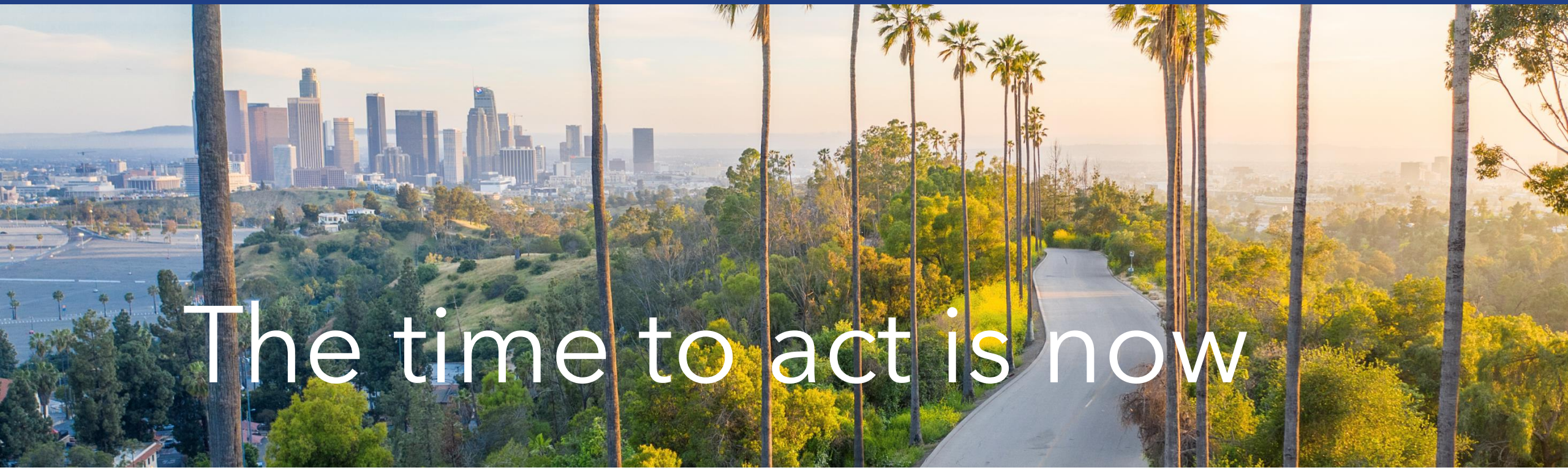
SoCalGas RD&D Public Workshop

April 25, 2023



SoCalGas™

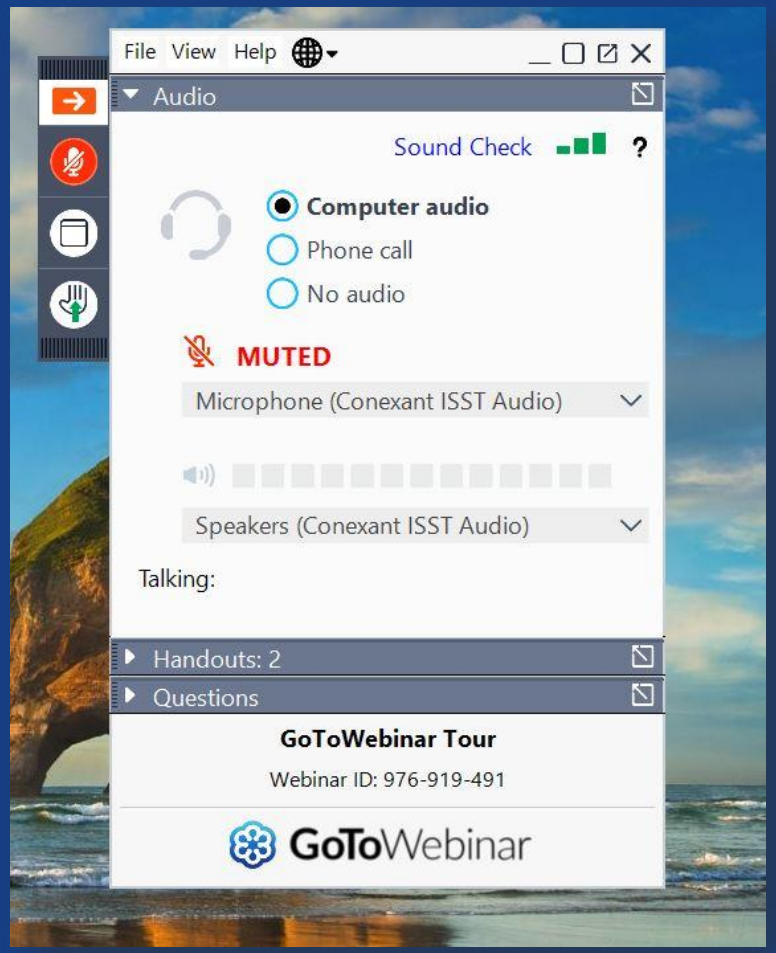
Meeting Notes

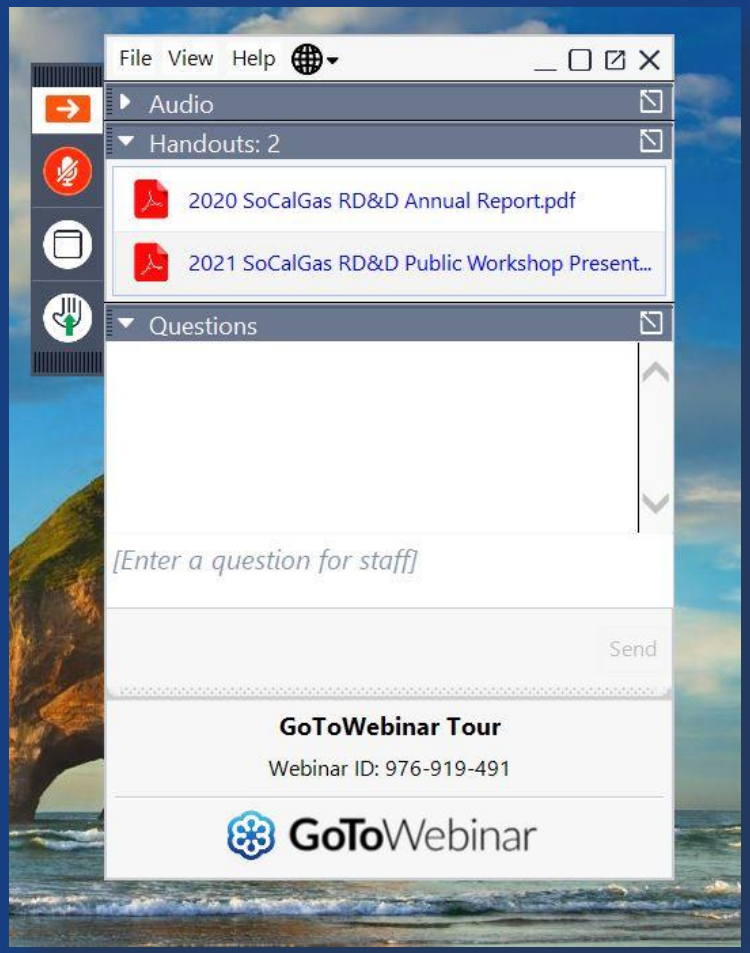
- A recording of today's workshop will be available for download.
- Each topical session will end with time for questions and comments. We will also dedicate time at the end of the day for additional questions and comments.
- Please submit comments via webform by Friday, May 5, 2023

  https://forms.office.com/r/r4PMUE6RRD

- For questions, email us: RDDinfo@socalgas.com

GoToWebinar Tour





Presentation Objectives & Structure

Share Successes

Explain RD&D

Summarize 2024 Plans

Seek Stakeholder Input

1. Introduction
2. 2022 in Review
3. 2023 in Brief
4. RD&D in Depth
5. Project Selection Process
6. 2024 Research Plan
7. Clean & Renewable Energy Resources
8. Gas Operations
9. Clean Transportation
10. Clean Energy Applications

Agenda

	Start Time	Duration (mins) Total *(presentation/Q&A)*	Topic
Section 1 90 mins	9:30am	45 mins *(35 pres. + 10 Q&A)*	Introduction (1 → 7)
	10:15am	30 mins *(20 pres. + 10 Q&A)*	Clean & Renewable Energy Resources (8)
	10:45am	**10 mins**	**BREAK**
Section 2 60 mins	10:55am	30 mins *(20 pres. + 10 Q&A)*	Gas Operations (9)
	11:25am	30 mins *(20 pres. + 10 Q&A)*	Clean Transportation (10)
	11:55pm	**5 mins**	**BREAK**
Section 3 60 mins	12:00pm	30 mins *(20 pres. + 10 Q&A)*	Clean Energy Applications (11)
	12:30pm	15 mins *(5 pres. + 10 Q&A)*	Wrap-up + Q&A
	12:45pm		**ADJOURN**

