Pacific Gas and Electric Company

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Pacific Gas and Electric Company
300 Lakeside Drive
Oakland, CA 94612

July 1, 2024

Advice 4931-G
(Pacific Gas and Electric Company ID U 39 G)

Public Utilities Commission of the State of California

Subject: **Pacific Gas and Electric Company 2025 Research & Development Plan in Compliance with Ordering Paragraph 15 of Decision 23-11-069.**

Purpose

Pacific Gas and Electric Company (PG&E) hereby submits for approval with the California Public Utilities Commission (Commission) this Tier 3 Advice Letter (AL) as directed by Decision (D.) 23-11-069, Ordering Paragraph (OP) 15 requiring PG&E's Gas Research Development and Deployment budget plan be filed and approved prior to recording project expenses in a one-way balancing account.[1]

Background

The 2023 GRC Decision required PG&E to submit a Tier 3 AL and include an annual R&D and Development research plan for the following calendar year for Commission approval. To ensure accountability of PG&E's Gas R&D and Development portfolio, PG&E is required to submit its annual research plan following guidance based on D.19-09-051[2], Resolution G-3586[3], and Resolution G-3592[4] as follows:[5]

1. The annual research plan should detail budgets broken down by research sub-program area and explain how the projects improve reliability, safety, equity, affordability, and environmental benefits, and incorporates input from key stakeholders, such as the Disadvantaged Communities Advisory Group.[6]

[1] D.23-11-069, Decision on Test Year 2023 General Rate Case for Pacific Gas and Electric Company.
[2] D.19-09-051, Decision Addressing the Test Year 2019 General Rate Cases of San Diego Gas & Electric Company and Southern California Gas Company.
[3] Southern California Gas Company requests approval to record Research, Development, and Demonstration (RD&D) expenses to its Research, Development, and Demonstration Expense Account.
[4] Approval, with Modifications, of the California Energy Commission's Gas Research and Development Program for Fiscal Year 2022-2023.
[5] D.23-11-069, p. 218.
[6] D.19-09-051, p. 379.

2. The annual research plan should include a proposed benefits analysis framework, created in consultation with Energy Division staff. This framework should provide sufficient quantitative estimates of potential safety, reliability, operational efficiency, improved affordability, environmental-related benefits, benefits to underserved communities, and numeric targets or a specified numeric range of potential benefits for projects.[7]
3. PG&E should cap its administrative costs for Gas RD&D at 10 percent.[8] PG&E's annual research plan should provide detail about administrative costs and require PG&E to allocate cost categories to its administrative budget.[9]
4. PG&E should explain how its proposals for low carbon research projects (rather than zero/no carbon projects) support the State's aggressive zero-carbon goals.[10] The annual research plan should include information on funds encumbered, spent, and unspent. The plan should also outline co-funding and collaborative partners and explain how P&GE engages with diverse academic populations. Further, PG&E should describe how its research plan will benefit underserved communities.[11]
5. Discuss how PG&E incorporated feedback from workshop stakeholders and Commission staff.
6. PG&E's research plan should allocate approximately $296,400 to an evaluation or audit.[12]
7. PG&E's research plan may separately allocate and track funds for gas research development and deployment in one database that tracks all ratepayer-funded R&D and Development projects across these industries.[13]

In addition to the requirements outlined in the 2023 GRC Decision for the 2025 plan, PG&E is requesting cost recovery for 2023 and 2024 expenses. Upon approval of this advice letter, PG&E will begin recording R&D and Deployment program expenses for 2023-2025 in the Gas Research Development and Deployment Balancing Account (GRDDBA).[14]

This submittal would not increase any current rate or charge, cause the withdrawal of service, or conflict with any rate schedule or rule.

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[7] CPUC Resolution G-3586, OP 5.
[8] D.21-11-028, Decision Approving The Utilities As Electric Program Investment Charge Administrators With Additional Administrative Requirements.
[9] Consistent with administrative cost categories described in Southern California Gas Company's 2021 Research Plan, approved in Resolution G-3586, OP 4.
[10] Resolution G-3586, pp. 20-21 describe the Commission's preference toward zero-emissions projects.
[11] Resolution G-3586.
[12] D.23-11-069, p. 221.
[13] Id, p. 221.
[14] In compliance with Gas Preliminary Statement Part GA, AL 4835-G/7088-E, filed December 14, 2023 and approved January 30, 2024.

Protests

Anyone wishing to protest this submittal may do so by letter sent electronically via E-mail, no later than **July 22**, **2024**, which is 21 days after the date of this submittal.[15] Protests must be submitted to:

CPUC Energy Division
ED Tariff Unit
E-mail: EDTariffUnit@cpuc.ca.gov

The protest shall also be electronically sent to PG&E via E-mail at the address shown below on the same date it is electronically delivered to the Commission:

Sidney Bob Dietz II
Director, Regulatory Relations
c/o Megan Lawson
E-mail: PGETariffs@pge.com

Any person (including individuals, groups, or organizations) may protest or respond to an advice letter (General Order 96-B, Section 7.4). The protest shall contain the following information: specification of the advice letter protested; grounds for the protest; supporting factual information or legal argument; name and e-mail address of the protestant; and statement that the protest was sent to the utility no later than the day on which the protest was submitted to the reviewing Industry Division (General Order 96-B, Section 3.11).

Effective Date

Pursuant to General Order (GO) 96-B, Rule 5.3, and OP 15 of D.23-11-069, this advice letter is submitted with a Tier 3 designation. PG&E requests that this Tier 3 advice submittal become effective upon Commission approval.

Notice

In accordance with General Order 96-B, Section IV, a copy of this advice letter is being sent electronically to parties shown on the attached list and the parties on the service list for R.19-10-005, R.20-01-007, R.19-01-011, R.13-11-005, R.15-01-008, A.21-06-021, and R.18-04-019. Address changes to the General Order 96-B service list should be directed to PG&E at email address PGETariffs@pge.com. For changes to any other service list, please contact the Commission's Process Office at (415) 703-2021 or at

[15] Pursuant to Rule 1.5 of General Order 96-B, PG&E requests to extend the protest period by one additional day because twenty days following submission of this advice letter is Sunday, July 21, 2024.

Process_Office@cpuc.ca.gov. Send all electronic approvals to PGETariffs@pge.com. Advice letter submittals can also be accessed electronically at: http://www.pge.com/tariffs/.

/S/
Sidney Bob Dietz II
Director, Regulatory Relations
CPUC Communications

Attachments:
Attachment 1 - Pacific Gas and Electric Company Gas Research & Development, 2025 Annual Research Plan

cc: Service List R.19-10-005, R.20-01-007, R.19-01-011, R.13-11-005, R.15-01-008, R.18-04-019, A.21-06-021

California Public Utilities Commission

ADVICE LETTER SUMMARY

ENERGY UTILITY

MUST BE COMPLETED BY UTILITY (Attach additional pages as needed)

Company name/CPUC Utility No.: Pacific Gas and Electric Company (U 39 G)

Utility type:
☐ ELC ☑ GAS ☐ WATER
☐ PLC ☐ HEAT

Contact Person: Michael Finnerty
Phone #: (279) 789-6216
E-mail: PGETariffs@pge.com
E-mail Disposition Notice to: michael.finnerty@pge.com

EXPLANATION OF UTILITY TYPE
ELC = Electric GAS = Gas WATER = Water
PLC = Pipeline HEAT = Heat

(Date Submitted / Received Stamp by CPUC)

Advice Letter (AL) #: 4931-G

Tier Designation: 3

Subject of AL: Pacific Gas and Electric Company 2025 Research & Development Plan in Compliance with Ordering Paragraph 15 of Decision 23-11-069.

Keywords (choose from CPUC listing): Compliance

AL Type: ☐ Monthly ☐ Quarterly ☑ Annual ☐ One-Time ☐ Other:

If AL submitted in compliance with a Commission order, indicate relevant Decision/Resolution #: D.23-11-069

Does AL replace a withdrawn or rejected AL? If so, identify the prior AL: No

Summarize differences between the AL and the prior withdrawn or rejected AL: N/A

Confidential treatment requested? ☐ Yes ☑ No

If yes, specification of confidential information:
Confidential information will be made available to appropriate parties who execute a nondisclosure agreement. Name and contact information to request nondisclosure agreement/ access to confidential information:

Resolution required? ☑ Yes ☐ No

Requested effective date: No. of tariff sheets: 0

Estimated system annual revenue effect (%): N/A

Estimated system average rate effect (%): N/A

When rates are affected by AL, include attachment in AL showing average rate effects on customer classes (residential, small commercial, large C/I, agricultural, lighting).

Tariff schedules affected: N/A

Service affected and changes proposed[1]: N/A

Pending advice letters that revise the same tariff sheets: N/A

[1]Discuss in AL if more space is needed.

Clear Form

Protests and correspondence regarding this AL are to be sent via email and are due no later than 20 days after the date of this submittal, unless otherwise authorized by the Commission, and shall be sent to:

California Public Utilities Commission
Energy Division Tariff Unit Email:
EDTariffUnit@cpuc.ca.gov

Contact Name: Sidney Bob Dietz II, c/o Megan Lawson
Title: Director, Regulatory Relations
Utility/Entity Name: Pacific Gas and Electric Company

Telephone (xxx) xxx-xxxx:
Facsimile (xxx) xxx-xxxx:
Email: PGETariffs@pge.com

Contact Name:
Title:
Utility/Entity Name:

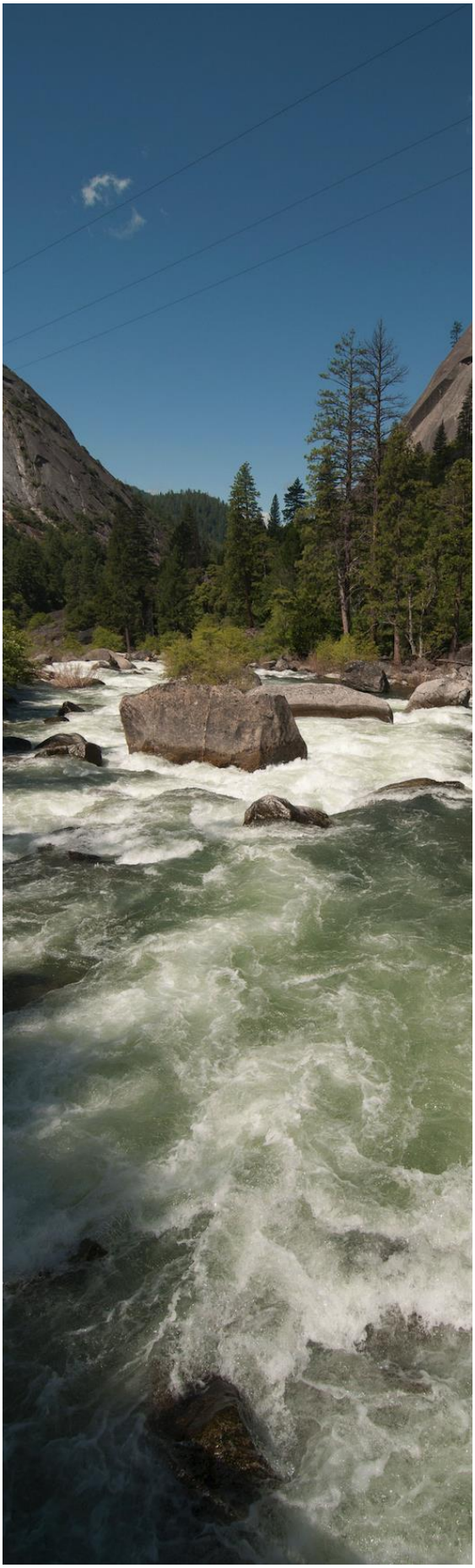
Telephone (xxx) xxx-xxxx:
Facsimile (xxx) xxx-xxxx:
Email:

CPUC
Energy Division Tariff Unit
505 Van Ness Avenue
San Francisco, CA 94102

Clear Form

Attachment 1

Pacific Gas and Electric Company Gas Research & Development, 2025 Annual Research Plan



Pacific Gas and Electric Company Gas Research & Development

2025 Annual Research Plan

July 1, 2024

Table of Contents

Acronyms

Acronym	Description
A.	Application
AANAPISI	Asian American and Native American Pacific Islander Serving Institution
AMP	Asset Management Plans
ARPA-E	US Department of Energy's Advanced Research Projects Agency–Energy
CalGEM	The California Geologic Energy Management Division of the California Department of Conservation
CARB	California Air Resources Board
CBO	Community-based Organization
CEC	California Energy Commission
CFR	Code of Federal Regulations
CPUC	California Public Utilities Commission
D.	Decision
DACAG	Disadvantaged Communities Advisory Group
DEIB	Diversity Equity Inclusion & Belonging
DOE	US Department of Energy
EFI	Emerging Fuels Institute
EPIC	Electric Program Investment Charge Program
ESJ	Environmental and Social Justice
EO	Executive Order
GHG	Greenhouse Gas
GRC	General Rate Case
HSI	Hispanic-serving Institution
IOU	Investor-owned Utility
LBNL	Lawrence Berkeley National Laboratory
LCFS	Low Carbon Fuel Standard
MSI	Minority-serving Institution
NETL	National Energy Technology Laboratory
NGA	Northeast Gas Association
NREL	National Renewable Energy Laboratory
NSF	National Science Foundation
NYSEARCH	Research organization within the Northeast Gas Association
O&M	Operations and Maintenance
OIR	Order Instituting Rulemaking
OTD	Operations Technology Development
PG&E	Pacific Gas and Electric Company
PHMSA	Pipeline and Hazardous Materials Safety Administration
PM	Project Manager
PRCI	Pipeline Research Council International
R&D	Research and Development
RNG	Renewable Natural Gas
R.	Rulemaking
RY	Reporting Year
SB	Senate Bill
SME	Subject Matter Expert
UTD	Utilization Technology Development

1 Overview

1.1 PG&E

Pacific Gas and Electric Company (PG&E) owns and operates one of the nation's largest natural gas systems, comprising 50,000 miles of combined transmission and distribution pipeline that serve approximately 4.5 million customer accounts. Today, methane—a potent greenhouse gas (GHG)—represents approximately 95% of the 895,520 million cubic feet of annual natural gas throughput delivered by its system.

In 2022, PG&E articulated its True North Strategy, a 10-year enterprise plan focused on rebuilding trust, delivering excellent service, and architecting a decarbonized, safe, and reliable energy system.[1] The True North Strategy reflects the conviction that PG&E has a vital role to play in building a better future and in supporting California's transition to a cleaner and more climate-resilient future.

In alignment with California environmental policy, PG&E has committed to reaching a net-zero energy system by 2040—five years ahead of California's current carbon neutrality goal. Achieving this ambitious goal will be challenging. To succeed, PG&E needs to shift away from fossil-based methane and adapt to expected reductions in demand for fossil-based natural gas while integrating cleaner fuels—such as renewable natural gas (RNG), synthesis gas, and "green" hydrogen—into its gas system and continuing to provide its customers with safe, reliable, and affordable service.

1.1.1 PG&E Has Already Made Great Strides Toward this Goal

Between 2021 and 2023, PG&E began accepting RNG from 36 dairies across its service territory. By the end of 2024, PG&E anticipates growing that number to approximately 50 dairies. In late 2022, PG&E launched an initiative to purchase California-produced RNG for its natural gas customers, the first step toward a goal to procure RNG to serve 15% of its core customer natural gas demand by 2030.

In June 2022, PG&E submitted its annual emissions data to the California Public Utilities Commission (CPUC). Using 2015 emissions levels as a baseline value, the data demonstrated that PG&E had achieved more than 24% emissions reductions for reporting year (RY) 2021 and 32.4% for RY 2022. In April 2023—two years ahead of schedule—the company formally announced that it had achieved its 2025 target of reducing pipeline emissions by 20%.[2] By June 14, 2024, PG&E had increased this number to 38%.[3]

1.2 Gas R&D

To bridge the gap between where California is today and the ambitious future that PG&E envisions requires research and development (R&D). California's natural gas systems were designed for a world powered centrally by fossil fuels in which supply and demand evolved predictably over time.

[1] https://www.pgecorp.com/assets/pgecorp/localized/en/sustainability/corporate-responsibility-sustainability/reports/2022/su05_our_true_north_strategy.html
[2] https://investor.pgecorp.com/news-events/press-releases/press-release-details/2023/PGE-Reduces-Emissions-from-Gas-Pipelines-by-More-than-20/default.aspx
[3] https://pgera.azurewebsites.net/Regulation/ValidateDocAccess?docID=796347

Figure 1: R&D will help bridge the gap between the current energy system and a world where energy is safe, clean, and available to all.

In response to these challenges, PG&E centralized its R&D efforts under its newly formed Utility Partnership and Innovation Organization, which includes the Gas R&D team. Composed of energy industry professionals and engineers, Gas R&D seeks to reduce emissions, increase the efficiency of pipeline operations and maintenance activities, and future-proof the gas system for the integration of clean renewable fuels. Since 2013, the Gas R&D team has focused on the development and deployment of breakthrough technologies and processes to improve gas system performance as measured in public and worker safety, customer satisfaction, cost effectiveness, environmental impact, regulatory compliance, and communication.

To optimize its efforts, Gas R&D leverages collaborative networks and research consortia, as well as relationships with national laboratories, universities, Minority-Serving Institutions (MSI), private businesses, community-based organizations (CBO), and public agencies, including the US Department of Energy (DOE), the Pipeline and Hazardous Materials Safety Administration (PHMSA), and the California Energy Commission (CEC). The Gas R&D team also participates in ad-hoc joint industry initiatives with other gas utilities or pipeline operators.

1.2.1 Research Areas

PG&E Gas R&D invests time, technical resources, and funding in projects across three main research areas: Operations and Maintenance (O&M), Reducing Methane Emissions, and Decarbonizing the Gas System.

- **Operations and Maintenance:** These projects support R&D aimed at maintaining and increasing the safety and reliability of the gas system while reducing costs and improving affordability for all customers—including those from environmental and social justice (ESJ) communities.

Reducing Methane Emissions: These projects support R&D that develops or advances technologies that, if deployed widely, would reduce methane emissions from PG&E's gas system.

- **Decarbonizing the Gas System:** These projects support R&D that develops or advances technologies that, if deployed widely, would decarbonize PG&E's gas system.

The figures below showcase examples of our projects. More information about Gas R&D and the projects it supports can be found in the PG&E Gas Research and Development 2023 Annual Report and its 2024 Annual Workshop Presentation.[4, 5]

Figure 2: In a project funded by the CEC, the University of California, Los Angeles, Graniterock, and PG&E's Gas R&D, researchers sought to identify the impact of hydrogen-natural gas blends on existing and new appliances and the maximum concentration of hydrogen that can be handled by these appliances with and without modification.

[4] https://www.pge.com/assets/pge/docs/about/pge-systems/Gas-RD-Annual-Report.pdf.coredownload.pdf
[5] https://www.pge.com/content/dam/pge/docs/about/pge-systems/pge-gas-rd-public-workshop-presentation.pdf

Figure 3: Funded by a US Department of Transportation/PHMSA University grant and Small Business Innovation Research funds, the project involved the first of its kind installation of a distributed fiber optic sensor monitoring system to assess pipeline strain associated ground movement at the Calaveras fault-crossing south of San Jose. The image captures the installation of the fiber optic sensor on the pipeline.

Figure 4: The near field fixed monitoring project is testing the technical specifications and leak detection capabilities of various methane sensors for continuous monitoring of wellheads at underground storage facilities. Incorporating fixed methane monitors can reduce operating risks though early detection of high-risk methane leaks, potentially preventing loss of containment.

2 Research Plan Development

Gas R&D staff consider a variety of factors in determining how to broadly allocate funding and in-kind support. These factors include regulatory and policy drivers, input from knowledgeable stakeholders (Section 3.1), input from the CPUC Energy Division staff and other interested parties at an annual workshop (Section 3.2), literature reviews, company goals, a gap analysis, and the potential impact of research on ESJ communities.

2.1 Regulatory and Policy Drivers

Category	Regulations & Policy Drivers
Operations & Maintenance	**PHMSA's Mega Rule:** Enhances safety by expanding repair criteria, strengthening integrity management requirements, updating cathodic protection guidance, codifying management of change processes, and updating related regulations for gas transmission pipelines. **49 Code of Federal Regulations (CFR) Part 192 Transportation of Natural and Other Gas by Pipeline:** Sets minimum federal safety standards for the transportation of natural and other gases by pipeline. **General Order No. 112-F:** Outlines rules for the design, construction, testing, operation, and maintenance of gas piping systems. **Order Instituting Rulemaking (OIR) R.20-01-007:** Establishes policies, processes, and rules for safe, reliable, and long-term gas system planning in California; requires performance of long-term gas system planning. **California Geologic Energy Management Division (CalGEM) Cal. Code Regs. Tit. 14 Sec. 1726:** Institutes regulations governing underground gas storage projects and gas storage wells. **PG&E's Gas Operations Asset Management Plans (AMPs):** Establishes lifespan strategy of assets spanning the entire lifecycle from design, construction, commissioning, O&M, and decommissioning. The AMPs are living documents that evolve as new asset or risk management information becomes available.
Reducing Methane Emissions	**Senate Bill (SB) 1371 & PG&E's Compliance Plan:** California's SB 1371 mandates the reduction of methane emissions from natural gas pipelines and infrastructure. Commission decision D.17-06-015 established a set of best practices and required utilities to file a compliance plan for methane abatement. **CalGEM GHG Emission Standards:** The California Department of Conservation's Division of Oil, Gas, and Geothermal Resources sets GHG emissions standards for crude oil and natural gas to reduce environmental impact. **California Air Resources Board** (**CARB) Oil and Gas Regulation:** CARB seeks to reduce methane emissions from oil and gas through monitoring, reporting, and control measures.
Decarbonizing the Gas System	**California Climate Commitment:** A set of world-leading actions to achieve carbon neutrality by 2045. **Executive Order (EO) B-55-18:** Aims for statewide carbon neutrality by 2045 and net negative greenhouse gas emissions thereafter. **Assembly Bill 32 (California Global Warming Solutions Act of 2006):** Mandates reducing greenhouse gas emissions to 1990 levels by 2020 through comprehensive measures. **Clean Air Act:** Establishes national air quality standards to protect public health and regulate air pollutant emissions.

	SB 1383: Aims to reduce short-lived climate pollutants, including methane and hydrofluorocarbons, to improve air quality and public health. **California's Low Carbon Fuel Standard:** Reduces GHG emissions by promoting the use of cleaner, low-carbon transportation fuels. **SB 1440:** Establishes a biomethane procurement program to reduce GHG emissions and promote renewable energy use. **Rulemaking (R.) 13-02-008:** Requires a procurement plan for biomethane. **Application 22-09-006:** Joint investor-owned utility (IOU) hydrogen blending demonstration projects.
Equity	**CPUC General Order 156:** Encourages IOUs to procure or contract goods and services from women-, minority-, disabled veteran-, and/or LGBT-owned business enterprises. **CPUC ESJ Action Plan:** Increases investment in clean energy resources to benefit environmental and social justice communities, especially to improve local air quality and public health. **R.19-10-005:** OIR on the Commission's Own Motion to consider renewal of the Electric Program Investment Charge Program.[6] **Decision (D.) 21-11-028:** Decision approving the utilities as electric program investment charge administrators with additional administrative requirements.

2.2 Technology Gap Analysis

In June 2023, PG&E published its R&D Strategy Report.[7] As part of its development, PG&E's R&D teams worked closely with company operations staff to conduct a gap analysis. Together, they identified 70 technology gaps—including 32 directly related to Gas R&D—that stand in the way of PG&E achieving its objectives for its energy system. PG&E further divided these 32 gaps into three Gas R&D research themes:

Operations and Maintenance	
Crack Assessment and Monitoring for Small Pipes	Accuracy of Well-Life Estimation
Material Properties Verification for Existing Pipe	Geohazard Risk Assessment
Toughness Assessments for Existing Pipe	Accuracy of Pipeline Locating Technologies
Crack Assessment Technologies	Meter Set Corrosion Inspections
Well Inspection and Monitoring	Distribution Saddle Leak Repairs
Corrosion Inspections	Plastic Insert Detection
Manual Customer Shutoffs	

[6] https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/energy-research-development-and-deployment
[7] https://www.pge.com/content/dam/pge/docs/about/pge-systems/PGE-RD-Strategy-Report.pdf

Reducing Methane Emissions	
Revised Emission Calculation Methodologies	Enhanced Leak Detection
Reducing Pipeline Blowdown Methane Emissions	Reducing False Positive on Leak Detection Surveys
Efficient Leak Repairs	Above Ground Leak Detection and Monitoring

Decarbonizing the Gas System	
Costly and Unstandardized Interconnection Skids	Uncertainty of Storage Facility Performance for Hydrogen Blends
Uncertainty about Risks and Impacts from Trace RNG Chemicals	Limited RNG Capacity from Traditional Sources
Hydrogen Embrittlement	Woody Biomass as an Energy Source
Safety Risks of Hydrogen Blend Leaks	Gas Appliance Combustion Emissions
Metering Accuracy with Hydrogen Mixtures	Lack of Operational Data for Hydrogen Effects on Gas System
Optimal Decarbonization Pathway	Need to Develop Cost-Effective and Safe Deblending Technologies
Compatibility of Customer Applications with Mixed Gas	

3 Stakeholder Input

PG&E's Gas R&D 2025 Annual Research Plan incorporates input from key stakeholders and subject matter experts (SME) at universities, MSIs, national labs, public agencies, businesses, CBOs, and industry research consortia to maximize the impact of its funding of promising technologies and products focused on producing or delivering cleaner, safer, and more reliable energy. These relationships enable PG&E to engage with science and technology experts, other utilities, and industry stakeholders to effectively identify and close knowledge and research gaps, avoid duplication of previous and ongoing research, and reduce technology and commercialization risks to achieve the goals of PG&E Gas R&D.

3.1 Stakeholder Outreach

Figure 5: Gas R&D staff conducted stakeholder interviews or discussions with individuals from 18 different organizations—many of which are MSIs—in early 2024.

Conversations with the key stakeholders and SMEs are ongoing throughout the year, but in preparation for the 2025 funding allocations, Gas R&D staff conducted a series of targeted interviews with numerous individuals from 18 different organizations (Figure 5) in early 2024. During the interviews, the SMEs and industry stakeholders were asked a series of standard questions and then engaged in a freeform discussion about the industry. See Section 3.3 for a summary of stakeholder input.

Gas R&D staff presented its plan during the Annual Workshop and solicited feedback from attendees (see Section 3.2).[8] Gas R&D was not able to secure a meeting with the CPUC's Disadvantaged Communities Advisory Group (DACAG), as recommended in Phase I of PG&E General Rate Case Decision D.23-11-069.[9]

[8] https://www.pge.com/content/dam/pge/docs/about/pge-systems/pge-gas-rd-public-workshop-presentation.pdf
[9] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M520/K896/520896345.pdf

2024 Stakeholder Outreach Questions

1. Which of the three research focus areas are most relevant to you?
   - ☐ Operations & Maintenance
   - ☐ Reducing Methane Emissions
   - ☐ Decarbonizing the Gas System
   - ☐ Other (please specify)
2. Within the areas you selected as most relevant, what are the most critical knowledge gaps or research priorities?
3. Keeping these areas of relevance in mind, are there any regulations on the horizon or current regulations we should be aware of?
4. What do you consider has the most potential in this space? What does that potential rest upon? Environmental benefits? Cost savings? Fast deployment? Something else?
5. What new technology developments excite you?
6. What new trends or technologies are you aware of that you would recommend us to explore further?
7. PG&E is interested in increasing the equity component of the projects it supports. Can you share any best practices or lessons learned from your program that we might adopt?
8. Do you know or have any Minority-Serving Institution contacts that could benefit from association with our R&D program?
9. What are some ways that research projects could benefit underserved populations?
10. Can you think of any relevant research and/or pilots that might benefit from our support?
11. If we were to remember only one thing from our discussion with you, what should that be?
12. Do you have any questions for us?

