Company: Southern California Gas Company (U 904 G)
Proceeding: 2024 General Rate Case
Application: A.22-05-015
Exhibit: SCG-12-R

REVISED

PREPARED DIRECT TESTIMONY

OF ARMANDO INFANZON

(CLEAN ENERGY INNOVATIONS (CEI))

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

August 2022

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SUMMARY

Clean Energy Innovations (In 2021 $, in 000s)			
	2021 Adjusted-Recorded	**TY2024 Estimated**	**Change**
Total Non-Shared Services	28,461	47,223	18,762
Total Shared Services (Incurred)	0	0	0
Total O&M	**28,461**	**47,223**	**18,762**

Summary of Requests

Southern California Gas Company (SoCalGas or Company) is requesting $47.223 million for Test Year (TY) 2024 Operations and Maintenance (O&M) costs associated with Clean Energy Innovations (CEI), an increase of $18.762 million over Base Year (BY) 2021 levels. In sum, CEI's O&M costs cover a variety of workstreams aiming to promote and innovate transformational clean energy products and technologies, including:

- Implementation of SoCalGas's sustainability strategy to advance California's climate goals and align with the United Nations' Sustainable Development Goals;
- Development of Clean fuels infrastructure, which accelerates the transition to clean energy and supports SoCalGas's sustainability strategy in alignment with the State's climate objectives;
- Creation of the Clean Energy Innovations Project Management Office (PMO) to support the expected growth in clean energy-related projects and tasks, including project governance and implementation to facilitate continued project portfolio alignment with CEI's goals; and
- Research Development & Demonstration (RD&D) Program and related activities that advance and champion technologies and that support widespread access to clean, affordable, and reliable energy for all Californians, including those living and working in environmental and social justice (ESJ) communities.[1,2]

Additional details regarding CEI's O&M requests, including forecast methodology and cost drivers, are discussed below in this testimony.

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[1] SoCalGas, "Research, Development, and Demonstration Program 2020 Annual Report," June 2021, available at: https://www.socalgas.com/sites/default/files/2021-06/2020-SoCalGas-RDD-Annual-Report.pdf.

[2] CPUC, "Environmental and Social Justice Action Plan, Version 2.0," April 7, 2022, available at: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/news-and-outreach/documents/news-office/key-issues/esj/esj-action-plan-v2jw.pdf.

REVISED PREPARED DIRECT TESTIMONY OF ARMANDO INFANZON (CLEAN ENERGY INNOVATIONS (CEI))

I. INTRODUCTION

A. Summary of Clean Energy Innovations (CEI) Costs and Activities

My testimony supports the Test Year 2024 forecasts for O&M costs for non-shared services, associated with the four following groups: (1) Sustainability, (2) Clean Fuels Infrastructure Development, (3) Clean Energy Innovations Project Management Office (PMO), and (4) Research Development and Demonstration (RD&D) Program. My testimony also identifies activities associated with capital expenditures for the [H2] Hydrogen Home Project and Hydrogen Refueling Stations related to CEI project development. The capital expenditure forecasts for these projects are referenced in other SoCalGas testimonies, including witness Brenton Guy's Real Estate and Facility Operations testimony (Ex. SCG-19) and witness Michael Franco's SoCalGas Fleet Services testimony (Ex. SCG-18).

As discussed in detail below, CEI supports the development and implementation of innovative technologies that support California's climate policy goals, including the continued use and increased adoption of clean fuels,[3] such as renewable natural gas, hydrogen, and synthetic natural gas, as well as carbon management in support of the State's carbon neutrality goals.[4] Development of clean energy solutions helps customers to adopt low carbon products and services and supports a variety of statewide clean policy commitments,[5] as discussed in detail by witness Naim Jonathan Peress in his Sustainability and Climate Policy testimony (Ex.

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[3] "Clean fuels" in this testimony are gases such as clean hydrogen (H_2), renewable natural gas (also referred to as biogas and RNG), synthetic natural gas (also referred to as syngas and SNG), and biofuels, the production and combustion of which can be carbon-neutral or even carbon negative. (*See* , SoCalGas, "Role of Clean Fuels Summary," October 2021, available at: https://www.socalgas.com/sites/default/files/2021-10/Role_Clean_Fuels_Summary.pdf, at p.1.)

[4] State of California, Executive Department, EO B-55-18 "Achieve Carbon Neutrality," available at: https://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf.

[5] Reducing GHG emissions to 40% below 1990 levels by 2030 (Senate Bill (SB) 32, California Global Warming Solutions Act of 2006), to 80% below 1990 levels by 2050 (State of California, Executive Department, Executive Order (EO) S-03-05); 100% carbon-free electricity by 2045 (SB 100, The 100 Percent Clean Energy Act of 2018); attaining carbon neutrality by 2045 (EO B-55-18), and reducing emissions of short-lived climate pollutants, such as methane, and reducing organic waste disposal by 75% by 2025 (SB 1383).

SCG-02, Chapter 1). CEI also provides support to enhance clean energy system and operational readiness and assists with system resiliency.

Table AI-1 below summarizes my sponsored costs for CEI's groups: Sustainability, Clean Fuels Infrastructure Development, CEI PMO, and RD&D. Additional details regarding these costs, including forecast methodology and support, are discussed in Section IV below.

Table AI-1
Test Year 2024 Summary of Total Costs[6]

Clean Energy Innovations (In 2021 $, in 000s)			
Categories of Management	**2021 Adjusted-Recorded**	**TY2024 Estimated**	**Change**
Sustainability	1,930	1,982	52
Clean Fuels Infrastructure Development	8,195	20,400	12,205
Clean Energy Innovations Project Management Office	297	1,592	1,295
Research Development and Demonstration	18,039	23,249	5,210
Total Non-Shared Services	**28,461**	**47,223**	**18,762**

B. Support To and From Other Witnesses

In addition to sponsoring CEI's costs, my testimony also references the testimony and workpapers of several other witnesses, either in support of their testimony or as cross-referential support for this testimony. Other testimony includes: Naim Jonathan Peress and Michelle Sim's SoCalGas Sustainability and Climate Policy testimony (Ex. SCG-02: Chapter 1 (Climate) and Chapter 2 (Sustainability)); R. Scott Pearson and Gregory S. Flores' RAMP to GRC Integration testimony (Ex. SCG/SDG&E-03, Chapter 2); Maria T. Martinez's SoCalGas Gas Engineering testimony (Ex. SCG-07); Daniel J. Rendler's SoCalGas Customer Services – Field and Advanced Meter Operations testimony (Ex. SCG-14); Brian C. Prusnek's SoCalGas Customer Services – Information testimony (Ex. SCG-16); Michael Franco's SoCalGas Fleet Services testimony (Ex. SCG-18); Brenton Guy's SoCalGas Real Estate and Facility Operations (Ex. SCG-19); and Rae Marie Yu's Regulatory Accounts (Ex. SCG-38).

[6] As described in the Angeles Link Application, costs associated with the Angeles Link application are excluded from the request in this GRC.

C. Organization of Testimony

My testimony focuses primarily on non-shared service costs addressing key activities for the four following areas: (1) Sustainability, (2) Clean Fuels Infrastructure Development, (3) Clean Energy Innovations Project Management Office, and (4) RD&D.

My testimony is organized as follows:

- Introduction
- Risk Assessment and Mitigation Phase Integration
- Sustainability And Safety Culture
- Non-Shared Costs
    - Sustainability
    - Clean Fuels Infrastructure Development
        - Business Development
        - Clean Fuels Power Generation
        - Carbon Capture, Utilization and Sequestration (CCUS) Front End Engineering Design (FEED) Study Program
        - Clean Fuels Operational Readiness Program
        - Clean Fuels Transportation Program
    - Clean Energy Innovations Project Management Office (PMO)
    - Research Development & Demonstration (RD&D) Refundable Program
- Capital
    - [H2] Hydrogen Home
    - H2 Refueling Stations
- Conclusions
    - Witness Qualifications

D. Organization Overview

As part of SoCalGas's sustainability strategy and in support of California's goal to deliver increasing amounts of renewable energy and support economy-wide decarbonization, SoCalGas aims to accelerate the energy transition by increasing the delivery of clean fuels, adapting its system for hydrogen, and supporting customer decarbonization.[7] CEI supports a

[7] Michelle Sim's Sustainability testimony (Ex. SCG-02, Chapter 2).

comprehensive portfolio of clean energy solutions that enhances SoCalGas's role as a long-term leader in California's clean energy future. As mentioned above, the groups discussed in this testimony are Sustainability, Clean Fuels Infrastructure Development, CEI PMO, and RD&D. To more clearly present this testimony, a brief overview of these areas is discussed here, with further details provided in Section IV below.

The forecasts in this testimony have been structured to address the costs related to specific functions and programs in the four aforementioned groups under the CEI umbrella. For example, the Clean Fuels Infrastructure Development group supports specific business functions and programs. These functions support a diverse portfolio of activities, whereas these programs support a specific set of activities to meet specific goals for the Company. All activities within CEI support the State's climate policy goals and sustainability plan, as noted in Naim Jonathan Peress and Michelle Sim's Sustainability and Climate Policy testimonies (Ex. SCG-02, Chapters 1 and 2).[8]

E. Sustainability

The Sustainability group is responsible for planning, developing, and tracking near and long-term environmental, social, and governance (ESG) business strategies, with a focus on implementing sustainable business practices to optimize operational activities, while serving customers safely, reliably, and affordably. It works across business units within the Company to facilitate ongoing discussions, workshops, and cross-functional collaboration, in its efforts to implement various sustainability-related initiatives and goals.

The group also monitors and assesses the rapidly changing ESG market, priorities, and requirements, and engages with external stakeholders including community advisory councils, customers, business partners, and ESG community members. The group tracks, monitors, and reports on sustainability goals and Key Performance Indicator (KPI) metrics. Specific projects and tasks performed by Sustainability that drive its costs include:

[8] As stated in Michelle Sim's Sustainability testimony (Ex. SCG-02, Chapter 2, at p. 35), "as part of SoCalGas's sustainability strategy and in support of California's goal to deliver increasing amounts of renewable energy and support economy-wide decarbonization, SoCalGas aims to accelerate the energy transition by increasing the delivery of clean fuels, adapting its system for hydrogen, and supporting customer decarbonization."

1. Coordination and execution of ASPIRE 2045[9] sustainability strategy goals through development of procedures, controls, internal communications, governance, and coordination across business units;
2. Continuous assessment and development of sustainable business practices that create near-term emissions reduction benefits and help to meet long-term climate objectives while creating opportunity and equity for employees, customers, and communities;
3. Continuous development and implementation of tools to track progress of sustainability strategies and KPIs for transparency and accountability; and
4. Continuous engagement with external stakeholders and ESG communities to shape sustainability strategies to develop science, policy, and best management practices.

Additional details regarding cost drivers and the funding request for Sustainability are discussed in Section IV.A., below.

1. Clean Fuels Infrastructure Development

The Clean Fuels Infrastructure Development group includes two functions: Business Development and Clean Fuels Power Generation as well as the three following programs: CCUS FEED Study Program, Clean Fuels Operational Readiness Program, and Clean Fuels Transportation Program. Details for each of these functions and programs are described below.

a. Business Development Function

The Business Development function supports development and deployment of cost-effective and environmentally sustainable clean energy solutions, including clean fuels and carbon management, to serve SoCalGas's customers. This function's activities include identifying, analyzing, selecting, and prioritizing clean energy and decarbonization initiatives and projects (including outside of RD&D) to advance the Company's sustainability goals. Business Development plays a vital role in the creation of a strategic long-term planning framework for the clean fuels infrastructure network that can provide customers with increasing amounts of clean energy, as well as developing carbon management solutions, to facilitate the

[9] SoCalGas, "ASPIRE 2045 Climate Commitment," available at: https://www.socalgas.com/sites/default/files/2022-01/SoCalGas_Sustainability_Strategy-final.pdf.

decarbonization of California's energy systems. With active engagement in the State's energy initiatives and working with multiple agencies – including the California Public Utilities Commission (CPUC), California Energy Commission (CEC), California Air Resources Board (CARB), and the California Independent System Operator (CAISO), municipal agencies, universities, national laboratories, and national and international partnership/associations – the Business Development function works with key industry stakeholders in the clean energy sector to initiate and/or collaborate on projects to advance the development of hydrogen, RNG, syngas (SNG), biofuels, and carbon management solutions across multiple end-use applications. The Business Development function also includes RNG infrastructure development activities to facilitate the development and utilization of biogas resources to support the State's policy goals for the growth of renewable gas resources. The function also conducts market research and engages in financial and business analytics activities to collect and analyze information on external clean energy trends, support the long-term capital planning process, and develop and maintain analytical and collaboration tools.

b. Clean Fuels Power Generation Function

This function is responsible for facilitating the adoption of clean fuel power generation resources in alignment with the State's environmental goals[10] and SoCalGas's ASPIRE 2045 and other clean fuels analysis.[11] The team works with various business units and evaluates project feasibility by bringing together operational, permitting, regulatory, financing, and other requirements to create a set of foundational practices that support clean fuels power generation projects. This function provides support to various business units (both customer-facing and operational) within the Company. The Clean Fuels Power Generation's additional activities include clean fuels market transformation (through active collaboration with different areas in the Company, including the RD&D program), development of education and communication

[10] Reducing GHG emissions to 40% below 1990 levels by 2030 (SB 32) and to 80% below 1990 levels by 2050 (EO S-03-05); 100% carbon-free electricity by 2045 (SB 100); attaining carbon neutrality by 2045 (EO B-55-18); reducing emissions of short-lived climate pollutants, such as methane, and reducing organic waste disposal by 75% by 2025 (SB 1383).

[11] SoCalGas, "The Role of Clean Fuels and Gas Infrastructure in Achieving California's Net Zero Climate Goal," October 2021, available at: https://www.socalgas.com/sites/default/files/2021-10/SCG_Whitepaper_Full-Report.pdf.

materials specific to clean fuel power generation technologies (with respect to tariffs, gas rates, safety considerations, regulatory and technical requirements), and policy support with regards to regulatory, legislative, local, and other policies that may impact clean fuel power generation technologies.

c. CCUS Feed Study Program

The CCUS FEED Study Program will work on activities to develop a CO2 pipeline to support the development of carbon management solutions in Southern California. The CCUS FEED Study Program will address scope, design, and technical specifications, and identify related environmental attributes so that all aspects of the project evaluation undergo a "due diligence" process to help finalize the project scope, technical specifications, and the project's capital investment estimates.

d. Clean Fuels Operational Readiness Program

The Clean Fuels Operational Readiness Program activities will include assessment of the current infrastructure, processes and standards for operational readiness, and identifying gaps in technological, material, operational, safety, workforce, and training standards, with the purpose of achieving safe, effective, and efficient adoption of clean fuels infrastructure into our operations to deliver clean fuels and help California achieve its carbon neutrality goal.

e. Clean Fuels Transportation Program

The Clean Fuels Transportation Program provides information, education, and training regarding Clean Transportation to a variety of stakeholders, including owners of hydrogen fuel cell vehicles (FCVs) and renewable natural gas vehicles (RNGVs), operators of hydrogen and RNGV refueling stations, vehicle and equipment manufacturers, government agencies, policymakers, and others. In response to customer demand, SoCalGas facilitates market adoption of hydrogen and renewable natural gas as transportation fuels in support of California's climate neutrality goals.[12]

Additional details regarding cost drivers and funding requests for Clean Fuels Infrastructure Development are discussed in section IV.B, below.

[12] State of California, Executive Department, EO B-55-18 "Achieve Carbon Neutrality," available at: https://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf.

2. Clean Energy Innovations Project Management Office

The PMO works to establish uniform project management and reporting standards across CEI's project portfolio. The team is responsible for developing and implementing project controls including scope, schedule, financials, risk analysis, and change management with the goal of mitigating risks and increasing the likelihood of project success. Specific activities performed by the PMO that drive costs include development and implementation of: (1) project governance standards for scope, schedule, and cost management; (2) tools for project monitoring and portfolio reporting; and (3) the management of project initiatives. The PMO also implements project management methodologies to align with SoCalGas's clean energy vision, strategy, and goals.[13,14] Additional details regarding cost drivers and funding request for the PMO are in section IV.C.

3. Research Development & Demonstration Refundable Program

SoCalGas's RD&D Program is a refundable program that plays a key role in the research, development, and demonstration of transformational products and technologies that promote decarbonization across the energy delivery value chain and a diversified portfolio of clean energy sources, distributed networks, tools, and applications.[15] The RD&D activities "offer reasonable probability of providing benefit to ratepayers," and support one or more RD&D objectives, including to "improve operating efficiency and reliability and otherwise reduce operating costs."[16]

The RD&D Program collaborates with customers, businesses, manufacturers, academic researchers, and other stakeholders to identify and test potential projects or technologies that will save energy and reduce carbon emissions. The four program areas of focus within the RD&D Program are: Clean & Renewable Energy Resources, Gas Operations, Clean Transportation, and

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[13] SoCalGas, "The Role of Clean Fuels and Gas Infrastructure in Achieving California's Net Zero Climate Goal," October 2021, https://www.socalgas.com/sites/default/files/2021-10/SCG_Whitepaper_Full-Report.pdf.

[14] SoCalGas, "ASPIRE 2045 Climate Commitment," January 2022, available at: https://www.socalgas.com/sites/default/files/2022-01/SoCalGas_Sustainability_Strategy-final.pdf.

[15] SoCalGas, "Research, Development, and Demonstration Program 2020 Annual Report," available at: https://www.socalgas.com/sites/default/files/2021-06/2020-SoCalGas-RDD-Annual-Report.pdf.

[16] Pub. Util. Code § 740.1(e)(5).

Clean Energy Applications. Additional details regarding cost drivers and funding request for RD&D Program are addressed in section IV.D, below.

II. RISK ASSESSMENT MITIGATION PHASE INTEGRATION

Certain costs supported in my testimony are driven by activities described in SoCalGas and SDG&E's respective 2021 Risk Assessment Mitigation Phase (RAMP) Reports (the RAMP Report).[17] The RAMP Reports presented assessments of the key safety risks for SoCalGas and proposed plans for mitigating those risks. As discussed in R. Scott Pearson and Gregory S. Flores' RAMP to GRC Integration testimony (Ex. SCG-03/SDG&E-03, Chapter 2), the costs of risk mitigation projects and programs were translated from the RAMP Report into the individual witness areas.

In the course of preparing the CEI GRC forecasts, SoCalGas continued to evaluate the scope, schedule, resource requirements, and synergies of RAMP-related projects and programs. Therefore, the final presentation of RAMP costs may differ from the ranges shown in the RAMP Report. TABLE AI-2 below provides a summary of the RAMP-related costs supported in my testimony.

TABLE AI-2
Summary of RAMP O&M Costs*

Report Cross-Functional Factor (CFF) Chapter	BY 2021 Embedded Costs (in 000s)	TY 2024 Estimated Total (in 000s)	TY 2024 Estimated Incremental (in 000s)
SCG-CFF-2 Energy Resilience	$0	$9,155	$9,155
Sub-Total			
Total RAMP O&M Costs	**$0**	**$9,155**	**$9,155**

* CFF-related information, in accordance with the March 30, 2022, Assigned Commissioner Ruling in A.21-05-011/-014 (cons.), is provided in R. Scott Pearson and Gregory S. Flores' RAMP to GRC Integration testimony (Ex. SCG-03/SDG&E-03, Chapter 2).

[17] Application (A.) 21-05-011/-014 (cons.) (RAMP Proceeding). Please refer to R. Scott Pearson and Gregory S. Flores' RAMP to GRC Integration testimony (Ex. SCG-03/SDG&E-03, Chapter 2) for more details regarding the 2021 RAMP Reports.

F. RAMP Cross-Functional Factor Overview

As summarized in Table AI-3 below, my testimony includes costs to help evaluate cross-functional factors (CFFs) included in the 2021 RAMP Report.[18] The applicable CFF is further described in below:

Table AI-3
RAMP CFF Chapter Description

SoCalGas (SCG-CFF-2) – Energy System Resilience [19]	This chapter addresses the energy resilience spanning multiple lines of business within SoCalGas and helps to mitigate several RAMP risks including transition to clean fuels.

The testimony of RAMP-to-GRC Integration witnesses Gregory Flores and Scott Pearson[20] describe all the risks and factors included in the RAMP report and the processes utilized for RAMP-to-GRC integration. While developing the GRC forecasts, SoCalGas evaluated the scope, schedule, resource requirements, and synergies of RAMP-related projects and programs to determine costs already covered in the base year and those that are incremental increases expected in the test year. Messrs. Pearson and Flores' testimony discuss all of the risks and CFFs included in the 2021 RAMP Reports and the RAMP to GRC integration process.[21]

G. GRC CFF Activities

Table AI-4 below summarizes the TY 2024 forecast by workpaper associated with the RAMP activities. For additional details, please refer to my workpaper (SCG-12-WP, 2RD000.001).

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[18] Unless otherwise indicated, references to the 2021 RAMP Report refer to SoCalGas's respective RAMP Report.

[19] SoCalGas, "Risk Assessment and Mitigation Phase Cross-Function Factor (SCG-CFF-2) Energy System Resilience," May 2021, available at: https://www.socalgas.com/sites/default/files/SCG-CFF-2_RAMP-Cross-Functional-Chapter-Climate_Change_62.pdf; R. Scott Pearson and Gregory S. Flores' RAMP to GRC Integration testimony (Ex. SCG-03/SDG&E-03, Chapter 2).

[20] R. Scott Pearson and Gregory S. Flores' RAMP to GRC Integration testimony (Ex. SCG-03/SDG&E-03, Chapter 2).

[21] Id.

Table AI-4
Summary of Safety Related Risk Mitigation Costs by Workpaper
(In 2021 $, in 000s)

Workpaper	RAMP ID	Activity	2021 Embedded-Recorded	TY 2024 Estimated	Change	GRC RSE*
2RD000.001	SCG-CFF-2 Energy Resilience	Carbon Capture, Utilization and Sequestration Front End Engineering Design (FEED) Study Program		6,655		
2RD000.001	SCG-CFF-2 Energy Resilience	Clean Fuels Operational Readiness Program		2,500		
		Sub-Total		**9,155**		

* No RSE was calculated for this activity.

The activities, forecast method, and cost drivers associated with RAMP-related expenses shown in Table AI-4 above are identified in the Clean Fuels Infrastructure Development section of this testimony under CCUS FEED Study Program (see Section IV.B.2, below) and Clean Fuels Operational Readiness Program (see Section IV.B.3, below).

H. Changes from RAMP Report

As discussed in more detail in R. Scott Pearson and Gregory S. Flores' RAMP to GRC Integration testimony (Ex. SCG-03/SDG&E-03, Chapter 2), in the RAMP Proceeding, the Commission's Safety Policy Division (SPD) and intervenors provided feedback on the RAMP Report. Appendix B in Ex. SCG-03/SDG&E-03, Chapter 2 provides a complete list of the feedback and recommendations received and the Company's responses.

Changes from the 2021 RAMP Report presented in my testimony, including updates to forecasts and the amount and timing of planned work, extend to the CCUS FEED Study Program and the Clean Fuels Operational Readiness Program as activities associated with the SCG-CFF-2 Energy Resilience Cross-Functional Chapter.

III. SUSTAINABILITY AND SAFETY CULTURE

Sustainability at SoCalGas focuses on continuous improvement, innovation, and partnerships to advance California's climate objectives incorporating holistic and sustainable

business practices and approaches. SoCalGas's sustainability strategy, ASPIRE 2045, integrates five key focus areas across the Company's operations to promote the public interest and the wellbeing of utility customers, employees, and other stakeholders.

The five key identified focus areas that provide a framework for integrating sustainability across the Company's business, guide investment decisions, and drive the sustainability-related proposals and programs of the SoCalGas TY 2024 GRC Application are:

a. Accelerating the transition to clean energy;

b. Protecting the climate and improving air quality;

c. Increasing clean energy access and affordability;

d. Advancing a diverse, equitable, and inclusive culture; and

e. Achieving world-class safety.

Each of these five focus areas are discussed in detail in Michelle Sim and Naim Jonathan Peress's Sustainability and Climate Change Policy testimony (Ex. SCG-02, Chapters 1 and 2).

