Research, Development, and Demonstration (RD&D)

2025 Annual Report

SoCalGas™

Glad to be of service®

Jawaad Malik

Senior Vice President of
Strategy and Sustainability

> Innovation through research, development, and demonstration is essential to shaping California's energy future. RD&D unlocks technologies that make our energy system stronger and more resilient—while expanding access to increasingly affordable, decarbonized energy for all Californians. By investing in these solutions today, we're helping create an energy future that is affordable, reliable, and accessible for every community we serve.
>
> — Jawaad Malik

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Executive Summary

SoCalGas RD&D Background

The SoCalGas Research, Development, and Demonstration (RD&D) program is a ratepayer-funded initiative authorized by the California Public Utilities Commission (Commission or CPUC). The RD&D program advances research, development, demonstration, and adoption of technologies that support California's safety, reliability, resilience, affordability, air quality and climate goals. In compliance with Public Utilities Code (PUC) § 740.1, the RD&D program prioritizes projects that have a reasonable probability of delivering benefits to ratepayers, including enhanced safety and operational performance, improved system reliability and resilience, reduced energy costs, lower greenhouse gas emissions (GHG), and improved air quality.

SoCalGas RD&D manages a diverse portfolio of projects spanning early-stage laboratory research to full-scale field demonstrations of emerging technologies. The program's objective is to rigorously assess new technologies prior to potential operational implementation and deployment. To maximize value and avoid duplication, SoCalGas collaborates with other California gas research administrators, including the California Energy Commission (CEC), Pacific Gas and Electric Company (PG&E), and Southwest Gas Corporation, to coordinate research priorities and share insights. Over time, the program has helped advance numerous technologies from early development to pilot demonstrations, and in some cases, toward operational and commercial deployments.

Summary of Report Contents

2025 Reporting Year

In 2025, the RD&D portfolio continued to operate under the 2023 program structure approved by the CPUC. Consistent with the direction provided in CPUC Decision (D.) 19-09-051 and the additional guidance set forth in Resolution (Res.) G-3586, SoCalGas did not initiate any new RD&D projects in 2025. Instead, the program focused on executing multi-year continuing projects initiated in 2024 under Res. G-3601 or prior authorizations. This report satisfies Ordering Paragraph (OP) 30 of D.19-09-051,[1] which requires that SoCalGas submit an annual report summarizing the prior year's RD&D program activities. A regulatory compliance matrix is provided in Appendix 1.

Major Accomplishments

In reporting year 2025, SoCalGas RD&D managed 157 active projects. Of these, 80 projects were completed during the year, including 25 projects that directly engaged or benefited ESJ communities. Across its portfolio, the program leveraged ratepayer-funded investments to attract third-party support, securing approximately five dollars in external co-funding for every dollar of RD&D investment.

[1] OP 30 at page 783.

Improve Safety	Improve Reliability	Improve Affordability	Increase Operational Efficiency	Reduce GSG Emissions	Improve Air Quality
55%	**60%**	**45%**	**52%**	**64%**	**45%**

Table 2: Percentage of SoCalGas RD&D project types active in 2025

This cost sharing extended the reach of the program and amplified the impact of RD&D activities while helping to reduce overall costs for ratepayers.

The projects supported by SoCalGas RD&D were designed to deliver a broad range of public and ratepayer benefits, including improved safety, enhanced system reliability and resilience, increased energy affordability, greater operational efficiency, reduced GHG emissions, and improved air quality. Together, these outcomes reflect the program's focus on advancing practical solutions that strengthen system performance while supporting California's energy and climate goals in compliance with the requirements under PUC § 740.1.

The Project Spotlights section highlights two case studies that demonstrate how RD&D program benefits are realized in practice. The first case study examines rapid, low-cost microbial testing to address microbiologically influenced corrosion in gas pipelines. By enabling field-ready identification of corrosion-causing microbes in under an hour, this work supports earlier intervention, more targeted treatments, and lower long-term maintenance costs, helping enhance pipeline reliability and safety.

The second case study illustrates how education and community engagement can support energy resilience. Through classroom instruction, hands-on demonstrations, and public deployments of microgrids and mobile fuel cell generators, SoCalGas RD&D helped students and communities—particularly those in ESJ areas—better understand how emerging technologies can support critical services during outages. By pairing learning with real-world demonstrations, these projects showed that resilience depends not only on the availability of advanced technologies, but also on people knowing how and when to use them. Insights from these initiatives are informing future deployments, supporting technology readiness and commercialization pathways, and helping assess performance, scalability, and community benefits in ways that directly align with California's climate, resilience, and equity objectives.

Building on these outcomes, project results are also applied to advance key state climate priorities, including GHG reductions under Assembly Bill (AB) 32 and the development and integration of renewable natural gas (RNG) consistent with Senate Bill (SB) 1383 and AB 1900. Research findings that improve RNG production and leverage existing gas infrastructure for RNG distribution may help reduce emissions from organic waste streams while supporting California's broader decarbonization and air quality goals. Through this approach, RD&D translates policy objectives into measurable system improvements that strengthen resilience, reliability, and long-term climate performance.

Quantified Impacts

In Resolution G-3601,[2] the CPUC directed SoCalGas to participate in the Commission's broader, Electric Program Investment Charge (EPIC)-led effort to develop a uniform impact analysis framework (UIAF) for RD&D, while continuing to report impacts and benefits to ratepayers in the interim.

Because there is no specific UIAF established for Gas RD&D administrators, SoCalGas continues to rely on the EPIC founding principles as a benchmark to explore, develop, and refine RD&D program and sub-program level metrics. In addition, SoCalGas RD&D continues to track and report a set of program- and project-level metrics that demonstrate benefits to ratepayers, including improvements in safety, reliability, affordability, operational efficiency, emissions reductions, and support for ESJ communities. These metrics provide transparency into program activity, outcomes, and leverage, while remaining consistent with CPUC direction and recognizing the distinct role of Gas RD&D.

In alignment with the Foundational Principles[3] (FPs) for the EPIC UIAF, during 2025, SoCalGas

[2] Available at: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M521/K196/521196139.PDF

[3] D.23-04-042, Appendix A: Foundational Principles for Development of a Uniform Impact Analysis Framework to Comply with Decision 21-11-028.

used the list of potential areas of measurement in Attachment 4 of D.13-11-025 as the basis for identifying metrics relevant to the natural gas industry. These metrics, combined with a systematic and documented approach for quantifying the value of initiative and project-level benefits, are intended to support a transparent, consistent method for estimating ratepayer benefits. Ratepayer benefits will continue to be assessed and reported within the following categories:

1. Safety
2. Reliability
3. Affordability
4. Operational efficiency
5. GHG emissions
6. Air quality
7. Support for ESJ communities

Background: Introduction and Program Overview

Program Purpose

Value Statement

The purpose of the SoCalGas RD&D program aligns directly with SoCalGas's mission: *"Safe, Reliable, and Affordable energy delivery today. Ready for tomorrow."*

SoCalGas RD&D champions technologies that enable access to safe, reliable, and affordable energy for all Californians. The program's science and engineering teams collaborate with leading researchers from California-based universities, national laboratories, and private industry to address some of today's most pressing energy challenges. By actively sharing research findings and technical insights with other utilities, national laboratories, academic institutions, and state agencies, SoCalGas delivers value to its ratepayers and contributes to California's broader decarbonization goals.

Program Basis

SoCalGas RD&D operates under the authority of the CPUC and PUC § 740.1, which authorizes the use of ratepayer funds for research, development, and demonstration activities that provide public interest benefits. Consistent with this statutory direction, the program supports research that may inform gas system operations, enhances safety and reliability, manages costs, and reduces environmental impacts.

The program is governed by CPUC decisions that establish and approve Gas RD&D activities, budgets, and reporting requirements, including:

- D.13-05-010: Provided specific authorization for the SoCalGas RD&D program and directed that RD&D costs be tracked in a one-way balancing account.[4]
- D.16-06-054: Approved continuation of SoCalGas's RD&D program for the Test Year (TY) 2016 cycle.[5]
- D.19-09-051: Serves as the central, modern framework for the current program. It approved and authorized RD&D funding for the 2019–2023 GRC cycle and required SoCalGas to submit its RD&D proposal annually through a Tier 3 Advice Letter to the Energy Division.[6]
- D.24-12-074: Authorized SoCalGas funding levels from 2024 through 2027 and provides RD&D budget authority for 2024 and beyond, subject to approval of RD&D plans and subsequent Commission direction. This decision explicitly authorizes continuation of the RD&D program under the rules adopted in D.19-09-051 and Resolutions G-3573, G-3586, and G-3601.[7]

The RD&D program is also subject to subsequent CPUC actions, including approval of annual RD&D research plans and reporting requirements through Resolution

[4] Available at https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M065/K336/65336060.PDF

[5] Available at https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M164/K606/164606603.pdf

[6] Available at https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M316/K704/316704666.PDF

[7] Available at https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M550/K485/550485071.pdf

G-3601 and related filings.[8] Together, these decisions and resolutions define eligible research areas, funding levels, and program oversight expectations.

From an operational standpoint, SoCalGas RD&D is structured to benefit ratepayers by addressing technical challenges that require research, testing, and validation before broader implementation. Projects evaluate technologies, validate methodologies, and generate data to inform field practices, compliance strategies, and long-term planning and investment decisions.

Consistent with CPUC guidance regarding prudent and reasonable use of ratepayer funds under PUC § 740.1, RD&D activities are coordinated to facilitate knowledge transfer, support potential implementation, and avoid duplication of efforts. In alignment with the CPUC's ESJ Action Plan 2.0, SoCalGas RD&D collaborates with PG&E's Gas RD&D program, the CEC, Southwest Gas Corporation, industry research consortia[9], national laboratories, and California universities. These collaborations help leverage shared knowledge and advance outcomes that may deliver benefits to communities that have been historically underserved or disproportionately impacted by pollution or reliability challenges.

The program's structure enables SoCalGas to evaluate emerging risks, assess new tools and processes, and make informed decisions prior to deploying technologies or solutions at scale. By operating within CPUC-approved frameworks and aligning research with operational needs and CPUC policy objectives, SoCalGas RD&D supports practical improvements to the performance of today's energy system while maintaining a clear focus on delivering measurable benefits to ratepayers and preparing for California's future energy landscape.

Investment Themes

SoCalGas RD&D identifies and supports projects and technologies with the potential to improve the safety, reliability, and affordability of energy, increase operational efficiency, reduce GHG emissions, and improve air quality for all SoCalGas customers, including those in ESJ communities. In compliance with PUC §740.1 and CPUC direction, the program emphasizes solutions that address operational needs while supporting the state's long-term decarbonization goals.

Pursuant to D.19-09-051, the annual report must describe the "…structure of the RD&D portfolio."[10] In 2025, the program continued operating under the most recently approved structure, as outlined in the 2023 Research Plan. No new projects were initiated in 2025, instead the program continued multi-year RD&D activities across five authorized program areas, each comprising one or more subprograms.

Low Carbon Resources (LCR)

The Low Carbon Resources program aims to decarbonize the gas supply while supporting affordability and reliability. The program focuses on developing, promoting, and advancing technologies to increase the production and availability of renewable gases. In 2025, the Low Carbon Resources program also completed ongoing projects within the Carbon Capture, Utilization, and Sequestration subprogram, which was retired under CPUC Resolution G-3601. Under Resolution G-3601 and AL 6273-G, SoCalGas RD&D was permitted to complete previously fully funded CCUS projects but not to initiate any new projects in this area.

In 2025, this program included one active subprogram:

- **Renewable Gas Production**. This subprogram focuses on the safe, reliable, and cost-effective production of renewable gaseous fuels—specifically RNG and clean renewable hydrogen[11] —from various feedstocks and multiple technological pathways. The goals of this subprogram are

[8] Available at https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M521/K196/521196139.PDF

[9] Additional information on the consortiums and SoCalGas RD&D involvement is included in the Research Consortia appendix.

[10] D.19-09-051, Ordering Paragraph (OP) 30 at 783.

[11] Resolution G-3601, page 7, notes projects conducted by SoCalGas must utilize clean renewable hydrogen, which is defined in D.22-12-057 as "hydrogen which is produced through a process that results in a lifecycle (i.e., well-to-gate) GHG emissions rate of not greater than 4 kilograms of CO2e per kilogram of hydrogen produced and does not use fossil fuel as either a feedstock or production energy source."

to increase the availability and affordability of renewable gas and support pipeline decarbonization by advancing production technologies that diversify renewable gas feedstocks.

Gas Operations (GO)

The Gas Operations RD&D program supports transmission, distribution, and storage operations through innovations that seek to enhance pipeline, public, and employee safety, maintain system reliability, increase operational efficiency, and reduce environmental impacts. The program also facilitates technology development driven by emerging operational needs, evolving regulatory requirements, and CPUC guidance. Its primary goals are to develop, test, and introduce new gas operations technologies that benefit ratepayers, public safety, and the environment.

In 2025, this program was divided into four subprograms:

- Environmental & Safety: Enhances environmental performance and physical pipeline integrity by reducing GHG and criteria pollutant emissions and improving safety for the public and workers. Projects focus on developing technologies that support state goals and strengthen the physical security and reliance of the pipeline network. Safety examples include protecting the pipeline from intentional and unintentional damage and improving the safety of the public and company employees or contractors working on or around the pipeline.
- Operations Technology: Advances techniques and tools for pipeline construction, operation, maintenance, rehabilitation, and testing. This subprogram supports continued safe and reliable service, while pursuing affordability through advancements in equipment and operations efficiencies.
- System Design & Materials: Develops materials, tools, and methodologies used to design and manage pipeline systems. Research in this area informs SoCalGas design standards, engineering practices, and long-term pipeline asset management strategies over the asset's life cycle. Ultimately, lessons learned on these projects help SoCalGas establish design and engineering parameters used to manage its pipeline system.
- System Inspection & Monitoring: Supports development of technologies and methods used for inspection, monitoring, and testing of pipelines and pipeline components to assess the condition and performance of pipeline facilities, improving affordability while maintaining system reliability and integrity.

Clean Generation (CG)

The Clean Generation program focuses on the development and demonstration of high-efficiency products and technologies associated with power generation across residential, commercial, and industrial sectors. Its goals are to improve energy reliability and resilience, lower customer costs, reduce GHG and criteria pollutant emissions, and enable integration of renewable fuels. In 2025, this program included projects in two sub-programs, one of which—Distributed Generation—was retired under Resolution G-3601. Under the resolution, SoCalGas RD&D was permitted to complete previously approved projects in this retired sub-program due to the significant funds already invested, but not to initiate any new projects in this area.

In 2025, this program included one active subprogram:

- Integration & Controls: Develops and demonstrates technologies and control systems that integrate diverse distributed generation, storage, and thermal loads. Projects aim to enable low-emissions distributed energy resources that support energy resilience and customer affordability.

Customer End-Use Applications (CEUA)

The CEUA program develops, demonstrates, and helps commercialize technologies that improve

efficiency and reduce environmental impacts of gas equipment used in residential, commercial, and industrial applications. In 2025, this program included projects in five subprograms, two of which—Industrial Process Equipment and Residential Appliances—were retired in CPUC Resolution G-3601. Under Resolution G-3601 SoCalGas RD&D was permitted to track the completion of previously funded projects in the retired sub-program Industrial Process Equipment, but not to initiate any new projects in this area.

In 2025, this program included three active subprograms:

- Advanced Innovation: Develops emerging, nontraditional technologies aimed at improving energy efficiency and reducing GHG and criteria pollutant emissions. Relevant applications include smart thermostats, sensors, advanced construction technologies, and machine learning.
- Commercial Applications: Advances technologies for commercial-sector gas end uses, including commercial heating, ventilation, and air conditioning (HVAC), hot water systems, and commercial laundry applications.
- Commercial Food Service: Develops and enhances technologies for commercial food service, including restaurants, catering services, and institutional kitchens where gas is used for cooking and water heating.

Clean Transportation

In compliance with CPUC Resolution G-3601, the Clean Transportation program has been retired. The program supported activities aimed at reducing transportation-related environmental impacts and facilitating the development of zero-emission technologies, including the use of clean renewable hydrogen[12] for on-road and off-road applications, and related infrastructure (e.g. fueling and storage). Under Resolution G-3601 and AL 6273-G, SoCalGas RD&D was allowed to complete previously funded projects, but not to initiate any new projects in this area.

[12] Resolution G-3601, page 7, notes projects conducted by SoCalGas must utilize clean renewable hydrogen, which is defined in D.22-12-057 as "hydrogen which is produced through a process that results in a lifecycle (i.e., well-to-gate) GHG emissions rate of not greater than 4 kilograms of CO_2e per kilogram of hydrogen produced and does not use fossil fuel as either a feedstock or production energy source."

SoCalGas RD&D 2025 Spending

In 2025, SoCalGas RD&D continued to manage its portfolio in alignment with the CPUC-approved 2023 program structure. RD&D staff evaluated all investments for consistency with PUC §740.1 and CPUC Resolution G-3601, so that expenditures supported ratepayer benefits, such as safety, reliability, affordability, operational efficiency, reduced GHG emissions, and improved air quality. Total 2025 RD&D spending was $6.5 million, which included $1.8 million for program administration. Because the 2024 and 2025 RD&D Research Plans remained pending before the CPUC, expenditures in 2025 were limited to continuation of previously authorized multi-year projects; see Budget and Actuals section for additional details.

Number of Completed Projects in 2025

In 2025, SoCalGas RD&D completed 80 projects, broken down by program, as follows:

Program	Projects Completed
Low Carbon Resources	5
Gas Operations	31
Clean Generation	10
Customer End-use Applications	27
Clean Transportation	7
Total	**80**

Preview of Cumulative Quantified Impacts from Portfolio

In Resolution G-3601, the CPUC stated:

> SoCalGas argues the Draft Resolution should be modified to include an assessment

of the applicability of a uniform impact analysis framework. We clarify that instead of continuing to develop its own benefits analysis framework, SoCalGas shall engage in the impact analysis framework process in proceeding R.19-10-005 (EPIC proceeding) anticipated in 2024. The Commission anticipates that its workshop process to develop an RD&D impact analysis framework will be applicable to all RD&D programs and may be tailored for its relevant applicability for Gas RD&D programs. In the interim,

Benefit	Metric
Total Number of Active Projects During 2025	157
Total Number of Projects Completed	80
Total Number of Projects Initiated	0
Total Number of Active Projects as of December 31, 2025	77
Number of Projects in ESJ Communities	25
Percentage of Projects Focused on Ratepayer Benefits:	
Safety	55
Reliability	60
Affordability	45
Operational Efficiency	52
GHG Emissions	64
Improved Air Quality	45
Overall Leverage Ratio and by Program:	
Overall	4.8x
Low Carbon Resources	2.6x
Gas Operations	6.4x
Clean Generation	5.2x
Customer End-Use Applications	6.5x

> SoCalGas should continue to report its impacts on, and benefits to, its ratepayers.[13]

In preparation for the finalized UIAF, SoCalGas reviewed the Foundational Principles and proposed metrics to identify analogous metrics applicable to Gas RD&D programs. SoCalGas looks forward to continuing its collaboration with the CPUC to develop an RD&D impact analysis approach that applies across all RD&D programs, while also supporting a tailored framework for Gas RD&D programs. In the interim, SoCalGas RD&D continues to report program impacts and ratepayer benefits across key categories, including safety, reliability, affordability, operational efficiency, reduced GHG emissions, and improved air quality.

Recent Changes to Program Requirements

Pursuant to D.19-09-051, this Annual Report is required to provide an "…explanation of processes used for selecting RD&D project areas."[14] Further, Resolution G-3601 states:

> SoCalGas describes its project selection process and criteria in detail in Appendix D of its 2023 Gas RD&D Plan. SoCalGas explains that it follows a high-level approach to project identification and selection: 1) identify potential areas for research, development, and demonstration and collaborate with researchers to develop project proposals; 2) prepare or receive project proposals; 3) review project proposals with the RD&D Program team and SMEs, considering a wide range of evaluation criteria and the overall portfolio strategy; 4) refine scopes of work for approved projects, if necessary; 5) allocate funding following SoCalGas accounting policies; and 6) execute the project contract and initiate project research. SoCalGas's 2023 project selection criteria are as follows: Customer Benefit, Alignment with California Policy, Lead Investigator/Team, Technical Feasibility, Co-funding Collaborators, Commercialization Potential, Equity Considerations. This is compliant with the requirement from G-3573.[15]

Accordingly, SoCalGas RD&D has included descriptions of its project selection process in both its Annual Research Plans and its Annual Reports.

However, in the Energy Division Staff Guidance to Gas Research, Development, & Demonstration (RD&D) Administrators on Annual Reporting (December 2025), the CPUC advised the following:

> Note: Energy Division requests that potentially extraneous information and content duplicative of Annual Plans and previous Annual Reports largely live on the administrators' Gas RD&D website, such as:
>
> - Detail on Gas RD&D program origin, requirements, and background
> - Access to proposed and approved Annual Plans
> - Access to historic Annual Reports
> - Initiative and project selection processes

Consistent with Energy Division staff guidance and to minimize duplicative background material, SoCalGas provides a concise, in-report summary of its RD&D project selection process and criteria to support transparency and stakeholder accessibility.

SoCalGas selects RD&D projects through a structured internal review process aligned with CPUC and California policy objectives, the approved Research Plan, and RD&D program goals. A visual workflow and summary of evaluation criteria are provided in Appendix 3.

[13] TBD

[14] D.19-09-051, OP 30 at 783.

[15] Resolution G-3601 at 10.

Budget and Actuals

Spent SoCalGas RD&D Funds

Pursuant to D.19-09-051, this Annual Report is required to describe "…program funds expended."[16] Spending in 2025 was significantly lower than prior years due to the impacts of pending regulatory approvals for the 2024 and 2025 RD&D Research Plans. As a result, SoCalGas was not able to initiate any new RD&D projects in 2025. Expenditures in 2025 were incurred to support the continuation of multi-year projects in program categories previously authorized in earlier decisions and resolutions (e.g., G-3601, G-3586).[17]

[16] D.19-09-051, OP 30 at 783.

[17] Information in the tables presented in the Budget to Actuals section only include RD&D Programs with 2025 spend. Data from the RD&D Clean Transportation Program, which was retired and did not incur expenditures in 2025 in accordance with resolution G-3601 is not included.

The table below summarizes funds expended in 2025 by program category:

Program / Category	2025 Spending
Low Carbon Resources	$1,302,676
Gas Operations	$2,754,534
Clean Generation	$374,388
Customer End-use Applications	$272,158
Subtotal	$4,703,756
Program Administration[18]	$1,788,950
Total	$6,492,706

[18] D.24-12-074, page 329 states SoCalGas RD&D funding includes 10 percent for program administration costs, which equals $1,838,900 as requested in AL 6496-G.

Plan Funding Balances Table

The table below presents 2025 SoCalGas project funding information by program category. It includes: SoCalGas's project budgeted amounts, total SoCalGas project expenditures by program through 2025, and remaining unspent funds for its current portfolio.

Because the 2024 and 2025 RD&D plans remain pending resolutions before the CPUC, SoCalGas has been unable to initiate new projects. As a result, the table reflects budgeted and actual spending associated solely with the continued execution of multi-year projects that are part of the programs included in previously approved Research Plans by the CPUC (e.g., Resolutions G-3601, G-3586, and G-3573).

Program	SoCalGas Project Budget as of December 31, 2025	Total Project Spend by Program as of December 31, 2025	Unspent[19]
Low Carbon Resources	$11,689,602	$9,827,070	$1,862,532
Gas Operations	$10,194,140	$9,136,671	$1,057,469
Clean Generation	$6,438,859	$4,729,359	$1,709,500
Customer End-Use Applications	$3,556,649	$2,715,643	$841,006
Totals	$31,879,250	$26,408,743	$5,470,507

[19] Does not include project management labor. The Unspent category represents the amount expected to be spent to complete active projects after December 31, 2025.

Matched / Leveraged Funds and Sources

Pursuant to D.19-09-051, this Annual Report is required to describe "…leveraged funding."[20]

New 2025 Matched / Leveraged Funds and Sources

No new projects were initiated in 2025 due to pending approval of the 2024 and 2025 RD&D plans.

[20] D.19-09-051, OP 30 at 783.

Total Leveraged Funds to Date by Program

While no new projects were initiated in 2025 due to pending approval of the 2024 and 2025 RD&D plans, project level details that include match funding and the sources of match funding are included online as noted in the **Project Summaries** section.

The table below shows SoCalGas's budgeted funding and co-funding for projects by program.

Program	**SCG Project Budget** as of December 31, 2025	**Match Amount** (All Sources)	**Leverage Ratio**
Low Carbon Resources	$11,689,602	$30,646,984	2.6x
Gas Operations	$10,194,140	$64,750,614	6.4x
Clean Generation	$6,438,859	$33,267,991	5.2x
Customer End-Use Applications	$3,556,649	$23,025,036	6.5x
Totals	$31,879,250	$151,690,625	4.8x

Funding Recipients

Per D.19-09-051 OP 30 (p. 783), this Annual Report is required to describe "…program funds expended."[21] The list below represents third-party entities that have received payments for project or program administration costs.

- Access California Services
- Active Global Solutions LLC
- Agnew Multilingual
- Alianza Coachella Valley
- Allstar Machinery Movers
- ALS Environmental
- Arizona State Land Department
- ASU Foundation
- AVH Technology, Inc
- Bloom Energy Corporation
- Brillio LLC
- Brown & Bigelow Inc
- C.H. Robinson Worldwide, Inc
- California Greenworks, Inc
- California Institute of Technology
- C-FER Technologies Inc
- Clean Energy Leadership Institute
- CNC Builders Inc
- D.G. Honegger Consulting

[21] D.19-09-051, OP 30 at 783.

- DNV USA Inc
- Electrochaea GmbH
- Emission Free Generators
- Enchanted Rock, LLC
- Energy Link Industrial Services, Inc
- ESTEM Consulting LLC
- Evoloh Inc
- Federal Express Corp
- Gas Machinery Research Council
- Gas Technology Institute
- GTI Energy
- H2U Technologies Inc
- Innovative Environmental Solutions
- Isco Industries Inc
- Jay's Catering Company
- McMaster Carr Supply Co
- MESA Products, Inc
- Microsoft Corporation
- Minuteman Press Torrance
- Momentum
- Northeast Gas Association – NYSEARCH
- Orange County Conservation Corps
- Pacific Petroleum California Inc
- Pipeline Research Council International
- Red Ball Oxygen Company Inc
- RockeTruck Inc
- Sequoia Riverlands Trust
- Skipper NDT Corp
- Soledad Enrichment Action, Inc
- Southwest Solar Technology LLC
- Spec Services Inc
- Staples Contract & Commercial LLC
- Structural Integrity Associates, Inc
- Susteon Inc
- Templar Shield, Inc
- The University of Tulsa
- Underground Construction Co, Inc
- University of California Irvine
- University of California Los Angeles
- Utility Partners of America LLC
- Valley Clean Air Now
- Vobecky Enterprises, Inc
- WestAir Gases & Equipment Inc
- Westland Group Inc
- World Wide Technology, LLC
- Zones LLC

Portfolio Accomplishments

Summary Paragraph

In 2025, SoCalGas RD&D continued a diverse portfolio of research activities initiated under previously approved research plans that delivered measurable progress toward CPUC program priorities and California's decarbonization goals. Across program areas, SoCalGas RD&D supported projects that generated actionable data, validated emerging technologies, and informed operational decision-making. Throughout the year, the program maintained a consistent focus on delivering ratepayer benefits, including enhanced safety, reliability, affordability, and operational efficiency, and reduced GHG emissions, and improved air quality.

Research conducted under the Low Carbon Resources program advanced pathways for renewable gas integration and decarbonizing the gas supply. Gas Operations projects contributed to GHG emissions reductions, improved system integrity, and the development of more efficient and innovative inspection and maintenance practices. Clean Generation projects advanced firm low-carbon power and enhanced energy resilience. Customer End-Use Applications projects and legacy work in the Clean Transportation program continued to advance research outcomes consistent with CPUC Resolution G-3601. Collectively, these efforts demonstrate sustained progress in translating RD&D investments into quantifiable

impacts and practical solutions that support California's decarbonization objectives, while maintaining safe, reliable, and affordable service for customers.

Introduction to Data

The data summarized in this annual report and provided in the accompanying attachments is intended to provide transparent, traceable information on SoCalGas's RD&D portfolio funding, expenditures, and project progress for the 2025 reporting year. The data is organized to show RD&D activity at multiple levels—Plan, program, subprogram, and project—so that readers can connect narrative highlights in the report to the underlying financial and performance details.

Examples of data provided include:

- Spending by program, subprogram, and project
- Leverage ratios
- Number of active projects
- Number of projects initiated and completed
- Percentage of projects focused on defined ratepayer benefits

Collectively, these tables are designed to support consistent interpretation of portfolio performance by providing funding and expenditures, as well as descriptions of the activities and outcomes that have been realized to date.

Total Number of Projects Completed

Per D.19-09-051,[22] SoCalGas RD&D tracks the number of projects that it initiates and completes every year. In 2025, a total of 157 projects were active for at least one day, of which 80 were completed during the year. No new projects were initiated in 2025. See the Number of Completed Projects in 2025 section.

[22] D.19-09-051, OP 30 at 783.

State Climate Goals

Decarbonizing the Gas Supply and Supporting Energy Integration

The Low Carbon Resources program supports California's climate goals by advancing pathways to decarbonize the gas supply while maintaining system reliability and affordability. Projects in this area focus on increasing the availability of RNG and clean renewable hydrogen[23] through diverse feedstocks and production technologies, helping reduce lifecycle GHG emissions while leveraging existing infrastructure. In 2025, the program also tracked close-out activities for previously fully funded CCUS projects, consistent with CPUC Resolutions G-3601 and AL 6273-G, which retired the subprogram while allowing completion of legacy work.

Improving Safety, Reliability, and Reducing Emissions Through Gas Operations Innovation

The Gas Operations program supports California's GHG emissions reduction and air-quality goals by developing technologies and practices that enhance system integrity, improve public and worker safety, maintain and strengthen system reliability, increase operational efficiency, and reduce emissions. Projects across the Environmental & Safety, Operations Technology, System Design & Materials, and System Inspection & Monitoring subprograms generate actionable data that inform inspection, monitoring, maintenance, and repair activities. These efforts support safe operations, more targeted use of capital and maintenance resources, improved affordability through operational efficiencies, and reduced fugitive emissions.

Supporting Clean Power, Resilience, and Firm Delivery

The Clean Generation program advances technologies that support reliable and resilient energy delivery while reducing GHG and criteria pollutant emissions. Research in this area

[23] Resolution G-3601, page 7, notes projects conducted by SoCalGas must utilize clean renewable hydrogen, which is defined in D.22-12-057 as "hydrogen which is produced through a process that results in a lifecycle (i.e., well-to-gate) GHG emissions rate of not greater than 4 kilograms of CO2e per kilogram of hydrogen produced and does not use fossil fuel as either a feedstock or production energy source."

supports the integration of renewable fuels, advanced controls, and energy storage with distributed generation systems. Projects explore how low-emission generation and microgrids can provide firm power during outages and extreme weather events, supporting grid reliability and community resilience while reducing reliance on higher-emitting backup resources. Consistent with Resolution G-3601, the program continued to track completion of previously funded Distributed Generation projects while focusing new work on integration and control technologies.

Decarbonizing End Uses and Hard-to-Electrify Sectors

The Customer End-Use Applications program supports California's climate goals by developing and demonstrating technologies that improve efficiency and reduce emissions from commercial and industrial gas end uses. In 2025, CEUA active projects were concentrated in the Advanced Innovation, Commercial Applications, and Commercial Food Service subprograms. Legacy work in hard-to-electrify high-heat industrial processes continues to be tracked where permitted under Resolution G-3601. These efforts address sectors that account for a significant share of gas demand and emissions, providing pathways to maintain safety and reliability, supporting affordability, and reducing GHG emissions.

Aligning Research Outcomes with Statewide Climate and Equity Objectives

Across all program areas, SoCalGas RD&D projects aim to accelerate the development and deployment of solutions that support California's climate and energy goals. Research focuses on enabling firm energy delivery from intermittent renewable resources, reducing emissions from critical infrastructure, improving the performance of backup generation and microgrids, and serving hard-to-electrify end uses with low-carbon fuels. In alignment with the CPUC's ESJ Action Plan 2.0, the program emphasizes collaboration and stakeholder engagement to support research outcomes that reflect community needs, particularly in disadvantaged areas.

Through this applied, portfolio-based approach, SoCalGas RD&D translates statewide policy goals into practical, data-driven solutions. Research findings and project results inform operational decision making, support regulatory compliance, and help position the gas system to play a constructive role in California's transition to a decarbonized and more resilient energy future—while continuing to deliver safe, reliable, and affordable service to more than 21 million consumers.

Scaling and Commercialization

SoCalGas RD&D seeks to fund projects that develop, demonstrate, and advance technologies with the potential to scale and ultimately be commercialized and deployed for the benefit of customers. Because technology maturity indicators (e.g., Technology Readiness Levels (TRLs)) and the U.S. Department of Energy's (DOE) Adoption Readiness Levels (ARLs) do not always align, RD&D plays a key role in advancing both technical development and adoption potential.[24]

In this context, "scale" refers to advancing a technology from a successful pilot to repeatable field use across multiple sites. "Commercialization" refers to transitioning from demonstration to routine operational deployment. Progress along both dimensions depends on proven performance, cost-effectiveness, safety, and compatibility with existing systems and work practices.

RD&D supports this transition by testing technologies under real operating conditions, generating performance data, and identifying installation, integration, and maintenance challenges before broader rollout. This process reduces deployment risk, clarifies operational value, and facilitates market readiness.

Many customers lack the capacity to

[24] https://www.energy.gov/technologycommercialization/adoption-readiness-levels-arl-framework

independently validate new technologies. SoCalGas RD&D fills this gap by supporting lab evaluations and field pilots that reduce uncertainty and demonstrate measurable benefits, helping move viable solutions toward broader adoption.

The programs and subprograms described in this report address technologies across the full value chain—upstream, midstream, and downstream of SoCalGas's core infrastructure. Coordinating efforts across these areas helps avoid duplication, supports informed infrastructure investments, and aligns research and technical development with regulatory and market signals.

For ratepayers, this integrated approach supports lower long-term system costs, improved safety and reliability, and practical pathways toward decarbonization. Advancing cost-effective solutions across the value chain is essential to enabling broader adoption and achieving California's climate goals.

Technology Readiness Levels

To deliver these benefits, SoCalGas supports projects with strong potential to advance through TRLs, a widely used framework for assessing technical maturity (see Table 1). SoCalGas RD&D uses TRLs to guide investment decisions to advance technologies toward field-ready applications.

Table 1: TRLs are measured on a nine-point scale.[25]

Deployment	9	Actual system proven in operational environment
	8	System complete and qualified
	7	System prototype demonstration in operational environment
Development	6	Technology demonstrated in relevant environment
	5	Technology validated in relevant environment
	4	Technology validated in laboratory
Research	3	Experimental proof of concept
	2	Technology concept formulated
	1	Basic principles observed

[25] See https://www.twi-global.com/technical-knowledge/faqs/technology-readiness-levels.

Most SoCalGas RD&D activities fall within TRLs 3 to 7 (see Figure 1), where investment risk is high and market incentives alone are insufficient. These stages represent the "Technological and Commercialization Valleys of Death", where technologies require targeted support to advance toward deployment. RD&D provides this support by offering non-dilutive funding that derisks technologies and enables private markets and customers to scale these technologies.

Not every RD&D project is expected to result in near-term commercialization. Early-stage

research builds foundational knowledge, reduces uncertainty, and enables future breakthroughs. Even projects that do not ultimately reach the market contribute valuable data, technical capability, and operational insights that strengthen future technology development for California's energy system.

At the same time, progress from demonstration to widespread adoption depends not only on technical maturity, but also on regulatory frameworks, market conditions, access to private capital, and the willingness of utilities and customers to adopt first-of-their-kind solutions. Even technologies with strong technical performance may face barriers related to system integration, limited deployment experience, or uncertainties about long-term operational value.

