of achieving proposed benefits for all research projects under this initiative, including through quantitative methodologies. As described in detail below, examples include air quality improvement calculations and safety challenges identified through modeling.**

- **Affordability:** Provides information to planners on costs and risks of different decommissioning pathways, supporting decisions on transition pathway management

and on setting gas and electricity rates. Also supports ratepayer decisions related to costs and benefits of electrifying gas end uses.

Possible metrics to assess affordability benefits include:

- **Effectiveness of information dissemination and adoption of research results, potentially including:**
  - **Applications in affordability planning**
  - **Consumer tools developed**
  - **State agency integration of quantitative results or insights**
- **Identification of barriers to adoption of equipment that could reduce individual consumer costs**

- **Safety and reliability:** Supports higher precision in anticipating and managing reliability and safety challenges associated with transitioning off fossil gas (CPUC ESJ Action Plan Objectives 6.1, 6.2).[41]

  Possible metrics to assess safety and reliability benefits include:

  - **Identification of prospective energy reliability and/or safety challenges based on modeling the impacts of gas end use conversion**
  - **The planning impacts of that identification (e.g., improved decommissioning strategies or reliability solutions)**
- **Adaptation:** Supports adaptation to climate change by providing insights easing successful conversions from fossil gas and improving outcomes, thus supporting California's transition to a decarbonized energy system, reducing GHG emissions, improving planning efficiency, and improving societal energy resilience.

  Possible metrics to assess adaptation benefits include:

  - **Identification of barriers, including more complex descriptions of the range and incidence of barriers to electrifying gas equipment**
  - **The actualization of strategies and pathways that overcome or mitigate these barriers (e.g., through workforce training or improved technologies)**
  - **Estimates of the number of people who would experience better outcomes due to these improvements**
- **Environmental sustainability:** Supports cleaner air through enabling reduced fossil gas combustion indoors and at power plants (CPUC ESJ Goal 2).[42]

  Possible metrics to assess environmental sustainability benefits include:

  - **Estimates of air quality impacts (e.g., direct emissions of NOx and particulate matter, as well as greenhouse gas emissions reductions) of**

[41] CPUC. April 7, 2022. *Environmental & Social Justice Plan, Version 2.0*.

42 CPUC. April 7, 2022. *Environmental & Social Justice Plan, Version 2.0*.

any acceleration of transition away from gas based on improved knowledge generated by this project, calculated relative to carefully specified counterfactuals

- **Equity**: Promotes engagement with ESJ and other communities on energy system transitions. Also provides data and insights to address barriers to improving energy affordability, availability of clean energy resources, and energy resilience for those facing underinvestment in energy infrastructure (CPUC ESJ Action Plan Items 2.1, 2.2 and 5). May also promote high-road career paths (CPUC ESJ Action Plan Item 7).[43]

  Possible metrics to assess equity benefits include:

  - **Dissemination of materials or approaches recommended to improve electrification workforce training**
  - **Identification and/or dissemination of resilience strategies tailored for lower-income households and businesses**

Rationale

A rapid transition away from gas is unlikely to be achieved through competitive markets. The initiative responds to key needs identified in state processes and studies, including:

- CPUC's Long-Term Gas Planning Rulemaking (R.20-01-007 and R.24-09-012) documents, **which point to the need to align gas planning and electric system planning, as well as to manage impacts on "transition-vulnerable" customers**.
- The related *2024 Joint Agency Staff Paper: Progress Towards a Gas Transition* supporting the CPUC's Long-Term Gas Planning Rulemaking (R.20-01-007);[44] **this paper identifies the need for social scientific research and for deliberate assessment of a range of benefits and costs.**
- IEPRs[45] and CEC's Gas Decarbonization OIIP,**[46] both of which highlight the need for long-term gas planning and the risks of unduly burdening ESJ communities. The IEPRs also present the results of the California Energy Demand Forecast; data and insights gained from this initiative can lead to better estimates of the impacts and pace of electrification, in turn supporting improved forecasts of future electricity and gas demand.**

43 The CPUC ESJ Action Plan 2.0 defines "high road" as a set of economic and workforce development strategies to achieve economic growth, economic equity, shared prosperity and a clean environment, in accordance with California State Code (see https://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=UIC&division=7.&title=&part=&chapter=2. &article).

44 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.*

45 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.*

46 See CEC. "Docket Log 22-OIIP-02," https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=22-OII-02.

- CPUC's ESJ Action Plan Version 2.0,[47] **which identifies the need to embed equity in all CPUC Proceedings, outlines requirements for community engagement plans, and emphasizes targeting clean energy investments toward justice communities.**
- **Senate Bill 1221, which among other requirements, directs CPUC to identify "priority neighborhood decarbonization zones" and to create a voluntary program piloting up to 30 neighborhood-scale gas decarbonization projects. This bill also directs gas utilities to partner in these neighborhood pilots and to provide annual pipeline replacement maps.**

The initiative reflects key research gaps and needs identified in coordination with CPUC, IOUs, and other interested parties including:

- Conversations with CPUC staff during CEC-CPUC research meetings held between 2022–2024; **these conversations identified information gaps such as understanding gas customer attitudes toward electrification of cooking and other end uses, supply chain limitations for heat pumps and other barriers to electrification faced by these customers, and the impacts of gas use electrification on peak loads.**
- **Conversations with IOU staff in 2024, for example with respect to developing innovations that can be deployed to improve the equitability of decommissioning strategies.**

Technology and Market Background

Gas decommissioning was first included in the FY ~~2019–2020~~**2015-2016** Gas R&D Program budget plan.[48] Since then, gas transition planning has evolved from **focusing on** the hypothetical assessment of an ideal transition to evidence-based analysis of **gas decarbonization** ~~a range of~~ challenges and opportunities. This progress**ion allows for**~~enables~~ the examination of early information on a variety of topics related to gas-user readiness to convert from fossil gas, implications of end-use conversion patterns for coordinating decommissioning with gas system hydraulics and electricity system expansion, and potential for integration of lower-carbon fuels. Important contextual changes have also emerged **since the first years of research**, such as the potential for redefining the utility obligation to serve, disputes regarding the legality of local ordinances restricting gas connections, and **substantial** increases in electricity rates.