Presenters

Matt Gregori

Technology Development Manager

Customer Solutions RD&D Team

Ethan Simonoff

Project Manager-Technology Development

Clean & Renewable Energy Resources

Ed Newton

Gas Engineering Programs Manager

Gas Operations RD&D Team

Jeff Chase

Project Manager-Technology Development

Clean Transportation RD&D

Alan Leung

Project Manager-Technology Development

Clean Energy Applications RD&D

1. INTRODUCTION

SoCalGas Research, Development, & Demonstration

SoCalGas RD&D is a ratepayer-funded program authorized by the CPUC[1]. Its goal is to fund research to develop new technologies that benefit our customers by:

- Saving energy
- Reducing GHG emissions
- Improving air quality
- Increasing the safety, reliability, and affordability of energy

1. See California Code, Public Utilities Code - PUC § 740.1

Commitment to Diversity

SoCalGas is committed to providing clean, safe, and reliable gas service.

We are also dedicated to improving the quality of life in the communities we serve by maintaining a diverse workforce, working with suppliers that represent and reflect the communities we serve, and giving back through charitable contributions and employee volunteer activities.

For more information, visit:
https://www.socalgas.com/our-community/empower
https://www.socalgas.com/for-your-business/supplier-diversity

2. 2022 IN REVIEW

RD&D Supported 339 Projects in 2022

TOTAL **ACTIVE PROJECTS** IN 2022

339

TOTAL **PROJECTS INITIATED** IN 2022

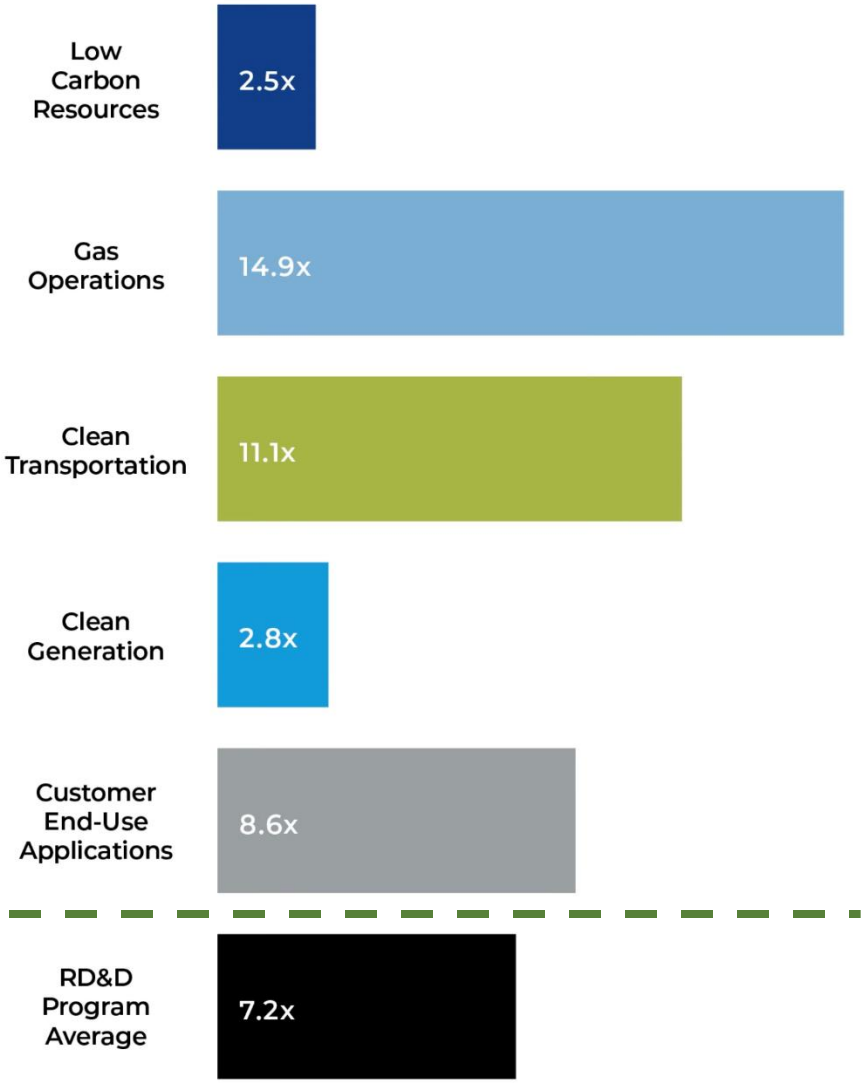
57

TOTAL **PROJECTS COMPLETED** IN 2022

90

2022 Financial Highlights

PROGRAM	2022 ACTUALS
Low Carbon Resources	$4,952,553
Gas Operations	$3,228,435
Clean Transportation	$1,778,809
Clean Generation	$1,697,347
Customer End-Use Applications	$1,773,120
SUBTOTAL	**$13,430,264**
Management & Administration	$1,567,990
TOTAL	**$14,998,254**