By focusing on solutions that still require technical and practical development, SoCalGas RD&D helps lay the foundation for future technologies that, once deployed, are expected to deliver long-term benefits. This includes efforts to improve affordability, bringing emerging technologies closer to cost parity with conventional fossil-fuel-based alternatives. RD&D also aims to enhance reliability and demonstrate compatibility with existing infrastructure, helping reduce barriers to future deployment and scale.

Within this broader commercialization ecosystem, RD&D plays a critical role in reducing technical risk, generating field-validated performance data, and improving the probability of successful scaling. These efforts help technologies progress beyond one-time demonstrations toward repeatable, financeable, and operationally proven solutions that can be adopted at scale.

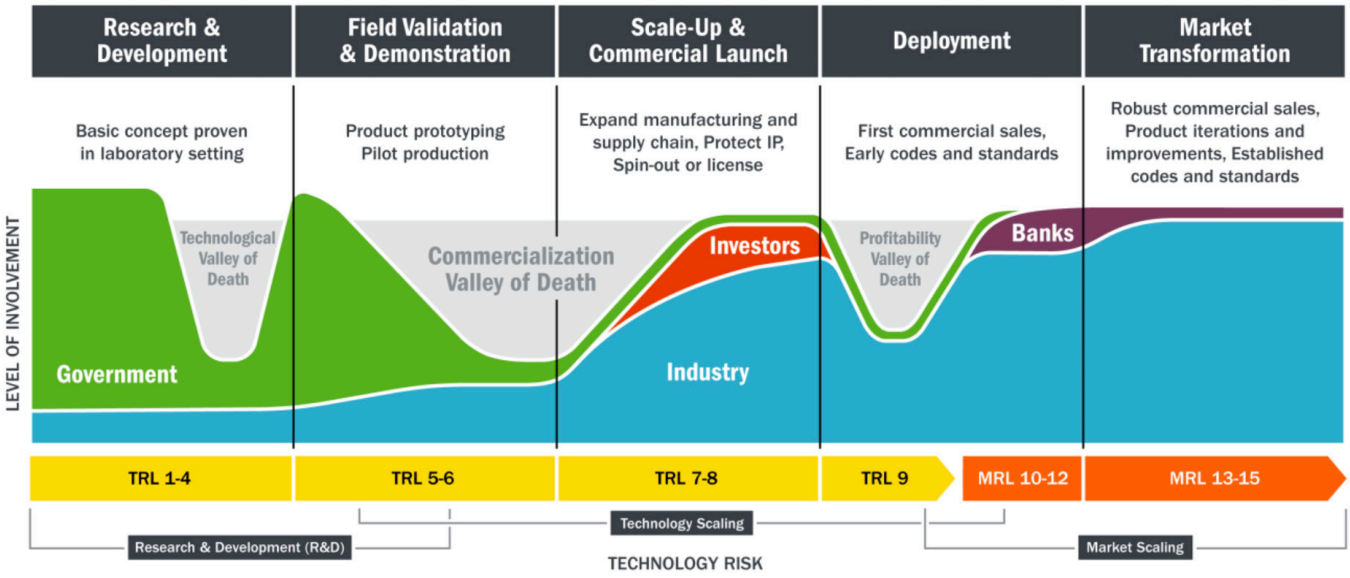

Figure 1: Tech to Market Process by TRL and Market Readiness Level (MRL). MRLs refer to the readiness of a market to accept and adopt a new technology. Image credit US Department of Energy.[26]

26 https://www.energy.gov/eere/buildings/technology-market

During the project development stage, SoCalGas RD&D staff work with researchers to identify and develop project metrics that can be used to quantify and evaluate project success. As part of this process, SoCalGas considers each technology's pathway to commercialization or deployment, including the likelihood of future pilot and demonstration projects as technologies advance from lower to higher TRLs.

At the completion of each project, SoCalGas RD&D reviews technical results along with operational relevance and broader market and policy conditions to determine whether

additional work is warranted. As appropriate, these reviews may include techno-economic analysis and commercialization considerations (e.g., market readiness, customer/partner interest, and implementation constraints) to inform decisions regarding potential additional research or demonstration opportunities.

SoCalGas RD&D seeks to shepherd technologies through a phased series of projects, each advancing the technology toward a higher TRL, with the long-term goal of enabling commercialization and deployment within SoCalGas's service territory. When feasible, higher TRL efforts leverage external funding from agencies such as the U.S. DOE and CEC to support larger scale demonstrations. In the absence of such funds, SoCalGas RD&D may support higher-TRL demonstrations to continue progress toward operational readiness. To advance this process, SoCalGas RD&D and its project collaborators routinely present project results at industry conferences, technical forums, and in quarterly research webinars. These efforts support knowledge transfer, stakeholder engagement, and broader visibility into emerging technologies relevant to California's decarbonization goals and energy affordability.

As an example, between 2021 and 2025, SoCalGas RD&D supported the development of a robotic pipeline inspection platform, supporting advancement from TRL 2 to TRL 6, with more development expected through 2027.

		Project
Start Date:	August 8, 2021	**Extending the Wireless Range of EXP Robotic Inspection Platforms** The project evaluated commercially available technologies and developed a high-level Wi-Fi–enabled system design. Deliverables included preliminary mechanical, electrical, software, and firmware components, and a test plan to assess integration feasibility.
End Date:	March 21, 2022	
TRL at Start:	2	
TRL at End:	3	
Start Date:	April 21, 2022	**Explorer Wireless Range Extender (M2021-006 PhII)** The project developed and tested an engineering prototype incorporating dual-mesh radio, including detailed design, manufacturing, full system validation, evaluation for other robot sizes, and communication protocol enhancements.
End Date:	October 31, 2022	
TRL at Start:	3	
TRL at End:	4	
Start Date:	November 1, 2023	**Explorer Wireless Range Extender (M2021-006 PhIII)** The project updated and field-tested the engineering prototype through controlled testing at the NYSEARCH facility and deployment in an operational pipeline, incorporating lessons learned to improve system reliability and performance.
End Date:	June 30, 2025	
TRL at Start:	4	
TRL at End:	6	

Start Date:	April 1, 2025[27]	**M2021-006 Phase IV – Explorer Wireless Range Extender** The project is developing a Software Defined Radio (SDR)–based wireless range extender for the Explorer platform, progressing through staged prototype development for both non-form-factor and form-factor-compliant systems. Work includes defining system architecture and COTS hardware, iterative software and interface development, multiple go/no-go decision points, engineering prototype manufacturing and testing, and an alpha field trial in an operational pipeline environment.
End Date:	In progress, anticipated June 30, 2027	
TRL at Start:	4	
TRL at End:	5	
Start Date:	Not started, circa 2026	**M2021-006 Phase V – Explorer Wireless Range Extender** The project team will further develop the engineering prototype to a pre-commercial prototype that includes the software defined radio. The project tasks have yet to be determined.
End Date:	Anticipated 12 months after project start; circa 2027	
TRL at Start:	5	
TRL at End:	6	

[27] The timing of some of the initial tasks in this project overlap with some of the final tasks of the preceding project.

Patents, Copyright, Publications, and Citations

2025 Publications

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Patents

Non-Provisional Application# 18/542,516; Systems for Direct Generation of High-Pressure Hydrogen Gas and Methods Thereof

Project Summaries

Pursuant to D.19-09-051, this Annual Report is required to provide a "…summary of ongoing and completed projects."[28] Further, "…[F]uture annual reports…should include an explanation of how SoCalGas has used (or intends to use) the results."[29]

[28] D.19-09-051, OP 30 at 783.
[29] *Id.*

No.	Project Title	Project Description	2025 Progress	Status
9-CG-IC	NREL Cybersecurity Gap Analysis for Distributed Energy Resources – TSA-24-31185	The goal is to conduct cybersecurity gap analyses for behind-the-meter renewable energy assets that may be deployed at SoCalGas facilities and/or customer sites. NREL will conduct two gap analyses: (1) high level, and (2) detailed, to assess potential threats, challenges, risks, and impacts to distributed energy resources (DERs). These deployed assets support renewable energy deployment and require strong cyber maturity to promote safe and reliable operation.	In Q2 2025, NREL hosted a webinar providing a foundational overview of cybersecurity considerations for renewable energy resources. The webinar aimed to increase awareness of the need for mature cybersecurity practices within these resources. In Q3 2025, NREL also submitted a high-level cybersecurity gap analysis of energy resources. Findings from the draft will be used to select energy resource segment(s) for a deeper dive gap analysis, followed by a subsequent webinar to present results.	Active

In this report, SoCalGas RD&D has provided brief summaries of all projects active during 2025—including those completed and those still in-progress at year's end—and provided descriptions of the work completed in 2025, as well as how project results are used to support potential technology implementation and/or deployment (Appendix 2). In addition to these summaries, SoCalGas RD&D includes detailed project information online, similar to materials provided in the annual research plan.[30]

Project Spotlights

Faster Detection, Safer Pipelines

How rapid, low-cost microbial testing helps protect infrastructure, reduce leaks, and lower long-term costs for ratepayers

Microbiologically influenced corrosion (MIC) of metal pipelines is a significant challenge for the oil and gas industry, contributing to leaks, equipment failures, and costly operational downtime. Traditionally laboratory-based methods for identifying the microbial drivers of corrosion can take weeks to complete, are costly, and may be prone to false positives or negatives. Earlier, lower-cost identification of corrosion risks enables safe and reliable operations, supports more targeted maintenance, and helps reduce long-term costs borne by SoCalGas ratepayers.

SoCalGas played a pivotal role in advancing the BioVind, Inc. (BioVind) technology to market by providing essential operational and technical support. This included real-world use cases, guidance on operator priorities, clarity on practical applications, and identifying potential barriers to industry adoption. SoCalGas also supplied physical samples and access to infrastructure, along with deep technical

[30] https://www.socalgas.com/sites/default/files/2026-03/2025_RDD_Project_Summaries.xlsx

expertise in internal corrosion and pipeline and storage well operations to validate that the technology meets real-world performance and industry needs.

"Microbiologically influenced corrosion is very common," said Patricia Stewart, Team Lead, Corrosion Management & Inspection at SoCalGas, in an interview conducted for this report.[31] According to a paper presented at CORROSION 2018 in Phoenix, Arizona, it represents a major concern within the oil and gas industry. The authors reported that MIC may be responsible for nearly 40 percent of internal corrosion issues and roughly 20–30 percent of external corrosion cases in pipelines.[32]

"Unfortunately, we have been limited in our ability to quickly and cost-effectively identify specific types of bacteria using traditional testing methodologies," said Patricia Stewart, Team Lead, Corrosion Management & Inspection at SoCalGas, in an interview conducted for this report. "Proper identification is essential to our understanding of what is happening in our gas system and how to respond most effectively."[33]

To address this challenge, SoCalGas RD&D collaborated with BioVind, a biotechnology company developing rapid, portable, and easy-to-use microbial detection tools for the gas industry. Stewart explained that "BioVind won just under $1 million from the CEC in 2023 to develop a test kit for detecting specific microbial species associated with MIC in gas pipelines and storage facilities. The goal was to produce lab-quality results in the field within one hour."[34] SoCalGas RD&D provided approximately $75,000 in in-kind support.

Before this project, BioVind had demonstrated proof-of-concept but had not yet validated its technology in the field. At project outset, BioVind collected samples from SoCalGas facilities and used them to develop assays, the analytical procedures that detect, measure, or identify a specific substance or biological component. To guide this early work, BioVind focused on four high-priority microbial targets: sulfate-reducing bacteria, acid-producing bacteria, methanogens, and pseudomonas.

BioVind also developed a user-friendly sample preparation protocol that would enable technicians with no specialized training to conduct the testing using a test kit composed of an amplification device and a disposable cartridge. The protocol and assay performance were validated through both laboratory and field testing.

Each test cartridge contains 20 wells, each with a different assay, including two control assays. "With one cartridge, operators can test for the presence of 18 different microbial species or groups," said Stewart. "Within 30 minutes, you know exactly which microbes are present."[35]

Figure 2: Remote tailgate setup of the test cartridge.

To validate the technology in the field, BioVind created several field samples, including one containing Desulfovibrio microbes. "Using the new approach, BioVind tested these samples and found four negative results and one positive," said Stewart. BioVind retested the samples using Next Generation Sequencing (NGS), the gold standard of laboratory testing. "NGS confirmed the field results and showed that BioVind's test

[31] Patricia Stewart, Team Lead, Corrosion Management & Inspection, SoCalGas, interview conducted for the 2026 Annual Report, December 4, 2025.

[32] Wolodko, John, Haile, Tesfaalem, Khan, Faisal, Taylor, Christopher, Eckert, Richard, Hashemi, Seyed Javad, Ramirez, Andrea Marciales, and Torben Lund Skovhus. "Modeling of Microbiologically Influenced Corrosion (MIC) in the Oil and Gas Industry – Past, Present and Future." Paper presented at the CORROSION 2018, Phoenix, Arizona, USA, April 2018.

[33] Stewart, interview for the 2026 Annual Report.

[34] Stewart, interview for the 2026 Annual Report.

[35] Stewart, interview for the 2026 Annual Report.

can accurately detect the presence of targeted microbial species."[36]

"We need to keep all of our equipment and pipelines functioning properly," said Stewart. "With this new approach, there are many benefits, including maintaining the overall integrity of our pipeline. The biggest benefit to SoCalGas and other potential users is that it functions well in the field and is not exorbitantly expensive. It is a much more practical tool than what we have now and is reasonably priced."[37]

The ability to rapidly identify microbial species with sound data supports more targeted treatment strategies. "When we can identify specific species, we are able to understand when it is appropriate to treat microbes with biocides—which are environmentally harsh and expensive—and, more importantly, when it is not," said Stewart.[38]

"BioVind developed a portable test that provides lab-quality specificity and sensitivity but can be operated by techs without any specialized training in the field," said Stewart. "It is fast, low-cost, and can test for multiple species with a single sample."[39]

Figure 3: Members of the BioVind team in the field with representatives from SoCalGas assisting with the project.

[36] Stewart, interview for the 2026 Annual Report.
[37] Stewart, interview for the 2026 Annual Report.
[38] Stewart, interview for the 2026 Annual Report.
[39] Stewart, interview for the 2026 Annual Report.

From Classroom to Commercialization

How education and mobile power systems advance energy resilience

The grid works—and we can make it better.

New technologies such as microgrids and mobile fuel cell generators (MFCGs) can make the difference between unexpected outages and the rapid restoration of critical services. These technologies support California's climate and resilience goals by enabling low carbon backup power, reducing reliance on diesel generators, and strengthening localized energy reliability during extreme events. In 2025, SoCalGas RD&D supported projects that paired education with hands-on demonstrations, helping communities better understand how emerging technologies can support energy resilience.

From classroom to energy

One such project involved collaboration with ESTEM Consulting to develop an interactive microgrid curriculum for students in grades 9–12 from ESJ communities. "First, we sought to demystify power generation, hydrogen, and microgrids through a pre-visit educational module," said Joe Leiva, R&D Program Manager at SoCalGas RD&D.[40]

Students then participated in hands-on learning opportunities and experiments at the SoCalGas Energy Resource Center (ERC). "We showed them how microgrids can support the larger energy system by providing localized power during outages or emergencies," said Leiva. "They help keep critical services running while the grid is restored."[41] By pairing foundational instruction with applied demonstrations, this project moved beyond theory to practical understanding—helping participants see how distributed energy systems are designed, deployed, and integrated into real-world operations.

In 2025, SoCalGas hosted nine educational events through this program, reaching more than

[40] Joe Leiva, R&D Program Manager, SoCalGas RD&D, interview conducted for the 2026 Annual Report, December 5, 2025.
[41] Leiva, interview for the 2026 Annual Report.

200 students and educators from schools and organizations, including Animo Compton, Animo Venice, UCLA COSMOS, the Reach Foundation, the CORO Fellowship, and Accenture's Learning to Lead initiative. Program impacts were measured through participation levels, repeat engagement, and qualitative feedback from educators and students, helping RD&D assess how effectively complex technical concepts were translated into applied learning outcomes.

Figure 4: SoCalGas RD&D's Joe Leiva teaches students at the SoCalGas Energy Resource Center.

Resilience for anyone, anywhere

But demand for power is not always confined to locations with reliable backup power or microgrids. Sometimes, power must be mobile—following people, equipment, and critical services wherever they are needed.

Mike Simon, President and CEO of RockeTruck, sought to address this challenge. Building on work completed during Simon's tenure at TransPower, RockeTruck applied for and was awarded a $3 million grant from the CEC's Mobile Renewable Backup Generation program to develop an MFCG. This CEC award supported development of the MFCG itself. RockeTruck received additional financial assistance from the DOE and SoCalGas RD&D. SoCalGas RD&D's funding specifically supported development of the advanced inverter component, complementing—but not duplicating—the CEC-funded MFCG development.

"Our concept was to develop a large hybrid mobile generator that included both a fuel cell and a battery," said Simon. "The battery could be used to augment the fuel cell for brief periods or greater power demand and could also provide redundancy if you run out of hydrogen."[42]

Originally, RockeTruck planned to build the generator on a large trailer with hydrogen fuel storage incorporated into the design. "The CEC wanted a system that could provide 35 kilowatts (kW) of power for 48 hours without refueling," said Simon. "To sustain that for two days, you need about 100 kilograms (kg) of hydrogen—roughly twice as much hydrogen as in a large fuel cell bus."[43]

However, RockeTruck soon encountered practical and economic challenges. "We designed a structure that held 13 hydrogen tanks, enough to provide 35 kW for about 36 hours," said Simon. "Unfortunately, that was way too big and expensive for the market."[44] In response, RockeTruck pivoted to a smaller more commercially viable design based on informed market research indicating that most portable generators are rented for short durations (typically a single day) and only need to produce 10 or 20 kilowatts of power for four to eight hours. This insight guided the shift toward a more compact, market aligned MFCG platform.

Figure 5: Pickup-mounted RockeTruck "Mini" Fuel Cell Generator at CSULA Demonstration

[42] Mike Simon, President and CEO, RockeTruck, interview conducted for the 2026 Annual Report, November 26, 2025.
[43] Simon, interview for the 2026 Annual Report.
[44] Simon, interview for the 2026 Annual Report.

This design evolution reflects the role of RD&D in reducing technical and cost barriers, validating performance under real-world conditions, and refining solutions to better align with market demand and customer use cases.

The new design—the "Mini"—includes the same MFCG paired with a larger battery, but only uses one six-foot hydrogen tank. "This system is much more versatile and cost-effective," said Simon. "It was designed to be carried in the bed of a heavy-duty pickup truck." For short-term power demands, the Mini provides more than enough power. "For greater demands, you can tow a large trailer with hydrogen tanks that can provide power for 48+ hours."[45]

Through staged development, testing, and public demonstration, the project advanced from concept to a field-ready prototype—an important step toward broader commercialization and private-sector scaling.

The Mini also became the focus of an engineering course at Cal State LA, whose student body predominantly comprises students from ESJ communities. Students assisted with development and testing of the Mini and then later helped host its official unveiling at Cal State LA's hydrogen fueling station. During the event, the students connected the Mini to a portable charger and successfully charged both a passenger EV and an electric truck. One week later, the students also exhibited the Mini at the Cal State LA Engineering Open House, where it was presented by students, staff, and community visitors.

These demonstrations provided performance data, operational validation, and public visibility—key steps in moving emerging technologies from pilot deployment toward broader market adoption.

[45] Simon, interview for the 2026 Annual Report.

Figure 6: RockeTruck "Mini" Fuel Cell Generator Installation and Walkthrough at CSULA Demonstration

RockeTruck is now building a second version of the Mini. "The most promising market appears to be outdoor entertainment," said Simon. "These venues need large amounts of power and can afford to upgrade from diesel generators to our mobile fuel cell generators, which are much cleaner and quieter." Another promising opportunity is LA28, the 2028 Olympic Games. "There will be a tremendous need for portable, temporary power and a desire to showcase sustainable technologies."[46]

As RockeTruck refines subsequent versions of the Mini and identifies commercial market segments, the project illustrates how RD&D support can help de-risk innovation, position technologies for private investment, and lay the groundwork for scaling solutions aligned with California's decarbonization objectives.

When the grid is under stress, knowledge matters

Through these projects, SoCalGas RD&D showed that education is a critical part of energy resilience, particularly for ESJ communities that are often most affected by outages. By pairing classroom learning with hands-on demonstrations, students and community members were able to see firsthand how technologies like microgrids and MFCGs can support the grid, keep essential services running, and shorten recovery time when

46 Simon, interview for the 2026 Annual Report.

disruptions occur. The same staged testing and public demonstrations that help educate communities also generate the operational data and user confidence needed to move emerging technologies toward broader deployment.

"Resilience isn't just about the equipment," said Leiva. "It's about people understanding how these systems work and when they can be used to help communities get back on their feet."[47] Together, these efforts helped turn resilience from an abstract concept into practical, shared knowledge—advancing both workforce readiness and the commercialization pathway for low-carbon mobile power solutions.

ESJ Communities and Equity

SoCalGas RD&D seeks to develop projects that deliver meaningful benefits to ESJ communities. Examples of potential benefits include enhancing local resilience, improving energy affordability, reducing GHG emissions, improving air quality, and fostering job creation, while supporting community participation in the transition to more sustainable, decarbonized energy solutions. SoCalGas RD&D identifies ESJ communities using California's environmental health screening tools, including CalEnviroScreen 4.0, and considers income thresholds, tribal lands, HubZones, Opportunity Zones, and other factors.

Equity Engagement Roadmap

On August 28, 2023, SoCalGas RD&D completed its Equity Engagement Roadmap (EER).[48] Designed to clearly communicate with public and government agencies, the EER outlines a vision for improving equity engagement across the SoCalGas RD&D program. The purpose is to increase the likelihood that the benefits of emerging decarbonized energy technologies are distributed equitably across communities throughout California. The EER was developed following an extensive literature review and consultation with internal stakeholders, subject matter experts, and representatives of disadvantaged communities. To support a more informed and inclusive research portfolio, SoCalGas established a framework consisting of six tasks to strengthen community engagement, as described below.

Task 1: Monitor & Report Key Equity Engagement Project Metrics

In 2025, SoCalGas RD&D monitored three equity engagement metrics. First, 25 of the 157 projects in the 2025 SoCalGas RD&D portfolio were located in ESJ communities. As discussed in the Engagement with ESJ Communities section, RD&D staff engaged representatives from seven community-based and environmental organizations during the 2025 Annual Public Workshop. In addition, RD&D staff engaged with representatives of the Disadvantaged Communities Advisory Group (DACAG) for feedback on RD&D planning.

Task 2: Regularly Assess the Effectiveness of EER Activities

SoCalGas RD&D regularly assesses its EER activities so that they remain responsive, meaningful, and aligned with program goals. At a minimum, this assessment occurs annually during preparation of the RD&D Annual Report, when staff reviews engagement activities, outcomes, and lessons learned. EER activities are also evaluated during development of the RD&D Research Plan, when staff considers how to refine or expand engagement for the coming year. This process allows RD&D to incorporate feedback, adjust priorities, and align community engagement efforts with emerging needs and research opportunities.

Task 3: Establish Stipend Program for Community Based Organization (CBO) Participation in Public Workshop

In 2025, SoCalGas RD&D established a stipend program and convened an ESJ Advisory Panel, in accordance with Resolution G-3601, to support CBO participation in the Annual Public

[47] Leiva, interview for the 2026 Annual Report.

[48] See https://www.socalgas.com/sites/default/files/2023-08/SoCalGas_RDD_Equity_Engagement_Roadmap.pdf

Workshop. Broader outreach encouraged participation from organizations across SoCalGas's service territory, capturing diverse regional and community perspectives. The panel consisted of seven ESJ stakeholders: California Greenworks, Valley Clean Energy Now, Soledad Enrichment Action Programs, Sequoia Riverlands Trust, OC Conservation Corps, Access California, and Alianza Coachella Valley.

SoCalGas RD&D collaborated with internal community engagement teams to prepare participants by clarifying expectations, explaining stipend eligibility, and reviewing workshop topics in advance. During the 2025 RD&D Public Workshop, panel members provided feedback on strengthening community benefits, including developing community-focused metrics into the UIAF that reflect human and social outcomes beyond technical performance. This input is informing ongoing efforts to refine RD&D evaluation frameworks to better reflect equity considerations.

Task 4: Provide Funding and Mentoring Support to Senior Design Projects

As part of its EER, SoCalGas RD&D supports senior design and capstone projects that provide hands-on experience for students from ESJ communities. This includes financial support, technical mentoring, and industry engagement. In 2025, SoCalGas RD&D collaborated with California State University, Los Angeles (Cal State LA), through its College of Engineering Capstone Program. Student contributed to the RockeTruck Mobile Fuel Cell Generator project, supporting system integration, testing, and public demonstrations (see From Classroom to Commercialization section). Through these efforts, SoCalGas RD&D supports workforce development and expands experiential learning opportunities aligned with the State's decarbonization goals.

Task 5: Commit to Review/Revise RD&D Literature to Include ESJ Language

SoCalGas RD&D has incorporated ESJ focused language across its key RD&D materials to promote and embed equity considerations across program planning, implementation, and evaluation. ESJ concepts are now included in the annual report, research plan, and public workshop materials. As described further under Task 6 below, ESJ language has been embedded in RD&D project selection and evaluation documents to support equity early in project development. Through these efforts, SoCalGas RD&D is addressing Task 5 of the Equity Engagement Roadmap by systematically reviewing and revising RD&D literature to reflect ESJ principles across external communications and internal processes.

Task 6: Review/Revise Project Policies to Include Equitable Components

SoCalGas RD&D has incorporated equity considerations into its project screening and evaluation processes.

SoCalGas RD&D uses a Project Concept Form as the initial screening tool for potential projects, which now includes ESJ-related questions. The form prompts staff to identify whether a project is located in an ESJ community, describes relevant equity practices or community benefits, outlines plans for local CBO engagement, and considers equitable contracting or DBE participation where applicable.

Equity is one of eight criteria used to determine whether a project advances in the review process. As projects move through later stages of review, staff further assesses potential community benefits, project siting considerations, and opportunities for meaningful CBO engagement. These modifications strengthen internal processes to support more systematic integration of equity, consistent with the goals of the EER.

Engagement with ESJ Communities

The Disadvantaged Communities Advisory Group

SoCalGas RD&D engaged with the DACAG, an 11-member advisory group created by Senate Bill 350 (de León, 2015) that advises the CEC and CPUC on designing and implementing policies

and programs that better serve disadvantaged communities. In Q1 2025, SoCalGas RD&D met with the DACAG to request feedback on its draft 2024 and 2025 RD&D Research Plans.

Leveraging Best Practices

SoCalGas RD&D leverages established programs and best practices to strengthen engagement with communities it serves. Rather than conducting outreach independently, RD&D coordinates with internal community engagement and public affairs teams that maintain strong relationships with CBOs and stakeholders across SoCalGas's service territory.

For example, RD&D collaborated with internal community relations groups to recruit and prepare ESJ stakeholders for the Annual Public Workshop. This included structured outreach, informational sessions, and advance review of workshop topics to support meaningful and informed participation. Staff drew on existing community programs and cross-functional grant evaluation efforts to strengthen RD&D project review, including consideration of community benefits. These collaborations help reduce duplication, builds on institutional knowledge, and integrates equity engagement into RD&D program planning and evaluation.

Benefits to ESJ Communities

SoCalGas RD&D develops research projects aligned with the DACAG Equity Framework[49], embedding equity considerations into project selection, design, implementation, and evaluation. The DACAG's Equity Framework is referenced to help identify various considerations, including non-energy benefits, affordability, access, outreach and education, community engagement, health and safety, financial benefits and economic development, workforce development, consumer protection, and metrics, evaluation, and accountability.

By integrating these considerations, SoCalGas RD&D can more effectively extend both energy and non-energy benefits—such as improved health, job creation, and consumer protections—to communities that have historically faced environmental and economic burdens. These practices improve transparency, deepen community trust, and guide future RD&D planning to align with California's equity and decarbonization goals—fulfilling the requirements of CPUC Resolution G-3601, Ordering Paragraph 6(f).[50]

Conclusion

Brief Synthesis

This Annual Report summarizes SoCalGas's 2025 Gas RD&D activities and results, demonstrating continued alignment with CPUC program priorities and California's broader safety, reliability, affordability, and climate objectives. Across five CPUC-approved investment areas, SoCalGas's RD&D program advanced a diverse portfolio of projects that generated actionable data, validated emerging technologies, and supported informed decision-making—while providing transparency into spending, visibility into leveraged funding, and progress across program- and project-level metrics.

Collectively, the 2025 portfolio reflects a deliberate focus on creating pathways to scale outcomes. Through phased research, development, and demonstration efforts, supported by strategic co-funding, and collaboration with other utilities, state agencies, research consortia, universities, and national laboratories, SoCalGas RD&D continues to help de-risk emerging technologies and position promising solutions for broader deployment and commercialization, where appropriate.

As CPUC requirements and evaluation frameworks continue to evolve, including ongoing efforts to develop a uniform impacts analysis framework, SoCalGas RD&D will continue documenting measurable ratepayer benefits, applying lessons learned to refine future portfolios, and supporting

[49] See https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/infrastructure/disadvantaged-communities/2024-dacag-equity-framework.pdf.

[50] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M521/K196/521196139.PDF

the Commission's oversight and proceeding objectives. Through this approach, SoCalGas RD&D remains committed to advancing practical solutions that enhance system safety, reliability, resilience, and affordability while contributing constructively to California's transition toward a lower-carbon energy future.

Anticipated Developments and Opportunities

Looking ahead, SoCalGas RD&D will continue advancing projects initiated under previously approved research plans while aligning future activities with evolving CPUC guidance and program priorities. As Energy Division priorities continue to develop—particularly regarding impact evaluation, equity integration, and portfolio focus—SoCalGas RD&D will aim to support future research initiatives that are responsive, clearly justified, and aligned with PUC §740.1 and related Commission directives.

Consistent with this direction, the program anticipates continued emphasis on initiatives supporting renewable gas development and integration, particularly RNG, as part of California's broader decarbonization strategy. SoCalGas RD&D will continue collaborating with other Gas RD&D administrators, state agencies, research institutions, and national laboratories to strengthen coordination, reduce duplication, and maximize ratepayer funds for the benefit of customers and communities.

In response to increasing climate-related risks, SoCalGas RD&D also anticipates supporting research aligned with Climate Adaptation and Vulnerability Assessment (CAVA) efforts. These activities are expected to focus on understanding infrastructure exposure to extreme weather events, and identifying technologies, materials, and operational strategies that enhance system resilience and reduce the risk of service disruptions.

The program also anticipates further development of data-driven tools to improve risk modeling and operational decision-making. This includes exploring ways to better utilize existing sensors, inspection technologies, and operational data sources to enhance predictive maintenance, optimize inspection intervals, and support cost-effective compliance with evolving regulatory requirements—particularly in the context of aging infrastructure and affordability considerations.

In accordance with Public Resources Code §25620.8(a), SoCalGas RD&D continues to identify opportunities for program improvement. These include strengthening alignment between research themes and measurable ratepayer benefits; improving documentation of how project results inform operational decisions; expanding coordination with Energy Division on evaluation frameworks; and refining internal road-mapping processes to guide decisions regarding staged projects or other related activities.

Over the next year, anticipated activities include continued completion of authorized legacy projects, refinement of portfolio priorities consistent with ED guidance, and targeted research initiatives that advance system safety, reliability, affordability, decarbonization, and climate resilience. Through these efforts, SoCalGas RD&D will continue supporting Commission oversight objectives while positioning the gas system to meet emerging environmental, operational, and customer needs.