CEI supports the Company's sustainability strategies. For example, the activities described in this CEI testimony support the advancement of the State's climate goals and align with SoCalGas's sustainability priorities. Specifically, CEI's proposal aims to drive progress in accelerating the transition to clean energy, protecting the climate, and improving air quality in our communities by increasing access to affordable and clean energy.[22] CEI is uniquely positioned to accelerate the energy transition by increasing the delivery of clean fuels such as renewable natural gas and hydrogen. CEI also supports the development of CCUS and SNG and support customer decarbonization through a portfolio of energy technology innovation and infrastructure.[23]

CEI also participates in supporting important sustainability initiatives, including some of the groundwork for developing what would be the largest green hydrogen energy infrastructure system in the United States (the "Angeles Link") to deliver clean and reliable renewable energy

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[22] *See* Michelle Sim and Naim Jonathan Peress's Sustainability and Climate Change Policy testimony (Ex. SCG-02, Chapters 1 and 2) for additional detail on SoCalGas's Sustainability Strategy.

[23] "The Role of Clean Fuels and Gas Infrastructure in Achieving California's Net Zero Climate Goal," SoCalGas, October 2021, https://www.socalgas.com/sites/default/files/2021-10/SCG_Whitepaper_Full-Report.pdf, p.75.

to the Los Angeles region.[24] As currently envisioned, Angeles Link would support the integration of more renewable electricity resources like solar and wind and could significantly reduce greenhouse gas emissions from electric generation, industrial processes, heavy-duty trucks, and other hard-to-electrify sectors of the Southern California economy. The proposed Angeles Link could also significantly decrease demand for natural gas, diesel, and other fossil fuels in the LA Basin, helping accelerate California's and the region's climate and clean air goals.[25]

CEI's clean fuels and carbon management activities are also integral to the State reaching its clean electricity and carbon neutrality goals.[26] Specifically, CEI functions support many activities to decarbonize hard-to-electrify sectors of the economy like heavy-duty transportation and industrial activities, as well as supporting the reliability of the electric grid by providing flexible and dispatchable power and developing comprehensive carbon management infrastructure.

In addition, safety is foundational to SoCalGas and SoCalGas's sustainability strategy. As the nation's largest gas distribution utility, with over 7,800 employees serving 22 million customers, safety is foundational to our business. SoCalGas's safety culture includes: (1) standardizing policies and procedures; (2) complying with applicable laws, regulations, and internal policies; (3) building and operating a system that supports the safe and reliable delivery of gas; (4) communicating with stakeholders; and (5) using data and data analysis to help make informed decisions. CEI engages in the safety culture by supporting clean energy policies and technologies that help reduce the environmental impacts, improve safety of the existing and new clean fuels infrastructure, and contribute to the carbon neutrality 2045 climate goals of the

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[24] As described and explained in the Angeles Link Project Memorandum Account Application (A.22-02-007), certain costs related to that Application and work included therein is being tracked separately and is not included in this GRC.

[25] PRNewswire, "SoCalGas Proposes to Develop United States' Largest Green Hydrogen Energy Infrastructure System to Help Decarbonize LA Basin and Accelerate California's Climate Goals," SoCalGas Newsroom, February 17, 2022, available at: https://newsroom.socalgas.com/press-release/socalgas-proposes-to-develop-united-states-largest-green-hydrogen-energy.

[26] Senate Bill 100, The 100 Percent Clean Energy Act of 2018; State of California, Executive Department, EO B-55-18 "Achieve Carbon Neutrality"; see also SoCalGas, "ASPIRE 2045, Sustainability and Climate Commitment to Net Zero," available at: https://www.socalgas.com/sites/default/files/2021-03/SoCalGas_Climate_Commitment.pdf

state.[27] In addition to the external environmental impacts, CEI also promotes safety amongst our employees and contractors. This includes safety messages in staff meetings, regular ergonomics training, building emergency planning and safety training, and participation in other Company safety programs.

IV. NON-SHARED COSTS

"Non-Shared Services" are activities that are performed by a utility solely for its own benefit. Corporate Center provides certain services to the utilities and to other subsidiaries. For purposes of this general rate case, SoCalGas treats costs for services received from Corporate Center as Non-Shared Services costs, consistent with any other outside vendor costs incurred by the utility.

A. Sustainability

Below are activities and associated O&M costs for sustainability, which are non-shared. The costs are summarized in Table AI-6 below.

Table AI-6
Sustainability Cost Summary

Sustainability (in 2021$, in 000s)			
O&M	**2021 Adjusted-Recorded**	**Estimated TY 2024**	**Change**
Labor	$994	$1,382	$388
Non-Labor	$936	$600	($336)
Total O&M	$1,930	$1,982	$52

1. Description of Costs and Underlying Activities

Sustainability is responsible for planning, developing, and tracking near and long-term environmental, social, and governance (ESG) business strategies. This function also implements sustainable business practices to optimize operational activities while serving customers safely, reliably, and affordably. It works across the Company's organizations to facilitate ongoing discussions, workshops, and cross-functional collaboration, review, implementation of sustainability-related initiatives and goals.

Sustainability also monitors and assesses rapidly changing ESG markets, priorities, and requirements, inclusive of engaging with external stakeholders like community advisory

[27] State of California, Executive Department, EO B-55-18 "Achieve Carbon Neutrality," available at: https://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf.

councils, customers, business partners, and ESG community members. With a goal to be transparent with all stakeholders, the Sustainability function also includes the review, utilization, and implementation of technologies to effectively track, monitor, and report on sustainability goals and KPI metrics.

The Company's sustainability strategy, ASPIRE 2045, is an important driver of this function, setting sustainable business priorities, goals to achieve its vision, and key performance indicators to track progress. The sustainability strategy aims to advance California's climate goals, align with the United Nations Sustainable Development Goals, and serve the public interest with increasing clean energy options safely, reliably, and affordably.[28]

2. Forecast Method

The forecast method developed for this cost category for labor and non-labor expenses is the base year method. Incremental adjustments to the base year were made to include additional expenses anticipated in TY 2024. This method is most appropriate because no historic costs exist for the sustainability group prior to its formation in January 2021. The only full year of cost data available is for calendar year 2021.

3. Cost Drivers

Sustainability's total adjusted-recorded expenditures of $1.930 million in base year (BY) 2021 consisted of $0.994 million in labor and $0.936 million in non-labor costs. Collectively, these expenditures provided a foundational-level sustainability strategy, governance framework, and sustainability tracking capabilities. The costs for this area include employee labor and expenses, software license fees, and external contractor support.[29]

For TY 2024, SoCalGas is requesting a total of $1.982 million for Sustainability. This amount reflects forecasted reduction of $0.336 million in non-labor costs because there was a one-time non-labor cost that will not be seen in the future years. In addition, during BY 2021, two full-time Program Managers were hired into the group mid-year. Since these are full-time positions, the full-year labor costs (prorated estimated expense of $0.103 million), is added to the

[28] For a more detailed discussion on the Company's sustainability strategy and initiatives see Michelle Sim's Sustainability testimony (Ex. SCG-02, Chapter 2 (Sustainability))

[29] For additional details, please refer to workpaper (SCG-12-WP, 2RD003.000).

TY 2024 labor cost totals. Finally, to support the roll-out of the sustainability strategy and expansive integration of sustainability across the Company's business units (as highlighted in the activities listed below), Sustainability will require an increase of $0.285 million to hire two Full Time Equivalent (FTEs): one Sustainability Manager and one Project Manager II/Programs Advisor. In summary, this forecast is based on the recorded expense in BY 2021 with a net incremental funding request of $0.052 million above the base year to accomplish the following activities:

1. Supporting execution and coordination of the ASPIRE 2045 sustainability strategy goals through the development of procedures, controls, internal communications, governance, and iterative coordination across business units;

2. Updating the existing sustainability strategy to incorporate the latest developments in science, policy, and best management practices, and develop additional goals and KPIs;

3. Deploying and managing sustainability performance tracking software to support progress against goals and enhance transparency and reporting on sustainability areas; and

4. Increasing sustainability communications and engagement on climate initiatives, through increased engagement with external stakeholders and ESG communities.

B. Clean Fuels Infrastructure Development

Activities and associated O&M costs for Clean Fuels Infrastructure Development, which are non-shared, are set forth below. The costs are summarized in Table AI-7 below.

Table AI-7
Clean Fuels Infrastructure Development

Clean Fuels Infrastructure Development (in 2021$, in 000s)			
O&M	**2021 Adjusted-Recorded**	**Estimated TY 2024**	**Change**
Labor	$3,975	$4,832	$857
Non-Labor	$4,220	$15,568	$11,348
Total O&M	$8,195	$20,400	$12,205

Clean Energy Infrastructure Development total adjusted-recorded expenditures of $8.195 million in BY 2021 consisted of $3.975 million in labor and $4.220 million in non-labor costs. For TY 2024, SoCalGas is requesting a total of $20.400 million. This amount reflects $12.205 million incremental increase from the base year, which includes $0.857 million in labor and $11.348 million in non-labor to support an expected increase in project activity associated with

clean fuels infrastructure development. The costs drivers include both labor and non-labor related expenses. Pertinent cost drivers are identified in the subsequent sub-sections of clean fuels infrastructure development activities. All O&M expenses related to Clean Fuels Infrastructure include the two following functions: Business Development and Clean Fuels Power Generation as well as the three following programs: CCUS FEED Study Program, Clean Fuels Operational Readiness Program, and Clean Fuels Transportation Program.

1. Forecast Method

The forecast method developed for this cost category (and all the sub-sections below) for labor and non-labor expenses is the base year method. Incremental adjustments to the base year were included to represent the expense requirements anticipated in TY 2024. This method is most appropriate because trends, multi-year averages, or other methods would not accurately reflect the fact that some costs associated with Clean Fuels Infrastructure Development are new and include functions under CEI that consolidated several pre-existing functions, while also adding new functions not included in the predecessor organizations.

2. Description of Costs and Underlying Activities

The costs associated with the Clean Fuels Infrastructure Development activities directly support the Company's goals of developing clean fuels infrastructure to meet SoCalGas's sustainability strategy and climate commitments[30] and California's decarbonization goals. The costs described in this section include both labor and non-labor costs.

SoCalGas will continue to lead the transition to a resilient and decarbonized clean fuel infrastructure in California. The word "clean" in clean fuels is defined as alternative fuels and/or carbon management solutions resulting in a net-zero carbon footprint.[31] Innovation and rapid development of new technologies will be essential to reach decarbonization goals set by the

[30] SoCalGas, "ASPIRE 2045 Climate Commitment," January 2022, available at: https://www.socalgas.com/sites/default/files/2022-01/SoCalGas_Sustainability_Strategy-final.pdf.

[31] SoCalGas, "The Role of Clean Fuels and Gas Infrastructure in Achieving California's Net Zero Climate Goal," October 2021, available at: https://www.socalgas.com/sites/default/files/2021-10/SCG_Whitepaper_Full-Report.pdf.

federal government,[32] State, and SoCalGas. The development and deployment of clean energy solutions is achievable through active collaborations to lead the transition to an affordable and resilient clean energy solutions at scale. The functions and programs under Clean Fuels Infrastructure Development are further described below.

3. Business Development

As described previously in Section I.D.2.i., above, under "Organization Overview," Business Development performs many key functions including identifying, analyzing, selecting, and prioritizing clean energy and decarbonization initiatives and projects to advance the Company's sustainability goals. Business Development also assists in accelerating the transition to a Clean Fuels Infrastructure, through development of hydrogen and carbon management projects to support multiple end use applications,[33] demonstrating the technical and operational readiness of the existing gas infrastructure to safely deploy, and managing clean fuels as part of SoCalGas's clean energy transition.

RNG is one area of recent development and emphasis in the state that Business Development is actively engaged in to identify projects to meet the State's renewable gas procurement goals. The recent decision by the CPUC to establish a Renewable Gas Standard (RGS),[34] is an important step toward decarbonizing the gas system and reducing short-lived climate pollutant emissions. Under the new RGS ruling, SoCalGas will be required to replace 12.2 percent of the traditional gas it delivers to core customers with renewable gas by 2030.[35] The RGS also sets an interim goal of procuring approximately 3 percent renewable gas by 2025.[36] Efforts by Business Development will help SoCalGas meet the RGS goals for RNG to

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[32] H.R. 3684 "Infrastructure Investment and Jobs Act," last modified November 15, 2021, available at: https://www.congress.gov/bill/117th-congress/house-bill/3684/text.

[33] Includes industries, transportation, thermal generation, residential and commercial building decarbonization, and distributed energy resources.

[34] CPUC Rulemaking R13-02-008; D.22-02-025.

[35] D.22-02-025 at 32, 60 (Ordering Paragraph 18).

[36] *Id.* at 10, 60 (Ordering Paragraph 14); see also SoCalGas Newsroom, PRNewswire, "SoCalGas Applauds Establishment of First Renewable Gas Standard in the United States," February 24, 2022, available at: https://newsroom.socalgas.com/press-release/socalgas-applauds-establishment-of-first-renewable-gas-standard-in-the-united-states.

core customers by 2030.[37] The Renewable Gas Customer Outreach group is specifically focused on pursuing these goals by supporting customer implementation of renewable gas projects.

Hydrogen opportunities are also advancing, and the Business Development group is actively engaged in SoCalGas's transition to a Clean Fuels Infrastructure. This includes the development of conceptual hydrogen infrastructure solutions (as part of a response to a request for information (RFI) from Los Angeles Department of Water and Power (LADWP)) to support an integrated vision and best practices that will help the LADWP to plan, design, and deploy in-basin 100% green hydrogen in the LA basin.[38] In many nations, hydrogen has been increasingly treated as a tool in the fight against climate change. Many utilities, energy companies, and nations are prioritizing the development of hydrogen infrastructure as an integral component of large scale decarbonization.[39] The European Union (EU) has unveiled REPowerEU, by increasing renewable energy development and quadrupling its 2030 targets for renewable hydrogen supply needs.[40] The EU plan also includes a Hydrogen Accelerator program to develop an additional 15 million tons of renewable hydrogen by 2030 and will fast-track reforms that promote hydrogen projects.[41] Australia's national hydrogen strategy has launched the "H2 under 2" target, which sets a production cost of below AU $2/kg (approximately USD $1.50) for green hydrogen sourced from solar and wind.[42]

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[37] SoCalGas, "ASPIRE 2045 Climate Commitment," January 2022, available at: https://www.socalgas.com/sites/default/files/2022-01/SoCalGas_Sustainability_Strategy-final.pdf at p. 8.

[38] LADWP, "Green Hydrogen Pathways for Supporting 100% Renewable Energy, RFI Number: 8.5.21-Power-SA," August 5, 2021, available at: https://www.ammoniaenergy.org/wp-content/uploads/2021/09/Green_Hydrogen_RFI_-_8.5.21-Power-SAL.pdf.

[39] Bloomberg Finance, "2H 2021 Hydrogen Market Outlook: A Defining Year Ahead," available at: https://about.bnef.com/new-energy-outlook/ [report behind a subscription paywall].

[40] International Renewable Energy Agency, "Green Hydrogen Needs Industrial Policy Making and Certification," March 11, 2022, available at: https://www.irena.org/newsroom/articles/2022/Mar/Green-Hydrogen-Needs-Industrial-Policy-Making-and-Certification.

[41] Recharge News, "'Bloody Hard – but possible': EU plots renewables and green hydrogen dash from Russian gas," March 8, 2022, available at: https://www.rechargenews.com/energy-transition/bloody-hard-but-possible-eu-plots-renewables-and-green-hydrogen-dash-from-russian-gas/2-1-1181308.

[42] S&P Global Commodity Insights, "Analysis: Asia's 'H2 at $2' Green Hydrogen Target is a Mission Not Impossible," January 14, 2021, available at: https://www.spglobal.com/platts/en/market-

Domestically, the Department of Energy's (DOE) Earthshot-Hydrogen Shot program seeks to reduce the cost of "clean hydrogen"[43] by 80 percent to $1 per 1 kilogram in 1 decade ("1 1 1") by 2030.[44] Similarly, the HyDeal LA initiative is aiming to achieve $1.5/kg of delivered green hydrogen to off-takers in the LA basin.[45] The recently passed Infrastructure Investment and Jobs Act (IIJA) allocates $9.5 billion for clean hydrogen programs including: $8 billion dollars in funding for the development of at least four regional clean hydrogen hubs addressing hydrogen feedstock, end-use, and geographic diversity;[46] $1 billion for research, development, demonstration, commercialization, and deployment of hydrogen electrolysis program for commercialization to improve efficiency, durability, and reduce the cost of producing clean hydrogen using electrolyzers; and $500 million to support a clean hydrogen supply chain.[47] In 2020, Energy and Environmental Economics, Inc. modeled three different scenarios to achieve carbon neutrality in California by 2045. All three scenarios, including a high-electrification scenario, include the use of hydrogen.[48]

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insights/latest-news/electric-power/011421-analysis-asias-h2-at-2-green-hydrogen-target-is-a-mission-not-impossible.

[43] "Clean hydrogen," refers to the phrase as used and interpreted with respect to the DOE, and the Infrastructure Investment and Jobs Act.

[44] US DOE, Office of Energy Efficiency and Renewable Energy, "Hydrogen Shot," available at: https://www.energy.gov/eere/fuelcells/hydrogen-shot.

[45] Green Hydrogen Coalition, "HyDeal LA: Architecting a Scalable Model for Green Hydrogen Hubs, Starting With Los Angeles," July 7, 2021, available at: https://static1.squarespace.com/static/5e8961cdcbb9c05d73b3f9c4/t/60ef84fb65edb26c8618d579/1626309884328/GHC+HyDeal_H2+Earthshots+RFI+response_July2021_HyDealSupporters.pdf at p. 5.

[46] H.R. 3684 "Infrastructure Investment and Jobs Act," last modified November 15, 2021, available at: https://www.congress.gov/bill/117th-congress/house-bill/3684/text. Feedstock diversity implies hydrogen produced using multiple feedstocks (fossil fuels, nuclear, and renewable energy); end-use diversity implies hydrogen uses across multiple end-use applications including electric power generation, industries, residential and commercial heating, and transportation; geographic diversity implies no hydrogen hub in the same region as another.

[47] *Id.*

[48] Energy and Environmental Economics, Inc. "PATHWAYS Scenario Achieving Carbon Neutrality in California," October 2020, available at: https://ww2.arb.ca.gov/sites/default/files/2020-10/e3_cn_final_report_oct2020_0.pdf at p. 79; see also National Renewable Energy Laboratory (NREL), "LA100: The Los Angeles 100% Renewable Energy Study Executive Summary," March 2021, available at: https://www.nrel.gov/docs/fy21osti/79444-ES.pdf at p. 12.

Activities under Business Development include market research, financial and business analytics associated with tracking of clean energy market trends, the techno-economic outlook, and decarbonization trends in the energy and utility sectors. These activities provide analysis support, guidance, and direction to the business development initiatives as part of the clean fuels infrastructure development, thereby improving the effectiveness of these efforts. To promote optimal deployment of capital to benefit our customers, the market research, financial and business analytics activities focus on collecting and analyzing information on external trends, assisting with financial and technical analysis related to clean fuels infrastructure development projects, supporting the long-term capital planning process, and developing and maintaining analytical and data collaboration tools.

To this end, the Business Development function and its activities incur both labor and non-labor related expenses to perform the key functional activities as described above.

4. Cost Drivers

For TY 2024, SoCalGas is requesting an incremental increase of $2.333 million for Business Development from the 2021 BY costs. This is part of the overall incremental request of $12.205 million for the Clean Fuels Infrastructure Development group as shown in Table AI-7. The $2.333 million incremental increase for Business Development includes $0.333 million in labor and $2.0 million in non-labor related expenses to accomplish the following:

- Labor expenses required to backfill 2 FTEs: two business development managers to support clean fuels development;
- Increase in non-labor expenses to conduct feasibility assessments related to the clean fuel infrastructure value chain to meet the SoCalGas's sustainability strategy. This cost includes consulting services support for the clean fuels infrastructure assessments including identifying, analyzing, selecting, and prioritizing clean energy project portfolio;
- Non-labor expenses related to the development of strategic initiatives including roadmaps and vision documents to advance the clean fuels infrastructure goals; and
- Non-labor expenses related to the increased engagement in the State's energy initiatives and working with multiple agencies, partners, research laboratories, and universities.

For additional details, please refer to workpaper (SCG-12-WP, 2RD000.000).

5. Carbon Capture, Utilization and Sequestration Front End Engineering Design (CCUS FEED) Study Program

SoCalGas is requesting $6.655 million for a CCUS FEED study program (as described in the cost drivers section below) to support the development of carbon management solutions in Southern California. The proposed CCUS FEED Study Program would identify a Carbon Dioxide (CO_2) pipeline route in Southern California to follow, to the extent possible, existing pipeline corridors and/or leverage existing rights-of-way to help optimize project development and reduce environmental disturbance and siting concerns while connecting the CO_2 source to the CO_2 sink for storage. The CCUS FEED study program would also address scope, design, and technical specifications and identify related environmental attributes so that all aspects of the project evaluation undergo a "due diligence" process to help finalize the project's scope, technical specifications, capital investment estimates.

CCUS is a set of technologies that remove CO_2 either from the atmosphere or from point sources. The captured CO_2 is then compressed and transported for various end-use utilization, or injected[49] into deep underground geological formations (that may include depleted oil and gas reservoirs or saline formations) for permanent storage. As stated in S.799 of the Storing CO_2 and Lowering Emissions (SCALE) Act, "Congress finds that carbon dioxide transport infrastructure and permanent geological storage are proven and safe technologies with existing Federal and State regulatory frameworks."[50] CCUS is a means to abate CO2 emissions from energy-intensive industries[51] where CO_2 emissions are inherent to current production processes and cannot be eliminated solely by switching to low-carbon electricity or clean fuels

The recently passed IIJA in the United States include substantial carbon management provisions and funding of $12.1 billion over the next five years including the funds to build out large-scale pilot projects, development of commercial CO_2 transport and storage infrastructure, authorizations to support commercial-scale demonstrations, and FEED (front-end engineering

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[49] S.799 "Storing CO2 And Lowering Emissions Act (SCALE Act)," last modified March 17, 2021, available at: https://www.congress.gov/bill/117th-congress/senate-bill/799/text.

[50] *Id.* at 3 (findings).

[51] Includes power generation and industrial facilities such as refineries, cement, iron, steel manufacturing, etc.

and design) studies as part of the carbon capture technology and utilization activities.[52] The SCALE Act (as part of the IIJA) also supports the buildout of critical regional CO_2 transport and storage infrastructure networks through several other programs including financing and innovation, carbon storage validation and testing, and geologic storage permitting activities.[53]

CCUS would be an essential technology solution needed to meet California's 2045 decarbonization targets. This is evident from the ongoing actions being taken within the State's governing entities. In 2006, Assembly Bill 1925 (Blakeslee, Chapter 471) required the California Energy Commission, in coordination with the Department of Conservation's Geologic Energy Management Division (CalGEM) and the California Geological Survey to prepare a report recommending how California could facilitate the adoption of geologic carbon sequestration…."[54] In 2021, the California Governor signed SB 27 into law, requiring the California Natural Resources Agency to establish the "Natural and Working Lands Climate Smart Strategy" creating a framework to advance California climate goals and specified carbon removal targets for 2030 and beyond. SB 27 also requires the Natural Resources Agency to track projects that remove carbon in a registry, with the projects reporting updates on status, benefits, and outcomes.[55]

As explained in the testimony of Naim Jonathan Peress and Michelle Sim (Ex. SCG-02, Chapters 1 and 2), AB 32, SB 32, and Executive Order B-55-18 promote the development and examination of CCUS solutions. CARB's 2022 Scoping Plan Update is being informed through

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[52] Great Plains Institute (GPI), "An Atlas of Carbon and Hydrogen Hubs for United States Decarbonization," February 2022, available at: https://scripts.betterenergy.org/CarbonCaptureReady/GPI_Carbon_and_Hydrogen_Hubs_Atlas.pdf at p.77.

[53] *Id.* at p.78.

[54] AB 1925, Chapter 471, September 26, 2006, available at: http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_1901-1950/ab_1925_bill_20060926_chaptered.pdf; CalGEM, "Carbon Capture and Geological Sequestration," available at: https://www.conservation.ca.gov/calgem/Pages/CarbonDioxideCaptureandStorage.aspx.