3.2 Stakeholder Workshop

On April 29, 2024, PG&E hosted an online workshop to present the results of the previous year's program and obtain input regarding its proposed funding allocations for 2025. PG&E publicly announced the workshop on its R&D website and by email using the following CPUC proceedings service lists:

- **R.18-04-019:** OIR to consider strategies and guidance for climate change adaptation.
- **R.19-10-005:** OIR on the Commission's Own Motion to consider renewal of the Electric Program Investment Charge Program.
- **R.20-01-007:** OIR to Establish Policies, Processes, and Rules to Ensure Safe and Reliable Gas Systems in California and perform Long-Term Gas System Planning.
- **R.19-01-011:** OIR Regarding Building Decarbonization.
- **R.13-11-005:** OIR Concerning Energy Efficiency Rolling Portfolios, Policies, Programs, Evaluation, and Related Issues.
- **R.15-01-008:** OIR to Adopt Rules and Procedures Governing Commission-Regulated Natural Gas Pipelines and Facilities to Reduce Natural Gas Leakage Consistent with SB 1371.
- **D.23-11-069:** Test Year 2023 General Rate Case (GRC) for Pacific Gas and Electric Company

Gas R&D staff also leveraged PG&E's Diversity Equity Inclusion & Belonging (DEIB) team to distribute the announcement to over 300 Tribal governments and ESJ contacts across the company's service territory.

Approximately 100 unique attendees from a wide variety of organizations attended the workshop. Organizations sending attendees included national laboratories, public agencies, and numerous industry organizations, universities, MSIs, CBOs, Tribal Nations, and private companies.

3.2.1 2023 Annual Stakeholder Workshop Attendee Organization List

Air Products	MKTNG
American Public Gas Association	Momentum
Avista Utilities	National Renewable Energy Laboratory
Buchalter	NiSource
California Air Resources Board	NW Natural
California Energy Commission	Peoples Gas
California Public Utilities Commission	PG&E
CH4IQ	Philadelphia Gas Works
City of Mesa	PSE&G
Con Edison	Rhode Island Energy
County of San Mateo	Seahold LLC
DTE Energy	Self-Help Enterprises
Electric Power Research Institute	SoCalGas
Electrochaea	Sonatrach
Engineers and Scientists of California Local 20, IFPTE	Southwest Gas
ENTRUST Solutions Group	Stoel Rives LLP
GTI Energy	Tejon Indian Tribe
H2EG	Tourmaline Oil
Lawrence Livermore National Laboratory	University of California, Berkeley
Mainspring Energy	University of California, Los Angeles
MCR Performance Solutions	U.S. Department of Transportation
MidSouth Utility Services	Vermillion Power Technologies

PG&E also posted a link to the workshop recording at www.pge.com/innovation. A complete list of the questions received during and following the workshop, along with responses from Gas R&D staff is posted online at pge.com/innovation and appears at the end of this document (Appendix A).

Start Time	Duration	Topic
9:00	10 minutes	Introduction
9:10	10 minutes	PG&E Gas R&D
9:20	30 minutes	2023 in Review
9:50	10 minutes	Project Selection Process
10:00	10 minutes	Q&A
10:10	5 minutes	BREAK
10:15	15 minutes	Proposed 2025 Plan
10:30	30 minutes	Operations and Maintenance (includes 10 minutes Q&A)
11:00	30 minutes	Reducing Methane Emissions (includes 10 minutes Q&A)
11:30	30 minutes	Decarbonizing the Gas Pipeline (includes 10 minutes Q&A)
12:00	10 minutes	General Q&A
12:10	N/A	Close

Figure 6: Agenda for the PG&E 2024 Annual Gas R&D Public Workshop

3.3 Summary and Incorporation of Stakeholder Input

In preparation for the 2025 funding allocations, R&D staff conducted a series of targeted interviews with numerous individuals from 18 different organizations (Figure 5) in early 2024. During the stakeholder interviews—which varied in length between 30 and 60 minutes—participants expressed interest in a variety of topics.

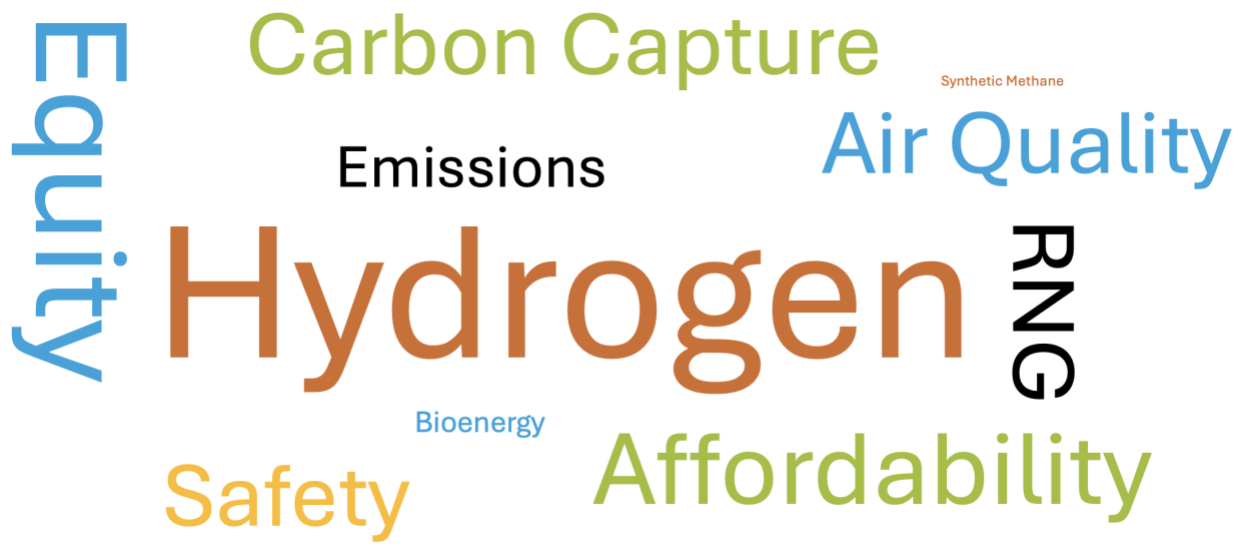


Figure 7: Word cloud of keywords from the 2024 Gas R&D stakeholder outreach program.

TABLE 1: 2024 STAKEHOLDER INTEREST IN RELEVANT TOPIC AREAS.

Topic	Number of Participants Expressing Interest	% of Participants Expressing Interest
Hydrogen	13	76
RNG	6	35
Synthetic Methane	1	5
Safety	6	35
Affordability	7	41
Equity	9	53
Bioenergy and Biogas	2	12
Air Quality	6	35
Carbon Capture	6	35

Using the interviews and workshop Q&A document, PG&E assembled a database of the responses, extracted the following high-level summaries, and developed strategies for how to incorporate the input into the 2025 research plan.

TABLE 2: STAKEHOLDER INPUT SUMMARY AND INCORPORATION

Input	Incorporation Strategy
Cost-effective decarbonization requires 1) leveraging existing infrastructure, equipment and facilities; 2) being technology/molecule agnostic; and 3) employing a multi-sectoral, economy-wide approach.	PG&E conducts on-going research related to RNG, hydrogen, and hydrogen blending, which will cost-effectively leverage existing infrastructure, equipment, and facilities to transport decarbonized fuels. See Section 7.4.2.
Decarbonization strategies should encompass the whole energy sector and include both gas and electric solutions.	In 2022, PG&E's Gas Research & Development team joined PG&E's Utility Partnerships & Innovation division, which encompasses both gas and electric R&D operations. This collaboration enables better identification, development, and deployment of novel solutions and technologies that support decarbonization of the whole energy sector. Thus, Gas R&D staff have already incorporated and will continue to incorporate this input.
Highly localized carbon capture at large emitting plants has value as a decarbonization strategy for hard-to-electrify sectors.	Carbon-capture-related research funding was denied in CPUC Res. G-3601.[10] PG&E did not incorporate this input into its 2025 Gas R&D Research Plan.
Hydrogen blending demonstrations at the commercial level would be valuable.	As highlighted during its 2024 Annual Gas R&D Public Workshop, PG&E is participating in the CEC-funded project "Pilot Testing and Assessment of Safety and Integrity of Targeted Hydrogen Blending in Gas Infrastructure for Decarbonization" (CEC Agreement PIR-22-003). For 2025, PG&E plans to support the next phase of the project to conduct a hydrogen blending field pilot at the same facility. See Section 7.4.2.

[10] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M520/K616/520616116.PDF

Assessing the suitability of existing gas infrastructure for hydrogen blending and 100% hydrogen.	As stated in the Climate Strategy Report, PG&E is maximizing its readiness for hydrogen blending but is not exploring the transport of 100% hydrogen.[11] PG&E is assessing the suitability of existing gas infrastructure to transport hydrogen blends through various research projects that are detailed in the Gas R&D 2023 Annual Report. In 2025, PG&E plans to continue supporting active projects and pursue new, relevant projects in response to this input. Thus, PG&E has already incorporated and will continue to incorporate this input. See Section 7.4.2.
Testing of monitoring and sensing tools for methane and hydrogen need to be prioritized in R&D.	PG&E has on-going research related to both methane and hydrogen detection that are detailed in the Gas R&D 2023 Annual Report and will continue in 2025. See Section 7.3.2.
Most participants expressed an appetite for deliberate and structured collaboration.	PG&E is committed to both ad hoc and structured collaboration across the Gas R&D ecosystem. Gas R&D staff maintain relationships with their counterparts at other California IOUs through regular calls. In 2024, Gas R&D held its first annual public workshop, in which it engaged individuals from more than 40 organizations throughout California and the United States, sharing its proposed plans for R&D spending in 2025 and seeking input (Section 3.2). In preparation for this research plan, Gas R&D staff participated in an extensive outreach campaign that included input from numerous individuals from 18 organizations in the Gas R&D ecosystem. PG&E is also active in a variety of industry groups and regulatory proceedings where deliberate and structured collaboration occurs. Moving forward, Gas R&D intends to continue its annual outreach campaign, public workshop, and other existing collaborative activities. Gas R&D staff also plan to meet regularly with representatives from SoCalGas, San Diego Gas & Electric Company, Southwest Gas, other smaller IOUS, and the CEC to discuss the state of gas R&D, share results, and plan new projects. Gas R&D maintains an inbox for ideas and feedback about gas R&D at innovation@pge.com. Gas R&D intends to further incorporate this input into its 2025 activities. See Section 6.
It is very important to be able to track and leverage national and international advancements in gas R&D. Working with industry research consortia is an important way to do this.	During the workshop, Gas R&D provided an overview of its work with industry consortia, which include national and international member organizations. In 2025, Gas R&D staff intend to continue leveraging their relationships with gas industry consortia on projects that deliver explicit benefits to PG&E's gas ratepayers.

[11] https://www.pge.com/content/dam/pge/docs/about/pge-systems/PGE-Climate-Strategy-Report.pdf

	See Section 6.2.
The energy transition must be cost-effective and grounded in the customers' reality.	PG&E recognizes that the energy transition must be affordable for our customers. We are committed to executing our goals in a cost-effective manner with minimal impact to customer bills and in a way that's consistent with our long-term affordability commitments. Gas R&D's projects align with our customers' realities and needs: • **Affordability:** Gas R&D prioritizes projects that have potential to reduce ratepayer costs through providing more affordable energy and reducing maintenance costs—particularly important as gas throughput declines in the coming decades. • **Reliability:** By enhancing the stability and dependability of the gas supply, our projects have potential to reduce interruptions and provide consistent service to our customers. • **Safety:** Our projects develop advanced technologies and practices to maintain and improve the safety of PG&E's gas infrastructure. • **Equity:** Equity is one of the criteria we consider when selecting projects to add to the Gas R&D portfolio. Examples of how we do this include siting R&D projects in ESJ communities, prioritizing projects whose principal investigator is from an underrepresented group, or collaborating with MSIs. • **Operational Efficiency:** We seek to support projects with the potential to enhance the efficiency of PG&E's operations, reducing waste and improving service delivery. • **Reduced GHG Emissions:** Lower emissions contribute to mitigating climate change, which can help prevent the costly impacts of extreme weather events and environmental degradation. This long-term stability benefits all ratepayers. • **Improved Air Quality:** We invest in technologies that reduce pollutants and enhance air quality, ensuring a healthier environment for our customers. PG&E has incorporated this input into the very structure of Gas R&D and will continue to do some moving forward.
Equity is related to public health through air quality improvements and emissions reductions.	Projects in Gas R&D's three research focus areas all seek to improve air quality and, thereby, public health by reducing GHG and criteria pollutant emissions. See Section 7 and PG&E Gas R&D's 2023 Annual Report for more information.[12]

[12] https://www.pge.com/assets/pge/docs/about/pge-systems/Gas-RD-Annual-Report.pdf.coredownload.pdf

	See also PG&E's Climate Strategy Report.[13]
Early and ongoing involvement with ESJ communities and CBOs is important.	As mentioned above, Gas R&D considers equity as one of its project selection criteria. Gas R&D staff have already begun to develop relationships within ESJ communities and CBOs. Additionally, Gas R&D staff have worked and continue to work closely with individuals at a variety of MSIs, including both Hispanic-Serving Institutions (HSIs) and Asian American and Native American Pacific Islander Serving Institutions (AANAPISIs). Gas R&D staff seek out new opportunities to collaborate, including with historically black college and universities. In promoting the Gas R&D Annual Workshop, Gas R&D staff sent notifications to over 300 CBOs and Tribal Governments. In 2025, Gas R&D staff will seek to incorporate this input by deepening its relationships with Tribes, ESJ communities, and CBOs in several ways, including: • Meeting with representatives from the CEC's DACAG for guidance on developing a Gas R&D Equity Engagement Plan. • Coordinating with PG&E's DEIB organization in the development of the Gas R&D Equity Engagement Plan. • Collaborate with our Regional Vice Presidents on outreach efforts. Gas R&D encourages engagement from ESJ communities and may be reached via email at innovation@pge.com.
Accelerate access to clean energy technologies for those in ESJ communities.	Gas R&D staff consider the equity implications of every project they review for inclusion in their project portfolio, including whether to site a clean energy demonstration project in an ESJ community. As Gas R&D ramps up its equity-related efforts moving forward, our staff will conduct engagement activities with representatives from ESJs and CBOs to understand their needs and the challenges associated with gaining access to clean energy technologies. As mentioned above, Gas R&D staff have included equity as one of the core project selection criteria. See PG&E's Climate Strategy Report for more information, as well as PG&E Gas R&D's 2023 Annual Report.[14, 15]
Projects should include meaningful workforce development, education, and training for those in ESJ communities.	Gas R&D staff consider the equity implications of every project they review for inclusion in their project portfolio, including whether a potential project includes meaningful workforce development, education, and training for those in ESJ communities. In 2025, Gas R&D will continue to consider

[13] https://www.pge.com/content/dam/pge/docs/about/pge-systems/PGE-Climate-Strategy-Report.pdf
[14] Ibid.
[15] https://www.pge.com/assets/pge/docs/about/pge-systems/Gas-RD-Annual-Report.pdf.coredownload.pdf

	these criteria when selecting projects for its portfolio. As Gas R&D ramps up its equity-related efforts moving forward, our staff will conduct engagement activities with representatives from ESJs and CBOs to understand their needs and the challenges associated with these three criteria. See PG&E's Climate Strategy Report for more information.[16]
Projects should use Justice40 principles when developing projects.	President Biden's Executive Order 14008 established the Justice40 Initiative, which directs 40% of the benefits of certain Federal investments to flow to disadvantaged communities. Gas R&D staff consider the following Justice40 policy priorities—those also used by the DOE—when evaluating potential projects for inclusion in their portfolios:[17] • Decrease energy burden in disadvantaged communities (DACs). • Decrease environmental exposure and burdens for DACs. • Increase parity in clean energy technology (e.g., solar, storage) access and adoption in DACs. • Increase access to low-cost capital in DACs. • Increase clean energy enterprise creation and contracting (MBE/DBE) in DACs. • Increase clean energy jobs, job pipeline, and job training for individuals from DACs. • Increase energy resiliency in DACs. • Increase energy democracy in DACs. Gas R&D staff will seek to incorporate this input into its ESJ and DAC project selection process in 2025.
Develop better tools for handling, storing, analyzing, transmitting, and leveraging data.	Gas R&D has incorporated this input into its research plan. See Section 7.2.2. See also PG&E's 2024 Gas Safety Plan for a description of the Data Asset Family.[18]
Cybersecurity is important.	Gas R&D has incorporated this input into its research plan. On all projects Gas R&D supports that require cybersecurity measures, the project team follows PG&E's Security Program, which covers both cyber and physical security measures.[19]
Improve measurement of behind-the-meter methane emissions.	This is out of scope for Gas R&D.

[16] https://www.pge.com/content/dam/pge/docs/about/pge-systems/PGE-Climate-Strategy-Report.pdf
[17] https://www.energy.gov/justice/justice40-initiative
[18] https://www.pge.com/assets/pge/docs/about/pge-systems/PDF_GasPipelineSafetyOIR_Report_PGE_20240315.pdf
[19] Ibid.

Develop and advance new technologies for leak prevention, sensing, and detection.	Gas R&D actively reviews available and emerging technology that supports leak management and prevention and is included in our 2025 plan. See Section 7.3.2.
Explore methane pyrolysis and thermochemical conversion/gasification.	Gas R&D has incorporated projects exploring methane pyrolysis and thermochemical conversion/gasification into its 2025 plan.
Explore maintaining system integrity and safety during decarbonization.	PG&E is assessing the suitability of existing gas infrastructure through various research projects that are detailed in the Gas R&D 2023 Annual Report.[20] Gas R&D will continue this approach in 2025.

[20] https://www.pge.com/assets/pge/docs/about/pge-systems/Gas-RD-Annual-Report.pdf.coredownload.pdf

4 Benefits

Projects in each of the three focus areas—O&M, Reducing Methane Emissions, and Decarbonizing the Gas System—are selected because they have the potential to deliver at least one, and generally more, of the following benefits: reliability, safety, equity, affordability, and environmental improvement.

4.1 Operations and Maintenance

Reliability	R&D projects in this area can enhance system reliability through the development of advanced monitoring technologies and predictive maintenance tools. These innovations could help detect and address issues before they cause service interruptions, helping maintain consistent gas delivery.
Safety	R&D projects in this area can enhance system safety by developing advanced monitoring and predictive maintenance tools. These technologies enable early detection and resolution of potential safety hazards, such as pipeline corrosion, cracking, mechanical damages, or pressure anomalies, thereby preventing accidents and ensuring safe gas delivery.
Equity	R&D projects in this area can improve social justice and equity by ensuring reliable and safe gas delivery to all communities, including underserved ones. Advanced monitoring and maintenance tools can prevent service interruptions, ensuring consistent access to essential energy resources. Engaging with diverse academic populations, such as universities and technical schools with strong science, technology, engineering, and math programs, can bring fresh perspectives and innovative solutions to R&D efforts. Collaborating with academic institutions through internships, research partnerships, and joint projects can harness the talents of students and faculty from diverse backgrounds, fostering innovation that is inclusive and representative of the wider community. Moreover, the R&D team's efforts can directly benefit underserved communities by focusing on affordability and environmental sustainability. By developing cost-effective technologies and solutions, PG&E can help lower energy costs for low-income households. Additionally, initiatives aimed at reducing GHG emissions and improving air quality can lead to healthier living conditions in these areas, addressing environmental justice concerns. Investing in community-driven projects and ensuring that these communities have a voice in the R&D process can lead to more equitable outcomes and empower residents to participate in shaping their energy future.
Affordability	R&D projects in this area can improve energy affordability by developing efficient maintenance practices and advanced monitoring technologies that reduce operational costs. These savings can be passed on to customers, lowering their energy bills.
Environmental Improvement	R&D projects in this area can lead to more efficient and reliable gas systems, reducing the need for emergency repairs and minimizing accidental releases of GHG emissions. Improved maintenance practices support optimal system performance, thereby reducing the overall environmental footprint.

4.2 Reducing Methane Emissions

Reliability	By researching and implementing methods to detect and repair leaks more efficiently, these projects minimize methane emissions. This not only addresses environmental

	concerns but also improves the integrity of the gas infrastructure, reducing the risk of leaks that could disrupt service.
Safety	Research and implementation of improved leak detection and repair techniques can significantly reduce methane emissions. This not only benefits the environment but also enhances safety, ensuring a safer operating environment for both workers and the public.
Equity	By focusing on reducing methane emissions, these projects help mitigate environmental health risks that disproportionately affect low-income and marginalized communities. Cleaner air leads to better health outcomes, promoting equity in public health.
Affordability	By researching and implementing better leak detection and repair methods, these projects can minimize gas loss, which benefits PG&E customers by reducing the harmful social impacts of methane, which are estimated to be roughly $1,600/ton.[21] The social cost of methane is the estimated damage caused by methane emissions to society, which can include health problems from polluted air, damage to crops and forests, and costs related to climate change, like extreme weather and rising sea levels.
Environmental Improvement	Research and implementation of advanced leak detection and repair technologies can significantly lower methane emissions, a potent GHG. By minimizing leaks, these projects directly contribute to reducing the overall GHG emissions from the gas utility sector, enhancing air quality and mitigating climate change impacts.

4.3 Decarbonizing the Gas System

Reliability	Integrating cleaner fuels such as clean hydrogen, RNG, and synthetic methane into the gas supply may enhance system reliability. These fuels diversify the energy mix, making the gas system more resilient to supply disruptions.
Safety	Integrating cleaner fuels like clean hydrogen, RNG, and synthetic methane into the gas system can raise safety concerns. For example, hydrogen may cause embrittlement in metallic pipelines or the combustion of RNG may produce trace constituents that can harm human health. Gas R&D addresses these issues with R&D that seeks to better understand the embrittlement process or explores what the safe upper and lower limits are of certain constituents to eliminate negative effects in the pipeline system and end-user appliance and equipment.
Equity	Integrating cleaner fuels such as clean hydrogen, RNG, and synthetic methane can create more equitable energy systems. These fuels reduce pollution and GHG emissions, benefiting communities most impacted by climate change and poor air quality. Additionally, the transition to cleaner energy sources can create new job opportunities in green energy sectors, promoting economic equity and providing sustainable livelihoods for disadvantaged populations.
Affordability	Integrating cleaner fuels such as clean hydrogen, renewable natural gas, and synthetic methane can diversify the energy supply, potentially lowering costs through competitive pricing. These fuels can also leverage existing infrastructure, reducing the need for expensive new investments. Furthermore, cleaner fuels can attract subsidies and incentives aimed at promoting sustainable energy, ultimately making energy more affordable for all consumers.
Environmental Improvement	Integrating cleaner fuels such as clean hydrogen, RNG, and synthetic methane can substantially reduce carbon and other pollutant emissions. Additionally, the adoption

[21] https://eelp.law.harvard.edu/2017/09/the-social-cost-of-carbon/

	of renewable and low-carbon energy sources helps decrease the overall GHG emissions of the gas system, supporting global climate goals and creating a healthier environment.

4.4 Proposed Impact Analysis Framework

4.4.1 Purpose

Gas R&D has begun developing the foundation for an impact analysis framework and will consult Energy Division staff to solidify clear line of sight to ratepayer benefits. Gas R&D will also collaborate with other California IOUs and the CEC to consider criteria that will maintain alignment of R&D projects and OIRs. As discussed below, considerations include the Electric Program Investment Charge (EPIC) Program guidelines and workshop materials.

In D.23-04-042, issued April 28, 2023, the Commission found that the term "benefits analysis framework" should be now called the "uniform impacts framework," further explaining that "research and development projects have an element of risk, which means that not all EPIC projects will directly benefit ratepayers in a quantifiable manner."[22] In support of these directives, Gas R&D proposes to participate in upcoming EPIC workshops as part of proceeding R.19-10-005 and work in consultation with Energy Division staff as directed in D.23-11-069 in the development of a uniform impact framework for Gas R&D.

On April 2, 2024, the CPUC hosted a virtual workshop "EPIC Impact Analysis Framework and Metrics Workshop." The Uniform Impact Analysis Framework is a set of metrics, assumptions, and methodologies designed to measure the progress of EPIC program investments toward meeting EPIC Strategic Goals and Strategic Objectives. D.23-04-042 requires all EPIC Administrators to use the same impact analysis framework and establish metrics to inform improved EPIC program evaluation and oversight, as well as greater transparency for to inform ratepayer benefits.[23]

The planned outcome of the process is to develop clear, measurable, and reasonable targets to be used by Gas R&D in developing research portfolios and used in program evaluations to measure impacts of Gas R&D projects.

4.4.2 Overarching Principles

In preparing this framework, Gas R&D relied upon four overarching principles:

- **Transparency:** Gas R&D staff are committed to ensuring that the methods, data, and findings used in the impact analysis are clearly communicated and accessible to stakeholders.
- **Accountability:** Gas R&D will assess and report the impacts of its R&D projects to stakeholders, increasing the odds that investments are producing the intended benefits.
- **Equity:** Equity is one of the key factors that Gas R&D staff consider when selecting projects for its R&D portfolio, with the intention that all communities, especially underserved ones, benefit from the R&D projects.
- **Sustainability:** Gas R&D seeks to develop processes and technologies that, when widely deployed, will deliver a range of benefits that support environmental, economic, and social

[22] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M507/K499/507499284.PDF
[23] https://www.epicpartnership.org/strategicobjectives.html

sustainability. These benefits include 1) reduced GHG emissions, 2) improved air quality, 3) public and employee safety, 4) improved affordability, 5) operational efficiency; and 6) reliability.

4.4.3 Net Impacts

Gas R&D staff track and measure the progress of the projects. Generally, they track three types of results:

- **Outputs:** These are results of Gas R&D projects, the specific innovations developed or deployed, and insights gained. Gas R&D staff track these outputs regularly and summarize them each year in the Gas R&D Annual Report.
- **Outcomes:** Outcomes are observed results from actions taken, such as market deployment. Outcomes are how outputs have been put into practice on a wider scale. Gas R&D staff track and measure these on an annual basis.
- **Impacts:** Impacts are effects attributable to Gas R&D outputs and outcomes in meeting goals. Impacts are reliant on other influences that are broader, deeper, and slower than those Gas R&D has direct effect over. The uniform impacts framework will provide a mechanism for measuring impacts and guidance for the frequency of these measurements.

4.4.4 Attribution

With this framework, Gas R&D seeks to develop a defensible methodology that it can use to establish clear links between specific R&D activities and observed outputs, outcomes, and impacts. Third parties using this methodology, as well as a clear set of defined assumptions (Section 4.4.7), should reach similar conclusions to those reached by Gas R&D staff when evaluating project results. One of the intents is to isolate the specific effects of R&D projects from other external factors.

4.4.5 Methods

In development of a project, each Gas R&D Project Manager (PM) will conduct an impact analysis, if needed, to evaluate the benefits of the planned project. During the project selection process, the PM will work with the project team to select metrics appropriate to the specific project scope and stated objectives.

At regular intervals during project execution, the Gas R&D PM will assess its progress towards its goals and objectives and, if appropriate, measure the selected metrics.

Upon conclusion of each project, Gas R&D staff will assess whether the program or project met applicable technical targets and estimate the value of the project results, including benefits expected if the technology or strategy achieves a reasonable market penetration. Staff will also explore how project results may be used.

For developed technologies that achieve commercialization, Gas R&D staff will perform conduct an in-depth assessment of benefits achieved and the extent to which those benefits are related to Gas R&D investment.