Appendices

1. Regulatory Compliance Matrix
2. Project Summaries
3. Project Selection Criteria
4. Research Consortia

Appendix 1: Regulatory Compliance Matrix

Req. No.	Description	Source	2025 Annual Report Section(s)
1	"Submit an Annual Report … describing the previous year's RD&D program."	D.19-09-051 OP 30, p.783	Summary of Report Contents
2	"…summary of ongoing and completed projects."	D.19-09-051 OP 30, p.783	Project Summaries; Appendices
3	"…program funds expended."	D.19-09-051 OP 30, p.783	Spent SoCalGas RD&D Funds
4	"…funding recipients."	D.19-09-051 OP 30, p.783	Funding Recipients
5	"…leveraged funding."	D.19-09-051 OP 30, p.783	Matched/ Leveraged Funds and Sources
6	"…explanation of processes used for selecting RD&D project areas."	D.19-09-051 OP 30, p.783	Recent Changes to Program Requirements
7	"…structure of the RD&D portfolio."	D.19-09-051 OP 30, p.783	Investment Themes
8	"…future annual reports…should include an explanation of how SoCalGas has used (or intends to use) the results."	Resolution G-3573 OP3, p.16[AL1.1][AL1.2]	Project Summaries
9	"Further, SoCalGas shall describe the benefits and impacts of its RD&D work in ESJ communities in its annual Plan.".	Resolution G-3601 OP6(f), p.42	ESJ Communities and Equity

Appendix 2: Project Summaries

Legend:

Program		Subprogram			
LCR	Low Carbon Resources	**RGP**	Renewable Gas Production	**CA**	Commercial Applications
GO	Gas Operations	**CCUS**	Carbon Capture, Utilization, & Sequestration	**IPH**	Industrial Process Heat
CG	Clean Generation	**E&S**	Environmental and Safety	**CFS**	Commercial Food Service
CEUA	Customer End-Use Applications	**Ops-Tech**	Operations Technology	**RA**	Residential Appliances
CT	Clean Transportation	**SD&M**	System Design and Materials	**AI**	Advanced Innovation
		SI&M	System Inspection and Monitoring	**OS**	Onboard Storage
		DG	Distributed Generation	**RS**	Refueling Stations
		IC	Integration and Controls	**OR**	On-Road

No.	Project Title	Project Description	2025 Progress	Status
70-LCR-RGP	AIChE RAPID Institute Modular Chemical Process Intensification (MCPI) Development	This is for a membership in the Rapid Advancement in Process Intensification Deployment (RAPID) institute, an organization led by the American Institute of Chemical Engineers (AIChE) and funded by the U.S. Department of Energy. Their intent is to support the development of early technologies in processing conversion, including renewable gas production, with the ultimate goal of improving safety and operational efficiency via process intensification. RAPID's DOE funds are allocated to support development of projects executed by different technology developers. This organization provides early, pre-vetted access to decarbonization technologies that can be further explored in the Low-Carbon Fuel Technologies initiative.	The RAPID membership ended in 2025. This membership provided some insights on decarbonization initiatives/technologies, but most projects were outside of California and were out-of-state based technologies. Considering these results, the membership will not be renewed beyond 2025.	Completed

No.	Project Title	Project Description	2025 Progress	Status
71-LCR-RGP	Caltech Hybrid Electrochemical and Catalytic Hydrogen Compression System Development	Researchers at Caltech propose to develop a hybrid electrochemical, catalytic approach for the generation of compressed hydrogen. This technology differs from water electrolysis in that it involves a two-step process in which the active media is first electrochemically charged and then sent to a catalytic reactor to generate hydrogen directly. A benefit of this catalytic compression technology is that hydrogen can be produced on demand with no intermediary steps at high pressure (up to 700 bar), allowing it to be stored with no additional compression or used for vehicle refueling. Low-cost hydrogen in a power-to-gas-to-power (PGP) system can help enable gigawatt (GW) scale and affordable long-duration energy storage. The project will focus on the off-peak operation to decouple and leverage renewable electricity intermittency and pricing. With data obtained during testing, the team plans to develop a comprehensive techno-economic analysis (TEA) to model the costs and performance of the system under these conditions. The project team also plans to integrate the hybrid technology to compress low-pressure hydrogen generated via water electrolysis.	The project team completed additional batch testing of the catalytic compression system. The team, with support from researchers at PNNL, also developed a detailed engineering design for a continuous pilot system which is planned to be tested in 2026.	Active

... Continued

No.	Project Title	Project Description	2025 Progress	Status
72-LCR-RGP	Caltech Sunlight Driven Redox System for Carbon Free H2 Generation Development	The objective of this project is to explore the use of sunlight to generate an intermediate compound that can react with water to produce hydrogen at high pressure. In traditional photoelectrochemical water splitting, sunlight can be used to directly produce hydrogen. This approach may be expected to introduce complexity in the balance-of-plant and downstream gas handling systems in a commercial setting, especially due to variable hydrogen production rates as a result of variable incident sunlight. In the technology being developed in this project, the downstream gas handling steps could be decoupled from the energy harvesting step, allowing solar energy to be stored in a reactive intermediate and subsequently generate hydrogen at a controlled rate or on demand after the sun is no longer shining.	The project team completed a selection of photovoltaic materials that will be used for testing the redox system. The photovoltaic-electrolyzer system was designed and validated prior to testing with the redox intermediate, which is planned for 2026.	Active
73-LCR-RGP	Evoloh Testing of Low-Cost Integrated AEM Electrolyzer System Demonstration	In this project, Evoloh will test their first commercial-scale anion exchange membrane (AEM) electrolyzer stack, produced by their high throughput roll-to-roll (R2R) process, to validate the integrated system performance with balance of plant (BOP) and inform the development of their future electrolyzer plant design. Evoloh plans to install a balance of plant test beds at their facility which will enable the first integration of their stack technology at the system-level. Results from operating the test-bed system will be used to optimize their technology and allow Evoloh to produce a reference design for a commercial AEM plant.	The balance of plant test bed was successfully procured and installed at Evoloh's R&D facility in California. Initial tests using small electrolyzer stacks have been performed with long-duration testing continuing into 2026.	Active

No.	Project Title	Project Description	2025 Progress	Status
74-LCR-RGP	Calicat (formerly H2U) Enabling Stable, Dynamic Operation of PEM Electrolyzers Powered by Renewable Electricity Profiles Development	In this project, Calicat (formerly H2U) will validate a new proprietary technology that improves proton exchange membrane (PEM) durability and performance under variable renewable electricity loads to minimize the carbon intensity of the hydrogen production, maximize tax incentives, and simplify hydrogen production from renewables. The project will first test Calicat's new coating in small scale electrolyzer cells before moving to larger system-level tests in commercial-scale electrolyzer stacks. The goals of the project are to improve the affordability of renewable hydrogen by improving stack durability and increasing hydrogen production efficiency.	Initial experiments performing accelerated stress tests and operation under renewable electricity profiles have been completed on small cells and stacks. Preliminary results indicate that the coating technology developed by Calicat significantly reduced catalyst degradation under dynamic operation. Future experiments will focus on validating laboratory test results on larger, commercial scale electrolyzer stacks.	Active
75-LCR-CCUS	IWVC (AVNOS) Combined Water and CO2 Direct Air Capture System Demonstration	The objective of this project is to demonstrate the outstanding technical and economic performance of a transformational Hybrid Direct Air Capture ("HDAC") technology that simultaneously captures CO2 and water from the air. Air is passed over a CO2 selective sorbent to remove ≥85% of the CO2 from the air stream. The atmospheric water extraction ("AWE") section of the unit utilizes a novel isothermal pressure swing regeneration cycle with desiccant beds thermally coupled by heat pipes that provide a passive heat transfer mechanism to "cancel" the heat of water vapor adsorption. By proving system performance through a demonstration project, our initial technoeconomic analysis ("TEA") will be validated, showing that HDAC technology: 1) is deployable in many more locations with limited water resources, 2) improves the financial returns, and 3) reduces risks from volatility in the price of CO2. The end goal is field testing of the HDAC unit and preparation of a final report on the testing, results, conclusions, and recommendations; and a commercial analysis of the economic viability of the system and candidate locations for commercial deployment.	The Final Report for the project was submitted by AVNOS/IWVC on September 2025. The project has been completed. This project was in a disallowed subprogram but was allowed to continue per AL-6273G.	Completed

No.	Project Title	Project Description	2025 Progress	Status
76-LCR-RGP	LLNL Composite Sorbents - Enabling Economical Biomethane Production - TCF-19-17586	This project aimed to refine and demonstrate a new class of sorbents for upgrading raw biogas to biomethane in order to significantly reduce cost barriers to biomethane production. The project team successfully formulated, synthesized, and tested the new sorbent to validate performance improvements over state-of-the-art biogas conditioning approaches. The team had originally planned to test their sorbent in a pilot-scale testbed that was fabricated by Xebec Adsorption, Inc. However, Xebec filed for bankruptcy during the project's period of performance and scope was modified at LLNL to refocus the project on risk analysis and sorbent development activities.	The Final Report for the project was submitted in Q1 2025. The project has been completed.	Completed
77-LCR-RGP	LLNL Modular Hybrid Electrobioreactor Demonstration CRADA TC02400	The objective of this project is to scale up and deploy LLNL's in-situ electro bioreactors to determine the feasibility and economics of a commercial demonstration. In particular, goals of the project are to increase scale and productivity of current-gen reactors by at least two orders-of-magnitude, optimize electrode and flow field topology to maximize process efficiency, demonstrate successful fabrication of optimized electrode geometries, evaluate stability of the technology under variable electrical loads and variable feedstock purities, and develop technoeconomic models that will aid in demonstration of the technology.	In 2025, initial optimization of the hybrid electrobioreactor has been completed with researchers at LLNL selecting the best-performing materials and testing the system under abiotic conditions to produce hydrogen. Electrochaea has further optimized the operating principles of the system to produce biomethane using their proprietary biocatalyst microorganisms.	Active

No.	Project Title	Project Description	2025 Progress	Status
78-LCR-RGP	NREL Biologic Hydrogen Production from an Expanded Set of Organic Waste Streams Development - TSA-24-30976-0	This project aims to expand research efforts at NREL to study the use of microbes to convert cellulose-rich organic waste biomass directly to hydrogen. This project will test multiple waste streams as well as evaluate feedstock toxicity and potential pre-processing steps to maximize hydrogen yield from organic waste. Previous project results identified promising feedstocks including California-based agricultural residues such as almond shells and residual fibrous material from dairy digesters. This project will evaluate genetic modifications to a type of bacteria called Clostridium thermocellum; these modifications can help the bacteria utilize organic waste more efficiently and greatly improve the yields of hydrogen from this process.	The team has successfully directed the evolution of the target bacteria, C. thermocellum, to allow it to survive at much higher temperatures, which can directly improve performance and prevent contamination from external sources. The team has also performed experiments to identify the biggest obstacles to conversion of biomass to hydrogen, which will be used to develop strategies for future research in 2026.	Active
79-LCR-RGP	NREL CRADA No. CRD-19-809 P2G Systems Integration & Optimization	The goal of this project develops and build an improved mass transfer system for biomethanation processes and implement that in NREL's Mobile Integrated Energy Research Apparatus (MIERA) portable trailer, a mobile system containing an optimized scaled-down bioreactor that can be used for RNG production testing at different biogas production sites. The efficiency of the biomethanation process is directly impacted by H2 mass transfer rates due to the gas' inherent low solubility in water. The biggest improvement to processes like these would be to improve H2 mass transfer so that the biocatalysts can metabolize the gas quicker and improve production rate. The H2 dissolved in the liquid water coming from the stack will be instantly accessible to the biocatalysts for conversion to RNG and other end products. The new configuration will deliver H2 directly to the bioreactor from a 10 kW PEM electrolyzer stack, bypassing the H2 drying system and the H2/H2O phase separation sub-systems. NREL already owns the 10 kW stack, which closely matches the H2 production rate required by the scaled-down 30 L bioreactor.	The MIERA system has been fully assembled and is currently going through testing and commissioning. The system will be completed in Q2/2026 and will be ready for deployment at partner locations to validate performance on locally sourced real biogas streams.	Active

No.	Project Title	Project Description	2025 Progress	Status
80-LCR-RGP	NREL Multi-Party CRADA No. CRD-18-00775 Biomethanation to Upgrade Biogas to Pipeline Grade Methane	The purpose of this project was to develop and de-risk an adaptable biomethanation process to upgrade biogas waste streams from different sources to RNG, focusing on optimizing design aspects and operational parameters. NREL developed multiple engineering documents, including basis for design, control strategies, cause and effect matrices, and drawings to enable the detailed engineering and design, and controls programming lab-scale and commercial scale bio-methanation reactors using methanogenic organisms and effective mass transfer of gases to liquid phase containing said organisms, and linked to electrolyzers for hydrogen production. This integrated approach can provide operational flexibility while maintaining the gas product within the quality needed for injection in the natural gas grid.	The project was completed in 2025 and successfully advanced the studied biomethanation process, which converts renewable hydrogen and waste CO- into pipeline-quality renewable natural gas (RNG), demonstrating adaptability to varying biogas compositions with the potential to achieve negative carbon intensity. Using information derived from this project, NREL built the Mobile Integrated Energy Research Apparatus (MIERA)—a 16-foot trailer housing a pressurized bioreactor and electrolyzer system. This mobile unit will allow field testing on real biogas streams at local sites, de-risking feedstock testing, process scale-up, and enabling future production of RNG from different sources.	Completed

No.	Project Title	Project Description	2025 Progress	Status
81-LCR-RGP	NREL Summit Renewable Power-to-Gas for Biogas Upgrading via Bio-methanation Demonstration	This project will deploy a next-generation pilot-scale system to assess the capital cost and efficiency improvements of coupling biomethanation, water electrolysis, balance of plant, and renewable biogas streams while identifying policy/regulatory and commercial support to enable market acceleration. The technology was previously demonstrated at the National Renewable Energy Laboratory in a simulated environment using pure carbon dioxide. In order to de-risk commercial deployment, the pilot-scale bioreactor will be deployed at a dairy digester to demonstrate the technology operating on real biogas. The team also hopes to register RNG produced using this technology as a CA low-carbon fuel standard (LCFS) pathway, to enable commercial adoption.	The team has completed detailed engineering and design for integrating the bioreactor with the dairy digester facility. The team is awaiting approval by DOE to begin construction, which is slated for 2026.	Active
82-LCR-RGP	NTS Iron-Based Catalytic Conversion of Raw Biogas into H2 Demonstration	NTS is leading the development of a technology that generates hydrogen from biogas using inexpensive, readily available metal-oxide catalyst materials. This technology is specifically well-suited for raw biogas processing applications since its natural chemical composition enhances the metal-oxide catalyst performance, creating a pathway for direct hydrogen generation from raw biogas, potentially reducing capital costs by completely eliminating the biogas upgrading step. As part of the project, a bench-scale testing unit is planned to be installed and tested at a biogas facility in a WWTP in California. Field testing will provide real-world data that will be used to evaluate, optimize, scale-up and continue advancing this technology.	The team has adjusted the original Iron-Based catalyst developed at Stanford University specifically for this application, testing the improved composition using simulated gas that matches the gas composition of the WWTP. The team also completed most of the tasks related to system design and is awaiting approval from the US-DOE to advance to Budget Period 2 and start fabrication.	Active

No.	Project Title	Project Description	2025 Progress	Status
83-LCR-RGP	ORNL High-Speed, High-Volume Manufacturing of Intermediate Temperature Electrolyzer Cells Development - NFE-23-09932	This project plans to address cost barriers associated with current manufacturing practices in high temperature electrolyzer manufacturing, which can greatly reduce costs and greatly increase manufacturing capacity. Currently, high temperature electrolyzer systems require extreme processing temperatures which are both very expensive and take a very long time to complete. This project aims to develop new manufacturing approaches that are compatible with roll-to-roll processes. These new fabrication methods can save time, improve affordability, and greatly reduce the energy required to produce solid oxide electrochemical cells.	The team has developed novel synthetic routes for SOEC cathode and anode catalyst materials that greatly reduce energy requirements, complexity, and duration. The team is working to refine the synthesis process and will begin testing to validate performance in 2026.	Active

No.	Project Title	Project Description	2025 Progress	Status
84-LCR-CCUS	PNNL Integrated CCU System (IC3M) for C1 and C2 Production Development - CRADA 568	In this project, PNNL further developed the Integrated Capture and Conversion of CO2 to Materials (IC3M) platform to make products while capturing CO2. This is a unique and promising technological pathway that can be explored in the utilization context of Carbon Management. This project explored C1- and C2-based material production from carbon dioxide. The team developed the platform to produce various products (formic acid, methyl formate, ethylene glycol, methane, and ethanol) and improve current methanol conversion rates to meet economic targets. Conventional CO2 capture and utilization technologies require CO2 desorption, compression, and transportation before use. In the IC3M system, captured CO2 becomes directly integrated into a final product so that the energy needed for CO2 desorption and compression is avoided. The project approach involved adapting other catalysts and reagent co-feeds for the same capture solvent system developed in the previous research effort. The strategy enabled the research team to tune the catalyst and process conditions required to target several large-market C1 and C2 products. By reducing the need for additional energy inputs, IC3M may become a viable technology for modular distributed-scale processing platforms, which could enable applications such as separating and converting CO2 from landfill gases, wastewater treatment gases, and manure off-gas.	Researchers continued to improve the integrated process that captures and converts CO2 into multiple products (methanol, glycol, formate, methane), achieving >80% selectivity for some products and improving the overall process by 30% compared with the state of the technology in 2022. This project was in a disallowed subprogram but was allowed to continue per AL-6273G. All project activities have been completed, and the team is awaiting receipt of the final report in Q1 2026.	Completed

No.	Project Title	Project Description	2025 Progress	Status
85-LCR-RGP	STARS Corporation Electric Induction Steam Methane Reforming (SMR) Demonstration	The goal of this project is to demonstrate and deploy a novel, advanced steam methane reforming (SMR) process to produce renewable hydrogen. STARS Corporation is developing an advanced, highly efficient SMR reactor that utilizes electrical induction-based heating instead of combustion heating, eliminating NOx formation. STARS' reactor design uses micro and mesoscale catalytic channels and efficient heat recycling to demonstrate record efficiencies in converting electrical energy and natural gas to produce hydrogen. STARS reactor technology features modularized construction capability and a small footprint. A first-of-its-kind (FOIK) system featuring this technology was used to support on-site storage and fueling operations for SunLine Transit's fleet of hydrogen-powered buses in Thousand Palms, California. The demonstration was successful, reaching 1000h of operations, and the lessons learned/data collected during this time are currently being used to design the next generation of STARS' hydrogen production systems.	The system has been decommissioned and removed from Sunline Transit in Q2/2025. STARS provided the final report for the project, which was published by SoCalGas RD&D. STARS is currently designing their next-generation system, which will be the base for their commercialization efforts.	Active
88-LCR-RGP	UCLA Direct Solar Conversion of Biogas to H2 and Solid Carbon Demonstration CEC GFO-21-502	UCLA is proposing to further develop and demonstrate a solar-thermal reactor that converts biogas into hydrogen using concentrated solar power (CSP). The team at UCLA developed a photon-activated catalyst that can break renewable methane molecules into hydrogen and solid carbon. The carbon by-product, besides being biogenic, is highly graphitic, which has applications in key areas in the energy transition such as battery production. This project was awarded $750,000 by CEC in 2021 and has been featured in global climate-change conferences such as the COP 28 in 2023. If successful, the project will provide valuable data to demonstrate the feasibility, cost-effectiveness, and readiness of this early-stage system and enable UCLA to collect operational data to assist in further scale up and advance the proposed system.	UCLA finalized the design, fabrication, and initial testing of the reactor. The design of the solar concentrator and other tasks related to the field implementation are progressing as planned. Field installation and testing are planned to occur in Q3/2026.	Active

No.	Project Title	Project Description	2025 Progress	Status
90-GO-E&S	Greenhouse Gases Emissions Reduction (SRP-GHG-01)	Pipeline Research Council International (PRCI) established a Strategic Research Priority (SRP) to coordinate efforts to reduce greenhouse gas (GHG) emissions across all technical committees. SoCalGas continued to follow research on Continuous Monitoring and Diagnostics for Facility Efficiency (CPS-14-06). The objective of this project was to develop a scoring methodology that considers operational optimization of emissions output along the pipeline. The tasks are to visualize what can be monitored, determine what is monitored, collect the data being monitored, and present the scoring methodology and data on a monitoring dashboard. SoCalGas could use this tool to determine how to mitigate emissions along the pipeline, including units at a compressor station, which benefits ratepayers by improving operational efficiency to balance increasing costs and by reducing greenhouse gas emissions and improving air quality.	In 2025, the team for CPS-14-06 collected data at a singular host site since the other host site was unavailable for this work. The host site provided three stations for data collection and monitoring, and in June 2025, issued the final report. The final report determined that the scoring methodology known as the Total Emissions Efficiency (TEE) score is an effective tool for identifying units that are underperforming in total emissions. The TEE Score can be used along a pipeline to help identify non-efficient emissions from the operation of a unit or station. This report details the best practices of the TEE score and draws conclusions about its efficacy as an emissions reduction tool.	Completed

No.	Project Title	Project Description	2025 Progress	Status
91-GO-E&S	Identify and Validate Best Practices for Applying Heat to Steel Near PE (5.19.s)	The objective of this project was to identify and validate best practices for applying heat to steel near polyethylene (PE) material. Field welding of steel pipeline components can transfer heat to adjoining PE material and affect its integrity. This study considered possible worst-case scenarios in the field and the associated parameters needed to create a model that allows the user to simulate field conditions and predict the risk of damage from heat to plastic facilities. The project team improved a preliminary simulation model previously developed to reduce its computational time. Additionally, the team fine-tuned the heat transfer model in 2023 and ran the heat transfer simulations against a 3D Finite Element Model (FEM). The FEM developed in this project included the necessary physics, such as accounting for gravity and gas flow, to successfully capture the temperature profiles generated in the polyethylene (PE) pipe due to the heat generated in the steel pipe section. This project benefits SoCalGas in reviewing and confirming best practices outlined in company standards for welding near PE pipe, along with ensuring the integrity and safety of PE pipelines.	In 2025, the study confirmed that existing procedures for applying heat to steel near PE are safe and effective. None of the modeled heat inputs, which greatly exceeded the in-field heat input, were able to induce temperature profiles in the PE pipe sections that would result in pipe collapse. Valuable insights into the heat transfer between a steel pipe and adjacent PE pipe were gained. Although existing procedures have been confirmed as safe, SoCalGas will review project results to determine if any additional safety measures need to be incorporated into the current procedures.	Completed

No.	Project Title	Project Description	2025 Progress	Status
92-GO-E&S	Living Lab for Hydrogen (M2020-008)	The objective of this project is to analyze and report data on the impacts of hydrogen blending at higher-volume percentages (i.e., 25%-35%) by evaluating the safety, maintenance, and emergency response changes on gas infrastructure. This is an in-house project, co-funded by NYSEARCH. The Living Lab demonstration will validate the feasibility of blending 25%-35% hydrogen by volume into the existing natural gas infrastructure by simulating system operations with steel and plastic pipelines and components, a pressure regulator station, and a compressor. The project will also test the sensitivity and check the performance of several leak detectors. SoCalGas will deliver a final report with results from all testing and material analysis to project sponsors. The project started with developing a test plan and requesting that sponsors begin collecting plastic and steel pipeline components for testing. In 2024, the project team worked to finalize the last stages of the construction plan and test plan. This project could yield valuable data to SoCalGas on hydrogen blending impacts with respect to safety and pipeline integrity, measurement, regulation, and procedures for safety and maintenance.	In 2025, testing began, which is anticipated to last 24 months and consists of four phases. Phase 1 focused on baseline testing of natural gas, followed by the introduction of a hydrogen blend (25% hydrogen and 75% methane) into the system in Phase 2, with progressively increasing hydrogen concentrations planned for Phase 3 and Phase 4. The project team completed Phase 1 testing successfully and transitioned to Phase 2 in 2025.	Active

No.	Project Title	Project Description	2025 Progress	Status
93-GO-E&S	Modify Pipeline Purging Program for Calculations of Methane Emissions Savings (5.17.m.2)	The project's objective was to add new capabilities to GASPurge, the existing pipeline-purging software used to calculate values associated with the purging and clearing of a natural gas pipeline. The project added features, such as equipment options, feasibility break-even analysis, calculations of emissions savings, and quantification of gas not vented into the atmosphere. The updated software would support calculations for Greenhouse Gas (GHG) emissions and emissions saving reporting. In Phase 1, the 1997 Gas Research Institute's Pipeline Purging Program was revamped, enabling its support by modern operating system platforms. The Phase 1a commercially available software, GASPurge, was deployed and used by SoCalGas for gas purging operations. In 2023, the team surveyed sponsors on equipment types, methods, and processes used for purging operations and alternatives to blowdowns, which were incorporated into the software. In 2024, the team demonstrated the beta version of the software, which incorporated survey feedback on operator needs, and requested additional feedback from the subject matter experts. The project supported industry efforts to reduce (GHG) emissions and improve environmental reporting. SoCalGas could use the updated software program to calculate emissions when purging operations are needed to support quantification of gas not vented to the atmosphere.	In 2025, the team released the final enhanced GASPurge software, which now allows natural gas operators to input detailed operational data to more accurately quantify emissions avoided via purging methods and emissions from equipment use and transportation. The team provided sponsors with trial access to the software and a user manual, as well as ongoing support and maintenance of the software.	Completed

No.	Project Title	Project Description	2025 Progress	Status
94-GO-E&S	NOx and NH3 Sensor Evaluation	The objective of this in-house project is to evaluate the usage of NOx and NH3 sensors as tools for trending selective catalytic reduction (SCR) performance and troubleshooting. These are laboratory-grade sensors and more advanced than typical on-road sensors, and that could enhance feedback controls to improve compressor engines and turbine operating efficiencies and SCR performance. This project will evaluate the reliability and accuracy of sensors in compressor engines and turbine applications for possible deployment. At present, these sensors have never been used for compressor applications. The project team will 1) evaluate the sensors for their ability to accurately measure and detect emissions from lean burn engines, with and without SCR, as well as rich burn engines, 2) determine if NOx sensor pressure correction is necessary, and 3) evaluate NH3 sensors to aid in the improvement of ammonia injection grid tuning. If successful, SoCalGas could add these sensors to its list of approved sensors and deploy the sensors to replace existing sensors currently used on compressor engines and turbines.	In 2025, the team kicked off the project and began developing and installing a sensor-based emissions monitoring system. In early 2025, the team selected the NOx sensor and procured all major components while creating preliminary exhaust manifold designs. The initial testing of NOx sensors provided foundational insights for system design. By mid-2025, the team refined the installation plans and advanced coding efforts to integrate multiple NOx sensors. By late 2025, the team completed the system installation, enabling data collection and preparations for additional sensor integration and evaluation. Progress with the NH3 evaluation was placed on hold due to the loss of a key resource.	Active

No.	Project Title	Project Description	2025 Progress	Status
95-GO-E&S	Odor Detection Study for Blended Hydrogen (M2021-005)	The objective of this project is to determine if the introduction of hydrogen to natural gas changes the perception of natural gas odorants. Federal regulations require odorant injection into natural gas to provide the first line of defense for consumers to detect natural gas leaks. As utilities seek to transition to new fuels such as hydrogen, there is a lack of data and information on the compatibility of odorants in blended hydrogen with natural gas. This study will investigate several natural gas odorants for detectability and recognizability when hydrogen, at various concentrations, is present. In 2024, the project team completed testing of one pure odorant and one commercial odorant blend at a hydrogen concentration of 20%. Based on the results and insights gained during this initial testing, the team identified the need to evaluate an additional pure odorant and an odorant blend at higher hydrogen concentrations of 50%, 75%, and 100%. SoCalGas will study project results to determine if adjustments to odorant levels are needed for hydrogen/natural gas blends to meet the safety standards for employees and customers.	The project team evaluated various hydrogen suppliers in 2025 for the Clean Hydrogen criteria and plans to begin testing in early 2026 once the supplier selection is finalized. A final report will be issued upon completion of all testing activities. This continued testing is intended to assess the effects of increasing hydrogen concentrations on odor detection and recognition.	Active

No.	Project Title	Project Description	2025 Progress	Status
96-GO-E&S	Pipeline Blending CRADA Phase 2 (Task 3, 4)	The Pipeline Blending CRADA Phase 2 (a HyBlend Project) is a three-year effort among industry partners and National Laboratories to evaluate the costs, benefits, and environmental impacts of blending hydrogen into the natural gas (NG) grid as a decarbonization strategy. SoCalGas is participating in tasks: 3) Lifecycle Assessment (LCA) and 4) Techno-Economic Analysis (TEA). The LCA will assess hydrogen-NG blend leakage throughout the supply chain and study hydrogen global warming potential with the inclusion of embodied emissions for a blended gas supply chain. The TEA will involve two efforts that build upon previous research by adding improvements and capabilities to the Pipeline Preparation Cost Analysis Tool and assessing hydrogen blending integration into existing regional energy systems, and the impact on coupled natural gas pipeline network and power grid systems. In 2024, the team completed a literature search to determine the baseline and range of hydrogen GWP and conducted a preliminary LCA. SoCalGas could use the results to support the development of its blending standard and understand the economic and technical aspects of implementing hydrogen blending, which could improve safety and reduce emissions.	In 2025 for the LCA, the team analyzed the hydrogen leakage in blended hydrogen/natural gas systems by region, technology, pipe material, and pipeline age. The analysis distinguished between controlled emissions and uncontrolled fugitive emissions. In 2025 for the TEA, the project team estimated pipeline modification costs based on hydrogen blending ratio, pipe material, and operating pressure. The team analyzed one small-scale system to assess changes in flow rate, pressure, and hoop stress. The next step is to develop a large-scale system with baseline hydraulic modeling and blend analysis in Q1 2026.	Active

No.	Project Title	Project Description	2025 Progress	Status
97-GO-E&S	Plastic Gas Pipe Damage Assessment due to high-pressure water jets and cross bores (5.23.g)	This project's objective was to evaluate the effect of high-pressure (HP) water nozzles used in the sewer cleaning industry on polyethylene (PE) pipe materials to determine the impact on PE cross-bores. Cross-bores occur when PE pipe is inadvertently installed crossing sewers or sewer laterals. HP sewer pipe cleaning jets can create holes or damage PE cross-bores during sewer cleaning, resulting in gas leaks or more serious incidents. Currently, no standard or guideline limits the pressure and performance of sewer cleaning nozzles. The team worked with industry leaders to identify multiple water nozzles used in the sewer industry, construct a testing rig, develop guidelines for safe and unsafe water jetting on cross-bores and standardize the procedure for testing and evaluating new sewer cleaning nozzles. In 2023, the team kicked off the project and in 2024, surveyed project sponsors to select nozzles for testing. The team had issues integrating all nozzles within the original test rig which prompted the test rig to be redesigned. SoCalGas could use these results to further review existing procedures and potentially coordinate with the local sewer companies on best practices for cleaning sewer pipe to avoid PE pipe damage, and resulting incidents, thus benefiting ratepayers by improving reliability, safety, operational efficiency, and supporting affordability.	In 2025, the team worked on compiling the details into the final report and by mid-year, delivered the final report as well as guidelines on the use of HP nozzles around PE cross-bores for sewer cleaning. The team will standardize these guidelines so that newer sewer cleaning nozzles can be tested and evaluated. Upon receipt of the final report, SoCalGas reviewed the results and found the results validated the current SoCalGas' procedures.	Completed

No.	Project Title	Project Description	2025 Progress	Status
98-GO-E&S	Remote Gas Sensing for First Responders - Phase 4 (7.15.b.4)	The project's objective was to develop technology with the capability to assess gas concentration outdoors, in manholes, and within buildings, and commercialize two instruments, the "First Responder" (FR) and the "Un-attended Methane Monitor (UMM)." The ability to determine the gas concentration remotely at multiple locations will save time and improve safety. In previous phases, the team developed a methane detection system prototype to enable a leak investigator to remotely monitor methane levels at multiple points. In this phase, the team would develop: 1) pre-commercial units that can be tested by utility members; and 2) a wireless communication system to enable a leak investigator to remotely monitor methane levels at multiple points. The team developed the FR Mesh Network application known as the Gas Investigation Zone Monitor. In 2023, the team presented the GIZMo prototype to sponsors with a field test and in 2024, demonstrated the prototype tool for active leak investigation. Since SoCalGas still has a need to assess outdoor gas concentrations, SoCalGas could explore other affordable alternatives as they become available or re-explore this development in the event market demand changes. The technical expertise gained from the research offers SoCalGas a foundation for future deployment of specialized leak detection tools, which could potentially improve response times and reduce risk in high-priority scenarios.	In 2025, the team conducted research and worked on the development of the UMM along with Voice of Customer (VoC) engagements. The VoC identified a small market of interest, thus the team decided to not proceed with the UMM development until after market demand increases due to the high production costs for developing the UMM.	Completed

No.	Project Title	Project Description	2025 Progress	Status
99-GO-E&S	Validation of Next Generation Predictive Emissions Monitoring System for Gas Turbines (CPS-2-03A)	The project objective is to continue validation of the next generation of predictive emission monitoring systems (PEMS) for gas turbines using data gathered in the previous phase of the project. The PEMS is a turbine operating parameter-based system for predicting turbine emissions, which uses a chemical kinetics model and advanced statistical analysis. The approach is less costly than continuous emission monitoring systems, which have high capital investment and operating costs. The PEMS could also be used as a diagnostic tool for evaluating turbine performance and optimizing downstream control equipment to reduce operating costs and emissions. The project team will continue to run the PEMS against 2024 data while preparing, implementing, and validating the tool for live onsite data streaming and analysis, demonstrate full sensor validation for improved robustness, and compare the performance of physics-based algorithms to Machine Learning-based PEMS algorithms. At completion, the project team will deliver a refined PEMS model to meet emission monitoring regulatory compliance and a final report detailing the validation analysis. SoCalGas could use the PEMS to monitor and potentially diagnose and improve turbine performance, which improves operational efficiency, affordability, and air quality for the benefit of ratepayers.	In 2025, the project was delayed due to lack of resources and information availability. The research is expected to continue in Q2 2026.	Active

No.	Project Title	Project Description	2025 Progress	Status
100-GO-Ops-Tech	Alternative Steel and Composite Material and Liquid Pipeline Systems (5.22.f)	The project's objective was to establish a framework and requirements for the installation, inspection, and integrity management of alternative steel and composite pipes in natural gas pipelines. The study addressed: 1) material testing, 2) construction requirements, 3) damage and assessment of defects, 4) degradation of pipe material, and 5) inspection and maintenance activities. The team designed the project to map the requirements under the 49 CFR Part 192, with the goal to identify and address the gaps in implementing a qualification process for non-steel and alternate-steel composite pipes similar to the ones currently used for steel pipes. In 2023, the project team completed testing to determine the maximum allowable operating pressures of composites and evaluated both the potential damage to composites during construction and their corrosion properties. In 2024, the project team completed the remaining evaluation of the properties of composites' resistance to erosion, integrity threats, and degradation; reviewed the code requirements; and drafted the project report. The project results could be incorporated into the 49 CFR Part 192 to qualify the composite pipes. SoCalGas can use these results to evaluate the use of alternative steel and composite materials within our pipe system for the pipeline repair program, which can lead to cost savings to ratepayers and improve the pipeline integrity program.	In Q1 2025, the final report has been provided to sponsors and to Pipeline and Hazardous Material Safety Administration (PHMSA), who will publish it on its website. The final report provided results that included a comprehensive evaluation of the practices and requirements of various standards for the safe adoption of composite and alternative steel pipes.	Completed

No.	Project Title	Project Description	2025 Progress	Status
101-GO-Ops-Tech	Data Logger Evaluation Project - Phase II	The project's objective is to evaluate a commercially available data logging technology (logger) for collecting data associated with the joint fusion process. Thermoplastic pipeline joints are produced in the field using a fusion process (e.g., heat and pressure). High-quality joints are critical to the integrity (e.g., safety and reliability) of natural gas pipeline facilities. There is presently no automated data collection process for field fusion operations. Existing processes have significant potential for errors and are an inefficient means of integrating fusion data into company data management systems (DMS), thus encumbering review and analysis. In cases of failure, the fusion data are not readily available for review to aid the investigative process. The team evaluated a proof-of-concept for a commercially available data logger in Phase 1 and researched the process of data collection, storage, and integration into DMS in Phase 2. Previously, the team collected fusion data, interpreted data formats generated by the logger software, and developed software to validate work orders (WOs) and train welding instructors. In 2024, the team advanced the integration process for importing fusion data into SoCalGas' DMS and developed WO validations and operator qualifications (OQs). SoCalGas anticipates that the data would allow real-time evaluation of fusion parameters before the pipe is put in service, which could benefit ratepayers by improving the quality and integrity of fused joints.	In 2025, the team continued to collect data on smaller pipe sizes using hydraulic fusions and finalized developments for WO and OQ validation and importing all data into SoCalGas' DMS. Also, the team developed the training model and company operations standard for the data logger.	Active

No.	Project Title	Project Description	2025 Progress	Status
102-GO-Ops-Tech	Guidance for H2/NG Blending Equipment Installation and Operations (5.23.p)	The objective of this project was to utilize the latest hydrogen research and information on natural gas blending technology to create guidance on blending that operators can include within their procedures. This project developed procedures and recommended practices to guide operators in planning, estimating costs, and executing hydrogen-natural gas blending projects with respect to safety, equipment, and operations. The financial analysis aims to help operators understand capital and operating cost implications for hydrogen blending projects. In 2024, a draft white paper was distributed to project sponsors for comment and feedback. SoCalGas may utilize the results of this research to inform company procedures, practices, and financial estimating information related to the potential implementation of hydrogen blends in the natural gas system.	In 2025, two white papers were completed: one on recommended practices and operating procedures, and another on high-level financial analysis for a distribution facility with on-site electrolytic hydrogen production and storage. The analysis evaluated two design blend scenarios and identified key cost drivers such as electrolyzer capacity factor, stack power consumption, and electricity price. The results showed that the estimated Levelized Cost of Hydrogen (LCOH) is significantly higher than DOE's targets due to assumptions on scale and energy cost. The team confirmed the sensitivity analysis that sourcing low-cost electricity, improving electrolyzer efficiency, and maintaining continuous operations can substantially reduce LCOH.	Completed

No.	Project Title	Project Description	2025 Progress	Status
103-GO-Ops-Tech	In-Situ Ultrasonic Gas Flow Meter Flow Verification (MEAS-6-17C)	The objective of this project is to develop and test a prototype for applying the gas tracer ultrasonic meter (USM) verification method from previous research efforts in a field setting. Previous research efforts (Pipeline Research Council International projects: MEAS-6-17, MEAS-6-17A, and MEAS-6-17B) tested the proof of concept for an in-situ gas tracer verification method for USMs in natural gas service using helium and achieved an average error of ±0.05%. A prototype for verifying USM field performance without service interruption would provide cost savings by identifying issues sooner and more quickly, and from not having to remove the USM from service for flow verification. The project team is developing a functioning prototype to deploy the gas tracer method of USM verification, will provide a final report that includes field data that illustrates the performance of the method and prototype, and will then propose this method to be used as a recommended practice within American Gas Association's published Report No. 9 (AGA 9), Measurement of Gas by Multipath Ultrasonic Meters. In 2024, the project team completed a scoping study to analyze the proof-of-concept of the mass balance in-situ verification method, developed a test plan, and completed the first round of testing. If the prototype and methodology are successful and adopted by AGA 9, SoCalGas may utilize this prototype verification method for calibration use for in-situ USMs if it is available as a service offering.	In 2025, the project team analyzed the results of the initial testing phase and began developing the full testing program, which is scheduled to begin in Q1 2026.	Active

No.	Project Title	Project Description	2025 Progress	Status
104-GO-Ops-Tech	No Heat Method of Wire Attachment	The objective of this project is to enhance the installation process of Electrical Test Stations (ETSs) and current-carrying wires for Cathodic Protection (CP) systems by validating the application of a magnetic/epoxy wire connection. The current method of applying CP connections requires "hot work" like pin brazing. Pin brazing uses heat at elevated temperatures, which poses hazards like exposure to fumes, gases, and thermal burns. At present, there is no approved cold solder wire connection. This project will evaluate the effectiveness and integrity of using the cold solder wire connection method by performing the following tasks: 1) lab testing, 2) field testing, and 3) pilot study. If the project is successful, SoCalGas could use the cold solder wire connection method to enhance the CP protection across SoCalGas' Integrity Management programs, thereby increasing operational efficiency, safety and supports affordability for the benefit of ratepayers.	In early 2025, the project team created and approved the project plan and procured materials for lab testing. In late 2025, the project team initiated the lab testing to validate the material and coating performance through environmental exposure, adhesion checks, surface-prep comparisons, and curing behavior, with additional mechanical and magnetic property assessments planned. The lab testing is projected to be completed by Q2 2026, after which favorable results would lead to field testing.	Active