Ratio of outside funding to SoCalGas Funding

Significant 2022 Milestones

Equity

THE RD&D PROGRAM SUPPORTED

61

PROJECTS LOCATED IN ESJ **COMMUNITIES** IN 2022

SOCALGAS SPENT

$1.032B

WITH DIVERSE **FIRMS** IN 2022

SOCALGAS WORKED WITH

578

DIVERSE **SUPPLIERS** IN 2022

Significant 2022 Milestones

Outreach

2022 Annual Workshop

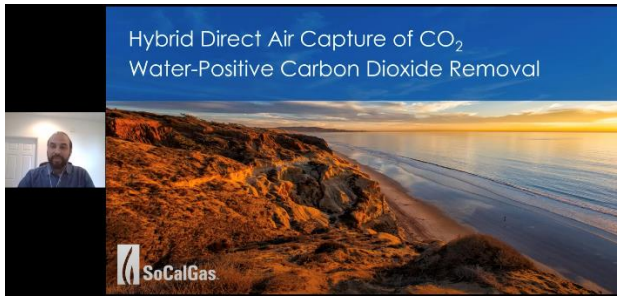
On April 27, 2022, RD&D held its annual workshop, hosting 402 individuals from a wide variety of organizations. RD&D incorporated input received into its 2023 Research Plan.

RD&D LinkedIn

RD&D now shares project updates, news, and more at https://www.linkedin.com/showcase/socalgas-research-development-&-demonstration-rd&d-/about/.

Research Webinars

In 2022, RD&D hosted four quarterly research webinars focusing on projects it supported.



For more information, visit: https://www.socalgas.com/sustainability/research-and-development

Significant 2022 Milestones

Publications

RD&D PROJECTS FEATURED IN

37

REPORTS, BRIEFS, AND JOURNALS

center for METHANE RESEARCH

GTI ENERGY

Proposed Changes to the EPA Greenhouse Gas Reporting Program Concerning Natural Gas Transmission and Distribution

Introduction

The EPA has recently proposed multiple revisions to the Greenhouse Gas Reporting Program (GHGRP) that aim to improve the quality of the data collected by adopting new calculations and monitoring methods or even collecting new data altogether where necessary.[1] The proposed revisions will become effective on January 1, 2023, and reporters will be required to implement these changes for the 2022

these important change

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The current draft of th

Register. Once publish

Transmission and

The natural gas transm

reporting requirements

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SPP Agreement Number FP00010434

Metal-Supported Solid Oxide Fuel Cells for Natural Gas

Final Report
January 2022

Märtha M. Welander, Michael C. Tucker (PI)
Lawrence Berkeley National Laboratory

BERKELEY LAB
Lawrence Berkeley National Laboratory

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Project Summary 1
Dissemination of project results 4
Plan for Follow On Funding 4
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Simulated natural gas reformate results 5
Screening of internal reforming catalysts 8
Conclusion 10

This document may contain research results which are experimental in nature. Neither the United States Government, nor any agency thereof, nor The Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately-owned rights. Reference to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not constitute or imply an endorsement or recommendation by the United States Government or any agency thereof, or by The Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof, or by The Regents of the University of California and shall not be used for advertising or product endorsement purposes.

1

energies

IMPACT FACTOR 3.252

CITESCORE 5.0

Article

Impact of Hydrogen/Natural Gas Blends on Partially Premixed Combustion Equipment: NO_x Emission and Operational Performance

Paul Glarville, Alex Fridlyand, Brian Sutherland, Miroslaw Liszka, Yan Zhao, Luke Bingham and Kris Jorgensen

Special Issue
Progress in Power-to-Gas Energy Systems
Edited by
Dr. Johannes Schaffert

MDPI

https://doi.org/10.3390/en15051706

Significant 2022 Milestones Leverage

Public Funding Awards
RD&D supported **eight** successful project proposals applying for public funding. These projects were awarded **$18,305,406** in research funding from the CEC and DOE.