4.4.6 Metrics

Gas R&D will develop project and program-level metrics in the following categories:

1) Reliability
2) Safety
3) Equity
4) Operational Efficiency
5) Improved Affordability
6) Reduced GHG Emissions
7) Improved Air Quality

4.4.7 Assumptions

- The uniform impacts framework's development will take time and existing research should continue during this period.
- Not all projects should be required to conduct an impacts analysis. Smaller projects may be more exploratory in nature and the effort associated with the analysis may be unduly burdensome.
- The framework's development will require active participation and collaboration with other IOUs and the CEC in consultation with the CPUC.
- The framework's development should be viewed as an organic process, changing as new information becomes available or priorities evolve.

4.4.8 Proposed Framework

Gas R&D provides the below suggested benefits.

Benefit Area	Measurement
Reliability	1. Outage number, frequency and duration reductions 2. Reduction in system and equipment failures 3. Improved reliability to DAC customers
Safety	1. Public safety improvement and hazard exposure reduction 2. Utility worker safety improvement and hazard exposure reduction 3. Safety improvements targeted towards ESJs
Equity	1. Number of projects in ESJ communities 2. Spending in ESJ communities
Operational Efficiency and Improved Affordability	1. Maintain/reduce operations and maintenance costs 2. Maintain/reduce capital costs 3. Reduce methane emissions due to leaks 4. Leverage ratio based on externally secured funding 5. Percentage of projects facilitated through consortiums 6. Total Federal and State grants secured
Reduced GHG Emissions	1. Reduction in measured GHG emissions 2. Reduction in projected GHG emissions in the absence of developed technology
Improved Air Quality	1. RNG procurement and injection into the system 2. Amount of hydrogen injected into the system

	3. Decommission parts of the gas system and electrification.
Effectiveness of Information Sharing	1. Number of industry sharing events/papers presented 2. Number of times reports are cited in scientific journals and trade publications for selected projects 3. Number of information sharing forums held 4. Stakeholder attendance at workshops 5. Results provided to standard development organizations
Adoption of Gas R&D Technology	1. Number of technologies/use cases demonstrated, in direct use post-Gas R&D project 2. Number of technologies included for funding in the GRC, or for which post-Gas R&D project funding has otherwise formally been committed
Technology Development Progress	1. Average increase in project technology readiness level
Informed Industry and/or Company Standards	1. Specific standards which were created or updated

5 Alignment with State's Zero Carbon Goals

PG&E Gas R&D's low-carbon R&D projects can play a crucial role in supporting California's aggressive zero carbon goals by acting as a transitional bridge between the current energy landscape and a zero- or -low carbon future. These projects can address immediate emission reductions while laying the groundwork for more comprehensive, long-term decarbonization strategies. More specifically, low-carbon R&D projects can support these goals as follows:

1. **Incremental Emission Reductions:** Low-carbon R&D projects focus on reducing emissions from existing gas infrastructure and operations. For instance, projects aimed at improving energy efficiency in gas utility operations can lead to significant reductions in carbon emissions. Enhanced maintenance protocols and advanced leak detection technologies can minimize methane emissions, which, despite being low-carbon as opposed to zero-carbon targets, represent a substantial improvement over current emission levels. By reducing methane emissions, these projects can significantly lower the overall GHG footprint, supporting California's intermediate carbon reduction milestones.
2. **Integration of Low-Carbon Fuels:** Research and development of low-carbon fuels such as RNG and synthetic methane can play a pivotal role. RNG, produced from organic waste materials, can be blended with conventional natural gas to lower the carbon intensity of the gas supply. Synthetic methane, derived from gasification of biomass, offers similar benefits. These low-carbon fuels can be integrated into the existing gas infrastructure, providing an immediate reduction in emissions while maintaining energy reliability and affordability. This step-by-step reduction in carbon intensity is aligned with California's progressive reduction targets.
3. **Economic and Social Feasibility:** Low-carbon R&D projects can help maintain economic stability and social feasibility as California undergoes the energy transition. By developing low-carbon solutions that can be implemented within the existing energy framework, utilities can attempt to avoid economic disruption that might accompany a rapid shift to zero-carbon technologies. This approach can also help maintain energy affordability and reliability, ensuring that the transition is equitable and inclusive.
4. **Preparation for Zero-Carbon Technologies:** Low-carbon projects serve as a preparatory phase for the eventual statewide shift to zero- or net-zero carbon technologies. They allow for the gradual adaptation of infrastructure, market mechanisms, and consumer behavior. For example, compatibility studies to assess and develop pipeline readiness for hydrogen (blended or 100%) transport could help ensure that when low- and zero-carbon hydrogen become more viable and cost-effective, the transition will be smoother and more efficient.
5. **Regulatory and Policy Alignment:** California's regulatory environment encourages progressive steps towards decarbonization. Low-carbon R&D projects align with state policies that mandate gradual emission reductions and support for renewable energy sources. By actively participating in these initiatives, gas utilities can demonstrate compliance with regulatory requirements while contributing to the state's broader environmental objectives. Examples of these policies and regulations include:

    a. **SB 1440:** Establishes a biomethane procurement program to reduce GHG emissions and promote renewable energy use.
    b. **(OIR) R.13-02-008:** Authorizes a state procurement plan for biomethane.
    c. **A.22-09-006:** Joint IOU hydrogen blending demonstration projects.

d. **D.22-02-025:** CPUC directs SoCalGas and PG&E to file an application by July 1, 2023, proposing at least one woody biomass pyrolysis/gasification pilot project that would include procurement of RNG from "agricultural, forest, and/or urban wood waste using methanation," as determined by each utility.

e. D.22-12-055: CPUC directs California's four large gas utilities to propose system testing on the effects of hydrogen blended into methane at concentrations ranging from 0.1% to 20%. It further establishes safety thresholds for hydrogen content in biomethane and makes modifications to existing biomethane-related reporting requirements.

f. Renewable Portfolio Standard: Requires utilities to procure a certain percentage of their electricity from renewable sources. The target is 60% renewable energy by 2030 and 100% clean energy by 2045.

g. **Low Carbon Fuel Standard (LCFS):** Aimed at reducing the carbon intensity of transportation fuels used in California by 20% by 2030. The LCFS encourages the use of cleaner fuels and the development of alternative fuel technologies.

h. **CARB 2022 Scoping Plan, Low Carbon Fuels for Buildings and Industry:** In 2030s, RNG blended in pipeline. Renewable hydrogen blended in natural gas pipeline at 7% energy (~20% by volume), ramping up between 2030 and 2040. In 2030s, dedicated hydrogen pipelines constructed to service certain industrial clusters.

6 Collaborative Partners

6.1 Public Agencies

The projects that PG&E's Gas R&D team support seek collaboration and funding from a variety of public agencies, including the DOE, the National Science Foundation (NSF), PHMSA, and the CEC.

- **US Department of Energy:** The DOE is a federal agency focused on advancing the national, economic, and energy security of the United States. Advanced Research Projects Agency-Energy (ARPA-E) funds high-impact energy technologies, fostering innovation in gas R&D. The Office of Fossil Energy and Carbon Management's National Energy Technology Lab (NETL) supports R&D for cleaner fossil fuel technologies, including methane emissions reduction and low-carbon fuels. Both ARPA-E and NETL provide essential funding opportunities for projects aimed at enhancing gas utility operations, reducing emissions, and advancing decarbonization, aligning with broader energy and environmental goals.
- **National Science Foundation:** The NSF is an independent federal agency that promotes the progress of science by funding research and education across various scientific and engineering disciplines. NSF supports innovative R&D projects through various grants and programs, which can include gas-related research. Potential funding sources for gas R&D projects include the Directorate for Engineering and the Division of Chemical, Bioengineering, Environmental, and Transport Systems. These programs fund advancements in gas utility operations, emissions reduction, and decarbonization technologies, supporting the development of sustainable and efficient energy solutions.
- **PHMSA:** PHMSA is a U.S. Department of Transportation agency that ensures the safe transportation of energy and hazardous materials. PHMSA provides funding for gas R&D projects through its Research and Development Program, which focuses on improving pipeline safety and integrity. This includes projects aimed at enhancing gas utility operations, reducing methane emissions, and developing technologies for the safe integration of low-carbon and renewable fuels. PHMSA's funding supports innovations that enhance the safety, reliability, and environmental performance of the nation's gas pipeline infrastructure.
- **The California Energy Commission:** The CEC is California's primary energy policy and planning agency, focused on promoting energy innovation and sustainability. CEC provides funding for gas R&D projects through programs like the Energy Innovation Grant Program and the Natural Gas Research and Development Program. These programs support projects aimed at improving gas utility operations, reducing methane emissions, and integrating low-carbon fuels like renewable natural gas and hydrogen. The CEC's funding initiatives align with California's aggressive climate goals, fostering advancements in energy efficiency, safety, and environmental performance within the gas sector.

6.2 Research Consortia

To optimize its efforts, Gas R&D leverages collaborative networks and research consortia such as the Pipeline Research Council International (PRCI), PRCI's Emerging Fuels Institute (EFI), NYSEARCH (a research suborganization with the Northeast Gas Association (NGA)), and GTI Energy and its two research subgroups, Operations Technology Development (OTD) and Utilization Technology Development (UTD). The Gas R&D team also participates in ad-hoc joint industry initiatives with other gas utilities or pipeline operators.

- **Pipeline Research Council International:** PRCI is a global research organization dedicated to enhancing the safety, reliability, and environmental performance of the pipeline industry. It collaborates with member companies, regulatory agencies, and other stakeholders to conduct research and develop innovative solutions for pipeline operation and maintenance. PRCI's research initiatives focus on key areas such as leak detection, pipeline integrity, and emissions reduction, supporting the industry's commitment to safe and efficient energy transportation.
- **PRCI's Emerging Fuels Institute** is a specialized division dedicated to advancing research and development of new and emerging fuels, including hydrogen, renewable natural gas, and other low-carbon alternatives. EFI focuses on the technical and operational challenges associated with integrating these fuels into existing pipeline infrastructure. By conducting cutting-edge research and developing best practices, EFI supports the transition to cleaner energy sources, enhancing the safety, reliability, and environmental performance of gas systems. EFI's work is pivotal in aligning gas R&D with the evolving landscape of sustainable energy.
- **NYSEARCH** is a leading research organization within the Northeast Gas Association that focuses on innovation and technology development for the natural gas industry. It collaborates with gas utilities, technology developers, and research institutions to address key challenges in gas operations, safety, and environmental performance. NYSEARCH's projects include advanced leak detection, pipeline integrity, and the integration of renewable gas sources. Through its R&D efforts, NYSEARCH drives advancements that enhance the efficiency, reliability, and sustainability of gas systems, supporting the industry's transition to a low-carbon future.
- **GTI Energy** is a leading research, development, and training organization focused on advancing energy technologies and solutions. It plays a significant role in gas R&D by developing innovative technologies that improve the efficiency, safety, and environmental performance of natural gas systems. GTI Energy's projects span areas such as methane emissions reduction, renewable natural gas integration, and advanced pipeline materials and methods. Through its collaborative research initiatives, GTI Energy supports the energy industry's transition to sustainable practices, fostering advancements that align with global decarbonization goals and enhance the overall reliability and sustainability of gas infrastructure.
- **Operations Technology Development** is a collaborative R&D consortium focused on advancing technologies for natural gas distribution and operations. It brings together gas utilities and industry stakeholders to identify, develop, and implement innovative solutions that enhance the safety, reliability, and efficiency of gas delivery systems. OTD's projects address critical areas such as pipeline integrity, leak detection, and emissions reduction. By fostering collaborative research and pooling resources, OTD accelerates the development of cutting-edge technologies that improve operational performance and support the industry's commitment to sustainability and regulatory compliance.
- **Utilization Technology Development** is a consortium focused on advancing the end-use applications of natural gas through collaborative R&D efforts. It involves gas utilities and industry partners working together to develop and deploy innovative technologies that enhance the efficiency, performance, and environmental benefits of natural gas appliances and systems. UTD's projects cover areas such as high-efficiency heating, water heating, and industrial processes. By driving innovation in natural gas utilization, UTD helps improve energy efficiency, reduce emissions, and support the transition to cleaner energy solutions, aligning with broader industry sustainability goals.

6.3 National Laboratories

The DOE national lab system comprises 17 research laboratories that drive innovation across various scientific fields. Key labs conducting energy transition and gas R&D include the National Renewable Energy Laboratory (NREL), which focuses on renewable energy technologies and integration; the Lawrence Berkeley National Laboratory (LBNL), which researches energy efficiency and grid modernization; and the NETL, which specializes in fossil energy and carbon management. These labs collaborate on developing advanced technologies to improve energy efficiency, reduce emissions, and support the shift to sustainable energy systems. PG&E Gas R&D collaborates regularly with scientists and researchers from several national labs, including NREL, LBNL, NETL, and Pacific Northwest National Laboratory.

6.4 Universities

PG&E Gas R&D also works closely with researchers at numerous universities, including several that qualify as MSIs. The list below represents a sampling of universities qualifying as MSIs in two subcategories—Hispanic-Serving Institution (HSI) and Asian American Native American Pacific Islander Serving Institution (AANAPISI)—that have collaborated with Gas R&D in the past. Gas R&D will continue to explore collaboration opportunities with MSIs moving forward.

University	HSI	AANAPISI
Aarhus University (Denmark)		
Colorado State University	X	
Scripp's Institution of Oceanography		X
Stanford University		X
University of California, Berkeley	X	X
University of California, Irvine	X	X
University of California, Riverside	X	X
University of California, San Diego	X	X
University of Edinburgh (Scotland, UK)		
University of Florida		
University of Texas, Arlington	X	X

7 Proposed 2025 Plan

7.1 Proposed 2025 Funding Allocations

The total adopted funding for PG&E Gas R&D was set by PG&E's 2023 GRC, which set PG&E's rates and service policies for 2023-2026.

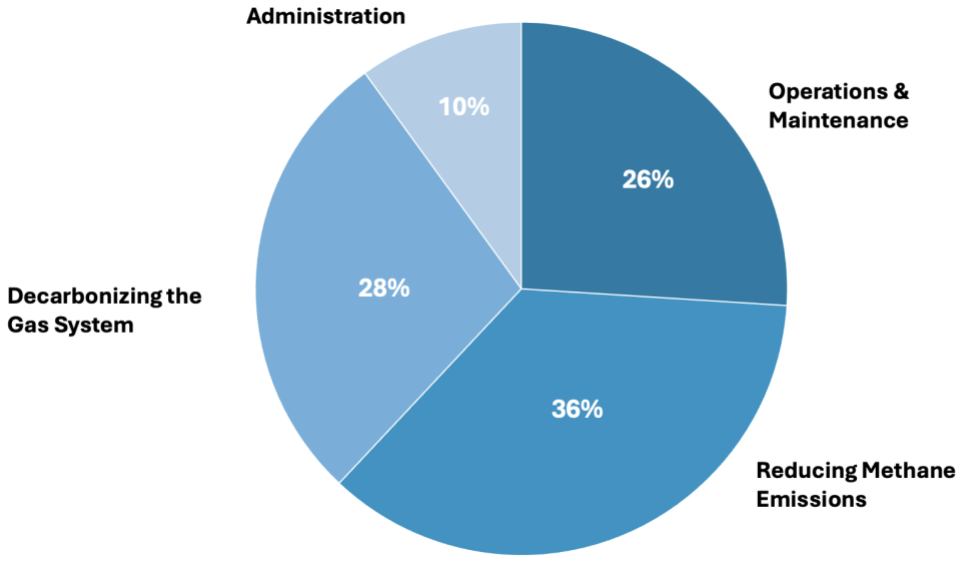


Figure 8: Proposed 2025 Gas R&D funding by percentage of total funds available.

The total imputed adopted funding for 2025 is $8,091,637. Of that total, PG&E Gas R&D will allocate no more than 10% or $809,164 to program administration. For the balance, PG&E Gas R&D will allocate approximately 26% of available funds to O&M (Section 7.2), 36% to Reducing Methane Emissions (Section 7.3), and 28% to Decarbonizing the Gas System (Section 7.4). PG&E based these funding estimates on historical spending percentages.

7.2 Operations & Maintenance

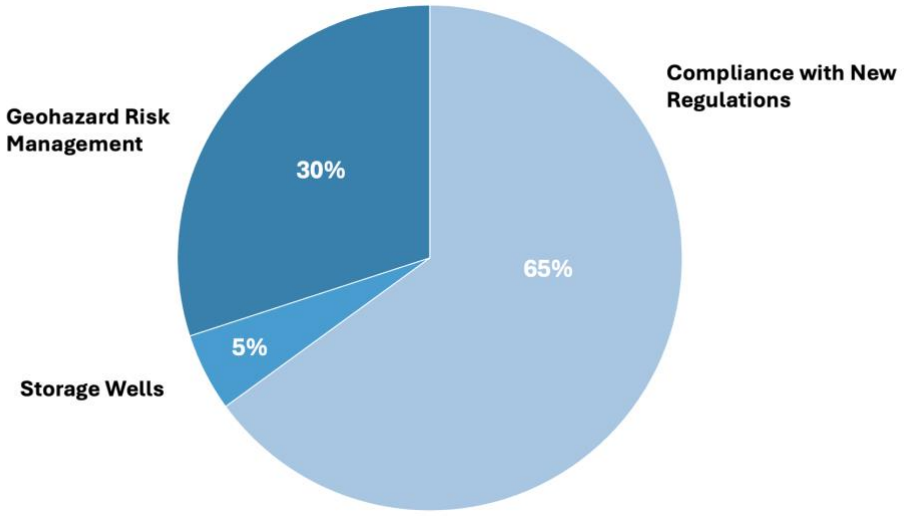


Figure 9: Estimated O&M spending by research focus in 2025.

As seen in Section 7.1, in 2025, PG&E Gas R&D anticipates spending 26% of total available funds, or $2,103,826, on projects in its O&M focus area. These projects develop or advance technologies that, if deployed widely, would maintain and/or increase the safety and reliability of PG&E's existing gas system while reducing O&M costs and improving affordability for all customers—including those from ESJ communities. PG&E based its funding estimates on historical spending percentages.

7.2.1 O&M-Related Technology Gaps

Operations and Maintenance	
Crack Assessment and Monitoring for Small Pipes	Accuracy of Well-Life Estimation
Material Properties Verification for Existing Pipe	Geohazard Risk Assessment
Toughness Assessments for Existing Pipe	Accuracy of Pipeline Locating Technologies
Crack Assessment Technologies	Meter Set Corrosion Inspections
Well Inspection and Monitoring	Distribution Saddle Leak Repairs
Corrosion Inspections	Plastic Insert Detection
Manual Customer Shutoffs	

7.2.2 O&M-Related Subcategories

Gas R&D's efforts in this area are broadly focused on three areas:

Compliance with New Regulations	Requirements for the PHMSA Mega Rule require that PG&E expand the scope of many existing inspection and monitoring processes and deploy entirely new processes across many of our assets.	
	2025 Funding (est.):	$1,367,487 (65%)

	Specific areas of focus may include, but are not limited to: • Hard spot detection and assessment • Stress corrosion crack and selective seam weld corrosion detection/characterization • Inline and/or in-ditch material grade verification and toughness measurement • Field pilot of thermal compression repair of crack-like seam defects • Pilot run of detecting/locating mechanical impacts/3rd-party damages through real-time CP current monitoring • Non-intrusive/aboveground anomaly screening Projects in these areas of focus complement PG&E's existing integrity management programs and corrosion programs by improving the efficiency of their technologies and processes and advancing their capabilities.

Storage Wells	High resolution in-line technologies are incredibly costly (up to $3 million per well for in-line methods). The current process requires that operations be shut down and tubing pulled out to complete the inspection. Gas R&D seeks to reduce the installation and real-time monitoring costs of continuous monitoring solutions, while ensuring high quality, ongoing data transmission.	
	2025 Funding (est.):	$105,191 (5%)
	Specific areas of focus may include, but are not limited to: • AI/ML data analytics of underground storage well integrity • Monitoring using fiber optic sensor systems	

Geohazard Risk Management	The industry's ability to accurately understand, predict and model changing risk levels is insufficient to enable the consistent and proactive identification of emerging issues. Through projects in this area, Gas R&D seeks to provide better ongoing visibility into the integrity of assets subject to enhanced geohazard risk; enhance understanding of how developing geohazards may impact PG&E assets, including the ability to more accurately model these impacts; and increase the ability to optimize the deployment of geohazard monitoring resources.	
	2025 Funding (est.):	$631,191 (30%)
	Specific areas of focus may include, but are not limited to: • Non-intrusive/aboveground pipeline strain assessment using manual cart and/or drone platform • Inline and aboveground measurement of transmission pipeline depth of cover • On-demand monitoring of the pipelines with fiber optic sensor systems at two fault crossing sites	

7.3 Reducing Methane Emissions

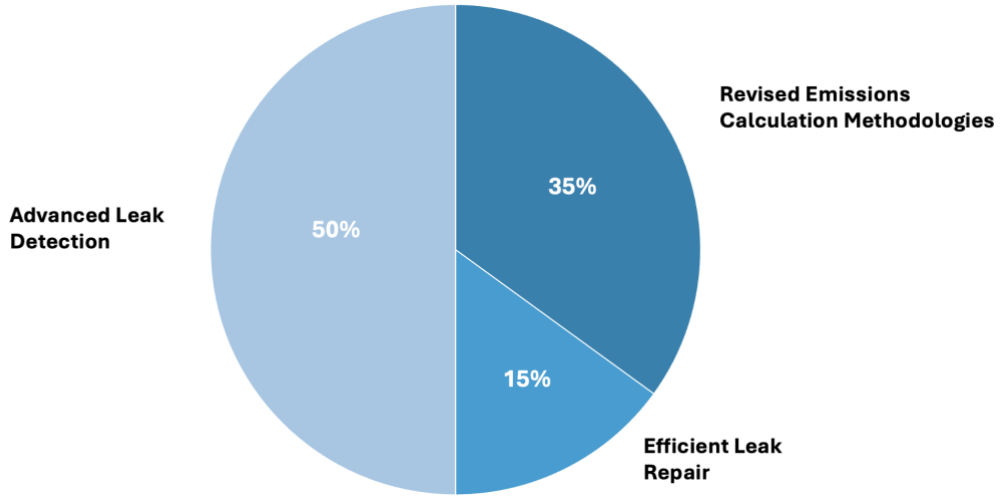


Figure 10: Estimated Reducing Methane Emissions spending by research focus in 2025.

As seen in Section 7.1, in 2025, PG&E Gas R&D anticipates spending 36% of total available funds, or $2,912,989, on projects in its Reducing Methane Emissions focus area. Projects in this area develop or advance technologies that, if deployed widely, would reduce methane emissions from PG&E's gas system. PG&E based its funding estimates on historical spending percentages.

7.3.1 Reducing Methane Emissions-Related Technology Gaps

Reducing Methane Emissions	
Revised Emission Calculation Methodologies	Enhanced Leak Detection
Reducing Pipeline Blowdown Methane Emissions	Reducing False Positive on Leak Detection Surveys
Efficient Leak Repairs	Above Ground Leak Detection and Monitoring

7.3.2 Reducing Methane Emissions-Related Subcategories

Gas R&D's efforts in this area are broadly focused on three areas:

Revised Emissions Calculation Methodologies	The figures for the Transmission Measurement and Regulation station leaks and emissions are not based on actual recorded emissions but instead on population-based emission factors. While efficient, this approach does not provide accurate emissions information. To address this challenge, the Gas R&D team supports projects that are developing more granular emission calculation methods and the ability to continuously and cost-effectively detect and quantify on-site emissions levels at frequent intervals at the component level.	
	2025 Funding (est.):	$1,019,546 (35%)
	Specific areas of focus may include, but are not limited to:	

	• Evaluate emissions from transmission M&R stations through direct measurements and piloting continuous monitoring technologies.

Efficient Leak Repair	The current meter set leak repair process is time-consuming and increases ergonomic exposure for workers completing the repairs. Technologies to shorten meter set repair times and ensure a high-quality seal without breaking down the meter set can help reduce emissions and ensure worker safety while completing repairs. Projects in this area seek to develop novel technologies that minimize repair times, reduce the need for follow-up service visits, maintain a high-quality seal that can handle pressure at 60 psi, and support subsequent parts replacements and repairs. Because visual atmospheric corrosion inspections of meter sets are costly and subjective, projects in this area also seek to develop technologies that can remotely monitor meter sets for corrosion and successfully detect corrosion, alert repair crews, and/or shut off the meter set if failure is imminent.	
	2025 Funding (est.):	$436,948 (15%)
	Specific areas of focus may include, but are not limited to: • Evaluate the use of innovative leak repair methods such as mechanical clamps, epoxy sealants, and compression-style adhesives to reduce methane emissions, decrease O&M costs, and improve safety by repairing leaks quickly and more efficiently.	

Advanced Leak Detection	The lack of cost-effective technologies to continuously monitor and quantify emissions from assets that intermittently bleed by design makes it difficult to estimate emissions. Continuous monitoring has the potential to improve emissions reporting from stations and storage facilities and maximize emissions reduction efforts by prioritizing the highest emitters for replacement.	
	2025 Funding (est.):	$1,456,495 (50%)
	Specific areas of focus may include, but are not limited to: • Refine existing, advanced leak detection methods within PG&E operations for efficiency, safety, and lower operating costs. • Evaluate the use advanced mobile leak detection systems and aerial leak detection platforms, including satellite technology, helicopter, and drone-based sensors.	

7.4 Decarbonizing the Gas System

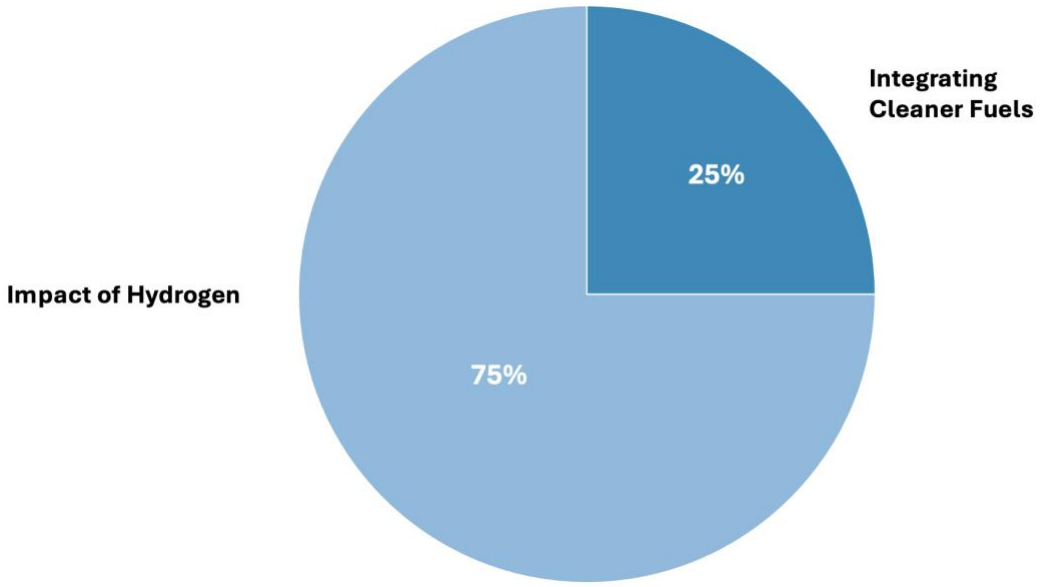


Figure 11: Estimated Decarbonizing the Gas System spending by research focus in 2025.