47 CPUC. April 7, 2022. Environmental & Social Justice Plan, Version 2.0.

48 Uy, Kevin. March 2019. *Natural Gas Research and Development Program Proposed Program Plan and Funding Request for Fiscal Year 2019–20.* California Energy Commission. Publication Number: CEC-500-2019-035, Available at https://www.energy.ca.gov/sites/default/files/2021-06/CEC-500-2019-035.pdf.

In 2024, the *2024 Joint Agency Staff Gas Transition White Paper*[49] set the stage for agency and interagency activity regarding next steps in the gas transition. The white paper informs the approach of this initiative, including in the application of social sciences to better advance coordinated combinations of social and technological change to support energy system decarbonization and combat climate change more generally.

This initiative builds on and contributes to other research and policy efforts and is purposefully not duplicative of them. The remainder of this section explains this complementarity. The white paper and broader Long-Term Gas Planning Rulemakings (R.20-01-007, R.24-09-012) recognize that "[l]ong-term planning work will require consideration of data and analytical needs and provide an additional tool for the [CPUC] to assess the trajectory of developments in the gas sector over time[…]."[50] However, development of these data, insights, and analytical resources is not directly funded by the Long-Term Gas Planning Rulemakings, and the CEC Gas R&D Program is well-positioned to play an important role in supporting this need, as it has in the past. For example, in 2020, the CEC funded the Mindful Decommissioning project (PIR-22-002, funded by the FY 2020-21 budget plan) as described above, which uses a data-driven approach to identify promising sites for gas decommissioning through a map-based tool that leverages gas system data and publicly available community data. The Mindful Decommissioning project aims to support state and local agencies in prioritizing potential pilot activities and initiating location-specific analyses that consider issues such as energy reliability and affordability. The proposed initiative outlines a potential project that would use a map-based tool. In this, it is not duplicative of the Mindful Decommissioning project; rather, this initiative would leverage completed work and compiled data from the Mindful Decommissioning project to deliver novel data and insights on social, demographic, and community elements related to gas decommissioning.

In addition, this initiative is scoped to further fill critical data and knowledge gaps and inform Gas OIR policies, processes, and rules. This includes: (1) informing expectations about the geographic, demographic, and end use patterns and pace of conversions across the state – all of which have tremendous implications for energy system planning, energy system reliability, gas safety, and energy resilience – and (2) identifying administrative, regulatory, planning, and other roadblocks that the Long-Term Gas Planning Rulemaking can address. The initiative would encompass both pilot-related and routine conversions from gas.

Lastly, while SB 1221 may spur a number of pilots, it does not provide for the social scientific research to inform and learn from those efforts. Research from this initiative could fill this gap and uncover social, technical, and contextual factors

49 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.*

50 R.24-09-012, Order Instituting Rulemaking to Establish Policies, Processes, and Rules to Ensure Safe and Reliable Gas Systems in California and Perform Long-Term Gas System Planning, 2024.

that shape responses to conversion, in turn informing the development of targeted strategies and technological innovations that enhance the appeal of converting from gas. Insights gained could support improved pilot implementation if, for instance, findings show that households or businesses with certain characteristics or needs are especially reluctant to convert from gas end uses. In turn, pilots could provide opportunities for further social scientific research. In all cases, this initiative deepens and expands California's capacity to advance gas decommissioning in strategic, additive, and valuable ways.

Initiative Title: Pilot Projects to Advance Gas Decommissioning

Initiative Description

This initiative aims to support decarbonization of the fossil gas system by advancing the strategic design, development, and demonstration of gas decommissioning pilot projects. It augments the "Scaled-Up Gas Decommissioning Pilots and Integrated Planning Tools" research initiatives in the FY 2022–2023 and FY 2023–2024 Gas R&D Budget Plans.[51] Collectively, these initiatives will fund gas decommissioning pilot demonstrations to gather empirical data on technical, economic, and environmental feasibility and assess practical implications and challenges of mid-term gas decommissioning. These pilot projects will be critical to understanding pragmatic implementation and insights of previously modeled frameworks, scalability, technical challenges, cost evaluation accuracy, ratepayer benefits and impacts, consumer behaviors, and public acceptance of gas system decommissioning.

Additionally, this research will support progress toward longer-term, larger-scale decommissioning projects with an advanced consideration of ratepayer benefits, impacts, and input.

Expected Outcomes

Successful pilot projects will provide valuable insights and lessons learned regarding the technical and logistical challenges associated with gas decommissioning and can guide decisions around scaling and broader implementation. Projects will advance focused decommissioning efforts with detailed geographic or zone-specific data profiles that showcase real-time technical feasibility, a full accounting of decommissioning costs, impacts on supply chain dynamics, and enhanced understanding of consumer behavior. Findings from these pilot demonstrations will be valuable to state energy planning and regulatory agencies, local governments, utilities, environmental justice advisory groups, and other key members of the public to inform gas decommissioning policy and program development.