No.	Project Title	Project Description	2025 Progress	Status
102-GO-Ops-Tech	Guidance for H2/NG Blending Equipment Installation and Operations (5.23.p)	The objective of this project was to utilize the latest hydrogen research and information on natural gas blending technology to create guidance on blending that operators can include within their procedures. This project developed procedures and recommended practices to guide operators in planning, estimating costs, and executing hydrogen-natural gas blending projects with respect to safety, equipment, and operations. The financial analysis aims to help operators understand capital and operating cost implications for hydrogen blending projects. In 2024, a draft white paper was distributed to project sponsors for comment and feedback. SoCalGas may utilize the results of this research to inform company procedures, practices, and financial estimating information related to the potential implementation of hydrogen blends in the natural gas system.	In 2025, two white papers were completed: one on recommended practices and operating procedures, and another on high-level financial analysis for a distribution facility with on-site electrolytic hydrogen production and storage. The analysis evaluated two design blend scenarios and identified key cost drivers such as electrolyzer capacity factor, stack power consumption, and electricity price. The results showed that the estimated Levelized Cost of Hydrogen (LCOH) is significantly higher than DOE's targets due to assumptions on scale and energy cost. The team confirmed the sensitivity analysis that sourcing low-cost electricity, improving electrolyzer efficiency, and maintaining continuous operations can substantially reduce LCOH.	Completed

No.	Project Title	Project Description	2025 Progress	Status
103-GO-Ops-Tech	In-Situ Ultrasonic Gas Flow Meter Flow Verification (MEAS-6-17C)	The objective of this project is to develop and test a prototype for applying the gas tracer ultrasonic meter (USM) verification method from previous research efforts in a field setting. Previous research efforts (Pipeline Research Council International projects: MEAS-6-17, MEAS-6-17A, and MEAS-6-17B) tested the proof of concept for an in-situ gas tracer verification method for USMs in natural gas service using helium and achieved an average error of ±0.05%. A prototype for verifying USM field performance without service interruption would provide cost savings by identifying issues sooner and more quickly, and from not having to remove the USM from service for flow verification. The project team is developing a functioning prototype to deploy the gas tracer method of USM verification, will provide a final report that includes field data that illustrates the performance of the method and prototype, and will then propose this method to be used as a recommended practice within American Gas Association's published Report No. 9 (AGA 9), Measurement of Gas by Multipath Ultrasonic Meters. In 2024, the project team completed a scoping study to analyze the proof-of-concept of the mass balance in-situ verification method, developed a test plan, and completed the first round of testing. If the prototype and methodology are successful and adopted by AGA 9, SoCalGas may utilize this prototype verification method for calibration use for in-situ USMs if it is available as a service offering.	In 2025, the project team analyzed the results of the initial testing phase and began developing the full testing program, which is scheduled to begin in Q1 2026.	Active

No.	Project Title	Project Description	2025 Progress	Status
104-GO-Ops-Tech	No Heat Method of Wire Attachment	The objective of this project is to enhance the installation process of Electrical Test Stations (ETSs) and current-carrying wires for Cathodic Protection (CP) systems by validating the application of a magnetic/epoxy wire connection. The current method of applying CP connections requires "hot work" like pin brazing. Pin brazing uses heat at elevated temperatures, which poses hazards like exposure to fumes, gases, and thermal burns. At present, there is no approved cold solder wire connection. This project will evaluate the effectiveness and integrity of using the cold solder wire connection method by performing the following tasks: 1) lab testing, 2) field testing, and 3) pilot study. If the project is successful, SoCalGas could use the cold solder wire connection method to enhance the CP protection across SoCalGas' Integrity Management programs, thereby increasing operational efficiency, safety and supports affordability for the benefit of ratepayers.	In early 2025, the project team created and approved the project plan and procured materials for lab testing. In late 2025, the project team initiated the lab testing to validate the material and coating performance through environmental exposure, adhesion checks, surface-prep comparisons, and curing behavior, with additional mechanical and magnetic property assessments planned. The lab testing is projected to be completed by Q2 2026, after which favorable results would lead to field testing.	Active

No.	Project Title	Project Description	2025 Progress	Status
109-GO-SD&M	Crack Management Analysis Tool	The project's objective is to support the development of an advanced web-based platform (WBP) to help operators with post-processing in-line inspections (ILI) and non-destructive evaluation data for crack management (CM). Utilities are often limited to traditional spreadsheets to perform crack analysis or rely on third-party vendors to post-process sensitive information. This project will fill in the technology gap to help operators input large data sets and perform advanced analysis to help mitigate crack features on steel assets. The WBP will include crack evaluation, cycle counting analysis, refinement and evaluation of hard-to-spot crack features, probabilistic evaluation tools, flaw types, and multi-flaw remaining strength calculations. In 2024, the team held its kick-off meeting and CM workshops to gather SME input for enhancing the WBP. With increasing need to inspect pipelines for cracks, the WBP could provide SoCalGas with robust inspection results, allowing for better understanding and assessment of pipe segments that are susceptible to cracking.	In 2025, the team advanced the WBP with modules for predicted failure pressure and remaining life calculations, completed a failure assessment diagram, hosted technical advisory committee workshops to discuss stress corrosion cracking flaw interaction, cycle fatigue assessment, and toughness testing, refined crack flaw characterization methods and advanced the use of probabilistic approaches for improving the accuracy and reliability of ILI tool assessments. The team continues to develop the basic tools and new tool training. Project deliverables include WBP and quarterly CM workshops to transfer knowledge. The team will deploy and evaluate the results from the ILI inspections that used crack detection tools via the WBP.	Active

No.	Project Title	Project Description	2025 Progress	Status
110-GO-SD&M	Deliver Comprehensive Metal-Loss Assessment Criterion (EC-2-10)	The objective of this project is to develop Level 1 and Level 2 metal-loss assessment criteria that are easy to use and cover all pipe grades and construction eras. These criteria will indicate the risk of leak and rupture, reduce inspection data scatter, and eliminate maintenance that does not affect risk reduction. The project integrates and builds on work completed in prior research, which developed a criterion for metal-loss assessment demonstrated in an independent evaluation to significantly reduce data spread and address bias, in contrast to the American Society of Mechanical Engineers (ASME) B31G and Modified B31G. This project's assessments will have less scatter and conservatism than ASME B31G, Modified B31G, and other assessment models without compromising pipeline operational safety. The project has multiple phases. Phase I developed a burst pressure predictive model for isolated metal loss Phases II and III are developing criteria to quantify interaction and coalescence for adjacent metal loss features, with the criteria to be evaluated relative to existing full-scale burst test data. The project team drafted the coalescence criteria for adjacent and nested metal loss features and verified them against historical full-scale test data in 2023 and completed the coalescence criteria verification in 2024. The outcome of this effort could provide SoCalGas with a comprehensive and representative assessment of failure pressure in areas of corrosion damage, thereby increasing safety for ratepayers.	In 2025, the team implemented the Likelihood vs Risk assessment and reviewed and verified the assessment against a full-scale test dataset and released the final report to sponsors in December for review.	Active

No.	Project Title	Project Description	2025 Progress	Status
111-GO-SD&M	Design and Placement of Compact Service Regulators (5.22.j)	The project's objective is to review existing practices and perform comparative testing on vent-limiting (VL) service regulators (regs) to determine installation requirements. Many utilities use the "minimum distance to a source of ignition" requirement for indoor and outdoor regs listed in the National Fuel Gas Code, which is based on the venting characteristics of standard internal relief valve (IRV) regs and not for VL regs. The results from Phase I showed that the enhanced safety features integrated into the VL service regs reduce the volume of gas vented under abnormal conditions, supporting less restrictive installation requirements. The team will: 1) review current industry practices for VL regs; 2) perform testing to quantify the amount of vented gas from VL and IRV reg, including SoCalGas specific regs; and 3) provide recommendations on safe location and clearance requirements for the indoor and outdoor installation of VL regs during various reg operating flow conditions and failure modes, including diaphragm ruptures. The team modified the scope to also test two of the non-relieving (NR) service regs to determine their sensitivity to trips from increasing temperatures. In 2021, the team kicked off the project. In 2022, the team identified currently available national and international VL service regs, selected the regs to be tested, finalized the test plan, and began testing regs and building the test rig to measure vented gas. The team completed the initial testing in 2023 and the testing on the 2 NR service regs in 2024. If PHMSA establishes the new distance guidelines for VL and NR regs, SoCalGas could use the results to inform and align current and future requirements for the installation of VL and NR service regs.	In 2025, the scope was modified to include evaluation of thermal expansion effects on outlet/house-line piping systems for NR with the overpressure shutoff feature. The team also completed its comprehensive testing and analysis of the regulators. The next step is for the team to analyze the data, perform temperature tests, and complete the final report.	Active

No.	Project Title	Project Description	2025 Progress	Status
112-GO-SD&M	Distribution System Analysis	This project's objective is to support future risk and threat analysis under different operating conditions by establishing families of pipes and components with specific characteristics that have similar risk profiles. The project will conduct a Critical Threat Review using a Phenomena Identification and Ranking Table (PIRT) and develop an advanced probability-of-failure (POF) model by analyzing various parameters. Some of these parameters include material type, manufacturing process, prior pipeline inspection, operating histories, lab testing results, and existing probability of failure framework. The project scope will review the distribution system by 1) assessing the threat/risk model, 2) conducting research and evaluating system material and components, and 3) providing recommendations for the current steel pipeline system. In Q4 2024, the team held a kickoff meeting. SoCalGas could use the project's results to visualize pipeline vulnerabilities, prioritize threats, and make data-driven decisions to enhance safety, and support greenhouse gas emission reduction and air quality improvement. SoCalGas could use the POF model across various pipelines to enhance the existing SoCalGas integrity management programs.	In 2025, the team completed the PIRT sessions with SoCalGas subject matter experts (SMEs) to provide a comprehensive review of SoCalGas's existing pipeline infrastructure. The PIRT sessions identified various potential threats and vulnerabilities, such as pipeline characteristics (welds, vintage, hard spot), system properties (alternative fuel effects on the pipeline), and evaluated and prioritized associated risks like third-party damage. The next steps are to compile the details into a final report, and review and issue the final report to SMEs.	Active

No.	Project Title	Project Description	2025 Progress	Status
113-GO-SD&M	Efficacy of Offline and Online Methodologies to Measure Siloxanes in RNG (MEAS-15-04)	The project's objective is to determine the precision, accuracy, and sensitivity of an online Gas Chromatography-Ion Mobility Spectroscopy (GC-IMS) siloxane sensor (analyzer) for biogas. Unlike offline analysis, developing a low-cost, low-maintenance online analyzer that can meet the sensitivity and precision needs of the industry could lead to timelier monitoring for regulatory compliance. In partnership with OTD 7.16.g.2, the project will 1) test the GC-IMS at a landfill site, 2) for a more robust dataset, evaluate the GC-IMS analyzer at a site that differs from the initial tests' digester feedstock and geography, and 3) using Standard Test Method for Measurement of Volatile Silicon-Containing Compounds in a Gaseous Fuel Sample Using Gas Chromatography with Spectroscopic Detection (ASTM D8230), the team will analyze collected samples and compare online data to offline techniques by independent labs. In 2023, the team performed validation tests and calibrated an updated version of the analyzer and in 2024, finalized the project plan with a different Southern California site. SoCalGas would determine the viability of monitoring siloxane levels online and review its value prior to installation at one of its biogas producer sites.	In 2025, the team improved analyzer installation, refined detection methods, shifted to controlled lab testing to expedite high-quality data collection, and resumed side-by-side comparisons of the GC-IMS and GC-Atomic Emission Detector with repaired equipment and refined test blends, to validate performance under various conditions. The next steps will be to perform multiple tests at varying siloxane concentrations, submit samples to monitor gas blend delivery at a third-party lab for the Interlaboratory Study under ASTM D8230.	Active

No.	Project Title	Project Description	2025 Progress	Status
114-GO-SD&M	Electrochemical Efficiency Testing of Galvanic Anodes for Cathodic Protection (CP)	The project objective is to evaluate the performance and characteristics of high- and standard-potential magnesium and zinc anodes according to ASTM G97-18 Standard Test Method for Laboratory Evaluation of Magnesium Sacrificial Anode Test Specimens for Underground Applications. This study should enhance SoCalGas' understanding of the relationship between the electrochemical efficiencies and densities of galvanic anodes to better predict anode service life, potentially minimizing excavations needed for anode installation. Currently, the industry follows a 50% efficiency factor for magnesium anodes, but this value can decrease at lower anode current densities. The drop in efficiency leads to a shortened anode service life. The current ASTM testing method applies to magnesium anodes and only considers a fixed current density at the anode surface area. The team will 1) determine the composition of metallic constituents, 2) test the anode specimens as per ASTM G97-18, 3) test multiple current densities against electrochemical efficiency, and 4) observe the microstructure of the anodes before and after testing. The results could better inform SoCalGas of optimal cathodic protection system designs and installations, leading to less excavations, reduced occurrence of out-of-tolerances (Abnormal Operating Conditions) discovered during mandatory inspections and monitoring, which could improve safety and reliability, and reduce GHG emissions, benefitting ratepayers.	In 2025, the team finalized the approved project plan to kick off the project and coordinated with anode vendors to secure anodes for testing. Three vendors are supplying the anodes at no cost. The team is working on securing a laboratory location, and once secured, will execute the preparation protocols, and begin testing.	Active

No.	Project Title	Project Description	2025 Progress	Status
115-GO-SD&M	Gas Machinery Research Council (GMRC)	This project supported the Gas Machinery Research Council (GMRC), which is a community of natural gas companies dedicated to investigating technical issues within the rapidly evolving gas machinery industry and uncovering innovative solutions that improve the reliability, efficiency, and cost-effectiveness of mechanical and fluid systems. GMRC has more than seventy plus member organizations, providing its members and the industry with an opportunity to exchange information and ideas and to participate in applied research and technology programs. GMRC accepts proposals relevant to current issues facing the gas machinery industry and seeks to improve the quality, performance and efficiency of pipeline facilities and gas compressor stations. The goal of this research was to address technology gaps that improve Rod Packing Operations. Participation with the GMRC benefited SoCalGas by providing access to a library of ongoing and completed research, like the Combined Recirculation of Crankcase and Rod Packing Gases.	In 2025, the team completed the work with Recompression Best Practices and Combined Recirculation of Crankcase and Rod Packing Gases and delivered the final report.	Completed

No.	Project Title	Project Description	2025 Progress	Status
116-GO-SD&M	Gas Turbine Component Research Roadmap (CPS-5-12)	The objective of this project was to develop a roadmap to guide future Pipeline Council Research Institute research in centrifugal components for gas turbine-driven centrifugal compressors. The previous roadmap was created in 2016 and does not reflect the current state of technology. The project will: 1) perform a literature review under the new roadmap and survey the current state of gas-turbine-drive centrifugal compressors; and 2) identify gaps that could improve gas turbine-drive compressor safety, reliability, and performance. In 2023, the project team issued a request for proposal and rescoped the project to include areas for optimizing efficiency and performance of compressors. In 2024, the team completed literature review, survey and updated the roadmap identifying and prioritizing future research projects to benefit gas utilities and their ratepayers by improving the safety, reliability, and reduction of GHG emissions in its turbine-driven compressors. SoCalGas will use the roadmap as a guide and reference to re-focus their current roadmaps in this research area and determine which future projects to sponsor, which improves operational efficiency that allows SoCalGas to maintain affordability for their ratepayers.	In 2025, the team published the final report and roadmap and held a webinar in Q1 2025.	Completed

No.	Project Title	Project Description	2025 Progress	Status
117-GO-SD&M	Individual Packaging Requirement for all Bulk Packaged Plastic Fittings (5.24.g)	The project's objectives are to develop and incorporate requirements for individual packaging of plastic fittings into the applicable American Society of Testing and Materials (ASTM) standards. Joining plastic pipes is a fundamental activity performed throughout all US gas utilities. Pipe and fitting contamination are one of the leading causes of joint integrity issues. Presently, there is no mandatory requirement or guidance for plastic fittings to be packaged individually when they are provided in bulk packaging, which can result in potential contamination or dislodged and/or missing components. The team will identify the ASTM standard(s) to be updated, create the appropriate packaging language to require individual component packaging when bulk packaging is used, and work to incorporate this new natural gas industry language into the appropriate ASTM standards. In 2024, OTD submitted the proposed changes to the packaging standard to the ASTM committee, but the proposal did not attain enough votes to change the materials' packaging standards. SoCalGas could use the requirement to guide installations to reduce or eliminate risk of potential contaminated fittings, potentially avoiding costly repair due to leaks from contaminated joints, thereby improving ratepayer reliability and safety.	In 2025, the team addressed the negative votes received on the changes to the existing standard from the ASTM committee and the developed new language to resolve their concerns. The team resubmitted the proposal to incorporate the new mandatory language into the standard and is awaiting ballot results to direct the publishing of the applicable ASTM standard with the new packaging requirement, potentially the costly repair of leaks due to contaminated joints.	Active

No.	Project Title	Project Description	2025 Progress	Status
118-GO-SD&M	LUAF Study	The project's objective was to characterize and estimate the measurement and theft-related variables and tampering components for lost and unaccounted-for (LUAF) gas volumes on the SoCalGas delivery system. The original SoCalGas study on determining LUAF gas volumes was developed by the Gas Research Institute in the early 1990s (GRI report 93/0115). SoCalGas updated the report for the measurement factor in 2006. Since then, equipment and operating practices have changed with the introduction of new technology. Historically, measurement has accounted for the greatest percentage of SoCalGas LUAF, and recent studies have shown this still holds true. The theft and tampering components to LUAF estimates have been difficult to define with new methods of theft have been identified in recent years. This team performed a detailed analysis of 1) metering technology and components within SoCalGas for 2018-2022, and 2) the main areas of annual variability, identifying the factors and variables that affect SoCalGas customer service and theft-related distribution LUAF. The deliverables included final reports on: 1) measurement-related LUAF; and 2) theft-related LUAF. Each report included recommendations for future consideration. In 2024, the team completed the measurement portion, identified the contributing factors, and updated the LUAF reporting process based upon the current SoCalGas meter population. SoCalGas could use the results to determine if the measurement and theft component totals could be utilized to improve its LUAF program and potentially in LUAF reports for regulators, which helps improve operational efficiency, reliability and supports affordability for ratepayers.	In 2025, the team completed the theft portion with only 2% of the field investigations identifying unauthorized gas usage, and a key finding that reflected a downward trend in theft attributed to the effectiveness of the advanced metering infrastructure. The recommendation was made to explore advanced data analytics to help identify high risk facilities and energy theft- an area that poses significant challenges to operational integrity, customer equity, and revenue assurance.	Completed

No.	Project Title	Project Description	2025 Progress	Status
119-GO-SD&M	Managing Stress from Uneven Supports and Settlement (CNST-2-2A)	The objective of this project was to develop guidelines and procedures to manage strains and stress from uneven support and soil settlement in the design, construction, and maintenance of pipelines. High strain and stress could lead to pipeline fractures, causing failures and disruptions to services for ratepayers. The project scope: 1) investigated current utility practices in addressing external strain and stress, 2) examined excavation and backfill practices that cause high strain and stress by analyzing utility data and 3) used models to simulate and quantify strain and stress to develop best practices to minimize them on pipelines. In 2022, the project team completed a literature review of PHMSA incident reports from uneven supports and conducted a member survey on current practices. In 2023, the project team collected and analyzed data for ILI and bending strain and maintenance records. In 2024, the project team added additional types of steel to the scope and completed the analysis. SoCalGas could use the guidelines and procedures for best practices to improve design, construction, and maintenance that could minimize strain and stress on its pipelines.	In 2025, the project team presented the final report with recommended practices and procedures for preventing pipeline failure from uneven supports to its sponsors and held a workshop to train utility sponsors on implementation of these best practices for minimizing pipeline strain and stress.	Completed

No.	Project Title	Project Description	2025 Progress	Status
120-GO-SD&M	Multi-Compound Green Corrosion Inhibitor for Gas Pipeline	The objective of this PHMSA co-funded project is to develop a novel "green" corrosion inhibitor (GCI), optimize its implementation in gas pipeline environments, and evaluate the GCI's effectiveness and compatibility via lab testing and nondestructive evaluation measurements. Unlike traditional chemical inhibitors, GCI offers high potential to mitigate internal corrosion and are environmentally friendly. This project will 1) evaluate and test multi-compound GCI derived from renewable feedstocks for performance, 2) simulate the implementation to recommend best practices for different pipe geometries, inhibitor properties, and operational factors, and 3) perform validation tests on inhibitor coating thickness, and gas and pipeline properties. The team designed and synthesized GCIs and identified candidates for gas pipeline protection in 2023 and selected two compounds that were used to coat steel samples to moderate corrosion effects in 2024. SoCalGas anticipates using environmentally friendly alternatives to prevent corrosion in pipelines. The research could help identify features for Integrity Management, which will benefit ratepayers by improving operational efficiency and safety, while reducing the environmental impact of using corrosion inhibitors to protect the pipelines.	In 2025, the team established the foundational performance metric, investigated the corrosion reaction of carbon steel and the chosen media, performed additional screening of GCIs, and expanded into other compounds. In parallel, the team developed AI-guided flow simulations to optimize GCI placement and dosing and improve steel coverage and film durability. Since federal funding was cut, the team could not continue the remaining tasks, and therefore the project was placed on hold.	Active

No.	Project Title	Project Description	2025 Progress	Status
121-GO-SD&M	On-Line Biomethane Gas Quality Monitoring Ph III (7.16.e.3)	The project's objective is to perform the product development of the selected analyzer and test the modified analyzer for the monitoring of unconventional trace contaminants. In past phases of this project, the team completed validation testing of several online biomethane analyzers to identify which would have the potential to detect unconventional trace constituents (TCs), which can sometimes be found in biomethane if cleanup technologies fail and are not routinely monitored by online instruments. Utilities need technologies to provide real-time data for these TCs since it impacts gas quality. The project will deliver a market-ready analyzer that can monitor the predominant species of ethylbenzene, toluene, siloxanes, organic arsenic, halogenated hydrocarbons, and n-nitroso-di-n-propylamine. In Phase 3, the team planned to work with the manufacturer, incorporating changes identified in Phase 2 into the analyzer for commercialization and testing it to evaluate precision, accuracy, and operational experience. In late 2024, the team discussed if Phase 3 should be canceled or rescoped to accommodate vendor recommendations. SoCalGas needs to continuously monitor TC levels to determine the variability of the TC concentration. If this project shows that the concentration exceeds the limits, SoCalGas may require biomethane quality monitoring systems to confirm consistent gas quality for the safety and reliability for ratepayers.	In 2025, sponsors approved to rescope Phase III and included procurement of calibration gases for use throughout analyzer development and optimization. The team also worked on developing an analyzer measurement program for Benzene-Toluene-Ethylbenzene-Xylene and siloxanes using the analyzer operating parameters.	Active

No.	Project Title	Project Description	2025 Progress	Status
122-GO-SD&M	Pathway to Achieving Efficient and Effective Crack Management (SRP-CM-01)	The objective of this research was to advance critical areas associated with the execution of crack management programs that eliminate crack-related failures. PRCI established the Strategic Research Priority (SRP) to coordinate efforts across all technical committees (e.g., Compressor Pump Station, Design Materials Construction, Surveillance Operations Monitoring, Measurement, and Underground Storage). The SRP provided a roadmap of research projects to understand further and efficiently and effectively manage cracks in pipelines. The research focused on four core areas: susceptibility, inspection, management, and assessment and remediation. SoCalGas plans to evaluate the results and recommendations for implementation in their Integrity Management Program to improve reliability and safety or ratepayers.	In 2025, three final reports were published for NDE-4-24: 1) The State-of-the-Art Pipeline Risk Assessment for Crack Management; 2) Circumferential Crack Hazard POF Analysis Process; and 3) Pipe Vulnerability Analysis Methodology.	Completed

No.	Project Title	Project Description	2025 Progress	Status
123-GO-SD&M	Pipeline Integrity Tool Cloud Based Assessment Software Consortium Project (MAT-8A/JCAS-01)	The objectives of this joint industry project (JIP) were to develop an improved model for pipeline seam weld anomalies and to improve the existing Pipeline Research Council International MAT-8A fracture mechanics model and its input parameters. The final product was a cloud-based software tool that can perform probabilistic assessments of cracks and crack-like flaws in pipelines. This software tool was implemented into the modified MAT-8 fracture model, which accounts for surface cracks with arbitrary depth profiles. In 2023, the project team updated the cloud-based software to incorporate both detected and undetected crack defect populations on pipeline segments. The project team also developed a methodology to model undetected populations of defects using extreme value analysis. In late 2024, the project team completed the Stress Corrosion Cracking analysis on data provided by a sponsor and incorporated this data into building the toughness database. The development of an analysis methodology for undetected populations of cracks in pipelines has already assisted SoCalGas in improving its threat evaluation models for seam cracking and could be used for performing Engineer Critical Analysis (ECA) without ILI to support the regulatory requirements of the Gas Transmission Safety Rule thereby increasing system safety.	In 2025, SoCalGas received all the project deliverables and implemented the cloud-based software tool incorporating the new model for use by the Integrity Management team.	Completed

No.	Project Title	Project Description	2025 Progress	Status
124-GO-SD&M	Practical Girth Weld Evaluation Criteria Considering Weld Strength Mismatch and HAZ Softening (MATH-5-3D)	The objective of this project was to develop weld acceptance test criteria to verify acceptable weld strengths and use the results to propose revisions to current welding standards, including American Petroleum Institute (API) Standard 1104 and Canadian Standard Association (CSA) Z662. This project continued the work from previous research projects (MATH-5-3B and MATH-5-3C) that identified the cause of many failures at girth welds on modern high-strength pipes. The reasons identified involved undermatching (i.e., where the weld is weaker than the adjoining pipe) and heat affected zone (HAZ) softening due to welding coupled with axial loads. The revisions associated with this research could improve pipeline integrity, safety, and reliability by updating the standards with new testing methods and procedures for minimizing HAZ softening and undermatching weld strength. In 2023, the project team tested and analyzed the tensile strain capacity to quantify weld strength and the performance to determine the strength capacity of the welds experiencing HAZ softening. The team also expanded the project scope to include increasing the confidence level in the project results. In 2024, the team completed additional sample testing. SoCalGas will evaluate the results and recommendations for additional testing methods to determine if changes are needed to welding practices to improve its Integrity Management Program.	In 2025, the team delivered a final report with recommendations and the acceptance criteria for girth welds that could be used by pipeline operators.	Completed

No.	Project Title	Project Description	2025 Progress	Status
125-GO-SD&M	PRCI Emerging Fuels Institute	PRCI established the Emerging Fuels Institute (EFI) in April 2021 to address the challenges of transitioning to clean fuels. The EFI focused on infrastructure related to various emerging fuels, such as RNG, ammonia, and biofuels. The EFI research areas included: pipeline system integrity; steel and non-steel components; compressor stations; pressure control and over-pressure safety devices; electrical classification and fire safety; and underground storage. Participation in the EFI enhanced SoCalGas' knowledge and expanded its knowledge library to assist in improving the safety of its pipeline network infrastructure as emerging fuels are considered for adoption.	In 2025, the findings of RNG Trace Components Database (EFI-02-01) were presented at the Spring 2025 PRCI technical committee meetings. In addition, the second edition of the EFI Guidance Document (JEFI0002A) was developed, providing: one-page executive summaries, detailed guidance on hydrogen transport and storage in pipelines, and a roadmap for updating codes and guidelines. For the Fiber Optic Technology for Underground Gas Storage Well Monitoring project (JEFI0503), laboratory testing was performed using acoustic and strain-based methods to systematically evaluate each technique's leak detection capabilities for underground gas storage. IJEFI0405 evaluated how hydrogen affects in-service welding, finding that hydrogen partial pressure, heat input, and wall thickness all influence the amount of hydrogen that dissolves during welding. Additional research was recommended.	Completed

No.	Project Title	Project Description	2025 Progress	Status
126-GO-SD&M	PRCI Guidance Document for the Twenty-Second Edition of API 1104 (API-1-2B)	The project's objective is to update the PRCI guidance document for the 22nd edition of the American Petroleum Institute Standard 1104 (API 1104) from the 21st edition. The development of the updated guidance document will allow users and regulators to better understand the intent regarding the interpretation and rationale behind the requirements and confidently tailor welding procedures to their specific needs within the bounds of API 1104 and help avoid misinterpretation of the requirements. The team will deliver 1) outline of guidance to address industry needs; 2) outline of guidance required for the 22nd edition; 3) summary of the changes from the 21st to the 22nd edition. The team completed Task 1 and 3 in 2023 and gathered PHMSA enforcement and interpretations, including feedback from the API 1104 interpretations task group meeting in 2024. The project's end date was extended to allow for continuing conversations with members and industry organizations. SoCalGas could use the results as an additional guide and resource to inform existing welding procedures, which could improve the integrity of the pipeline, thus improving reliability and safety.	In 2025, the team released a comprehensive white-paper that summarized the substantive changes from the 21st to the 22nd editions of API 1104, which modernizes welding practices, adds new definitions, and expands guidance on welding and repair procedures, improving system integrity, reliability, and supporting affordability for ratepayers. The next step will continue with the development of the guidance document, engagement with industry stakeholders, and plan for a future webinar on the proposed 22nd Edition.	Active

No.	Project Title	Project Description	2025 Progress	Status
127-GO-SD&M	Product Standards for Plastic Tapping Tees (5.24.f)	The project's objective is to develop a draft product standard document for tapping tees, or sidewall fusion fittings, which could serve as purchasing specifications for operators and used to develop standards for the American Society for Testing and Materials. While there is a standard for tapping tees to confirm a level of joint integrity, there is no defined product standard for the manufactured tapping tee fitting itself. The materials used and the overall design and dimensions of these tapping tees can impact the performance of these fittings. History has shown that improper selection of materials or poor fitting designs can lead to premature fitting failure. Creating a product standard for conventional heat fusion tees will support the overall integrity of a plastic piping system. With sponsor input, the team will 1) determine what fittings to focus on, and how they should be designed, manufactured, and tested, and 2) develop specifications for incorporating design criteria, design stresses for the components, and methodologies to address the potential types of failure for each component. In 2024, the team began the literature review covering standards and industry papers that pertain to the design and fittings' performance. The next step is for the team to refine the draft, address gaps in existing standards, and incorporate sponsor feedback, and confirm quality and alignment. The manufacturers' guidelines established could assist SoCalGas with their review of material specification requirements for tapping tees, thereby increasing system reliability and ratepayer safety.	In 2025, the team continued their extensive review of standards, technical papers, and industry documents, have met with sponsors on the preliminary draft specification in late 2025, and extended the project for 12 months to accommodate for sponsor feedback, thoroughly refine the draft specification to incorporate sponsor feedback and confirm alignment across all stakeholders.	Active

No.	Project Title	Project Description	2025 Progress	Status
128-GO-SD&M	Revision of the PRCI Hot-tap Model Two Different Base Material (MATR-3-1B)	The objective of this project is to complete the development of the PRCI's Hot Tap Model V5, a thermal analysis model for in-service welding. This project will update version 4.2.1 of the model and software to expand its coverage to include welding of two different materials and to meet current technology standards. Modeling two kinds of metal could enable a clear understanding of the cooling aspect of the different materials. The project team has updated the model and incorporated it into the software. Although the team completed programming, during testing, they encountered issues with the software's graphical user interface (GUI). In 2024, the project team updated the software's programming language to C++ and transitioned to a cloud-based platform, resolving the GUI issues. During testing of the program, the project team discovered a problem with the program's weld cooling algorithm and is currently working on a resolution to correct the issue. Once the project is completed, the Hot Tap Model V5 program will be available to PRCI members on a cloud-based platform. The updated software will allow SoCalGas and other utilities to better predict weld properties, thereby enhancing the safety and reliability of pipeline in-service welding.	In mid-2025, the team executed a contract with a university to address modifications to the weld cooling algorithm. The project team has shifted the project completion date to Q3 2026.	Active

No.	Project Title	Project Description	2025 Progress	Status
129-GO-SD&M	RNG Blending Skid Study	The objective of this project was to develop a process and skid design supporting new RNG interconnections in achieving pipeline gas quality specifications per SoCalGas' Rule 45. The intention behind this effort was to qualify RNG blending equipment and configurations via field demonstrations that could; 1) meet Rule 45 requirements; 2) maintain existing pipeline integrity requirements; 3) mitigate the risk of allowing substandard gas to enter the pipeline system; 4) help RNG interconnectors provide RNG to SoCalGas; and 5) support SoCalGas in accepting more RNG in its pipeline system. The team developed a computational fluid dynamics (CFD) model and validated it via demonstrations and equipment testing. In 2023, the team finalized the design of the skid and began procuring test materials. In 2024, the team began testing without the use of the blending subsystem, installed the skid, and tested with the blending skid. The team used cylinders containing different concentration levels of biogases and tested each biogas concentration at different pressures to provide baseline data. SoCalGas will study the recommendations on process simulations for optimal skid operation and to potentially satisfy the Rule 45 requirement, reduce greenhouse gas emissions, and improve air quality, benefitting SoCalGas' ratepayers.	The team completed testing in early 2025 and delivered the final report. The project findings were that the skid blending results revealed stable pressure and flow can be achieved, but not below 400 PSI; gas chromatography verified that the skid remained homogenous without separation; injection of the RNG Blend without the blending skid did not achieve a homogenous blend.	Completed

No.	Project Title	Project Description	2025 Progress	Status
130-GO-SD&M	Study on the Impact of Trace Constituents in RNG on Natural Gas Grids and Consumer Appliances (M2020-008)	This project's objective is to study the impact of trace constituents (TCs) on RNG and traditional pipeline gas to address any potential safety or maintenance risks on local distribution company infrastructure and consumer gas appliances. The project includes two literature reviews, gap analysis, and preliminary laboratory testing on TCs identified in the gap analysis. The testing includes: 1) volume swell testing; 2) visual inspection and dimensions; 3) mass change; 4) Shore D Harness; and 5) tensile testing. In 2021, the gap analysis identified that TCs, ammonia, and organohalides (methylene chloride), may require test data to improve their justification. In 2022, the testing was delayed due to procurement issues. In 2023, the team completed most of the testing and released an interim report to sponsors on the materials' compatibility testing with recommended TC limits to mitigate risk. In 2024, the team continued testing for TCs and analyzing the test results to determine if new concentration limits for RNG need to be proposed or if limits currently being followed are sufficient. SoCalGas plans to use the results to justify SoCalGas Rule 45, Standard Renewable Gas Interconnection, which governs business specifications and conditions that must be met for SoCalGas to accept RNG into its pipeline network.	In 2025, the team released the final report, which included risk mitigation recommendations based on the observed effects, showed an insignificant increase in NOx emissions and no effects on appliance integrity even at concentrations several times of tariff limits. Therefore, modifications to the existing limits were deemed unnecessary. The project results were of value, so the project team will also provide a white paper in Q1 2026.	Active

No.	Project Title	Project Description	2025 Progress	Status
131-GO-SD&M	Universal Analytical Technique for Siloxane - Phase 2 (7.16.g.2)	The objective of this project is to develop a universal industry-wide sampling and analysis procedure for measuring the presence of siloxanes in biomethane. The project team will develop this procedure in collaboration with the American Society for Testing and Materials (ASTM) Committee on Gaseous Fuels. ASTM requires the performance of an Interlaboratory Study Program (ILS) within five years of the standard publication date. In Phase 1, the project team developed and published the ASTM Standard D8230 for the Measurement of Volatile Silicon-Containing Compounds in a Gaseous Fuel Sample Using Gas Chromatography with Spectroscopic Detection. In Phase 2, the project team will complete the ILS and field-test an online siloxane analyzer. Initially, the scope of work only included one field test, but the project team added a second field test in collaboration with PRCI's MEAS-15-04 project. In 2024, the project team concluded testing the siloxane analyzer at the initial test site, recalibrated it in the laboratory, and managed the logistics for its installation at a second test site located in Southern California. SoCalGas intends to use the research to determine repeatability and reproducibility levels of siloxane analysis. Once approved, SoCalGas will use the ASTM standard to validate siloxanes' trigger level. This research will also help bridge the technology gap to monitor siloxane concentration levels online in real-time at RNG sites.	In 2025, the team finalized the plans with the ASTM ILS Group for the interlaboratory study, reviewed the test results from both test sites and ASTM D8230, and submitted ASTM D8230 for re-ballot. The team also installed the GC-IMS system at a wastewater treatment plant, and advanced ASTM standard development and online siloxane detection. The results at the treatment plant found siloxanes to be mostly undetectable, which prompted the team to cut field testing short, mid-2025, and shift to laboratory comparisons to validate detection methods and improve standards for renewable gas applications.	Active