As seen in Section 7.1, in 2025, PG&E Gas R&D anticipates spending 28% of total available funds, or $2,265,658, on projects in its Decarbonizing the Gas System focus area. Projects in this area develop or advance technologies that, if deployed widely, would decarbonize the gas system. PG&E based its funding estimates on historical spending percentages.

7.4.1 Reducing Decarbonizing the Gas System-Related Technology Gaps

Decarbonizing the Gas System	
Costly and Unstandardized Interconnection Skids	Uncertainty of Storage Facility Performance for Hydrogen Blends
Uncertainty about Risks and Impacts from Trace RNG Chemicals	Limited RNG Capacity from Traditional Sources
Hydrogen Embrittlement	Woody Biomass as an Energy Source
Safety Risks of Hydrogen Blend Leaks	Gas Appliance Combustion Emissions
Metering Accuracy with Hydrogen Mixtures	Lack of Operational Data for Hydrogen Effects on Gas System
Optimal Decarbonization Pathway	Need to Develop Cost-Effective and Safe Deblending Technologies
Compatibility of Customer Applications with Mixed Gas	

7.4.2 Reducing Decarbonizing the Gas System-Related Subcategories

Gas R&D's efforts in this area are broadly focused on two areas:

Integrating Cleaner Fuels	In the transition to a net zero energy system by 2040, PG&E seeks to integrate clean fuels such as traditional RNG, non-traditional RNG, renewable hydrogen, and synthetic methane. Gas R&D seeks to support R&D and pilot projects exploring cost-effective interconnection, feedstock limitations, compatibility with existing infrastructure and processes, and novel fuel production processes.	
	2025 Funding (est.):	$556,415 (25%)
	Specific areas of focus may include, but are not limited to: • RNG trace constituents • Reduction of RNG interconnection costs • Woody biomass to RNG • Power-to-methane	

Impact of Hydrogen	As hydrogen and other green alternatives become more widely accepted, the importance of studying how this emerging fuel will be utilized and how existing infrastructure and customer end uses must adapt becomes critical. Projects in this area will seek to understand how hydrogen will impact the existing gas system, customer end uses, and appliances.	
	2025 Funding (est.):	$1,699,244 (75%)
	Specific areas of focus may include, but are not limited to: • Hydrogen Blending system assessment (HyBlend, targeted blending in existing gas network) • Hydrogen to Infinity (H2 Infinity) R&D Support • Hydrogen Leak Detection and management • Hydrogen Underground Storage • Hydrogen impact and changes to Integrity Management Programs • Safe operation and maintenance of hydrogen blended systems • Hydrogen gas quality, measurement, regulation, and compression • Hydrogen end-use, including NOx emissions	

7.5 Management & Administration

Per D.23-11-069, PG&E should cap its administrative costs for Gas R&D at 10%. For 2025, using the $8,091,637 in funding authorized by the CPUC, administrative costs would be $809,164. PG&E will allocate administrative costs to the following program administrative cost budget items:

1. Investment Plan Development
2. Project Planning and Initiation
3. Project Oversight and Governance
4. Stakeholder Communication, Engagement, and Outreach
5. Regulatory Support Compliance
6. Internal Management Coordination

7. Program and Process Coordination and Improvement
8. Administrative Activities
9. Supervision and Personnel
10. Training and Development

7.6 Funds Encumbered, Spent, and Unspent

See Appendix B.

7.7 Co-Funding

In 2023, PG&E Gas R&D leveraged an average of $21.50 for every dollar of Gas R&D funds invested in projects. Total co-funding associated with this 21.5:1 ratio equaled $141,748,137. In 2025, PG&E Gas R&D anticipates achieving a similar co-funding ratio.

	2023 CY Spend	PG&E Cumulative Spend	Co-Funding	Total Value of Projects	Leverage Ratio
O&M	$173,955	$3,371,499	$45,625,238	$48,996,737	14.5
Reducing CH4 Emissions	$789,405	$1,178,336	$5,848,730	$7,027,066	6.0
Decarbonizing the Gas System	$196,315	$2,363,405	$90,274,169	$92,637,574	39.2
TOTAL	$1,159,675	$6,913,240	$141,748,137	$148,661,377	21.5

Figure 12: PG&E co-funding in 2023—the most recent year for which PG&E has complete records—totaled $141,748,137, achieving a leverage ratio of 21.5:1.[24]

7.8 Research Consortia

In 2025, PG&E plans on renewing its membership in six research consortia.

TABLE 3: PLANNED PG&E CONSORTIA 2025 MEMBERSHIPS

Consortium	2025 Dues (est.)
Colorado State University Methane Emissions Technology Center	$10,000
NYSEARCH/NGA	$72,250
OTD	$750,000
PRCI (general membership)	$177,450
PRCI (Emerging Fuels Institute membership)	$100,000
UTD	$350,000
TOTAL	$1,459,700

7.9 Audit

Per Commission decision D.23-11-069, in 2025, PG&E's Gas R&D program should allocate approximately $296,400 on an evaluation or audit.[25]

[24] CY = Calendar Year
[25] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M520/K896/520896345.pdf

7.10 Request for 2023 and 2024 Cost Recovery

PG&E requests that the approval of this Annual Plan that will also allow PG&E to recover $7.63 million in total for 2023-2024 revenue requirements, all of which is expense revenue requirement. The table below shows the total actual expenses for calendar year 2023 and January 1, 2024, through May 31, 2024, as well as forecasted expenses for the remainder of 2024. The expenses support Gas R&D's on-ongoing research and administrative costs, as articulated in the 2023 Annual Report.

TABLE 4: BREAKDOWN FOR 2023 AND 2024 COST RECOVERY (MAT GZA).

Line No.	Expense Category	2023 (Recorded)	2024 (Recorded through 05-31-2024)	2024 (Forecast June-Dec)	Total
1	Administrative	$949,747	$643,642	$18,668	$1,612,057
2	Project costs	$2,583,088	$1,587,634	$1,848,083	$6,018,805
	Total	$3,532,836	$2,231,276	$1,866,750	$7,630,862

Appendices

Appendix A

Gas R&D 2023 Public Workshop Q&A Document

Question	Response
Will we have slides after the meeting?	Yes. Slides from the meeting as well as a recording of it will be posted at www.pge.com/innovation.
Will you be testing hydrogen gas introduction into the gas supply pipeline?	Yes. Please refer to the Hydrogen to Infinity project.[1]
Can you talk a little bit about how the technology gaps were developed?	We worked closely with multiple lines of business within PG&E, including gas operation's integrity management groups for transmission, storage, facilities, and distribution, as well as other groups, such as customer field services. After producing an initial problem statement list, we narrowed it in collaboration with the other lines of business. The result was the list of 32 gas-related priorities that we included in the PG&E R&D Strategy Report.[2]
Can you explain further what was meant by "95% greenhouse gas-free energy in 2022?"	Using the California Energy Commission's methodology, PG&E delivered electricity to customers that was 95% greenhouse-gas emissions free, with nearly 40% from state-qualified renewable resources, including solar, wind, small hydroelectric, and various forms of biopower.[3]
Can you send out the slides after the workshop?	Yes. Slides from the meeting as well as a recording of it will be posted at www.pge.com/innovation.
I found this concept intriguing. Has PG&E looked into the technology discussed in the following article? https://www.science.org/content/article/taking-	We have a project with NYSEARCH and Stanford that has a similar concept, where we're evaluating power-to-methane through electromethanogensis via microbial electrolysis.

[1] https://www.pge.com/en/about/pge-systems/hydrogen-to-infinity.html
[2] https://www.pge.com/assets/pge/docs/about/pge-systems/PGE-RD-Strategy-Report.pdf
[3] https://www.pge.com/en/about/corporate-responsibility-and-sustainability/taking-responsibility/clean-energy-solutions.html.

cue-plants-new-chemical-approach-converts-carbon-dioxide-valuable-fuel	
When you screen for R&D projects, how do you include equity impacts? Are they specifically identified in your process?	We have a lot of room to mature in that area. Equity is a huge area of emphasis among all investor-owned utilities (IOUs) within California. In 2023, we tracked how much R&D funding our program spent on projects located in environmental and social justice (ESJ) communities. In 2024 and beyond, we want to expand the metrics we use to measure success in this area, particularly as they relate to the 32 gaps we identified above. Some ideas we have include 1) engaging community-based organizations within our service territory, 2) exploring through outreach how R&D projects can benefit ESJ populations, and 3) from that input developing new metrics for tracking our progress in this area. We are actively soliciting ideas in this area and welcome your input. Please send your ideas to innovation@pge.com.
How do you engage customers as a stakeholder group?	We look at customers in the broadest sense—everyone from technology developers and funding agencies to our residential and business customers. In our research, we keep potential end users and downstream applications top of mind when selecting projects to support. More and more often, we are incorporating surveys into our process up front. We ask questions such as: Does this research mean anything to you? What kind of outcomes would you like to see from this research? What benefits do you hope to realize if we are successful? Our hope is to tailor our research, as appropriate, to meet our customers' needs.
When will the gas R&D funding be renewed and is there a chance to increase the total amount?	PG&E goes through its general rate case (GRC) regulatory process as determined by the California Public Utilities Commission (CPUC). Currently, we are in the 2023-2026 GRC period, which was approved in late 2023. This GRC increased funding available for Gas R&D projects in 2025

	to $8.092M. As a result, we see a tremendous opportunity to broaden the scope of our research, perhaps by funding larger pilot projects.
You spoke of what was completed in 2023, and the funding for 2025. Will you be speaking to what you are doing in 2024?	In 2024, we are adapting our processes to align fully with our CPUC-approved 2023-2026 GRC, which occurred in November 2023. This year, we are presenting our 2023 program results and 2025 planned research and spending. This year's plan will also include ongoing projects in 2024. In 2025, we will present the 2024 program results and our planned 2026 research and spending. Again, this is a time of transition for our program as we adapt to a new process. In addition to funding R&D projects, we plan to 1) expand our efforts to improve the benefits of our projects to ESJ communities and 2) organize our administrative processes to track all administrative costs per CPUC requirements.
Can you please provide a link to the R&D strategy document?	The PG&E R&D Strategy Report is posted here: Website: www.pge.com/innovation Direct link: https://www.pge.com/assets/pge/docs/about/pge-systems/PGE-RD-Strategy-Report.pdf
Are you working with any green waste anaerobic digester projects within the State?	Yes. Our business development and implementation teams are actively interconnecting RNG onto the gas system, a process that includes anaerobic digestors.
How are you aggregating burden on communities of transportation fueling facilities? For example, other hydrogen fueling stations in PG&E territory that are already in communities (e.g., Chevron stations subsidized by CEC and CNG stations).	Transportation is out of scope for the Gas R&D Team.

Your strategy document is very comprehensive. How far out do you typically look?	The R&D Strategy Report articulates problem statements that are aligned with six key business areas that are core to PG&E's operations and encompass challenges that are most urgent and critical to achieving our goals. These needs will undoubtedly evolve over time as dynamics shift; thus, this will be a living document that we intend to update periodically to communicate evolving priorities. We recognize that this report likely does not capture the full range of problem statements that we will need to address to achieve our True North outcomes. We welcome your feedback on topics that may be missing or require re-framing, as we seek to continually refine our strategy over time. Please submit your suggestions and ideas to innovation@pge.com.
How are you connecting these activities to real needs in programs such as SB 1440 procurement? For example, cost reduction across the board, use of non-combustion (fuel cells and linear generators) on site to power RNG production, and methane pyrolysis to convert RNG to hydrogen for local applications while utilizing carbon black in industrial/ agricultural applications.	SB 1440 establishes the goal of incorporating RNG within PG&E's core gas throughput. Gas R&D projects evaluate processes and technologies that feed into the strategy and programs for deployment. We're evaluating the idea of converting RNG to power or hydrogen. More work is needed around the coordination of gas and electric to bring these technologies towards deployment.

OPERATIONS AND MAINTENANCE	
[Are you researching or developing any] cybersecurity [tools] for [PG&E'S gas] facilities?	Cybersecurity is very important to PG&E, but to date, Gas R&D has not funded any technology development projects specifically focused on it. We have, however, funded projects—such as those researching and developing continuous monitoring technologies—that incorporate cybersecurity in the scope of their activities. See PG&E's 2024 Gas Safety Plan for a description of PG&E's Security Program, which includes both cyber and physical security.[4]
[Is PG&E considering Distributed Energy Resource] deployment as an alternative to gas infrastructure upgrades?	PG&E is exploring the deployment of Distributed Energy Resources (DER) that complement existing gas infrastructure or eliminate the need for costly infrastructure upgrades. One theme discussed in the PG&E 2023 R&D Strategy Report on page 29—expanding load management capabilities across all levels of the gas system—speaks to the importance of DERs.[5] Please refer to that report for a more detailed response to your question.
Do you foresee an increase in power demand due to growth in artificial intelligence (AI) data centers on your system?	Yes. The U.S. Department of Energy's Better Building Program provides information about energy solutions for data centers. https://betterbuildingssolutioncenter.energy.gov/sectors/data-centers

[4] https://www.pge.com/assets/pge/docs/about/pge-systems/PDF_GasPipelineSafetyOIR_Report_PGE_20240315.pdf
[5] https://www.pge.com/assets/pge/docs/about/pge-systems/PGE-RD-Strategy-Report.pdf

I see you are getting ideas from other U.S. companies. Are you also consulting with utilities in other countries that have had far more experience with gas transmission as well? Sweden for example?	Yes. We are committed to open, collaborative research and follow technology developments in our areas of interest quite closely, both within the U.S. and abroad, such as in Europe and Asia. We collaborate with international operators that participate in different consortia, such as the Pipeline Research Council International and Emerging Fuels Institute, in which companies from both Canada and France actively participate. PG&E is also a member of the California Hydrogen Business Council. Through this organization, we can connect with peers nationally and internationally. For example, recently we held meetings with delegations from South Africa and the Netherlands. Additionally, PG&E's 2023 Innovation Summit created connection opportunities with operators and technology companies in Australia and the United Kingdom. Other countries that we have collaborated with include Canada, France, Italy, Germany, Australia, Korea, Japan, Chile, and South Africa.
What do you mean by benefits?	Using guidance from the CPUC's Energy Division, Gas R&D tracks seven different potential benefits associated with the projects it supports: 1. Reliability 2. Safety 3. Equity 4. Operational Efficiency 5. Improved Affordability 6. Reduced GHG Emissions 7. Improved Air Quality
Can you explain how you do technology transfer from [Gas] R&D to different business units [within PG&E]?	As mentioned earlier, we included a variety of internal stakeholders in the identification of the 32 gas-related challenges that PG&E is seeking to address. We continue to be in regular communication with these internal

	stakeholders across gas operations. They are involved not only in identifying the types of projects we plan to support, but also in selecting and executing specific projects and, ultimately, in deploying developed technologies that meet our requirements for safety, reliability, and cost-effectiveness.
Could you describe the research you're doing on storage well integrity? Who are your partners and co-funders?	In collaboration with the California Energy Commission (CEC) and Paulsson, Inc., PG&E supported a project titled "An All-Optical Multi-Sensor Well Monitoring System to Support Gas Operations" (CEC PIR-19-001).[6] In this project, the team developed and applied cost-effective, all-optical Underground Gas Storage (UGS) reservoir surveying and monitoring technologies. Specifically, the project team sought to determine the capabilities that fiber optic sensor technology may have in monitoring a natural gas wellbore and reservoir. In Phase 3 (2021-2023), the team completed data processing, data interpretation, results reporting, and all remaining planned project field monitoring work during various operation events. With the successful completion of this work, PG&E will be able to continue real-time or on-demand well operation and integrity monitoring for many years ahead. This is expected to improve safety and operational efficiency while lowering costs. Specifically, this will allow PG&E to replace or complement some of the costly in-line inspection practices with a high risk of insertion mechanical damage and service interruption.[7]
What is the forecasted customer rate impact over the next five to 10 years as it related to these projects?	At this stage, the maturity of the projects does not allow us to quantify the specific impact on customer rates.
How does PG&E solicit federal co-funding [from agencies such as the Pipeline and Hazardous	Gas R&D does not typically serve as the prime applicant on any proposals to federal or state agencies. Instead, we support technology providers or

[6] https://www.energy.ca.gov/filebrowser/download/2203

[7] https://www.paulsson.com/_files/ugd/f886aa_4c7db412b8de4076aa73ed2cc4825ce1.pdf

Materials Safety Administration and the U.S. Department of Energy]? Does PG&E submit its own proposals, [submit] in partnership with others, or both?	academic institutions by providing letters of support, testing and deployment locations, and technical support. We also support many different R&D efforts through our membership in industry research consortia, such as Pipeline Research Council International, GTI Energy, and NYSEARCH, all of which may serve as the lead applicant to a state or federal funding opportunity. See page 11 of the PG&E Gas Research and Development 2023 Annual Report for more information, as well as pages 43-124.[8]
REDUCING METHANE EMISSIONS	
How do you verify PG&E has reached the 20% methane emissions reduction in 2023, two years ahead of time?	In response to Senate Bill 1371, PG&E takes part in the CPUC's Natural Gas Leak Abatement Program.[9] Through that program, we report our systemwide emissions annually, as measured against a 2015 baseline.
Besides reducing leaks what else will PG&E do to further decrease methane emissions and stay competitive at the same time (i.e., not excessively burdening ratepayers)?	PG&E's Gas Operations and Engineering teams take a comprehensive approach to reducing emissions from the natural gas system, including:[10] • Enhancing the leak survey program that now assesses more than 42,000 miles of natural gas distribution pipeline every three years versus the previous every-five-years rotation. • Applying enhanced leak detection technologies and utilizing an accelerated repair schedule for the largest emissions findings through PG&E's Super Emitter Program. • Modifying standard natural gas release or "venting" practices used to prepare transmission pipelines for maintenance, repair, or replacement projects. • Replacing more than 100 pneumatic controllers at compressor stations and natural gas storage facilities.

[8] https://www.pge.com/innovation

[9] https://www.cpuc.ca.gov/about-cpuc/divisions/safety-policy-division/risk-assessment-and-safety-analytics/natural-gas-leak-abatement

[10] https://www.pgecurrents.com/articles/3704-pg-e-reduces-emissions-gas-pipelines-20

	• Introducing quarterly leak surveys at compressor stations and natural gas storage facilities.
In the "Efficient Leak Repair" category, how are you tracking and quantifying leaks?	When we speak about efficient leak repairs, we are usually referring to the repair of gas leaks that occur at the meter set assembly. We quantify those leaks using the bubble classification method.[11] This involves applying soapy water to the meter and its connections. If there's a leak, bubbles will form. The size and rate at which bubbles appear help determine the leak's severity. Smaller, slower-forming bubbles indicate a smaller leak, and larger, faster-forming bubbles indicate a more significant leak. For more information, see page 134 of PG&E's Gas Safety Plan.[12]
Can you elaborate on how PG&E was able to achieve its emissions reduction [goal] two years early and what methods were instrumental, as well as how those methods might develop or influence PG&E's progress going forwards?	In the workshop, I addressed one of the methods we used to achieve our emissions reduction goal two years early, PG&E's Super Emitter Program. In that program, we seek to maximize our emissions reductions by detecting and repairing the largest distribution system leaks in our service territory first. Our current threshold is 7 standard cubic feet per hour. Each year, we reduce that threshold, with the goal of repairing more leaks and maximizing abatement. We have also implemented a procedure for capturing and repurposing gas during "blow downs" of a section of our gas system rather than releasing it to the atmosphere. Critically, we have also revised our emissions calculation methodology. Until recently, we used a rough, population-based emissions factor to quantify meter set leaks. Using the bubble leak classification method mentioned earlier, we were able to target the higher-emitting leaks for repair first, which drives down emissions because the majority of emissions result from a small subset of very large leaks.

[11] https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/safety-policy-division/documents/11---meter-set-emissions_jan2019-pge.pdf
[12] https://www.pge.com/assets/pge/docs/about/pge-systems/PDF_GasPipelineSafetyOIR_Report_PGE_20240315.pdf

You mention [research consortia]. Can you please speak to the specific members of, or type of members, for each of the following consortia: NYSEARCH, OTD, PRCI, and METECH?	NYSEARCH members represent primarily gas distribution companies from around North America. There are also members who are either straight transmission companies or who operate transmission as well as distribution pipelines. In fact, a significant program within the NYSEARCH portfolio, focuses on developing innovative technologies for transmission pipelines owned by Local Distribution Companies.[13] GTI Energy—a technology development organization focused on low-cost, low-carbon energy systems—leads 10 energy-related collaboratives, including Operations Technology Development (OTD), which seeks to improve the safety, reliability, and operational efficiency of gas systems through innovative R&D projects.[14] OTD is a not-for-profit corporation with 29 natural gas distribution members serving over 70 million natural gas consumers in the United States, Canada, and France and supplying 60% of the households currently using natural gas in those countries. Pipeline Research Council International (PRCI) is a community of the world's leading pipeline companies, and the vendors, service providers, equipment manufacturers, and other organizations supporting the industry.[15] The Methane Emissions Technology Evaluation Center (METEC) is a unique and renowned test and research facility for emissions leak detection and quantification (LDAQ) technology development, field demonstration, hands-on LDAQ equipment training, and protocol and best practices development. It is operated by the Energy Institute at Colorado State

[13] https://www.nysearch.org/about.php#membership
[14] https://www.otd.org/
[15] https://www.prci.org/Membership/MembershipDirectory.aspx

	University. It is staffed by researchers, scientists, professors, and graduate students.[16]
What are your major methane leak causes?	Leaks occur due to a variety of reasons, including but not limited to, corrosion failure, natural force, excavation damage, equipment failure, operator error, and pipe, weld, or joint failure. Based on the Reporting Year 2023 Gas Distribution, Gas Gathering, Gas Transmission, Hazardous Liquids, Liquefied Natural Gas, and Underground Natural Gas Storage Annual Report by the Pipeline and Hazardous Materials Safety Administration, most of the leaks on the distribution main are due to corrosion failure and the majority of the leaks on distribution services are due to corrosion failure and incorrect operations.[17]
How do you depressurize the line [in order to] repair any gas leak with the thread connection? Do you purge gas to the atmosphere or apply other technologies?	When repairing meter set leaks, we purge gas to the atmosphere. When performing "blow downs," we save the gas through cross compression and repurpose it for something else.
So those emissions reductions are largely based on dairies injecting into the system for [the Low Carbon Fuel Standard]? How is potential methane leakage at the dairies themselves being tracked? [How do you track] other possible emissions increases, such as [those resulting from] changing manure handling practices?	Emission reductions are categorized in four scopes: • Scope 1: Direct emissions from PG&E's operations. • Scope 2: Indirect emissions from facility electricity use and electric line losses. • Scope 3: Emissions resulting from value chain activities not owned or controlled by PG&E that can be indirectly impacted by PG&E actions.

[16] https://metec.colostate.edu/metec-team/

[17] https://www.phmsa.dot.gov/data-and-statistics/pipeline/gas-distribution-gas-gathering-gas-transmission-hazardous-liquids

	• Scope 4: An emerging term for categorizing emission reductions enabled by a company. PG&E can make a significant contribution by enabling these emission reductions in our service area. PG&E's R&D methane emissions reduction pillar focuses on reducing Scope 1 emissions. PG&E does not track emissions reductions or leakage from dairies. PG&E supports emissions reduction for dairies (Scope 3) via interconnections to capture RNG that would otherwise be emitted to the atmosphere.
I am very interested in the soap bubble rate!	Please see page 134 of PG&E's Gas Safety Plan.[18]
How do you differentiate between your budget allocations for those R&D projects [related] to SB 1371 (NGLA program) and the Best Practices specified therein, and your overall company efforts to reduce methane emissions? How much of your planned $2.9 million 2025 methane emissions [reduction] budget is specifically devoted to the NGLA projects?	PG&E's goal to reduce emissions by 45% by 2030 is very similar to Senate Bill (SB) 1371's requirement to reduce emissions by 40% by 2030. Thus, 100% of our projects—and their respective budgets—in this focus area are geared toward both the PG&E and SB 1371 goals.
Can you speak to the sectors that are represented by the membership in each consortium?	GTI Energy is a technology development organization focused on developing, scaling, and deploying energy transition solutions that improve lives, economies, and the environment. It leverages the expertise of a team of scientists, engineers, and partners to deliver impactful innovations needed for low-carbon, low-cost energy systems worldwide.[19] GTI Energy leads 10 energy-related collaboratives, including Operations Technology Development (OTD) and Utilization technology Development (UTD).

[18] https://www.pge.com/assets/pge/docs/about/pge-systems/PDF_GasPipelineSafetyOIR_Report_PGE_20240315.pdf
[19] https://www.gti.energy/working-with-gti-energy/collaborations-partnerships/

	OTD seeks to improve the safety, reliability, and operational efficiency of gas systems through innovative R&D projects.[20] OTD is a not-for-profit corporation with 29 natural gas distribution members serving over 70 million natural gas consumers in the United States, Canada, and France and supplying 60% of the households currently using natural gas in those countries. UTD seeks to maximize the environmental performance, affordability, efficiency, and safety of gas and renewable energy systems and processes through innovative R&D projects. UTD's utility members represent 37+ million natural gas customers across the country. Each member allocates its individual resources to specific UTD research efforts that directly benefit their own customers, but all members share the results of all UTD efforts.[21] The Methane Emissions Technology Evaluation Center (METEC) is a unique and renowned test and research facility for emissions leak detection and quantification (LDAQ) technology development, field demonstration, hands-on LDAQ equipment training, and protocol and best practices development. It is operated by the Energy Institute at Colorado State University. It is staffed by researchers, scientists, professors, and graduate students.[22] NYSEARCH members represent primarily gas distribution companies from around North America. There are also members who are either straight transmission companies or who operate transmission as well as distribution pipelines. In fact, a significant program within the NYSEARCH

[20] https://www.otd.org/
[21] https://www.utd-co.org/members/
[22] https://metec.colostate.edu/metec-team/

	portfolio, focuses on developing innovative technologies for transmission pipelines owned by Local Distribution Companies.[23] Pipeline Research Council International (PRCI) is a community of the world's leading pipeline companies, and the vendors, service providers, equipment manufacturers, and other organizations supporting the industry.[24] Established by PRCI, the Emerging Fuels Institute provides PRCI members the opportunity to execute the research needed to ensure the safe transportation and storage of the next generation of energy, such as hydrogen, RNG, and other potential gas and liquid fuel sources that will help meet the world's energy needs while reducing the impact to the environment.[25]
DECARBONIZING THE GAS SYSTEM	
Why won't PG&E consider SB 1440 (biomethane procurement) projects in Tier 3, at least initially, to accelerate biomethane procurement?	PG&E considers all RNG projects, however an RNG project that would require a Tier 3 Advice Letter would need to be able to provide an abundance of evidence to pass significant regulatory oversight and receive CPUC approval. In D22-02-025, CPUC requires PG&E to file a Tier 3 Advice Letter for approval of projects with a social cost of methane greater than $26/MMBtu.[26] In addition, affordability is a key factor and concern for PG&E in its RNG procurement efforts, and it is not clear that procurement above the social cost of methane should be pursued on behalf of customers at this point in time.

[23] https://www.nysearch.org/about.php#membership
[24] https://www.prci.org/Membership/MembershipDirectory.aspx
[25] https://www.prci.org/218003.aspx
[26] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M454/K335/454335009.PDF, p.9.