A successful pilot could involve decommissioning gas infrastructure that electrifies a neighborhood or a street segment (zonal electrification) with long-term cost savings and

51 Dani, Nicole. May 2023. *Gas Research and Development Program Proposed Updated Budget Plan for Fiscal Year 2022–23.* California Energy Commission. Publication Number CEC-500-2022-001-REV, https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M525/K660/525660391.PDF. Molin, Daphne. July 2024. *Gas and Research Development Program: Proposed Budget Plan for Fiscal Year 2023–24.* California Energy Commission. Publication Number: CEC-500-2023-020, https://www.energy.ca.gov/publications/2023/gas-research-and-development-program-proposed-budget-plan-fiscal-year-2023-24.

community benefits. Pilot demonstrations will prioritize community engagement to ensure that participating home and business owners can provide input throughout the process, are well-informed, are broadly supportive of the project, and can benefit from the process and outcomes. Impacts will likely include, but not be limited to, long-term cost savings, improved energy resilience, and minimized infrastructure disruption and maintenance requirements.

Benefits to Californians

This initiative focuses on innovative pilot demonstrations to maximize environmental, economic, and community benefits for California ratepayers. Equitable, strategically planned gas decommissioning will reduce GHG emissions and improve air quality while advancing California's long-term energy security. Pilot projects will also enhance the safety of California's long-term gas transition; foster critical engagement among communities, policymakers, and others; and facilitate broader commitment to statewide decarbonization of the gas system. **The EPIC Program's Uniform Impact Analysis Foundational Principles will be used to demonstrate outcomes of achieving proposed benefits for all research projects under this initiative, including through quantitative methodologies. As described in detail below, examples include assessing changes in net energy usage, system cost and improved safety.**

- **Affordability:** Provides a transparent cost-benefit analysis and assesses potential long-term affordability benefits to ratepayers through reductions in costly infrastructure maintenance. The funded projects will deliver valuable insights into the upfront and operational costs and benefits for customers, businesses, and policy makers, including ~~factors such as~~**potential efficiencies for** upgrading supporting infrastructure, purchasing new equipment, and deploying technologies to support the transition.

  Possible metrics for assessing affordability benefits include:

  - **Measured or projected change in net total energy usage per household, block, or neighborhood**
  - **Total system cost at neighborhood scale (e.g., hardware, installation, equipment) analysis and comparison among different engineering system designs (e.g., for new construction versus retrofitting older homes, retrofitted versus newly developed technologies)**
  - **Cost comparisons to existing systems per household**
  - **Avoided operations and maintenance costs on gas system**
- **Safety and reliability:** Identifies vulnerabilities within California's aging gas system and reduces concerns with safety and reliability by accelerating decommissioning of risk-prone and potentially hazardous fossil gas infrastructure. Demonstration pilots can also inform best practices for safely removing or repurposing portions of the gas system.

  Possible metrics for assessing safety and reliability benefits include:

- **Use of research results in safety protocols and practices to remove or retire corroded pipeline infrastructure**
- **Identification and reduction of environmental harms (e.g., soil and water contamination from corroded metal and pipeline coating substances) from abandoned pipe segments**

- **Adaptation:** Assesses strategies to transition away from fossil gas and demonstrates a proactive approach to addressing aging and vulnerable gas pipeline infrastructure that could be more prone to failure. Improves energy system reliability and resilience by informing investments to address the state's aging gas infrastructure via strategies including electrification and other alternatives.

  Possible metrics for assessing adaptation benefits include:

  - **Number and criticality of potential points of failure identified and addressed in the local energy supply system through forecasting projections of electricity load capacity, electric grid and gas technologies, and other system designs to strengthen the system's ability to adapt to changing conditions and maintain reliable service across various types of utility infrastructure and IOU territories**
- **Environmental sustainability:** Improves environmental health, reduces local air quality impacts resulting from fossil fuel use, avoids incidental GHG leakage from pipeline failure, and supports renewable energy alternatives.

  Possible metrics for assessing environmental sustainability include:

  - **Calculated reductions in local air pollutants (e.g., methane, NOx, carbon dioxide, carbon monoxide, hydrogen sulfide, VOCs) and GHG emissions from fossil gas usage and leakage**
- **Equity:** Explores geographic or zonal differences across California to tailor strategic plans for gas decommissioning. This initiative aims to foster inclusion of ESJ communities and the public at large in decision-making processes, address unique community challenges, and ensure accessibility to low-cost electrification for ESJ communities.

  Possible metrics for assessing equity benefits include:

  - **Number of communities engaged (e.g., participation in outreach events, workshops, or surveys) or involved in pilots and proportion of which are considered ESJ communities**
  - **Detecting and analyzing points of failure in ESJ communities for lessons learned and development of future programs to support large-scale decommissioning**
  - **Calculated reductions in local air pollutants (e.g., methane, NOx, carbon dioxide, carbon monoxide, hydrogen sulfide, VOCs) in ESJ communities**

Rationale

~~The initiative supports key priorities identified in the *2024 Joint Agency Staff Paper: Progress Towards a Gas Transition.*~~The designed pilot demonstrations will build on prior gas decommissioning studies from the solicitation "Strategic Pathways and Analytics for Tactical Decommissioning of Portions of Natural Gas Infrastructure (GFO-20-503, **funded by FY 2020-21**)." These studies enhance site selection framework tools and apply empirical data to improve comprehensive decommissioning guidelines, accounting for environmental, technical, social, and economic considerations.[52] This approach will incorporate valuable insights from ratepayers, technical experts, utilities, businesses, and affected communities. These pilots will also bridge the gap from computational studies to demonstrations and establish a foundation for longer-term, larger-scale decommissioning.