[55] SB-27, Chapter 237, "Carbon sequestration: state goals: natural and working lands: registry of projects," last modified September 24, 2021, available at: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220SB27.

the development of decarbonization scenario modeling efforts.[56] All of the four alternative scenarios currently proposed in the 2022 Scoping Plan scenario modeling framework include the role of CO_2 removal from the atmosphere and the development of carbon capture and sequestration technologies to help capture carbon emissions from industrial facilities in California. In 2018, CARB expanded the Low Carbon Fuel Standards (LCFS) program to include carbon capture and sequestration into the regulation with the goal to incentivize and enable these technologies to scale more widely.[57]

California possesses a sizeable carbon emissions market as well as ample and conducive geologic storage potential for safe and permanent CO_2 storage. According to the Lawrence Livermore National Laboratory, the previously estimated storage capacity of onshore geologic saline formations in California's ten largest basins range from 75 to 300 billion tons of CO_2 capacity.[58]

California currently lacks CO2 transport infrastructure to support CCUS development. Los Alamos National Laboratory, in its assessment of CCUS at a DOE workshop on April 19, 2022, has stated "Regional CO2 transport infrastructure connecting regional sources to geologic sinks is a critical need[.]"[59] A CO_2 transport pipeline infrastructure network in California, connecting hard to electrify industrial sources of emissions to the geologic CO_2 storage sites, is essential to spur the development and deployment of large-scale CCUS infrastructure solutions.

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[56] California Air Resources Board (CARB), "PATHWAYS Scenario Modeling 2022 Scoping Plan Update," December 15, 2021, available at: https://ww2.arb.ca.gov/sites/default/files/2021-12/Revised_2022SP_ScenarioAssumptions_15Dec.pdf.

[57] The federal 45Q tax credits can be combined with California's LCFS carbon capture and sequestration credits.

[58] Lawrence Livermore National Laboratory, "Getting to Neutral: Options for Negative Carbon Emissions," January 30, 2020, available at: https://livermorelabfoundation.org/2019/12/19/getting-to-neutral/; see also Energy Futures Initiative and Stanford University Center for Carbon Storage, "An Action Plan for Carbon Capture and Storage in California: Opportunities, Challenges, and Solutions," October 22, 2020, Rev. 2, December 11, 2020, available at: https://sccs.stanford.edu/california-projects/opportunities-and-challenges-for-CCS-in-California (a collaborative study between the California Energy Commission (CEC) and the U.S. Department of Energy (DOE) that estimated the CO_2 storage capacity of saline formations in the state's 10 largest basins ranged from 150 to 500 gigatons (Gt)).

[59] Los Alamos National Laboratory, "CCS Pipeline Infrastructure Development in the Gulf Coast and Southeast US," April 19, 2022, p.2, https://usea.org/sites/default/files/event-/Rajesh%20Pawar%2C%20Bailian%20Chen.pdf at 2.

Los Alamos also noted "CCS [(carbon capture and sequestration)] infrastructure is a long term investment" and "strategic development of infrastructure could help address large number of sources and help save on costs[.]" [60]

As part of the Communities Local Energy Action Program grants, the DOE has recently pledged technical assistance to two communities in SoCalGas's service territory, Kern County and Bakersfield, to support these energy overburdened communities in making a clean energy transition, including the development of carbon capture, utilization, and sequestration solutions.[61]

With SoCalGas's extensive experience in engineering, constructing, operating, inspecting, safety, and maintaining pipelines in the backcountry and urban settings, the Company is well-positioned to play a key role in the development of a region-critical CO_2 pipeline network that would benefit ratepayers and the state by advancing California's net-zero goals, reducing emissions from the hard to electrify economic sectors in the LA Basin, and creating new jobs and economic benefits.

SoCalGas has analyzed publicly available research on CCUS by Stanford[62], Lawrence Livermore[63], and others, as well as EPA data[64] on emissions to assess Southern California's potential for carbon capture, transport, and a storage network and its subsequent implementation for a wide-scale CCUS development. SoCalGas is planning to conduct additional Pre-FEED evaluations prior to a comprehensive FEED study[65] for the CO_2 pipeline transport infrastructure necessary to enable the deployment of carbon capture, utilization, and storage technologies in Southern California.

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60 *Id*.

61 Kern County News, "Kern County Awarded U.S. Department of Energy Communities LEAP Technical Assistance Grant for Development of Clean Energy & Carbon Management Business Park," March 29, 2022, available at: https://www.kerncounty.com/Home/Components/News/News/660/34810.

62 EFI and Stanford University, "An Action Plan," October 2020, Rev. 2, Dec. 11, 2020.

63 Lawrence Livermore National Laboratory, "Getting to Neutral."

64 "Environmental Protection Agency Facility Level Information on Greenhouse Gases Tool," last modified August 7, 2021, available at: http://ghgdata.epa.gov/ghgp.

65 A FEED study is the basic engineering work required to produce a quality process in documenting engineering and project requirements prior to a capital investment. FEED studies are commonly performed after a conceptual or feasibility study but before any detailed engineering work is conducted for the EPC stage (Engineering, Procurement, and Construction).

a. Cost Drivers

For TY 2024, SoCalGas is requesting an incremental increase of $6.655 million for the CCUS FEED Study program from the 2021 BY costs. This is part of the overall incremental request of $12.205 million for the Clean Fuels Infrastructure Development group as shown in Table AI-7.

The $6.655 million non-labor incremental increase is to support the activities related to the development of a CCUS FEED study program. The non-labor estimate is based on industry guidance of FEED studies for large, first of its kind infrastructure projects, and based on previous costs for studies of this nature. The associated cost for the FEED study is part of the RAMP activities as identified in Table AI-4 of this testimony (see Section II). Cost drivers include non-labor expenses to accomplish the following activities:

- Conduct a FEED study to evaluate the development of a CO_2 pipeline transport infrastructure system necessary to enable the deployment of carbon capture, utilization, and storage technologies in Southern California;
- Identification of routes in Southern California to follow, to the extent possible, existing pipeline corridors and/or leverage existing right of ways to help optimize project development and reduce environmental disturbance and siting concerns while connecting the CO_2 sources to the CO_2 sink for storage; and
- Development of a final scope, design, and technical specifications for the CO_2 pipeline as a precursor to the evaluation of the project's capital investment estimates.

For additional details, please refer to workpaper (SCG-12-WP, 2RD000.000).

6. Clean Fuels Operational Readiness Program

Development of a clean fuels operational readiness program will be pivotal to demonstrate and deploy clean fuels technologies as part of the clean fuels' infrastructure transition. The clean fuels operational readiness program is intended to help SoCalGas develop a strategic framework for operational and system readiness to help accelerate the Company towards new clean fuels infrastructure.

Assessment of the current processes, standards, systems, and infrastructure for operational readiness and identifying gaps in technological, material, operational, safety, workforce, Information Technology (IT), Operational Technology (OT) systems, training standards, regulatory and compliance protocols, and fleets and facilities will promote an effective and efficient deployment of the clean fuels infrastructure. The clean fuels operational readiness

program will also evaluate current transmission and distribution integrity standards, operational tools, and management practices to optimize transmission, distribution, storage, IT/OT, & metering systems that would assist in integrating systems operations with the clean fuels infrastructure.

Transitioning to a balanced and diversified portfolio of clean fuels delivery network in California can enhance system-wide energy resilience to meet energy demands. Innovation and rapid development of new technologies requires evaluating not only the key benefits, but also the associated risks to the overall energy system. Currently, data is either limited or unavailable (both internally at SoCalGas or available in the public domain) to evaluate asset-related risks as part of the RAMP requirements to integrate emerging clean fuel technologies into the energy ecosystem in California to address system resiliency. As discussed in the RAMP Integration section of this testimony, the clean fuels operational readiness program will also evaluate the overall benefits and risks to the energy system to address system resiliency with the adoption of clean fuels infrastructure.

a. Cost Driver

For TY 2024, SoCalGas is requesting an incremental increase of $2.500 million for Clean Fuels Operational Readiness Program from the 2021 BY costs. This is part of the overall incremental request of $12.205 million for the Clean Fuels Infrastructure Development group as shown in Table AI-7. The $2.500 million non-labor incremental increase is to support the activities related to the development and implementation of the Clean Fuels Operational Readiness Program. The costs associated with the Clean Fuels Operational Readiness Program is part of the RAMP activities as identified in Table AI-4 of this testimony (see Section II). Cost drivers include non-labor expenses to accomplish the following activities:

- Assessment of current processes, standards, systems, and infrastructure for operational readiness to embrace clean fuels infrastructure, identifying gaps in technological, material, operational, safety, workforce, and training standards, etc.;
- Evaluation of current transmission and distribution integrity standards, operational tools, and management practices to optimize transmission, distribution, storage, IT/OT, and metering systems for clean fuels delivery;
- Integration of research, testing, and demonstration results as part of the operational readiness plan; and
- Identification of risk drivers and mitigation strategies to address clean fuels system resiliency.

For additional details, please refer to workpaper (SCG-12-WP, 2RD000.000). Cost drivers related to expenses required to support hydrogen blending operational readiness activities are identified separately in Maria T. Martinez's Gas Engineering testimony (Ex. SCG-07) and is not part of this testimony.

7. Clean Fuels Transportation Program

The SoCalGas's Clean Transportation Program supports customer demand for renewable natural gas and the market adoption of hydrogen as transportation fuels in support of California's regional and state air quality and GHG emission reduction goals. The Clean Fuels Transportation Program provides information, education and training related to Clean Transportation a variety of stakeholders, including owners of hydrogen fuel cell vehicles (FCVs) and renewable natural gas vehicles (RNGVs), operators of hydrogen and RNGV refueling stations, vehicle and equipment manufacturers, government agencies, policymakers, and others.

This testimony provides background information and support for several other testimony areas that seek costs relating to Clean Transportation. Direct customer contact activities (Customer Outreach) for Clean Transportation customers are handled by Customer Energy Solutions (CES), and those associated costs and underlying activities are included in Brian Prusnek's Customer Services – Information testimony (Ex. SCG-16).[66] Indirect customer support activities (Customer Support) for Clean Transportation customers, including product and service development, public access station management, and regulatory and legislative support for Clean Transportation customers are handled by CEI. This testimony (both non-shared costs and capital costs) is also referenced by Brenton Guy's Real Estate and Facility Operations testimony (Ex. SCG-19) as well as the Rae Marie Yu's Regulatory Accounts testimony (Ex. SCG-38) related to the associated costs and underlying activities for utility-owned and operated hydrogen refueling stations.

The Clean Transportation Program (Customer Support) includes costs related to the development and management of new and existing Clean Transportation-related products and services, including customer outreach tools and materials, grant funding tracking and reporting, the truck loan program, fleet financial analysis tools, utility public access refueling station

[66] Direct customer contact activities include, but are not limited to, customer information, education, and training, as well as utility new business and existing account management services.

management (customer credit card sales, development of monthly retail pricing and LCFS credit revenue return) and offering subject matter expertise regarding Clean Transportation-related local, state, and federal regulations. These products and services are provided to the Clean Transportation (Customer Outreach) team for direct use with customers.

b. Background

i. Existing Stations

As of March 22, 2022, thirty (30) retail hydrogen FCV stations were in operation in the SoCalGas's service territory.[67] Most of these retail hydrogen FCV stations serve light-duty FCVs. As described below, it is expected that more medium-duty and heavy-duty FCVs will be introduced into the market, including in maritime and rail applications, and adopted by commercial fleets.

SoCalGas serves 349 RNGV refueling stations dispensing 154 million therms of natural gas or over 123 million gasoline gallon equivalents to G-NGV customers.[68] As of the end of 2019, over 98% of the natural gas dispensed by RNGV refueling stations in California and reported to CARB's Low Carbon Fuel Standard (LCFS) Program was renewable natural gas.[69] SoCalGas owns and operates 27 RNGV refueling stations dispensing 100% renewable natural gas to the utility fleet and general public. Most Clean Transportation customers own and operate both RNGVs and RNGV refueling stations, but some customers operate "public access" fueling stations to serve the general public and nearby fleets. RNGV customers vary significantly in terms of the number and type of RNGVs operated, including commuter vehicles, transit buses, school buses, waste haulers, street sweepers, airport fleets (taxis, shuttles), goods movement trucking, and port drayage trucking.

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[67] California Fuel Cell Partnership, "California Fuel Cell Partnership Hydrogen Station List," March 25, 2022, available at: https://cafcp.org/sites/default/files/h2_station_list.pdf.

[68] Source is G-NGV billing data. Data based on actual 2021 volumes and stations.

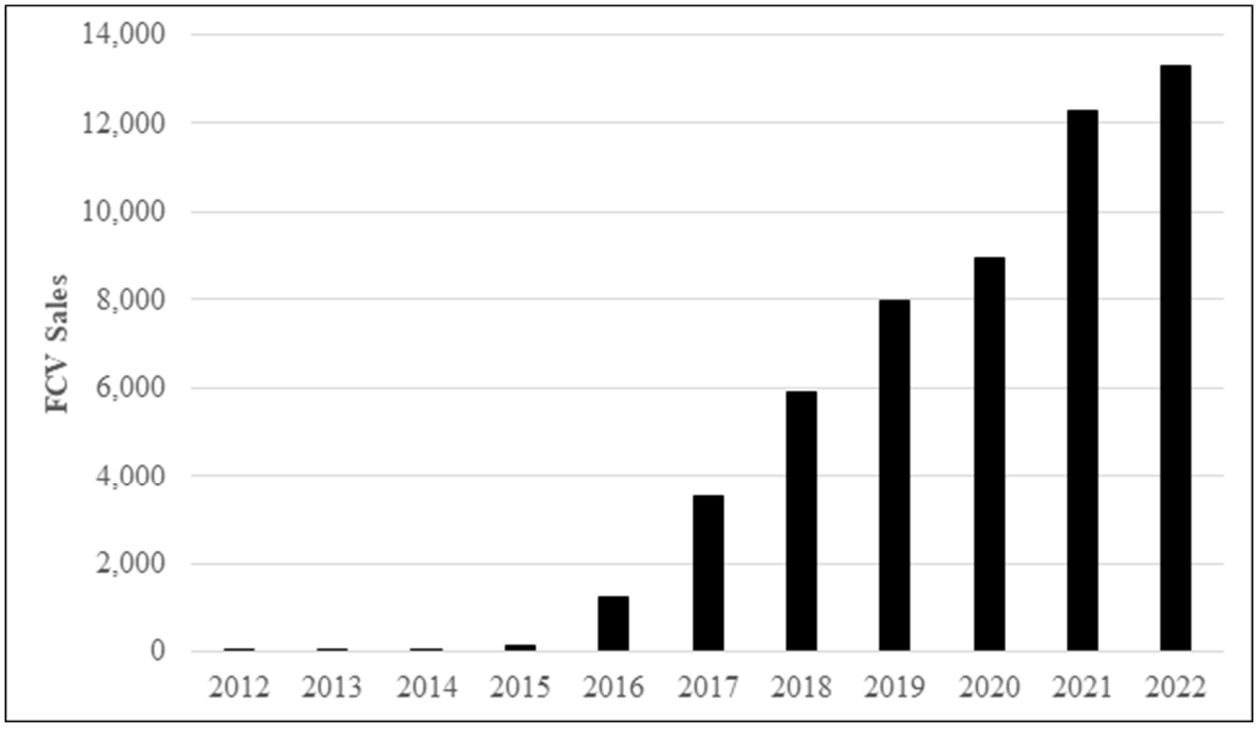
[69] California Air Resources Board and LCFS Data Dashboard, "Alternative Fuel Volumes and Credit Generation," April 30, 2021, available at: https://ww3.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm at Figure 2.

ii. Customer Demand

The primary cost driver for an increase in Clean Transportation utility services is based on the increasing demand for hydrogen FCVs and hydrogen refueling stations to support transition into Zero Emissions Vehicles (ZEV). This increase in utility service demand will occur due to: (a) increasing industry and customer interest in and sales of hydrogen FCVs, (b) regulatory requirements mandating the use of zero emission vehicles, including hydrogen FCVs, and (c) the steadily increasing price competitiveness of hydrogen compared to petroleum fuels.

According to the California Fuel Cell Partnership, FCV sales in the United States have been steadily increasing since 2016, as shown in Figure AI-1 Cumulative FCV Sales in the United States).

Figure AI-1
Cumulative FCV Sales in the United States [70]



[70] FCV sales data, California Fuel Cell Partnership (CAFCP), available at: https://cafcp.org/sites/default/files/FCEV-Sales-Tracking.pdf.

There is also a significant number of off-road FCVs, as evidenced by the over 20,000 hydrogen FCV forklifts in operation throughout the United States.[71]

SoCalGas has also observed an increase in customer interest and requests for hydrogen station natural gas utility service. For example, in 2020, SoCalGas received a single request to evaluate a location for hydrogen station natural gas utility service. In 2021, this figure jumped to sixteen requests.

In March 2022, SoCalGas commissioned a market research study to quantify customer interest in proposed utility hydrogen-related products and services, including customer information, education, and training programs as well as utility-owned public access hydrogen stations.[72] Ninety-four percent (94%) of respondents stated SoCalGas's proposed hydrogen products and services would be beneficial. Eighty-one percent (81%) of respondents stated SoCalGas' proposed hydrogen products and services would motivate them or their company to adopt the use of hydrogen vehicles sooner. Respondents ranked the need for more hydrogen fueling stations as well as affordable hydrogen fuel as the most appealing aspects of SoCalGas's proposed hydrogen products and services. These findings are consistent with the most recent CEC AB 8 report on hydrogen refueling stations, which states "general barriers … to overall widespread FCEV commercialization and deployment remain" and include "high hydrogen fuel and FCEV prices, hydrogen station downtime due to equipment failures and other factors, and the lack of vehicle models and consumer options…. The need for a reliable hydrogen supply and reliable stations also presents a barrier to widespread FCEV commercialization and deployment, as does expanded geographic coverage of the stations. FCEV adoption may increase at a higher pace when these barriers are addressed."[73]

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[71] U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, Hydrogen and Fuel Cells Program Record #18002, "Fact of the Month November 2018: There are Now More Than 20,000 Hydrogen Fuel Cell Forklifts in Use Across the United States," November 2018, available at: https://www.energy.gov/eere/fuelcells/fact-month-november-2018-there-are-now-more-20000-hydrogen-fuel-cell-forklifts-use.

[72] "Clean Air Intercept Study", Q-Insights, March 2022.

[73] California Energy Commission Joint Agency Staff Report on Assembly Bill 8: 2021 Annual Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California, CEC-600-2021-040, December 2021, available at: https://www.energy.ca.gov/sites/default/files/2021-12/CEC-600-2021-040.pdf at p. 55.

iii. ZEVs for Addressing Climate Change

To aggressively address climate change, state policies are increasingly mandating the use of zero emission vehicles, including hydrogen FCVs. As an example, the CARB Innovative Clean Transit (ICT) regulation approved in 2019 requires that "Starting January 1, 2029, all new bus purchases must be zero-emission buses" where a zero emission bus is defined as "a bus with zero tailpipe emissions and is either a battery electric bus or a fuel cell electric bus."[74,75] Since hydrogen fuel cell electric buses can fuel faster and often have greater range than battery electric bus counterparts, many transit agencies throughout the state plan to procure, fuel and operate hydrogen fuel cell bus fleets. As of September 2, 2021, 60% of the SoCalGas transit agencies that have submitted ICT implementation plans to CARB intend to operate hydrogen fuel cell buses.[76] Similar regulations have been approved for other types of vehicles, such as the CARB Advanced Clean Truck regulation that requires a portion of all heavy-duty trucks sales from each manufacturer to be a zero-emission truck starting in 2024. The proposed CARB Advanced Clean Car II regulations requires 100% of all light-duty new vehicle sales from each manufacturer to be zero emission by 2035.[77] Other regulations are currently under development, such as the draft Advanced Clean Fleets (ACF) regulation, that will require a transition to zero emission medium- and heavy-duty vehicle fleets "performing drayage operations, public agencies, federal governments, and high-priority fleets that own, operate or direct vehicles with a gross vehicle weight rating (GVWR) greater than 8,500 lbs."[78] Collectively, these regulations will result in additional ZEV adoption, including hydrogen FCVs, within the state of California. This increased adoption, in turn, will result in increasing demands for utility Clean Transportation products and services.

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[74] Title 13, California Code of Regulations, §§ 2023.1(a)(1)(A)(3) and (a)(1)(B)(2).

[75] Title 13, California Code of Regulations, § 2023(b)(54).

[76] Title 13, California Code of Regulations, § 2023.1(d); see also "The Innovative Clean Transit (ICT) regulation, last modified December 16, 2021, available at: https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans.

[77] CARB, "Advanced Clean Cars II Staff Report: Initial Statement of Reasons," April 12, 2022, available at: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/accii/isor.pdf. at p. 9

[78] CARB, "Advanced Clean Fleets Fact Sheet," last modified August 17, 2021, available at: https://ww2.arb.ca.gov/our-work/programs/advanced-clean-fleets/advanced-clean-fleets-fact-sheets

As the cost of hydrogen fuel drops, demand for hydrogen to fuel hydrogen FCVs would likely increase. A 2021 Bloomberg NEF forecast states "the costs of producing green hydrogen from renewable electricity should fall by up to 85% from today to 2050, leading to costs below $1/kg ($7.4/MMBtu) by 2050 in most modeled markets."[79] Since 1 kg of hydrogen is approximately equal to a gallon of gasoline [80] and hydrogen FCVs are expected to be more efficient than internal combustion engines, this forecast indicates renewable hydrogen will be less costly than petroleum fuels in the next thirty years. Declining hydrogen prices are also reflected in fuel price forecasts used in the California Energy Commission 2020 IEPR and shown below in Figure AI-2

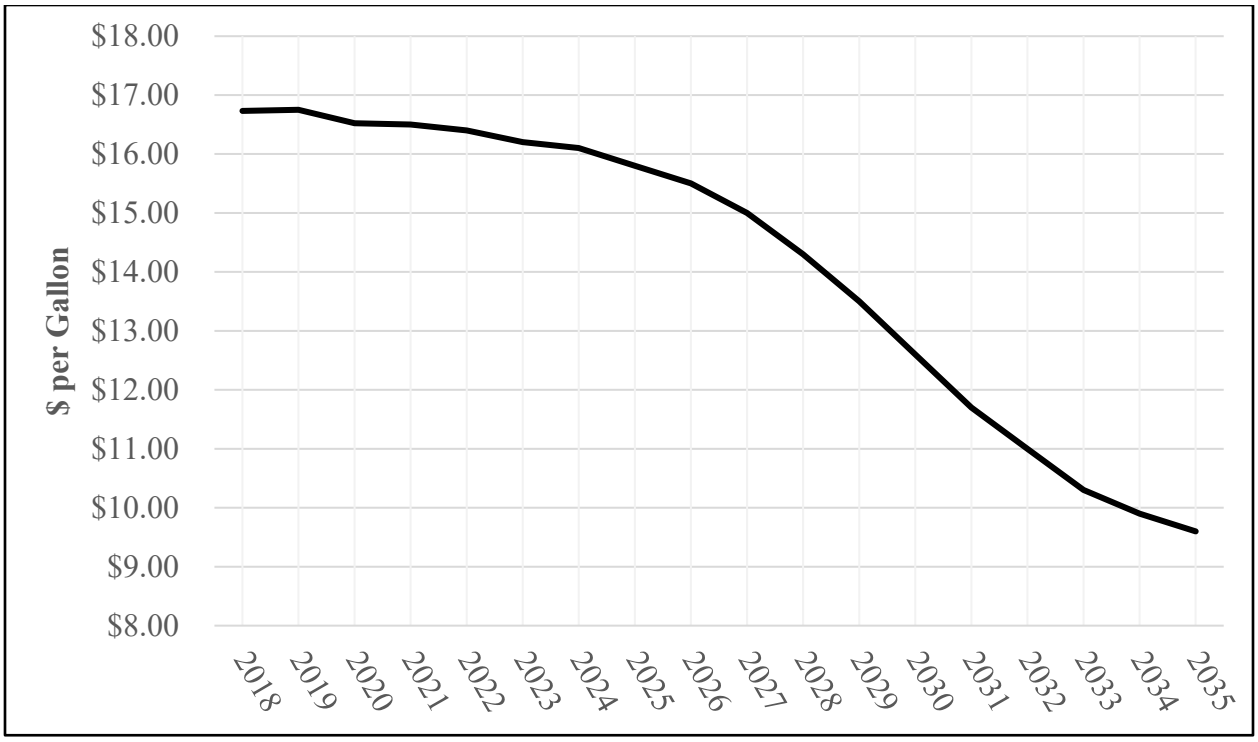
CEC Hydrogen Fuel Price Forecast.

Figure AI-2
CEC Hydrogen Fuel Price Forecast [81]

[79] Bloomberg NEF, Green Car Congress, "BloombergNEF Forecasts Green Hydrogen Should be Cheaper Than Natural Gas by 2050 in Some Markets; Falling Costs of Solar PV Key," April 7, 2021, available at: https://www.greencarcongress.com/2021/04/20210407-bnef.html.

[80] RMI, "Run on Less with Hydrogen Fuel Cells," October 2019, available at: https://rmi.org/run-on-less-with-hydrogen-fuel-cells/

[81] Hydrogen Fuel Price Forecasts provided by Ysbrand van der Werf, California Energy Commission Transportation Energy Forecasting Unit, November 19, 2021.