8
PROJECTS WON A TOTAL OF **$18,305,406** FROM THE CEC AND DOE

Follow-On Funding
14 RD&D-supported companies received more than **$513 million** in follow-on funding:

Avnos · Blue Frontier · bp Bridger Photonics · Brimstone · Captura · CZero · Electrochaea · H2U Technologies · kevala · Mainspring · Sustæra · Susteon · STARS Technology Corporation · twelve

Significant 2022 Milestones Real-World Deployment

16+

TECHNOLOGIES AND PRODUCTS DEPLOYED AS A DIRECT RESULT OF RD&D SUPPORT

CENTER FOR Hydrogen™ SAFETY

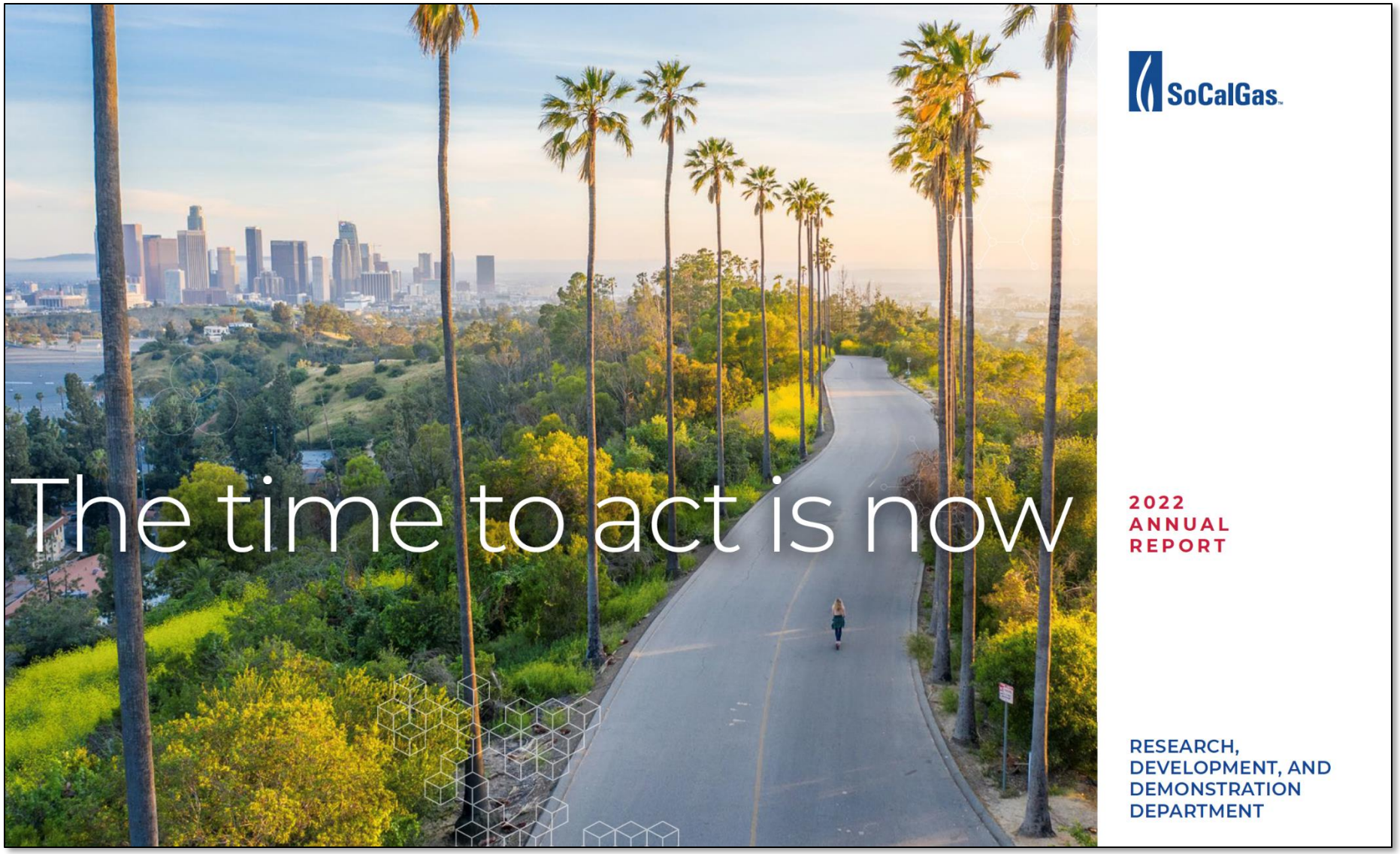
NYSEARCH

PRCI™

ASTM INTERNATIONAL

For more information, visit: https://www.socalgas.com/sustainability/research-and-development