The initiative responds to key needs identified in state policies and CPUC proceedings, including:

- ***2024 Joint Agency Staff Paper: Progress Towards a Gas Transition*** **supporting the CPUC's Long-Term Gas Planning Rulemaking (R.20-01-007); this paper identifies zonal electrification and gas decommissioning as one strategy for smoothing costs and managing the gas transition.[53] This initiative will use past and current ongoing frameworks and tools to demonstrate and validate its technical and financial feasibility.**
- **CPUC's Long-Term Gas Rulemaking (R.24-09-012) and Decision (D.) 23-12-003, both of which support a more comprehensive planning process for the gas transition, including determining when pipelines can be decommissioned without negatively affecting reliability. This initiative will identify lessons learned during pilot project demonstrations and support future statewide gas decommissioning.**
- **SB 1221, which requires utilities to identify priority neighborhood decarbonization zones and allows for a limited number of neighborhood-scale decommissioning pilot projects.[54] This initiative will help translate this policy into action by directly supporting and implementing additional gas decommissioning pilot projects to accelerate the scale-up and replicability of diverse gas decommissioning approaches, collect independent data for assessment, and provide complementary insights to those gleaned by SB 1221.**

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

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52 Empower Innovation. "Strategic Pathways and Analytics for Tactical Decommissioning of Portions of Natural Gas Infrastructure,".

53 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.*

54 California Legislative Information, September 26, 2024, Senate Bill No. 1221 Chapter 602"

- **In August 2024, CEC staff presented early initiative outlines to IOUs for feedback. CEC and SoCalGas staff discussed and agreed on the feasibility of developing pilot projects in Northern California and Southern California based on preliminary studies by E3 and RAND. CEC staff and IOUs collectively agreed that further assessment is needed on system integration and community outreach methods. CEC and IOUs agreed to continue coordination with one another throughout SB 1221 implementation.**
- **In October 2024, CEC staff held a discussion with representatives of the City of Albany on the current ongoing pilot decommissioning assessment in Albany. This coordination has strengthened the relationship between CEC staff and local agencies that are engaged in an ongoing decommissioning project and provided insights into realistic costs to complete a gas decommissioning project. CEC staff will continue to work with local governing agencies to learn about their specific barriers related to gas decommissioning.**

Technology and Market Background

Gas decommissioning is a growing area of interest driven by the state's efforts to decarbonize, reduce reliance on fossil fuels, and advance clean energy deployment. Recently, CEC-funded research by E3 conducted a cost-benefit analysis for gas decommissioning, using site-specific data for 11 potential pilot sites in Northern California. The research found that, if successfully and cost-effectively implemented, targeted electrification and gas decommissioning can provide net benefits to the state, gas ratepayers, and electric ratepayers.

Furthermore, through previous CEC-funded research projects, E3 and RAND developed analytical frameworks for Northern and Southern California, respectively, that can be used to identify specific locations where gas decommissioning could result in gas system cost savings.[55] These findings highlight the economic feasibility of gas decommissioning and the associated potential to reduce long-term infrastructure costs, which would ultimately reduce ratepayers' utility costs and provide a host of other benefits.

Electrification and other clean fuel technologies are also playing a pivotal role in this transition, offering viable alternatives to the traditional gas system. Innovations such as heat pumps, which efficiently transfer heat to provide heating and cooling, and thermal energy systems that store and distribute heat are proving to be effective, low-cost options for transitioning away from gas.

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55 E3. June 2024. *An Analytical Framework for Targeted Electrification and Strategic Gas Decommissioning: Identifying Potential Pilot Sites in Northern California's East Bay Region*. California Energy Commission. Publication Number: CEC-500-2024-073, https://www.energy.ca.gov/sites/default/files/2024-06/CEC-500-2024-073.pdf. Energize Innovation. "Strategic Pathways and Analytics for Tactical Decommissioning of Portions of Natural Gas Infrastructure in Southern California," https://www.energizeinnovation.fund/projects/strategic-pathways-and-analytics-tactical-decommissioning-portions-natural-gas-0.

Recognizing the challenge of maintaining the state's aging gas infrastructure while meeting decarbonization goals, the California Legislature passed SB 1221 in September 2024, requiring the CPUC to establish a voluntary program to promote the cost-effective decarbonization of priority neighborhoods and include a limited number of gas decommissioning projects.[56] Continued and expanded investments in pilot demonstrations like these are essential for assessing gas decommissioning strategies, as they provide critical data to guide policy decisions and ensure an equitable, efficient transition to decarbonization across the state. **This Pilot Projects Initiative is designed to address social barriers and technical system integration details that have not been previously explored or studied by the IOUs. Using public interest R&D funding for these efforts is critical to accelerate the scale-up and replicability of diverse gas decommissioning approaches, collect independent data for assessment, and provide complementary insights to those gleaned by the IOUs.**

CEC-funded research is structured with transparent criteria, open data requirements, and independent evaluation. Data from public-interest research on the costs, benefits, and challenges of decommissioning could equip CPUC and other interested parties with independent information and openly available results with which to evaluate utility pilot proposals and progress and ensure that ratepayer dollars are optimized. Independent public-interest research can minimize the potential risk from pilot programs that encounter conflicts of interest when utilities design and evaluate programs that may impact their business models.

Importantly, the research studies proposed in the gas decommissioning initiatives will exceed the reporting requirements set forth by SB 1221.[57] While SB 1221 will require the CPUC to report annually on high-level metrics, such as location of pilots; number of customers affected; funding sources; and any outcomes, challenges, and recommendations, the CEC's Gas R&D Program's independent pilots would expand on these findings and elicit robust understanding of issues critical to ratepayers, such as affordability, health, sustainability, and resilience impacts. These insights could also be integrated into CEC-funded research on an open-source planning tool designed to support scoping, design, and implementation of community-engaged gas decommissioning at a range of timescales.