Increasing demand for hydrogen FCVs will result in an increased demand for public and private hydrogen refueling infrastructure, customer information, education, and training. The Company team will support customers by providing the necessary hydrogen refueling infrastructure, information, education, and training.

iv. Market Activity

In the past few years, there has been increasing market activity related to third-party hydrogen FCV products and services including the production of Original Equipment Manufacturer (OEM) vehicles, hydrogen refueling stations, and associated equipment and hydrogen production capability. Customers seeking to operate hydrogen FCVs and hydrogen refueling stations will require information and education on third-party Clean Transportation products and services available and have traditionally sought such information from utilities.

Prominent OEMs, including Toyota, Honda, and Hyundai, have already begun producing hydrogen FCVs for the consumer market.[82] Heavy-duty FCVs are under development for eventual commercialization. For example, the CARB Zero Emissions for California Ports

[82] As of January 1, 2022, consumer fuel cell vehicles were available for sale/lease from Toyota (Mirai), Honda (Clarity), and Hyundai (Nexo).

project started in 2019 will be validating "the commercial viability of zero-emissions hybrid fuel cell-electric yard trucks operating in a demanding, real-world cargo-handling application at the Port of Los Angeles."[83] As of June of 2021, two zero-emissions fuel cell-electric yard trucks began operating as part of this demonstration.

As stated earlier, 30 retail hydrogen refueling stations are currently in operation within the SoCalGas service territory. These stations produce or procure hydrogen in a variety of ways, including gaseous transport, liquid transport, on-site electrolysis, and hydrogen pipelines. These production and procurement methods require different types of products and services. As the portfolio of hydrogen refueling stations grow within California, the demand for these products and services will grow as well.

New hydrogen FCV products and services will benefit and impact the transportation fleets of many of our largest commercial and industrial customers. The Clean Transportation team will support our customers by helping them understand new and evolving hydrogen FCV products and services through information, education, and training.

v. Regulatory and Legislative Activity

Federal, state, and local air quality and climate change related programs, regulations, and legislation directly impact individual and fleet customers that operate or could benefit from operating hydrogen FCVs and/or hydrogen refueling stations. Customers seeking information on Clean Transportation regulatory and legislative requirements and opportunities (grant funding) have traditionally sought such information and education from the utilities. The Clean Transportation team will also support our customers by helping customers understand both existing and new hydrogen fuel quality, measurement, and safety regulations and standards.

Any increase in the associated regulation and legislation will increase the demand on utility resources to adapt to those changes.

These numerous laws, regulations and policies include:

- In 2018, Governor Brown issued Executive Order B-48-18 that states, in part, "It is further ordered that all State entities work with the private sector and all

[83] CARB, "Zero Emissions for California Ports ZECAP," March 2020, available at: https://ww2.arb.ca.gov/sites/default/files/movingca/pdfs/zecap.pdf.

appropriate levels of government to spur the construction and installation of 200 hydrogen fueling stations...by 2025."[84]

- In 2020, Governor Newsom issued Executive Order N-79-20 that states, in part, "It shall be a goal of the State that 100 percent of in-state sales of new passenger cars and trucks will be zero-emission by 2035. It shall be a further goal of the State that 100 percent of medium-and heavy-duty vehicles in the State be zero-emission by 2045 for all operations where feasible and by 2035 for drayage trucks. It shall be further a goal of the State to transition to 100 percent zero-emission off-road vehicles and equipment by 2035 where feasible."[85]
- The CARB 2020 Mobile Source strategy states, "a key focus of the 2020 Strategy is advancing the use of zero-emission technologies wherever feasible," and "deployment of approximately 1.4 million medium and heavy-duty zero-emission vehicles (ZEVs) in California by 2045" and for "on-road light-duty vehicles … 100 percent of sales will be ZEVs by 2035…."[86]
- In November 2021, the U.S. Department of Energy announced it "awarded $199 million to fund 25 projects aimed at putting cleaner cars and trucks on America's roads [that] align with DOE's commitment to reaching President Biden's goals of having zero-emission vehicles make up half of all vehicles sold in America by 2030 and achieving net zero emissions economy-wide by 2050."[87]
- In 2018 and 2019, CARB updated the Low Carbon Fuel Standard (LCFS) program, which now mandates a 20% reduction in the carbon intensity of transportation fuels used in California by 2030. Hydrogen, when used as a motor vehicle fuel, has GHG emissions that are up to 228% lower than diesel fuel.[88]
- In response to California's clean energy goals and Governor Newsom's Executive Order N-79-20, SoCalGas has observed the California Legislature introducing

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84 State of California, Executive Department, EO B-48-18, available at: https://www.library.ca.gov/wp-content/uploads/GovernmentPublications/executive-order-proclamation/39-B-48-18.pdf.

85 State of California, Executive Department, EO N-79-20, available at: https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf.

86 CARB, "Proposed 2020 Mobile Source Strategy," September 28, 2021, available at: https://ww2.arb.ca.gov/sites/default/files/2021-09/Proposed_2020_Mobile_Source_Strategy.pdf. at p. 4.

87 U.S. Department of Energy, "DOE Announces Nearly $200 Million to Reduce Emissions in Cars and Trucks," November 1, 2021, available at: https://www.energy.gov/articles/doe-announces-nearly-200-million-reduce-emissions-cars-and-trucks.

88 CARB, "Current LCFS Regulation," modified July 2020, available at: https://ww2.arb.ca.gov/sites/default/files/2020-07/2020_lcfs_fro_oal-approved_unofficial_06302020.pdf at p. 54, Table 1 and p. 73, Table 5.

legislation to increase the adoption of zero emission vehicles, including hydrogen fuel cell vehicles and associated refueling infrastructure.[89]

- The California Department of Food and Agriculture is "responsible for overseeing the fuel quality, dispenser accuracy, and advertising of fuels sold at retail, including hydrogen" and has adopted the SAE International hydrogen fuel quality standard J2719.[90]
- CARB also has adopted hydrogen fuel quality regulations.[91]
- Many municipalities use the National Fire Protection Association (NFPA) to establish refueling station permitting and safety standards, including NFPA 2, "Hydrogen Technologies Code".

At the local level, the two largest regional air basins within the SoCalGas service territory, South Coast and San Joaquin Valley, are in extreme non-attainment for ozone and both must achieve significant reductions in particulate matter (PM) for National Ambient Air Quality Standards under the Federal Clean Air Act.[92] More than 85% of the region's emissions come from mobile sources.[93] With heavy-duty diesel trucks as the single largest contributor to these emissions, the widespread deployment of near-zero and zero emission heavy-duty trucks, including hydrogen FCV trucks, is the single most impactful emission reduction strategy.[94]

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[89] SoCalGas monitors state legislative activity impacting both the utility and customers. Over the past three legislative sessions, the number of bills addressing natural gas and hydrogen mobility has increased from 2 bills in the 2018-2019 legislative session, to 6 bills in the 2019-2020 legislative session, and to 9 bills in the 2020-2021 legislative session.

[90] California Department of Food and Agriculture, "Division of Measurement Standards," available at: https://www-test.cdfa.ca.gov/dms/hydrogenfuel/hydrogenfuel.html.

[91] California Code of Regulations, Title 13, Division 3, Chapter 5, Article 3, Sub-Article 1, § 2292.7, "Specifications for Hydrogen."

[92] South Coast Air Quality Management District, "Final 2016 Air Quality Management Plan," March 2017, available at: https://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2016-air-quality-management-plan/final-2016-aqmp/final2016aqmp.pdf?sfvrsn=15 at ES-1-2; see also San Joaquin Valley Air Pollution Control District, "2016 Ozone Plan for 2008 8-hour Ozone Standard," June 16, 2016, available at: http://valleyair.org/Air_Quality_Plans/Ozone-Plan-2016/Adopted-Plan.pdf at 1-6.

[93] South Coast Air Quality Management District, "Final 2016 Air Quality Management Plan," available at: https://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2016-air-quality-management-plan/final-2016-aqmp/final2016aqmp.pdf?sfvrsn=15 at ES-7; see also San Joaquin Valley Air Pollution Control District, "2016 Ozone Plan," available at: http://valleyair.org/Air_Quality_Plans/Ozone-Plan-2016/ES.pdf at ES-5.

[94] South Coast Air Quality Management District, "Final 2016 Air Quality Management Plan," available at: https://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2016-

Further, in November 2017, the San Pedro Bay Ports (Los Angeles, Long Beach) approved a Clean Air Action Plan that includes a goal "to transition the current drayage truck fleet to near-zero technologies in the near-term and ultimately zero-emissions technologies by 2035."[95]

Significant air quality and climate change policy developments at the federal, state, and local levels are likely to impact the transportation fleets of many of our largest commercial and industrial customers. The Clean Transportation team will support our customers by helping them understand new and evolving regulatory and legislative requirements through information, education and training.

c. Cost Drivers

For TY 2024, SoCalGas is requesting an incremental increase of $0.357 million for Clean Fuels Transportation Program from the 2021 BY costs. This is part of the overall incremental request of $12.205 million for the Clean Fuels Infrastructure Development group as shown in Table AI-7.

The $0.357 million incremental increase for Clean Fuels Transportation Program includes $0.224 million in labor and $0.133 million in non-labor to support an expected increase in demand for Clean Transportation services (Customer Support) associated with hydrogen-related customer demand, market activity, and regulatory and legislative activity.[96] The increase in labor and non-labor expenses is to support the following:

- Labor expense for 2 FTEs (two project managers) to support the development and management of new hydrogen-related Clean Transportation customer information, education, and training products and services.
- Non-labor expenses will support the FTEs engaged in the development and management of new hydrogen-related Clean Transportation customer information, education and training products and services.

For additional details, please refer to my workpaper (SCG-12-WP, 2RD000.000).

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air-quality-management-plan/final-2016-aqmp/final2016aqmp.pdf?sfvrsn=15 at 3-32; see also San Joaquin Valley Air Pollution Control District, "2016 Ozone Plan," available at: http://valleyair.org/Air_Quality_Plans/Ozone-Plan-2016/ES.pdf at ES-6.

[95] Port of Los Angeles, "San Pedro Bay Ports Clean Air Action Plan 2017 Final," November 2017, at 33.

[96] As stated above, other costs related to clean transportation are captured in other testimony areas.

8. Clean Fuels Power Generation

The primary goal of this group is to strategically manage policy, technology, compliance, and operational requirements relevant to the deployment of clean fuel power generation projects in efforts to achieve the State's carbon neutrality goals and SoCalGas's vision as described by the ASPIRE 2045 and clean fuels analysis.

The major activities of the clean fuels power generation teams consist of providing policy, technical, and economic feasibility analyses to internal and external facility operators advising in areas that pertain to regulatory, tariffs, contracts, air quality, legislation, market transformation, and education and training specific to clean fuel power generation. This group is a highly cross-functional team that works in collaboration with Customer Energy Solutions Account Representatives to provide customer support in the deployment of clean fuel power generation to all customer segments as described in Brian Prusnek's Customer Services-Information testimony (see Ex. SCG-16, Table BP-14).

Clean fuel power generation projects are subject to many operational, permitting, and safety requirements set forth by the many regulatory and legislative policies. Over the last several years, the number of policies related to clean fuel power generation projects has increased. SoCalGas assists customers in their deployment of clean fuel power generation by answering questions relating to policies that may impact the deployment of the projects. The clean fuels power generation team will also inform customers of the environmental and financial benefits of adopting microgrids. For example, the Clean Fuels Power Generation group provides assistance to customers looking to maximize microgrid benefits by integrating a multitude of Distributed Energy Resources (DER) such as photovoltaics, CHP, energy storage, fuel cells, and linear generators, along with clean fuels such as renewable gas and hydrogen to increase resiliency and reliability as well as economic benefits.[97] Ultimately, customers are looking to deploy microgrids that will yield the best financial outcome, which requires a full understanding of the numerous programs, tariffs, credits, and subsidies. Increasing customer support is not only

[97] U.S. Department of Energy, "The US Department of Energy's Microgrid Initiative," The Electricity Journal, Volume 25, Issue 8, October 2012, available at: https://www.energy.gov/sites/prod/files/2016/06/f32/The%20US%20Department%20of%20Energy's%20Microgrid%20Initiative.pdf.

in alignment with state goals, but it is also necessary to increase customer awareness and education.

Furthermore, climate change and extreme weather events are putting electric system resiliency and reliability at risk, posing serious safety and financial risks to California's people and electric utilities. Extreme weather in and outside of California has significant impacts on the planned operation of California's electric and gas grids making power system resiliency and reliability increasingly important. While the intent of planned outages in the electric system is to avoid greater loss or damage from the extreme climate events, the planned outages still have significant economic and health impacts on many customers.[98] Despite the efforts to reduce the related capacity shortfall due to climate-related events, customers remain vulnerable to unplanned power outages. According to the US Environmental Protection Agency's (EPA) assessment of indoor air quality and climate change, power outages may occur with more frequent extreme weather, making it more difficult to maintain comfortable indoor temperatures and healthy indoor air quality, and leading to more frequent use of portable generators."[99] SoCalGas's clean fuels power generation activities can potentially drive a zero-carbon resiliency solution as traditional gas is displaced with clean fuels for power generation.

The Clean Fuels Power Generation team will increase education, outreach and project support to customers who are looking to adopt clean fuel generation technologies. The intent is to provide customer support in the deployment of projects that meet or exceed expected environmental goals of the State with clean fuels such as renewable natural gas and hydrogen, and technologies such as fuel cells, electrolyzers, combined heat and power, and linear generators.

a. Cost Drivers

For TY 2024, SoCalGas is requesting an incremental increase of $0.360 million for Clean Fuels Power Generation from the 2021 BY costs. This is part of the overall incremental request

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[98] California Governor's Office, Emergency Services, "FY 2019-20 Public Safety Power Shutoff Legislative Report," available at: https://www.caloes.ca.gov/GrantsManagementSite/Documents/Public%20Safety%20Power%20Shutoff%20Legislative%20Report%20FY%202019-20.pdf.

[99] U.S. Environmental Protection Agency, "Indoor Air Quality and Climate Change," December 16, 2021, available at: https://www.epa.gov/indoor-air-quality-iaq/indoor-air-quality-and-climate-change.

of $12.205 million for the Clean Fuels Infrastructure Development group as shown in Table AI-7. The $0.360 million incremental increase for Clean Fuels Power Generation includes $0.300 million in labor and $0.060 million in non-labor to support increased workload to address growing interests in clean fuel power generation projects, and to increase resiliency, reliability, decarbonization, air quality benefits and new technology adoption. The increase in labor and non-labor expenses is to support the following:

- Labor expenses to account for 3 FTEs (two project managers and one administrative assistant) to support clean fuels power generation objectives through research and data gathering efforts, document review, customer outreach, education, and admin support;
- Non-labor expenses required to support clean fuel power generation projects, including feasibility analysis of clean fuel power generation with the intent to transition to clean fuels such as hydrogen and adoption of CCUS; and
- Non-labor expenses required for the development and ongoing maintenance of clean fuel power generation feasibility tool, as well as providing outreach and education to customers transitioning to clean fuels such as renewable gas, hydrogen, or carbon reduction.

For additional details, please refer to workpaper (SCG-12-WP, 2RD000.000).

C. Clean Energy Innovations Project Management Office (PMO)

Included in this section of the testimony are activities and associated O&M costs for PMO, which are non-shared. The costs are summarized in Table AI-8 below.

TABLE AI-8
Clean Energy Innovations PMO Cost Summary

Clean Energy Innovations Project Management Office (PMO) (in 2021$, in 000s)			
O&M	**2021 Adjusted-Recorded**	**Estimated TY 2024**	**Change**
Labor	$293	$1,523	$1,230
Non-Labor	$4	$69	$65
Total O&M	$297	$1,592	$1,295

1. Description of Costs and Underlying Activities

The complexity of projects and activities executed as part of CEI's project portfolio and the integration between them and other existing enterprise systems and organizations requires the institution of formal project management processes and procedures to mitigate risks and increase

the likelihood of project success. To accomplish this, the CEI PMO is responsible for the establishment and implementation of a project governance and management framework to reduce risks through checks and balances during the project life cycle. The governance processes are guided by industry standards and best practices, designed to standardize project execution across the project portfolio, and to provide leadership with clear, timely, and accurate portfolio information and allow management to assess whether projects follow scope and schedule, meet quality expectations, and are on target to achieve established goals.

The project management framework includes:

1. Defining project and portfolio management standards including common templates and documentation standards, project staging guidelines, processes for ending project activities, and transition project outcomes to operations;
2. Establishing a common methodology for tracking and reporting project scope, project risk, project changes, scheduling strategy and execution, and project communications;
3. Implementing monitoring tools to provide timely and accurate project reporting to aid leadership in ensuring continued portfolio alignment with clean energy strategies, and best allocation of resources;
4. Establishing Organizational Change Management (OCM) processes and methodologies for introducing changes driven by project results to the organization;
5. Developing and executing a process to help achieve project benefits;
6. Facilitating tracking of project plans; and
7. Establishing and staffing an organization with experienced management staff in each of the core PMO control areas.

The CEI PMO is comprised mainly of two focus areas: (1) the PMO Portfolio Management Group that is responsible for the establishment and implementation of project management standards and reporting across the entire portfolio of CEI projects, and (2) the PMO Special Initiatives Group that is responsible for project management of specific initiatives and established based on the initiatives' changing needs. PMO functions are aligned to support project activities while providing the Company leadership with visibility of the project portfolio

through project lifecycles. In support of a lean organization, cross-training is performed whenever feasible.

2. Forecast Method

The forecast method developed for this cost category for labor and non-labor expenses is the base year method. Incremental adjustments represent the anticipated expense requirements in TY2024. This method is most appropriate because the CEI PMO group was formed in January 2021 and no historic cost information exists prior to this date.

3. Cost Drivers

Clean Energy Innovations Project Management Office's total adjusted-recorded expenditures of $0.297 million in BY 2021 consisted of $0.293 million in labor and $0.004 million in non-labor costs. For TY 2024, SoCalGas is requesting a total of $1.592 million. This amount reflects $1.295 million incremental increase from the base year. The incremental increase includes $1.230 million in labor and $0.065 million in non-labor to support an expected growth in activity associated with clean energy-related projects and activities that help deliver future products and services to customers. The increase in labor and non-labor expenses is to support the following:

- Labor expenses include PMO project managers and project advisors.
- Non–Labor expenses include project management software acquisition and maintenance.

For additional details, please refer to workpaper (SCG-12-WP, 2RD002.000).

D. Research Development & Demonstration (RD&D) Refundable Program

TABLE AI-9
Research Development & Demonstration Cost Summary

Research Development & Demonstration Refundable Program (in 2021$, in 000s)			
O&M	**2021 Adjusted-Recorded**	**Estimated TY 2024**	**Change**
Labor	$2,111	$2,608	$497
Non-Labor	$15,929	$20,641	$4,712
Total O&M	$18,040	$23,249	$5,209

1. Description of Costs and Underlying Activities

The RD&D Program is a statutorily authorized program that identifies and supports new technologies and research activities.[100] The mission and values of the RD&D Program align with SoCalGas's mission to build the cleanest, safest, and most innovative energy company in America. The RD&D Program's mission, which is to "Identify transformational energy Solutions. Build them. Share them with the world," is supported by three core values: (1) Science – Our experts in science, engineering, energy systems, and environmental policy seek to answer some of today's most pressing energy questions; (2) Synergy – We work with the world's finest researchers in universities, nation labs, and industry to develop transformational technologies that support decarbonizations, energy security, and economic development; and (3) Equity – We champion technologies that support affordable access to clean, safe, and reliable energy.

The RD&D Program cost forecast for TY2024 of $23.249 million is driven by the need to develop and deploy technologies that: (1) reduce GHG emissions, (2) increase safety, and (3) improve energy reliability for all Californians.

As in prior GRC cycles, the RD&D Program costs will be tracked in a one-way balancing account and all RD&D Program funding is refundable. Costs incurred and tracked in the RD&D Program balancing account include direct project expenditures and all project related management and administration costs.[101] This includes non-labor costs used for the direct

[100] Pub. Util. Code § 740.1.

[101] Balancing account is further described in Rae Marie Yu's Regulatory Accounts testimony (Ex. SCG-38).

execution of RD&D projects by third parties under contract to SoCalGas, as well as labor and non-labor costs used in planning, directing, managing, and administering these projects.

2. Forecast Method

The forecast method developed and used for this cost category is the zero-based method. This method is most appropriate because specific RD&D needs and activities evolve over time as technologies progress and new public policies and goals are established. Additionally, a zero-based methodology is more forward-looking as it considers funding for projects that are being planned rather than projects that have already been completed. The zero-based method has been utilized for this workpaper in SoCalGas's last two GRCs and has been previously approved by the Commission. To provide additional support for the zero-based method, technology gaps and needs were assessed in each RD&D program area based on the current state of technology and then compared to the performance required to meet safety and reliability enhancements, energy efficiency goals, criteria pollutant and GHG emission reductions, and other cost and performance goals (more detail on the technology needs assessment is provided in Appendix B – "Technology Needs Assessment Summary"). The identified technology needs were combined with prior experience on project cost and co-funding requirements to develop target project funding requirements in each program area. To manage larger and more complex research initiatives, policy directives, and reporting requirements, two additional FTE are needed to manage these efforts. The TY2024 forecast reflects increased RD&D activity in hydrogen production and utilization, building decarbonization, energy reliability and resilience, carbon capture, zero-emission transportation, and gas transmission and distribution system safety and reliability.

3. Cost Drivers

The RD&D Program costs support the State's climate policy goals, including the continued use and adoption of clean fuels such as renewable natural gas and hydrogen, as well as carbon management in support of the State's carbon neutrality goals.[102] Additionally, the RD&D Program costs support the Company's goals of reducing emissions, improving performance, reducing cost across the full range of gas applications, and improving the safety and reliability of

[102] State of California, Executive Department, EO B-55-18 "Achieve Carbon Neutrality."

utility operations, all of which are aligned to SoCalGas's mission, strategy, safety, and sustainability plan.[103]

As explained in previous sections, SoCalGas is intent on leading the transition to a resilient and decarbonized clean fuels infrastructure in California.[104] Innovation and rapid development of new technologies will be essential to reach the decarbonization goals set by the State and SoCalGas. The development and deployment of clean energy solutions including hydrogen, renewable natural gas, synthetic fuels, and carbon management is made more achievable through active research, development, and demonstration of technologies that lead to increased affordability and adoption of resilient clean energy solutions at scale.

Additional cost drivers for this forecast include efforts to increase equity consideration and program transparency:

- SoCalGas, in consultation with the Commission and Energy Division Staff, is working to increase consideration of Environmental and Social Justice in RD&D funding decisions and to track and report efforts towards these considerations and to quantify their benefits. Additional resources are required to develop new policies and procedures, educate RD&D Program staff and research partners, and track and report progress.
- The RD&D Program began development of a multi-year, public-facing Equity Engagement Roadmap that seeks to include face-to-face encounters aimed at building trust, gathering and disseminating critical information, reporting, synthesizing data, and responding to ESJ needs appropriately.
- SoCalGas continues its efforts to increase transparency in the RD&D Program by providing research webinars on recently completed projects and compiling an annual report that both summarizes the RD&D Program's structure, objectives, and accomplishments and provides project level detail on each of the active and completed projects within the RD&D Program's portfolio.

Furthermore, additional RD&D resources are required to track and identify relevant funding opportunities that will result from the recently passed IIJA.[105] Some of the objectives of the IIJA that are relevant to the RD&D Program include: (1) to advance research and development to demonstrate and commercialize the use of clean hydrogen in the transportation,

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[103] SoCalGas, "ASPIRE 2045 SoCalGas Sustainability Strategy," available at: https://www.socalgas.com/sites/default/files/2022-01/SoCalGas_Sustainability_Strategy-final.pdf.

[104] *Id*.

[105] H.R. 3684 "Infrastructure Investment and Jobs Act," last modified November 15, 2021, available at: https://www.congress.gov/bill/117th-congress/house-bill/3684/text.

utility, industrial, commercial, and residential sectors; and (2) to demonstrate a standard of clean hydrogen production in the transportation, utility, industrial, commercial, and residential sectors by 2040. To help accomplish these goals, the IIJA has appropriated $500 million to advance clean hydrogen manufacturing and recycling research and development and $1 billion toward research, development, demonstration, commercialization, and deployment of hydrogen electrolysis program. The RD&D Program, along with project partners will develop proposals and seek to secure federal funding for these projects within California generally and specifically within SoCalGas's service territory.