Significant 2022 Milestones



To download a copy, visit: https://www.socalgas.com/sustainability/research-and-development

Safety Moment #1

To learn more about safety, visit:
https://www.socalgas.com/stay-safe/safety-and-prevention

20-20-20 Exercise

- Every 20 minutes
- Look at something 20 feet away
- For 20 seconds

Symptoms of eye strain:

- Dry eyes
- Watery eyes
- Blurred vision
- Double vision
- Headaches
- Soreness in the neck, shoulders, or back
- Sensitivity to light
- Trouble concentrating

Source: https://www.healthline.com/health/eye-health/20-20-20-rule

3. 2023 in Brief

2023 Update

CPUC Resolution

On June 15th, 2022, SoCalGas RD&D submitted the 2023 Research Plan by Tier 3 Advice Letter.

The CPUC Resolution approving SoCalGas RD&D's 2023 Research is pending.

2023 Update

Equity

RD&D Equity Engagement Roadmap Development

- Engaged a consulting firm with DE&I expertise
- Conducted 100+ hours of literature review to compile general themes and industry best practices
- Surveyed internal stakeholders for capabilities, opportunities, and needs
- Identified three key themes
- Evaluated potential tasks based on internal factors, e.g., potential impact, resources required, etc.
- Incorporated feedback from internal and external stakeholders

ESJ Community Defined

- Predominantly communities of color or low-income
- Underrepresented in the policy setting or decision-making process
- Subject to a disproportionate impact from one or more environmental hazards
- Likely to experience disparate implementation of environmental regulations and socio-economic investments in their communities
- Disadvantaged Communities, defined as census tracts that score in the top 25% of CalEnviroScreen 4.0, along with those that score within the highest 5% of CalEnviroScreen 4.0's Pollution Burden but do not receive an overall CalEnviroScreen score
- All Tribal lands
- Low-income households
- Low-income census tracts[1]
  Federal HUBZones[2] and Opportunity Zones[3]

1.Environmental & Social Justice Action Plan, CPUC , V.2 Oct 26, 2021
2.https://www.sba.gov/federal-contracting/contracting-assistance-programs/hubzone-program

Equity Engagement Themes & Tasks

Context

Obtain Situational Awareness

- **Task 1:** Monitor and report key RD&D Equity Engagement project metrics in the RD&D Annual Report
- **Task 2:** Regularly assess the effectiveness of Equity Engagement Roadmap activities

Community

Increase Community Engagement

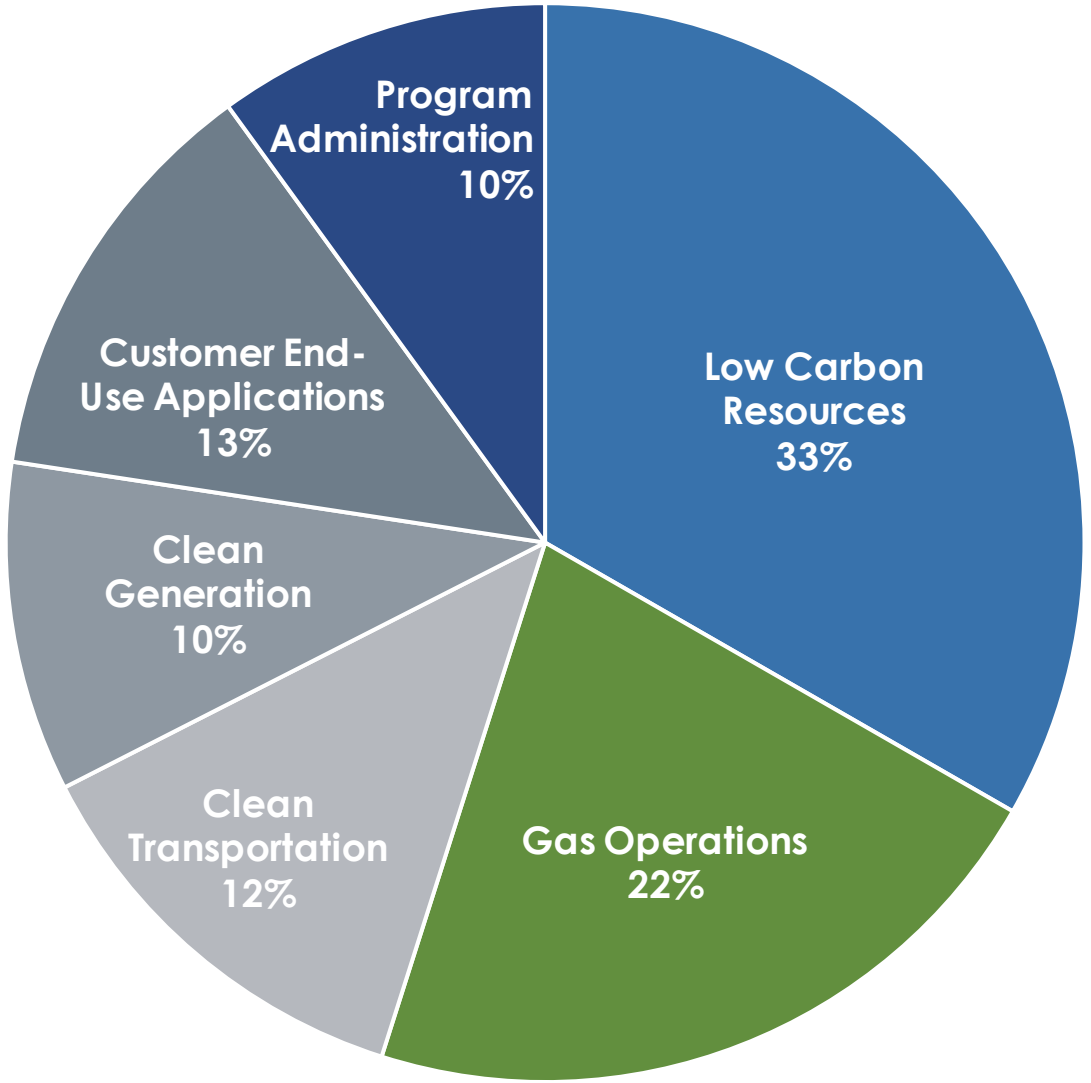
- **Task 3:** Establish a stipend program to encourage CBOs and other stakeholders to participate in the RD&D Public Workshop
- **Task 4:** Provide funding and mentoring support to senior design projects