The scale and urgency of the energy transition amplify the need for conducting research that could inform and expand near-term and longer-term efforts. By 2045, the aging gas network is estimated to incur a cumulative total of $43 billion in maintenance costs.[58] Proposed research investments are designed to provide

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56 California Legislative Information, SB 1221: Gas corporations: ceasing service: priority neighborhood decarbonization zones, 2024. https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202320240SB1221

57 Chapter 3 of Part 1 of Division 1 of the Public Utilities Code, Article 11 664(b)

58 Smillie, Sean, Dan Alberga, Aryeh Gold-Parker, and Dan Aas. (2024), "Avoiding Gas Distribution Pipeline Replacement Through Targeted Electrification in California".

insights that avoid costly missteps in gas transition planning and implementation and deliver significant ratepayer benefits. These insights require R&D, as well as demonstration in a sufficient number of pilots, to enable replicability and scalability across diverse social and technical contexts. Given the voluntary nature of the policy, SB 1221 may result in as many as 30 pilots or may result in far fewer. There is also no guarantee that pilots will take place across the state, particularly in areas where gas utilities do not also provide electric service and thus may lack incentive to shift customers. The research proposed under this initiative, in ongoing coordination with SB 1221 implementation, can fill knowledge gaps and ensure scalable and replicable insights.

SoCalGas proposed several research areas in its 2023 RD&D Program Research Plan on gas decarbonization that complement but differ from the CEC's proposed initiatives on gas decommissioning. The SoCalGas plan describes that its programs would aim to: 1) advance clean gas production technology for gas decarbonization (Low Carbon Resources Program), 2) enhance pipeline safety (Gas Operations Program), and 3) improve gas equipment efficiency (Customer End-Use Applications Program). While these efforts enhance strategies for reducing GHG emissions from the existing gas system, they differ in approach from zonal gas decommissioning, which involves retiring portions of California's fossil gas infrastructure. To ensure gas research efforts are complementary and not duplicative, CEC and SoCalGas will continue to coordinate.

Initiative Theme: Building Decarbonization

Residential and commercial buildings are responsible for about a quarter of California's total GHG emissions; therefore, decarbonizing buildings is important to achieving net-zero emissions goals set forth by the state.[59] However, the "unit-by-unit" incremental approach to building decarbonization is beginning to shift to community-scale approaches that enable scaling, higher efficiencies, and greater impacts. One such decarbonization pathway that has been identified in the *2024 Joint Agency Staff Paper: Progress Towards a Gas Transition* is networked geothermal.[60]

Networked geothermal uses the relatively constant temperature of the bedrock (50–60° F) as a source and sink for heat pumps to provide energy-efficient heating and cooling for multiple buildings through a shared network. Ground-source heat pumps are among the most efficient modes of building heating and cooling, performing with 25 to 50 percent lower energy consumption than air-source heat pumps, which are already two to three times more efficient than electric resistance and fossil gas heating.[61] Networked geothermal heat pumps (GHPs) expand the versatility and high efficiency of ground-source heat pumps for heating and cooling

59 CEC. August 2021. *Assembly Bill 3232 and the California Building Decarbonization Assessment*. https://www.energy.ca.gov/sites/default/files/2021-08/AB3232_Building_Decarbonization_Assessment_Factsheet_ADA.pdf

60 CPUC. February 22, 2024. *2024 Joint Agency Staff Paper.*

61 US DOE. February 2011. *Guide to Geothermal Heat Pumps.* https://www.energy.gov/sites/prod/files/guide_to_geothermal_heat_pumps.pdf

to a networked neighborhood or community scale, thereby decreasing overall energy consumption, replacing fossil gas use, and enabling high thermal efficiencies at a large scale.

~~Networked geothermal technology is being studied and deployed in several states. Since 2021, seven states have passed legislation requiring utilities to build these networks. In June 2024, the first utility-scale networked geothermal system pilot was commissioned in Massachusetts. While networked geothermal demonstrations are advancing in other states, research that accounts for California's climate, population, and other unique features is critical to understanding the role this technology can play in helping California achieve its climate and clean air goals.~~

Initiative Title: Networked Geothermal Heat Pumps

Initiative Description

This initiative will assess the potential cost-effectiveness and comparative environmental advantages of deploying networked geothermal technology as a zero-emission heating and cooling alternative for gas customers in California through a two-phase approach. Phase 1 will include a technology assessment and technoeconomic analysis of networked GHP deployment compared to competing technologies within the context of California's unique features. Phase 2 will be informed by Phase 1. Phase 2 will include one or more pilot demonstration projects that aim to:

- Evaluate the costs and benefits of deploying this technology in California-specific locations.
- Study different business and community models.
- Assess impacts on ratepayers and local communities.
- Explore synergies between fossil gas and networked geothermal pipeline workforce opportunities.
- Identify market barriers and existing and potential gaps in construction and design standards.
- Provide real-world data and an enhanced understanding of implementation opportunities, procedures, and challenges specific to California's climate, geology, and policy landscape.

Expected Outcomes

Phase 1 of this initiative will focus on assessing the potential to deploy networked GHPs in the context of California's unique climate, geology, population, and policy landscape:

- Most of California's population lives in mild and moderate climates, but extreme weather events have increased in frequency in the past several decades.[62] Research supported by this initiative will explore the effectiveness and benefits of networked

62 California Office of Environmental Health Hazard Assessment. 2022. *Indicators of Climate Change in California*, https://oehha.ca.gov/media/epic/downloads/02extremeheat.pdf.

GHPs in California's climate compared with those of other competitive heating and cooling solutions. It will also examine the potential peak-load reduction benefits of networked GHPs to the grid and pipeline systems in the face of increasing cooling and heating extremes due to long-term climate impacts specific to California.