For additional details, please refer to workpaper (SCG-12-WP, 2RD001.001).

E. The RD&D Program Supports California's Environmental, Health, Safety, and Reliability Policy Goals

The RD&D Program tracks and evaluates projects based on a set of six potential ratepayer benefits: safety, reduced GHG emissions, improved air quality, improved affordability, operational efficiency, and reliability. These six benefits were identified based on the project objectives outlined in CPUC Section 740.1 as well as some of California's environmental, health, safety, and reliability policy goals, including SB 32 (Reduce carbon dioxide emissions 40% below 1990 levels by 2030), Executive Order B-55-18 (Carbon-neutral California economy by 2045), AB 3232 (Reduce GHG emissions from residential and commercial buildings by 40% below 1990 levels by 2030), Executive Order N-79-20 (100% of MHDs be zero emission by 2045 for all operations where feasible), and CPUC General Order No. 112F (Rules governing design, testing, operation, and maintenance of gas transmission and distribution systems).

1. RD&D Projects Target Specific Ratepayer Benefits

Benefits are identified for each project funded by the RD&D Program. For example, in 2021, the RD&D Program supported 379 active projects. Of those projects, 177 contributed to safety, 203 supported improved reliability, and 211 had the potential to reduce GHG emissions. In accordance with CPUC Resolution G-3586, the RD&D Program is working with Energy Division staff to develop a framework to better quantify and report the specific benefits of funded projects.

SoCalGas's internal processes and stakeholder outreach promote relevant, non-duplicative, and effective RD&D, as set forth below.

2. A Rigorous Review Process Checks RD&D Projects Against CPUC Section 740.1 Standards

When identifying promising projects and evaluating them for potential funding, RD&D Program staff take a comprehensive yet flexible approach that enables them to: (1) identify potential projects that are most in alignment with RD&D Program goals, state and federal environmental policy, and industry demand; (2) assess the likelihood of potential projects to succeed; (3) work with proven partners and technologies over time; and (4) respond nimbly to changing market, technology, and policy drivers. In addition—remembering that some technologies will not result in concrete benefits until implemented at scale—RD&D Program staff consider the overall development and implementation process and research life cycle of a given technology or product.

RD&D Program staff relies primarily on CPUC Code Section 740.1 in developing project evaluation criteria. Key project evaluation criteria are customer benefit, alignment with California policy, lead investigator/team, technical feasibility, co-funding collaborators, commercialization potential, and equity considerations. SoCalGas's RD&D Program staff follow a rigorous approach to project identification and selection. In this process, program staff: (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 inputs, including the current CPUC approved RD&D Research Plan, California policies and targets, project evaluation criteria, and the overall portfolio strategy; (4) refine scopes of work for approved projects, if necessary; (5) review funding sources following SoCalGas accounting policies; and (6) execute the project contract and initiate project research. Projects that do not receive internal approval or sufficient funding may be directed to adjust the project scope and re-start that approval process at Step 2.

3. Annual Report, Public Workshop, and Research Plan Process Promote Public Engagement

Following the requirements of D.19-09-051, there is a robust annual process for presentation and approval of SoCalGas's RD&D plans. Each year, the SoCalGas RD&D program produces and submits to Energy Division an Annual Report that includes a summary of ongoing and completed projects; funds expended, funding recipients, and leveraged funding; and

an explanation of the process used for selecting RD&D project areas as well as the structure of SoCalGas's RD&D portfolio. These reports are also posted on the SoCalGas RD&D website[106] for public access.

In addition, each year, the RD&D Program hosts a public workshop to present the results of the previous year's RD&D activities and obtain input regarding its intended spending for the following calendar year. Prior to the workshop, the RD&D Program directly engages key stakeholders in the R&D community, including DOE, CEC, and GTI Energy. In 2020, the online workshop was attended by 148 individuals from organizations, including CPUC, CEC, CARB, CalState LA, and Orange County Hispanic Chamber of Commerce. The 2021 workshop was attended by 165 individuals from organizations including CPUC, California Governor's Office of Business and Economic Development, GTI, SCAQMD, Earthjustice, and Latino Chamber of Commerce of Compton. Public comments during and after the workshops have proven valuable in providing guidance to RD&D staff in research planning efforts. Many comments have also highlighted the value that SoCalGas RD&D brings to the broader research landscape.

After considering stakeholder comments during the workshop, SoCalGas files a Tier 3 Advice Letter with its research plan for the following calendar year. The research plan includes budgets broken down by Sub-program, a description of how RD&D projects help improve reliability, safety, environmental benefits, or operational efficiencies, and a discussion of the ways RD&D staff incorporates feedback from workshop stakeholders and Commission staff.

Overall, this review process has proven to be extremely valuable, through incorporation of stakeholder input, sharing the results of the RD&D Program's research projects with them, and better connecting the members of the clean energy research community through various workshops.

4. Proposal to Modify Advice Letter Requirement

Although the newer, robust process for RD&D Program approval has resulted in more engagement and feedback from interested parties, the requirement of a Tier 3 Advice Letter

[106] https://www.socalgas.com/sustainability/research-development-demonstration-rdd.

filing presents the Commission with an enormous review and approval burden. Therefore, SoCalGas is respectfully requesting that the process be modified to a Tier 2 Advice Letter to streamline and improve the program approval process.

In 2021, SoCalGas submitted the 2022 Research Plan (Advice No. 5824) on June 21st, 2021. Resolution G-3586, which approved the Research Plan in its entirety, was voted on and approved on March 17, 2022.

For almost the entire 1st quarter of 2022, the RD&D Program could not issue payment to research teams. As such, we respectfully request to modify the Advice Letter requirement from Tier 3 to Tier 2 to help reduce the administrative burden on the Commission and ED staff. A Tier 2 Advice Letter is appropriate for matters such as "A tariff change that is consistent with authority the Commission previously has granted to the Utility submitting the advice letter, such as a rate change within a price floor and ceiling previously approved by the Commission for that Utility."[107] Since RD&D Program funding is authorized by the Commission through the GRC process and approval of the RD&D Annual Research Plan simply allows the RD&D Program to adapt to an ever-changing research landscape, a Tier 2 Advice Letter is appropriate. A Tier 2 Advice Letter requires approval of Commission Staff, who are actively engaged throughout the process described in the proceeding section. Furthermore, all Advice Letter filings include a 20-day protest period, further ensuring public oversight and transparency, and allowing the same opportunity for the public to be heard. SoCalGas is committed to working closely with the Commission, Energy Division Staff, and our public stakeholders to ensure that the RD&D Program provides the greatest possible benefit to our ratepayers.

5. The RD&D Program's Equity Engagement Activities Improve Deployment of Clean Energy Benefits to Historically Underserved Communities

The RD&D Program seeks to advance and champion technologies that support widespread access to clean, affordable, and reliable energy for all Californians, including those living and working in ESJ communities. Equity is one of the Program's core values that is considered in every funding allocation decision.

[107] CPUC, General Order 96-B, Industry Rule 5, § 5.2(2) ("Matters Appropriate to Tier 2").

In 2021, the RD&D Program, in coordination with SoCalGas Regional Public Affairs (RPA) group, conducted five community outreach sessions to facilitate a dialogue with leaders from community-based organizations (CBOs) from across the SoCalGas service territory. Participants included El Concilio Family Services, Black Voice Foundation, Asian Youth Center, Community Action Partnership of Kern, UC Riverside, and CSU Los Angeles. Based on these conversations, the RD&D Program launched the development of an Equity Engagement Roadmap to identify specific activities that the RD&D Program will undertake to enhance the equity component of the program.

Furthermore, the RD&D Program works with the SoCalGas Supplier Diversity group to identify resources available to help diverse and minority-owned businesses connect and work with the RD&D Program. Supplier Diversity can help diverse business owners navigate the paperwork required to obtain certification by the CPUC as a Diverse Business Entity (DBE).

Finally, the RD&D Program seeks out underserved communities to identify host sites for demonstration projects. In 2021, the RD&D Program supported 27 projects located in SB535 disadvantaged communities including the cities of Compton, West Sacramento, and Riverside.

6. The RD&D Program Supplements and Complements Other R&D Programs

The RD&D Program is an important element of a larger technology funding ecosystem that includes federal, state, and regional public agencies, and a variety of gas industry research entities. RD&D Program staff works with leading industry professionals and SMEs from these organizations, as well as from universities, national labs, and businesses, to maximize the impact of their investments in promising technologies and products with high commercialization potential. These relationships enable SoCalGas to engage science and technology experts, other utilities, and industry stakeholders in open dialogues to effectively identify and close knowledge and research gaps, avoid duplication of previous and ongoing research, and mitigate technical, economic, and commercialization risks. Engagement with these groups help facilitate development of products and technologies that reduce customer costs, save energy, increase safety and reliability, improve air quality, and reduce GHG emissions. Together, information and research concepts are exchanged, project collaborations are developed, partnerships are established, and public and private funding opportunities are actively sought, with the goals of

securing additional co-funding for projects as well as assembling the most capable and impactful team of SMEs to work on any particular project.

Within this rich state and national funding ecosystem, the RD&D Program plays a unique role. Whereas many other funding programs focus on national and statewide needs, the RD&D Program concentrates on the needs of its many residential, commercial, and industrial customers in Southern California. This focus enables the RD&D Program to better serve its customers by driving the scope of research sponsored by entities like DOE, ARPA-E, and EPA to concentrate on California's specific energy transition needs.

The SoCalGas RD&D Program also has many strengths of its own. First, SoCalGas is dedicated to engaging with and supporting the communities it serves, providing energy, time, and financial support in areas where it can make a difference. Because SoCalGas serves residential, commercial, and industrial gas customers in Southern California as its primary line of business, RD&D Program staff have access to the existing infrastructure, information, and expertise of the entire Company, including an intimate knowledge of customer challenges, needs, and desired benefits. In addition, the Company's existing infrastructure—as well as the relationships the Company has built with its customer base and regional public agencies—also provides access to a rich base of potential demonstration sites within the region. Importantly, the RD&D Program can act nimbly, providing funding to innovative new products and technologies that federal, state, and regional agencies cannot support due to slower funding cycles. Finally, the RD&D Program is positioned to supplement[108] and complement[109] the work of other organizations, by stepping in to fund early-stage research or middle- to late-stage technology

[108] D.19-09-051 at 377 ("SoCalGas provided evidence that their RD&D programs complement other R&D programs such as solicitations, host sites, and co-funding projects that complement the CEC's Natural Gas R&D program as well as projects that supplement programs by the Environmental Protection Agency and Air Resource Board.…The above shows that SoCalGas' RD&D program is not duplicative of and actually supplements other R&D projects by government agencies and other groups.")

[109] SoCalGas Advice Letter 5652, July 25, 2020, Appendix C at C-8 ("SoCalGas' RD&D program can complement the CEC's R&D efforts to help meet the state's clean energy goals…. Historically, the CEC has successfully partnered with SoCalGas on projects spanning residential and commercial end use appliances, industrial process energy improvements, and transportation with high- efficiency low-emission CNG heavy-duty engines. These collaborative projects have delivered important deployments (e.g., Hyperlight, GTI on food processing) and commercialization achievements (e.g., Cummins Westport)").

development that other organizations cannot support.

7. Recent Accomplishments Demonstrate the Effectiveness of the RD&D Program

In 2020 and 2021, SoCalGas RD&D projects resulted in the production of 95 publications, reports, and technology briefs. The RD&D Program's research work also produced four patents and patent applications. A major goal of the RD&D Program is to bring technology from lab to market. In 2020 and 2021, organizations across California and throughout the nation deployed numerous products and technologies for real-world use. Examples include a method for measuring fracture toughness via in-ditch, non-destructive testing; real-time visualization and notification of gas utility threats; an in-line inspection tool for gas storage piping; and a method to protect tracer wires from corrosion.

In 2020, 19 research proposals supported by the SoCalGas RD&D Program were awarded funding by government agencies including CEC, DOE, NSF, and ARPA-E. These awards represented over $38M of additional funding to support SoCalGas RD&D research initiatives. In 2021, 11 research proposals were awarded funding by public agencies including CEC, DOE, and PHMSA. These awards represent over $48M of additional funding to support SoCalGas RD&D research initiatives. Examples of such research initiatives include collaboration with DOE to demonstrate a technology that captures carbon dioxide from the air while simultaneously collecting water that can then be reused for irrigation[110]; funding from CEC to support SoCalGas, Sierra Northern Railway, Gas Technology Institute (GTI), and other technical experts to develop and test a zero-emission hydrogen fuel cell engine for a switcher locomotive;[111] and funding from CEC to support SoCalGas and Zero Emission Industries (ZEI)

[110] SoCalGas, "SoCalGas to Fund Testing of First-of-its-Kind Direct Air Capture Technology," November 16, 2021, available at: https://newsroom.socalgas.com/press-release/socalgas-to-fund-testing-of-first-of-its-kind-direct-air-capture-technology.

[111] SoCalGas, "SoCalGas Partners with Sierra Northern Railway to Fund Development of Hydrogen Fuel Cell Switcher Rail Locomotive," July 28, 2021, available at: https://newsroom.socalgas.com/press-release/socalgas-partners-with-sierra-northern-railway-to-fund-development-of-hydrogen-fuel.

to develop a zero emissions solution for small commercial marine vessels by modifying a commercial boat with a hydrogen fuel cell in place of a combustion engine.[112]

Finally, numerous RD&D Program alumni companies have received significant following their participation in the RD&D Program. For example, Electrochaea's biomethanation technology was demonstrated at NREL with support from the RD&D Program. In 2021, Baker Hughes, a $20B industrial services company,[113] purchased a 15% stake[114] in Electrochaea, backing a technology intended to address concerns about greenhouse gas emissions. Also in 2021, electrochemical carbon dioxide reduction startup, Twelve (formerly Opus 12), which received early technology development support from the SoCalGas RD&D Program, raised $57 million in Series A[115] funding from lead investors Capricorn Technology Impact Fund and Carbon Direct Capital Management. These examples show the RD&D Program's ability to identify promising technology early, but also show the impact that SoCalGas's support can have in advancing those technologies to commercialization.

8. Funding Detail

The RD&D Program supports projects in four main research domains:

a. Clean & Renewable Energy Resources RD&D

The primary goal of the Clean & Renewable Energy Resources program area is to decarbonize the gas supply while maintaining its affordability and reliability. To accomplish this

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[112] SoCalGas, "SoCalGas & California Energy Commission to Provide Funding to Test Hydrogen Fuel Cell Technology for Marine Vessels," April 27, 2021, available at: https://newsroom.socalgas.com/press-release/socalgas-california-energy-commission-to-provide-funding-to-test-hydrogen-fuel-cell.

[113] Baker Hughes Company Profile, available at: https://craft.co/baker-hughes.

[114] Bloomberg News, "Baker Hughes Takes a Stake in Synthetic Natural Gas Startup." June 28, 2021, available at: https://www.bloomberg.com/news/articles/2021-06-28/baker-hughes-takes-a-stake-in-synthetic-natural-gas-startup.

[115] Yahoo Finance, "Twelve, Formerly Opus 12, Secures $57 Million in Series A Funding Led by Capricorn and Carbon Direct," July 8, 2021, available at: https://finance.yahoo.com/news/twelve-formerly-opus-12-secures-120000904.html?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuYmluZy5jb20v&guce_referrer_sig=AQAAAKBIzUQYylBtZ5HUE8pbgBHCQ2h837FsthpVLnGtb2_OIg09pJ_c_PhNY9FAwxfkg-1eT0NjnCFUNWFRM2dmRFookOUFDJ8Huutl80EREhLiL5UahF5EIK08OH9nFBeRSs1pvWQ8W9kwdshvf9YNV4rPhNKcJHtrmqTlIJ69fcUe.

goal, program staff members develop, promote, and advance new technologies aimed at increasing and expanding the production of renewable gas to displace conventionally sourced pipeline gas, while aggressively eliminating GHG emissions.

b. Gas Operations RD&D

The Gas Operations RD&D program supports pipeline transportation and storage operations through innovations that enhance pipeline and employee safety, maintain system reliability, increase operational efficiency, and minimize GHG impacts to the environment.

c. Clean Transportation RD&D

The Clean Transportation RD&D program supports activities that minimize environmental impacts related to the transportation sector through the development of low-carbon fuels, zero and near-zero-emissions drivetrains, refueling infrastructure, and on-board storage technologies.

d. Clean Energy Applications RD&D

The Clean Energy Applications RD&D program supports the development and demonstration of highly efficient low-emission technologies associated with the stationary utilization of gaseous fuels for power generation and thermal applications. This program seeks to improve efficiencies, reduce emissions, lower costs, and improve reliability for residential, commercial, and industrial customers.

9. RD&D Program Cost Forecast

The RD&D Program cost forecast is a small fraction of the total GRC request. This level of RD&D funding as a proportion of annual authorized GRC base margin revenues is also consistent with the historical range over recent last program cycles.

TABLE AI-10
TY 2024 RD&D Program Funding Forecast
In Thousands of (In 2021 $, in 000s)

Program	Sub-Program		TY 2024 Forecast
Clean & Renewable Energy Resources	Renewable Gas Production		$ 3,701
	Carbon Management		$ 3,701
		Subtotal	**$ 7,402**
Gas Operations	Environmental & Safety		$ 784
	Operations Technology		$ 587
	System Design & Materials		$ 1,568

	System Inspection & Monitoring		$	980
		Subtotal	**$**	**3,919**
Clean Transportation	Off-Road		$	1,970
	On-Road		$	1,970
	Refueling Infrastructure		$	470
		Subtotal	**$**	**4,410**
Clean Energy Applications	Energy Reliability		$	1,970
	Residential & Commercial		$	1,470
	Industrial Operations		$	1,470
		Subtotal	**$**	**4,910**
Total			**$**	**20,641**

V. CAPITAL

Included in this section of the testimony are descriptions of activities associated with capital expenditures for the [H2] Hydrogen Home and Hydrogen Refueling Stations related to CEI. The capital expenditure forecasts and the actual costs for these projects are referenced in other SoCalGas testimonies including in witness Brenton Guy's Real Estate and Facility Operations testimony (Ex. SCG-19) and Mike Franco's SoCalGas Fleet Services testimony (Ex. SCG-18).

A. [H2] Hydrogen Home

In TY2024, SoCalGas is forecasting $4.573 million to support the capital expenditure activities to build the [H2] Hydrogen Home project, a state-of-the-art clean energy project to showcase the role hydrogen could play in attaining California's decarbonization goals. Included in this section of the testimony is the overview and the associated scope of the non-shared project. Refer to the Real Estate and Facility Operations testimony of Brenton Guy's Real Estate and Facility Operations testimony (Ex. SCG-19) for the detailed capital expenditure forecast for the [H2] Hydrogen Home project.

1. Description

As part of SoCalGas's clean energy solutions to help its 22 million customers enjoy a more sustainable future, the CEI is currently building the [H2] Hydrogen Home project, a state-of-the-art clean energy project to showcase the role hydrogen could play in attaining California's decarbonization goals. The [H2] Hydrogen Home project is one of first of its kind clean energy projects that incorporates solar panels, battery storage, green hydrogen production, hydrogen fuel cell, hydrogen storage, and hydrogen blending into the natural gas system for a less carbon-

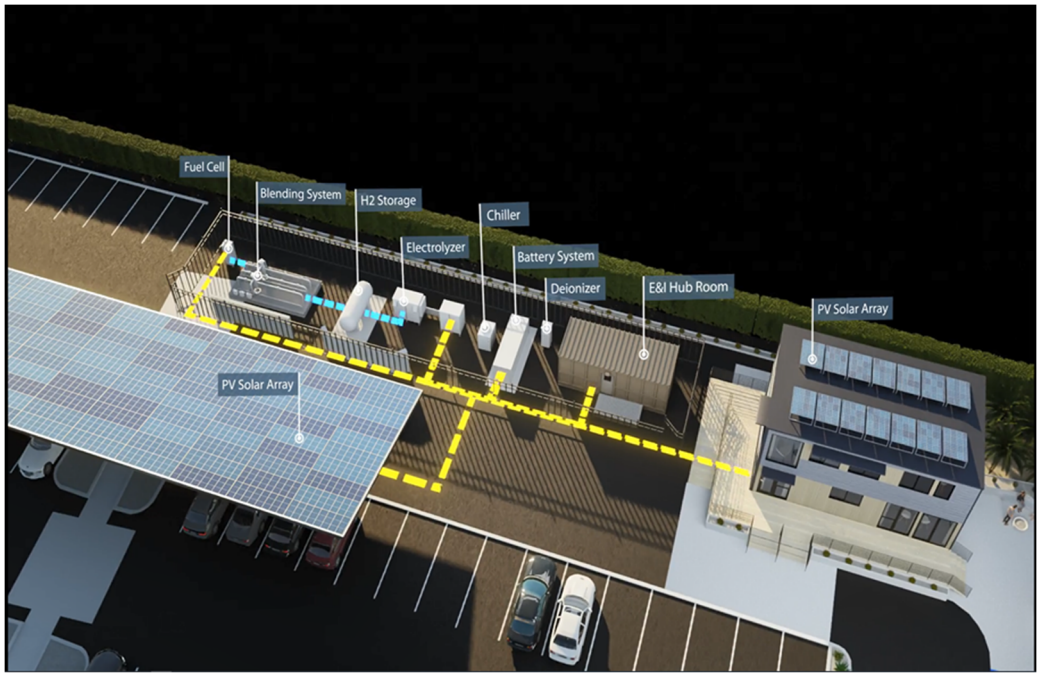
intensive energy source to be used in the home's appliances, including the heat pump, heating and air conditioning unit, water heater, clothes dryer, and gas stove.

Being the first of its kind in the U.S., the [H2] Hydrogen Home project will create an islanded microgrid that includes a home, solar arrays, a home battery, and an electrolyzer to convert solar energy into green hydrogen. It will also include a fuel cell to convert the hydrogen back to electricity. The home will function and feel exactly like a regular home but use reliable and clean energy 24 hours a day, 7 days a week, 365 days a year. The [H2] Hydrogen Home project has been named one of Fast Company's 2021 World-Changing Ideas in the North America category because of its impact on climate goals, design, scalability, and ingenuity in innovation.[116]

The [H2] Hydrogen Home project integrates renewable hydrogen production and fuel cell technology with a renewable energy stand-alone-power-system in a "living lab" microgrid setup. The [H2] Hydrogen project will have renewable energy generated from the 65 kW cart port and 7 kW rooftop solar photovoltaics, which will also be used to produce renewable hydrogen from a 62 kW electrolyzer. Excess renewable energy will also be stored for non-sunshine hours-usage in 230 kWh capacity as onsite battery energy storage. Green hydrogen will be stored in a 30-bar high-pressure storage vessel on-site and will either be distributed within the microgrid as a blended fuel with natural gas (20% hydrogen by volume) for use as a direct fuel for home appliances or as direct power to the home via a 100% hydrogen fuel cell. The [H2] Hydrogen Home design is a two story 1,920 square foot, pre-engineered sustainable modular home. The [H2] Hydrogen Home is being designed for Platinum LEED certification upon its completion.

[116] SoCalGas Newsroom, PRNewswire, "SoCalGas' H2 Hydrogen Home Named a Fast Company 2021 World-Changing Idea," June 15, 2021, available at: https://newsroom.socalgas.com/press-release/socalgas-h2-hydrogen-home-named-a-fast-company-2021-world-changing-idea.

Figure AI-3
[H2] Hydrogen Home Scope



The [H2] Hydrogen Home project is currently under construction and scheduled to be completed in 3rd quarter of 2022.

The research, testing, and showcase efforts as part of the [H2] Hydrogen Home project would inform the viability assessments and to further innovate and adopt future hydrogen technologies at scale. The [H2] Hydrogen Home project aims to accelerate the clean energy transition by increasing the delivery of clean fuels such as green hydrogen and to meet SoCalGas' sustainability goals[117] and California's decarbonization goals. The results from the [H2] Hydrogen Home project will help advance SoCalGas's clean energy and sustainability endeavors with a focus on protecting California's communities with the goal to achieve net zero greenhouse gas emissions and helping to improve local air quality and to increase access to clean and more affordable energy for all energy customers.

[117] SoCalGas, "ASPIRE 2045 SoCalGas Sustainability Strategy" available at: https://www.socalgas.com/sites/default/files/2022-01/SoCalGas_Sustainability_Strategy-final.pdf.

B. Hydrogen Refueling Stations

1. Description

SoCalGas plans to construct and operate public access Hydrogen Refueling Stations (HRS) at utility operating bases, as sponsored in Brenton Guy's Real Estate and Facility Operations testimony (Ex. SCG-19). These HRS will be designed to serve the utility fleet located at the bases in question as well as the general public. The general public will be offered hydrogen fuel once a retail rate for hydrogen vehicle fuel is approved in the next applicable Triennial Cost Allocation Proceeding. See Section IV.B.7, above for more detail on hydrogen transportation.