Culture

Institutionalize Diversity, Equity, & Inclusion

- **Task 5:** Commit to review/revise RD&D literature to include ESJ language
- **Task 6:** Review/revise RD&D project policies to include DEI components

2023 Research Plan



Pending resolution of the 2023 Research Plan (Advice Letter 5991-G, submitted June 15, 2022) allocating a budget of $16.5 million

2023 Update

YTD Financials

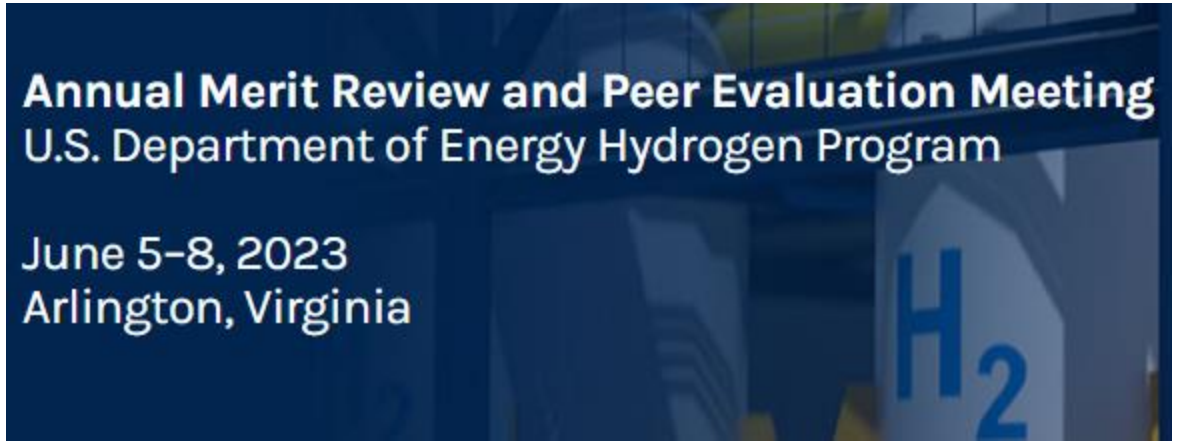
Spending is currently $2.6M variance to plan pending CPUC approval of the 2023 budget.

Until final approval, program staff cannot approve new contracts.

We thank all of our researchers and funding partners for their patience!