- California encompasses a diverse range of geological features at different depths and variations in the composition, thickness, porosity, permeability, water table depth, and other geophysical properties and soil characteristics. These varying features can affect temperature profiles, thermal characteristics, and moisture content, all of which, in turn, influence geothermal heat pump performance. Research supported by this initiative seeks to identify regions with high potential for cost-effective implementation and optimum GHP performance. This research will inform future pilot sites while seeking to account for public health; safety, integrity, and environmental concerns, including water usage; population densities; census tracts; and consumption portfolios.
- While existing policies, such as the utilities' "obligation to serve," can limit implementation of networked GHPs at community scale,[63] there has been recent interest in exploring opportunities to meet these obligations by offering alternative services. For example, SB 1221 (September 2024) appoints the CPUC as the deciding entity that could provide flexibility to relieve the IOUs of the obligation to serve in pilot areas where customers have been transitioned to zero-emission alternatives.[64] Research supported by this initiative will investigate all relevant regulations pertinent to networked GHPs and explore precedents and models from other regions to assess the applicability or potential adaptation for California.
- The research will assess the approximate decrease in energy demand for consumers of various sizes when transitioning to networked GHPs and determine the opportunities to optimize potential customer bill savings.
- The research will assess consumer awareness and willingness to adopt networked GHP technology, as well as strategies for increasing community engagement and support.

Key Phase 2 outcomes will include one or more pilot demonstrations that enable the CEC to collect valuable information and knowledge on technology performance, procurement, commissioning, and economics of the deployment of networked GHPs. Pilot sites that have the highest potential to provide the most insight in the implementation phase will be selected. Expected outcomes include, but are not limited to, demonstrating that networked GHPs can provide an efficient and effective option for heating and cooling while validating potential energy and cost savings. Moreover, pilot demonstrations can identify remaining barriers and potential solutions derived from real-world California-specific data.

63 Kristin G. Bagdanov. October 2024, *Decarbonizing the Obligation to Serve*. Building Decarbonization Coalition. https://buildingdecarb.org/wp-content/uploads/FINAL_Decarbonizing-the-Obligation-to-Serve_Aug2024.pdf

64 Bill Text - SB-1221 Gas corporations: ceasing service: priority neighborhood decarbonization zones.

Benefits to Californians

In the context of California's transition away from fossil gas-fueled technologies and thermal delivery systems, networked geothermal is a promising approach for neighborhood-scale decarbonization that could also promote workforce transitions from the fossil gas sector. As California aims for a net-zero carbon system, more consumers will depart from gas infrastructure, potentially resulting in higher gas bills for the remaining customers. Community- or neighborhood-scale pruning of the gas infrastructure could avoid burdening remaining customers with operational costs on an underused main line. Reduction in the use of fossil gas in homes and gas-fired power plants will result in direct air quality and health benefits, especially in ESJ communities, which are often disproportionately impacted. Further, the diversity of end users in thermal energy networks helps reduce costs for users by balancing energy demand across the network, leading to more efficient operations and cost savings. The workforce involved in commissioning and maintaining the gas system can be readily trained for the proposed technology because of fundamental similarities in the two systems. **The EPIC Program's Uniform Impact Analysis Foundational Principles will be used to demonstrate outcomes of achieving proposed benefits for all research projects under this initiative, including through quantitative methodologies. As described in detail below, examples include changes to ratepayer bills, system reliability, and GHG emissions and air pollution reduction.**

- **Affordability:** Networked geothermal technology can decrease gas demand for end users throughout the gas system and provide lower costs and greater price stability for those connected. It could also offer a new potential business model for utilities to provide gas customers with a suitable zero-emission substitute.

  Possible metrics to assess affordability benefits include:

  - **Comparison of ratepayer monthly bills among networked GHPs, other decarbonized solutions, and existing gas systems, modeled using existing utility business models (e.g., for fossil gas) and allowable rates of return. This comparison could consider different geographical, geological, and climate zones within the state and include how changes in energy use could affect both gas and electric rates in cooling and heating seasons.**

- **Safety and reliability:** This non-combusting technology provides a safer, healthier, and **more** reliable alternative **to**~~for~~ gas-fired heating. Certain configurations of these networks can allow for stand-alone operation**, which in case of loop or module malfunction, can maintain reliable operation and improve total system resilience.** Also, by decreasing **electricity** demand during **both** cooling and heating seasons **and gas demand during heating season**, networked GHPs will decrease the strain on power generation and transmission infrastructure, thereby reducing the risk of overload and equipment failure and increasing reliability.

  Possible metrics to assess safety and reliability benefits include:

- **Decreased risk of power failure (measured by average number, frequency, duration of interruptions: SAIDI[65], SAIFI[66], CAIDI[67], MAIFI[68], etc.) on the grid and failure of pertinent equipment assuming various levels of technology deployment and the consequent balancing of the "duck curve."**
- **Improved reliability through eliminated risks of gas system failures (e.g., loss of containment, emissions, fire and explosion, loss of capacity)**

- **Adaptation:** Networked GHP technology offers high efficiencies and can drive a substantial reduction of fossil gas demand during the heating season and electricity demand during the cooling and heating seasons. If modularity is built into the network design, it offers incremental and less expensive system expansion as funding resources become available. It also increases gas and electric system resiliency, as it offers a sustainable and constant heating and cooling option that is less likely to be impacted by extreme climate events. The workforce involved in the gas system can be readily trained for the proposed technology because of system similarities.

  Possible metrics to assess adaptation benefits include:

  - **Comparison of resilience metrics, such as performance loss ratios, probabilities of recovery, and adaptive capacity, between the existing and proposed technologies given extreme load and climate conditions and considering omission of fossil gas and potential decrease of electric demand due to improved efficiencies.**
  - **Use of study results in utility long-term planning and development of business models to incorporate the technology and support the clean energy transition.**
- **Environmental sustainability:** Adoption of this technology will directly reduce the use of fossil gas, in turn facilitating GHG emissions reductions, water use reductions, and improvements in air quality locally and statewide.