2. Low Carbon Fuel Standard

Since SoCalGas is seeking authority to construct and operate HRS, it will now be possible to begin generating hydrogen related green credits, including but not limited to CARB Low Carbon Fuel Standard (LCFS) credits. As a result, SoCalGas requests the authority to sell and disburse hydrogen related green credits generated by utility owned, public access hydrogen vehicle refueling stations to customers, consistent with the treatment of natural gas vehicle related green credits described in D.14-05-021, D.14-12-083 and Advice Letter 5295-G. The green credit revenue will be placed in the Hydrogen Refueling Station Balancing Account (HRSBA) as described in the Rae Marie Yu's Regulatory Accounts testimony (Ex. SCG-38).

VI. CONCLUSION

My testimony covers a variety of functions and activities that supports innovative clean energy technologies and pathways to create a portfolio of clean energy solutions, which is foundational to the energy transition for California and to meet SoCalGas' sustainability goals.

The incremental funding requests in my testimony are driven by SoCalGas's sustainability strategy and in support of California's goal to meet the States' decarbonization goals. The CEI's activities are carried out to protect the interests and safety of our customers and our community that we serve and to ensure that State's decarbonization goals are achieved cost-effectively.

This concludes my prepared direct testimony.

VII. WITNESS QUALIFICATIONS

My name is Armando Infanzon. My business address is 555 West 5th Street, Los Angeles, California 90013. I am employed by Southern California Gas Company as Director of Business Development. My present responsibilities are the project development of clean fuels infrastructure including hydrogen, carbon capture, utilization and sequestration and distributed energy resources. I also manage the Federal Energy Retrofit Program (FERP) for SoCalGas.

Between 2011-2014, I served as Smart Grid Policy Manager for San Diego Gas and Electric (SDG&E) representing the company on regulatory and legislative issues at state and federal level. I served as a witness for SDG&E's Energy Storage Procurement Application (A. 14-02-006).

I have been employed by Sempra Energy, SDG&E and/or SoCalGas since 1998 and have held various management level positions covering an array of different areas including business development, regulatory and energy policy, economic analysis, financial planning, corporate finance, and asset management. I received a bachelor's degree in accountancy from the Autonomous University of Baja California in 1997 and a master's degree in business administration from San Diego State University in 2000.

APPENDIX A

Glossary of Terms

Appendix A
Glossary of Terms

Acronym	Definition
ACF	Advanced Clean Fleets
BNEF	BloombergNEF
BY	Base Year
CAISO	California Independent System Operator
CARB	California Air Resources Board
CBO	Community-based organizations
CCUS	Carbon Capture, Utilization, and Storage
CDFA	California Department of Food and Agriculture
CEC	California Energy Commission
CEI	Clean Energy Innovations
CES	Customer Energy Solutions
CFF	Cross-Functional Factor
CFR	Code of Federal Regulations
CO2	Carbon dioxide
CoRE	Consequence of Risk Event
CPUC	California Public Utilities Commission
DBE	Diverse Business Entity
DOE	Department of Energy
DOT	Department of Transportation
E3	Energy and Environmental Economics, Inc.
EO	Executive Order
EPC	Engineering, Procurement, and Construction
EPIC	Electric Program Investment Charge
ESJ	Environmental & Social Justice
FCVs	Fuel Cell Vehicles
FEED	Front-End Engineering and Design
FERP	Federal Energy Retrofit Program
FTE	Full-Time Equivalent
GFO	Grant Funding Opportunity
GHG	Greenhouse Gas
Gt	Gigatons
GTI	Gas Technology Institute
GVWR	Gross Vehicle Weight Rating
HRSBA	Hydrogen Refueling Station Balancing Account
ICT	Innovative Clean Transit
IIJA	Infrastructure Investment and Jobs Act
IT	Information Technology
kg	Kilogram

Acronym	Definition
KPI	Key performance indicator
LADWP	Los Angeles Department of Water and Power
LCFS	Low Carbon Fuel Standard
LoRE	Likelihood of Risk Event
NFPA	National Fire Protection Association
NGVs	Natural gas vehicles
NOx	Nitrogen oxides
O&M	Operations and Maintenance
OCM	Organizational Change Management
OEM	Original Equipment Manufacturer
OIR	Order Instituting Rulemaking
OT	Operational Technology
PM	Particulate matter
PMO	Project Management Office
RAMP	Risk Assessment Mitigation Phase
RD&D	Research Development & Demonstration
RGS	Renewable Gas Standard
RNG	Renewable Natural Gas
RPA	Regional Public Affairs
RSE	Risk spend efficiency
SB	Senate Bill
SCALE	Storing CO2 and Lowering Emissions
SCG	SoCalGas
SDG&E	San Diego Gas and Electric
SNG	Synthetic Natural Gas also referred to as Syngas
SoCalGas	Southern California Gas Company
T&D	Transmission and distribution
TY	Test Year
ZEI	Zero Emission Industries
ZEVs	Zero-Emission Vehicles

APPENDIX B

Technology Gap Assessment

APPENDIX B

Technology Gap Assessment

Technology Gap Assessment Summary

Program	Sub-Program	TY2024 Forecast ($,000)
Clean & Renewable Energy Resources	Renewable Gas Production	3,701
	Carbon Management	3,701
	Subtotal	**7,402**
Gas Operations	Environmental & Safety	784
	Operations Technology	587
	System Design & Materials	1,568
	System Inspection & Monitoring	980
	Subtotal	**3,919**
Clean Transportation	Off-Road	1,970
	On-Road	1,970
	Refueling Infrastructure	470
	Subtotal	**4,410**
Clean Energy Applications	Energy Reliability	1,970
	Residential & Commercial	1,470
	Industrial Operations	1,470
	Subtotal	**4,910**

Total	**20,641**

Clean & Renewable Energy Resources Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
Renewable Gas Production	EO B-55-18: 2045 Carbon-neutral California economy AB 3232: Building decarbonization Clean Air Act: Air quality standards for NOx and PM	Reliability: Increase in-state production of renewable hydrogen and methane. Safety: These technologies can help	Electrochemical Methods	Baseline: The current cost of producing hydrogen gas through electrolysis pathways is between $5 and $6/kg-H2. Mass adoption of electrolyzers to produce hydrogen has high cost barriers due, mostly associated with the use of rare materials and the need of a balance of plan. Source: https://www.hydrogen.energy.gov/pdfs/20004-cost-electrolytic-hydrogen-production.pdf	1) Explore alternatives to traditional electrolyzer designs for the production of renewable hydrogen. Promising approaches include: a) novel electrolyzer geometries, b) development of next-generation membrane technology, and c) integrated photoelectrochemical

	SB 32: Regulating and monitoring GHG emission sources AB 32: GHG emission reduction targets SB 1383: Methane (CH4) emissions from organic waste LCFS: Reduce carbon intensity of transportation fuels AB 8: Development of 100 hydrogen Refueling Infrastructure in California EO B48-18: 200 hydrogen	promote the safe production of hydrogen. Operational Efficiency: The CCNTP (Catalytic Non Thermal Plasma)system enhances operational efficiency through reduced capital costs and energy requirements, both on the front end and post-production. Improved Affordability: The ability to		Gap: The DOE's goal for hydrogen production is to produce hydrogen via net-zero-carbon pathways and reduce the cost of clean hydrogen to $1/kg in one decade. Deployment at scale may require identifying and leveraging earth-abundant materials for use in catalysis or other electrochemical processes. Source: https://www.energy.gov/policy/energy-earthshots-initiative	water splitting devices 2) Develop and scale-up production of earth-abundant catalysts to enable alternatives to the relatively scarce platinum group metals used in current state-of-the-art applications. 3) Support development and demonstration of electrochemical hydrogen pumping, separation, compression, and storage technologies due to their potential to maximize the efficiency of the hydrogen production chain while reducing costs and systemic carbon footprint.
			Renewable Hydrocarbon Conversion	Baseline: The current cost of producing hydrogen gas through traditional SSMR (Steam Methane Reforming) pathways is around $2.27/kg. The cost to produce renewable hydrogen from net-zero-carbon pathways is even more expensive, upwards of 2.5x more than traditional methods.	1) Identify technologies to enable efficient production of renewable hydrogen from renewable hydrocarbon feedstocks. 2) Explore alternatives to traditional SMR for the production of renewable hydrogen via non-

	Refueling Infrastructure in California by 2025	sell valuable carbon from methane pyrolysis will lower the production cost of renewable hydrogen gas. Environmental: Reduced GHG Emissions Environmental: Improved Air Quality		Gap: The DOE's goal for hydrogen production is to produce hydrogen via net-zero-carbon pathways and reduce the cost of clean hydrogen to $1/kg in one decade. Meeting these goals in systems generating hydrogen from hydrocarbon feedstocks requires improvements in conversion efficiency and appropriate management or leveraging of any byproducts. Source: https://www.energy.gov/policy/energy-earthshots-initiative	conventional pathways with high potential for scale-up. Promising approaches include: advanced SMR or pyrolysis solutions such as: a) inductively heated microchannel reactors, b) catalytic non-thermal plasma technology applications, c) membrane reactors, and d) renewable methane pyrolysis. 3) Explore technological advancements in hydrogen production from biomass streams through biomass gasification and biomass pyrolysis.
				Gap: Biogas upgrading technologies that can reduce RNG production costs may drastically reduce GHG emissions from live feedstock agriculture. To achieve California state target and company goals of net carbon neutrality by 2045, SoCalGas needs to remove fossil sourced natural gas from its system, cumulatively reducing approximately 2 million tons of carbon dioxide per year over the next 20 years. https://www.socalgas.com/sites/default/files/2022-01/SoCalGas_Sustainability_Strategy-final.pdf	

Carbon Management	EO B-55-18: 2045 Carbon-neutral California economy AB 3232: Building decarbonization Clean Air Act: Air quality standards for NOx and PM LCFS: Reduce carbon intensity of transportation fuels AB 8: Development of 100 hydrogen Refueling Infrastructure in California EO B48-18:	Environmental: Reduced GHG Emissions and potentially create pathways to achieve negative emissions. Improved Affordability: Reduced operating and capital costs. Operational Efficiency: Direct conversion of CO2 to materials, increase conversion rate.	Point-Source Carbon Capture	Baseline: Commercial systems for post-combustion carbon capture. At scale ($400-$500 million per unit), the current cost is $40-$100 per ton of carbon dioxide captured. https://www.pnnl.gov/news-media/cheaper-carbon-capture-way Gap: Cheap and rapidly deployable small-scale carbon capture technology to meet or beat current large-scale carbon capture costs. DOE has funded research targeting $30 per ton of carbon dioxide captured at point-sources by 2030. In order for California to achieve its goal of net carbon neutrality by 2045, carbon capture technology must be developed and deployed at scale. Sources: https://netl.doe.gov/projects/project-landing-page-list.aspx https://www-gs.llnl.gov/content/assets/docs/energy/Getting_to_Neutral.pdf	1) Identify technologies involving flue gas/tailgas processing for CO2 capture and conversion to reduce cost and improve capture efficiency. 2) Develop new solvent, sorbent, or membrane technologies to increase capture efficiency. 3) Explore modularization of carbon capture devices to enable fast adoption at a wide range of industrial scales. 4) Perform fundamental research and pre-commercial development to advance carbon capture technologies, including microchannel devices, supersonic compression, cryogenic modular processes, and flue gas aerosol pretreatment.

	200 hydrogen Refueling Infrastructure in California by 2025	Environmental: Improved Air Quality	Carbon Dioxide Removal (CDR)	Baseline: Commercial carbon dioxide sorbents capture carbon dioxide from the atmosphere. The projected cost for direct air capture (DAC) using current technologies ranges from $100 to $1,000 per ton of carbon dioxide captured. Sources: Nisbet (2019) THE CARBON REMOVAL DEBATE. Asking Critical Questions About Climate Change Futures, Carbon Removal Briefing No. 2, Institute for Carbon Law Removal and Policy, American University, 24 pages, https://www.american.edu/sis/centers/carbon-removal/upload/carbon-removal-debate.pdf Fuss, et al. (2018) Negative emissions-Part 2: Costs, potentials and side effects, in: Environmental Research Letters, Vol 13(6): 063002, https://iopscience.iop.org/article/10.1088/1748-9326/aabf9f Gap: DOE goal is <$100 per ton CO2 captured (DOE 10-year target, Earthshot goal). In order for CA to achieve its goal net carbon neutrality by 2045, carbon capture technology must be deployed at scale.	1) Develop/improve high-efficiency sorbents and optimize device design to bring total direct air capture system costs down. 2) Explore carbon capture from ocean and other systems with increased carbon concentrations relevant to atmospheric levels. 3) Develop technology to capture carbon dioxide while simultaneously co-producing clean water. 4) Develop electrodialysis technology to efficiently extract carbon dioxide from oceanwater sources. 5) Identify other technology to accomplish mineralization or conversion-to/capture-as other solid products for sequestration on a geologically relevant time scale.

				Source: https://www.energy.gov/policy/energy-earthshots-initiative https://www-gs.llnl.gov/content/assets/docs/energy/Getting_to_Neutral.pdf	
			Carbon Conversion/Recycling	Baseline: The current market size for carbon-dioxide-based products is $10.67 billion, with a compound annual growth rate of 4.0%. The global petrochemical market is $556 billion with a compound annual growth rate of 6.4%.	1) Explore the conversion of sequestered or captured carbon to useful, durable products and to improve the emissions outlook on the ~50-100 year time-scale vs. unconverted carbon material through life cycle assessment (LCA) analysis. 2) Identify carbon recycling opportunities, including synthesis of building materials from captured carbon dioxide; electrochemical reduction; conversion of carbon dioxide to industrially useful chemicals; and extraction, conversion, and recycling of carbon compounds from waste/wastewater streams for the production of
				Gap: Diversion from fossil-based to carbon-dioxide-based synthesis of durable carbon-based products and an increased market share of carbon-dioxide-based products to reduce emissions from newly-extracted fossil sources.	

					biologically-sourced and industrially-relevant precursors (i.e. biocrude oil and renewable fuels). 3) Explore further opportunities for diversion and conversion of waste streams to mitigate organic decay emissions and reduce/replace fossil extraction.

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
Environmental and Safety	EO B-55-18: 2045 Carbon-neutral California economy Clean Air Act: Air quality standards for NOx and PM SB 32: Regulating and monitoring GHG emission sources AB 32: GHG emission reduction targets SB 1383: Methane emissions from organic waste	Reliability: Pipeline safety management system and high consequence area assessment tools improve public safety and pipeline reliability. Safety: Accurate asset-locating technology prevents mechanical damage caused by excavation and construction activities. Ratepayers experience increased safety through avoiding accidental damage to	Systems Emissions	**Gap #1: Technology to Reduce Combustion GHG and Criteria Emissions from Transmission and Storage**	**How we are planning to address Gap #1**
				1. Continuous efficiency performance monitoring for turbochargers 2. Improved catalyst regeneration process 3. Reciprocating engine exhaust methane slip reduction 4. Precombustion chamber design 5. Engine controller design solutions to address variable fuel composition of lean-burn engines--field based evaluation 6. Low-cost sensors for	1) Efficiency monitoring technology for compressor station equipment 2) Technology to retrofit existing equipment to improve efficiency and reduce GHGs 3) Diagnostic technology to provide real-time monitoring of facility to improve operating performance 4) Low-cost and accurate sensors for measuring criteria pollutants 5) Alternatives to natural gas-powered equipment 6) Control algorithms for

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
	LCFS: Reduce carbon intensity of transportation fuels AB 8: Development of 100 hydrogen Refueling Infrastructure in California EO B48-18: 200 hydrogen Refueling Infrastructure in California by 2025 Cal/OSHA Title 8 CC: Injury and Illness Prevention Program	pipelines. Remote monitoring technology to alert operators of mechanical damage also enhances safety by enabling operators to respond to accidents. Operational Efficiency: Decreases in operating costs benefit ratepayers with reliable and affordable energy. Improved Affordability: Increases in operating		accurate sensors for measuring criteria pollutants	criteria pollutant reduction in equipment 7) Reciprocating engine exhaust methane slip reduction 8) Improve precombustion chamber for GHG reduction
				Gap #2: Technology to Reduce Combustion GHG from Transmission and Storage Using Hydrogen or Alternative Fuels	**How we are planning to address Gap #2**
				1. Fuel reforming and segregation as alternative for compressor fuels 2. Alternative fuels for combustion equipment	1) Non-carbon fuels for compressors to reduce GHGs 2) Renewable Natural Gas 3) Alternatives to natural-gas-powered devices

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
		efficiency not only reduce GHG emissions, criteria pollutants, and toxics, but also decrease operating costs. Environmental: Reduced GHG Emissions: Non-carbon fuel source eliminates CO2, criteria pollutants, and some toxic byproducts. Ratepayers		**Gap #3: Develop and improve Pipeline Repair Technology to Reduce GHG Emissions**	**How we are planning to address Gap #3**
				1. Evaluate in-situ repair techniques 2. Centrifugal compressor dry gas seal reliability enhancement 3. Methods to reduce pipeline blowdowns to effectuate inspection and repair	1) In-situ valve repair techniques 2) Alternative pipeline repair methods 3) Energy recovery 4) Low-cost instruments to detect/quantify leaks from seals, packings, and valves 5) Alternative technology to reduce blowdowns
				Gap #4: Explore Paths to Abating GHG Emissions	**How we are planning to address Gap #4**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
		benefit from elimination of GHG emissions and better air quality. Environmental: Improved Air Quality: Technology reducing criteria pollutants and toxics improves air quality for ratepayers.		1. Methane oxidation catalysts for reduction of emissions in flaring 2. Classification of methane emissions at regulator stations	1) Better air pollution control technology 2) Better leak detection and monitoring technology 3) Certified renewable natural gas 4) Preparing relief valves for emissions control which includes a—detection of leakage through valve; b—technology to sense overflow; and c—technology to capture emissions 5) Study of ability to reduce emissions after commissioning of new pipeline by pickling 6) Pilot study assessment of reductions from certified natural gas
			Environment	**Gap #1: Identify potential sources for emissions and the**	**How we are planning to address Gap #1**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				impact to the environment	
				1. Development and evaluation of high-resolution historical climate dataset over California 2. Stanford Natural Gas Initiative Program 3. Center for Methane Research 4. PRCI (Pipeline Research Council International) GHG strategic research priorities	1) Participate in industry-led organization to focus on new fuels to reduce GHG 2) Leverage research funding to benefit ratepayers
				Gap #2: Determine research gaps that need to be studied supporting decarbonization efforts	**How we are planning to address Gap #2**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				1. LDC (Local Distribution Company) focused gap analysis and SOTA (state of the art) study on decarbonization	1) Preparation of RNG market (sources and regions, development over last 10 years and market projection, US and Canadian production capacity and example North American and European projects) 2) Identification and evaluation of RNG treatment technologies and technology readiness levels 3) Assessment of pipeline-quality specifications for RNG (by country, regions and example specifications) 4) Overview of available credits for environmental attributes (e.g., RINs, LCFS, and others)
			Safety	**Gap #1: Determine Hydrogen Impact on Pipeline Infrastructure**	**How we are planning to address Gap #1**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				1. Gap identification between hydrogen and natural gas pipelines 2. Study of natural gas dispersion with blended hydrogen in residential structures 3. Center for Hydrogen Safety 4. In service welding onto methane/hydrogen mixture pipelines 5. Impact of blended hydrogen on threaded connections	1) Explore paths to carbon neutrality and conversion of infrastructure 2) Impact of blended hydrogen on CGI leak detection instruments
				Gap #2: Damage Prevention: Develop sensors that monitor and alert operators of third-party excavation activities, encroachment, and other natural events	**How we are planning to address Gap #2**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				1. Smart shutoff technology for commercial and residential buildings 2. Subsurface multi-utility asset location detection 3. Advanced computed tomography for pipeline inspection 4. Recommended practice for post-construction geohazard management	1) Technology to prevent accidental mechanical damage from excavations 2) Technology to accurately inventory asset locations for use in avoiding excavation damage 3) IT technology to assist inspection of pipelines for safety 4) Best practices for construction activities to avoid mechanical damage 5) Remote monitoring technology to locate mechanical damage
				Gap #2a: Damage Prevention: Improve locating technologies to reduce or prevent damages	**How we are planning to address Gap #2a**
				1. Aboveground service tee identification and mapping system 2. ORFEUS obstacle	1) Reduce cross bore intrusions caused by horizontal boring, independent of the operator

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				detection technology for horizontal directional drilling 3. Selecting locating and excavation technologies	2) Improve and develop new locating technology for identifying asset locations 3) Technology to locate PE pipes with accuracy
				Gap #3: Explore new technologies to improve worker safety and explore innovative training approaches	**How we are planning to address Gap #3**
				1. B31Q Training Documentation Portal 2. Virtual Reality (VR) Training: emergency response situations 3. Work zone intrusion detection and warning system 4. Clothing performance guidelines to reduce heat stress for natural gas workers	1) Effective training methods and technology, interactive technology 2) Protective equipment technology 3) Ergonomic technology/equipment
				Gap #4: Develop systems to support more real-time data to	**How we are planning to address Gap #4**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				support safety management systems	
				1. A process-based approach to pipeline safety management system 2. Tracking software development for pipeline safety management system 3. Improving HCA (High Consequence Area) classification methods	1) Tools to implement and benchmark API (American Petroleum Institute) 1173 Pipeline Safety Management System for continuous improvement to pipeline operations 2) High consequence area assessment tools
				Gap #5: Explore Means to Use Predictive Analytics to increase Proactive Decision-making	**How we are planning to address Gap #5**
				1. Airborne automated threat detection system-monitoring and surveillance of imminent threats through remote sensing	1) Cybersecurity and pipeline component security (Smart)

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				2. Optimal approach to cost-effective, multi-source, satellite surveillance of river crossings, slope movements, and land use threats to buried pipelines	
Operations Technology	DOT 49 CFR Part 192: Federal pipeline safety regulations PUC General Order 112F: Gas Transmission & Distribution rule AB 32: GHG emission reduction targets AB 1900: Biomethane	Reliability: Improved evaluation methods and testing standards adapting the use of new technologies will benefit ratepayers with more reliable gas services. Safety: Accuracy in locating buried assets avoids mechanical damage resulting in accidents.	Equipment and Tool Evaluation	**Gap #1: Develop and maintain industry standards for Equipment & Tool Evaluations (New or Revised)**	**How we are planning to address Gap #1**
				1. Uniform frequency code 2. Update ASTM standard on soil compaction control using the DCP	1) Improve evaluation methods for equipment and tools 2) Improve equipment and testing standards adapting new technologies
			Mapping and Locating Technologies	**Gap #1: Technology to locate underground assets to prevent mechanical damage from construction and pipeline repair**	**How we are planning to address Gap #1**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
	quality standards D.14-06-007: Approved SoCalGas's Pipeline Safety Enhancement Program	Operational Efficiency: Locating technology improves operational efficiency by decreasing labor hours in locating buried assets. Improved Affordability: New technologies will also improve efficiency and reduce costs. Environmental: Reduced GHG Emissions:		1. 3D visualization software for mapping underground pipelines and improving pipeline asset management 2. Enhanced locating technologies for underground pipelines with better accuracy 3. GIS portal data quality improvement	1) Investing in research and development in the technology to accurately locate buried assets 2) Improve GIS and mapping processes to manage locations of buried assets 3) Locating “unlocatable” pipe (PE pipe, congested urban areas) 4) Standardized locator frequencies for industry
			Measurement & Regulation Operations Technologies	**Gap #1: Evaluate new meter and regulator technology to enhance performance and determine viable options with decarbonization**	**How we are planning to address Gap #1**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
		Reliable meters help reduce GHG emissions through the capability to self-monitor their reliability and enabling repairs to be conducted as soon as		1. Continuation of single-path ultrasonic meter long-term performance testing and monitoring 2. Determine impact of hydrogen on meter accuracy and performance	1) Install single-path ultrasonic residential meters on live gas distribution systems and conduct long-term performance and accuracy testing over an 18-month period.
			Steel and Plastic Pipeline	**Gap #1: Develop more cost-effective methods for repairing pipe**	**How we are planning to address Gap #1**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
		problems are detected.	Construction, Operations, and Repair Technologies	1. Automation of the Explorer series of robotic platforms 2. Data logger evaluation project 3. PE systems research program 4. Composite repair wrap for PE 5. Update of PRCI repair manual 6. Evaluate in situ valve repair techniques	1) Develop autonomous operating capability in the Explorer robot that can collect a large amount of data in the field 2) Reduce operational complexity 3) Increase capability 4) Improve data quality 5) Increase robustness 6) Alternative pipeline repair methods to reduce GHG emissions 7) Repair leaks using composite technologies
System Design & Materials	DOT 49 CFR Part 192: Federal pipeline safety	Reliability: Understanding the properties of hydrogen within	Gas Composition and Quality	**Gap #1: Explore Paths to Carbon Neutrality and Conversion of Infrastructure**	**How we are planning to address Gap #1**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
	regulations PUC General Order 112F: Gas Transmission & Distribution rule AB 32: GHG emission reduction targets AB 1900: Biomethane quality standards D.14-06-007: Approved SoCalGas' Pipeline Safety Enhancement Program	the gas system improves reliability. Safety: Safety training of workers result in safer and more reliable energy services. New safety training methods also reduce training costs and improve affordability for ratepayers. Operational Efficiency: Better technology and assessment tools increase operational efficiency and reduce operating		1. Biomethane justification study for improved/accepted gas quality standards 2. Study on the impact of trace constituents in RNG on natural gas grids and consumer appliances 3. Trace constituent database 4. Identification and development of an analyzer for siloxane measurement 5. On-line biomethane gas quality monitoring 6. PRCI emerging fuels institute 7. Universal analytical technique for siloxane	1) Study impacts of properties in RNG and traditional pipeline gas, such as TC on gas network infrastructure 2) Common (standardized) RNG skid development for utilities (est. start 1/22, est. completion 12/22) 3) Study on changing accuracy and variability of thermal zones affecting metering of new gas supplies 4) Address hydrogen, RNG, carbon capture and sequestration (CCS), ammonia, and biofuels with emphasis on integrity of pipeline system steel and non-steel components, compressor stations and facilities, pressure control and over-pressure safety devices, design requirements for electrical classification