No.	Project Title	Project Description	2025 Progress	Status
132-GO-SD&M	Updating Lost-and-Un-accounted-For (LUAF) Estimates in the Distribution System (5.23.t)	The objective of this project is to update the factors that contribute to the LUAF gas volume in a natural gas distribution system and apply the factors to a case study with participating utilities based on estimates of fugitive and vented emissions, meter readings and characteristics, and other contributing factors. The original study on determining LUAF gas volumes was performed by the Pacific Gas and Electric Company and SoCalGas in the early 1990's (GRI reports 90/0067 and 93/0115). Estimating the contribution of gas leaks supports emissions reporting and more efficiently directs resources to address causes. More accurate estimates of LUAF gas result in better inventory planning, which saves supply costs. The project outcome will provide a clearer understanding of the current causes of annual gas volume variabilities and help reduce LUAF gas volumes. The team will deliver a final report that 1) describes the case study process, data collected, and general findings; and 2) quantifies the effects of various sources (i.e., measurement, leakage, accounting, and theft) of LUAF gas and identification of areas of concern or improvement. In 2024, the team received data from a sponsor that volunteered to provide datasets. At project completion, the team will deliver the final report to sponsors, and SoCalGas will evaluate the final report and evaluate if the results identified areas where changes or improvements could be implemented to reduce LUAF.	In 2025, the team published an interim report and extended the project into Q1 2026 to allow for the incorporation of additional data collected on LUAF by theft.	Active

No.	Project Title	Project Description	2025 Progress	Status
133-GO-SI&M	Advanced Through-Tubing Casing Inspection for UGS Wells (US-4-04)	The project's objective was to advance the sensor technology through-tubing (TT) inspection tools, which will increase their ability to detect, measure, and characterize metal loss features. The team worked with PRCI to develop a Multi-String Well Integrity Platform that provides a circumferential measurement of corrosion and isolation of external casing strings. The scope of work included 1) Literature Review 2) Laboratory Testing and Field Trials, and 3) Development of an Assessment Methodology. The team completed an engineering review, design, and assessment of TT technology in 2022, and developed the preliminary framework for reliability-based casing integrity assessment as well as began ongoing tool performance evaluations for several logging tests in 2023. In 2024, the team completed a baseline high-resolution UT inspection using its data to evaluate the performance of the through-tubing tools and demonstrated two different TT vendors at a SoCalGas facility. SoCalGas could use the results to better inform SoCalGas how to effectively plan for well intervention, which could increase safety, improve operational efficiency, and support affordability.	In 2025, the team completed the inspection tool performance evaluation, conducted a comprehensive field demonstration analysis, finalized the casing integrity assessment workflow, and delivered the final report to sponsors. The final report showed that current tools are valuable, but limited, and vary in their detection abilities and that no one tool has all the abilities needed. The final report also provided a structured approach for interpreting inspection data and estimating casing integrity and recommended both the TT tools and the assessment methods be improved, focusing on specified areas.	Completed

No.	Project Title	Project Description	2025 Progress	Status
134-GO-SI&M	Advancing Hydrogen Leak Detection and Quantification Technologies Compatible with Hydrogen Blends (7.23.f)	The project's objective was to understand and advance leak-sensing technologies to detect hydrogen and natural gas blends supporting decarbonization. Quick and efficient detection of leaks, mitigation of potential harm caused by undetected leaks, and reduction of misinterpretations are essential to reinforcing safety as the need for new sensing schemes for hydrogen– natural gas blends grow. The team, GTI Energy and SENSIT Technologies, 1) evaluated leak detection equipment currently used by natural gas pipeline operators; 2) guided new and altered usage protocols; 3) validated the H_2 blending threshold at which these devices become ineffective; 4) quantitatively mapped out the impact of varying amounts of H_2 on the calibration and analytics of current leak detection equipment; and 5) developed a proof-of-concept H_2 detection scheme to remedy technology gaps. In 2023, the team completed tasks 1, 2, and 3. In 2024, the team began laboratory testing and field trials. These results will support SoCalGas in refining company leak detection policies, thereby increasing safety, reliability, and operational efficiency for ratepayers.	In 2025, the team completed all trials including one at a SoCalGas facility and delivered the final report to sponsors. The final report showed three field campaigns ran leak simulation trials to test methane blends up to 20% hydrogen, which revealed results on blends up to 20% to have minimal impact on detection performance and that the adoption of up to 20% blends appear feasible without major infrastructure changes. The team recommended that further study is needed on higher hydrogen blends and low-flow leak rates, and future work should target hydrogen-selective sensors and improved multi-gas calibration to maintain safety and accuracy of detection.	Completed

No.	Project Title	Project Description	2025 Progress	Status
135-GO-SI&M	Downhole Inspection Tool Performance Evaluation	The project's objective was to enhance the understanding of established and novel downhole inspection tools used to assess the integrity of gas storage wells. Inspection tools have been tested by running them inside tubing and casing that have known manufactured and natural corrosion anomalies. The measured inspection results have been compared with known anomaly dimensions to evaluate the tools' performance and accuracy. The team conducted testing in two phases; Phase 1 included four ultrasonic thickness (UT) tools, two novel high-resolution (HR) tools, five through-tubing (TT) tools, and one magnetic flux leakage tool. Phase 2 research built on the initial findings from Phase 1, such as adding different sized features on the tubing test string and evaluating the most viable tools in a deeper environment. In Phase 2, SoCalGas evaluated three HR UT and two TT tools. From this research, SoCalGas gained knowledge of established and novel inspection tools' performance and limitations. SoCalGas could use the knowledge gained to better inform how they perform their gas storage well assessments, which could improve service reliability and support affordability for SoCalGas' ratepayers.	In 2025, the team completed evaluations of HR downhole tubular inspection tools via full-scale field testing at SoCalGas. The inspections and evaluations assessed how well various inspection technologies detected size and characterize defects in downhole tubulars used in gas storage wells, and how an improved understanding of inspection tool performance supported accurate storage well integrity assessments. In December, the team held a close-out webinar and released the final report. The results showed the two novel HR UT tools were observed to generally outperform established inspection tools.	Completed

No.	Project Title	Project Description	2025 Progress	Status
136-GO-SI&M	Evaluation of Screening and Assessment Methods Incorporated in API 1183 (MD-05-06)	The objective of this project was to offer recommendations for inclusion in the second edition of API RP 1183 and propose improvements to enhance the effectiveness of dent screening processes. This review will define the applicability limits of current methodologies, recommend necessary modifications for broader industry use, and provide guidance for safe implementation. The project would have involved a comprehensive review of completed PRCI research projects, as well as ongoing efforts. The team would have conducted a workshop to develop an execution plan, critically analyzed model assumptions, validation data, and methodology limitations, performed the Full-scale testing on various dent features, and reviewed the findings with industry experts to confirm practical relevance and technical accuracy. The project team would have 1) established a framework for engineering-based dent assessment, 2) conducted a one-day workshop to gather feedback, 3) revised the report accordingly, and 4) conducted 8-10 large-scale tests. The results would have been shared with the API 1183 Working Group and disseminated through webinars, public forums, and technical papers to promote broad industry awareness and adoption. The project results could have enhanced SoCalGas' dent assessment practices, reduced unnecessary excavations, supported regulatory compliance, and contributed to much needed software development of tools for efficient dent screening, improving pipeline safety and integrity management.	In 2025, SoCalGas and the project team worked on finding options to conduct the scope of work (SOW) within California, but efforts were unsuccessful, leading to SoCalGas canceling its participation. As a result, the project did not move forward due to a lack of sponsors.	Canceled

No.	Project Title	Project Description	2025 Progress	Status
137-GO-SI&M	Explorer Automation Demonstration	The project's objective was to perform a field demonstration of the Explorer ILI tool equipped with an Inertial Measurement Unit (IMU) technology. The IMU technology was developed in a previous NYSEARCH project, M2017-002 - Explorer Automation, to improve pipe mapping and the collection of x-y-z location data during ILIs. When anomaly locations are accurate, the number of digs in incorrect locations is reduced, resulting in cost savings with integrity inspections. An added benefit of capturing this information is that it can be used to analyze ground shifts or strain on the pipeline in areas of potential geohazard risks, improving safety. After the demonstration, the team delivered an inspection report with the results. In 2023, the team selected a 30" pipeline to demonstrate and validate the ILI tool and its ability to gather data such as GPS coordinates, feature locations, and data for pipe and bend strain analysis, thereby expanding integrity management capabilities. In 2024, the team successfully demonstrated the Pipe Explorer Robot on SoCalGas' 30" diameter pipeline with both the Magnetic Flux Leakage and Laser Deformation Sensor technologies. SoCalGas has benefited from this research through routine use of the Explorer tool which is already part of the approved tools SoCalGas uses to conduct ILIs for difficult-to-inspect pipes. This research will benefit ratepayers by improving operational efficiency, reliability, and supporting affordability.	In 2025, the team issued the final report, which showed robust data coverage and provided comprehensive results across two runs, and SoCalGas reviewed the results and validated that the technology could detect metal loss features. The data revealed that the external metal loss features were all within acceptable thresholds, and no critical dents or internal metal loss were detected. Future inspections using the explorer will include the new sensor.	Completed

No.	Project Title	Project Description	2025 Progress	Status
138-GO-SI&M	Explorer Wireless Range Extender (M2021-006)	The project's objective is to build upon initial research to take the Explorer Wireless Range Extender through the technology readiness levels to commercialize the existing Explorer ILI robot with expanded wireless communication range while deployed in the gas pipeline. In Phase I, the team completed a feasibility study and developed a prototype that can be field tested in a controlled environment. The feasibility study showed that significant communication range extension was possible with combinations of wireless technologies and in-pipe antenna deployment via range extender modules (REMs). In Phase II, the team completed the design, construction build, and laboratory system testing to improve the range extender module, upgraded the mesh network to increase the bandwidth and allow for multipoint communications, and successfully completed the feasibility study of the software-defined radio (SDR). In 2024, the team completed the pre-commercialized prototype and field testing and requested sponsors to provide a pipeline to conduct test trials for Phase III. SoCalGas could benefit from this project by using the commercialized prototype to improve operational efficiency and reducing cost of inspections.	In 2025, the team finalized and tested the REMs, confirmed mesh network functionality. Test trials were halted after the vendor discontinued the mesh network technology. Design development and architecture evaluation commenced with a new RF antenna and electrical hardware options on the SDR engineering prototype, which can be integrated into the Explorer Robot, for lab and field. The next step is to develop software for both non-form and form-factor compliant systems.	Active

No.	Project Title	Project Description	2025 Progress	Status
139-GO-SI&M	Extending Energy Harvesting to Other Explorer Sizes - A Feasibility Study (M2021-011)	The project's objective is to assess the scalability of the Explorer 20/26 Energy Harvesting (EH) system—designed to operate within 20"-26" diameter pipe — to other platforms specifically to determine the performance envelope for the Explorer 10/14, 16/18, and 30/36 within 10"-14," 16"-18," and 30"-36" diameter pipe, respectively. The team will analyze the power consumption, the tow force, and energy generation ability for each robot across different pipe sizes. The team will also investigate the mechanical design of the EH system and its impact on the overall weight of the robots, quantify the power and energy generated for different pipe sizes under different operating conditions, and modify the EH system's electronics, if necessary. The team will deliver a report outlining the tasks conducted during the feasibility study, which includes 1) key parameters for an EH system for different pipe sizes of the Explorer fleet; 2) remedies for technical obstacles that EH systems need to overcome to be successfully developed in future phases; and 3) recommendations on next steps. The team analyzed the power consumption and tow force for each robot in varying size pipes and conditions in 2023 and identified that the system level evaluation design with input parameters, such as pipeline flow conditions during operation, component sizing and integration, and reviewed generator and turbine designs. The team identified that the existing 20/26 design can be scaled up to 30/36, but not down. SoCalGas could benefit from these technological improvements by its use of the Explorer ILI Robotics Platform, which could improve operational efficiency and reduce cost of ILIs, improving reliability and safety of the system while supporting ratepayer affordability.	In 2025, the team broadened market research, identified several battery manufacturers, initiated supplier engagement, and analyzed the entire robot fleet with particular focus on the 16/18 platform. The team also began to collect battery samples for upcoming testing and integration. The next step is for the team to finalize the supplier comparison matrix, pare down battery candidates for laboratory evaluation and prototype integration, and continue Phase III-a development activities, such as drivetrain efficiency improvements and alternative interconnect joint concepts.	Active

No.	Project Title	Project Description	2025 Progress	Status
140-GO-SI&M	Ground Cover Change Detection for Transmission Pipelines (8.23.k)	The objectives of this project are to evaluate existing manual, time-consuming, and costly processes for monitoring pipelines and to automate the processes for identifying threats around transmission pipelines. The project will identify cost-effective modern technologies and methodologies that may enhance the monitoring of critical assets and help identify previously undetected threats. The project addressed weather-related outside forces in ground cover detection for potential landslides, erosion and change detection of pipeline crossing agriculture land focusing on short-range (instrument attached to a vehicle) and remote (satellite) detection technologies. The team defined the scope to explore two related monitoring solutions: 1) proximity sensing with LiDAR for pole- or vehicle- mounted applications; and 2) remote sensing to detect threats in remote areas. Upon completion of market research, the team selected commercially available, open-source, and turnkey technologies for testing, and used LiDAR for proximity monitoring and satellite imagery with GIS for remote monitoring. At project completion, the team will deliver a final report. In 2024, the team kicked off the project, and conducted the market research on commercially available technologies for ground coverage, change detection, object detection and other similar use cases that might have applications for transmission pipeline, selected the technologies for testing and began testing, and started field demonstration plans. SoCalGas could use this research to complement its existing practices, and provide operators an alternative for monitoring inaccessible areas, and could aid processes for identifying threat areas caused by potential mechanical damage and weather-related outside forces.	In 2025, the team completed the lab tests with short-range LiDAR, focusing on open-source turnkey technologies. The team also performed satellite imagery analysis scans to over a region in California to demonstrate ground cover changes, and compared vegetation changes from 2023 through 2025 with a change detection too. The comparison revealed noticeable increase in vegetation growth in areas that were stripped bare by landslide events. The results showed that LiDAR testing has potential, and GIS with satellite imagery could be used for wide-area monitoring for threats like excavation, construction, and landslides.	Completed

No.	Project Title	Project Description	2025 Progress	Status
141-GO-SI&M	Hard Spot Detection (MAT-7-2A)	The objective of this project was to assess various ILI tools with hard spot detection capabilities to provide guidance on their usage and identify areas of improvement for these tools and analytics. Hard spots are areas on the pipe with hardness levels higher than the surrounding pipe and can be more susceptible to cracking mechanisms such as bending strain and corrosion. ILI tools that can identify hard spots, as well as recognize metallurgical properties, grade determination, and fracture behavior, and are essential elements to any integrity management program. The team 1) built a robust framework for hard spot management following a gap analysis of key variables; 2) evaluated commercially available hard spot ILI tools identifying potential areas for improvement; and 3) developed a model using the results of phases 1 and 2 to enhance operator guidance. In 2024, the team released the final first report to sponsors. SoCalGas could use the results to guide its integrity management program on pipeline segments with susceptibility to hard spots and selection of hard spot detection tools, thereby increasing customer safety.	In 2025, the team released the final second report to sponsors. In late 2025, the team published both final reports. These reports detail an evaluation methodology for hard spot manufacturing anomalies on pipeline, and prioritizes the anomalies identified using ILI and NDE, and an evaluation of the effectiveness of various hard spot repair methods, which compares tensile hoop stress within the hard spot using finite element analysis. This project supports the recommendations of NTSB report NTSP/PIR-22/02 to improve hard spot detection and sizing.	Completed

No.	Project Title	Project Description	2025 Progress	Status
142-GO-SI&M	High Resolution MFL for Explorer Series of Robotic Platforms - (M2021-009)	The project's objectives are to conduct a study on integrating a high-resolution magnetic flux (MFL) sensor onto the Explorer robot platform, assess commercially available sensors, and optimize the resulting system for maximum efficiency and interchangeability among the various robots. The tasks are to find an optimal sensor for the use case, identify schemes for sensor positioning and design, build the benchtop prototype, and provide a final report. The team began the feasibility study for the proof-of-concept prototype in early 2022, and resources delayed their development until early 2024. In 2024, the team resumed work and completed its feasibility study. The team found that smaller components in the sensor head were optimal, resulting in add-on tasks of configuring the new sensor and developing various concept designs. The designs will consider sensor shoe assembly, mechanical and electrical configuration, power and data management of communication, software architecture, and incorporation of additional magnetic bars. The last tasks require the team to refine the previous designs to a high-level toward an assembly level design and manufacturing, where a Go/No-Go decision will be made. If successful, SoCalGas could use these sensors in ILI to detect the smallest defect, resulting in higher confidence levels in obtained measurements by operators, and reinforcing the SoCalGas ILI program, thereby improving reliability and safety for ratepayers.	In 2025, the team began to enhance the MFL system by integrating modern Hall effect sensors, refining designs (i.e., mechanical, electrical, and software), and preparing for prototyping and future field trials. The next steps are to complete the newly added tasks and build the benchmark prototype.	Active

No.	Project Title	Project Description	2025 Progress	Status
143-GO-SI&M	Improved In-Field Evaluation of Strain Demand (NDE-4-29)	The objectives of this project are to quantitatively evaluate the capabilities, limitations, accuracy, and implementation costs of instantaneous strain measurement technologies for buried in-service pipelines. This includes developing and enhancing strain-based ILI technology to reliably detect, size, and characterize specific indications that may compromise pipeline integrity. This is crucial for improving real-time pipeline integrity evaluations in areas prone to geohazards or extreme weather events. The project will 1) validate strain-based ILI tools on active pipeline segment with known geohazard anomalies; 2) compare tool performance before and after a strain relief construction event; and 3) use finite element models and strain gauge data to establish reference strains and evaluate accuracy and gaps in current technologies. Upon completion, the SoCalGas Threat & Risk team could incorporate the abilities of the technologies developed by these tools into their Geohazard Risk Management Program, which could quickly determine if a ground movement event increased the strain on a pipe segment.	In 2025, the project kicked off. Since the researcher selected does not satisfy the California requirement in Resolution G-3601 Ordering Paragraph 5, SoCalGas withdrew from the project.	Canceled

No.	Project Title	Project Description	2025 Progress	Status
144-GO-SI&M	Innovative Leak Detection Methods for Gas Pipelines (MEAS-2-01)	The objective of this project was to address the following current technology gaps in Computational Pipeline Monitoring (CPM) systems, such as 1) balancing zones are minimal in number encompassing too large areas; 2) difficulty in retrofitting inline flow measurement systems; 3) challenges in changes in gas pipeline systems inventory or distinguishing measurement errors from leaks; and 4) unavailable, infrequent, or asynchronous data. Addressing these gaps enhanced CPM leak detection methods through accurate and swift detection and location of leaks. The team developed: 1) improved algorithms to estimate pipeline inventories lacking full pipeline transient modeling applications; 2) a new algorithm for enhanced zone balancing calculations; 3) pattern identification methods that identify how corrected zone balances shift due to changes in system flow, which the project team will use to identify meters that are most likely attributing to measurement flow errors; and 4) recommended practices for facilities to troubleshoot with high error probabilities. In 2023, the team performed a literature review for leaks and other LUAF gas in Pipeline Systems, developed and tested algorithms and methods on simulated systems, and validated the algorithms and methods on a gas pipeline system. In 2024, the team developed a host site review checklist, gathered host site data, and published two final reports. SoCalGas could use the final reports to aid in reducing LUAF gas volumes and potentially be used in SoCalGas measurement accounting systems, which could improve safety and air quality, and reduce greenhouse gas emissions.	In 2025, the team completed all the project deliverables, released the remaining three final reports to sponsors, and published one of the final reports.	Completed

No.	Project Title	Project Description	2025 Progress	Status
145-GO-SI&M	Low Flow EMAT ILI Tool Demonstration	The objective of this project was to demonstrate the capabilities of the 12-inch and 16-inch free-swimming Electromagnetic Acoustic Transducer (EMAT) tool in a field demonstration by inspecting SoCalGas transmission pipelines. Common ILI technologies use a Magnetic Flux Leakage (MFL) detection method to measure wall loss on metallic pipelines from internal and external corrosion. In previous research projects, an EMAT sensor and robotic platform were developed capable of identifying small defects in small-diameter, non-piggable pipelines that traditional MFL tools were incapable of ILIs. Building upon this research, the team developed a free-swimming version of the EMAT tool. Free-swimming tools are propelled by the flow of internal pipeline pressures, which reduces energy usage and extends the range of the tool. In 2023, the team completed a feasibility review of the EMAT tool and outlined a plan for its demonstration. In 2024, the team demonstrated the EMAT ILI tool on 16-inch and 20-inch transmission lines successfully. The tool traversed approximately 0.079 miles, and identified several girth welds, with no reportable cracking anomalies detected. Since the demonstration, SoCalGas has implemented the tool as an alternative for performing pipeline inspections on non-piggable pipelines, and conducted several runs post-demonstration with this tool, thereby improving safety and reliability.	In 2025, the team compiled the inspection results and released the final report. The report showed that while the inspection experienced some odometer slippage and isolated data loss, corrective measures were applied to promote accurate distance referencing and data integrity. The demonstration reflected robust performance of the inspection tool throughout the evaluated section.	Completed

No.	Project Title	Project Description	2025 Progress	Status
146-GO-SI&M	Microbial Influence Corrosion (MIC) Detection (GFO-21-506, Group 2)	The project objective is to develop and pilot a self-contained portable microbial detection kit that enables fast detection and identification of various corrosion-related microbes from raw samples with minimal hands-on time. Microbial testing is an essential component in detecting, controlling, and mitigating microbiologically influenced corrosion (MIC) in natural gas systems. Current testing approaches are hampered by long wait times, the inability of rapid tests to identify specific corrosion-related microorganisms, and complex sample preparation and testing processes that require laboratory equipment or specialized personnel. The project deliverables will be a test kit and field-testing guide to support improved microbial corrosion management in California gas pipelines. In 2023-24, the team assessed the current MIC testing and mitigation practices and collected field samples to support the development of species-specific characterization of microbes commonly found in natural gas systems. A microbe testing kit was then developed with species level characterization capabilities to enable differentiation between MIC specific microbes and nonharmful microorganisms. SoCalGas could use the portable kit as a more efficient and lower-cost alternative for detecting and identifying the presence of MIC-specific microbes in natural gas systems, thereby reducing unnecessary mitigation efforts.	In 2025, the team improved sample collection and preparation protocols to expedite species detection and conducted field tests of the full-scale prototype at two SoCalGas' sites to assess sensitivity and specificity under real world conditions and presented the project in a SoCalGas RD&D webinar. The next step is to expand the test kit characterization capabilities followed by further validation testing at SoCalGas locations.	Active

No.	Project Title	Project Description	2025 Progress	Status
147-GO-SI&M	NJIT Advanced Terahertz (THz) Imaging & Spectroscopy for Non-Destructive Evaluation of Polyethylene Pipes (M2018-009)	The objectives of this project are to continue the development of terahertz (THz) time-domain spectroscopy and imaging for the non-destructive evaluation (NDE) of polyethylene (PE) gas pipeline butt fusion (BF) joints and to combine the advancements of the instrument with pre-commercial adoption for hardware development and the development of a prototype for demonstration and commercialization. Technology advancements may be useful in quality assessments of questionable BF joints and prevent unnecessary cutouts of good BF joints with the appearance of a bad fusion. The project team will evaluate the THz capability on BF joint samples with inclusions at the acceptance criteria threshold by performing extensive NDE inspections of specific PE joint defects containing a lack of fusion. The team advanced the THz NDE process with improved inspection procedures and analytical signal processing, and improved signal resolution to identify potential defects, including "cold" or lack of fusion within the BF. SoCalGas will use the knowledge gained to demonstrate and incorporate the THz technology into the existing processes and procedures, thereby improving reliability and safety.	In 2025, the team discussed the science behind THz, collaborated on THz testing methods and shared technical THz equipment information including how the THz power source and camera equipment work, and reviewed the results from scanning holes and anomalies in PE blocks. The team demonstrated the THz camera equipment testing and discussed the relationship between mechanical stress in plastics and the resulting changes in optical properties, along with experimental methods and innovations utilized for measurements. The team also began planning for future visits to review equipment setup, testing, and results.	Active

No.	Project Title	Project Description	2025 Progress	Status
148-GO-SI&M	Plastic Pipeline Inspection for Pipeline Integrity Management (GFO-22-503, Group 2)	The objective of this project is to demonstrate the probability of detecting various categories of anomalies in plastic pipe assemblies when using Phased Array Ultrasonic Testing (PAUT) non-destructive evaluation (NDE) tools for inspecting both plastic pipe and fusion joints. The most common modes of material failure for polyethylene piping systems are slow crack growth and non-ductile fusion joint failure. Current NDE methods for plastic piping are not as well developed as they are for steel piping systems. This project will also identify the correlation of expected residual lifetimes for assets, given the indication of defect, by utilizing the information provided by NDE inspections allowing for input into risk assessment models. The project focuses on extensive testing of a relatively mature PAUT tool capable of identifying cracks in pipe walls and defects in fusion joints. The extensive laboratory testing could verify inspection results obtained in the field and accelerated lifetime testing of the pipe assemblies where indications of defects may be identified. In 2024, SoCalGas reached out to internal field personnel to begin collecting polyethylene samples. In late 2024, SoCalGas shipped out the collected samples to the project team. If the results are fruitful, SoCalGas will deploy the technology to enhance the safety of plastic pipelines by introducing new NDE inspection tools for both plastic pipe and fusion joints.	In 2025, the project team completed draft reports describing their approach for accelerated lifetime testing and their assessment on the correlation between infrastructure defects and their effect on system performance. SoCalGas also provided pipe samples and served on the Technical Advisory Panel. Additionally, a public outreach workshop was planned in which the project team will solicit input on how to present project results in a way that will be most useful for a wide range of decision-making processes.	Active

No.	Project Title	Project Description	2025 Progress	Status
149-GO-SI&M	Selective Seam Weld Corrosion Detection with In-Line Inspection Technologies (NDE-4-13)	The project's objective is to evaluate and validate magnetic flux leakage (MFL) technologies currently in use by ILI vendors for detecting selective seam weld corrosion (SSWC). SSWC is a type of corrosion that affects the bond-line region and heat-affected zone of the longitudinal seam of a pipeline, forming grooves in the seam. Circumferential MFL technologies can detect the long-seam weld position and accurately detect the presence of corrosion on the long seam. However, these MFL tools generally cannot differentiate between SSWC and coincidental corrosion. With improved technologies and processes, ILI vendors can better detect SSWC. This project will provide pipeline operators with up-to-date knowledge about ILI capabilities to detect SSWC and differentiate it from coincidental corrosion interactions with the long seam weld. This knowledge will better inform SoCalGas' decision-making with pipeline management and SSWC or corrosion. In 2023, the team completed pull/flow loop testing with the ILI tools at Pipeline Research Council International's Technology Development Center and the destructive testing of the test strings. In 2024, the team began analyzing the vendor's ILI data and collaborated with ILI vendors to finalize the report format. SoCalGas could use this research to identify tools that best detect SSWC in SoCalGas' pipelines, thereby improving safety and reliability.	In 2025, the team delivered the MFL reports and ultrasonic testing reports. In Q3 2025, the team released the draft report for sponsor review and gathered stakeholder feedback on data visualization and best practices. The next steps are for the team to incorporate the comments and feedback into the final report, which is expected in Q1 2026.	Active

No.	Project Title	Project Description	2025 Progress	Status
150-GO-SI&M	Sensing Liquid Accumulation in Mains (5.24.e)	The objective of this project was to identify level-sensing technology that could be used in natural gas systems to detect accumulation of liquids in pipelines. Utilities install drips to collect liquids, so customers are not impacted. A low-cost system is needed to alert the utility of liquid accumulation in near real-time, and this project was the first step toward this goal. The project team surveyed available liquid level measuring technology and selected a sensor for testing in the laboratory. The sensor testing results and a reference design for a field system will be provided which could be incorporated into a remote monitoring system in the project's next phase if a sensor tested proves to be accurate and reliable. The project tasks included: 1) identifying commercially available level-sensing/ranging sensors, 2) bench-testing the selected sensor, 3) performing an analysis of the data to determine the accuracy and whether the sensor is a viable option for this use case, and 4) developing a field prototype design for sensor(s) passing laboratory testing. In 2024, the project team selected a sensor and started testing it in the laboratory. SoCalGas will evaluate if the remote liquid sensor system could be used to detect in SoCalGas pipelines, which could improve operational efficiency or reliability benefiting ratepayers.	In 2025, the team performed data analysis and sensor bench testing and released the final report in September. The final report revealed better performance from the pulsed sensor vs the infrared optical sensor, performing better with steel than with plastic and recommended further exploration with steel.	Completed

No.	Project Title	Project Description	2025 Progress	Status
151-GO-SI&M	Skipper NDT Demonstration	The objective of this project is to demonstrate and validate the performance of an electromagnetic field geospatial locating system to aid in identifying geohazard threats, specifically for fitness-for-service assessments. The project approach was to temporarily install the technology on SoCalGas' existing small-unmanned aircraft system (sUAS) platform to collect grade survey mapping (pre-planning), latitude, longitude, and pipeline depth data. The known use case for this technology is to collect and evaluate data on transmission pipelines. The scope planned for the demonstration to occur in areas with extreme environmental conditions due to continuous rainfall, which resulted in damage and exposed transmission pipelines. In 2024, the field demonstration was completed and validated its ability to capture latitude (X), longitude (Y), and depth (Z) data on transmission pipelines in remote areas with ample vegetation growth. The lessons learned from the first demonstration are that remote areas with rugged terrain, inability to satisfy sUAS line of sight requirements, and signal interference impede data collection. In late 2024, the team identified a second demonstration of the technology, but in an area with known ground movement and steel distribution pipeline. SoCalGas could look to add this technology to its list of tools for monitoring and managing geohazard threats and potentially performing fitness-for-service assessments.	In 2025, the team demonstrated the technology to validate a potential use case for collecting and evaluating data on a distribution system in a residential area. The results from the second demonstration validated the technology's ability to capture XYZ data and perform a bend strain analysis on the second site. The next step is to validate the technologies capabilities by monitoring the demonstration site and gathering additional data.	Active

No.	Project Title	Project Description	2025 Progress	Status
152-GO-SI&M	Speir Hunter Demonstration	The objective of this project was to demonstrate and validate the effectiveness and completeness of the defect detection captured via Stress Concentration Tomography (SCT) inspection technology. SCT would have compared the changes within the localized pipeline wall stress to the pipeline's naturally generated magnetic field using large stand-off magnetometry. This data would have been used to determine the presence of defects, their location, and their magnitude of stress. The project team had planned to collect the data via 1) walking survey, and 2) aerial survey using SCT. The team had planned to perform a demonstration in late 2025. In early 2025, the Speir Hunter was acquired by another vendor, resulting in the transfer of all intellectual property, which decided to discontinue the product line for the technology to be validated. As a result, the decision to cancel the project was presented and approved in mid-2025. The results of this project could have provide SoCalGas an alternative tool for identifying defects on pipelines, which improves our integrity management program through improving operational efficiency, reliability, and supporting affordability.	The team had planned to perform a demonstration in late 2025. In early 2025, the Speir Hunter was acquired by another vendor, resulting in the transfer of all intellectual property, which decided to discontinue the product line for the technology to be validated. As a result, the decision to cancel the project was presented and approved in mid-2025.	Canceled

No.	Project Title	Project Description	2025 Progress	Status
153-GO-SI&M	Technology Development Center (TDC-1-1 & 1-A)	This project supported the new PRCI Technology Development Center (TDC) in Houston, Texas, which opened in the summer of 2015. The TDC was the result of a major commitment by the energy pipeline industry to address key issues it faces in enhancing the safety and integrity of vital national and international steel pipeline infrastructure. The TDC provides the industry with an independent third-party site to thoroughly describe the capabilities of current pipeline inspection tools and to guide the development of modern technologies needed to make progress toward pipeline safety and integrity goals. The TDC enables efficient and timely access to industry samples in support of technology projects and programs. The TDC continues to be utilized by PRCI projects, such as NDE-4-18 Validate ILI Capabilities to Detect and Characterize Mechanical Damage. In addition, a virtual TDC has been created, which consolidates data collected during physical testing at the TDC into databases. This approach allows PRCI members to streamline access to data and summary reports. SoCalGas provided two pipe samples to be added to the TDC pipe library to support future research and technology evaluations.	In 2025, the TDC held an open house to highlight its value and capabilities for technology providers and pipeline operators. The Open House highlighted how PRCI members advance safety and integrity within the industry through the TDC and introduced stakeholders to advanced technologies and research aimed at enhancing pipeline safety and reliability.	Completed

No.	Project Title	Project Description	2025 Progress	Status
154-GO-SI&M	UCB Monitoring and Risk Assessment for Natural Force Damage to Pipelines (GFO-22-503, Group 1)	This California Energy Commission (CEC) funded project will focus on the innovative combination of emerging sensing technologies in sensors (e.g., distributed fiber optics, wireless sensors, computer vision, aerial systems, UAVs/robots, and satellites) and data management and analysis (Open SRA) for long term sensing of geotechnical infrastructure. This project will build upon the results of previous CEC research projects. The team will: 1) evaluate the technologies' readiness for use by gas pipeline infrastructure portfolio managers, and 2) assess the current condition and predict the future reliability of gas pipeline infrastructure components and systems using the integrated monitoring and risk assessment tool developed in this project. In Q4 2024, the project team held the first Technical Advisory Committee meeting to discuss the project plan and the evaluation of the capabilities of the selected remote and embedded sensing technologies, in conjunction with the OpenSRA II software, through quantifiable and measurable metrics. SoCalGas could use the results to cover a wider range of ground motion scenarios and support performing risk assessments based on field data, which may reduce the risk of pipeline failure caused by natural hazards, thus improving safety.	In 2025, the team collected LiDAR, multispectral, thermal, and InSAR datasets from two California locations, and embedded sensing data from one of the sites to aid in the development of digital twin models. The team continues to collect data on gas pipeline locations while using two water pipelines at test sites. The team used data collected from the test sites to establish a new framework that enables efficient processing of high-volume data generated by embedded and remote sensors.	Active

No.	Project Title	Project Description	2025 Progress	Status
155-GO-SI&M	UCLA Monitoring and Risk Assessment for Natural Force Damage to Pipelines (GFO-22-503, Group 1)	The objective of this CEC-funded project is to mature the seismic risk assessment software tools developed under the past CEC-funded project, "Seismic Risk Assessment and Management of Natural Gas Storage and Pipeline Infrastructure in CA (PIR-8-002)," by adding various data obtained from monitoring technology. The project will use ground-motion measurements to predict pipe strain support, which can be used to expand and update the fragility database to combine direct and indirect measurements. The project will also update the software platform created in project PIR-18-002 to work in near-real-time data and to provide training to California gas operators and industry partners on how to use the software. In 2024, resource constraints delayed the project kickoff. SoCalGas could use the results of this project to cover a wider range of ground motion scenarios and perform near real-time risk assessments based on reading field data, which can reduce the risk of pipeline failure caused by natural hazards, thereby increasing safety and reliability for ratepayers.	In 2025, the team kicked off the project and worked on integrating direct pipeline strain and indirect ground displacement sensing into a unified monitoring framework to track earthquake, landslide, subsidence, and liquefaction hazards affecting gas pipelines. The project team also set up the tests for the lab, the field, and an outdoor soil test chamber at UC Irvine, and for the lab study, SoCalGas donated thirty feet of steel pipe. The next step is for the team to continue to update the pipeline fragility (capacity) model that fuses these sensor streams for probabilistic failure prediction and continues to build a user-friendly, open-source decision support software for operators.	Active