  Possible metrics to assess environmental sustainability include:

  - **Reduction in GHG emissions, criteria air pollutant (e.g. particulate matter, carbon monoxide, NOx) emissions, and water use per Btu of cooling and heating at demonstration sites, as compared to the existing heating and cooling systems in use (e.g., furnaces, air source heat pumps, adsorption chillers).**

[65] System Average Interruption Duration Index

[66] System Average Interruption Frequency Index

[67] Customer Average Interruption Duration Index

[68] Momentary Average Interruption Frequency Index

- **Equity:** As is being implemented in other states, networked GHPs can be adopted by utilities and rate-based. Therefore, **any** high capital investment upfront could be borne by the utility and potentially amortized and recovered through rates over a longer period. Operational and maintenance costs can be reduced. Combustion from fossil gas systems in buildings would be reduced as well**, generating localized health benefits and reducing related healthcare costs.** Workforce opportunities **– due to the similarity in systems – could** potentially **be** maintained or expanded. As this technology does not use an energy commodity prone to price spikes from seasonal scarcity or global market fluctuations, ESJ and other communities could be spared the price volatility experienced with fossil gas.

  Possible metrics to assess equity may include:

  - **Savings on monthly overall energy bill cost for ESJ communities based on historical data of gas and electric price spikes.**
  - **Number and characteristics of job potential and recommendations for transitioning the gas utility workforce to support the deployment and maintenance of networked geothermal technologies.**
  - **Number of ESJ communities engaged or involved in pilots and the socioeconomic and demographic statistics portraying indicators of diversity (e.g. housing types, household income, census tract) within those communities.**

Rationale

The initiative responds to key needs identified in state policies and CPUC proceedings, including:

- **The** *2024 Joint Agency Staff Paper: Progress Towards a Gas Transition* **and the CPUC's Long-Term Gas Planning Rulemakings (R.20-01-007, R.24-09-016) have outlined the need for interagency coordination to develop strategic plans for reducing demand for and transitioning away from fossil gas. Pilots and projects that integrate gas decommissioning and installation of networked GHPs could encourage multi-benefit coordination of research teams, community representatives, policy makers, and IOUs.**
- *Recommendations for the Long-Term Gas Research Strategy to Achieve Aggressive Statewide Carbon Neutrality Goals* **identified a need to develop optimal decommissioning practices and considerations for California's legacy gas system[69]. Networked GHPs could offer an effective and efficient pathway to decarbonize portions of the gas system at a large scale while providing opportunities to gas utilities.**

[69] CEC. December 12, 2022. "Workshop on Long-Term Gas Research Strategy Recommendations," https://www.energy.ca.gov/event/webinar/2022-12/webinar-long-term-gas-research-strategy-recommendations.

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

- **In August and October 2024, CEC staff presented initiative outlines for the Proposed FY 2025-26 Gas R&D Budget Plan and requested insights and feedback. IOU representatives made note of the Eversource pilot[70] in Massachusetts and encouraged CEC staff to follow its progress and engage where appropriate. CEC staff are following progress of the Eversource pilot for the data, information, and lessons learned. This pilot is in the early stages of operation and, once available, resulting technical and economic insights can help optimize the Networked GHP pilot selection process in California. Eversource has briefed the larger Networked GHP audience on its progress through the quarterly Geothermal Network Regulator Forum, which is moderated by HEET[71] and attended by CEC staff.**
- **In December 2024, CEC staff met with PG&E and discussed the Networked GHP initiative's extent, outlines, and research objectives and solicited feedback. PG&E subject matter experts indicated they are not actively pursuing networked GHP research and would be interested in following the progress of this initiative.**

Technology and Market Background

Networked geothermal technologies may be able to offer California ratepayers better performance and greater efficiency than competing technologies when optimal use cases and applications are identified. A cost performance study by the National Renewable Energy Laboratory on single-owner networked GHPs reported ~~"loop"~~ coefficients of performance **for ground loops** ~~upwards~~**between three and**~~of~~ 10, indicating extreme efficiency.[72] This efficiency helps reinforce system resilience by reducing energy consumption, alleviating demand on the gas system and, during the cooling season, the electric grid. Furthermore, these systems become more valuable due to the associated reliability and resilience under unforeseen stressors such as extreme weather events.

Furthermore, wells drilled to access the bedrock at target temperatures for networked GHPs are less capital-intensive because they are shallower (tens to hundreds of meters) than those intended for district heating purposes (thousands of meters). ~~While p~~**P**revious CEC-funded research has ~~explored~~ **assessed the potential for** ground-source heat pump **systems in California buildings and found promising energy and emissions benefits.**[73]

[70] https://www.eversource.com/residential/save-money-energy/clean-energy-options/geothermal-energy

[71] Home Energy Efficiency Team, https://www.heet.org/

72 Oh, Hyunjun and Koenraad Beckers. July 2023. *Cost and Performance Analysis for Five Existing Geothermal Heat Pump-Based District Energy Systems in the United States.* National Renewable Energy Laboratory, https://www.nrel.gov/docs/fy23osti/86678.pdf.

73 Glassley, William; Adam Asquith; Tucker Lance; Elise Brown. April 2012. *Assessment of California's Low Temperature Geothermal Resources: Geothermal Heat Pump Efficiencies by Region.* California Energy Commission. Publication Number: CEC-500-2014-060, https://cgec.ucdavis.edu/wp-content/uploads/CEC-500-2014-060.pdf.

However, the networked GHP concept is a recently developed model that has not yet been studied for the associated potential in the context of California's climate, geology, population, and policy landscape**, nor brought to the pilot phase, and it may yield significant additional benefits**. **The networked loop allows for balancing across a variety of connected loads and end users, resulting in higher efficiencies compared to standalone GHPs, which include a dedicated set of boreholes and are most often designed for a single building or end user.** In addition to the decarbonization opportunities presented by networked GHPs, their deployment can — in the appropriate scenarios — offer a sustainable and scalable strategy for gas utilities, the gas workforce, and communities alike.