Is the biomethane you are procuring generated and injected in state or do your purchases include "book and claim" (undelivered) biomethane?	PG&E has one "book and claim" biomethane RNG contract to serve PG&E's CNG transportation customers. However, Senate Bill (SB) 1440 requires that biomethane procured through the SB 1440 program provides environmental benefits to California. Therefore, out-of-state and "book and claim" RNG does not qualify for the SB 1440 program. Regarding delivery onto the system, we currently have dairy feedstock. We are working with several other feedstock types for future interconnections, such as but not limited to food waste, wastewater treatment plants, landfills, and agricultural waste.
Is PG&E examining fuel-flexible generating technologies (e.g., linear generators) to more readily transition from existing fuels to cleaner fuels like biomethane and hydrogen?	Yes, we have several projects looking at fuel-flexible generating technologies. See PG&E Gas Research and Development 2023 Annual Report for more information.[27]
When Lodi Gas Storage was permitted it was revealed in the CEQA documents that some PG&E pipelines were permitted under the War Powers Act. [Some] local residents [gave] PG&E notice of Reverse Condemnation and did not allow agricultural activities on their land due to presence of gas pipelines. Gas pipelines in that area go through canals and failure could lead to flooding islands in the delta. How are you addressing safety and disadvantaged communities with regard to the hydrogen pilot [project] in the Lodi area?	Hydrogen to Infinity is a large-scale and long-term field demonstration, with a new and standalone high-pressure gas transmission system within PG&E's service territory in the City of Lodi.[28] The transmission equipment and pipe (both new and vintage) that we will utilize will be representative of those found in our existing natural gas system. The project will consider the impacts to disadvantaged communities by: • Learning how to encourage the use of hydrogen as a decarbonization pathway, which in turn may reduce greenhouse gas emissions that may disproportionately affect disadvantaged communities.

[27] https://www.pge.com/assets/pge/docs/about/pge-systems/Gas-RD-Annual-Report.pdf.coredownload.pdf
[28] https://www.pge.com/en/about/pge-systems/hydrogen-to-infinity.html

	• Providing options for skilled workers in disadvantaged communities to receive training and education in hydrogen blending pipeline operations, such as through PG&E's Power Pathway program. Opportunities to be considered as part of the new workforce needed to operate and maintain the Project facilities will be given. • Using the project as a model for community-based energy solutions, inspiring community members to explore hydrogen and other renewable energy options to meet their needs. The project's test loop is a standalone and custom-built facility, separate from PG&E's existing natural gas system. This approach helps ensure the safe testing of live hydrogen blending in a controlled large-scale environment. The appropriate design and construction standards and operating the test loop within designed parameters will minimize the risk of hydrogen leakage. The project team will provide fixed, continuous monitoring of the entire facility to detect any leaks that may occur. The onsite control center facility will monitor and control the Full-Scale Testing Facility.
What ongoing projects are exploring reducing RNG production costs and market prices?	PG&E has multiple RNG projects that were awarded funding to help with interconnection costs through CPUC Decisions 17-12-004 and 15-06-029. PG&E filed an application per CPUC Decision 22-02-025 for a Woody Biomass to RNG pilot project.[29] This pilot project will attempt to demonstrate a gasification and methanation technology, with the hopes that a successful demonstration will allow for financing of a commercial-scale facility with reduced offtake cost. Moreso than ongoing projects and pilots, PG&E will work with the CPUC, other California Gas IOUs and the California RNG community to discuss

[29] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M454/K335/454335009.PDF

	design changes to the Renewable Gas Standard that could improve the program for California gas IOUs and sellers of RNG when the CPUC reexamines the Renewable Gas Standard in 2025.
What is PGE doing with e-NG? This technology using renewable energy to create hydrogen which is then converted to methane gas. It's therefore usable in existing infrastructure.	There is an opportunity to capture and convert approximately 40% of the carbon dioxide in biogas into e-NG, increasing the RNG throughput and avoiding carbon dioxide emissions. A few years ago, we evaluated a chemical electrolysis process developed by Opus 12 (now called Twelve) to create e-NG. We have a longstanding project with NYSEARCH and Stanford that is evaluating power-to-methane through electromethanogensis via integrated microbial electrolysis.
What does PG&E think is the biggest remaining technical or operational challenge associated with full implementation of RNG?	The ability to procure sufficient RNG that meets all state requirements and meets customer demand. Depending on where the project is located, capacity could be a challenge for full implementation of RNG.
What price would you need to pay per kg for green hydrogen to decarbonize natural gas?	These are two different topics. Pricing is determined by the market; decarbonizing the gas system is tied to the amount of hydrogen injected into the system. Regarding market pricing, the current cost of hydrogen from renewable energy is about $5/kg. The U.S. Department of Energy's Hydrogen Earthshot, launched in 2021, seeks to reduce the cost of clean hydrogen to $1/kg in one decade.[30]
Has PG&E looked at the energy and resource requirements to produce hydrogen and RNG to supply the current energy requirements and future growth of PG&E?	PG&E currently transports gas and electricity. We do not produce hydrogen or RNG.

[30] https://www.energy.gov/eere/fuelcells/hydrogen-shot

Do you use/produce clean renewable hydrogen for your projects?	PG&E has not yet deployed any hydrogen production projects. In the Hydrogen to Infinity project in Lodi California, our collaborator, Northern California Power Agency (NCPA) plans to produce and provide a portion of its hydrogen to our test facility. Based on our discussions, NCPA is exploring numerous options for how to power the hydrogen production process, including the use of carbon-free resources.
Can PG&E spend R&D funds on technology transfer to implement solutions that lower [the] cost of RNG or hydrogen, such as standardized skid design?	Yes. We have projects with NYSEARCH to evaluate how to standardize RNG and hydrogen interconnection skids across its membership in North America, with the end goal of reducing fabrication costs.
My issue re flooding delta islands relates to gas pipelines that go through berms in the delta. Those are a conduit for water from the delta to the islands that are subject to subsidence [and have] lower ground level than [the] surrounding delta. So, testing H2 in pipes that go through berms might not be advisable.	Thank you for that feedback. We have shared it with the Hydrogen to Infinity team, which includes our integrity management staff who are evaluating potential risks to the project.
How does PG&E determine locations that are suitable for electrification in their effort to decarbonize?	At PG&E, we have teams that look at upcoming projects that may require updated or new gas infrastructure. One of the criteria they use to evaluate a potential project is whether it makes sense to transition to an alternative fuel or to electrify instead. They look at other factors, such as emissions, cost, and customer needs.
What are [the] challenges related to H2?	There are several potential challenges. Two of the most prominent are preventing leaks and embrittlement. PG&E faces challenges in preventing hydrogen leaks due to the small molecule size of hydrogen, which may be able to more quickly escape through existing infrastructure compared to

	natural gas. Additionally, hydrogen can cause embrittlement in metallic materials, which can lead to reduced pipeline integrity. DOE's National Renewable Energy Laboratory is leading a multi-lab, multi-industry R&D effort to address and overcome these challenges.[31] PG&E's Hydrogen to Infinity demonstration project seeks to close operational data gaps, including evaluation of leak detection and management as well as impacts to the material integrity of new and vintage assets over time.
Question for clarity: I thought the H2 application was for a new system to test H2 blend in a transmission system?	That is correct. Hydrogen to Infinity is a large-scale and long-term field demonstration that encompasses a new and standalone high-pressure gas transmission system within PG&E's service territory in the City of Lodi. The transmission equipment and pipe (both new and vintage) that we will utilize will be representative of those found in our existing natural gas system. Other utilities, including Southwest Gas and SoCalGas, are exploring the distribution system. PG&E and these other utilities regularly share information about their respective projects.
What are your investments regarding H2?	Much of the research into hydrogen that we support is conducted through industry research consortia. Typically, our PRCI projects focus on the transmission side while OTD and NYSEARCH projects focus on distribution. Projects led by UTD tend to explore customer applications, including fuel-flexible end uses. A lot of our research is also aimed at evaluating safety, system integrity, and how the introduction of hydrogen or hydrogen blends impacts them. Our Hydrogen to Infinity demonstration project is an important investment in providing the nation with a comprehensive, real-life test facility to close operational data gaps for a high-pressure gas transmission system.

[31] https://www.nrel.gov/hydrogen/research.html

What keeps PG&E awake at night?	Team members provided personal responses to this question. Their responses do not represent the company's official position. Refer to the presentation recording posted at www.pge.com/innovation.
Thank you for holding this workshop. It's very helpful and would be great if PG&E does more of these.	You're welcome.
In terms of Gas R&D what kind of coordination happens between PG&E, the CEC, other IOUs, and the CPUC to ensure that all R&D and demonstration work is coordinated, avoids overlap, leads towards long-term goals, and focuses on active gaps that are affecting programs?	Through our participation in the Natural Gas Leak Abatement Program (NGLA), we gather annually at a workshop with other California utilities, the CPUC, and the California Air Resources Board to share ideas and discuss our ongoing R&D efforts. It's a very collaborative environment. We also have memberships in several gas industry research consortia, such as OTD, UTD, and NYSEARCH, which, for example, holds quarterly meetings for similar discussions among its members. Again, it's a very collaborative environment where people brainstorm, share research results, and discuss new regulatory environments. Starting in 2023, we also initiated a new coalition of all California utilities that meets annually to discuss best practices and new developments in leak detection. All this activity has a meaningful impact on reducing emissions and mitigating the effects of climate change. But we are not stopping there. We are considering holding annual ideation workshops where representatives from the California IOUs and regulators can come together to align their thinking, educate each other, and discuss strategies to further reduce emissions, improve efficiency, and decarbonize the gas system.

How does PG&E expect the transferred risk (shifting from gas system to electric system through electrification) to impact the rise of electric rates and wildfire risk going forward?	At PG&E, Gas R&D is a part of the Utility, Partnership, and Innovation Group. We work very closely with our electric R&D department and our asset management team to make sure that we consider cost and wildfire risk in all the R&D work that we support.
In your expert opinion what has been the biggest headwind to decarbonization on your grid?	No one obstacle stands above the rest. It will be important to remain flexible to different pathways, processes, and technologies that could emerge as the state moves toward carbon neutrality by 2045. PG&E Corporation developed the Climate Strategy Report as part of its long-standing commitment to lead the way on addressing climate change. The document is designed for our customers, policymakers, investors, and other stakeholders and shares our goals, actions, and progress toward addressing climate change. The report provides information on PG&E's strategy and the steps we are taking to meet the challenge of climate change on behalf of the more than 16 million Californians who rely on PG&E to deliver their energy. The report describes the risks and opportunities PG&E faces from a changing energy landscape—along with the potential physical impacts of a changing climate and associated weather patterns. It also describes how PG&E governs climate-related issues and manages climate-related risks.
Thanks for hosting this, great workshop! On behalf of SoCalGas RD&D, we look forward to working together and continuing our coordination! (Matt Gregori, SoCalGas RD&D)	You're welcome. It was our pleasure.
Excellent Meeting. Greatly Appreciated. Much Thanks!	You're welcome!

Thanks! Looking forward to coordinating more closely and learning more details about what you're doing (Sasha Merigan, CPUC).	We are looking forward to that as well.

Appendix B

2023 Gas R&D Project List

Name	Project ID	Vendor Name	Description	R&D Strategy Category	Start Date	Anticipated End Date	Total Project Cost	PG&E Budget	Amount of Cofunding	Co-Funders	Funds Already Spent (2023 and 2024)	Funds to be Spent
1.11.H Ph6 - RC - Residential Gas Heat Pump Water Heater	1.11.H Ph6	UTD	Gas-fired heat pump technology offers significant greenhouse emissions reductions and higher energy efficiency compared to existing offerings for gas water heaters, and can bring gas water heaters to be more on par with electric heat pumps. This continuing project seeks to develop and bring to market a gas heat pump water heater (GHPWH) for residential applications. Previous phases brought the technology from a proof-of-concept to a pre-production prototype. In this final phase, the goals are to demonstrate successful operation of the GHPWH, and frame its requirements and constraints. With the requested additional funds, the project will include a task which encompasses the design, build, shipment, and testing of the "pre-production" GHPWH unit, including extended testing with Hydrogen-blended fuels up to 40%.	Decarbonization	11/1/2021	3/31/2024	$ 200,000	$ -	$ 200,000	UTD members	$ -	$ -
1.16.H.4 -RC- EnergyPlus Model for Gas Heating System Ph 4	1.16.H.4	UTD	An important goal for the gas industry is to enable the adoption of gas heating systems that are comparable with or better than high-efficiency electric alternatives. To achieve this, it is important to provide reliable information regarding their potential benefits (e.g., cost and energy savings). This project aims to provide decision-makers accurate and reliable modeling simulation tools for gas heating systems in order to enable fair comparison with competing technologies. Phase 4 will focus on adding data on emerging gas heat pumps and hybrid gas-electric systems which will build on the work accomplished in Phase 1-3 where data on advanced furnaces, tankless water heater combis, and gas absorption heat pumps were added into the EnergyPlus model.	Decarbonization	6/1/2022	1/31/2024	$ 150,000	$ 10,000	$ 140,000	UTD members	$ -	$ -
1.18.F - RC - Mitigate Methane Emissions ResCom End Use Ph2	1.18.F	UTD	Space heating has been targeted in recent publications as a major source of greenhouse gas emissions in the residential sector. Gas-fired equipment could be subject to future regulations or regulatory scrutiny due to perceived methane emission. Nationally, air pollution control boards (and equivalent agencies) are very concerned with establishing an inventory of greenhouse gas emissions. With concerns of methane emissions from natural gas infrastructure ramping up quickly, attention is also shifting towards gas fired appliances. Like the control of conventional criteria air pollutants (NOx, SOx, etc.), appliances are a ready target as they have large populations and fast turnover, such that establishing emission limitations can result in swift changes in product offerings and thus, emissions reductions. Just under half of US households use natural gas as their main space heating fuel. This project will establish the first technically-sound greenhouse gas emissions rate, focusing on methane, for a variety of modern residential furnace types.	Decarbonization	8/1/2020	2/28/2024	$ 145,000	$ 25,000	$ 120,000	UTD members	$ -	$ -
1.18.H Economical High-Efficiency Residential Gas Absorption	1.18.H	UTD	Design, fabricate and evaluate in laboratory settings a complete working "alpha" prototype unit that adds cost-effect cooling with low-global warming potential (GWP) refrigerant to the upcoming 40k Btu/h version of the low-cost gas absorption heat pump (GAHP) product developed in UTD project 1.18.H with Stone Mountain Technologies Inc (SMTI) shown in Figure 1. The GAHP uses an economical single-effect, ammonia/water absorption cycle, and GTI Energy has estimated an annual fuel utilization efficiency (AFUE) of 140%, but the current unit only provides whole-house heating and domestic hot water (DHW). If successful, this effort will add a low-GWP vapor compression module to provide air-conditioning reaching a seasonal energy efficiency rating (SEER) rating of 12.0 and heat recovery for water heating using a SMTI's advanced hydronic air handler (AHU). Low-GWP refrigerants likely to be evaluated include R-32 but not NH3.	Decarbonization	7/1/2023	12/31/2024	$ 267,000	$ 7,100	$ 259,900	UTD members	$ 7,100	$ -
1.19.B Ph2 - FS - Gas Fired Warewasher	1.19.B	UTD	Electric units currently dominate the warewasher market. Some of these have gas-fired booster heaters, but this gas load is relatively small. In addition, a large percentage of consumers choose electric warewashers that use chemicals (i.e. "chemical warewashers") rather than high temperature electric warewashers, which further reduces the heating load but increases costs and environmental impact. The cost savings over basic electric elements is very large on top of cleaner dishes with no chemical etching compared to chemical machines. This project will develop a reliable gas-fired conveyor type warewasher prototype for consumers to choose over electric units. The primary benefit is to save consumers money, while also providing additional efficient direct use of gas and another reason to maintain gas service to CFS establishments. Initial estimates from UTD 1.18.B indicate the site will only spend 1/3 for energy use with a gas warewasher compared to what they were spending before.	Decarbonization	7/1/2020	3/30/2024	$ 175,000	$ 13,988	$ 161,012	UTD Members	$ -	$ -
1.19.B Ph3 - FS - Gas-fired Warewashers	1.19.B Ph3	UTD	Electric units currently dominate the warewasher market and few gas-fired options exist. In addition, a large percentage of consumers choose electric warewashers that use chemicals (i.e. "chemical warewashers") rather than high temperature to disinfect, which increases operating costs and environmental impact. This project will develop a gas-fired conveyor type warewasher prototype for consumers to choose over electric units. The primary benefit is to save consumers money, while also providing additional efficient direct use of gas and another reason to maintain gas service to CFS establishments. Initial estimates from UTD 1.18.B indicate that energy savings up to 66% is possible ($1,100 per year) with a gas warewasher. Phase 3 will demonstrate the effectiveness of 5 prototype gas fired door warewashers. Test one unit at GTI's labs, one unit at our manufacturing partner Hobart, and three units at three field test sites selected in partnership with UTD project funders.	Decarbonization	11/1/2021	3/30/2024	$ 145,000	$ 2,000	$ 143,000	UTD members	$ 1,625	$ -
1.20.B - RC - Boostheat Thermal Compression Gas Heat Pump	1.20.B	UTD	Develop a "North American" thermal compression based heat pump (THP) product, with a focus on high modulation ratio, integration with forced-air distribution, and adding cost-effective cooling. Project partner boostHEAT has recently established a innovative and new business model in Europe; however to successfully enter the North American market, this UTD project will address key product development needs. Thermal compression-based THPs have significant potential for 20% or greater improvement in energy/emission reductions versus best-in-class conventional sorption and vapor compression-type THPs.	Decarbonization	7/1/2020	12/31/2024	$ 225,000	$ 16,236	$ 208,764	UTD Members, OEMs	$ -	$ -
1.20.G - RC - Combi System Integrating PV and Self Power	1.20.G	UTD	Develop and demonstrate an integrated energy system (IES) using hybrid residential combined HVAC and water heating (combi) system in the laboratory and novel controls to integrate gas/electric systems with micro-CHP, energy storage, and renewable energy in order to reduce operating costs and GHG by up to 50% and achieve COPs up to 1.5.	Decarbonization	7/1/2020	2/29/2024	$ 550,000	$ 16,502	$ 533,498	UTD members	$ -	$ -
1.20.H - RC -High H2 Fuel in ResCom Combustion Equip. Ph2	1.20.H Ph2	UTD	Adapt and demonstrate solutions to utilize high-hydrogen (H2) blends (> 50% H2 by volume) and 100% H2 in residential and commercial combustion equipment, by demonstrating multiple solutions in a controlled laboratory environment and leveraging international developments and technology transfer. This is being done in anticipation of a possible future where such high levels of hydrogen are required to replace natural gas to meet climate goals.	Decarbonization	8/15/2020	3/31/2024	$ 180,000	$ 5,425	$ 174,575	UTD members	$ 775	$ -
1.20.H.3 -RC- Hydrogen-Blended Gas in ResCom Equipment Ph 3	1.20.H.3	UTD	The goal of the project is to demonstrate solutions to utilize up to 30% hydrogen blends in residential and commercial combustion equipment. Where in phase 1 and 2, the focus was on common appliances such as water heaters and furnaces, the focus of phase 3 is peripheral gas appliances such as gas lights, outdoor furnaces, space heaters. It is expected that appliances with the lowest tolerance for hydrogen will set the upper limit for hydrogen blends in natural gas, making it important to be exhaustive in testing various appliances. Phase 2 demonstrates that residential and commercial appliances can operate reliably at up to 30% H2 blend with a small risk of flashback.	Decarbonization	6/1/2022	3/31/2024	$ 150,000	$ 17,443	$ 132,557	UTD members	$ 7,443	$ -
1.21.C - RC - CleanO2 CARBiNX Carbon Capture	1.21.C	UTD	The objective is to continue working with a commercial partner (CleanO2) to further evaluate and improve the CARBiN-X carbon capture technology. Laboratory testing of CleanO2's current CARBiN-X 3.3 prototype will be expanded to include higher firing rates, different reactant load sizes, and potentially condensing appliances. Once development of the CARBiN-X v 4.0 prototype is complete, a unit will be shipped to GTI for laboratory testing to validate claims of CO2 capture rate of 4 metric tons per year and cost savings of at least 30% for hot water heating. Another objective is to perform a codes and standards review for implementation of distributed carbon capture in the residential and commercial space and potential compatibility issues with different venting categories.	Decarbonization	7/13/2021	3/31/2024	$ 150,000	$ 13,000	$ 137,000	UTD members	$ 13,000	$ -

1.21.E Gas Engine Heat Pump Modeling, Testing and Implementation	1.21.E	UTD	Validate natural gas engine-driven heat pump (GEHP) performance for VRF systems across a range of conditions and expand the market through: • Enhanced GEHP energy models using measured performance data • Validation of new ANSI / CGA method of test (MOT) for new GEHP performance metrics • Techno-economic assessments to assess best use of three new GEHP equipment options: 1. AHU Integration Kits (for VRF retrofits) 2. Yanmar Hydrobox and BME Sierra AWS System (for hydronic unit integration) 3. Aisin Hi-Power (for self-powered resiliency) This project will validate the performance metrics needed to expand the U.S. market for an important high-efficiency gas technology for commercial buildings that can achieve heating and cooling COPg>1. GEHPs reduce peak electric demand through the use of gas-fired cooling and levelized year-round gas demand with ultra-high-efficiency heating performance. The use of cost-effective high-efficiency gas technologies also support the direct use of natural gas in High Performance Buildings and expand customer's competitive choices of product offerings.	Decarbonization	7/1/2021	2/28/2024	$ 320,000	$ 5,000	$ 315,000	UTD members	$ -	$ -
1.21.F Commercial Heat Pump Water Heater Field Performance Comparison	1.21.F	UTD	Compare the performance of a commercial gas and electric heat pump water heater technology in 1-2 field locations and also in GTI's laboratory using ASHRAE standards to establish the cost and energy-saving capability of each technology. The specific goals are: • Assess the performance of commercial gas and electric and HPWH at GTI and in-field • Provide equitable comparative information between commercial heat pump technologies	Decarbonization	9/1/2023	12/31/2025	$ 136,000	$ 2,000	$ 134,000	UTD members	$ -	$ -
1.21.H.2 - FS - CFS Burner Technology Hydrogen Blending Ph 2	1.21.H.2	UTD	The objective is to determine the potential decarbonization of commercial food service (CFS) appliances when up to 30% hydrogen is blended with natural gas. Phase 2 will focus on full appliance testing and cooking performance impacts, and will build on the testing of burners and controls completed in Phase 1. GTI will work with appliance manufacturers to identify and supply appliances for testing. The main outcome of this project is performance, efficiency, and emissions (CO, NOx) data for a variety of stock CFS appliances when operating on 0-30% hydrogen blend. The second outcome is recommendations for limits on hydrogen for CFS appliances.	Decarbonization	6/30/2022	1/30/2024	$ 160,000	$ 17,778	$ 142,222	UTD members	$ 7,778	$ -
1.21.I - CI - Ionic Liquid Heat Pump for Comm. Water Heating	1.21.I	UTD	Water heaters for commercial buildings have not received the same amount of innovation as water heaters for residential buildings which gave rise to tankless and electric heat pump water heaters. The project objective is to develop a prototype of a low-cost, high-efficiency gas-fired commercial heat pump water heaters. The technology uses a benign ionic liquid for its absorption cycle to provide latent cooling which further maximizes efficiency. The target coefficient of performance (COP) is > 1.8 if providing hot water, indoor cooling, and dehumidification (Generally, COP of 2 is considered very high for a HVAC device, it means that for an input power of 1000 W, the system generates 2000 W of heat). The outcome is a cost-effective solution for commercial water heating with minimal emissions and runs on natural gas.	Decarbonization	11/1/2021	12/31/2024	$ 225,000	$ 10,000	$ 215,000	UTD members	$ -	$ -
1.22.A -RC- Hydrogen Blending End Use Demo	1.22.A	UTD	This project intends to serve gas utilities that are planning to engage in hydrogen/natural gas blending pilots by demonstrating the safety, technical and performance implications of blended hydrogen/natural gas from an end user perspective at a simulated neighborhood operated by Southwest Gas. The goals are to measure the end user performance and safety impacts from a variety of gas-fired equipment and to quantify the efficacy of in-field retrofits/mitigation strategies for individual appliances. Another important goal is to develop best practices for field service technicians during utility blending programs.	Decarbonization	6/30/2022	7/31/2025	$ 450,000	$ 5,000	$ 445,000	UTD members	$ -	$ -
1.22.C - RC - Fuel-flexible Ultra-Low NOx Catalytic Burners for ResCom Appliances	1.22.C	UTD	This project will pave the way for adoption of hydrogen-blended gas and address the need for deep NOx reduction in domestic burners by developing and demonstrating a catalytic combustion gas burner for residential and commercial applications that is able to accommodate up to 50% H2 while achieving lower NOx emissions than the current state of the art. Whereas standard burners combust fuel with oxygen at high temperatures, catalytic burners use catalysts to trigger a chemical reaction between the fuel and oxygen without creating a flame. The lower temperature helps with minimizing NOx production while still providing a steady heat output to the load.	Decarbonization	6/30/2022	3/31/2024	$ 150,000	$ 17,100	$ 132,900	UTD members	$ -	$ -
1.22.G -RC- Safe Use of Hydrogen in Buildings	1.22.G	UTD	This project intends to proactively address consumer and regulator concerns about the safety of hydrogen use in buildings relative to natural gas use. To achieve this, this project will characterize the propensity of hydrogen (in blends with natural gas) to preferentially leak from existing building and gas distribution systems. Additionally, this project aims to address barriers for safe use of higher hydrogen blends (>30%) in residential and commercial appliances. With codes and standards revision efforts in this topic increasing, this project will provide valuable information to help shape how hydrogen's use will be enabled or restricted in the future.	Decarbonization	7/31/2022	3/31/2024	$ 150,000	$ 8,824	$ 141,176	UTD members	$ 3,824	$ -
1.22.H Hybrid Fuel-Fired and Electric-Driven Rescom HVAC Sys	1.22.H	UTD	Develop and characterize the simultaneous operation of a hybrid (dual fuel) gas furnace/electric heat pump in a laboratory environment to demonstrate its performance, and then develop installation and operational guidelines for its efficient and cost-effective use in various climate zones. The prototype will be developed in collaboration with Carrier based on their gas furnace and high efficiency heat pump.	Decarbonization	10/1/2024	10/30/2026	$ 240,000	$ 10,000	$ 230,000	Carrier	$ 110,000	$ 110,000.00
1.22.P Emerging Distributed Methane Pyrolysis Technologies	1.22.P	UTD	Perform a technology survey of options for distributed methane pyrolysis technologies, including a techno-economic assessment over a range of applications, including the underlying conversion process, hydrogen end uses, and handling of carbon outputs. This effort will be informed by outreach to primary technology developers in this space (e.g. Modern Electron). Given the intent to complete this effort intra-cycle and in advance of a Phase 2, the project team will also look ahead to application/process modeling by defining the approach taken up through developing a draft system modeling plan, which will be used in a later phase to couple with end user demand modeling and identify a range of distributed methane pyrolysis solutions (good/better/best).	Decarbonization	9/1/2023	9/30/2024	$ 60,000	$ 15,000	$ 45,000	UTD members	$ 15,000	$ -
1.23.E Combustion Technology for Emerging Low Carbon Manufacturered Gases	1.23.E	UTD	Conduct an experimental, technical and safety evaluation of equipment that is already designed or being operated with manufactured gases in non-North American markets, with a focus on water heating and cooking applications and evaluations will include performance and reliability tests. Identify key principles to apply to the types of natural gas-certified equipment that are typically sold in North America. Also conduct a safety and technical review of emerging low carbon manufactured gases used in water heating, cooking, space heating, etc.	Decarbonization	7/1/2023	6/30/2025	$ 225,000	$ 8,300	$ 216,700	UTD members	$ 14,940	$ -
1.23.G Accerlated Life Testing of ResCom Equipment Components with Hydrogen-Blended Gases	1.23.G	UTD	Assess the compatibility of commonly used non-burner components in Res/Com combustion appliances and equipment when subjected to hydrogen-blended gas. This will help gas equipment and appliance manufacturers, gas utilities, standards-setting organizations, and others to better understand the potential challenges from using hydrogen in natural gas distribution networks. Key Performance Indicators of success will be: • Report listing component compatibility or degradation when exposed to H. • Recommended mitigation strategies for any problems identified. Published results and methodology in a peer-reviewed journal or conference proceedings detailing what compatibility problems were or were not found.	Decarbonization	7/1/2023	6/30/2025	$ 150,000	$ 11,000	$ 139,000	UTD members	$ 11,000	$ -
1.23.I Inherently Safe ResCom Combustion Systems for Hydrogen-Blended Gases	1.23.I	UTD	Ensure safe, reliable, and efficient operation of customer gas appliances with H2-blended gas (5-50% H2 by volume) by: • Developing and demonstrating inherently safe combustion systems for common gas appliances (furnaces, water heaters, ranges, etc.) • Identifying inexpensive options to retrofit typical existing appliances (e.g., deployed in less than one hour at a cost of <$100) This will help gas utilities to demonstrate hydrogen blending levels well above 5% by volume and to broadly deploy blended gas in their networks.	Decarbonization	7/1/2023	12/31/2024	$ 175,000	$ 9,579	$ 165,421	UTD members	$ 9,579	$ -
1.23.J Hydrogen Flame Visibility and Colorants	1.23.J	UTD	Evaluate and identify colorants for hydrogen-enriched gaseous fuel at various conditions to: • Establish a matrix of hydrogen/methane mixtures to text visibility from 0% to 100% hydrogen. • Enhance the safety of open flame operation of hydrogen-enriched natural gas at four common lighting conditions with appropriate and safe gas colorants.	Decarbonization	7/1/2023	12/31/2024	$ 150,000	$ 11,833	$ 138,167	UTD members	$ 11,833	$ -
1.24.R Impact of Trace Constituents in Renewable Natural Gas	1.24.R	UTD	Advance the use of RNG by addressing end-user concerns about the impact of trace constituents on end-use appliances, when the percentage of RNG becomes a large portion of the total delivered gas. This project will perform accelerated life testing of water heaters with trace constituents of concern (e.g., hydrogen sulfide and halogenated hydrocarbons) in order to inform and improve gas utility interconnection guideline requirements as they pertain to trace constituent levels.	Decarbonization	10/1/2024	10/1/2026	$ 250,000	$ 44,600	$ 205,400	list any co-funders here	$ 150,000	$ 100,000.00