No.	Project Title	Project Description	2025 Progress	Status
156-GO-SI&M	UCLA PISRAM Program Enhancement	The objective of this project is to refine the capabilities of the UCLA program, PISRAM, for risk assessment of pipeline failures associated with earthquake faults through a collaboration between SoCalGas and PG&E. The team will: 1) update the fault database developed from the California Energy Commission (CEC) project to include the faults that cross SoCalGas' pipelines, 2) incorporate enhancements to PISRAM that allows for ease of program implementation and flexibility in how quantification is executed for pipelines, and 3) perform a limited trial to compare the results from the modified PISRAM to its recently updated version, which incorporates the qualitative ranking of individual crossings and transmission lines. Since SoCalGas has a need to improve its seismic fault crossing hazard risk assessment process from qualitative to quantitative, if the enhancements are successful, SoCalGas could use the results to update SoCalGas' existing fault crossing hazard risk assessment process to include quantitative assessments, which could strengthen their Geohazard Management Program by improving reliability, safety, and integrity of its pipeline infrastructure.	In 2025, the team streamlined data inputs, expanded fault-scenario modeling, customized flaw, and displacement probabilities, and added previously unmapped faults that are critical to system-wide risk evaluations into PISRAM. The team also resolved legacy computational issues and improved access to strain-demand insight. The next step is for the project team to continue to resolve the technical issues that affect how system information is transferred. At completion, the project team will deliver a final technical memorandum with an updated version of PISRAM via UCLA website access and a copy of the program for internal use.	Active

No.	Project Title	Project Description	2025 Progress	Status
157-GO-SI&M	Underground Natural Gas Storage and Risk of Corrosion/Souring (7.22.i)	The project's objective was to better understand the risks and opportunities of microbial hydrogen interactions in a storage reservoir. The project focused on pure and natural-gas-blended hydrogen storage in depleted hydrocarbon reservoirs. The work included lab experiments simulating reservoir conditions using high-pressure (HP) bioreactor systems to collect data on gas composition changes, microbial activities, and chemical and microbial data analysis. In 2023, the team kicked off the project and identified field test sites and the associated reservoir parameters. In 2024, the team began lab testing using clean, renewable hydrogen, using samples from sponsors and from two SoCalGas storage fields. SoCalGas could use the results to inform when to introduce and store hydrogen in existing underground storage systems, identify solutions for managing integrity risks and gather information regarding the potential loss/conversion of hydrogen in a storage reservoir, thus improving storage integrity and improving safety.	In 2025, the team completed the lab testing, which evaluated hydrogen and fluid samples from all sponsors for hydrogen consumption, gas composition changes, and microbial activity under ambient and HP conditions. The team also performed chemical and microbiological analyses to identify and quantify microbial bacteria, assess the impact of core material on microbial activity, and establish correlations between microbial growth, hydrogen loss, and reservoir characteristics. In late 2025, the team released the final report, which revealed that HP conditions suppress microbial activity and hydrogen biotransformation, and the presence of core material reduces hydrogen loss. The team recommended further study of dissimilar materials and fluids is needed since each storage reservoir has unique parameters.	Completed

No.	Project Title	Project Description	2025 Progress	Status
1-CG-DG	Bloom Energy Coupled Electrolyzer and Fuel Cell Demonstration	This project demonstrated the coupling of Bloom Energy's new solid oxide electrolyzer cell coupling (SOEC) with an existing Bloom solid oxide fuel cell (SOFC). A 240kW SOEC utilizes grid electricity to generate hydrogen, blended with natural gas, to fuel Bloom SOFCs. Hydrogen blending occurs downstream of the SoCalGas meter at a manifold that feeds multiple existing SOFC units on the Caltech campus. The system successfully produced over 6 GWh of baseload electricity for the site, utilizing over 11 tons of Hydrogen produced by the Bloom Electrolyzer and blended into the customer's gas line. The integrated demonstration illustrated a theoretical carbon-dioxide reduction of 81 tons over the 12-month operating period.	The final report was submitted, satisfying the remaining project deliverable. This project was in a disallowed subprogram but was allowed to complete per AL-6273G.	Completed
2-CG-IC	EFG Portable Hydrogen FC Integration Development	This project aims to integrate an uninterrupted power supply (UPS) device inside the Fuel Cell (FC) generator package. This integration will allow users to plug the portable FC generator indoors and into standard 120VAC customer outlets rather than at customer electrical panels, which currently adds complexity and cost. This feature will allow the FC generator to turn on instantaneously and power customer loads when a grid power outage is detected. EFG has successfully completed a CO2 evaluation of its hydrogen production, in compliance with the CPUC's definition of "Clean Renewable Hydrogen" (per D.22-12-057).	EFG successfully exited its 2nd Stage gate design review and is in the process of identifying a suitable host for an extended demonstration of the generator.	Active

No.	Project Title	Project Description	2025 Progress	Status
3-CG-IC	Enchanted Rock Engine with Blended Hydrogen Integration and Demonstration	This project aims to enhance Enchanted Rock's generator technology by developing controls to safely and reliably manage power output and emissions, while operating on varying blends of hydrogen (H2). Integration of hydrogen into gas fired distributed generation may affect emissions and reduce engine performance and consequently affect the ability to meet energy demand within customer systems or microgrids. Resultingly, the team seeks to address performance impacts of hydrogen integration by developing the necessary engine software controls to account for the change in hydrogen blend. The team will use its existing suite of sensors to monitor and optimize the engine combustion controls, which includes spark timing and dynamic air/fuel ratio controls	The team is currently resolving integration setup delays and is expected to commence first fire characterization testing in Q1 2026.	Active
4-CG-DG	GTI Energy Kyocera Residential Fuel Cell Laboratory Testing	The goal of this project was to evaluate and introduce a residential fuel cell for commercialization and widespread deployment in California. To help achieve this, SoCalGas acquired two 400W SOFC units from Kyocera for evaluation by GTI Energy. The units were modified versions of the commercially available systems in Japan. Modifications included tuning for US gas composition. GTI Energy worked with SoCalGas and Kyocera to develop a test plan, which aimed to assess the following items: power characteristics (I-V data), power capacities and efficiencies of the system at various loads, system endurance, and stack degradation, load following capabilities, system cycling, start-up and shut-down times, emission rates, heat recovery potential, and stand-alone operation. During testing, only 1 of 2 units were successfully commissioned due to unit issues, which Kyocera decided not to replace. The second unit failed during the test campaign execution. As a result, the evaluation was directed to closure.	Accordingly, the final report was delivered in Q2 2025, with limited results, and was provided to the Business Development Team for further consideration. This project was in a disallowed subprogram but was allowed to complete per AL-6273G.	Completed

No.	Project Title	Project Description	2025 Progress	Status
5-CG-DG	GTI Energy Mobile Hydrogen Fuel Cell Generation System Demonstration (CEC MORBUGS)	This project aims to design and build four easily transportable, integrated hydrogen fuel cell backup generators. Each system will consist of a hydrogen fuel cell, hydrogen storage, battery energy storage, power conversion system, customer and grid interconnection resources, energy management, safety, and monitoring systems. The system will self-sufficiently support a minimum of 10 kW, with 35 kW of continuous load for more than 24 hours, with a peak load capacity of 180 kW. The system will be fueled by hydrogen, providing an opportunity to replace high-emitting diesel backup generators with fuel cell systems that have virtually no emissions and little noise. The units will be deployed for emergency response in disadvantaged communities and Tier 2 and 3 Fire Threat Zones throughout California. The systems will also support other customer functions during non-emergency conditions, including battery electric vehicle charging, peak shaving, and replacement for fossil-based backup power.	The project experienced several disruptions, including a one-year Stop Work order lifted in Q1 2024 with updates to unit specifications and additional equity, demonstration, and communications tasks. Subsequent development efforts in 2025 were further impacted when the original generator technology vendor exited the project and an alternate vendor later announced the closure of its fuel cell business in Q4 2025. The project team is currently working with a secondary vendor to continue the project.	Active

No.	Project Title	Project Description	2025 Progress	Status
6-CG-IC	GTI Marathon / EC Power mCHP Integration and Demonstration	This Phase 2 project aims to complete the integration and testing of two micro-combined heat and power (mCHP) systems—a 4.5 kW Marathon and a 25 kW EC Power—to certify both systems under the CARB Distributed Generation Certification Program (CARB-DG). This project builds upon and supports the prior CEC co-funded project (GTI Marathon/EC Power Testing and Demonstration), focusing on completing the field installs and conducting long-term performance monitoring to support CARB certification.	The 25 kW Lochinvar system completed its field evaluation, and the team submitted the CARB application in April 2025. CARB subsequently requested additional data, which has now been completed and was repackaged for a revised application to be submitted in Q1 2026. A CARB certified unit allows customers to install the system and enable resiliency and energy affordability. Integration of the 4.5 kW Marathon unit is ongoing and is expected to commission for field demonstration in Q1 2026. As part of this project, the team also developed and deployed the Energy Transitions Opportunity Program, engaging a high school class through a three-part instructional series on renewable energy, CHP, and grid systems—including microgrids—which culminated in a final student assignment focused on energy systems resilience and clean energy careers.	Active

No.	Project Title	Project Description	2025 Progress	Status
7-CG-DG	GTI Marathon/EC Power mCHP Testing and Demonstration	This project aimed to test and demonstrate two micro-combined heat and power (mCHP) systems—a 4.5 kW Marathon and a 25 kW EC Power—to certify both systems under the CARB Distributed Generation Certification Program (CARB-DG). CARB certified units allow customers to install the system and enable resiliency and energy affordability. First, GTI Energy worked with the manufacturers to conduct performance and emissions testing of the system in its lab. Working with a third party, GTI Energy, confirmed both systems' ability to meet CARB-DG emissions requirements.	GTI Energy installed and commissioned the EC Power system at a commercial bakery within SoCalGas' service territory in 2022 and measured/verified emissions data. A site for the 4.5kW Marathon system was selected, and the team worked to install and commission the unit. As a result of challenges and delays experienced during the demonstration portion of the program, additional funding was contributed to support a successful integration and demonstration of the two mCHP systems. This additional funding has been provided in the form of a new contract to continue the integration and demonstration of the systems. The final report and CARB application submissions for this effort will be delivered under the new contract.	Completed

No.	Project Title	Project Description	2025 Progress	Status
8-CG-DG	Noble Thermodynamic Systems Ultra-Efficient CHP using a Novel Argon Power Cycle Development	This project aims to demonstrate the ability of Noble Thermodynamics Systems (NTS) argon power cycle (APC) to provide an 18% increase in efficiency while eliminating emissions in an internal combustion engine. The APC, first developed at the University of California (UC), Berkeley, utilizes an internal combustion engine operating in a closed loop, with argon as the working fluid (instead of air) in conjunction with a membrane gas separation unit. The closed-loop nature of the system eliminates air pollutants (e.g., NOx) and GHG emissions. The project will take place at UC Berkeley, with work to be completed in two phases: 1) high-fidelity modeling and sub-component development and 2) full system integration and operation. The team has completed the development of the fully integrated system model, integrating carbon capture technology, reciprocating engine power train, and heat transfer mode. Additionally, the team has completed the design of the overall plant and the design and manufacturing of the retrofit kit for the stock diesel engine.	The project team is currently building the integrated system for testing and is expected to commence testing in December 2025. This project was in a disallowed subprogram but was allowed to continue per AL-6273G. Project is awaiting receipt of final deliverable posttest completion.	Active
9-CG-IC	NREL Cybersecurity Gap Analysis for Distributed Energy Resources - TSA-24-31185	The goal is to conduct cybersecurity gap analyses for behind-the-meter renewable energy assets that may be deployed at SoCalGas facilities and/or customer sites. NREL will conduct two gap analyses (1) high level, (2) a detailed, to assess potential threats, challenges, risks, and impacts to distributed energy resources (DERs). These deployed assets support renewable energy deployment and require strong cyber maturity to promote safe and reliable operation.	In Q2 2025, NREL hosted a webinar providing a foundational overview of cybersecurity considerations for renewable energy resources. The webinar aimed to increase awareness of the need for mature cybersecurity practices within these resources. In Q3 2025, NREL also submitted a high-level cybersecurity gap analysis of energy resources. Findings from the draft will be used to select energy resource segment(s) for a deeper dive gap analysis, followed by a subsequent webinar to present results.	Active

No.	Project Title	Project Description	2025 Progress	Status
10-CG-IC	NREL GKN Metal Hydride Storage Integration with Renewable Energy and Fuel Cells Demonstration - CRD-21-18281	This project aims to validate and demonstrate the dynamic operation of GKN's HY2MEGA metal hydride hydrogen storage system integrated with the National Renewable Energy Laboratory's (NREL) ARIES platform. The H2MEGA, to be constructed at NREL's Flatirons Campus, will be the largest known metal hydride storage system (520 kg H2 / 17.2 megawatt-hour). It will leverage ARIES resources: 1.25 MW PEM electrolyzer, 1.0 MW PEM fuel cell, 600 kg compressed hydrogen, 6.3 MW controllable grid interface, battery, and renewable power assets. The project will use renewable electricity to produce clean, renewable hydrogen via electrolysis, which will be stored in the HY2MEGA system and compressed storage. The project will use hydrogen to generate electricity via fuel cells. Simulated energy production and consumption via the controllable grid interface will enable the team to validate HY2MEGA performance in various real-world scenarios. These simulated use cases will include data centers and remote communities. This project will help advance the proven, at a smaller commercial scale, HY2MEGA technology. in Q4 2024, GKN informed the project team of its planned business closure.	As a result of the business closure, the project was terminated. Unspent ratepayer funds were returned.	Completed

No.	Project Title	Project Description	2025 Progress	Status
11-CG-IC	NREL Grid Forming Inverters for Fuel Cells Research - CRD-21-18272	This project aimed to develop interconnection and interoperability standards for grid-forming fuel cell inverters. Grid-forming inverters are critical to maintaining and regulating voltage and frequency for grid parts without traditional rotational assets (which typically perform this function). The industry has successfully integrated grid-forming inverters with battery storage systems in the past few years. The operational differences between fuel cells and batteries require standards specific to fuel cell integration with grid-forming inverters. This project utilized the National Renewable Energy Laboratory's cutting-edge ARIES research platform, capable of integrated systems modeling and testing at scales up to 20MW. The team performed the tasks in three phases: 1) hardware-in-the-loop modeling, 2) interconnection and interoperability requirement evaluation, and 3) testing and validation of the developed standards in the ARIES platform. The project had three technical goals: 1) demonstrating the ability of fuel cell inverters to transition between grid following and grid forming modes, 2) interconnection standards (how fuel cells connect to the grid), and 3) interoperability standards (how fuel cells communicate with other assets).	The report can be found here: https://resourcecenter.ieee-pes.org/publications/technical-reports/pes_tr_128_psope_021825	Completed

No.	Project Title	Project Description	2025 Progress	Status
12-CG-IC	NTS Argon Power Cycle with Blended Hydrogen Integration and Demonstration	NTS will integrate its Argon Power Cycle DG system into a customer facility and will optimize its controls to modulate its output power real-time to meet a varying demand of industrial-grade process heat and electric power while fueled with varying blends of clean renewable hydrogen. This CHP solution will be deployed and demonstrated at a Southern California Edison Company's (SCE) site in Pomona, CA. It is intended to be integrated as a power source in an island-capable microgrid that serves both power to electric vehicle charging stations, and heat in the form of steam to adjacent building heat takeoffs. The project tasks will be focused on controls design, lab verification testing, site integration, and demonstration.	NTS is actively engaged in another project under the Clean Generation Program. The current project faced delays in system integration and full-scale testing due to a stop work order and rebudgeting with the DOE. As of August 2024, the stop work order has been lifted, and NTS is resuming the technology demonstration in their lab, expected to be completed by the Q4 2025. Due to this circumstance, RD&D funding for design tasks of this new project (HyBLOX) will be on hold until the successful completion of the prior project demonstration test, with performance targets met.	Active
13-CG-IC	Rocketruck Mobile Fuel Cell Generator Integration and Demonstration	RockeTruck aims to enhance its mobile fuel cell technology by developing and demonstrating improved system operation controls and integration of hardware. The motivation for this stemmed from performance observations during the CEC project, where reliance on "off-the-shelf" (OTS) integration equipment led to subpar system performance due to the absence of a suitably matching inverter in the market.	In 2025, RockeTruck developed and protoyped a new multiport power converter (MPC), customized to work with fuel cells and batteries, and capable of delivering power in accordance with MFCG project specifications. A successful demonstration of the integrated MPC and mobile fuel cell generator was hosted at CSULA (Mobile EV charging Demo). RockeTruck is preparing a final report, which is expected in Q1 2026.	Active

No.	Project Title	Project Description	2025 Progress	Status
14-CG-DG	UCI Effect of Hydrogen Addition into Natural Gas on SCR of NOx Lab Testing	The goal of this project was to investigate the impact hydrogen blended natural gas has on the performance of selective catalytic reduction (SCR) units for deNOx. SCR of NOx is used in several applications such as gas-fired utility boilers, process heaters, gas turbines, and stationary engines. Since the hydrogen molecule is a carbon-free fuel, combustion products are different than that of carbon-containing fuel. Introducing a flue gas with a different composition into the SCR unit would affect the chemistry that is taking place on the catalyst, hence the performance of the catalyst. This might cause a change in the resulting NOx emissions downstream of the SCR unit, which would be released from the stack. Experimentation showed that H2 addition does not have a significant effect on the NOx reduction performance of the catalyst, and the effect becomes less pronounced for fuel-lean mixtures because the excess oxygen in the flue gas increases NOx conversion. However, the presence of water vapor in the flue gas as a result of H2 addition was shown to increase NOx conversion when SO2 is present, making the catalyst more resistant to sulfur poisoning. The project was extended to explain why NOx conversion increases with water vapor and SO2 present.	The final report was delivered mid Q4 2025 and is currently in review. This project was in a disallowed subprogram but was allowed to continue per AL-6273G.	Completed

No.	Project Title	Project Description	2025 Progress	Status
15-CG-IC	UCI Fuel Cell Supported Nanogrid Controls Evaluation	The purpose of this project is to evaluate two microgrid control platforms in the context of a fuel cell supported residential microgrid ("nanogrid"). This project leverages the results of an ongoing project to develop and test a nanogrid control strategy designed to achieve ZNE in a residential setting with an SOFC, PV solar, and battery storage. UCI will work with two microgrid controls vendors to evaluate and further develop the capabilities of their control platform(s). The microgrid controllers will be installed in UCI's laboratory nanogrid, which includes a 1.5kW SOFC, 5kW of rooftop solar, and a 9.8kWh battery.	Test results showed that real SOFC systems have the flexibility needed for optimal ANE operation. The project also found that optimization-based controls strategies closely matched model simulations and deliver the lowest operating cost in real world testing. In contrast, simple rule-based controls consistently underperform because they cannot adjust efficiently to changing energy conditions. These findings highlight those smart controls and strong interoperability between the SOFC, battery, and PV systems are essential to effectively use SOFCs in residential nanogrids. The final report was delivered mid Q4 2025. This project was in a disallowed subprogram but was allowed to continue per AL-6273G.	Completed

No.	Project Title	Project Description	2025 Progress	Status
16-CG-IC	UCI Hydrogen Enabled Microgrids for Critical Infrastructure Research	The goal of this project was to demonstrate that hydrogen-based renewable fuels – in concert with a cheap and renewable power supply on the electric grid – provide the best techno-economic and long-term solution to meet both 100% renewable energy conversion goals and stringent reliability requirements for essential services such as data centers and hospitals. This project leverages previous and ongoing Microsoft co-funded data center research. UCI will design and optimize a fully integrated energy system for a data center. System design will account for site loads, electrochemical energy conversion and storage devices (fuel cells, electrolyzers, batteries), renewable generation (on- and off-site), and dynamic integration with infrastructure grids (electric, gas, water). Optimizations and comparisons will be based on technical capabilities, achieved reliability, and cost.	The project was designed to cover a comprehensive scope of work; however, due to limited progress and exhausted funding, the team produced results based on the work completed to date. These results show that hydrogen transported through existing gas pipelines can help maintain energy service during electric transmission outages, supporting both critical loads and overall grid stability. Hydrogen-fueled distributed generation reduces transmission line overloads and maintains service even when major corridors are offline, though multiple simultaneous outages may require additional infrastructure. The findings demonstrate that a hydrogen-enabled system can support the transition to renewable energy while leveraging existing pipelines, enhancing resiliency, and advancing California's renewable energy goals. A final report was submitted.	Completed

No.	Project Title	Project Description	2025 Progress	Status
17-CG-IC	UTD High-Efficiency Combi System Integrating PV and Self-Power - Phase 2 (1.20.G.2)	The goal of this project is to develop and demonstrate a hybrid residential combined HVAC and water heating (combi) system in the laboratory that uses off-the-shelf appliances and novel controls to integrate gas/electric systems with micro-CHP, energy storage, and renewable energy in order to improve efficiencies, reduce GHG emissions, reduce operating costs, and increase resilience. GTI has successfully operated the nanogrid to achieve self-powered hybrid residential HVAC and water heating using the mCHP system and thermal/electric energy storage to power the combi system and ASHP. The nanogrid controller manages various power sources including mCHP, grid power, and solar PV. By using thermal heat recovery from the micro-CHP system together with the ASHP and supplemented with the tankless as necessary, GTI is targeting annual COPs greater than 1.0 serving heating loads down to 5MBH.	This project found that the most practical, lowest-cost path to household heat resilience during grid outages is pairing existing gas furnaces with a right-sized battery that islands only the HVAC load. In modeled cold-climate scenarios (8–72+ hour outages), rooftop PV reduces required storage and improves economics for day-long events; beyond ~48 hours, portable or standby generators can be cheaper than very large batteries. Fully electrified heating did not pencil when evaluated solely for resilience under 2024 tariffs; in this context, reliability—not operating-cost savings—drives value. Lab testing of a packaged "nanogrid-in-a-box" (8 kW micro-CHP + inverter + 15 kWh/8 kW BESS) showed promise but exposed readiness gaps: lower-than-expected electric (~17%) and total (~69% HHV) efficiency, NOx above stationary limits, hazardous noise (~100 dBA), unreliable starts/ramping, sensor inaccuracies, inadequate thermal protections, and sluggish inverter coordination. In response, the OEM's pivot to a split architecture—outdoor mCHP with heat dump, third-party BESS/inverter, and an indoor heat hub/Hybrid AHU—targeting ~30% electric efficiency is directionally sound but requires emissions compliance, safety hardening, controls integration, and certification before field trials.	Completed

No.	Project Title	Project Description	2025 Progress	Status
			Accordingly, this project recommends a dual-track strategy: (1) near-term deployment of furnace-plus-BESS (optionally with PV) with simple "outage mode" controls and (2) continued R&D with OEM partners to mature packaged nanogrids, including standardized interconnection, fail-safe protections, thermal optimization around ~140 °F setpoints with ~20 °F deadbands, and rigorous reliability testing.	
18-CG-IC	UTD Integrated mCHP System for Multi-family Building - Phase 2 (1.20.J.2)	The goal of this project was to leverage the results of Phase 1, which integrated a Lochinvar CHP, distributed air source heat pumps, and thermal storage in an integrated energy system (IES). This project is intended to expand the capabilities of the system to further test and demonstrate the capabilities of the IES in a multifamily setting. The project team integrated EV charging, PV integration, and hydrogen blending in a microgrid configuration to demonstrate resiliency and efficiency benefits. The system will be designed and evaluated in both grid-connected and islanded configurations. Additional details are available in the 2025 UTD Annual Report.	The final report was completed.	Completed

No.	Project Title	Project Description	2025 Progress	Status
19-CG-IC	Xendee Adaptive Microgrid Controls Demonstration	Xendee will demonstrate its new adaptive microgrid control technology, which can achieve up to 50% total energy cost savings and reduce on-site gas consumption by operating the customer's DERs more efficiently. Xendee's control technology leverages AI and machine learning to adaptively manage systems based on weather forecasts, load forecasts, and other dynamic factors. Current market controllers are rule-based and lack forward-looking capabilities. Resultingly, this leads to operational inefficiencies due to their reliance on hardcoded rules that are not adaptive to a microgrid's real-world operating environment, where renewable energy output, load demand, and market opportunities are continuously changing. The demonstration will take place at a SoCalGas customer site with existing DER assets, including a gas-fired gen set, battery energy storage, and solar PV. The goal of this project is to validate Xendee's energy cost reduction performance and compare it to the customer's baseline operation.	Xendee and SoCalGas are currently collaborating to identify a suitable customer demonstration site.	Active

No.	Project Title	Project Description	2025 Progress	Status
20 -CEUA -CA	GTI Advanced Commercial Window Retrofits Demonstration	GTI, in partnership with LBNL and Frontier Energy, is pioneering advancements in window retrofits by improving industry solutions, showcasing enhanced products in commercial buildings, and driving market adoption. The project emphasizes Secondary Windows (SW) as a cost-effective alternative to full replacements. Collaborating with Alpen Winsert, GTI aims to deliver a thin triple-pane SW achieving R 7.7 or higher, upgrading single-pane windows to quadruple-pane for exceptional energy efficiency. The initiative also explores innovative technologies such as VIG and AeroShield's silica aerogel inserts, which enhance insulation and energy performance, through field demonstrations.	In 2025, GTI Energy, Lawrence Berkeley National Laboratory, and Frontier Energy are evaluating high-performance secondary window solutions from Alpen, LuxWall, Inovues, and Aeroshield through laboratory testing. Specifically, they are focused on technical tasks such as technology assessment and market characterization, condensation mitigation, and air infiltration impacts. Early results show these products can upgrade single-pane windows to near quadruple-pane performance, and parallel energy modeling and techno-economic analyses are assessing their cost-effectiveness. Laboratory testing is expected to be completed in Q1 2026.	Active

No.	Project Title	Project Description	2025 Progress	Status
21-CEUA-IPH	GTI Burner Exchange to Support Radiative Recuperator Demonstration	The project aimed to demonstrate natural gas savings and emission reductions utilizing an advanced radiative recuperator with secondary emitters (RRSE). For this CEC-funded project (PIR-15-006), GTI Energy and the host site, California Die Casting (CDC), modified a furnace to melt aluminum for die casting with an improved RRSE. The RRSE is more efficient and cost-effective than commercially available recuperators, which primarily recover heat from the exhaust gas and preheat combustion air. The project team will couple the RRSE with commercial hot air, ultra-low NOx burners (Bloom 1500S060C) operated with air preheated to as high as 1200°F. This approach forms a combined heat recovery system that is highly efficient with low NOx. In addition, a stack to preheat scrap on its way to the furnace with exhaust gas leaves the RRSE to increase furnace efficiency further, lowering natural gas demand. The simple payback for this technology is 30 months.	The team completed this project and provided the final report to SoCalGas in 2022 but cannot publish the final results until the CEC's final approval. The project is kept active to track the final publication of the report. This project was in a disallowed subprogram but was allowed to continue per AL-6273G. Project is awaiting receipt of final deliverable. As of 2025, the final report has yet to be published by the CEC. Because this project falls under a terminated program, we will no longer be dedicating resources to continued tracking or reporting of progress beyond the end of 2025.	Completed

No.	Project Title	Project Description	2025 Progress	Status
22-CEUA-IPH	GTI Hydrogen Commercial and Industrial Market Characterization End-Use Research	This project will support the CEC's GFO-21-503 - Examining the Effects of Hydrogen in End-Use Appliances for Large Commercial Buildings and Industrial Applications. The objective is to conduct a technical study of the impacts of utilizing hydrogen, blended with natural gas and 100% hydrogen, in existing appliances and equipment as a decarbonization strategy for large commercial buildings and industrial processes in California. The research aims to identify and resolve key research and technology gaps through techno-economic analysis, laboratory testing and calibrated simulation of representative combustion equipment and materials, air quality modeling, and stakeholder engagement. The focus will be on understanding the cost, performance, and safety implications and the emissions benefits of adopting hydrogen in these sectors. The project team will also identify and address key benefits, challenges, and potential solutions for increasing hydrogen use in end-use equipment. GTI Energy is leading this effort with the Electric Power Research Institute (EPRI) and the University of California, Irvine (UCI) to complete this wide-reaching study. The team will establish a methodology to select equipment categories based on the magnitude of the GHG emissions associated with the type and the potential for reduction via hydrogen use. The techno-economic analysis will seek to understand the decarbonization potential of using hydrogen to fuel these equipment categories and other measures (e.g., energy efficiency) to 2035 and 2050. The team will make a comparison against business-as-usual and alternative pathways (e.g., electrification vs. diversified path).	In 2025, GTI Energy is leading the research team which includes UC Irvine, EPRI, AHRI, and others to define the practical limits of using hydrogen in large commercial and industrial heating equipment. The team reviewed feasibility and cost data for hydrogen blends and 100% hydrogen, tested a wide range of equipment (boilers, ovens and kilns, furnaces, HVAC, etc.) with blends up to 95% and evaluated common construction materials in hydrogen combustion environments. Using these results, they performed statewide techno-economic modeling and regional air-quality simulations to estimate the emission-reduction potential of hydrogen in these end uses. This project was in a disallowed subprogram but was allowed to continue per AL-6273G. Project is awaiting receipt of final deliverable.	Active

No.	Project Title	Project Description	2025 Progress	Status
23-CEUA-CFS	GTI SCAQMD HE/ Low-NOx EcoZone Burner Kroger Demonstration	The project objective was to demonstrate at least 25% NOx emission reduction by optimizing the combustion process in a multi-zoned commercial baking oven within a South Coast Air Quality Management District environmental justice area. The team estimated a 10% reduction in carbon dioxide emissions through combustion system optimization. The goal was to install the major components of the demonstration system (such as the innovative high-efficiency low-NOx ribbon burners and flame analyzers along with advanced combustion and flow controls) on a multi-zone baking oven at a major commercial bakery located in La Habra, California. The project team followed this step by testing and performing data collection over a wide range of operating conditions to illustrate the anticipated energy savings and environmental benefits. The proposed approach provided the means to minimize carbon monoxide, carbon dioxide, and NOx emissions while operating the burners at the most efficient firing rate possible at every moment of the baking process. Due to limitations caused by COVID-19, the team was delayed in completing field engineering and demonstration system installations until mid-2021. Fortunately, the team turned the project around in August of 2021 when they installed the demonstration system (i.e., the modified combo-burners and oven control system). In 2022, the team was able to successfully startup and shakedown the demonstration system. They are now actively collecting data and monitoring the performance of the EcoZone burner.	In 2025, GTI Energy completed laboratory testing and confirmed substantial NOx reductions—approximately 28–38% lower NOx in IR and Combo modes compared with ribbon mode—demonstrating meaningful emissions-reduction potential relative to traditional ribbon burners. The testing also identified retrofit challenges, including ignition behavior in IR mode, flame-sensor limitations at low firing rates, and physical clearance concerns within multi-zone ovens, and the EcoZone flame-analyzer control concept did not function effectively with multiple smaller burners in a commercial oven environment. Based on these findings, the OEM has shifted its focus to hybrid electric/gas burner technologies for future development.	Completed

No.	Project Title	Project Description	2025 Progress	Status
24-CEUA-RA	GTI Strategic Pathways and Analytics For Tactical Decommissioning of Natural Gas Infrastructure Research	This project developed a multi-disciplinary and objective analytical framework to identify locations in Southern California where decommissioning can occur in a just, equitable, and cost-effective way. California has some of the most ambitious policies in the U.S. for reducing emissions associated with natural gas use. In some areas, decommissioning natural gas and switching customers to electricity may be a cost-effective approach to meeting these goals. Over time, decommissioning practices of the gas system will greatly impact customers and gas and electric utilities. Avoiding socioeconomic equity issues being exacerbated through decommissioning is paramount. The project team included an impartial California-based think-tank—the RAND Corp—along with SoCalGas, Southern California Edison, GTI Energy, and LA Regional Collaborative (LARC). The team combined detailed gas system models with data on candidate communities' socioeconomic conditions to evaluate different decommissioning approaches. The team worked directly with Long Beach and Santa Monica stakeholders in a series of workshops to understand the key needs and concerns of the natural gas customers and then evaluate different decommissioning strategies along with cost, viability, and equity lines. Through these workshops, the team presented specific recommendations for three decommissioning pilot projects and wrote a set of guidelines and criteria to inform decommissioning of natural gas infrastructure in other areas. In 2022, the project team developed a set of decommissioning scenarios with their engineering teams. They are performing detailed engineering analyses to understand the impacts of decommissioning different portions of the system in Santa Monica.	The draft final report was delivered to SoCalGas in 2024. In 2025, the CEC published the final report and the report can be found at the CEC webpage: https://www.energizeinnovation.fund/projects/strategic-pathways-and-analytics-tactical-decommissioning-portions-natural-gas-0 This project was fully funded prior to being disallowed per G-3601. Project is awaiting receipt of final deliverable.	Completed

No.	Project Title	Project Description	2025 Progress	Status
25-CEUA-IPH	UCI Solid Oxide Electrolysis Cells for Green Steel Production Demonstration	The objective of this project is to study, demonstrate, and optimize an integrated, zero-emission prototype for the direct reduction of iron (DRI) with hydrogen produced from a Solid Oxide Electrolysis Cell (SOEC) system. The project is a close collaboration of academia (University of California, Irvine, and Politecnico di Milano), industry (FuelCell Energy (FCE), Inc.), and a technology transfer company (LEAP). The team has proposed three system configurations representing incrementally integrated layouts between the SOEC unit and the shaft furnace. In 2021, the team determined the primary energy consumption < 8 GJ/ton Direct Reduced Iron (DRI) for the best-performing Hydrogen Direct Reduction configuration at nominal load. The team also completed a SOEC model validation on voltage-current curves with an average prediction error of <5% on the steam electrolysis experimental measurements. The model predicted electric-to-hydrogen production efficiency of < 35 kWh/kg (or >95% with 120 MJ/kg of H2 Lower Heating Value) at nominal design steady-state conditions. The project team plans to complete the validation of the SOEC co-electrolysis model for the Hybrid Hydrogen Direct Reduction (HDR) scenario with literature data, begin pressurized stack testing at FCE's manufacturing site, optimize system layouts for steam electrolysis scenarios, and initialize system configurations for co-electrolysis (hybrid HDR) in 2022. The project was awarded follow-on funding with the DOE for a large-scale field demo project with Cleveland Cliffs in Toledo, OH. This project was in a disallowed subprogram but was allowed to continue per AL-6273G. Project is awaiting receipt of final deliverable.	In 2025, the team completed prototype development and testing. In the first quarter of 2025, efforts centered on prototype design, construction, and testing, along with the design and characterization of the follow-on pilot-scale SOEC+DRI process. By September 2025, all technical tasks were finished. The team then focused on consolidating inputs from project contributors to finalize the report for submission to the U.S. DOE. The project is pending close-out upon receipt of the final report.	Active

No.	Project Title	Project Description	2025 Progress	Status
26-CEUA-CA	UTD Accelerated Life Testing of ResCom Equipment Components with Hydrogen-Blended Gases (1.23.G)	The objective of this project was to assess the compatibility of commonly used non-burner components in Res/Com combustion appliances and equipment when subjected to hydrogen-blended gas. The results will be used to help gas equipment and appliance manufacturers, gas utilities, standards-setting organizations, and others better understand the potential challenges from using hydrogen in natural gas distribution networks. Some of the deliverables included reporting the component compatibility or degradation when exposed to H2, recommended mitigation strategies for any problems identified, and publish results and methodology in a peer reviewed journal or conference prå oceedings detailing what compatibility problems were or were not found.	GTI Energy completed procurement and buildout of the accelerated life test rig for non-burner Res/Com gas train components, including finalizing the test plan, updating the P&ID, and completing SOP/JSA documentation. The team also successfully completed long-term nitrogen leak testing and validated purge procedures in preparation for initiating exposure testing under 100% hydrogen at the start of the next phase. While progress remains on track, the schedule is expected to extend through at least the end of 2025 and possibly into early 2026 to allow sufficient exposure-test duration.	Active
28-CEUA-CFS	UTD Advanced Controls for Residential Kitchen Ventilation Systems (1.23.M)	This project focuses on improving residential cooking ventilation systems to address indoor air quality (IAQ) concerns. It involves developing and testing advanced controls for Demand Controlled Kitchen Ventilation systems, aiming to enhance capture effectiveness by 30% and reduce conditioned air losses by 10% compared to standard hoods. The team will also model and measure energy savings.	During Q1 2025, GTI Energy focused on reviewing collected test data and advancing the analysis needed for the final report, including confirming whether any additional testing is required to close out the scope. A lead-engineer transition temporarily delayed testing and analysis, but a new lead has been assigned, and the team plans to finish remaining testing in Q2, complete data analysis, and begin the final report while maintaining the targeted schedule.	Active