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
		costs, leading to more affordable energy. Improved Affordability: Low-cost meters and regulators improve ratepayer affordability. Environmental: Reduced GHG Emissions: Utilization of hydrogen reduces GHG emissions.			and fire safety, and downhole reservoir and cavern storage
				Gap #2: Explorer Paths to Carbon Neutrality and Conversion of Infrastructure - Hydrogen	**How we are planning to address Gap #2**
				1. Blending modeling (hydrogen) 2. Hydrogen blend into natural gas, metallic materials 3. Hydrogen embrittlement and crack growth 4. Impact of	1) Analyze and report data on the impacts of hydrogen blending at higher percentages in the natural gas system

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				hydrogen/natural gas blends on LDC infrastructure integrity 5. Microstructural characterization of pipe steels exposed to hydrogen blends 6. Expansion of NYSEARCH range model, to include hydrogen test data 7. Living lab for hydrogen 8. HyBlend collaborative research partnership	
				Gap #3: Identify and update industry standards for Odorants as new constituents are introduced to the pipeline system	**How we are planning to address Gap #3**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				1. Odor detection threshold study 2. Impact of trace constituents on odor masking 3. Effects of odor masking agents 4. Trace constituents from gas processing plants as masking agents	1) Odorant masking agent studies 2) Odor threshold studies 3) Operational safety training
				Gap #3a: Identify and update industry standards for Odorants as new constituents are introduced to the pipeline system - Hydrogen	**How we are planning to address Gap #3a**
				1. Odor detection study for blended hydrogen	1) Odorant threshold studies using natural gas-hydrogen blends and investigate whether hydrogen is a masking agent

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
			Materials & Equipment	**Gap #1: Assess the effects of metering designs, operating conditions and other variables that impact metering accuracies (Evaluate field operation tools and equipment)**	**How we are planning to address Gap #1**
				1. Review and evaluation of the Utonomy smart regulator 2. In-situ ultrasonic meter flow verification	1) Research and develop to produce more accurate, safer and more reliable regulators and meters
				Gap #1a: Assess the effects of metering designs, operating conditions and other variables that impact metering accuracies. - Hydrogen (Evaluate field operation tools and Equipment)	**How we are planning to address Gap #1a**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				1. Effect of hydrogen blended natural gas on performance of gas meters and diaphragm type service regulators	1) Examine the effect of hydrogen-blended natural gas on the performance of domestic gas meters in terms of measurement accuracy and intrinsic safety through extensive, long-duration testing 2) Examine the effect of hydrogen-blended natural gas on the normative performance of diaphragm-type service regulators, specifically addressing materials compatibility and gas leak concerns 3) Consider other meter set assembly (MSA) components for evaluation in the long-duration testing
				Gap #2: Develop new Materials and construction methods that are cost effective and support Tracking	**How we are planning to address Gap #2**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				and Traceability requirements	
				1. Alternative caps for pe service tees 2. MAOP & materials verification 3. Product & process validation program 4. Tracking & traceability counterfeit detection, 2-way production communication using GS1 standards 5. Tracking and traceability for transmission, pipe materials 6. Tracking and traceability marking standard for transmission components 7. Automate field data collection to reduce human error and duplicative work	1) Improve methods for tracking materials using modern technology 2) Improve QA/QC processes and programs

Gas Operations Program					
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				Gap #3: Develop new Materials and operating parameters that will reduce O&M costs and extend the service life of PE piping and components	**How we are planning to address Gap #3**
				1. NDE material strength verification for an index of long seam fracture toughness of ERW Pipes 2. ARPA-E Repair Program (TTSP)	1) ARPA-E research deliverables
			System Design	**Gap #1: Assessing risk on the infrastructure by unforeseen events**	**How we are planning to address Gap #1**
				1. Seismic risk assessment and management of natural gas storage and pipeline structure - 2 Projects Slate/Berkeley & UCLA 2. Hot tap branch connections	1) Improve risk and management assessment tools

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				3. Investigate CLSM to manage axial soil loads on buried pipelines 4. Enhance risk assessment tools for decision making	
			Design, Materials, and Construction	**Gap #1: Develop new test methods for materials used in construction of pipelines and processes, and improve procedures in pipeline construction**	**How we are planning to address Gap #1**
				1. Full thickness weld tensile round robin 2. Evaluate higher strength consumables for manual root bead in x70 girth welds 3. Evaluation of semi-automatic FCAW-S welding process and implications to pipeline girth weld integrity	1) Low-cost alternatives to stress relieving pipelines undergoing axial strain due to ground movement 2) Revise and update testing and construction standards 3) PRCI guidance document on API welding standard 1104 4) Field performance of coatings exposed to soil

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				4. Revision of the PRCI hot-tap model to include two different base metals	5) PRCI guidance document on fatigue assessment procedures for pipeline girth welds 6) Improve tensile strength capacity estimation tool for vintage pipes 7) Shielded metal arc welding best practices
			Mechanical Damage	**Gap #1: Develop improved methods for detection and mitigation of mechanical damage**	**How we are planning to address Gap #1**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				1. Validate in-line inspection capabilities to detect/characterize mechanical damage 2. Improve dent/cracking assessment methods 3. Performance evaluation of in-line inspection systems for detecting and discriminating metal loss, cracks and gouges in geometric anomalies 4. Remaining life model and assessment tool for dents and gouges 5. Pipeline mid-wall defect and fitness for service assessment 6. Improvements to mechanical engineering assessment tools	1. Database of bursting pressure tests for corrosion, cracking, dent, and interacting defects 2) Improve mechanical damage engineering assessment tools 3) Methods for analyzing remaining fatigue life prediction of cracks in dents 4) Investigating and identifying failure modes between cracks in pipes and in dents to better understand which mode dominates failure 5) Strain-based design methods
			Corrosion and Crack Management	**Gap #1: Address technical gaps in corrosion control from**	**How we are planning to address Gap #1**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				conventional corrosion and environmental cracking	
				1. Guidelines on the selection and applications of cathodic protection coupons 2. Review of plausible corrosion assessment model 3. Understanding why cracks fail 4. Improve dent/cracking assessment methods 5. CT fundamentals with calibration and reference standards for pipeline anomaly detection 6. Effect of pressure fluctuations on growth rate of near neutral PH SCC-phase iii	1) Material property database, corrosion and crack performance of materials 2) Autogenous weld defects and weld corrosion 3) Reliability models to assess cracks to mitigate pipeline failure 4) Improve models for improved assessment and prioritizing of stress corrosion cracking threats 5) Improve predictive model for assessing pipeline service life with corrosion 6) Acquisition of real-time pipe defects 7) Metal-loss assessment tools 8) Prevention of crack growth

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
					9) Development of guidelines for rehabilitation of corroded pipes 10) Development of primer sets for microbiologically influenced corrosion analysis 11) Assessment of stress corrosion cracking using machine learning methods/AI 12) Improve assessment methods of axial cracks and weld seams with in-line inspection data 13) Improve assessment method of fitness for service for cracks within corrosion 14) Crack management for low-toughness pipes
System Inspection & Monitoring	AB 32: Reducing GHG emissions CPUC General	Reliability: Effective monitoring technology of cathodic	**Corrosion Inspection & Monitoring**	**Gap #1: Develop new technologies to improve Corrosion Inspection & Monitoring**	1. Guidelines on the selection and applications of cathodic protection coupons 2. Review of plausible corrosion assessment model

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
	Order 112F: Gas Transmission & Distribution rule DOT 49 CFR Part 192: Federal pipeline safety regulations Clean Air Act: Air quality standards for NOx and PM	protection prevents corrosion and improves reliability. Safety: This work improves ratepayer safety because it enables the advanced determination of the condition of polyethylene pipeline without excavation. Operational Efficiency: This work improves reliability because it enables robotic operations to be performed			3. Impact of drag reducing agents on corrosion management 4. Water wetting tools for pipeline integrity 5. Understanding why cracks fail 6. Improve dent/cracking assessment methods
				1. Monitoring solution for pipeline A/C interference 2. Evaluation and mitigation of selective seam weld corrosion in the field 3. Comprehensive metal-loss assessment criterion 4. ILI-based generic external corrosion growth rate distribution for buried pipes 5. Pipeline CP monitoring using real-time current measurement 6. Validate the accuracy	1) Remote monitoring technology for cathodic protection for pipelines 2) Inspection technology for assessing corrosion damage 3) Development of real-time detection of pipeline defects

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
		without excavation and interruption of flow. Affordability: The application of modern technology will also decrease costs and lead to reduced costs in energy for ratepayers.		of cathodic protection effective modeling 7. Selective seam weld corrosion detection with in-line inspection technologies	
			Pipeline Systems Inspection Technologies - Inline and	**Gap # 1: Improve Operational Effectiveness for all NDE Pipeline Inspection**	**How we are planning to address Gap #1**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
			Non-Destructive Examination (NDE)	1. Xray and terahertz development for NDE of pe pipe (study for the application of x-rays in the inspection of plastic pipe and fittings) 2. Eclipse scientific red/green light tool for NDE of PE pipe butt fusion joints 3. Standard library of PE joint samples with embedded defects for NDE tool validation 4. NJIT advanced terahertz (THz) imaging and spectroscopy for non-destructive evaluation of polyethylene pipes 5. Validation of NDT technology for PE pipe	1) Determine pros/cons of X-ray & THz techniques for field use 2) Develop an automated tool to be operated by properly trained but non-NDE expert gas industry workers using PAUT & NYSEARCH established acceptance criteria to create NDE interrogation algorithm 3) Produce a PE pipe BF joint sample library of known defects 4) Advance THz NDE technology with enhancement of techniques to interpret PE BF joint defects & stress related to established acceptance criteria 5) Evaluate/validate claims of commercially available NDT for PE pipe & fitting joints

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
					6) Review and evaluation of pipe stress inspection techniques for pipelines 7) Ultrasonic crack size detection
				Gap #2: Expand Understanding and Assure Integrity of Gas Pipelines	**How we are planning to address Gap #2**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				1. Alternate crack sensor 2. Electromagnetic time domain reflectometry (EM-TDR) for pipeline integrity 3. Modeling and assessing PE assets with 3D scanning technology	1) Use an integrated onboard system on Explorer Robot to find and scan long-seam weld in a more diverse set of live pipelines 2) Wireless accessibility 3) Refinement of MFL sensor to detect defects in the pipeline 4) Innovative probes and/or remote inspection techniques for PE pipe (est. start 09/22, est. completion 06/25)
				Gap #3: Expand Understanding and Assure Integrity of Gas Pipelines - Internal Inspection	**How we are planning to address Gap #3**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				1. Energy harvesting in gas industry applications 2. Explorer wireless range extender 3. Extending energy harvesting to other explorer sizes - a feasibility study 4. High resolution MFL for Explorer series of robotic platforms - feasibility study (feasibility study for robotic platform and suite of sensor to ID degradation in non-conforming Driscopipe 8000) 5. Pipeline cleaning tool for liquids with flow 6. Low flow EMAT ILI tool demonstration 7. Energy harvesting for recharging of explorer robotic platforms	1) Develop a robotic module that can be integrated with Explorer to harvest energy from the pipeline gas flow 2) Energy harvesting and on-board rechargeability 3) Robotic/visual inspection for 2" plastic pipe 4) Robotic inspection for large-diameter plastic pipe

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				Gap #4: Mechanical Damage, Pipeline Infrastructural Integrity	**How we are planning to address Gap #4**
				1. Heat affected zone susceptibility testing development 2. Practical girth weld evaluation criteria considering weld strength mismatch and haz softening 3. Integrity impact of HAZ softening on type-B sleeves and hot tap on modern steel 4. Guidance on the use, specification, and anomaly assessment of modern line pipes	1) New testing methods and standards 2) New predictive models for mechanical properties prediction to prevent corrosion and mechanical damage 3) Better pipeline construction methods
			Remote Pipeline Monitoring Systems	**Gap #1: Develop new technologies to improve remote monitoring and data collection to**	**How we are planning to address Gap #1 non-intrusive technologies include satellite, aerial (manned and unmanned),**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				support Corrosion management programs	**and aboveground measurement of ground subsidence, methane emissions, distressed or dead vegetation, pipeline coating condition, and corrosion.**
				1. Remote monitoring of pipe-to-soil readings, AMI network integration 2. AC stray current monitoring system evaluation 3. Corrosion logging tool	1. Improve and develop new remote monitoring technology
			Data Analytics	**Gap #1: Develop technologies**	**How we are planning to address Gap #1 Leveraging machine learning, AI, image recognition, virtual and augmented reality technologies, neural networks, and advanced connectivity through social networks and the Internet of Things (IoT)**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				1. Digitalize system information and advance the use of data analytics to improve system safety, reliability, and integrity in addition to being a pathway for achieving operational efficiency and emissions reductions.	1. Develop AI using existing and new data sensors to address the safety, reliability, and integrity of pipelines and to improve efficiency and emission reductions
			Geohazard Threat Inspection and Monitoring	**Gap #1: Develop technologies to monitor environmental threats, such as weather-related landslides and floods, as well as seismic ground faults impacting pipeline integrity providing continuous real-time measurement of strain imposed onto the pipeline and alert pipeline operators to take mitigative measures to avoid pipeline failures.**	**How we are planning to address Gap #1**

Gas Operations Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
				1. Modernize the assessment of pipeline water crossings 2. UCLA Fault Displacement Hazard Initiative	1. Modernize the assessment of pipeline water crossings 2. Satellite-based early warning systems for pipelines for threat inspection and monitoring 3. Develop slope monitoring methods using remote sensing techniques and in-situ instrumentation 4. Sensors for measuring pipeline strains caused by geohazards 5. Enhancement of strain capacity of pipelines subjected to geohazards

Clean Transportation Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
Off-Road	EO N-79-20: 100% zero-emission off-road vehicles and equipment by 2035 where feasible. CARB Clean Fleets Rule: Establishes a medium- and heavy-duty zero-emission fleet regulation with the goal of achieving a zero-emission truck and bus California fleet by 2045 where feasible CARB At-Berth Regulations:	Environmental: Reduced GHG Emissions: Increasing adoption of hydrogen fuel for zero-emission vehicles provides an environmental benefit by reducing the reliance on fossil fuels and, therefore, the associated CO2 emissions. Environmental: Improved Air Quality: Increasing adoption of hydrogen fuel cell, zero-emission vehicles provides	Zero-Emission Technology for Rail	Baseline: Typical freight and passenger locomotives are powered by a diesel engine that drives an electrical generator or alternator. This is referred to as a "diesel-electric" locomotive. There are three major groups of locomotives categorized by ARB: • Interstate line haul – (>4,000 hp); • Medium horsepower (MHP) – (2,301 to 3,999 hp); • Switch (yard) – (1,006 to 2,300 hp) Newest diesel-electric freight interstate line haul locomotives can	1) Develop and demonstrate zero-emission hydrogen fuel cell switcher and line haul locomotives. 2) Develop and demonstrate liquid hydrogen tender cars to extend the range of line-haul locomotives. 3) Develop higher-efficiency fuel cell systems that take advantage of lower projected costs and modularity to reduce fuel cell system costs from $285/kW to *$130/kw and, ultimately, *$60/kW to achieve TCO cost parity with diesel.

	Reduce diesel PM and NOx emissions from the auxiliary engines of ocean-going vessels while they are docked at California ports IMO 2020: from 1 January 2020, marine sector emissions in international waters will have to reduce Sulphur emissions by over 80% by switching to lower Sulphur fuels	an environmental benefit by reducing NOx and PM emissions.		have engine efficiencies of up to 40 to 50 percent. In California, UP and BNSF primarily operate newer or remanufactured locomotives. These locomotives are subject to the federal emissions standards (Tier 4 NOx: LH/SW-1.3 g/bhp-hr) during their specified useful life. Under the federal definition, the useful life for a freight interstate line haul locomotive can be between 30,000 and 40,000 megawatt-hours (MWh), which typically translates to about seven to ten years of operation, before replacement or remanufacture.	4) Develop and demonstrate advanced materials, system controls, and optimized operating conditions. 5) Pursue development of fuel cell stacks capable of operating beyond current ambient operating temperature limits to prevent overheating or freezing (extreme temperature ranges). 6) Seek to reduce storage costs from *$1130/kg to *$500/kg and, ultimately, *$266/kg.

			Zero-Emission Technology for Aviation	Baseline: Aviation fuel (Jet-A kerosene, Gasoline, Diesel) for low-range, regional, and long-range flights.	1) Develop and demonstrate zero-emission hydrogen fuel cell aircraft (under 30 passengers and 1,000 miles). 2) Explore the use of hydrogen for sustainable aviation fuels (SAF) in the aviation sector. This will include prototype/proof-of-concept aircraft and demonstrations; higher-efficiency fuel cell systems that take advantage of lower projected costs; and advanced materials, system controls, and optimized systems capable of operating in challenging conditions (high/low temperatures, pressure changes, etc.).

			Advanced On-Board Storage for Off-Road Applications	Baseline: Gaseous hydrogen tanks currently operate at 350 bar or 700 bar at a temperature of -40°C. Costs for these systems can be in excess of $1,000/kg for off-road applications. This is a new area of focus and will require significant research for larger applications that operate in challenging environments. Gap: Onboard storage systems for gaseous and liquid hydrogen to operate at lower pressures, with reduced footprints, or increased storage space for onboard off-road applications. On-board storage systems that can operate efficiently in various challenging environments such as aviation where ambient temperatures can vary significantly or the	1) Develop and demonstrate advanced storage systems for off-road applications. Examples include: 1) liquid hydrogen boil-off management and advanced gaseous and liquid hydrogen tanks; 2) advanced storage systems for gaseous and liquid hydrogen storage in aviation, marine, and challenging environments; 3) methods for meeting and exceeding the critical target of $4/kg-H2 at the pump; and 4) H2 tender for line haul locomotives to achieve longer ranges sufficient for interstate routes.

				marine space where systems can be impacted by high salt content or corrosion. Reduce storage system costs to $300/kg by 2030 and $266/kg beyond 2030 and 10kg/min refueling.	
On-Road	EO B-48-18: 5 million ZEVs by 2030; 200 hydrogen Refueling Infrastructure by 2025 EO N-79-20: Eliminate new internal combustion engine vehicles by 2035; 100% light-duty vehicles and	Environmental: Reduced GHG Emissions: Increasing adoption of hydrogen fuel for zero-emission vehicles provides an environmental benefit by reducing the reliance on fossil fuels and, therefore, the associated CO2	Hydrogen Fuel Cell Development for MHD Trucks	Baseline: MHD vehicles include a wide variety of vocational, drayage, buses, and long-haul trucks that currently use diesel. These trucks are capable of hauling anywhere from 1-20 tons of goods (Class 4-8), can operate on a range of 300-1,000 miles on a full tank, and can last upwards of 1 million miles.	1) Develop and demonstrate zero-emission hydrogen MHD trucks to serve in hard-to-electrify vocations and on longer routes. 2) Target increasing fuel cell efficiency to 68% and 72% by 2030 and beyond. 3) Achieve an ultimate fuel economy of 17 mpkg/19.4mpgde for

	drayage trucks sold will be zero emission by 2035; 100% MHD vehicles sold and operated are zero-emission by 2045 CARB Clean Truck Rule: 100% ZEV where feasible for drayage, public fleets, last-mile delivery by 2045 CARB Clean Fleet Rule: 100% zero-emission trucks and buses where feasible by 2045	emissions. Environmental: Improved Air Quality: Increasing adoption of hydrogen fuel cell, zero-emission vehicles provides an environmental benefit by reducing NOx and PM emissions.		Current diesel MHD trucks achieve an average fuel economy of 6-12 MPG, depending on duty cycle.	fuel cells vs 15.6 mpgde for diesel.
				Gap: Current fuel cell electric vehicle (FCEV) MHD trucks are limited on usable range (up to 300 miles) and have a lifespan of up to 6-8 years. Future FCEV MHD trucks need to reach 25,000 hours or 10 years/1,000,000 miles, and achieve at least 1.9x fuel economy improvements and a total cost of ownership reduction of at least 30%.	

			Hydrogen Fuel Cell Development for LD Fleet Trucks	Baseline: Current developments in the light-duty vehicle truck space are limited to battery-electric vehicles and conventional gasoline and diesel. Such trucks operate on shorter ranges compared to MHD vehicles, but account for over 1 million of the total truck population in California.	1) Develop, demonstrate, and commercialize light-duty fuel cell electric vehicle trucks to meet the demands of utility fleets and emergency services such as SoCalGas and Caltrans that serve communities in rural areas and diverse climate regions.
				Gap: Currently, there are no hydrogen fuel cell light-duty vehicle trucks that fall in the Class 2a, 2b, and 3 categories. These categories will eventually need to be zero-emissions to comply with CARB and California mandates. Over 50% of SoCalGas' fleet falls in the class 2b category and needs to be available and operational 24/7/365 to	

				respond to customers and emergency events.	
			Advanced On-Board Storage for On-Road Applications	Baseline: High-pressure non-conformable tanks for hydrogen (350 bar and 700 bar, temperature of -40C). Gaps: Increased storage of gaseous and liquid hydrogen at lower pressures that require less space to be packaged in a vehicle (lower pressures and temperatures above -40C). Reduce storage system costs to $300/kg by 2030 and $266/kg beyond 2030.	1) Develop and demonstrate advanced storage systems for MHD trucks and off-road applications. Examples include: 1) conformable hydrogen storage; 2) low-pressure hydrogen storage; and 3) advanced materials for hydrogen storage for on-road applications. 2) Support development of liquid hydrogen boil-off management and advanced gaseous and liquid hydrogen tanks. 3) Develop advanced materials for gaseous and liquid hydrogen storage in aviation,

					marine, and challenging environments. 4) Develop methods for meeting and exceeding the critical target of $4/kg-H2 at the pump.
			Advanced Innovation and Connected Vehicles	Baseline: Level 0 Autonomous Vehicles	The RD&D Program should develop and demonstrate advanced vehicles, autonomous vehicles, or advanced routing solutions to reduce emissions and increase safety and reliability.
				Gaps: Level 2 and above autonomous vehicles, connected vehicles for fleets, and advanced fleet monitoring/tracking to reduce emissions.	
Refueling Infrastructure	AB 8: 100 Hydrogen Refueling Infrastructure in California EO B-48-18: 5 million ZEVS by 2030; 200 hydrogen Refueling Infrastructure by 2025	Reliability: Advancing refueling technologies and the hydrogen supply chain will help promote sustainable and reliable fuel for transportation and other sectors. Safety: As technology	Hydrogen Refueling Infrastructure Optimization and Safety	Baseline: Current hydrogen fill technology limits fueling to 1-5 kg/min @ 40°C. One of the many challenges for the hydrogen industry is the efficiency, reliability, and availability of hydrogen supply and Refueling Infrastructure for on-	1) Develop and demonstrate fast-fill and hydrogen refueling technologies to achieve hydrogen fill rates of 8kg/min by 2030 and 10kg/min beyond 2030 for transportation. 2) Develop advanced cooling systems.