2.14.O Ph3 - CI - Gas Quality Sensor Validation H2 Sensor	2.14.O Ph3	UTD	With hydrogen addition to natural gas expected to become common, a need exists to monitor gas compositions containing hydrogen. The project objective is to enhance the current Gas Quality Sensor (GQS) designed by GTI with an add-on hydrogen detector so the economical GQS instrument can support introduction of hydrogen blending with natural gas. The technology is currently patented by GTI and has been licensed to the CMR group for potential commercialization. Key benefits from using the GQS with an incorporated hydrogen sensor include fuel savings, ability to operate with natural gas containing hydrogen, and improved engine or furnace control.	Decarbonization	7/1/2021	3/31/2024	$ 75,000	$ 5,000	$ 70,000	UTD members, CMR Group	$ -	$ -
2.16.A - CI - Next Gen Infrared Burner - Ph 3: Field Test	2.16.A	UTD	The objective is to design, build and test in the field a prototype next-generation, high-response, higher-efficiency infrared (IR) burner. Key performance indicators and goals to measure and demonstrate success of the proposed Phase 3 will be to demonstrate in the field: Improved efficiency of at least 4% versus existing gas-fired units; Improved start-up times of < 3 seconds through advanced materials; Reliable operation of the burner at the host site for at least 100-200 hours. Burner manufacturer Solaronics has been offering the new technology to its customers, but only about 20% of Solaronics' customers have shown even potential interest in the new metal foam burners since the technology is not completely demonstrated and field-proven. Phase 3 will work to address this market penetration hurdle by putting a near-commercial prototype at a customer host site for testing and demonstration. In doing so Phase 3 will advance the introduction of another new high-performance commercial product that efficiently directly uses natural gas, and with its high-performance response can compete and be successful in a product category that is dominated by electric units which on a source energy basis may consume 3 times as much energy vs. gas-fired.	Decarbonization	6/1/2020	3/31/2024	$ 300,000	$ 27,300	$ 272,700	UTD members	$ 10,000	$ -
2.16.A.4 - CI - Infrared Burner Phase 4: Hydrogen Focus	2.16.A.4	UTD	Infrared (IR) burners are widely used in industrial space heating, food processing, coating treatments, paper and textile drying processes. Currently 75% of IR heaters are electric units but this sector represents a good opportunity for renewable gas and hydrogen since energy consumption is prohibitive with electric and leads to 2 times greater source energy consumption than RNG/H2 IR. This project aims to test and optimize the performance of the new gas-fired InfraRed (IR) burner that UTD is developing under project 2.16.A with up to 100% hydrogen to assess technical feasibility and identify design gaps. GTI will partner with Solaronics, Inc. (a leading gas-fired IR heater OEM) and Alantum Corp. (a leading metal foam material OEM) on this project. The deliverable is a preliminary design for IR burner that is compatible with high levels of hydrogen while maintaining fast start-up and low emissions characteristics.	Decarbonization	6/30/2022	7/31/2024	$ 180,000	$ 10,000	$ 170,000	UTD members	$ -	$ -
2.20.F - TR - Next Generation NGV Driver Information System	2.20.F	UTD	The objective is to develop and demonstrate a next-generation natural gas vehicle (NGV) driver information system which provides an accurate miles-to-empty estimate for the vehicle. This is particularly challenging in gaseous-fueled vehicles because the gas sees wide ranges of temperature fluctuation as the pressure changes during fueling and engine operation. Maximizing fuel use from onboard storage is among the identified challenges to more widespread NGV use by heavy duty trucks. US DOE Clean Cities has performed a nation-wide survey of NGV drivers and the unreliable fuel gauge is one of the consistently mentioned deterrents to increased adoption. US DOE created a major solicitation and awarded a prime contract to GTI because it would directly address and resolve a long-standing industry issue. An advanced vehicle driver information system is needed to address major barriers constraining increased deployment of NGVs including: "Range anxiety"; More frequent and unnecessary fueling stops; Reduced driver productivity; Disrupted workflow for the fleet operator.	Decarbonization	7/1/2020	3/31/2024	$ 250,000	$ 50,000	$ 200,000	UTD members	$ -	$ -
2.20.G - TR - Smart CNG Station - Field Demonstration	2.20.G	UTD	The objective is to develop a Smart compressed natural gas (CNG) fueling system that will increase the usable, "onboard" CNG storage capacity by 10% - 25% compared to current practice and demonstrate the system at five field locations. The Smart CNG fueling system will provide consistent, "full-fills" resulting in lower capital cost for fuel storage on NGVs and reduced operating costs for filling. The Smart station will communicate live gas properties between the vehicle and the pump so that the mass of gas in the tank can be accurately predicted. This will result in the full capacity of the tank being utilized instead of a pressure limit artificially limiting the molecules of natural gas allowed into the tank.	Decarbonization	7/1/2020	3/31/2024	$ 4,320,000	$ 120,000	$ 4,200,000	DOE, UTD members	$ -	$ -
2.20.G.2 -TR- Smart CNG Station Demo Ph 2	2.20.G.2	UTD	The objective is to further develop a smart compressed natural gas (CNG) fueling station system that will enable "full fills" of CNG vehicles and demonstrate the system at five field locations. Heavy-duty CNG trucks often experience "under-filling" to the order of 20-25% as frequently cited by industry experts. The Smart station will communicate live gas properties between the vehicle and the pump so that the mass of gas in the tank can be accurately predicted. The outcome of this phase 2 is a commercial prototype of the smart dispenser hardware and results of demonstrating this technology on CNG trucks.	Decarbonization	7/1/2020	3/31/2024	$ 2,000,000	$ 25,000	$ 1,975,000	DOE, UTD members	$ -	$ -
2.21.B - CI - Energy Recovery from Brewing/Distilling	2.21.B	UTD	Process heat from industrial processes in breweries, distilleries, and laundry facilities are often wasted and not recovered. This CEC-funded 3-year project aims to design, fabricate, and install a low-cost waste heat recovery system (Waste Heat Effective Transfer, WHET) to recover and repurpose heat from brewery and distilling operation for facility water heating. WHET has the potential to save 15-25% of facility energy cost and reduce CO2 emissions by 25% while having a payback period of 5 years. WHET consists of a heat exchange module made with flared/spiraled copper tubing, a water flow rate controller, and a flow control loop with valves to mix heated water with plant water.	Decarbonization	11/1/2021	7/31/2024	$ 1,670,000	$ 40,000	$ 1,630,000	CEC, UTD Members	$ -	$ -
2.21.F - CNG Locomotive Field Demonstration	2.21.F	UTD	The project objective is to design, build, test, and operate a pre-production, compressed natural gas (CNG) hybrid line-haul locomotive to demonstrate the Cummins Westport ISX12N natural gas engine (CWI 12L) near-zero emission engine in rail service.	Decarbonization	7/1/2021	12/31/2024	$ 5,199,733	$ 10,000	$ 5,189,733	DOE, UTD Members	$ -	$ -
2.21.H - TR - Hydrogen Fueling for Heavy-Duty Vehicles	2.21.H	UTD	As of July 2021, there is no national standard for high-flow hydrogen fueling of heavy-duty, long-haul trucks. This collaborative project with National Renewable Energy Laboratory (NREL) will create a publicly available protocol for high-flow fueling of heavy-duty vehicles. There is an industry protocol for hydrogen fueling of light duty vehicles (SAE J261) which establishes maximum flow rate and rate of pressure increase, but this protocol is too slow for heavy-duty trucks which require at least 10 times the amount of hydrogen for light duty vehicles during each fill.	Decarbonization	7/1/2021	4/30/2024	$ 692,500	$ 5,000	$ 687,500	NREL, UTD Members	$ -	$ -
2.22.B - CI - Ribbon Burner with Hydrogen Blended Gas	2.22.B	UTD	Increasing hydrogen blend levels in natural gas may require modifications to end-use burner systems. Ribbon burners are widely used in wholesale baking facilities and are not good targets for electrification due to the high temperature it operates under. This project aims to evaluate the performance of ribbon burners when operating with up to 100% hydrogen to assess technical feasibility and identify design gaps. GTI will partner with Flynn Burner, a major ribbon burner manufacturer, to conduct testing. This project will provide valuable performance data on ribbon burner to develop retrofit recommendations for industrial bakeries to facilitate increasing levels of hydrogen in the gas pipeline.	Decarbonization	6/30/2022	7/31/2024	$ 175,000	$ 10,000	$ 165,000	UTD members	$ -	$ -
2.22.G -TR- Pre-Cooling for High-Flow Hydrogen Fueling	2.22.G	UTD	Precooling hydrogen prior to fueling is important because hydrogen has a negative Joule Thompson coefficient which means that hydrogen gets warmer when its pressure drops unlike natural gas which cools down. Considering that hydrogen is less energy dense than diesel, fueling has to happen at a very high flow rate for the truck to have enough energy as a full tank of diesel, further increasing the risk of overheating. This project will develop a chilling system to pre-cool hydrogen for high flow fueling of heavy duty trucks at 10,000 psi (70 MPa). GTI won a very competitive federal solicitation process to secure $2.2 M of DOE funds for this project with an additional contribution of $250k from SoCal Gas. The goal is to have a pre-cooler design capable of fueling 10 kg/min of H2 (equivalent to diesel fueling speeds) with a cost of <$500,000.	Decarbonization	7/31/2022	6/30/2024	$ 2,450,000	$ 29,000	$ 2,421,000	DOE, UTD members	$ -	$ -
2.22.H -TR- Heavy-duty Hydrogen Truck Deployment	2.22.H	UTD	This project will address a key technology gap for heavy duty hydrogen fuel cell powered trucks. Currently, there is no zero-emissions vehicle that can operate more than 250 miles in one shift. The objective of this project is to design and build a hydrogen fueled, zero-emissions regional-haul Class 8 vehicle, and demonstrate the technology by operating it for 12 months on a 400-mile route from Fontana, CA to Lathrop, CA. The team has selected this range because it can effectively cover most of intra-state California freight movement.	Decarbonization	7/1/2022	7/31/2024	$ 5,300,000	$ 25,000	$ 5,275,000	CEC, UTD members	$ -	$ -
2.23.A Decarbonizing Large Commercial and Industrial Equipment with Hydrogen	2.23.A	CEC, UTD	Identify and resolve research and technology gaps for using hydrogen (H2) in various combustion equipment in commercial buildings and in large commercial and industrial (C&I) processes (Figure 1) through experimentation to establish upper limits for H2 blending for 3 to 6 different equipment or equipment categories, and testing up to 100% H2. Partner with the University of California Irvine (UCI), the Air-conditioning, Heating and Refrigeration Institute (AHRI), and Electric Power Research Institute (EPRI) in order to ensure that the research effort is based on comprehensive existing knowledge, is done in coordination with other global research efforts, and has significant manufacturer involvement. Leverage UTD's resources 5:1 with $2.735M co-funding - - with the California Energy Commission (CEC) providing the prime funding.	Decarbonization	7/1/2023	7/31/2026	$ 2,735,000	$ 26,100	$ 2,708,900	UTD members, CEC, SoCalGas, LCRI, secured	$ 26,100	$ -

2.24.B Fuel-flexible Infrared Ultra-Low NOx Steam Boiler	2.24.B	UTD	Develop an advanced infrared H2 boiler that operates on H2 blended natural gas (0-100%), producing high-temperature steam for food and beverage production. The boiler will utilize an AI-assisted controller, which can operate the boiler on H2 and natural gas. The boiler will have extremely low NOx emissions (3 ppm or less evaluated at 3% O2), benefiting from the moderate combustion temperature lower than 1100 ºC. An economizer heating intake air by recovering the waste energy from flue gas will increase boiler efficiency to 98%	Decarbonization	10/1/2024	4/30/2027	$ 42,500,000	$ 15,000	$ 42,485,000	UTD members, WVU, SoCalGas, Fulton, CSI	$ -	$ 15,000.00
2.24.C FlexGen-H High Efficiency, Fuel-Flexible, Ultra-Low	2.24.C	UTD	Develop and demonstrate a next generation regenerative high efficiency burner system to decarbonize process heating and related industrial use sectors. Integrating with natural gas the combustion of green hydrogen.	Decarbonization	10/1/2024	10/30/2027	$ 4,900,000	$ 15,000	$ 4,885,000	UTD members, DOE, SoCalGas, Bloom Engineering	$ 120,000	$ -
2.24.H Hydrogen-blending at Asphalt Plants – Field Tests	2.24.H	UTD	To test and validate equipment for Natural Gas-Hydrogen (NG-H2) blending at an asphalt plant site. Design and installation of storage, delivery and end-use blending H2 at the Graniterock facility.	Decarbonization	10/1/2024	10/30/2026	$ 5,700,000	$ 30,000	$ 5,670,000	UTD members	$ 120,000	$ 80,000.00
2.24.I Carbon Capture Technologies for Large Commercial	2.24.I	UTD	Evaluate CO2 capture technologies for different industrial processes. A number of factors influence the choices of carbon management technology in different industrial settings. The goal is to match industrial processes with the optimum carbon capture technology, provide insight into the reasons for that selection, identify the developers of carbon capture technologies and the maturity of those technologies, and to provide costs for carbon capture.	Decarbonization	10/1/2024	1/30/2026	$ 125,000	$ 11,000	$ 114,000	UTD members, Penn State, CSU, USG	$ 65,000	$ 35,000.00
5.21.j H2 impact on Aldyl A and HDPE	OTD 5.21.j	OTD	Develop a lifetime-prediction and risk model for Aldyl-A and vintage HDPE pipes pressurized with a natural-gas/hydrogen blend.	Decarbonization	5/26/2021	3/31/2024	$ 867,800	$ -	$ 867,800	OTD members	$ -	$ -
5.21.t Ph1 Effect of H2 on Meters and Regulators	5.21.t.1	OTD	To examine the effect of hydrogen blended natural gas on the performance of domestic gas meters in terms of measurement accuracy, intrinsic safety through extensive, long duration testing. As well as on the normative performance of diaphragm type service regulators, specifically addressing materials compatibility, and gas leak concerns.	Decarbonization	10/1/2021	7/31/2024	$ 55,000	$ 1,515	$ 53,485	OTD members	$ -	$ -
5.24.s De-blending Demonstration	5.24.s	OTD	This project will install and demonstrate a de-blending technology in a closed system to evaluate performance and operations under various operating conditions. The data collected would support development of recommended practices for operating and maintaining a de-blending system.	Decarbonization	10/1/2024	12/1/2026	$ 1,044,000	$ 5,000	$ 1,039,000	UTD Members	$ 650,000	$ 394,000.00
5.24.z SUSTAIN H2 (Subsurface Storage Technological Advance	5.24.z	OTD	The primary focus of SUSTAIN H2 is to conduct a comprehensive assessment of large-scale UHS development across all U.S. regions, considering technical aspects such as capacity, efficiency, safety, and potential infrastructure reutilization, along with economic feasibility. Additionally, SUSTAIN H2 strives to furnish business developers and regulators with overarching guidelines and information to facilitate the safe and cost-effective deployment of UHS.	Decarbonization	10/1/2024	10/1/2026	$ 900,000	$ 50,000	$ 850,000	OTD members	$ 50,000	$ 50,000.00
7.16.e Ph3 On-Line Biomethane Gas Quality Monitoring	7.16.e.3	OTD	Develop and test the on-line analyzer validated as best performing in Phase II for monitoring the unconventional trace contaminants found in biomethane (BM) injection if cleanup technologies fail. The focus is on the constituents that are not routinely monitored by on-line instruments but that are critical to pipeline integrity, end use integrity, and human health.	Decarbonization	11/1/2021	12/31/2024	$ 267,000	$ 25,000	$ 242,000	OTD members	$ -	$ -
7.16.g Ph2 Siloxane Content in Biomethane - ASTM ILS	7.16.g Ph2	OTD	In the previous phase of this project, a method for sampling and measuring siloxane content in biomethane was recommended for an ASTM standard. This phase will perform an Inter Laboratory Study (ILS) to determine the standard's precision and bias as required by ASTM. In addition, the study will evaluate an on-line siloxane analyzer, the GC-IMS-SILOX, that was identified and deemed promising in phase 1.	Decarbonization	5/22/2019	3/31/2025	$ 253,000	$ 50,600	$ 202,400	OTD members	$ -	$ -
7.21.d Accuracy of Hydrogen Analyzers and Survey Instruments	OTD 7.21.d	OTD	This project will conduct a laboratory evaluation on the precision, accuracy, and bias of analytical equipment for natural gas blended with hydrogen at concentrations between 5% and 20%. A hydrogen analysis train for the ABB NGC 8206 will be evaluated for online BTU gas chromatographs (GCs). Two to four current-market leak detection and leak survey instruments will be selected to evaluate the calibration impacts of lower (LEL) explosive readings when measuring natural gas / hydrogen blends.	Decarbonization	4/21/2021	3/31/2024	$ 248,000	$ 19,528	$ 228,472	OTD members	$ -	$ -
7.21.j Assessing Performance Impacts of Blended Hydrogen on Thread Sealants	OTD 7.21.j H2 Thread Sealants	OTD	Observe the impacts of hydrogen blended natural gas on specific components in the distribution system, specifically low pressure thread sealants typically used on meter set assemblies (MSAs). This work will leverage equipment designed and fabricated in another current proposal - OTD 5.21.t Effect of hydrogen blended natural gas on the performance of gas meters and diaphragm type service regulators.	Decarbonization	9/1/2021	4/30/2024	$ 150,000	$ 4,500	$ 145,500	OTD members	$ -	$ -
7.22.L Open Hydrogen Initiative	7.22.L	OTD	HI is an international research consortium with the express intent of laying the foundation for technology-neutral hydrogen markets. Through this, all forms of hydrogen production can be compared on an apple-to-apples basis, void of technology or feedstock-based biases. Phase II of OHI will focus on expanding the impact and adoption of the solutions built in Phase I. This effort will prioritize expansion of the OHI toolkit to include pipeline transportation, further refinement and improvement of the OHI toolkit, conducting a public comment period for OHI tools, exploring assurance and validation around hydrogen carbon intensity (CI) expansion of the existing toolkit to include production of ammonia, educational advocacy with regulators and policymakers, and industry convening.	Decarbonization	10/1/2024	10/1/2025	$ 50,000	$ 5,000	$ 45,000	OTD Members	$ 50,000	$ -
Brimstone Energy Carbon Negative Cement Production	Brimstone Energy - Cement Production	Brimstone	Brimstone Energy is developing a carbon negative cement production process by changing the chemistry of production such that limestone is no longer used as raw material and one of the mineral co-products captures carbon dioxide from the air. At the core of their technology is a chemical leaching process that takes in silicate rocks as raw materials (abundant in California) and generates calcium oxide which can be used to make clinkers for Ordinary Portland Cement (OPC). Unlike limestone, calcium oxide does not emit CO2 when heated to high temperatures The other output is magnesium hydroxide which readily absorbs carbon dioxide from the air. By generating revenue from the sales of OPC and cementitious materials, Brimstone can potentially make the carbon capture process run at zero cost. In early 2021, Brimstone pivoted away from hydrogen production using byproducts of cement production to developing this new process because the membrane they were using to separate hydrogen kept getting poisoned by impurities.	Decarbonization	9/30/2021	12/31/2024	$ 13,000,000	$ 50,000	$ 12,950,000	ARPA-E	$ 25,000	$ -
CEC GFO 18-501 - RNG and Value Added Chemicals from Biomass	CEC GFO 18-501 West Biofuels	CEC	Demonstrate production and separation technology that will convert forest biomass residues to pipeline quality renewable gas and valued-added byproducts. 1.Pilot the complete process from forest biomass to RG 2.Verify the system stability and reliability with testing 3.Validate nth-plant commercial opportunity for the proposed process for RG and byproducts 4.Determine the environmental footprint and the low-carbon fuel pathway for the RG and byproducts	Decarbonization	11/15/2019	3/31/2024	$ 2,560,000	$ -	$ 2,560,000	CEC	$ -	$ -
CEC GFO-20-604 Port of West Sac Hydrogen Fuel Cell Switcher Rail Demo	H2RAM - GTI/CEC	GTI	This leverages CEC GFO-20-604 - Hydrogen Fuel Cell Demonstrations in Rail and Marine Applications at Ports (H2RAM). GTI was awarded $4 million and the project title is Sierra Northern Hydrogen Locomotive Project. GTI and Sierra Northern Railway are working with Group 1 partners to design, build, and demonstrate a hydrogen fueled, zero emission switcher locomotive. Integration of advanced fuel cell and battery technologies represent a new platform that will enable commercialization within a few years. The locomotive will be demonstrated in Sierra Northern Railway's short-line operations that serve the railyard and seaport in West Sacramento. Shell and Sierra Northern Railway are submitting a fully integrated Group 2 application to establish a long-term hydrogen fueling facility for locomotives and on-road vehicles consistent with CEC goals and efforts. This fueling facility will be on Sierra Northern Railway's land in the heart of their short-line operations in the Port of West Sacramento.	Decarbonization	11/1/2021	12/31/2024	$ 9,000,000	$ -	$ 9,000,000	CEC	$ -	$ -
CEC GFO-21-503 Effects of H2 in End-Use Equipment for Comm. and Ind. App.	CEC GFO-21-503	CEC	Hydrogen utilization has impacts on equipment safety, emissions, operating costs that are partly understood. This CEC study seeks to quantify the costs, safety implications, and emissions benefits of adopting H2-based fuels in these sectors, through a broad techno-economic assessment, informed by laboratory testing, combustion simulation, air quality modeling, and stakeholder engagement as a function of H2 utilization (0-100% blended). If awarded this project, GTI will partner with EPRI and UC Irvine, both of whom have substantial experience in techno-economic analysis and fuel cell tech respectively.	Decarbonization	11/14/2022	11/28/2025	$ 3,557,500	$ 50,000	$ 3,507,500	CEC, UTD members	$ -	$ -
CEC GFO-21-507 Hydrogen Blending in Existing Gas Networks	CEC GFO-21-507	CEC	The purpose of the solicitation is to fund research that helps to shape and develop the safety practices of blending hydrogen into natural gas pipeline system by identifying the requirements, steps, and procedures involved.	Decarbonization	2/9/2023	12/31/2025	$ 7,250,021	$ -	$ 7,250,021	CEC	$ -	$ -
DE-FE0032008 Ph2 H2 Storage for Load-Following & Clean Power	GTI CHG H2 Storage	GTI	The objectives are to: advance H2 energy storage solutions for addressing VRE impacts on fossil-fueled assets; and use low-cost electricity to generate hydrogen from fossil energy and store for utilization during peak demands in duct-burning application.	Decarbonization	10/5/2022	9/30/2024	$ 1,131,971	$ 37,500	$ 1,094,471	DOE	$ -	$ -