No.	Project Title	Project Description	2025 Progress	Status
29-CEUA-CA	UTD Boostheat Thermal Compression-Based Gas Heat Pump (1.20.B)	The objective of this project is to develop a North American thermal heat pump (THP) with a focus on 1) a high modulation ratio, 2) integration with forced-air distribution, and 3) adding cost-effective cooling. Project partner BOOSTHEAT has recently established an innovative and new business model in Europe. To successfully enter the North American market, however, this UTD project will address key product development needs. THPs have significant potential for 20% or greater improvement in energy savings and emissions reductions versus best-in-class conventional sorption and vapor compression-type THPs. The project team completed laboratory preparations for testing the BH.20 using a Virtual Test Home (VTH) protocol. The test infrastructure is complete, and the remainder of the activity focuses on data acquisition and control setup. The test apparatus is undergoing shakedown to test a different heat pump before the arrival of BOOSTHEAT's unit. BOOSTHEAT experienced a production delay in 2020-2021 for various reasons. The company addressed key technical challenges and consolidated staff under a single roof. In early 2022, the company indicated that their new units' reliability and performance had improved. BOOSTHEAT is also re-developing the packaging and controls of the thermal compressor so that the BH.20 can provide both space heating and domestic hot water. BOOSTHEAT is expected to make a unit available for testing and additional technical refinement (including using a Virtual Test Home protocol in the first quarter of 2023.	The project was ultimately terminated in 2024 after BOOSTHEAT ceased THP product development, pivoted to a hybrid thermal compressor concept, and later sold related IP and prototypes to non-HVAC industrial partners, which prevented delivery of a unit for planned lab evaluation; nevertheless, in 2025, GTI Energy completed the test plan and delivered substantial THP testbed hardware and software infrastructure upgrades that were subsequently leveraged to support other thermal heat pump and integrated energy system projects.	Completed

No.	Project Title	Project Description	2025 Progress	Status
30-CEUA-CFS	UTD CFS Burner Technology Carbon Reduction Including Hydrogen Blending - Phase 3 (1.21.H.3)	This project explored the decarbonization potential of Commercial Food Service (CFS) appliances by blending natural gas with hydrogen, using improved burner technologies, and enhanced control systems. It addressed energy-reduction strategies, burner modulation, and challenges related to outdated burner designs that struggle with fuel content changes. Phase 3 involved testing a griddle and up to five CFS appliances with hydrogen blends, focusing on efficiency, emissions, cooking performance, and flame appearance.	In 2025, the team evaluated full-appliance performance using hydrogen-enriched natural gas blends up to 30% H_2 by volume, including testing on an Avantco charbroiler and an AccuTemp AccuSteam griddle to assess efficiency, emissions, cooking performance, and operational impacts; results generally showed acceptable, stable operation across blends, with indirect/thermostatically controlled designs exhibiting the most consistent cooking outcomes. Testing with 100% hydrogen on the Heatlie griddle was postponed to a subsequent phase due to evolving safety requirements and alignment with a separate DOE co-funded effort, and the team also advanced plans to improve cook-test objectivity using image analysis tools while disseminating results through industry venues and planned publications.	Completed

No.	Project Title	Project Description	2025 Progress	Status
32-CEUA-CFS	UTD CFS Decarbonization Tool Development and Demonstration (1.23.K)	This project enhances the Foodservice Energy Monitoring System (FEMS) software to analyze carbon footprint, efficiency, emissions, lifecycle cost savings, and payback periods for various Commercial Foodservice (CFS) appliances, including those using natural gas and NG/hydrogen blends. It aims to provide data-driven insights for equipment choices, promoting energy savings, and reduced emissions while maintaining cooking performance. The team will demonstrate the software and NG/hydrogen capabilities through live cooking tests and showcase the carbon reduction potential of high-efficiency gas-fired appliances.	In 2025, the team advanced the Commercial Foodservice (CFS) Decarbonization Tool by upgrading the FEMS software to better quantify and communicate energy and emissions impacts across electric, natural gas, and natural gas/hydrogen-blend cooking configurations. Key progress included implementing and validating new outputs for carbon footprint, source efficiency, and source emissions, installing the updated build on GTI's lab system for review, refinements, and testing, and confirming prior fixes are performing as intended. In Q4, the software was further modified to support Modbus communications required for Duke Energy's test kitchen environment, and coordination began to install the finalized version on Duke's test-kitchen computers in preparation for a live demonstration aligned with the March UTD meeting. While software modification work ran slightly behind schedule, the project remains on track with a no-cost time extension through July 31, 2026, with next steps focused on completing Duke test-kitchen installation/testing and executing the live demonstration.	Active

No.	Project Title	Project Description	2025 Progress	Status
33-CEUA-CA	UTD CleanO2 CarbinX Carbon Capture - Phase 2 (1.21.C.2)	Phase 2 of 1.21.C aims to validate the importance of distributed carbon capture (DCC) technology in buildings by tackling complex scenarios in residential and commercial water heating. This includes retrofitting condensing boilers and addressing large, high-efficiency commercial boilers. The investigation will focus on expanding the technology's potential to decarbonize water heating appliances powered by natural gas and propane. Propane, though less common, represents about 5% of U.S. heating systems, particularly in rural areas, and serves as a cleaner alternative to heating oil, reducing CO2 emissions by about 20%. This project was fully funded prior to being disallowed per G-3601. Project will be closed out upon receipt of final deliverable.	During Q3 2025 (Phase 2), the team finalized and issued separate test and modeling plans, with the lab test plan expanded to include detailed experimental infrastructure, instrumentation, and a defined test matrix. Key equipment was specified and ordered, including a cascade array of three high-efficiency condensing boilers to enable carbon-capture testing across firing rates and with both natural gas and propane, and representative DHW draw schedules were established for economizer testing while coordinating with CleanO2 on delivery of the CarbinX unit for integration and testing. This project was fully funded prior to being disallowed per G-3601. Project will be closed out upon receipt of final deliverable.	Active

No.	Project Title	Project Description	2025 Progress	Status
34-CEUA-CA	UTD CleanO2 CARBiNX Carbon Capture (1.21.C)	This project aimed to evaluate the performance of a CleanO2 CARBiN-X v 4.0 carbon capture device in the laboratory to validate claims of a carbon dioxide capture rate of 4 metric tons per year and cost savings of at least 30% for hot water heating. It further identified areas for continued technical improvement. Implementing distributed carbon capture technology such as the CARBiN-X helped reduce greenhouse gas emissions in residential and light commercial and industrial spaces while allowing facilities operators to use natural gas in Zero Net Energy Buildings. For the CARBiN-X v 4.0, the CleanO2 team worked on more advanced prototypes to further disrupt the distributed carbon capture market. Depending on the progress in developing these prototypes, GTI Energy could have performed preliminary regulatory and technical analyses to support the advancement of this technology. In 2022, the project team worked with CleanO2 to fully commission the new production version of the carbon capture unit in the improved experimental test stand for next-round tests. Researchers completed baseline and advanced testing and provided continued assistance to CleanO2 to refine the new system. This project was fully funded prior to being disallowed per G-3601. The project was to be closed out upon receipt of the final deliverable.	In 2025, GTI Energy provided the final report while completing all technical tasks including the completion a controlled lab evaluation and codes-and-standards assessment across four test campaigns, with CARBiN-X demonstrating roughly 3–4% direct CO_2 capture plus an additional ~10–12% CO_2 reduction attributable to waste heat recovery (for a total net reduction of ~13–16%), while also identifying practical improvement needs such as venting/condensate management, moisture control, and reactor/flow optimization to support commercialization.	Completed

No.	Project Title	Project Description	2025 Progress	Status
35-CEUA-CA	UTD Combustion Technology for Emerging Low Carbon Manufactured Gases (1.23.E)	This project evaluated the performance, reliability, and safety of equipment using manufactured gases prevalent outside North America, focusing on water heating and cooking applications. It aimed to identify principles applicable to natural gas-certified equipment in North America and reviews emerging low-carbon manufactured gases. The research built on the historical use of synthetic natural gas in North America, with modern examples such as Hawai'i Gas blending synthetic natural gas with renewable natural gas and hydrogen.	In 2025, GTI Energy delivered the final report which described laboratory testing of 12 residential appliances (six stovetops and six instantaneous water heaters) intended for manufactured gases using a representative "Singapore town gas" blend (50% H_2 / 25% CH_4 / 5% CO / 15% CO_2 / 5% N_2), and results showed generally effective operation under hydrogen-rich conditions, with measured efficiencies typically within about 10% of rated values and combustion/emissions behavior underscoring the importance of aeration/orifice design and flashback protection.	Completed
37-CEUA-CA	UTD Commercial Heat Pump Water Heater Field Performance Comparison (1.21.F)	This project compares commercial gas and electric heat pump-based water heater technologies. These tests are being carried out at one or two field locations and in GTI Energy's laboratory using ASHRAE standards. The aim is to establish each technology's cost and energy savings capabilities. The goals are to assess the performance of these technologies under various conditions and to provide comparative information between commercial heat pump technologies. In 2022, the project team executed a contractual agreement with SMTI. The initially planned host site pulled out from participating in this field of study. An alternate host site for the demonstration was identified. The U.S. Department of Energy is providing prime funding for this research.	In 2025, the team-initiated measurement and verification activities and successfully collected field data in both baseline and retrofit modes for the commercial gas absorption heat pump (GAHP) water heater demonstration. Preliminary results showed clear domestic hot water draw peaks around lunch and dinner, along with early correlations between DHW load, gas use, and COP versus return-water-temperature minus outdoor-air-temperature (RWT–OAT), which also highlighted potential system design improvement opportunities related to outdoor/indoor flow differentials. Next quarter, work will continue with additional data collection and analysis, with no scope of changes reported.	Completed

No.	Project Title	Project Description	2025 Progress	Status
39-CEUA-CA	UTD Controlled Mixing Burner for Process Heating (2.23.C)	This project focused on developing and testing a prototype burner (0.5–1 million Btu/hr) for natural gas and low-carbon fuels (LCFs), enabling process heating applications to use diverse fuel blends, including 100% carbon-free fuels (CFFs) like hydrogen and ammonia. Laboratory tests validated that flame characteristics, emissions, and performance remain stable regardless of fuel carbon content. The prototype was assessed under various conditions to confirm its suitability for end users aiming to decarbonize operations.	In 2025, testing demonstrated reliable ignition, stable operation at low combustion-air pressure, and turndown capability, but also identified uneven and fluctuating flame structure and consistently elevated CO emissions driven by insufficient fuel-air mixing and non-uniform air distribution, which limited meaningful alternate-fuel evaluation during this phase; the project concluded with recommendations to redesign key burner features (e.g., nozzle position/angle/quantity, plenum configuration, and natural-gas injection geometry) to improve mixing and enable future hydrogen/ammonia testing and scale-up discussions with commercial partners.	Completed

No.	Project Title	Project Description	2025 Progress	Status
41-CEUA-CA	UTD Deep Energy Customized Affordable Retrofit of Building Envelope and Mechanicals - Phase 2 (1.22.E.2)	This project emphasized whole-building decarbonization by prioritizing reduced energy demand through improved building envelope measures paired with next-generation high-efficiency mechanical systems. Phase 2 involved modeling and validating HST's mechanical distribution system for space conditioning, testing Navien's Hydro-furnace retrofit for single-family homes, and developing an integrated gas-fired HVAC pod concept with ventilation and potential battery electric storage.	In 2025, GTI Energy delivered the final report which described advancement in deep-retrofit approach by modeling and validating Hydronic Shell Technologies' (HST) mechanical distribution concept for space conditioning, testing and laboratory-evaluating Navien's NPF Hydro-furnace retrofit for low-load homes (including part-load performance and hybrid operation with an air-source heat pump), and validating HST's Hydrobox heating and cooling capacity while assessing integration pathways with reversible gas absorption heat pumps. The team also completed feasibility modeling and a market assessment that clarified gaps and emerging opportunities for an integrated hybrid gas/electric "HVAC pod" concept incorporating ventilation and potential battery storage for North American residential and multifamily applications.	Completed

No.	Project Title	Project Description	2025 Progress	Status
43-CEUA-CA	UTD Emerging Distributed Methane Pyrolysis Technologies - Phase 2 (1.22.P.2)	This project evaluated emerging distributed methane pyrolysis solutions to identify the best options for gas ratepayers and consumers to support decarbonization. It combines application and process modeling with end-user demand modeling and technology assessments. Initial research included outreach to leading technology developers to create a landscape survey and conduct a techno-economic assessment (TEA) of various applications, focusing on conversion processes, hydrogen uses, and carbon outputs. Current efforts build on this foundation by expanding outreach and refining the TEA.	In 2025, GTI Energy drove UTD 1.22.P Phase 2 to completion (targeting Q3 2025) by translating the Phase 1 techno-economic assessment into an application- and process-focused screening framework that identifies "good/better/best" distributed methane pyrolysis fits across end uses and carbon handling pathways. Building on Q4 2024 progress that advanced developer due diligence and completed initial scoping, screening, and sorting criteria for model development (including how "drive energy" is treated), the 2025 work will emphasize collecting and anonymizing real-world pilot/scale-up data (with two or more site visits anticipated), beta-testing the screening tool, and finalizing a TEA spanning five or more hydrogen end-use scenarios and carbon-output scenarios. The year will culminate in a consolidated set of recommendations and a clear summary of RD&D gaps for both conversion technology performance and carbon handling, supported by an updated schedule reflecting the project extension needed for added data gathering and model development.	Completed

No.	Project Title	Project Description	2025 Progress	Status
44-CEUA-CA	UTD Energy Recovery from Brewing-Distilling Operations - Phase 2 (2.21.B.2)	This project developed and validated Waste Heat Effective Transfer (WHET) energy recovery technology at brewing and distilling operations in California. WHET is planned to economically recover and reuse low-level waste heat, addressing past barriers of complexity and high costs. Researchers are exploring broader applications, such as commercial laundry, agriculture, and food processing, to improve energy efficiency across various industries. WHET systems are designed to operate efficiently at any scale where waste heat is available, and hot water is needed.	In 2025, the team completed additional field data collection and analysis from two WHET demonstrations at Sacramento-area microbreweries, showing the system recovered up to about 60% of available exhaust-gas waste heat and converted it into useful hot water. The work also expanded evaluation of broader market applications (including food processing, bakeries, laundries, and related sectors) through a techno-economic assessment that identified conditions under which WHET could achieve attractive paybacks and operate effectively at facilities of varying scale where waste heat was available and hot water demand existed. As of 2025, the final report has yet to be published by the CEC.	Completed
45-CEUA-CA	UTD Energy Source Options for Industrial and Large Commercial Gas Customers - Phase 3 (2.20.E.3)	This project develops an analytical tool to help industrial and large commercial users reduce greenhouse gas (GHG) emissions. The tool evaluates fuel-substitution options, renewable natural gas blends, and efficiency upgrades by analyzing economic and environmental impacts. It accounts for factors like energy costs, equipment expenses, full-fuel-cycle emissions, and life-cycle costs. Currently, researchers are refining and testing the tool, focusing on boilers for process and space heating, to support informed decision-making on cost-effective carbon mitigation strategies.	In 2025, GTI Energy completed the Energy Source Options (ESO) tool as a web-based resource, integrated it into GTI's Carbon Management Information Center (CMIC), incorporated hydrogen production-pathway cost and emissions inputs, and delivered outputs such as annual energy use, annual and life-cycle costs, avoided emissions, and cost of avoided emissions, with rollout supported through internal quality reviews and UTD member webinars.	Completed

No.	Project Title	Project Description	2025 Progress	Status
46-CEUA-CA	UTD Flex Fuel Gas Nozzle and Burner for Boilers (2.23.D)	This project aims to design and test a 500,000 Btu/h flex fuel nozzle prototype that can retrofit existing commercial burners. It will assess flame flexibility under simulated boiler conditions using natural gas, hydrogen-enriched gas, and other low-carbon fuels (LCFs). The nozzle allows on-the-fly adjustments to flame size and shape, optimizing performance across various applications. Preliminary designs for larger 3-5 million Btu/h nozzles and burners will also be developed.	In 2025, the team continued advancing the Flex Fuel Gas Nozzle and Burner for Boilers project (UTD 2.23.D) toward a lab-scale (500,000 Btu/h) prototype that can operate on natural gas and analog low-carbon fuels while enabling wide, on-the-fly control of flame size and shape under simulated boiler conditions. During Q4, fabrication again surfaced a key barrier: the tight-tolerance assembly and moving parts required for the original nozzle concept are not sustainable from a manufacturability standpoint, so the team pivoted to an alternative test path that preserves the core concept by adapting the control mix burner platform (UTD 2.23.C) to bring fuel into close proximity to the air nozzles. Early baseline results show this platform is promising for ultra-low emissions performance, with NOx and CO around ~4 ppm and ~5 ppm at 200 MBH and ~3% O_2, and a lowest measured NOx of <2 ppm under higher excess O_2 conditions, which compares favorably to conventional burners that often need ~9% O_2 to achieve single-digit NOx. Next steps are to complete the burner modification, initiate burner testing, and push toward data analysis and performance assessment; the team noted a time extension may be needed if fabrication challenges continue, but they have a defined path forward and intend to expedite progress.	Active

No.	Project Title	Project Description	2025 Progress	Status
47-CEUA-CA	UTD Gas Engine Heat Pump Modeling, Testing, and Implementation (1.21.E)	This project is planned to validate natural gas engine-driven heat pump (GEHP) performance for variable refrigerant flow systems across various conditions. It aimed to expand the market through enhanced energy models using measured performance data, validation of a new method of testing (ANSI/CGA) for new GEHP performance metrics, and a techno-economic assessment to determine the best use of three new GEHP equipment options. These options include air handler unit integration kits, Yanmar Hydrobox, and Aisin Hi-Power. In 2022, the project team continued to refine hourly performance curves for the Yanmar GEHP VRF system. The team integrated measured heating and cooling field data from 2021 through 2024 from two UTD GEHP demonstrations to validate Yanmar's GEHP performance curves. Researchers incorporated National Research Council Canada's laboratory and field data for an eight-ton GEHP to validate the manufacturer performance curves. The team collected additional GEHP datasets from demonstration projects with the Illinois Army National Guard (2023-2024). The research team explored different modeling approaches for EnergyPlus.	In 2025, GTI Energy completed multi-site field monitoring of 14-ton Yanmar 2- and 3-pipe GEHP VRF systems, developed improved EnergyPlus curve-fit correlations from measured performance data, and compared measured seasonal performance against ANSI Z21.40.x/CGA 2.9x ratings, finding that systems operated predominantly at very low part-load ratios and that right-sizing, fan coil-to-outdoor-unit matching, and careful integration and controls with DOAS/ERV and supplemental equipment were critical to minimizing cycling losses and improving installed efficiency (including in heat-recovery operation).	Completed

No.	Project Title	Project Description	2025 Progress	Status
48-CEUA-AI	UTD Gas Fired High Efficiency Liquid Desiccant Air Conditioning and Humidity Control - Phase 2 (1.15.E.2)	The goal of this project was to develop a gas-fired liquid desiccant dedicated outdoor air system (LDDOAS) to address many critical issues facing the HVAC industry. The research team collaborated with a manufacturer to compare the current state-of-the-art LDDOAS technology with other systems. The team designed and experimentally evaluated a breadboard LDDOAS test rig rated at approximately 100 CFM using a novel, non-corrosive, non-toxic desiccant. In Phase 1, the project team constructed an experimental gas-fired liquid-desiccant air-conditioning system. In Phase 2, the team upgraded a one-tower test rig and completed liquid desiccant distribution tests. Progress was made on continuous regeneration tests, demonstrating efficiency as high as 70% while sufficiently regenerating the desiccant. In 2021, the project team conducted rigorous testing of dew point sensors and determined that an energy imbalance detected in earlier testing was not due to instrument accuracy. It was discovered that insufficient mixing of water vapor in the air at the exit of the tower was causing an imbalance. To make certain proper mixing of the air occurred as it exited the tower, the project team constructed a reducer for the top of the tower to increase the flow of velocity and turbulence. In 2022, the team completed plans for building a second packed bed column tower to allow for simultaneous regeneration and conditioning. Construction of the second tower is currently underway. The group purchased a new digital refractometer to measure the desiccant solution's refractive index. The project team plans to begin benchtop tests of the desiccant on different material surfaces in the next reporting period. A more detailed project description can be found in the 2024-2025 UTD Annual Report.	UTD Project 1.15.E.2 (Phase 2) closed in 2025, with a final report issued April 1, 2025 (covering work through July 31, 2024). GTI Energy developed and lab-validated a liquid-desiccant dedicated outdoor air system (LDDOAS) to separate sensible and latent cooling and reduce "overcool and reheat" humidity control. The system uses a silicone-based liquid desiccant (reported as non-toxic, non-corrosive, and non-volatile) and was tested from a single packed-bed tower to a two-tower recirculating prototype under AHRI 920-style conditions. Dehumidification effectiveness was ~23–30% (two-tower average ~26%), with module COP averaging ~0.6 (peaks near ~0.8), varying by inlet humidity and desiccant strength. Using the lab performance map, EnergyPlus simulations across 12 U.S. cities and multiple commercial building types showed the strongest benefits in hot-humid climates; in New York State, modeled averages indicated ~41% electric demand reduction, ~44% GHG reduction with gas regeneration (up to ~79% with renewable/waste-heat regeneration), ~43–63% operating cost savings, and paybacks generally under five years for several building types.	Completed

No.	Project Title	Project Description	2025 Progress	Status
49-CEUA-CFS	UTD Gas Fired Warewasher - Phase 2 (1.19.B.2)	The project's objective was to develop a gas-fired prototype of a conveyor-type warewasher (dishwasher). Door-type (low-volume) and conveyor-type (high-volume) warewashers represent a combined 43% of the market segment of warewashers. Most commercial warewashers are electric, and many use chemicals rather than high temperatures to disinfect, further increasing their environmental impact. Initial estimates indicate that a site will only use one-third of the source of energy with a gas warewasher compared to alternative technologies. In this project, researchers and a manufacturing partner modified current electric warewashers, modeling different heat exchanger designs to determine the best-performing configurations that fit into the footprint of an existing electric warewasher. Various prototype heat exchangers were fabricated and put into a prototype unit along with a burner and blower. The team tested a functional prototype for combustion efficiency, safety, and emission standards. Researchers modeled thirteen variations of heat exchanger designs and examined the combustion system in the laboratory with the prototype tank and heat exchanger. The project team used custom controls to tune everything, and the group achieved highly favorable results (under 10ppm NOx). Technicians assembled the burner, blower, and gas valve assembly, along with a new controller for the combustion system. The project group completed the initial testing of the combustion system with the prototype heat exchanger. A follow-on project could be to apply the design to additional models or to prove its performance and reliability in a field test.	During Q3 2025 (Phase 2), GTI Energy installed baseline monitoring instrumentation at all three field locations and began collecting baseline performance data for existing conveyor warewashers ahead of retrofits. Two school demonstration sites (South Carolina and Utah) were confirmed under signed field test agreements, with plans to install new gas-fired heat-recovery warewashers and gas booster heaters around late 2025/early 2026 (coordinated with school breaks) to quantify energy and water savings and support utility efficiency program adoption; the schedule is expected to require an additional time extension to allow at least six months of post-install monitoring.	Active

No.	Project Title	Project Description	2025 Progress	Status
50-CEUA-CFS	UTD Gas Fired Warewasher Door Machine Demonstration - Phase 3 (1.19.B.3)	The project objective is to develop and demonstrate a gas-fired prototype door-type warewasher (dishwasher). Door-type (low-volume) and conveyor-type (high-volume) warewashers represent a combined 43% of the market segment of warewashers. Most commercial warewashers are electric, and many use chemicals rather than high temperatures to disinfect, further increasing their environmental impact. Initial estimates indicate that a site will only use one-third of the source of energy with a gas warewasher compared to alternative technologies. In this project, researchers and a manufacturing partner modified current electric warewashers, modeling different heat exchanger designs to determine the best-performing configurations that fit into the footprint of an existing electric warewasher. In 2022, the project team tested a control system for the door-type warewasher burner system that controls ignition for the burner, firing rate, and safety controls. Upon completion of the controller testing, the final prototype system will be sent to the manufacturing partner for further testing. The manufacturer will test one prototype in its facilities and one in the research laboratory to prove the machine's performance. Initial discussions regarding the field demonstration of the gas-fired door warewashers have begun. Research on the conveyor warewasher is currently focusing on heat-exchanger modeling and design.	During Q3 2025 (Phase 3), GTI Energy advanced the refocused conveyor-warewasher demonstration by completing the field test plan, ordering and installing baseline monitoring instrumentation at all three locations, and initiating baseline data collection. Two school field sites (South Carolina and Utah) were secured under signed agreements, and the team began planning installation of the new gas-fired heat-recovery conveyor warewashers and gas booster heaters for late 2025/early 2026 to quantify energy and water savings and support utility efficiency program adoption; an additional time extension is expected to allow at least six months of post-install monitoring.	Active

No.	Project Title	Project Description	2025 Progress	Status
51-CEUA-IPH	UTD Gas Quality Sensor Validation Hydrogen Sensor - Phase 3 (2.14.O.3)	This project will broaden the Gas Quality Sensor (GQS) capability to measure gas composition, heating value, Wobbe number, and methane number for natural gases blended with hydrogen. Indicators that the team sees suggest that GQS accuracy will improve when they add a hydrogen detector. The team will add a hydrogen detector to the previously developed GQS and conduct calibration tests in the project's third phase. Phase three will provide data allowing the extension of the GQS capabilities beyond natural gases to hydrocarbon fuel gas mixtures containing hydrogen. The team will give the generated data to the licensee CMR Group, and combining it with their data, will help to accelerate GQS deployment with hydrogen detection capability. The team will conduct testing in the GTI Energy Industrial Combustion Laboratory's Optical lab space. The lab has the needed blending station, mixing system, computer, and data acquisition system. When CMR is ready to ship the GQS unit for testing, GTI Energy engineers will acquire needed calibration gases and set up instrumentation and data collection computers.	During the April–June 2025 reporting period, the team's planned laboratory validation work for the gas quality sensor (GQS) with an add-on hydrogen detector could not proceed because commercialization partner CMR was unable to provide an augmented unit for testing. GTI maintained regular communications with CMR while the final report was prepared and moved into internal review, with no project charges incurred this quarter due to the lack of test hardware. This project was in a disallowed subprogram but was allowed to continue per AL-6273G. Project is awaiting receipt of final deliverable.	Active

No.	Project Title	Project Description	2025 Progress	Status
52-CEUA-CA	UTD Gas-Fired Binary Fluid Ejector Heat Pump Water Heater (1.20.E)	This project aims to model, design, and build prototypes of a gas-fired ejector heat pump water heater (GFEHP). The overall objective is to develop and demonstrate GFEHP technology at 12,000 Btu/hr (3.5 kW) capacity in the laboratory and to achieve a coefficient of performance of 2.0. This first-of-a-kind heat pump uses a novel cycle that combines a binary-fluid ejector and sorption subsystem into one high-efficiency process. The technology integrates several components that are thermally and hydraulically coupled. This new approach will make the unit twice as efficient as the current state-of-the-art technology on a primary energy basis. This method will help retain a high-efficiency role for natural gas for more than 80 million residential users of gas-fired water heaters in the U.S. alone. In 2022, the research team completed the initial design of an integrated burner and evaporator design and is currently working on fabricating the assembly. The project team will test it in-house and then ship it to the University of Missouri for integration with the alpha prototype.	During Q1 2025, GTI Energy completed construction and shakedown testing of the High-Temperature Evaporator (HTE) that uses a combustion system to generate high-pressure refrigerant vapor, confirming stable combustion, functioning flame supervision/limit switches, and the ability to achieve superheat. Testing with distilled water showed the unit could generate superheated steam while maintaining flue gas temperatures above 200°F, normal CO emissions (<100 ppm AF), and approximately 79% efficiency, and the HTE was scheduled for delivery and integration into the alpha prototype at the University of Missouri in late April 2025.	Active

No.	Project Title	Project Description	2025 Progress	Status
53-CEUA-CA	UTD Hydrogen Blending End-Use Performance and Safety Field Demonstration (1.22.A)	This project intends to demonstrate blended hydrogen gas safety, technical, and performance implications from an end-user perspective in a simulated neighborhood. The project aims to 1) measure the end-user performance and safety impacts of a wide array of fuel-fired equipment (e.g., HVAC, water heating, cooking), 2) quantify the efficacy of in-field retrofits and mitigation strategies for individual appliances, and 3) estimate the decarbonization potential of hydrogen blending through population modeling. In coordination with Southwest Gas, the project team seeks to leverage their utility training facility in Henderson, NV, as a hydrogen-blended equipment demonstration and outreach platform. The project will leverage the site's existing plans to install and operate an on-site electrolyzer to blend hydrogen at a variable rate into an islanded distribution network serving the training facility. The 15 homes within the simulated neighborhood will house the experimental equipment.	During Q3 2025, the team completed final installation and commissioning activities at the Southwest Gas Henderson, NV training facility (including a September site visit), which enabled initiation of testing across all eight appliance test stands; baseline testing was completed and the first-wave appliances began operating on a 5% H_2 blend after verification of electrolyzer/blending skid output and site instrumentation, controls, and data collection readiness. Next quarter, the project will continue manual and automated testing (approximately one month per appliance), while working through remaining electrolyzer items and managing overall schedule impacts from the extended, safety-intensive commissioning process.	Active
54-CEUA-CA	UTD Hydrogen Flame Visibility and Colorants (1.23.J)	This project addresses the safety risk of hydrogen flames, which can be nearly invisible under certain lighting conditions. It aims to evaluate and identify colorants for hydrogen-enriched gaseous fuels, testing hydrogen/methane mixtures (0% to 100% hydrogen) for flame visibility under four common lighting conditions.	In 2025, GTI Energy and Yale confirmed that pure hydrogen flames were difficult to see under typical indoor lighting, identified primary visible emission features (including a blue continuum, red emissions from excited water species, and orange sodium fluorescence), and found that adding roughly 15 vol% methane could more than double visible intensity, while higher hydrocarbons (butane and toluene) increased yellow tipping with potential incomplete-combustion concerns.	Completed

No.	Project Title	Project Description	2025 Progress	Status
55-CEUA-CA	UTD Impacts of Hydrogen-Blended Gas on Venting, Condensation, and Weatherized Equipment (1.23.H)	The project evaluates the effects of hydrogen blending, at levels up to 30% or higher on the compliance of gas appliances with the National Fuel Gas Code (NFPA 54) and global standards like ASHRAE guidelines. It focuses on aspects such as flue gas venting, condensate management, and weatherized equipment. The project will create new vent tables for hydrogen-blended gases and publish the findings in a technical paper or final report.	In 2025, GTI Energy applied an analytical approach based on the legacy VENT/VENT-II methodology using a simplified "Simple-VENT" model to assess Category I venting impacts, including draft behavior and condensation risk. Results indicated that blends up to 20% H_2 by volume had minimal impact on heat loss, pressure drop, and condensation performance and therefore did not justify changes to NFPA 54 venting tables at that blend level, while noting that marginal condensation risk could increase in already-challenging configurations such as oversized vents or orphaned water heaters; the work concluded with recommendations for standards engagement and modernization of VENT-II as a web-based tool to support future code-development needs.	Completed

No.	Project Title	Project Description	2025 Progress	Status
56-CEUA-CA	UTD Inherently Safe ResCom Combustion Systems for Hydrogen-Blended Gases (1.23.I)	This project aims to develop safe combustion systems for common gas appliances and identify affordable retrofit options for existing appliances using hydrogen-blended gas (5-50% by volume). It seeks to enable gas utilities to demonstrate and deploy higher hydrogen blending levels, aligning with industry goals to reduce greenhouse gas emissions through renewable fuels. Multiple pilots are underway, exploring hydrogen compatibility with conventional appliances. Challenges include ignition instability with blended gas, which can lead to unsafe CO emissions, overheating, and performance issues.	In 2025, GTI Energy kicked off the subcontract with Convergent Science and held a project kickoff meeting to initiate the computational fluid dynamics (CFD) simulations supporting inherently safe burner concepts for hydrogen-blended gas applications. In parallel, the team continued literature and background review on burner design parameters to mitigate flashback and improve stability and began preparing initial designs for numerical assessment in the next quarter; budget and schedule remained on track with no scope changes reported.	Active

No.	Project Title	Project Description	2025 Progress	Status
57-CEUA-CA	UTD Ionic Liquid Absorption Heat Pump for Commercial Water Heating (1.21.I)	This project aimed to design and demonstrated in a lab environment an "alpha" working prototype of a low-cost, ultra-high efficiency gas-fired commercial heat pump water heater with a novel semi-open absorption cycle (SOA-GHPWH) in partnership with the University of Florida and leading OEMs. The system also used a mild ionic liquid, providing integrated latent cooling to maximize efficiency. The target efficiency is COPgas, HW≥1.60 if only providing hot water, or COPtotal>1.80 if the system also offers indoor cooling and dehumidification. The prototype was performance-tested at loads (steady and dynamic) typical of commercial buildings with 100 gallons of storage and nominal heating output at 145 kBtu/hr. The system used a simple plastic pump; most construction materials are polymers. In 2021, the project team continued to refine the product definition and consider codes and standards implications, and controls specification options. In addition to defining the concept for the target application, the effort leveraged a parallel commercial HVAC effort using a hospital application to consider deep dehumidification applications (defined as a different sensible and latent air-conditioning version) and a compressor-less HVAC version. In 2022, the research team completed the fabrication of the desorber and is prepared to apply instrumentation and complete the test rig assembly for testing. Researchers continue to hold frequent design meetings to discuss product-definition challenges and designs for the desorber and condenser, including results from modeling and analysis and desorber system and component testing.	Completed in 2025, UTD Project 1.21.I advanced a novel semi-open absorption, ionic-liquid gas-fired heat pump water heater concept for commercial applications by completing the core "alpha" module design, validating key subsystems, and establishing the lab infrastructure needed for full-system performance mapping. The team demonstrated (via calibrated component testing plus system modeling) a viable path to the targeted heating performance (up to ~1.60 gas COP for the double-effect heating case), with experimental results showing combined COP as high as 2.55 at ~52 °C delivery water under hot/humid conditions (and ~1.93 at ~82 °C), confirming feasibility for hot water-intensive end uses. Major 2025 closeout deliverables included validated hot-side desorber/condenser assembly performance, fabricated absorber modules with improved manifolding, and a commissioned full-scale 1000 CFM test system and test plan; ultra-low-NOx-compatible combustion performance was also demonstrated at the component level. While full integrated prototype assembly and end-to-end cycling tests were ultimately constrained by custom-fabrication/DOE project timing impacts, the project concluded with proof-of-concept performance evidence, commercialization engagement, and a clear next-step pathway to scale-up and field testing.	Completed

No.	Project Title	Project Description	2025 Progress	Status
58-CEUA-CA	UTD Low Emission Efficient Burner for Ovens and Dryers - Phase 3 (2.20.A.3)	This project focuses on developing and refining a new burner with ultra-low emissions (9 ppm NOx and < 50 ppm CO). It leverages 3D printing to produce the entire burner assembly in a single step, reducing labor and tooling costs while enabling complex internal geometries unattainable with conventional methods. The innovation eliminates the need for brazing separate nozzles. Phase 3 will involve installing a commercial prototype in the factory of a major burner manufacturer.	During Q3 2025 (Phase 3), GTI Energy continued coordination with the host site on test planning and burner integration for the 3 MMBtu/h low-emissions, 3D-printed, UTD-patented oven/dryer burner field demonstration, while also engaging two OEMs and working to identify an alternate host site better aligned with the application. A no-cost time extension was submitted to address schedule delays, and next quarter's work will remain focused on finalizing next steps with the host site.	Active