	Low Carbon Fuel Standard: Reduce carbon intensity in transportation fuels as compared to conventional petroleum fuels, such as gasoline and diesel	advances and is adopted widely throughout California, safety protocols and monitoring efforts need to be increased to enable the hydrogen ecosystem across off-road and on-road applications Operational Efficiency: Reducing refueling time and effort across multiple transportation sectors. Improved Affordability: Advancing refueling technologies can help reduce the cost of equipment, reduce refueling time, and increase energy storage. Environmental: Reduced GHG Emissions:		road and off-road applications. Gaps: Increase fueling reliability and safety to allow higher fill rates to meet DOE targets of 8kg/min by 2030 and 10kg/min beyond 2030 for transportation. Fueling stations and infrastructure for on-road MHD trucks, rail, marine, and construction.	3) Develop integrated fueling systems. 4) Explore development of liquid hydrogen boil-off management. 5) Develop hydrogen bunkering for marine applications. 6) Develop advanced materials, system controls, and optimized operating conditions. 7) Explore methods for meeting and exceeding the critical target of $4/kg-H2 at the pump. 8) Explore co-location of light-duty and MHD Refueling Infrastructure. 9) Explore the use of multi-modal Refueling Infrastructure for off-road and on-road applications.

		Improving Refueling Infrastructure can reduce auxiliary electrical loads to compress and store hydrogen for transportation. Environmental: Improved Air Quality: Increasing the availability of hydrogen by expanding the hydrogen refueling network will promote the adoption of hydrogen fuel for transportation, thus reducing NOX and PM emissions.			

Clean Energy Applications Program					
Sub-Program	**Policy Drivers for Technical Development Work**	**Ratepayer Benefits**	**Research Area**	**Technology Gap between current performance and required performance**	**RD&D Development Activities**
Energy Reliability	CPUC R.19-09-009: Microgrids and resiliency proceeding AB 3232: Building decarbonization SB 32: Reduce CO2 emissions Clean Air Act: Air quality standards for NOx and PM SB 100: Zero-carbon electricity by 2045 EO B-55-18: Carbon-neutral	Reliability: Distributed generation improves customer electrical reliability and resilience, both in areas prone to wildfire-related outages as well as "regular" grid disturbances. Enabling and simplifying the integration of gas fueled distributed generation with solar and battery improves power reliability and resilience for customers. Safety: Distributed generation can also improve customer safety by providing the reliability and resilience mentioned above (required for critical infrastructure and life saving/sustaining devices). Enabling the integration of gas-fueled distributed generation can improve	Small Scale (less than 50 kilowatt) Fuel Cell Development	Baseline: There are currently no commercially available small scale fuel cells available in the US. However, these technologies exist in other countries at various scales. Current alternative forms of resilient distributed generation are gas/diesel engines, either stationary or mobile. Gap: Fuel cells for the residential and small commercial sectors that can meet US and California safety and emissions requirements. A pathway to being cost-	1) Identify commercially available technologies from overseas and demonstrate their ability to function as expected, comply with all safety requirements, yield the desired benefits, and meet California market needs. 2) Support lab testing and demonstrations, which will be needed to confirm performance and understand how systems work prior to installing in real homes and businesses. 3) Support field

	California economy by 2045 SB 1298: Established DG Certification Standard requirement SGIP: Self-Generation Incentive Program SB 1339: Microgrids for increased electricity reliability CA Title 24: Buildings Energy Efficiency	customer safety by providing the reliability and resilience mentioned above (required for critical infrastructure and life saving/sustaining devices). Operational Efficiency: Projects in this sub-program aim to develop technologies that can optimize onsite energy production and consumption, potentially improving customer energy efficiency. Improved Affordability: Projects in this area aim to develop distributed generation technologies that provide customer cost savings compared to alternatives (solar, battery, grid power). Microgrids are still typically very customized and therefore costly. Projects in this area aim to simplify gas distributed generation integration and showcase the ability of gas-supported microgrids to meet societal and customer needs, potentially increasing adoption and driving down		competitive with solar/battery, although there is no agreed upon metric to value resilience.	demonstrations. They will range from a few units to larger-scale pilots, depending on the technology readiness and funding availability.
			Hydrogen Blending in Existing Power Generation Technologies	Baseline: Most OEMs seem to indicate an ability for existing systems to accept blends of <20%, although this has not yet necessarily been demonstrated in the field. OEMs are also working on systems that can accept 100% hydrogen.	1) Support projects ranging from fundamental combustion lab scale research and OEM system design to field demonstrations. 2) Identify blending limits, increase blending thresholds, and demonstrate blending capabilities. 3) Explore a wide range of technologies and project types in this space.
				Gap: Need to demonstrate capability for systems to actually accept 20% hydrogen blends in the field for sustained durations. Need to identify cost-effective (retrofit) pathways to bridge the gap between 20% and	

		prices. Environmental: Reduced GHG Emissions: Projects in this area aim to develop technologies with reduced GHG emissions, either indirectly through improved efficiencies or directly through hydrogen integration and/or carbon capture. Environmental: Improved Air Quality: Projects in this area aim to develop technologies that meet or exceed CARB-DG certification standards, which regulate NOx, CO, VOCs, and PM.		100%. Ability to eventually operate on 100% hydrogen safely, while performing similar to or better than current technology.	
			Backup Generation Development	Baseline: Current backup generation typically consists of gas and diesel engines. Backup generation is not CARB-DG, and sometimes flies under air board regulations based on supposed low operating hours.	1) Target lab evaluations to confirm emissions performance. 2) Target field demonstrations to showcase real-world benefits of the new technologies.
				Gap: Need low-emissions options across all sizes to compete with diesel and un-regulated gas technologies. Target emissions to meet CARB-DG certification requirements.	

			Fuel Cell Integration	Baseline: Current microgrid integration hardware (controllers, inverters, etc.) is typically tailored to solar + battery, without specific ability to integrate fuel cells. Fuel cell integration and control is usually specific to OEMs, aside from inverters.	1) Work with technology developers and research institutions to identify and evaluate the performance of integration hardware and control platforms. Evaluation will range from paper studies and lab testing to field demonstrations.
				Gap: Need technologies that simplify the integration of fuel cells with solar, battery, and grid energy.	
			Backup Power Integration	Baseline: Similar to above, integration of backup generation is either non-existent (manual switch) or very costly. Backup generation has different operating constraints from baseline production, which is what fuel cells	1) Work with technology developers and research institutions to identify and evaluate the performance of integration hardware and control platforms. Evaluations will

				mentioned above typically provide.	range from paper studies and lab testing to field demonstrations.
				Gap: Should be simple and seamless. Should also be cost-comparative to solar / battery systems.	
			CHP Efficiency Improvements	Baseline: This area covers technologies that optimize "waste" heat utilization, such as heat-driven cooling processes that offset electrical consumption.There are a wide range of technologies, but most have low penetration due to relative novelty or high costs.	1) Support a broad range of project types, from early-stage prototype development to field demonstrations of almost commercialized systems.
				Gap: Fuel-cell-based CHP systems offer ~30% increase in system efficiency when heat is utilized. Maximizing the value of that utilized heat to offset energy-intensive (and therefore	

				costly) processes is the goal.	
			Cybersecurity of Integrated Energy Systems	Baseline: Since the integration technologies mentioned in prior research areas are fairly novel, this is a new challenge/opportunity for research. Presumably more active connections can/will lead to potential security threats at various scales (customer or grid/pipeline side of meter).	1) Support projects ranging from or progressing from paper studies and prototype development to field testing (possibly in conjunction with other research areas).
				Gap: Need to develop technologies that ensure customer and infrastructure security.	

			Hydrogen Based Energy Storage	Baseline: The primary baseline technology is battery storage, which is poorly suited for long-duration storage. There are some other emerging options for long duration, such as pumped hydro and compressed air, but these are early stage and not necessary "baseline." Gap: Need sufficient storage capacity to bridge both daily and seasonal gaps in renewable power production.	1) Address hydrogen storage integration in front of and behind the meter. 2) Develop and/or demonstrate the capabilities for various hydrogen storage technologies to integrate with the grid, on-site renewable production, fuel cells, and site loads (both hydrogen and electric).
Residential & Commercial	2016 Air Quality Management Plan: NOx and PM emissions regulationCA Title 24: Buildings Energy EfficiencyCA Title 20: Appliance Energy EfficiencyAB 3232: Reduce	Operational Efficiency: Increasing energy efficiency and burner performance for CFS appliances provides improved operational efficiency for customers by reducing cooking time, increasing food output, and reducing fuel cost.Improved Affordability: Increased energy efficiency improves cost savings and ensures that energy is affordable and equitable. Additionally, near-term improvements on	Hydrogen in Residential Homes	Baseline: In the last three years, several projects have been completed to evaluate the impact of low blends of hydrogen on residential appliances. Research has validated that residential appliances can consume blends containing up to 30% hydrogen with no modification and major consequences. Generally, there were	1) Conduct equipment testing. 2) Pursue near-term modifications to increase hydrogen tolerance. 3) Develop design guidelines. 4) Test and compare older vintage appliances with new. 5) Test less-common appliances. 6) Perform material durability testing.

	the emissions of greenhouse gases from the state's residential and commercial building stock by at least 40% below 1990 levels by 2030AB 32: Reduce CO2 emissions 40% below 1990 levels by 2030EO B-55-18: Carbon-neutral	energy efficiency can aid in the energy transition to low-carbon fuels such as hydrogen. Increased energy efficiency improves cost savings. This reduces overhead expenditures for businesses and delivers an attractive ROI for adoption of high-efficiency technologies.Environmental: Reduced GHG Emissions: Projects in this sub-program seek to increase energy efficiency and burner performance, which provides GHG benefits by reducing emissions from		few notable variations in process temperatures or emissions. For partially-premixed-type combustion equipment, which is prevalent in North America, the dominant impact of hydrogen blending is an increase in excess air, often resulting in lower NOx emissions and reduced surface temperatures. Therefore, hydrogen blending in residential space at low blends seems somewhat well understood.	7) Gain experience with blending in the field to assess the potential impact/challenge on the customer base. 8) Conduct field demonstrations to help end-users become comfortable with hydrogen.

	California economy by 2045AB 617: DACs for air quality improvements	CFS equipment. Developing advanced appliances that are compliant with RNG and hydrogen provides an environmental benefit by reducing GHG emissions from residential and commercial buildings.Environmental: Improved Air Quality: The CFS sector is a highly energy-intensive sector. Improved burner performance and energy efficiency significantly reduce GHG and NOx emissions. Increasing energy efficiency and burner performance for residential and commercial appliances provides an environmental benefit by reducing NOx and PM emissions.		Gap: 1) Increase residential appliance tolerance of hydrogen blends by up to 50%. Design should consider efficiency, emissions, safety, and performance issues. Ideally, the solution should allow for easy modification to existing appliances in service through a form of a retrofit kit. 2) Examine the long-term material durability impact due to hydrogen blends. 3) For high blends of hydrogen, explore additives to colorize hydrogen flame for safety. 4) Explore technologies that have synergies between short-term needs such as energy efficiency and emissions reduction and hydrogen compatibility. 5) Field-demonstrate hydrogen-compatible appliances.	

			Commercial Development of Gas Heat Pump	Baseline: Several European manufacturers have commercialized residential gas heat pump water heaters that offer a coefficient of performance of > 1.2. Gas heat pumps could provide an immediate step-change increase in gas appliance efficiency and facilitate achievement of the state's building decarbonization goals.	1) Streamline the North American Gas Heat Pump Water Heater field demonstration and turn field results into actionable steps towards market entry. 2) Explore other gas heat pump variants such as combi and space heating.
				Gap:This research area will focus on coordination efforts by U.S. manufacturers and distributors to modify those products for extensive deployment in the U.S., particularly in the SoCalGas service territory.1) Implement residential gas heat pump demonstrations extensively.2) Support development of commercially available, consumer-focused gas heat pumps.	

			Burner Development for Auxiliary Gas Appliances (i.e., Patio Heaters, Barbeques, Range Tops, Pool Heaters) With Focus on Energy Efficiency	Baseline: Since auxiliary gas appliances do not have any efficiency criteria or testing requirements to be sold in the marketplace, they have traditionally lagged behind in technological advancement (i.e., efficiency gains and emissions reduction). As a result, the appliance class represents an easy win for significant energy and emissions savings opportunities for building decarbonization. Similar to issues faced by the gas-fired food service appliance classification, auxiliary gas appliances use relatively simple and inexpensive technology.	1) Identify promising new burner designs. 2) Support burner testing, prototyping, collaboration with manufacturers, commercialization activities, and collaboration with customer programs on incentivizing the adoption of new technologies.
				Gap: Focus on energy efficiency improvements in this research area and strive for 50-100% efficiency improvements from the current	

				appliance performance level.	
			Catalytic Burner for Near-Zero Emission in Residential Water and Space Heating	Baseline: This technology has been utilized extensively in industrial boilers due to the increasingly challenging emission regulations imposed on these systems. Research is currently being done to utilize these types of burners for water heating and space heating in both residential and commercial settings. The benefit of this technology is that it allows operation at much leaner fuel conditions, resulting in lower temperatures that discourage the formation of NOx and the reduction of fuel consumption.	1) Pursue prototyping. 2) Conduct field demonstrations. 3) Work with customer programs to incentivize consumer adoption.
				Gap: Commercialization in the next three years since this technology has	

				the potential to achieve near-zero emissions.	
			Hydrogen Blends in Commercial Equipment	Baseline:Research into residential hydrogen blending will also close the knowledge gap in commercial buildings. The unique challenge will be creating an expansive dataset to allow for extrapolation across the diverse ranges of equipment and appliance types in the commercial end-use space. Similar to the residential space, there are limited data from North America on hydrogen blending in commercial buildings. Thus, researchers typically cite European studies. Special consideration should also be given to commercial foodservice. Hydrogen will most likely have a larger impact on this customer segment An additive may need to be	1) Pursue equipment testing and near-term modifications to increase hydrogen tolerance, production of design guidelines, and material durability. 2) Expand datasets in order to extrapolate to many other potential end-uses.

				considered in order to safely cook with hydrogen since hydrogen flame is more difficult to see. Additionally, the reduced heat output due to hydrogen could affect cooking time and food quality.	
				Gap: Additional studies on the lower blends of hydrogen (up to 30%) covering a range of commercial-grade end-uses are still worthwhile because commercial equipment typically has a higher output/throughput compared to residential appliances. However, other projects also make strategic sense, including pursuing increased appliance tolerance of	

				hydrogen blends up to 50%, assessing material durability, and gaining experience blending hydrogen in commercial buildings.	
			Advanced Building Equipment	Baseline: Condensing technologies have brought traditional, direct-fired natural gas equipment efficiencies to the upper 90% range, so few additional opportunities exist for incremental performance increases without embracing transformative technologies like gas heat pumps. Stakeholders have broad interest in improving natural gas system efficiency through system-level improvements, not just through improved combustion efficiency. Areas of interest include waste-heat recovery, innovative controls, and low-cost sensors that enable data-driven	1) Pursue new product development, system design, and integration through AI, controls, sensors, gas heat pumps, waste heat recovery, HVAC, phase change, combi systems, and building retrofits.

				operations. Interest in low-cost, innovative multi-function natural gas products is increasing, including the more common combined space heat and hot water systems, as well as more exotic products such as combined cooling, heating, and power systems (CCHP, or trigeneration).	
				Gap: Late-stage development of gas heat pumps, waste heat recovery, catalytic burners, smart technologies, advanced building construction technologies, machine learning, and block-chain.	

			Solar and Ground-Source Heating in Commercial Applications	Baseline:This program will focus on the technology development and application of solar and ground-source heating as a form of renewable energy to decarbonize gaseous end-users. The technologies being pursued includes solar water and space heating and district heating and cooling through ground-source. Increasing the use of geothermal energy for U.S. heating and cooling can significantly contribute to the Biden-Harris Administration's decarbonization goals to cut U.S. emissions in half by 2030.	1) Focus on early wins for this new research area to gain experience and insight. 2) Participate with industry experts to understand and develop technologies that can improve the energy efficiency of gaseous technologies in order to decarbonize the commercial market segment. 3) Actively seek to participate with technology experts to pursue the most competitive grant funding opportunities. Based on recent publications by the DOE and NREL, there may be more opportunities to collaborate with researchers in pursuing government grants
				Gap: Technology development and the application of the following technologies: flat-plate solar collectors, evacuated tube solar collectors, concentrating solar	

				systems, ground source heat pumps, direct use of geothermal, and deep and enhanced geothermal systems.	in the geothermal space.
Industrial Operations	2016 Air Quality Management Plan: NOx and PM emissions regulation CA Title 24: Buildings Energy Efficiency CA Title 20: Appliance Energy Efficiency AB 3232: Reduce the emissions of greenhouse gases from the state's residential and commercial building stock	Operational Efficiency: Increasing energy efficiency and burner performance for industrial equipment also provides operational efficiency improvements for industrial customers by reducing fuel costs associated with high-temperature processes and improving throughput. Improved Affordability: Developing solutions that can be implemented as modifications or retrofits to existing equipment allows for cost-effective and energy efficient decarbonization of industrial end-uses. Environmental: Reduced GHG Emissions: Developing advanced industrial equipment that is compliant with RNG and hydrogen reduces GHG emissions from industrial	Advanced Combustion System & Thermal Management for Heavy Industrial Process Equipment	Baseline: Industrial processes are the second-largest contributor to GHG emissions in California and one of the most difficult sectors to decarbonize. There is a large technical potential for GHG emissions reductions from a range of mitigation options that can help decarbonize the industry sector. Given the complexity and diverse nature of many industrial processes, however, an effective decarbonization strategy will require tailored solutions that take into account the unique challenges and opportunities in each industrial subsector.	1) Pursue continued technology development and demonstration in equipment energy efficiency, waste heat recovery, and the other technologies outlined in the GAP strategy. 2) Focus on the 15 key subsectors that account for 95% of all energy-use: chemicals, petroleum refining, forest products, food & beverage, iron & steel, plastics, fabricated metals, transportation equipment, electronics, aluminum, cement, glass, machinery,

	by at least 40% below 1990 levels by 2030 AB 32: Reduce CO2 emissions 40% below 1990 levels by 2030 EO B-55-18: Carbon-neutral California economy by 2045 AB 617: DACs for air quality improvements	processes that are difficult and costly to electrify.		Waste heat losses are a major consideration in process heating, especially for higher-temperatures process such as steelmaking and glass melting. Some R&D opportunities include integrated manufacturing control systems, waste heat recovery systems, high-efficiency industrial boilers, and new catalyst and reaction process to improve yields of process conversion. Gap: Some areas that RD&D program is focusing on in this area include: smart energy management systems, advanced Combustion System (e.g., immersion tube burner, surface burner, radiant tube heaters, ribbon burners), waste heat and water recovery systems, emissions control systems and catalytic material to enhance	textiles, and foundries. 3) Conduct a market assessment to gain valuable insight into which areas and/or activities offer the highest decarbonization potential.

				process yield, and thermal energy storage.	
			Hydrogen Blends in Process Heat	Baseline: No substantial interrelated research in North America--other than a few pockets of independent projects--currently exists to integrate hydrogen into industrial processes.	1) Target applications that are difficult to decarbonize for hydrogen blending which includes processes requiring combustion-based heat (e.g., blast

				Gap:Recently, the CEC issued a grant funding opportunity to fund a technical study to identify the impact of the potential use of hydrogen and hydrogen-natural gas blends on existing equipment as a potential decarbonization strategy for large commercial buildings and the industrial sector. The study will identify operating parameters such as the maximum concentration of hydrogen that can be handled by existing equipment with and without modification. This study will inform policymakers and the private sector of the potential for hydrogen and hydrogen-natural gas blends as a decarbonization strategy for industrial and large commercial building applications. Some of the objectives of the	furnace for iron production), ethylene crackers, chemicals and fuels refining, feedstock, reducing agents, cement kilns, and high-temperature process heat requirements that are complementary to applications that cannot be electrified. 2) Address customer concerns, including: a) Metal forming - Metal forming and working companies are sensitive to changes in the gas composition and many have in-line gas chromatographs to monitor the heating value and composition. Since hydrogen is not a standard component measured by typical commercial in-line gas chromatographs, equipment upgrades are necessary to

				study include: market characterization report, equipment testing, equipment simulation to identify "safe" limits for hydrogen-natural gas blends, and exploration of modifications to enable higher hydrogen blends.	monitor for hydrogen. b) Ferrous metal working - Natural gas is used to create endothermic and exothermic atmospheres and for carburizing processes. According to literature, the typical atmospheres used in carburizing processes contain significant quantities of hydrogen, thus the 5 vol% hydrogen blend may be tolerable. However, these customers will have to work with the equipment manufacturers to assure proper modifications are made when necessary. c) Glass manufacturers - Glass manufacturers are sensitive to changes in the

					heating value. The 5 vol% hydrogen gas blend is at the low end of the acceptable range. Thus, if the value fell much, it might become unacceptable. RD&D program will pursue activities that address these concerns. The program has identified UCI's Advanced Casting Research Center as a potential strategic partner in addressing these customer needs.

			Point-of-Use Carbon Capture and Utilization	Baseline:Commercial systems for post-combustion carbon capture. At scale ($400-$500 million per unit), current cost is $40-$100 per ton of carbon dioxide captured.Current capture capacity is at just 44 million tons per annum (Mtpa), or 0.1% of global emissions. Very few large projects have come online in the last five years, and only 0.2Mtpa were added in 2021. Last year broke records for CCS announcements, and the industry is set to expand faster than ever. Capture capacity could grow at a compound annual rate of 18% to reach 225 Mtpa by 2030, according to BNEF's CCUS database. The power, gas processing, and hydrogen industries were first to implement CCS projects, but now industries such as cement, chemicals, and	1) Focus on point-of-use carbon capture & utilization, enhanced weathering for agricultural customers. California's state rock, serpentinite, naturally absorbs carbon dioxide. 2) Explore less carbon-intensive ways to make cement through carbon capture and utilization. 3) Demonstrate cement production technologies and processes that may be able to sequester carbon dioxide. 4) Explore application to metals customers.

				direct air capture are also announcing large facilities. The U.K., U.S., Canada and the Netherlands have the most ambitious CCS plans.	

				Gap: Cheap and rapidly deployable small-scale carbon capture technology to meet or beat current large-scale carbon capture costs. DOE has funded research targeting $30 per ton of carbon dioxide captured at point-source by 2030. In order for California to achieve its goal of net carbon neutrality by 2045, carbon capture technology must be developed and deployed at scale. This program will focus on distributed point-of-use capture that would scale in size for commercial and industrial end-users.	

			Solar and Ground-Source Heating in Industrial Process Heat	Baseline: This program will focus on the technology development and application of solar and ground-source heating as a form of renewable energy to decarbonize gaseous end-users. The technology being pursued includes solar water and space heating and district heating and cooling through ground-source. Increasing the use of geothermal energy for U.S. heating and cooling can significantly contribute to the Biden-Harris Administration's decarbonization goals to cut U.S. emissions in half by 2030.	1) Focus on early wins for this research area because it is a new program to gain experience and insight. 2) Participate with industry experts to understand and develop technologies that can improve the energy efficiency of gaseous technologies in order to decarbonize the industrial market segment. 3) Actively seek to participate with technology experts to pursue the most competitive grant funding opportunities. Based on recent publications by the DOE and NREL, there may be more opportunities to collaborate with researchers in
				Gap:Technology development and the application of the following technologies: flat-plate solar collectors, evacuated tube solar collectors, concentrating solar systems, ground source	

				heat pumps, direct use of geothermal, and deep and enhanced geothermal systems.	pursuing government grants in the geothermal space.

APPENDIX B
Technology Gap Assessment

SoCalGas 2024 GRC Testimony Revision Log –August 2022

Exhibit	Witness	Page	Line or Table	Revision Detail
SCG-12	Armando Infanzon	AI-iii	Summary of O&M Costs	Revised values in table and revised TY 2024 O&M cost from "$47,251 million" to "$47,223 million."
SCG-12	Armando Infanzon	AI-2	Table AI-1	Revised values in table.
SCG-12	Armando Infanzon	AI-16	Table AI-7	Revised values in table.
SCG-12	Armando Infanzon	AI-16	Lines 23-26	Revised adjusted-recorded expenditures from "$8.223 million" to "$8.195 million," BY 2021 from "$4.003 million" to "$3.975 million," and TY 2024 request from "20.428 million" to "$20.400 million."