Eval of Hydrogen-NG on Engine Performance and Durability	PGE UC Riverside	UC Rviverside	The objective of the proposed work is for UC Riverside to evaluate the impact of hydrogen content in natural gas on the performance and durability of one end use technology, specifically the Cummins L9N 8.9 liter near-zero natural gas engine. Cummins has a set limit for hydrogen content of 0.03% by volume, a long-standing limit probably set based on typical natural gas composition. Since the limit is part of the Cummins specification, using natural gas with hydrogen content greater than 0.03% could void the warranty of the engine. The proposed work will provide data that could justify the initiation of extensive validation work to increase the hydrogen limit in the Cummins Fuel Standard. This program will also provide valuable information on the deterioration rates of a current technology ultra-low NOx natural gas engine when operated on a hydrogen blend. Phase 1 of the project will focus on testing the impacts on engine emissions and Phase 2 on the durability of the engine.	Decarbonization	1/15/2021	2/28/2024	$ 489,977	$ 125,000	$ 364,977	SoCalGas	$ -	$ -
G4 Insights PCH Process Confirmation Project	G4 Insights	G4 Insights	G4 PyroCatalytic Hydrogenation (PCH) is a proprietary thermochemical process to convert forestry biomass into renewable natural gas (RNG). Pacific Gas and Electric Company (PG&E) is interested in evaluating G4 PCH for potential commercial applications. G4 will conduct a series of test runs leading up to a 7 day continuous operation run. Data will be collected, analyzed, and shared with PG&E in a final report. The project will start in April or May 2021 and be completed over a 12-16 week period. The project leverages G4's latest iteration of process testing apparatus built for its $2.2M ATCO Gas demonstration project. The project will also benefit from the base line data and operating experienced acquired from the ATCO project.	Decarbonization	2/15/2022	7/31/2024	$ 80,000	$ 40,000	$ 40,000	ATCO	$ -	$ -
JEFI-00-02 – EFI Guidance Document	JEFI-00-02	PRCI - 2023	The project objective is to serve as a technical resource for pipeline operators, standards organizations, and regulators on the unique aspects and considerations specific for new and repurposed hydrogen pipeline systems as compared to natural gas pipelines.	Decarbonization	8/1/2023	8/31/2024	$ 300,000	$ -	$ 300,000	PRCI members	$ -	$ -
JEFI-01-02 Electrical Area Modelling and Risk Assessment of Hydrogen-Natural Gas Blends	JEFI-01-02	PRCI - 2022	The modeling capabilities developed through this project will leverage existing science and engineering frameworks (e.g., HyRAM/HyRAM+) to assess risk of H2/NG blends in compressor stations and provide a foundation to further development of codes and standards to ensure the safety of blended gas systems. Developing the capability for HyRAM+ to model blended gas releases and perform quantitative risk assessments for a relevant subsystem will provide a path for permitting blended gas in the natural gas infrastructure. Additionally, investigation into the electrical code requirements and documentation of necessary facility modifications (if any) will demonstrate the issues and remediation necessary to advance options for blending hydrogen into existing natural gas assets. These tasks will provide industry with the appropriate data and a template for science-based decision-making for blending hydrogen into natural gas toward pathways toward decarbonization	Decarbonization	1/1/2023	12/31/2024	$ 70,000	$ -	$ 70,000	PRCI members	$ -	$ -
JEFI-02-02 Develop H2/NG composition analysis tools	JEFI-02-02	PRCI - 2022	The project will include the following tasks: Determine technical and financial requirements for the analysis of hydrogen blends in natural gas, Determine the state-of-the-art of hydrogen quality measurement in natural gas, Select the most promising technologies that meet the requirements, Create a technology development plan to cover lab testing, field demonstration, and commercialization, Lab testing with pure hydrogen in the H2/NG blend to confirm the validity of technology and what needs further development in preparation for a field demonstration, and Field demonstration of 1-3 technologies at PRCI member company sites in Europe and North America --> the impurities of hydrogen will be taken into account on the hydrogen quality measurement in natural gas (at this time, no knowledge on impurities in H2 regarding H2 production)	Decarbonization	12/1/2023	12/31/2025	$ 117,000	$ -	$ 117,000	PRCI Members	$ -	$ -
JEFI-03-01 DNV JIP Guidelines Integrity Mgmt H2 Pipelines	JEFI-03-01	PRCI	The focus of the current JIP is to develop guidelines on assessing defects in pipelines for transporting H2 blends. The guidelines will be based on compiling information from various ongoing industry efforts as well as developing specific information on relevant materials under representative environmental and loading conditions. The guidelines will provide a framework to assess the feasibility of transporting H2 blends in existing pipelines along with providing a basis for construction of new pipelines for H2 service.	Decarbonization	7/15/2022	3/31/2024	$ 450,000	$ 15,000	$ 435,000	PRCI members	$ -	$ -
JEFI-03-04 CO School of Mines - Technologies for Enabling the Safe and Efficient Trans of H2 in US	JEFI-03-04	PRCI - 2023	The project objective is to determine the influence of microstructure on steel line pipe qualification metrics for H-blended gas environments at higher strength levels than conventionally used for these applications, e.g. X65 and X70 grade steels.	Decarbonization	6/1/2023	5/31/2025	$ 1,500,000	$ -	$ 1,500,000	DOE, EFI Members	$ -	$ -
JEFI-04-01 EWI JIP Material Qualification New Steel Pipe H2	JEFI-04-01	PRCI	This program will focus on evaluating Option B of the current ASME B31.12 standard. Option B requires a series of fracture toughness and fatigue crack growth rate tests to characterize the effects of hydrogen embrittlement on toughness and fatigue resistance in the pipe body and seam welds and the seam weld heat affected zones (HAZs).	Decarbonization	9/7/2022	3/31/2024	$ 340,000	$ 34,000	$ 306,000	PRCI members	$ -	$ -
JEFI-04-05 DNV GL In service welding H2/NG pipelines	JEFI-04-05	PRCI - 2023	The project objectives are to determine if welding onto an in-service pipeline that contains a mixture of methane and hydrogen results in an increased risk of hydrogen cracking and, if so to develop guidance pertaining to measures that can be taken to mitigate the increased risk.	Decarbonization	1/1/2023	6/30/2024	$ 90,000	$ -	$ 90,000	EFI Members	$ -	$ -
JEFI-04-08 Full Scale Testing of Pipe for Hydrogen Service	JEFI-04-08	PRCI - 2023	This project focuses on full scale testing of pipeline samples containing defects. Hydrogen embrittlement effects occur in metallic materials in gaseous hydrogen environments. These are typically reduction in ductility, accelerated fatigue crack growth and reduced fracture capacity of a pipeline material although the material strength is largely unaffected by gaseous hydrogen. Impact of hydrogen on pipeline integrity requires a combination of environmental, material and stress mechanisms to act concurrently and increase susceptibility to fatigue and fracture failures.	Decarbonization	10/5/2023	9/30/2025	$ 2,600,000	$ -	$ 2,600,000	Alberta Innovate, EFI Members	$ -	$ -
JEFI-04-11 Develop Pipeline Industry Consensus Engineering Requirements (CER) for Hydrogen Transmission	JEFI-04-11	PRCI - 2023	The objective of this project is to develop guidance to be used as an overlay appendix to ASME 31.8, similar to that developed for sour gas service. In ASME terminology, this an exception chapter. Key inputs into this deliverable will incorporate recent and ongoing research in the following areas: 1. Develop and/or validate of technology and analytical processes capable of confirming pipeline material properties for pipeline integrity assessments. 2. Identify processes to confirm the fundamental integrity and safe operation of vintage pipelines by expanding the applicability and reducing the uncertainty of current Fitness for Service methodologies, including definition of critical feature dimensions, associated models & response criteria. 3. Develop, demonstrate, and validate pipeline repair systems, including those that can be deployed on in-service facilities. Determine the useful life and safe operating envelopes of such repair systems. 4. Define, understand and improve the key practices, including models, involved in the design, construction and integrity management of pipelines and related facilities.	Decarbonization	8/1/2023	6/30/2024	$ 400,000	$ -	$ 400,000	PRCI Members	$ -	$ -
JEFI-05-01 DNV JIP Material Selection Underground Storage	JEFI-05-01	PRCI	The objective of the JIP will be achieved by: 1. Characterizing the damage response of the various materials of interest in hydrogen storage applications to both environmental and loading variables. 2. Develop an appropriate fracture mechanics framework to incorporate the material damage mechanisms. 3. Leverage existing data on various materials in sour environments as well as seawater under cathodic protection conditions to help correlate materials data to long term in service performance.	Decarbonization	8/19/2022	3/31/2024	$ 300,000	$ 12,000	$ 288,000	PRCI members	$ -	$ -
JEFI-05-02 SHASTA Participation	JEFI-05-02	PRCI - 2023	SHASTA participation will allow the EFI to have access to a large amount of underground storage research pertaining to hydrogen service.	Decarbonization	1/1/2023	12/31/2024	$ -	$ -	$ -	DOE	$ -	$ -
M2018-011 Ph3 Scaling of Microbial P2G Conversion	M2018-011 Ph3	NYSEARCH	The objective of the proposed Phase III effort is to build, test, and scale a new generation of advanced bioelectrochemical reactors for high current density Power-to-Gas conversion at high energy efficiency exceeding the current state-of-the-art efficiency values. This work will be completed by Stanford University and a collaborating research group at Aarhus University in Denmark.	Decarbonization	9/7/2023	12/7/2025	$ 339,000	$ 37,905	$ 301,095	NYSEARCH members	$ -	$ -
M2020-008 Study Impact Trace Constituents in RNG	M2020-008	NYSEARCH	The objective of the proposed project is to study the impact of trace constituents in Renewable Natural Gas and traditional pipeline gas on LDC infrastructure and customer appliances. The goal of the project is to determine appropriate trigger limits for the deleterious trace constituents to preclude any safety or maintenance risks on LDC infrastructure and gas appliances. This project will be carried out in two tasks as described below with a Go/ No Go Decision at end of Task 1 (referred to in DNV-GL proposal as Stage 1).	Decarbonization	1/15/2021	6/1/2024	$ 606,810	$ 71,390	$ 535,420	NYSEARCH members	$ -	$ -
M2021-008 Hydrogen Living Lab	M2021-008 Hydrogen Living Lab	NYSEARCH	The proposed "Hydrogen-Natural Gas Living Lab" demonstration aims to validate the feasibility of blending and injecting hydrogen (up to 20% by vol. or more) into the existing natural gas infrastructure by simulating system operations. The specific objective of this NYSEARCH project is to analyze and report data on the impacts of hydrogen blending at higher percentages (i.e., greater than 20 vol%) by evaluating safety, maintenance and emergency response changes on gas distribution infrastructure and appliances	Decarbonization	5/4/2022	12/31/2025	$ 1,222,402	$ 83,855	$ 1,138,547	NYSEARCH members, SoCalGas	$ -	$ -
MEAS-15-04 Efficacy of Siloxane Measurement	MEAS-15-04	PRCI - 2021	With the growth of renewable natural gas (RNG) production expected to continue in markets throughout the US and abroad, additional RNG pipeline specifications similar to those in California are expected to be established. Producers, regulators, and utilities would benefit from validated and standardized measurement methodologies which meet these new, lower specifications. In August 2019, ASTM published the first standard method for the offline analysis of siloxanes in biogas (ASTM D8230) for laboratories to adopt and follow. However, the ability to develop a low cost, low maintenance online analyzer that can meet the sensitivity and precision needs of the industry will allow suppliers to ensure near same-time compliance to regulations compared to offline analysis.	Decarbonization	6/1/2022	12/31/2024	$ 100,000	$ -	$ 100,000	PRCI members	$ -	$ -

NSF 22-546 Four Networks for Geologic H2 Storage	NSF 22-546 UHS	UC Berkeley, Lawrence Berkeley National Laboratory	Hydrogen from renewable energy will provide opportunities for transitioning energy-intensity industries to carbon-free energy, a critical step for combating the climate crisis. Establishing geologic storage in porous rock reservoirs would unlock distributed capacity for hydrogen hub development. This project will address critical scientific, environmental and socioeconomic questions associated with the proposed development of geologic hydrogen storage in porous rock.	Decarbonization	12/1/2022	12/31/2025	$ 1,500,000	$ -	$ 1,500,000	NSF	$ -	$ -
T-792 Market/Tech Study High Conc H2 Leak Detector	NYSEARCH T-792 Market/Tech Study High H2 Leak Detector	NYSEARCH	The objective of the proposed project is to determine what technologies are available or need further adaptation to meet specifications for stationary and/or mobile leak survey instruments to detect up to 100% H2. The first part of the proposed work will focus on technical and economic requirements for detection of H2 at volume percentages of 20, 30, 50 and 100%. There are four small tasks proposed as part of this market and technology assessment work. The specifications that are important to the funders will be reviewed and agreed upon prior to the State-of-the-Art market survey. In Task 2, the survey will be completed and technologies that meet the specifications would be identified and evaluated for commercial readiness and Technology Readiness Level (TRL) if not already commercial. The funders would be presented with technology descriptions and with the input from the funders, the most promising options would be shortlisted. Then in Task 4, the work that would be needed would be examined and then described in the form of an R & D roadmap.	Decarbonization	1/2/2023	3/29/2024	$ 71,127	$ 6,940	$ 64,187	NYSEARCH members	$ 3,470	$ -
T-794 Crack Assessment of Squeeze Off Locations with Blended Hydrogen	T-794	NYSEARCH	The objective of the proposed project is to examine whether hydrogen blended with natural gas has the potential to leak from flaws induced by pipe squeeze-off operations on medium-density and high-density polyethylene (MDPE/HDPE). The test design would consider the various plastic pipe that has been installed for gas pipeline over the past 40 years. For the test design, the contractor would assume that blended hydrogen gas is to flow throughout all of the existing distribution pipeline infrastructure. This is to include a pipe sampling based on year of installation (age), material and diameter as a basis for selection. Considerable effort will be required of the participating gas companies to search their existing PE pipe infrastructure, exhume a section of operating pipe, perform a standard squeeze off procedure and then cap both ends of the sample pipe to create a sealed pressure vessel for DNV lab testing.	Decarbonization	7/1/2023	7/31/2024	$ 160,075	$ 15,615	$ 144,460	NYSEARCH Members	$ 15,615	$ -
T-795 Standardized Hydrogen Blending & Injection Skid for LDCs	T-795	NYSEARCH	The goal of this proposed work would be to pioneer a digital database to provide a common framework on hydrogen blending and interconnection and allow utilities to select the optimal design for their systems as they begin to accept hydrogen and control blend and hydrogen volume consistency throughout the distribution system. The database would serve as a valuable resource for local distribution companies as the gas industry is continuing to evaluate and fully understand the impact of hydrogen to the gas utility system and would help establish best practices for hydrogen system planning using this database tool. As part of the scope of work, CEPC would develop standard Process Flow Diagrams (PFDs), Pipeline and Instrumentation Diagrams (P&IDs), and fabrication drawings. Utilities would be able to choose the skid that best fits their needs and select customized instrumentation and equipment from the database. CEPC also proposes to develop a manufacturing specification that would accompany the skid design to provide guidance with the fabrication of the skid.	Decarbonization	7/1/2023	5/31/2024	$ 376,810	$ 35,885	$ 340,925	NYSEARCH members	$ 35,885	$ -
5.16.k.2 Ph2 ORFEUS Obstacle Detection Technology for HDD	5.16.k.2 Ph2	OTD	With $1MM of PHMSA funding, the project will build upon prior ORFEUS bore-head GPR research that has been conducted during a multiannual collaboration by a consortium of European companies. This has led to the development of a practical drill string radar system that has now undergone a series of demanding operation field trials in Europe, and a successful demonstration on a prepared PG&E test site in Livermore, CA. The robustness of the system has been proven, as well as the ability to fulfill the requirement of locating, and recognizing, obstacles within the drilling envelope. Most of the engineering problems have been overcome, and the task ahead is to refine the technology to produce a marketable system.	O&M Efficiency	1/14/2021	4/30/2024	$ 3,500,000	$ 350,000	$ 3,150,000	OTD Members, PHMSA, Southern California Gas	$ -	$ -
5.17.m.2 Modify Pipeline Purging Program for Calculations of Methane Emissions Savings, Including H2	5.17.m.2	OTD	OTD members have been using equipment and procedures that repurpose natural gas that would have been normally vented to the atmosphere. Quantifying the emissions savings from using these types of equipment and improved procedures can be difficult. As hydrogen blending is implemented, quantifying emissions savings from hydrogen will also be an important part of emissions reporting. The objective of this project is to update the pipeline purging software program (B3PE LLC/GTI Energy Software) to allow users to more easily calculate methane emissions savings from using various types of purging alternative processes and equipment (i.e., cross compression) and hydrogen blending operations.	O&M Efficiency	8/30/2023	9/30/2024	$ 174,000	$ 1,000	$ 173,000	SoCalGas, OTD Members	$ 1,000	$ -
5.20.k Smart Shut-off Tech for Residential and Commercial Buildings	5.20.k	OTD	GTI and Lorax Systems Inc. will perform research and development to enhance the resiliency of the natural gas infrastructure by developing a smart residential and light commercial shut-off system. The research team will modularize the already-developed and commercially available 1-¼" diameter meter set assembly safety shut-off system to fit the sizing needs of residential and light commercial California IOU gas utilities customers (¾" diameter). This ¾" safety valve will leverage the existing Lorax sensor-valve-utility communications platform to link the sensors to the meter set assembly valve and communicate the valve status to gas utility operator via a Low Power Wide Area Network (LPWAN).	O&M Efficiency	8/4/2020	4/30/2024	$ 1,230,000	$ 7,000	$ 1,223,000	OTD Members, CEC, Southern California Gas	$ -	$ -
5.20.k.2 Addition of Low Power WAN (LPWAN) Communication Network	5.20.k.2	OTD	OTD 5.20.k Project Smart Safety Shutoff System has two focuses: (1) conduct a global state-of-the-art survey to identify an integrated meter that contains the a safety shut-off technology and (2) further develop the stand-alone Lorax Safety Shutoff System and associated communications systems. 5.20.k.2 was a result of the product discovery phase of the 5.20.k that identified Low Power Wide Area Network (LPWAN) communication networks are being utilized for similar natural gas safety systems in Europe and Asia. The feedback has been that these communication networks are easy to deploy, reliable, ideal for battery operated sensors, easy to use to complement other communication networks, have a lower cost. This project will add LPWAN to the project and develop a roadmap for implementation.	O&M Efficiency	11/1/2021	4/30/2024	$ 82,000	$ 7,500	$ 74,500	OTD Members, CEC, Southern California Gas	$ -	$ -
5.22.j Ph1 Design and Placement of Compact Service Regulators	5.22.j Ph1	OTD	This project will review existing "vent-limiting" service regulators practices and perform comparative service regulator testing that will result in recommendations and guidance to the natural gas industry. The project will measure the level of natural gas produced from "vent-limiting" service regulators as compared to traditional IVR service regulators to determine safe clearance distance requirements; will determine whether "vent-limiting" service regulators offer more options for outside installation by having a smaller footprint that includes the ability to install at reduced clearance distances as compared to traditional IRV service regulators; and provide guidance on safe distance allowances when installed.	O&M Efficiency	11/19/2021	3/31/2025	$ 489,629	$ -	$ 489,629	OTD Members, PHMSA	$ -	$ -
5.24.m: Field Pilot of Real-Time Pipeline Threat Detection System (SPADE System)	5.24.m	OTD	This project is to demonstrate the SPADE real-time detection technology for detecting mechanical threats to steel pipeline systems through field pilot run. The main work is to install (3) SPADE units on each of (3) different PG&E transmission pipelines, for a total of (9) SPADE units.	O&M Efficiency	3/14/2024	6/30/2025	$ 477,497	$ 477,497	$ -	OTD Members	$ 250,000	$ 74,827.00
5.24.p Ultrasonic Meter Testing	5.24.p Ph1	OTD	The objective of this project is to evaluate the integration of the GNSS Smart Automation (GSA) technology into working GPS prototype to assess effectiveness and viability of this product, with the eventual goal of entering into a long-term, royalty bearing license agreement with Bad Elf.	O&M Efficiency	10/1/2024	1/1/2026	$ 230,000	$ 5,000	$ 225,000	OTD Members	$ 115,000	$ 115,000.00
7.17.d.3 Soap Solution Comparison Study for Rate Estimation/Hazard Assessment	7.17.d.3	OTD	There is a need to better understand if bubbles and frequency of bubbles are indicative of a potentially hazardous event, or a result of variables such as pressure, wind, and other factors. Objective of this project is to perform a comparison study between soap solutions to understand if solution additives may lead to relatively large variations in bubble sizes or formation rate.	O&M Efficiency	8/18/2023	8/1/2024	$ 125,000	$ 1,000	$ 124,000	OTD Members	$ 1,000	$ -
7.23.o Methane Detection Technology - Regulation Equivalence Testing	7.23.0	OTD	Continuous advancement in the leak detection market has inundated the industry with products of varied function and outputs with operational differences that can be ambiguous. A testing protocol developed for a consistent benchmark would seek to remove the external variables and focus on the effectiveness of each technology to complete a specific task. The objective of this project is to develop a protocol to evaluate leak detection technologies on a common benchmark, highlighting functional differences and comparing effectiveness. Equivalence testing of various technologies will provide an understanding of detection effectiveness and of performance comparisons, despite equipment variations. The protocol will aim to be agnostic across various detection	O&M Efficiency	8/18/2023	2/1/2025	$ 200,000	$ 1,000	$ 199,000	OTD Members	$ 1,000	$ -
7.24.c Near Field Fixed Monitoring, Phase 1	7.24.c	OTD	The objective of this project is to evaluate the use of fixed methane monitors for leak detection to be located near potential high flow locations on above ground equipment. Fixed methane monitors may aid with early detection of potential high risk and high methane leaks. This evaluation may aid operations in reducing the need for daily monitoring/survey of such asset class/equipment. Additionally, incorporating fixed monitoring could allow for fast detection of an unintentional release event and reduce operating risk.	O&M Efficiency	11/20/2023	6/30/2024	$ 73,000	$ 36,500	$ 36,500	OTD Members	$ -	$ -

8.20.L Enhanced Locating Technologies for Underground Pipelines with Better Accuracy	8.20.L	OTD	Gas Technology Institute (GTI) along with White River Technologies (WRT) proposes to conduct a field demonstration of a natural gas pipeline locate technology that improves the accuracy of underground infrastructure locates in both the horizontal and vertical dimensions over current practices and technologies. The hardware will achieve accuracy improvements in two ways; using adapted and improved above-ground large standoff 3D electromagnetic detection technology (developed by WRT) and also using an in-pipe mechanism (developed by Reduct) to focus on congested areas and plastic materials. To help address the estimated 21% of excavation damages caused by insufficient or inaccurate locating practices, the locate technology will provide data access and visualization in near real-time.	O&M Efficiency	11/4/2020	4/1/2024	$ 2,021,631	$ 12,554	$ 2,009,077	OTD Members, CEC, White River Technologies	$ -	$ -
8.20.m 3D Visualization Software for Mapping Underground	8.20.m	OTD	GTI will develop 3D visualization software for mapping underground pipelines and improving pipeline asset management. This platform will assist the field users in visualizing locate data from a variety of	O&M Efficiency	12/2/2020	3/31/2024	$ 2,090,436	$ 35,200	$ 2,055,236	CEC, SoCalGas, OTD Members	$ -	$ -
8.24.L Commercialization of GSA/Smart Pole	8.24.L Ph1	OTD	The objective of this project is to evaluate the integration of the GNSS Smart Automation (GSA) technology into working GPS prototype to assess effectiveness and viability of this product, with the eventual goal of entering into a long-term, royalty bearing license agreement with Bad Elf.	O&M Efficiency	10/1/2024	4/1/2026	$ 170,000	$ 10,000	$ 160,000	OTD Members	$ 100,000	$ 70,000.00
8.24.m Steel Material Traceability Unique ID and Smart Tags	8.24.m	OTD	The objective of this project is to convert the specification for steel material traceability Unique IDs and Smart Tags into an API Recommended Practice. Previous work funded by OTD and PRCI developed a specification for Unique IDs, Smart Tags, and Digital MTRs. The Digital MTR specification was published as API RP 5MT. The work in this proposed project will add the Unique IDs and Smart Tags to provide a complete RP for steel pipe traceability.	O&M Efficiency	10/1/2024	10/1/2026	$ 75,000	$ 5,000	$ 70,000	OTD Members	$ 75,000	$ -
Dev and Eval of a Hi-Res Historical Climate Dataset over CA	GFO-19-501 2of2	UC San Diego-Scripps Institute, Southern California Gas, CEC	Scripps will use state-of-the-art dynamical models to generate new statewide dynamical climate/weather at 2-kilometer, hourly resolution, driven by modern global weather re-analyses, and the regional model output will be validated using historical observed data from various available datasets. Two separate regional model re-analyses will be developed -- one targeted to realistically describe a range of wet weather including atmospheric rivers, and a second one targeted toward dry weather with an emphasis on wildfire conditions. To better inform users, the Recipient will evaluate the output data in terms of high-impact extreme events, including compound weather/climate events, and also conduct an attribution study to determine sources of trends.	O&M Efficiency	1/19/2021	12/31/2024	$ 1,363,550	$ -	$ 1,363,550	UC San Diego-Scripps Institute, Southern California Gas	$ -	$ -
EC-2-10 2019 Development of a Comprehensive Metal-loss Assessment Criteria	PRCI EC-2-10 2019	PRCI - 2019	EC-2-10 is a multi-year effort to combine results of EC-2-6, EC-2-7, and EC-2-8 (in progress) into a metal loss evaluation tool that is validated (part of the project) and ready for presentation to ASME B31.G. The tool will allow operators to identify areas where the existing tools (ASME B31.G / Modified 0.85 dL / Modified 0.85 dL Effective Area) are under and over conservative and should allow for use across all generations / strengths of pipeline steels.	O&M Efficiency	2/28/2019	7/30/2024	$ 1,493,000	$ 201,800	$ 1,291,200	PRCI Members	$ 5,758	$ -
Electromagnetic and Optical Sensor Technologies for Natural Gas Storage Safety Monitoring	GFO-19-502-2	CEC, Other	The CEC project PIR-19-1 awarded to Lawrence Berkeley National Lab is to develop and demonstrate an integrated suite of novel, autonomous and real time natural gas wellbore integrity monitoring technology based on distributed electromagnetic (EM) and fiber optic reflectometry methods. The approach combines novel guided-wave EM Time Domain Reflectometry (EM-TDR) with state-of-the-art Brillouin scattering based Optical Time Domain Reflectometry (BO-TDR) methods for distributed monitoring of NGS borehole conditions over the entire length. The combination of EM-TDR and BO-TDR provides multi-modal, multi-physics diagnosis of borehole health conditions by providing (1) EM signals from corrosion or stress related borehole damages; and (2) fiber optic strain and temperature signals from borehole operation, deformation or leakage events. The approach will be field tested at McDonald Island NGS facility once experimentation and validation are completed in the laboratory. Note: PG&E's cash cofund comes from the UGS group.	O&M Efficiency	7/16/2020	6/30/2024	$ 2,280,000	$ 440,000	$ 1,840,000	PG&E (in-kind), CEC	$ -	$ -
Fiber optic sensor monitoring of pipeline strain under geohazards (R-1143)	PHMSA #6913G620P8000102 and #693JK32050007CAAP	PHMSA	This project is to support PHMSA's#6913G620P8000102 and #693JK32050007CAAP -Using state-of-the-art distributed fiber optic sensing technologies to examine the feasibility of long-term monitoring of buried gas pipelines that are potentially vulnerable to ground deformation across faults and landslides related to PG&E's fault crossing mitigation project R-1143 in Gilroy CA.	O&M Efficiency	8/11/2021	12/30/2025	$ 1,241,000	$ -	$ 1,241,000	PG&E (in-kind), OEM, PHMSA	$ -	$ -
IM-1-08 Pragmatic Application of MegaRule RIN 1 - 192.712 Toughness Values	IM-1-08	PRCI - 2022	Current requirements defined in CFR 192.712 regarding the default charpy V Notch toughness values are to be effective in both HCA's and non-HCA's starting May 2023. Furthermore, it is anticipated that similar regulatory requirements can be expected to be applicable for liquid pipelines in the near future. The requirements, as prescribed, tend to provide excessively conservative results when applied using conventional, simplistic assessment methods and would likely lead to a scenario where almost any anomaly detected by a crack ILI tool would result in an immediate excavation. This, in turn, disincentivizes prudent integrity management practices and introduces massive inefficiencies. Successful completion of the proposed project would provide pipeline operators with practical guidelines, based on established science, for the implementation of the rule requirements while minimizing the inefficiencies.	O&M Efficiency	12/12/2022	4/30/2024	$ 249,995	$ -	$ 249,995	PRCI Members	$ -	$ -
IM-3-03 Comprehensive Review of SSWC Assessment	PRCI IM-3-03	PRCI - 2023	This PRCI Crack Management Strategic Research Priority (SRP) project will perform a comprehensive review of previous work done in industry on the selective seam weld corrosion (SSWC), the current approaches and look for a path forward for assessment of reported SSWC features. These new directions are formulated to overcome the inherent shortcomings in the current approaches.	O&M Efficiency	6/12/2023	5/30/2024	$ 100,000	$ 1,920	$ 98,080	PRCI members	$ 1,920	$ -
Investigation of EddyFi's Eddy Current NDE Tool for Hard Spots	ATS-HardSpots-2024	PG&E ATS	Hard sopt screening as part of standard H-form process. Rapid detection of pipeline hard spots at integrity inspection sites. Aligns with company decarbonization goals, as hydrogen can cause cracking and we need to make sure the risk of H2 cracking is minimized. The project will be conducted at ATS using the existing EddyFi tools with strong technical support from a TIMP contractor who is developing the hard spot inspection and management program for TIMP.	O&M Efficiency	5/1/2024	4/30/2025	$ 141,400	$ 60,000	$ 81,400	N/A	$ 81,000	$ -
JIP - Development of New Fracture Mechanics Features in APTI	JIP-SI-2024	Structural Integrity Associates	This JIP is to further develop and enhance Structural Integrity's APTITUDE™ fracture mechanics tools that include the following tasks: Task 1: Development of a web-based APTITUDE application Task 2: Hard Spot Module updates Task 3: Probabilistic Analysis Tools for Hard Spot and SCC Task 4: Incorporation of a Fatigue Crack Growth model for Hydrogen blending Task 5: Rainflow Calculator Tool Task 6: Fracture Mechanics Training Task 7: Four quarterly crack management workshop sessions.	O&M Efficiency	5/15/2024	3/31/2025	$ -	$ 29,750	$ (29,750)	list any co-funders here	$ 29,750	$ -
M2016-002 Ph2 Odor Detection Threshold Study Phase II	M2016-002 Ph2	NYSEARCH	The overall objective of the project is to complete a comprehensive review of the state-of-the-art methodology to measure natural gas odorants and mixtures and to update the measurement of detection and readily detectable (recognition) thresholds. The primary goals of Phase II of the project are to determine the degree of self-adaptation/de-sensitization to NG odorants and blends, how specific chemical compounds may mask or otherwise render NG odorants as less detectable or less identifiable/recognizable when experienced together, and how real-world factors decreases the ability of a person to be aware of the presence of NG odorants in real room air conditions.	O&M Efficiency	10/1/2019	3/31/2024	$ 1,281,783	$ 117,405	$ 1,164,378	SoCalGas, NYSEARCH Members	$ -	$ -
M2019-004 Ph2 Development of Mercaptan Sensor Systems with Non-Radioactive Ionizer Phase II	M2019-004 Ph2	NYSEARCH	The objectives of the Phase II proposal (submitted early because of the PHMSA cofunding opportunity) are to: 1) advance the sensor performance based on PhI testing, 2) build and deliver (10) pre-commercial prototypes, 3) support and complete field testing of the built pre-commercial systems using the non-radioactive ionizer to demonstrate commercial readiness, and 4) finalize documentation for technology transfer to a commercial partner.	O&M Efficiency	9/21/2021	3/31/2024	$ 923,147	$ 49,610	$ 873,537	PHMSA, NYSEARCH Members	$ -	$ -
M2019-010 PhII Eclipse Scientific Red/Green Light NDE Tool for PE Butt Fusion Joints	M2019-010 PhII	NYSEARCH	This project is to develop an automated NDE red/green light tool to inspect PE pipe butt fusion joints operated by properly trained but non-NDE expert gas industry workers. The Phase II work is to continue advancing the PAUT scanning techniques and apply machine learning AI toward the automated NDE red/green solution. If this Phase II is successful, the next Phase will develop the field final deployable PAUT scanning system.	O&M Efficiency	7/25/2022	12/31/2024	$ 442,000	$ 77,000	$ 365,000	NYSEARCH members	$ -	$ -
M2021-002 Ph3 sUAS (drone) Inspection for Submerged Pipes, Ph III	M2021-002 Ph3	NYSEARCH	The overall objective of this project is to further develop drone technology to perform enhanced leak detection surveys and mechanical integrity inspections for difficult to access suspended pipe and submerged pipelines. The objective of Phase III is to advance, optimize and finalize development of the inspection platforms, sensors and operating procedures.	O&M Efficiency	1/18/2024	6/20/2025	$ 209,050	$ 18,880	$ 190,170	NYSEARCH Members	$ -	$ -
M2021-004 Electromagnetic Time Domain Reflectometry (EM-TDR) for Pipeline Integrity	M2021-004	NYSEARCH	This project is to develop a novel pipeline integrity inspection tool based on electromagnetic time domain reflectometry (EM-TDR) technologies. The proposed Phase-1 work will focuses on building a laboratory prototype system to carry out first a feasibility study (simulations and experiments in the lab) on the potential of EM-TDR to provide direct assessment of pipeline conditions followed by a detailed laboratory and field study on ability to detect common defects in natural gas transmission pipelines. If the Phase-1 work is successful, it will lead to additional phases to develop and test an engineering prototype, a pre-commercial prototype and ultimately result in commercialization.	O&M Efficiency	10/1/2021	3/31/2024	$ 339,000	$ 28,850	$ 310,150	NYSEARCH member	$ -	$ -