No.	Project Title	Project Description	2025 Progress	Status
59-CEUA-CA	UTD Mitigating Methane Emissions from ResCom End Use Equipment - Phase 3 (1.18.F.3)	This project quantified methane emissions from at least six key residential appliances that have yet to be tested in past phases of the project. The goal was to 1) develop and publish representative methane emission factors, 2) determine the conditions under which these appliances release unburned methane, and 3) identify potential mitigation options. At least six residential appliances, including cooking ranges and tank water heaters, were tested under specific operating conditions and representative use patterns, including steady-state, standby, and cyclic operation. In 2021, under Phase 2, researchers prepared the testing area and instrumentation for testing furnaces. The team conducted several shakedown tests to address issues with methane analyzers, instrumentation, control programs, and data acquisition. The team completed testing of the first furnace (two-stage 80% AFUE), and they tested the remaining furnaces in early 2022 under Phase 3. The other furnaces included a single stage and two modulating condensing units. The team collected total hydrocarbon emissions data for both steady-state and part-load tests to generate a full picture of the emission profile for typical furnace operations. The team has started data analysis for the Final Report since the experimental phase is completed for Phase 2. The team will quantify the methane emissions profiles for the four furnaces at various part-load conditions to generate emission factors. Differences in emissions will be correlated to operational differences to understand how the team can mitigate emissions in equipment design and operation.	In 2025, the team completed testing on the remaining furnaces (including a single-stage unit and two modulating condensing units) and conducted controlled laboratory measurements to quantify methane emissions from residential storage tank water heaters and a cooking range, enabling annualized emission factors; results showed very low methane emissions for the storage water heaters tested (on the order of 10^{-3} kg CH_4 per unit annually) while the cooking range exhibited materially higher methane emissions than prior literature, reinforcing the need to expand sampling across range/oven designs, brands, and vintages and to correlate emissions differences to operational characteristics to guide mitigation in equipment design and operation.	Completed

No.	Project Title	Project Description	2025 Progress	Status
60-CEUA-CFS	UTD Next Generation Commercial and Residential Range Top Burner (1.23.N)	This project addressed the impact of cooking emissions on residential indoor air quality, with a focus on pollutants from natural gas and propane combustion. It sought to commercialize advanced burner designs to improve efficiency and reduce NOx emissions. The project's goal was to develop prototypes for residential and commercial ranges that achieved a 20% improvement in energy efficiency and a 75% reduction in NOx emissions. This effort was co-funded by the Propane Education and Research Council (PERC) and built on previous research.	In 2025, GTI Energy built a cooktop-burner performance dataset by laboratory testing eight OEM burners and three commercially available ranges on natural gas and 5%/30% hydrogen blends, measuring NOx/CO and cooking efficiency using a standardized water-boiling method. Results showed most conventional "blue flame" burners operated at ~30–40% efficiency with NOx typically ~60–100 ppm (@3% O_2), while radiant burner technology demonstrated a pathway to ultra-low NOx (<20 ppm) but highlighted CO/optimization tradeoffs, and hydrogen blending up to 30% by volume generally did not materially affect operability or overall performance across the tested designs; the effort was co-funded by PERC and built on prior research.	Completed

No.	Project Title	Project Description	2025 Progress	Status
61-CEUA-IPH	UTD Next Generation Infrared Burner - Phase 4 (2.16.A.4)	This project aimed to test and optimize the performance of a new gas-fired infrared (IR) burner that UTD had been developing under previous project efforts (2.16.A), in partnership with Solaronics, Inc.—a leading gas-fired IR heater OEM—and a top metal-foam material OEM. The project sought to enable operation on high hydrogen-blended natural gas, conduct tests with up to 100% hydrogen, and optimize the burner design to achieve fast start-up, a uniform temperature profile, and ultra-low emissions (i.e., <5 ppm NOx and <30 ppm CO). Key performance indicators included demonstrating stable operation with up to 100% hydrogen, providing comparative analyses of temperature, heat flux, stability, emissions, and turndown capability, and achieving fast start-up, uniform temperature and ultra-low emissions. In 2022, the team performed heat-flux measurements under multiple operating conditions and compared the results with the performance of traditional IR burners. Researchers also reviewed data from the host site, which appeared promising.	In 2025, GTI Energy delivered the final report which described the establishing and safety reviewing of a laboratory test rig. GTI Energy evaluated Solaronics infrared burner on natural gas and NG/H_2 blends (10–60% H_2) across multiple excess-air conditions, demonstrating stable operation up to 60% H_2 with materially improved emissions at ≥20–30% H_2 (including NOx <5 ppm under several conditions and generally lower CO with increasing H_2) while maintaining similar temperatures (within roughly 5–10% of natural gas operation); earlier heat-flux comparisons and host-site data reviews also supported the technical promise of the approach. This project was in a disallowed subprogram but was allowed to continue per AL-6273G. Project is awaiting receipt of final deliverable.	Completed

No.	Project Title	Project Description	2025 Progress	Status
62-CEUA-RA	UTD Next Generation Residential Gas Dryer Development - Phase 3 (1.15.C.3)	The goal of this project was to identify a technology capable of achieving a 5–15% efficiency advantage over standard gas dryers. Researchers investigated next-generation gas dryer technologies to exceed ENERGY STAR efficiency levels and developed an early-stage prototype with promising performance. Phase 1 focused on assembling a test station within an environmental chamber to control temperature and humidity and promote accurate testing conditions. In Phase 2, researchers investigated additional heat-recovery options, modulation techniques, indirect-fired methods, direct venting, and alternative burner designs. Testing at four firing rates consistently showed approximately a 2% efficiency improvement at lower firing rates. The dryer was insulated and sealed to evaluate potential gains from reduced air leakage and to enable heat-recovery implementation. After several design iterations, technicians achieved a 5–6% improvement in in insulation and sealing efficiency and a 6% reduction in drying time. This insulation and sealing improvements also enabled the implementation of an innovative heat-recovery design. Any proprietary technologies identified during the project were to result in a UTD invention of disclosure. In 2022, under Phase 3, the team built an environmental chamber to support a subsequent round of product development and testing. At the time of reporting, researchers were awaiting completion and availability of a new test chamber to finalize testing.	In 2025, GTI Energy provided a final report which described building and validating a new environmental chamber and advanced an integrated high-efficiency gas-dryer prototype that combined improved insulation/air sealing with an internal energy-recovery ventilator (ERV) and burner-rate modulation, with the best-performing configuration (30,000-15,000 Btu/hr modulation with the integrated ERV) achieving approximately a 14–15% Combined Energy Factor improvement and a 6–7% drying-time reduction versus baseline. This project was fully funded prior to being disallowed per G-3601. Project is awaiting receipt of final deliverable.	Completed

No.	Project Title	Project Description	2025 Progress	Status
63-CEUA-RA	UTD Residential Gas Absorption Heat Pump Water Heater - Phase 5 (1.11.H.5)	This project builds upon a gas-fired heat pump water heater (GHPWH) developed and supported in conjunction with UTD Project 1.11.H, scaling up the same absorption heat pump technology by an eight-fold factor. The objective of this project is to support the development of next generation GHPWH by eliminating a major cost hurdle for some installations and enhancing reliability and efficiency diagnostics. One effort was to reduce the installation cost/barrier of condensate drain by developing a proprietary method of neutralizing, collecting, and disposing of combustion condensate where access to a sanitary sewer drain is otherwise cost-prohibitive and improving the onboard diagnostics by exploring the use of Enhanced Solution Level Control (ESLC) which can improve system reliability and long-term performance. Using the experience of 12 demonstrations of Phase 1 to 4 GHPWH precommercial prototypes, GTI and SMTI have identified typical conditions and root causes of poor efficiency and/or product failure. The project team is finalizing preparations for installation of GAHP hybrid equipment in the laboratory, with thermal heat pump test station upgrades. Researchers are analyzing the results of testing to make recommendations on system design modifications, sizing considerations, and controls updates.	In 2025, GTI Energy provided a final report which described validating the de-condensator's technical feasibility (and secured IP via U.S. Patent 11,353,238) while ESLC work established bench-scale proof-of-concept direction but identified reliable ultrasonic level sensing through stainless steel as a remaining challenge. This project was fully funded prior to being disallowed per G-3601. Project is awaiting receipt of final deliverable.	Completed

No.	Project Title	Project Description	2025 Progress	Status
64-CEUA-RA	UTD Residential Gas Absorption Heat Pump Water Heater - Phase 6 (1.11.H.6)	This project was based upon a gas-fired heat pump water heater (GHP-WH) developed and supported in conjunction with UTD Project 1.11.H. This project aims to scale up the same absorption heat pump technology by a factor of eight. The objective is to support the development of the next-generation GHP-WH by eliminating a major cost hurdle for some installations, along with enhancing reliability and efficient diagnostics. One effort is to reduce the installation barrier and cost of a condensate drain by developing a proprietary method of neutralizing, collecting, and disposing of combustion condensate. This aspect benefits users where access to a sanitary sewer drain is otherwise cost-prohibitive. Also, the team can leverage Enhanced Solution Level Control (ESLC) to improve the on-board diagnostics, which can enhance system reliability and long-term performance. Using the experience of 12 pre-commercial GHPWH prototypes tested in demonstrations conducted in Phases 1 to 4, GTI Energy and Stone Mountain Technologies, Inc. (SMTI) identified typical conditions, root causes of poor efficiency, and product failures. Technical tasks under Phases 5 and 6 improved the final design and fabrication of test setups to evaluate the proof of concept of the liquid level sensor (LLS) platform and the de-condensation idea. For Phase 6, the team completed an agreement with SMTI to produce a next-generation alpha prototype GHPWH. SMTI delivered the updated unit in the fourth quarter of 2022. Researchers concluded the Phase 6 test plans and fabricated prototypes of additional features.	During Q2 2025 (Phase 6), GTI Energy completed reporting on Phase 5 highlights (including promising proof-of-concept results for a non-intrusive, retrofittable liquid-level sensor approach using off-the-shelf electronics, with further optimization still needed before integration into an operating absorption cycle). For Phase 6, SMTI requested additional time because the updated GHPWH prototype still had not demonstrated pre-shipment performance (targeting UEF > 1.15) and was being modified to address issues tied to the EEV/controller and HP cycle-to-tank integration, pushing expected delivery to GTI to Q3 2025 so testing and controls development could proceed. This project was fully funded prior to being disallowed per G-3601. Project is awaiting receipt of final deliverable.	Active

No.	Project Title	Project Description	2025 Progress	Status
65-CEUA-IPH	UTD Ribbon Burner Performance with Hydrogen-Blended Gases (2.22.B)	This project aims to evaluate traditional ribbon burners' performance when operating with hydrogen and hydrogen-natural gas blends (i.e., 0-100%). The goal is to prove technical feasibility and identify optimal design performance and design gaps. Some key performance indicators include heat release-temperature profile-emission data in the range of tested conditions and the correlation between hydrogen content in the fuel and test burner performance. The data and correlations obtained will serve as a basis for developing innovative decarbonization concepts that will integrate green hydrogen production, advanced waste heat, and water recovery combined with VOC mitigation and self-powered control.	In 2025, GTI Energy delivered a final report which described completion of a controlled laboratory evaluation of a conventional Flynn ribbon burner operating on natural gas through 95% hydrogen blends across a broad firing-rate range, generating performance, flame stability, and emissions correlations relevant to industrial baking applications. Results showed hydrogen-rich operation was generally feasible with appropriate re-optimization, delivering average NOx reductions of roughly 60–70% and CO_2 reductions of about 50%, but also revealing CO increases and stability considerations at certain high-hydrogen/low-load conditions that indicated the need for improved air-fuel control and burner-geometry refinements to support future decarbonization concepts. This project was in a disallowed subprogram but was allowed to continue per AL-6273G. Project is awaiting receipt of final deliverable.	Completed

No.	Project Title	Project Description	2025 Progress	Status
66-CEUA-CA	UTD Sequestering Non-Condensable Gases for Enhanced GHP Reliability - Phase 2 (1.19.E.2)	The goal of this project is to design and develop non-condensable gas isolation modules and provide research and development support to employ novel, low-cost aluminum heat exchangers to increase long-term system efficiency, reliability, safe operation, and reduced cost of any absorption-type heat pump. It is important to minimize the impact of non-condensable gases on long-duration performance and reliability to successfully advance the use of high-efficiency gas absorption heat pumps (GAHP). The project team plans to demonstrate the technology's performance in a prototype GAHP. Phase 1 of this project is complete, and the team is preparing the final report. For Phase 2, the project team will finalize approaches toward novel corrosion inhibitor methods for non-condensable gas management. The project team is reviewing options for the initial procurement of samples for testing, fulfilling an 18-point test matrix in the test vessels.	In 2025, GTI Energy provided a final report which described completion of a detailed reliability assessment of corrosion-driven non-condensable gas (hydrogen) formation in ammonia-water GAHP loops using literature review and OLI Studio modeling to define corrosion-risk trends and target pH windows, and it developed a conceptual Non-Condensable Gas Isolation (NCGI) module design (membrane-based H separation with hydride storage) alongside corrosion-mitigation pathways (water chemistry, coatings, and “green” inhibitors). Planned high-temperature ammonia testing, sample procurement against the test matrix, and prototype validation were deferred due to pressure-vessel integrity and lab safety/ventilation readiness constraints, and the team documented a test-readiness roadmap for a follow-on phase.	Completed

No.	Project Title	Project Description	2025 Progress	Status
67-CEUA-CA	UTD Thermoelectric Generator for Self-Powered Water Heater - Phase 4 (1.17.B.4)	This project aimed to develop a self-powered, gas-fired tankless water heater to save ratepayers money and energy while enhancing resiliency. In Phase 4, the team designed, built, and tested a working alpha prototype. Phase 4 built upon hardware testing conducted in earlier stages to develop critical components and integrate the overall design to power a condensing tankless water heater. Three different approaches for integrating the thermoelectric generator with a storage-type water heater were analyzed. As the research progressed, the team also sought opportunities to leverage UTD funding with potential prime funding from governmental agencies interested in supporting research on resilient, high-efficiency water heating technologies.	In 2025, GTI Energy designed, fabricated, and integrated a thermoelectric generator (TEG) assembly into a tankless water heater and evaluated multiple TEG configurations and integration approaches (including concepts informed by storage-type water-heater integration) to inform an alpha-prototype pathway. Testing showed the integrated multi-TEG "drop-in" approach did not yet produce sufficient electrical output to sustain tankless operation due to the short premixed flame, limited access to high-temperature zones, and high parasitic loads, while a more direct, stripped-down TEG placement over the burner generated higher power and identified a promising direction for a more intrusive next-design iteration and follow-on manufacturer engagement and potential co-funding opportunities.	Completed

No.	Project Title	Project Description	2025 Progress	Status
68-CEUA-CA	UTD Zero Emission Processes with Carbon Recovery - Phase 2 (2.21.C.2)	This project advanced Synthetic Air Combustion (SAC), an oxygen-fired process that reduced fuel demand and emissions while improving the efficiency of industrial boilers or furnaces using natural gas. The project sought to lower CO_2 emissions and enable integration of CO_2 capture or conversion into valuable products. Phase 1 included laboratory testing that compared SAC with traditional combustion approaches. Phase 2 focused on refining process layouts, mass and energy balances, and CO_2 capture integration to prepare for large-scale funding proposals and continued technology development.	In 2025, GTI Energy delivered a final report which described completion of a refined process layouts and mass/energy balances and performed techno-economic analysis of SAC and related variants (including SEAC) to support scale-up proposals and continued development. Modeling indicated potential natural gas and CO_2 reductions of roughly 8–15% (with higher potential depending on exhaust conditions) while eliminating NOx by removing nitrogen from the oxidant stream, and it identified SEAC paired with bi-reforming as the most attractive pathway for converting CO_2 into CO/H_2 syngas with improved economics. This project was fully funded prior to being disallowed per G-3601. Project will be closed out upon receipt of final deliverable.	Completed

No.	Project Title	Project Description	2025 Progress	Status
69-CEUA-CA	UTD Hydrogen-Blended Gas in ResCom Combustion Equipment - Phase 2 (1.20.H.2)	The objective of this project was to determine the decarbonization potential of typical commercial food service (CFS) appliances when utilities blend up to 30% hydrogen with natural gas. Phase 2 focused on full appliance testing and cooking performance impacts and building on the testing of standalone burners and controls in Phase 1. GTI, through its contacts at the North American Foodservice Equipment Manufacturers, worked with CFS manufacturers to identify and supply appliances for testing. Water heaters and a non-condensing furnace experienced slight efficiency decline, whereas the condensing two-stage furnace showed improvement, increasing its efficiency from 88% to 92.4%. When efficiency dropped, the expected greenhouse gas reduction potential decreased from 12% to 10%. The use of hydrogen blends significantly lowered NOx emissions in an ultra-low NOx furnace, reducing them from 44.2 ppm to 17.3 ppm. Other appliances showed only minor changes in emissions. Performance remained generally consistent, but hydrogen blends led to reduced firing and heating rates. Water heater efficiency showed a slight decline, with the Uniform Energy Factor decreasing from 0.62 to 0.60 and from 0.67 to 0.65. Findings suggest that adjustments to burner assemblies and primary air intake may be necessary to prevent efficiency losses when using hydrogen blends. Future studies should explore automated modifications or factory-level adjustments to optimize appliance performance before distribution.	In 2025, GTI Energy completed Phase 2 and issued a final report on how up to a 30% hydrogen / 70% methane blend affects common residential and commercial appliances. Testing showed generally modest but important performance changes. The non-condensing ultra-low NOx furnace and both storage water heaters saw small efficiency declines, which reduced practical CO_2 abatement from an ideal roughly 12% to about 10%, or about 9% for the power-vent water heater. By contrast, the condensing two-stage furnace improved in several test conditions, suggesting some higher-efficiency equipment may realize greater decarbonization benefit from hydrogen blends. Emissions impacts varied by appliance, but the most notable result was a major NOx reduction in the ultra-low NOx non-condensing furnace, falling about 61% at the 30% blend. The report also found that lower heating value in the blend caused appliances to derate and use significantly more gas volume, and concluded that reducing efficiency losses may require burner, orifice, and air-mix adjustments, potentially through future hydrogen-blend-ready appliance designs.	Completed

No.	Project Title	Project Description	2025 Progress	Status
27-CT-OS	GTI Energy Advanced On-board Hydrogen Storage Technology Assessment	The goal of this project was for GTI Energy to identify state-of-the-art on-board hydrogen storage technologies for transportation. Current vehicle hydrogen storage consists of high-pressure gaseous hydrogen, which requires a high volume to achieve the required runtimes. GTI Energy conducted a market assessment of advanced onboard storage technologies. This market assessment identified the most promising state-of-the-art technologies to potentially be further evaluated in the future. These technologies are important for advancing fuel-cell electric vehicles because fuel storage systems are typically the largest individual cost component. Developing these technologies could yield the following benefits: increased volumetric energy density, reduced storage of vessel costs, and lower weight, resulting in increased payload and improved vehicle fuel efficiency (fueling economy).	This project was fully funded prior to being disallowed per G-3601. A final report was issued by GTI Energy and SoCalGas RD&D provided comments. Finalization and publication of the final report are still pending. Because this project falls under a terminated program, we will no longer be dedicating resources to continued tracking or reporting of progress beyond the end of 2025.	Completed
31-CT-RS	GTI Energy H2 at Scale Hydrogen Refueling Demonstration	The H2@Scale project had two unique research, development, and demonstration tracks to better understand the potential of integrating hydrogen with multiple platforms throughout the economy. First, the project included the demonstration of numerous hydrogen generation and end-use applications co-located at the University of Texas, Austin. Demonstrated technologies include 100% renewable hydrogen generation (electrolysis and steam methane reformation of RNG), a 100kW fuel cell powering a data center, and hydrogen dispensers for fuel cell electric vehicles and drone refueling. In the second track, the project leveraged the experience from the demonstration portion to develop a framework for additional H2@Scale pilot opportunities.	This project was fully funded prior to being disallowed per G-3601. A final project meeting is scheduled for January 2026, and the final report is still pending. Because this project falls under a terminated program, we will no longer be dedicating resources to continued tracking or reporting of progress beyond the end of 2025.	Completed

No.	Project Title	Project Description	2025 Progress	Status
36-CT-OR	SCAQMD and WVU Alternative Fuel Vehicle Maintenance Study	This project aimed to study maintenance-related efforts and costs of medium- and heavy-duty vehicle engines powered by various alternative fuels across multiple vocations. The alternative fuels considered in this study were natural gas, propane, electric, and high biodiesel blends. This maintenance cost assessment sought to incorporate the link between the operational characteristics of alternative fuel vehicles and how they affect maintenance and repair activity. The team also planned to perform a comparative evaluation of vehicle maintenance costs between natural gas and diesel-fueled vehicles. Vehicles included in the planned analysis were Class 6, 7, and 8, which the industry often uses in goods movement and delivery vocations. The project team used vehicle maintenance costs of available fleet information, real-world vehicle activity, and in-use emissions data from another study upon which this project was built on. The team further leveraged emissions and activity data previously collected and pre-established relationships from previous research.	Project was canceled due to project team disbanding and being unable to complete the final deliverable. SoCalGas RD&D is working with SCAQMD to process a refund for any unspent funds by WVU. This project was in a disallowed subprogram but was allowed to continue per AL-6273G.	Completed

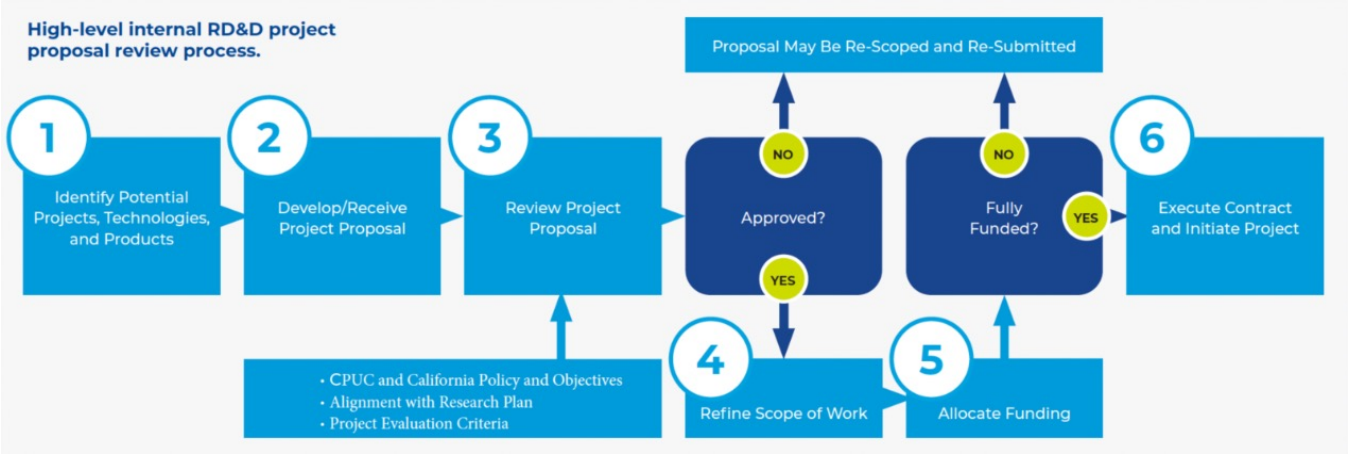
No.	Project Title	Project Description	2025 Progress	Status
38-CT-OR	SCAQMD Hydrogen Blended Natural Gas in NZE Engine Emissions Study	This research project assessed the criteria of pollutant and greenhouse gas impacts of hydrogen-natural gas fuel blends on near-zero NOx emission heavy-duty natural gas engines. Past studies have shown that adding hydrogen to natural gas may reduce engine emissions when combined with optimized engine calibration. The University of California Riverside's Center for Environmental Research and Technology designed and built a hydrogen-compressed natural gas (H-CNG) blending apparatus as part of the study and evaluated hydrogen blends from zero to five percent by volume. The study's first phase focused on the impacts of H-CNG blends on emissions compared to the baseline on regulated engine test duty cycles. CWI provided the test engine, after-treatment systems, engineering, data analysis support, and oil sample analysis. A 2005 comprehensive study by the National Renewable Energy Laboratory showed that an H-CNG-fueled engine reduced NOx emissions by 50 percent compared with a CNG-fueled engine in a transit bus application. Recent low-carbon and renewable fuel initiatives have renewed interest in further decarbonization of natural gas, providing a source of lower carbon content fuel for the transportation sector.	UCR completed all testing and provided a final report to the project sponsors. Results showed higher tailpipe NOx emissions for the 5% blend. However, the tailpipe emission factors for all blends were very near zero. The engine-out NOx emission factors showed a trend where the 1% and 3% blends were generally lower than the baseline and 5% fuel blends, with the 5% blend close to the baseline. Overall, the findings suggest that low hydrogen blends can provide a strong pathway for tailpipe emissions reductions from heavy-duty vehicles in the South Coast Air Basin. More research work is necessary to better control NOx emissions with hydrogen addition by recalibrating existing engines and also better control particulates with the use of particulate filters. This project was in a disallowed subprogram but was allowed to continue per AL-6273G.	Completed

No.	Project Title	Project Description	2025 Progress	Status
40-CT-OR	UC Riverside Hydrogen Blended Natural Gas Engine Durability Test	This project aimed at evaluating the impact of hydrogen content in natural gas on the performance and durability of one end-use technology, 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 based on typical natural gas composition. Since the limit is part of the Cummins specification, using natural gas with a hydrogen content greater than 0.03% could void the engine's warranty. The University of California, Riverside research team, planned to operate the motor on hydrogen blended natural gas for 500 to 1,000 hours, simulating normal heavy-duty truck and transit duty cycles. After completing 500 to 1,000 hours of testing, the research team planned to disassemble the engine to identify and analyze impacts on the components, fluids, and performance. The research was expected to provide data to justify the initiation of extensive validation work to increase the hydrogen limit for near-zero-emission of natural gas engines. Increasing the hydrogen limit in CNG engines will help reduce CO2 emissions.	Testing was completed in 2025; however the final report is still pending. This project was in a disallowed subprogram but was allowed to continue per AL-6273G. However, because this project falls under a terminated program, we will no longer be dedicating resources to continued tracking or reporting of progress beyond the end of 2025.	Completed
42-CT-OR	US Hybrid CNG Plug-In Hybrid Electric Truck Demonstration	The objective of this project was to develop and demonstrate an advanced Plug-In Hybrid Electric Truck (PHET) powertrain with an existing Cummins Westport Inc (CWI) L9N Near-Zero Emission (NZE) Compressed Natural Gas (CNG) engine on a Freightliner Cascadia sleeper-cab truck in a parallel hybrid configuration. The truck was optimized for over 1,000 miles of total range—including 35 miles of all-electric range—along with more than 600 horsepower to accommodate trucks that require more torque and power. The electric motor, coupled with the L9N CNG engine, targeted exceeding the performance of existing 13-liter diesel engines while reducing carbon dioxide and NOx emissions. The truck was demonstrated in real-world conditions and received positive reviews from the host fleet operator.	The project was closed out prior to the receipt of the final report due to significant delays in receiving the report and the fact that this project falls under a terminated program. Because this project falls under a terminated program, we will no longer be dedicating resources to continued tracking or reporting of progress beyond the end of 2025.	Completed

No.	Project Title	Project Description	2025 Progress	Status
89-CT-RS	Frontier Energy MC Formula Protocol for H35HF Fueling Demonstration	This project validated a high-flow (HF) hydrogen fueling method developed for medium-duty (MD) and heavy-duty (HD) vehicles with large fuel storage systems of a nominal working pressure of 35 MPa. In recent years, the hydrogen market started expanding from light-duty to MD & HD vehicles. To help enable and drive adoption of MD/HD fueling stations and vehicles, the team developed a new fueling protocol (SAE J2601-5). The team experimentally proved the reliability of the fueling method with a 35 MPa HF dispenser and vehicle storage tank that are equivalent to commercially available dispensers and vehicle storage tanks. First, this study implemented the hydrogen fueling method in the 35 MPa HF dispenser. When hydrogen is sourced from the dispenser at rates complying with the fueling method, the vehicle storage tank temperature and pressure are monitored if those two parameters stay below their upper limits (43.75 MPa and 85 °C) set by the fueling method.	Based on the results, this study assesses that the fueling method is well structured to safely and quickly fill MD/HD vehicles. The team presented their results at the 2024 DOE Annual Merit Review and published the final report in 2025. This project was fully funded prior to being disallowed per G-3601. Project was closed out upon receipt of final deliverable, and can be found on the NREL website: https://docs.nrel.gov/docs/fy25osti/95350.pdf	Completed

Appendix 3: Project Selection Criteria

When identifying promising projects and evaluating them for potential funding, RD&D staff take a comprehensive yet flexible approach that enables them to 1) identify potential projects most in alignment with CPUC policies and objectives, RD&D Department goals, state and federal policy 2) initiate projects that have a reasonable probability of providing benefits to ratepayers; 3) assess the likelihood of potential projects to succeed; 4) work with proven organizations and technologies over time; and 5) respond nimbly to changing market, technology, and policy drivers. In addition — remembering that some technologies will not result in concrete ratepayer benefits until commercialized and implemented at scale — RD&D staff consider the overall development, implementation process, and research life cycle of a given technology or product. In response to new stakeholder input, changing market conditions, new legislation or policy drivers, or significant advances in technology, RD&D staff may also choose to fund projects that are in alignment with overall program goals and objectives but do not fall exactly within the potential research areas listed in the Research Plan. Although individual teams within RD&D have distinct research interests, goals, and industry relationships, all follow a similar approach to project identification and selection:



Appendix 4: Research Consortia

SoCalGas RD&D staff have forged strategic alliances with several research consortia focused on the gas energy industry. The membership of many of these organizations consists of utility companies across North America. Typically, these consortia serve member utilities by facilitating technical collaboration and pooling financial and technical resources to collectively address ongoing or anticipated challenges in the natural gas industry. By working closely with these and other similar organizations, RD&D staff can share knowledge and pool funding with other utilities and researchers to develop and execute impactful projects. Coordination of work among these organizations and access to technical libraries greatly reduce the odds of reproducing previously completed work or work currently underway.

The majority of the SoCalGas RD&D costs associated with consortia is directly allocated to collaborative research and development projects that are either initiated by or specifically selected for funding by SoCalGas. These projects leverage significant funding from other consortia members, thus reducing the cost burden of research on ratepayers. Participation in the research consortia facilitates collaboration and knowledge sharing among subject matter experts from other natural gas system operators, industry RD&D programs, academia, national laboratories, and other research organizations.

Research consortia generally provide members the opportunity to learn about and discuss emerging operational issues and needs within the industry, both nationally and internationally. One example is sharing knowledge about pipeline incidents, their causes, or insights on interactive threats about which SoCalGas may not otherwise have been aware (as they may have very low probability of occurrence but a high consequence). Consortia memberships also provide access to well-maintained libraries of relevant information to gas system operations. In addition, participation in consortia enhances SoCalGas' awareness of other research efforts, enabling SoCalGas RD&D staff to leverage these findings and identify unique research gaps. This approach maximizes ratepayer dollars by focusing on more pressing and unaddressed issues.

The ratepayer value of such collaboration includes:

- Providing subject matter experts a forum for knowledge sharing and gaining operational insights regarding differences in pipeline system materials and equipment, operating environments, operational experiences, procedures, and practices;
- Operational knowledge that may only apply to a small subset of system assets or operational conditions; Knowledge sharing of pipeline incidents, causes, or insights on interactive threats with very low probability of occurrence but high consequence;
- Knowledge sharing between large and small system operators that can provide a positive effect on the performance of the overall natural gas supply chain;
- Knowledge of emerging areas of research or technologies that could be utilized by SoCalGas to support operational efficiency, pipeline safety, system reliability, and environmental improvement.

The following are areas where consortia bring expertise that increases the chance of industry adoption of research that could lead to more tangible ratepayer benefits:

- For a technology or tool to evolve from the early stage and advance to commercialization within Technology Readiness Levels (TRL), it must withstand various operational challenges and impacts that often do not appear until later stages of product development or in early customer adoption trials. With R&D consortia, more companies are involved in piloting the technology or service in pre-commercial demonstrations or testing in a wider range of commercial and operational conditions than individual operators can typically achieve.

- R&D consortia are better positioned to identify and develop potential commercial partners who may need encouragement to take the business risk with innovations developed from consortium projects. Also, consortia provide prospective manufacturers or service providers more market potential because of the larger number of customers that they represent throughout the country, continent, or globe.
- R&D consortia can provide commercial partners with insight into broader industry needs to set market expectations and input on metrics for success.
- R&D consortia can provide more expedient commercialization and implementation of technologies available for the natural gas industry.
- R&D consortia can have experience and visibility with government agencies especially with their research funding opportunities and solicitations.

SoCalGas RD&D is a member of three subscription-based organizations: Northeast Gas Association (NGA)/ NYSEARCH, Operations Technology Development (OTD), and Pipeline Research Council International (PRCI).

Northeast Gas Association (NGA)/NYSEARCH

NYSEARCH manages one of the premier natural gas RD&D programs in North America. NYSEARCH is a collaborative RD&D organization dedicated to serving its 19 gas utility member companies and project funding partners. NYSEARCH members voluntarily participate in projects and programs to target RD&D areas that address their unique challenges and opportunities. For more than 20 years, NYSEARCH has worked as a consortium of natural gas local distribution companies (LDCs) that have common interests and needs, such as continually improving the operation, safety, efficiency, maintenance, and upgrade of gas delivery systems.

Today, as part of NGA, NYSEARCH manages numerous projects in various stages of development. NYSEARCH has grown steadily in recent years because of its success in delivering high-value RD&D projects. The organization is unique in its ability to help member companies and partners leverage RD&D investments while targeting their participation to projects that best meet their individual needs. The core of the NYSEARCH model is joint collaboration and guidance from participating members. These members participate in a variety of RD&D projects, organized under the following categories:

- Improved installation
- Maintenance and repair
- Pipeline integrity/direct and remote assessment
- Pipe location and damage prevention
- Leak detection, real-time sensing, and inspection for distribution
- Environment/reducing greenhouse gas emissions
- Gas quality
- Evaluation of new materials
- Advanced polyethylene piping and joining
- Oracle (emerging technologies from other industries)

Total 2025 Projects

6

Initiated

0

Completed

0

Annual Dues

$85,000

2025 Dues Paid

$85,000

Total RD&D Funding

$773,131

Total Consortium Funding

$6,581,325

Operations Technology Development

OTD is a member-controlled partnership of 33 natural gas distribution companies formed to develop, test, and implement new technologies. The objective of OTD is to address a wide range of technology issues relating to gas operations and its infrastructure. Its projects are designed to:

- Enhance system safety
- Improve operating efficiencies
- Reduce operating costs
- Maintain system reliability and integrity

Since 2003, OTD's collaboration of industry leaders, scientists, technicians, and manufacturers has been charting a course to address integrity issues and other concerns by identifying industry needs and providing focused R&D responses that benefit the natural gas industry and its customers.

By working collaboratively, participating companies leverage funds so that no single company is responsible for carrying the entire financial burden. In addition, participants benefit from input from numerous sources, address common regulatory issues, and demonstrate the broad industry support needed to gain the interest of potential product manufacturers.

Total 2025 Projects

18

Initiated

0

Completed

11

Annual Dues

$750,000

2025 Dues Paid

$0

Total RD&D Funding

$1,400,886

Total Consortium Funding

$7,843,727

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. Since 1952, PRCI has been recognized around the world as a unique forum within the energy pipeline industry delivering great value to its members and the industry—both quantitative and qualitative—through the development and deployment of research solutions to improve pipeline safety and performance. PRCI's mission is to collaboratively deliver relevant and innovative applied research to continually improve the global energy pipeline systems.

PRCI is dedicated to ensuring the maximum efficiency of research, development, and deployment through a highly leveraged funding model of member and external funding, information sharing, cooperative research development, and the broad dissemination and application of its results. Along with funding, the strength of the collaborative model stems from the contributions to PRCI of member technical and operations experts and the ongoing support to them from PRCI and its companies. It is this collaboration in the direction, implementation, and adoption of research that defines PRCI's value to its members and the industry.

PRCI's Value Proposition is to use the leverage generated by its members' resource contributions to create a research forum of ideas and results, producing solutions that ensure the safe, reliable, environmentally sound, and cost-effective pipeline transportation of energy to consumers worldwide.

Total 2025 Projects
21

Initiated
0

Completed
11

Annual Dues
$167,537

2025 Dues Paid
$0

Total RD&D Funding
$1,778,647

Total Consortium Funding
$34,598,481

Message funded by ratepayers