Networked geothermal technology is being studied and deployed in several states. Since 2021, seven states have passed legislation requiring utilities to build these networks.[74] In June 2024, the first utility-scale networked geothermal system pilot was commissioned in Massachusetts.[75] While networked geothermal demonstrations are advancing in other states, research that accounts for California's climate, population, and other unique features is critical to understanding the role this technology can play in helping California achieve its climate and clean air goals. CEC will leverage and build on data and lessons learned from other jurisdictions where feasible while also developing targeted R&D specific to the California context.

Nearly all current and planned studies and pilots are concentrated in cold climates where the heating load makes up the predominant share of space conditioning. California's cooling loads vary, and there will be a need to determine the applicability and feasibility of networked geothermal as a versatile technology for California's heavily populated coastal regions, which have experienced an increasing trend in annual cooling degree days, as well as for more inland and temperate regions.[76]

The initiative further seeks to study the benefits of Networked GHPs as an alternative to water-intense air-conditioning in large buildings, a particularly relevant R&D work stream for California, where water is often scarce. In Los Angeles County alone, an estimated 2.5 billion gallons of water are used annually in cooling towers. This figure is likely to increase given the proliferation of data centers, which typically house cooling systems with high water intensities.[77] The first phase of this Networked GHP Initiative will assess the potential benefits of

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74 Building Decarbonization Coalition. June 4, 2024 (last modified on March 5th, 2025). *A legislative heatwave: thermal energy network legislation updates (June 2024)* https://buildingdecarb.org/tens-legislation-june-2024

75 Eversource. *Geothermal Pilot Program in Massachusetts*. https://www.eversource.com/content/business/save-money-energy/clean-energy-options/geothermal-pilot-program-in-massachusetts

76 Office of Environmental Health Hazard Assessment, *2022 Report: Indicators of Climate Change in California,* Cooling and heating degree days Updated 2024

77 Building Decarbonization Coalition, *Building Decarbonization Meets Water Conservation Brief* (Building Decarb Brief), available at https://buildingdecarb.org/wp-content/uploads/BDC_Water_Conservation_2024.pdf

water use reduction through replacement of current air conditioning methods with networked GHPs.

Most operating networked GHP projects in the US are constructed as single-owner loops, such as at university campuses and military bases,[78] which have characteristics, load profiles, and economics distinct from multi-user networked geothermal loops. While the available data on these loops will provide valuable insight to inform these R&D efforts, the targeted multi-owner, multi-user model has clear technical and economic distinctions that deeply warrant study, evaluation, and demonstration in California.

Additionally, the largest costs currently associated with GHP installation are those for drilling and labor, which significantly vary by region and depend on availability of technical expertise, local regulation and policy (e.g., permitting costs, lead time), and subsurface geological characteristics. These costs and the associated factors influencing them throughout California will be investigated and evaluated in the first phase of this Networked GHP Initiative.

With the exception of one demonstration in Massachusetts being led by a local IOU, Eversource, which is currently in the operations and maintenance phase, most of the activities in other states are at the very early stages of pilot selection, and therefore little information is available in the public domain. Even for the Eversource demonstration, no operational data has yet been released to the public.

To ensure CEC is tracking and learning from these various efforts, CEC along with CPUC staff participate in the Geothermal Network Regulator Forum, an initiative launched by the Home Energy Efficiency Team[79] and attended by regulators and interested public parties from around the country to facilitate collaboration and knowledge sharing in support of widespread adoption of networked geothermal technology.

Equity Benefits of Proposed Initiatives

The CEC applies the DACAG Equity Framework[80] 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)

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[78] US Department of Energy (DOE), *Pathways to Commercial Liftoff: Geothermal Heating and Cooling*, January 2025

[79] Home Energy Efficiency Team, *Charrette emphasizes the role of regulators*, December 23, 2024, available at https://www.heet.org/blog-items/charrette-emphasizes-the-role-of-regulators

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

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 2025–2026 Gas R&D Plan Equity Framework Matrix

#	R&D Topic	Health and Safety	Access and Education	Financial Benefits	Economic Development
1	Social Science Research for Gas Decommissioning	Indirect	Direct	Indirect	Indirect
2	Pilot Projects to Advance Gas Decommissioning	Direct	Direct	Indirect	Indirect
3	Networked Geothermal Heat Pumps	Direct	Indirect	Direct	Direct

Source: California Energy Commission

Next Steps

Upon review and approval of the Proposed 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.[81] 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 Energize Innovation website, and final reports for completed projects are published on CEC's publication website.[82]

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

82 Energize Innovation. California Energy Commission. "*Project Showcase,*" https://www.energizeinnovation.fund/projects. 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
CALSEED	California Sustainable Energy Entrepreneur Development
CARB	California Air Resources Board
CEC	California Energy Commission
COVID	Coronavirus disease
CCA	Community choice aggregator
CPUC	California Public Utilities Commission
DACAG	Disadvantaged Communities Advisory Group
DOE	U.S. Department of Energy
EPIC	Electric Program Investment Charge
ERDD	Energy Research and Development Division
ESJ	Environmental and Social Justice
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
GHP	Geothermal heat pumps
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
LADWP	Los Angeles Department of Water and Power
LGBTQ	Lesbian, gay, bisexual, transgender, and queer
LNG	Liquified natural gas

Acronym	Spelled-Out Terms
NOx	Oxides of nitrogen
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
SME	Subject matter expert
SoCalGas	Southern California Gas Company
TAC(s)	Technical Advisory Committee(s)
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.[83]

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 both) of its properties and that persists for an extended period, typically decades or longer.

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

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 webpages.[84]

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.

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

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.