M2021-006 Ph3 Explorer Wireless Range Extender	NYSEARCH M2021-006 Ph3	NYSEARCH	Based on the successful completion of the Phase2 (an engineering prototype), the Phase3 work focuses on field testing the developed technology to extend the range of the wireless communication system on the Explorer robots. The proposed work scope calls for two field deployments. The first would to be carried out at the NYSERACH Test Bed and the second in a pipeline operated by a funding company.	O&M Efficiency	11/1/2023	9/30/2024	$ 194,388	$ 23,565	$ 170,823	NYSEARCH members	$ 16,647	$ -
M2021-009 Feasibility Study on High Resolution MFL for Explorer Series of Robotic Platforms	M2021-009	NYSEARCH	This study is focusing on assessing various sensors available in the market, identifying the best one to be integrated on the MFL sensors for high inspection resolution (reduction from 0.24" to 0.16" in sensor size (-33%)) and better confidence level, which will result in improving detection and characterization of defects, especially pinhole corrosion pits and reducing excavation costs for verification.	O&M Efficiency	4/30/2021	12/31/2024	$ 215,084	$ 23,900	$ 191,184	PHMSA members	$ 20,395	$ -
M2021-011 A Feasibility Study on Extending Energy Harvesting to Other Pipetel Explorer Sizes	M2021-011	NYSEARCH	The proposed work is a feasibility study to determine the ability to scale-up the existing Explorer 20/26 energy harvesting system to other platforms, greater than 10", and to determine the performance envelope for each of those robots (Explorer 10/14, 16/18, 30/36).	O&M Efficiency	4/30/2021	12/31/2025	$ 193,948	$ 19,395	$ 174,553	NYSEARCH members	$ 13,000	$ 6,395.00
M2023-003 Optimal Design and Operation of Soil Aeration Systems for belowground Natural Gas Mitigation	M2023-003	NYSEARCH	The objective of this project is to use numerical models, analytic methods and controlled and field testing to investigate the feasibility of developing a practical approach for design, operation and monitoring of site-specific soil aeration systems.	O&M Efficiency	2/13/2024	12/31/2025	$ 261,853	$ 37,410	$ 224,443	SoCalGas, NYSEARCH Members	$ -	$ -
MAT-1-8 Post-Heating and Interpass Control as an Alternative to Delayed Nondestructive Examination	PRCI MAT-1-8	PRCI - 2023	This project will define weld procedure parameters that may be used to ensure sufficient hydrogen effusion to mitigate the risk of hydrogen cracking for Shielded Metal Arc Welding (SMAW) in-service fillet weld (Phase I) and and SMAW girth weld production/tie-in (Phase II) procedures. These approaches can be generalized to develop recommended welding procedure parameters that may be used to reduce inspection delay time, while ensuring that hydrogen cracks do not enter service, and thus increase efficiency (reduce cost and increase safety) for SMAW weld procedures.	O&M Efficiency	6/8/2023	6/30/2024	$ 224,200	$ 20,000	$ 204,200	PRCI Members	$ 18,852	$ -
MAT-7-2 Hard Spot Susceptibility Review - Pipe Manufacturers, Pipe Type, Vintage	PRCI MAT-7-2	PRCI - 2023	This PRCI SRP project is to develop guidelines for operators to follow when a hard spot detection in-line inspection (ILI) survey should be performed. It is anticipated that guidelines will be developed or updated related to: Updated Hard Sport Population Table Pipe Manufacturer Pipe Seam Type Year of Production Number of failures Number of hard sports reported or found in the field Flow chart for when to perform a hard spot detection ILI survey	O&M Efficiency	4/8/2023	4/30/2024	$ 150,000	$ 2,820	$ 147,180	PRCI members	$ 1,048	$ -
MAT-7-2A New Multi-Year Project: Hard Spot Detection	PRCI MAT-7-2A	PRCI - 2023	This project is to develop improved hard spot detection/sizing in response to NTSB report NTSB/PIR-22/02 re: Danville, KY. It is a follow-up work of MAT-7-2 Hard Spot Susceptibility Review Objectives include: deeper understanding of pipeline susceptibility, response criteria and time, in-ditch assessment and repair, impact of cathodic protection and influence of operating conditions State of the Art on hard spot detection tools Hard spot tool validation, performance analysis and gap analysis potential for AI output using defect/tool machine learning model	O&M Efficiency	9/11/2023	2/28/2025	$ 848,391	$ 25,614	$ 822,777	PRCI members	$ 18,863	$ -
NDE-2-15 SSWC Identification, sizing, and measuring grooving ratio in the ditch	PRCI NDE-2-15	PRCI - 2023	This project is to develop in-the-ditch evaluation methods and necessary tools to • Identify external SSWC verses other defects such as lack of fusion or seam trim • Measure external SSWC depth and length Outline pros / cons for each method. Relevant seam types for the main and sub-tasks are DSAW, SSAW, EFW, and ERW.	O&M Efficiency	10/16/2023	12/31/2024	$ 325,000	$ 20,000	$ 305,000	PHMSA members	$ 25,180	$ -
NDE-3-6 Review and Evaluation of Pipe Stress Inspection Techniques for Onshore Pipelines	PRCI NDE-3-6	PRCI - 2022	This project is to provide a comprehensive review, an operation manual and guideline document for all the known pipeline stress (strain) detection technologies, including ILI technologies (IMU bending strain, EM axial strain), in-the-ditch stress detection (ultrasonic stress, and radiographic stress) and above-ground screening/estimation (weak magnetics such as LSM-like developed by the PIs).	O&M Efficiency	11/8/2022	12/31/2024	$ 237,000	$ 20,000	$ 217,000	PRCI Members	$ 8,429	$ -
NDE-4-12 2019 Phase-2 Continuous Improvement of ILI Capabilities	PRCI NDE-4-12 2019 Phasell	PRCI - 2019	API and Association of Oil Pipe Lines (AOPL)'s R&D Work Group (RDWG) and PRCI are undertaking a JIP to develop pull test strings and protocols to validate and test the performance specifications published for UT crack detection, EMAT, spiral and circumferential MFL ILI tools. The purpose is to assess the current industry specifications and improve ILI crack tool capabilities. DNV serves as the project manager to validate and test the performance specifications published for the various crack detection ILI tools currently offered to the pipeline industry. DNV will work with Kiefner and Battelle in conducting this work. This Phase II work is part of the PRCI Crack SRP.	O&M Efficiency	12/12/2019	12/31/2024	$ 1,287,010	$ 21,740	$ 1,265,270	PRCI members	$ -	$ -
NDE-4-13 Selective Seam Weld Corrosion Detection with In-line Inspection Technologies	PRCI NDE-4-13	PRCI - 2020	This 3-year project is to test and evaluate the performance specifications published for Selective Seam Weld Corrosion (SSWC) detection by MFL, EMAT, and UT shear-wave ILI tools currently offered to the pipeline industry. The outcome will provide pipeline operators with the ability to make informed decisions for managing a pipeline with SSWC or corrosion that interacts with a long seam using ILI tools.	O&M Efficiency	7/27/2020	12/31/2024	$ 811,500	$ 39,137	$ 772,363	PRCI members	$ -	$ -
NDE-4-13A Seam Weld Corrosion Detection with ILI Technologies	NDE-4-13A	PRCI - 2023	NDE-4-13 project is to provide users with the knowledge of current ILI capability in detecting selective seam weld corrosion (SSWC) and differentiating from coincidental corrosion that interacts with the long seam weld. A second targeted result is a step change in ILI capabilities with respect to detecting, identifying, and characterizing SSWC. This project is the expansion of NDE 4-13 to analyze more data and have a larger sample size of how well ILI technology is able to differentiate SSWC and coincidental corrosion that interacts with the long seam weld.	O&M Efficiency	8/2/2023	12/31/2024	$ 275,412	$ 10,000	$ 265,412	PRCI members.	$ 10,000	$ -
Open Solutions for Historical Climate Data for California	GFO-19-501 1of2	Eagle Rock Analytics, Inc.	Lead by Eagle Rock Analytics, this project will advance natural gas system reliability in three ways: (1) provide historical climate data at the spatial and temporal resolutions requested by IOUs, (2) operationalize state of the art landslide risk metrics on climate and seasonal timescales, and (3) advance understanding of climate-natural gas infrastructure risk dynamics by producing a state of the art climate data assimilation platform. IOU's require historical climate data to support risk assessments. This project will operationalize recent advances by developing an open source data assimilation platform to produce historic data and infrastructure risk proxies in near real-time.	O&M Efficiency	9/27/2021	3/31/2024	$ 1,000,704	$ -	$ 1,000,704	CEC	$ -	$ -
US-4-04 Advancement of Through-Tubing Case Inspection for Underground Storage Wells	PRCI US-4-04	PHMSA, PRCI - 2022	This project will advance the current state of through-tubing casing inspection technology for underground storage wells, and establish a workflow that provides operators with improved efficiency in casing corrosion management using through-tubing inspection technology with reduced cost and well entry risk. A fit-for-purpose lab test program will assist logging tool vendors to improve their commercial through-tubing logging tools. A reliability-based assessment methodology will be developed to inform the use and interpretation of through tubing logs for casing corrosion management. A field trial will be conducted with vendor tools to validate their performance and demonstrate the new assessment methodology. PHMSA #693JK32110008POTA	O&M Efficiency	9/30/2021	6/30/2025	$ 1,576,998	$ 85,200	$ 1,491,798	PRCI Member	$ 16,715	$ -
1.14.g.6: RMD Phase 6: Support for NFPA Standard Development	1.14.g.6	OTD	Customer behavior suggests that odorant alone may not be enough for customers to report leaks. Having an alert system at homes provide a more proactive approach to gas leak detection. The previous phases of this project tested and evaluated residential methane detectors (RMDs), and developed guidelines for the UL Standard 1483 (Standard for residential gas detectors) and recommendations such as the 10% alarm threshold. This project will provide continuing support for the standard approval process and committee work.	Reduce Methane Emissions	7/1/2021	8/1/2024	$ 48,000	$ 4,000	$ 44,000	OTD Members	$ -	$ -
2.24.E Fuel-flexible, Ultra-low NOx, Cross-cutting OCS	2.24.E	UTD	Advance the deployment of low-carbon fuels across large commercial and industrial sectors by developing and demonstrating in both the lab and field a continuously fuel-flexible (NG, H2, biogas, syngas, etc.) combustion system.	Reduce Methane Emissions	10/1/2024	10/30/2027	$ 4,854,000	$ 15,000	$ 4,839,000	UTD members, DOE, SoCalGas, Honeywell Thermal Solutions, Georgia Tech	$ 65,000	$ 125,000.00
5.19.f.2 Ph2 Purging Gas Pipes into Service w/o Venting Gas	5.19.f.2	OTD	The distribution mains and service asset families have a combined 42,700 miles of pipeline that connects to the gas M&C asset family on the upstream side and transports natural gas to customers throughout the service area. It also includes 3.4 million service lines that deliver gas from distribution mains to the Customer Connected Equipment (CCE) family on the downstream side. The program has a number of replacement projects that will achieve the replacement rate that limits asset age to 100 years by 2030. During this work, it is routing to purge the natural gas to atmosphere from the line. However, this routine process releases potent GHG to the atmosphere, making it difficult to achieve our environmental commitments. This project will bring the vacuum purge technology to a state of commercial offering.	Reduce Methane Emissions	11/20/2020	8/31/2024	$ 175,000	$ 17,500	$ 157,500	OTD Members, Southern California Gas	$ -	$ -

5.24.v Development of a Low-Cost Hydrogen Sensor for in-pipe	5.24.v.2	OTD	GTI Energy will develop a high accuracy (<0.5%), low cost, hydrogen sensor to detect 0% to 100% hydrogen concentrations. Fuel mixture properties (heating value, Wobbe Index, etc.) will be configured using existing data from GTI Energy and demonstrate the sensor in at least two OTD member field sites. This project will also summarize existing commercially available hydrogen sensors.	Reduce Methane Emissions	10/1/2024	10/1/2026	$ 200,000	$ 10,000	$ 190,000	OTD members, University of Wisconsin, Madison	$ 120,000	$ 80,000.00
7.16.a.3 Leak Repair Prioritization Ph3	7.16.a.3	OTD	Further explore the development of the leak rate estimation algorithms developed in Phase 1 and 2 which were originally focused solely on leak repair prioritization. Phase 3 will focus on taking these estimation algorithms a step further by combining the collected data with advanced modeling and a detailed estimation equation developed by the University of Texas-Arlington (UT-Arlington). This phase of work will also examine current leak detection thresholds for multiple sponsor companies to determine if the minimum detection threshold results in leaks that are too small to quantify with existing protocols. This phase of work will again focus on non-hazardous leaks (e.g., Grade 2 or 3) that pose minimal safety hazards.	Reduce Methane Emissions	2/28/2022	12/31/2024	$ 150,000	$ 1,000	$ 149,000	OTD Members	$ -	$ -
7.20.f Ph1 Characterizing Methane from Purging	7.20.f	OTD	The project objective is to develop a method to quantify the volume of natural gas emitted during the commissioning of a pipeline. This method will be validated at GTI in preparation for field studies. It is envisioned that the knowledge gained from this project could be applied to emergency blowdowns at a later stage.	Reduce Methane Emissions	4/1/2020	9/30/2024	$ 100,000	$ 20,000	$ 80,000	OTD Members	$ 5,889	$ -
7.20.l Methane Mitigation Using Linear Recovery Motor Comp	7.20.l	OTD	Currently in PG&E's emissions reporting to the CPUC, transmission compressor stations account for 110 MMCF of emissions (~3% of PG&E's total reported emissions). Most of these emissions cannot currently be easily abated. To help achieve the mandated emissions reduction of 25% and 40% below 2015 levels by 2025 and 2030 (respectively), PG&E needs to evaluate as many emission reduction strategies as possible. This linear compressor technology offers an opportunity to recover a large portion (>70%) of the emissions from transmission compressor stations.	Reduce Methane Emissions	11/4/2020	9/30/2024	$ 1,917,000	$ 30,000	$ 1,887,000	OTD Members, DOE, SoCal	$ -	$ -
7.21.b Advanced Tools for Methane Emissions Estimation	7.21.b	OTD	This project aims to develop an advanced tool to estimate the emission rate based on spatial methane concentration measurements. This is proposed to be done by incorporating dispersion physics models and deep learning algorithms to enhance estimation and prediction accuracy. A proof-of-concept study is to be conducted to demonstrate feasibility of this new methodology. A follow-up project to be proposed based on the results of the proof-of-concept study to perform field testing and evaluation by collaborating with leak survey data.	Reduce Methane Emissions	1/1/2021	8/31/2024	$ 140,000	$ 14,000	$ 126,000	OTD Members	$ -	$ -
7.21.f Developing a Framework for Certifying Responsible Natural Gas	7.21.f	OTD	Currently, gas suppliers and certifying organizations lack a standardized method for reporting and quantifying GHGs including methane emissions, natural resources, and other Environmental Social Governance factors. CARB has started estimating the out-of-state methane emissions for the California natural gas supply. AGA and EEI are promoting a system of reporting estimates of upstream methane emissions based on the protocol developed by M.J. Bradley and Associates. The purpose of this project is to publish a white paper outlining a technical framework to certify Responsible Natural Gas with guidelines on how to report environmental attributes of a gas product important to utilities.	Reduce Methane Emissions	1/1/2021	6/30/2024	$ 207,000	$ 16,000	$ 191,000	OTD Members	$ -	$ -
CPS-17-04A Improved GHG Fugitives Leak Detection	CPS-17-04A	PRCI - 2021	Presently, operators are unable to clearly identify and pinpoint which isolation valve(s) exhibit large leaks as multiple valves are typically manifolded to a single vent. As such, the operator doesn't have the ability to know which valve requires replacement or repair. The improved diagnostics will inform valve repair/replacement decisions and provide the basis for focused GHG leak mitigation.	Reduce Methane Emissions	11/8/2021	3/31/2024	$ 120,000	$ 10,000	$ 110,000	SoCalGas, PRCI Members, OTD Members	$ -	$ -
Evaluating Emissions from Transmission M&R stations	Internal_Transmission M&R Station Emissions	Sensit	This internal project will investigate emissions from transmission M&R stations as they are among the top 3 emission sources. Current emission factors for AG stations are based on an outdated study overestimating emissions. The main source of station emissions are pneumatic devices which can be categorized into low, intermittent, and high bleed. Open path sensors will be installed at stations from each category to continuously monitor emissions for several months. Measurements with other devices will also be taken since the sensors measure concentration only. The results will help us encourage CPUC to update the current emission factors for transmission stations.	Reduce Methane Emissions	8/21/2017	12/31/2025	$ 117,100	$ 117,100	$ -	N/A	$ 35,149	$ 6,000.00
M2014-001 Ph 3 JPL Methane Detector and Control System for sUAS Technology	M2014-001 Ph 3	NYSEARCH	During the initial phases of this project, NASA/JPL and Automated Aeronautics assembled and tested the JPL methane research sensor and commercial Pergam methane detector on a small Unmanned Aerial System (sUAS) platform for NYSEARCH interests in methane detection and ground localization. These initial studies concluded that sUAS-based methane detection can be performed with these sensors and detectors while staying within the FAA Part 107 commercial sUAS regulations. The final conclusions in the initial project phases are that while methane detection and ground localization can be performed, further improvements may be achievable through additional iterative algorithm refinement, collecting data in controlled and field test environments. This proposed phase will advance the sUAS technology for leak survey already established for methane detection capability and ground emission location accuracy, as well as develop methods for methane emission quantifications.	Reduce Methane Emissions	11/3/2020	6/30/2024	$ 338,140	$ 67,630	$ 270,510	NYSEARCH Members	$ 24,069	$ -
M2017-004 Ph3 Methane Oxidation Catalysts to Replace Flaring	M2017-004 Ph3	NYSEARCH	Objective is to develop materials that oxidize hydrocarbons at low temperatures via a catalytic process. In phase 1, Stanford improved the activity of Pd-based catalysts by 10 times relative to commercial Pd catalysts and explored the influence of water on combustion rates. In phase 2, results were tested under realistic conditions. A lab prototype was designed by Stanford to show proof-of-concept of the champion catalyst system's performance. Phase 3 will focus on the feasibility in a larger scale, cost/benefit analysis, unit fabrication, and performance verification. The expected project outcome is an improved technology providing flaring alternatives for contaminated hydrocarbon streams.	Reduce Methane Emissions	1/1/2021	12/31/2024	$ 238,122	$ 39,155	$ 198,967	NYSEARCH Members	$ 23,057	$ -
M2020-006 Standardization of NYSEARCH Methane Emissions Validation Process	M2020-006	NYSEARCH	Non-hazardous leak indications (Grade 3) are given a lower priority from a safety perspective and can be monitored rather than scheduled for repair. By adding a process for validating methane emissions, gas company operators and their constituents can prioritize the environmental impact of Grade 3 leaks. This completed validation process provides a confirming and independent verification of a technology provider's claims regarding specific methane emissions measurement capabilities of the provider's tool(s). The overall objective of the project is to identify, apply and test a methodology or set of methodologies that allow a gas distribution operator to validate the accuracy of measuring, locating and quantifying the methane emissions rate from non-hazardous natural gas infrastructure leaks. When this work has been completed, this methodology will be standardized.	Reduce Methane Emissions	6/30/2020	12/31/2024	$ 71,820	$ 9,265	$ 62,555	NYSEARCH members	$ 6,730	$ -
MSA Leak Prevention_Jomar Male Tailpiece	Jomar Male Tailpiece	Jomar	Meter set leak prevention a high priority for PG&E as meter set leaks make up some of the top methane emitters. Many above ground meter set leaks on the nipple below the regulator. Jomar manufactures a male tailpiece for their insulated meter valves. This component has the ability to reduce MSA threaded connections by 50%, resulting in 50% fewer potential leak points.	Reduce Methane Emissions	2/26/2024	12/31/2024	$ 15,000	$ 15,000	$ -	None	$ 15,000	$ -
T-786 Ph2 Classifying Methane Emissions at Regulator Stations	T-786 Ph2	NYSEARCH	The purpose of this project is to design a test protocol for how to measure emissions from regulators and general emission sources found at regulator stations. The completed test protocol will be provided to funders across the country so they can carry out emission measurements at their own M&R stations.	Reduce Methane Emissions	6/3/2023	9/4/2024	$ 191,535	$ 28,375	$ 163,160	NYSEARCH Members, Southern California Gas Company	$ 28,375	$ -
T-796 LDC Validation of Satelytics' Aerial System for Methane Detection & Emission Quantification	T-796	NYSEARCH	The objective of this project is to test Satelytics' aerial methane detection and emission quantification technology including initial evaluation of its probability of detection (PoD) performance. Satelytics has adapted mid-IR spectroscopy and satellite captured imagery in near Earth orbit collecting methane detection emission with associated GPS coordinates.	Reduce Methane Emissions	8/10/2023	4/30/2024	$ 649,497	$ 112,955	$ 536,542	NYSEARCH Members	$ 112,955	$ -
T-797 LDC Validation of Bridger Photonics' Aerial System for Methane Detection & Emission Quant.	T-797	NYSEARCH	The objective of this project is to test Bridger Photonics' aerial methane detection and emission quantification technology including initial evaluation of its probability of detection (PoD) performance.	Reduce Methane Emissions	7/26/2023	6/30/2024	$ 445,022	$ 80,912	$ 364,110	NYSEARCH Members	$ 80,912	$ -

PG&E Gas and Electric
Advice Submittal List
General Order 96-B, Section IV

AT&T

Albion Power Company
Alta Power Group, LLC

Anderson & Poole

Atlas ReFuel BART

BART
Buchalter
Barkovich & Yap, Inc.
Braun Blaising Smith Wynne, P.C.

California Community Choice Association
California Cotton Ginners & Growers Association
California Energy Commission
California Hub for Energy Efficiency
California Alternative Energy and Advanced Transportation Financing Authority
California Public Utilities Commission
Calpine
Cameron-Daniel, P.C.
Casner, Steve
Center for Biological Diversity
Chevron Pipeline and Power
City of Palo Alto
City of San Jose
Clean Power Research
Coast Economic Consulting
Commercial Energy
Crossborder Energy
Crown Road Energy, LLC
Communities Association (WMA)

Davis Wright Tremaine LLP

Day Carter Murphy
Dept of General Services
Douglass & Liddell
Downey Brand LLP
Dish Wireless L.L.C.

East Bay Community Energy

Ellison Schneider & Harris LLP
Electrical Power Systems, Inc. Fresno
Engineers and Scientists of California

GenOn Energy, Inc.

Green Power Institute

Hanna & Morton LLP

ICF consulting
iCommLaw

International Power Technology

Intertie
Intestate Gas Services, Inc.

Kelly Group

Ken Bohn Consulting
Keyes & Fox LLP

Leviton Manufacturing Co., Inc.
Los Angeles County Integrated

Waste Management Task Force

MRW & Associates
Manatt Phelps Phillips
Marin Energy Authority
McClintock IP
McKenzie & Associates
Modesto Irrigation District

NOSSAMAN LLP
NRG Solar

OnGrid Solar

Pacific Gas and Electric Company
Peninsula Clean Energy
Pioneer Community Energy

Public Advocates Office

Redwood Coast Energy Authority
Regulatory & Cogeneration Service, Inc.
Resource Innovations
Rockpoint Gas Storage
SCD Energy Solutions
San Diego Gas & Electric Company
SPURR
San Francisco Water Power and Sewer
Sempra Utilities

Sierra Telephone Company, Inc.
Southern California Edison Company
Southern California Gas Company

Spark Energy

Sun Light & Power
Sunshine Design
Stoel Rives LLP

Tecogen, Inc.
TerraVerde Renewable Partners
Tiger Natural Gas, Inc.
TransCanada

Utility Cost Management
Utility Power Solutions

Water and Energy Consulting
Wellhead Electric Company
Western Manufactured Housing Communities Association (WMA)

Yep Energy