2023 Update
Projects Featured at Conferences

HYDROGEN & FUEL CELL SEMINAR



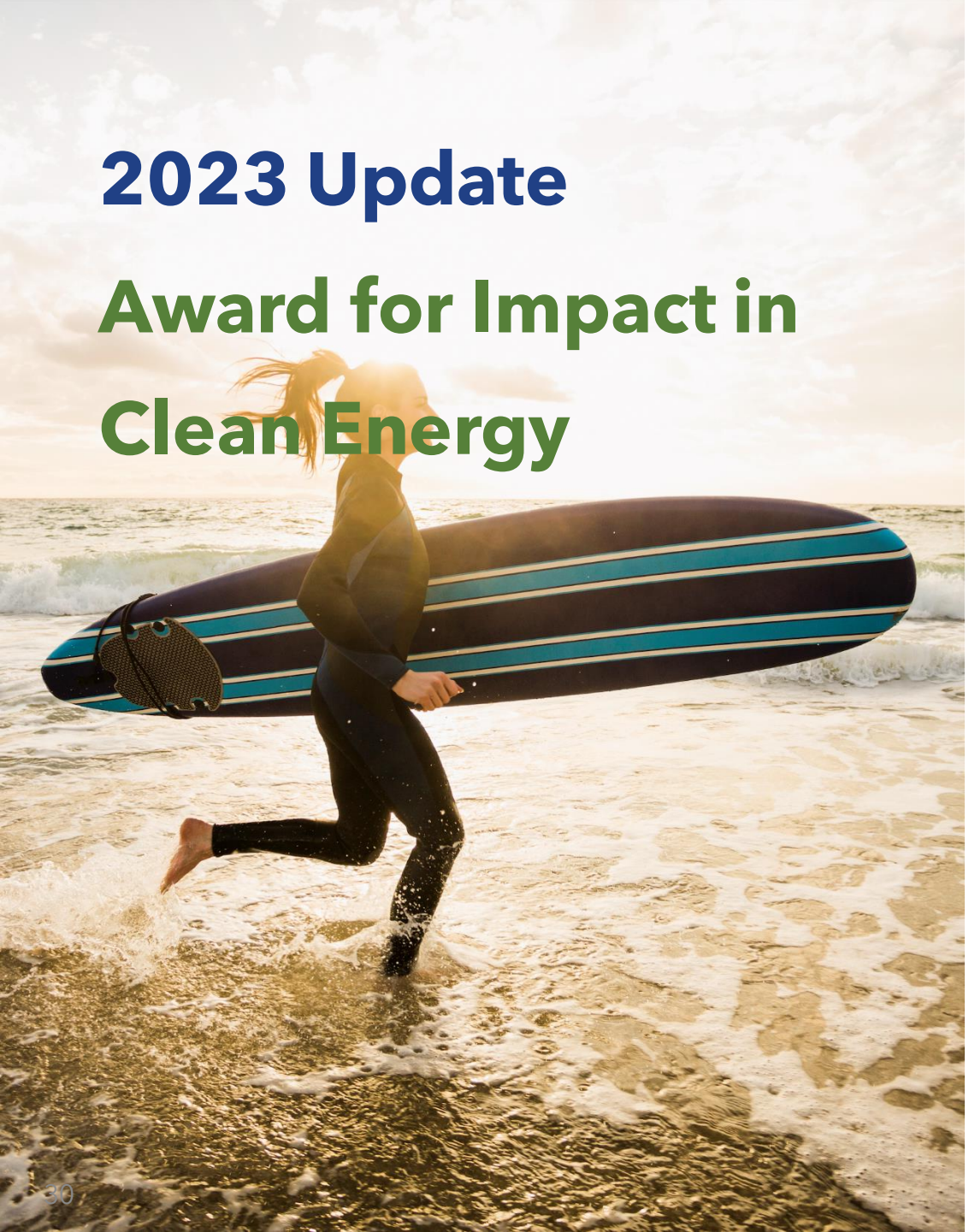
2023 Update

Funding Awards

- DOE – $3,000,000 to PARC Spiral Wound Aerogel Polymers for Direct Air CO_2 Capture
- DOE – $1,500,000 to Susteon Bench-Scale Development of Ionic Liquid Catalyzed High-Capacity Structured Sorbents
- CEC - $864,506 to GTI Commercial Inserts and Non-intrusive Demonstrations of Optimal Window Systems (Comm-INDOWS)
- CEC – $2,992,909 to UCLA System Approach for Monitoring and Risk Assessment for Natural Force Damage to Gas Pipelines
- CEC – $1,007,091 to UC Berkeley Performance-based Monitoring and Risk

2023 Update

Award for Impact in Clean Energy



SoCalGas™

THE CLEANIE AWARDS®

2022

investment
leader of the year
silver winner

thecleanieawards.com

4. RD&D In Depth

What is SoCalGas RD&D?











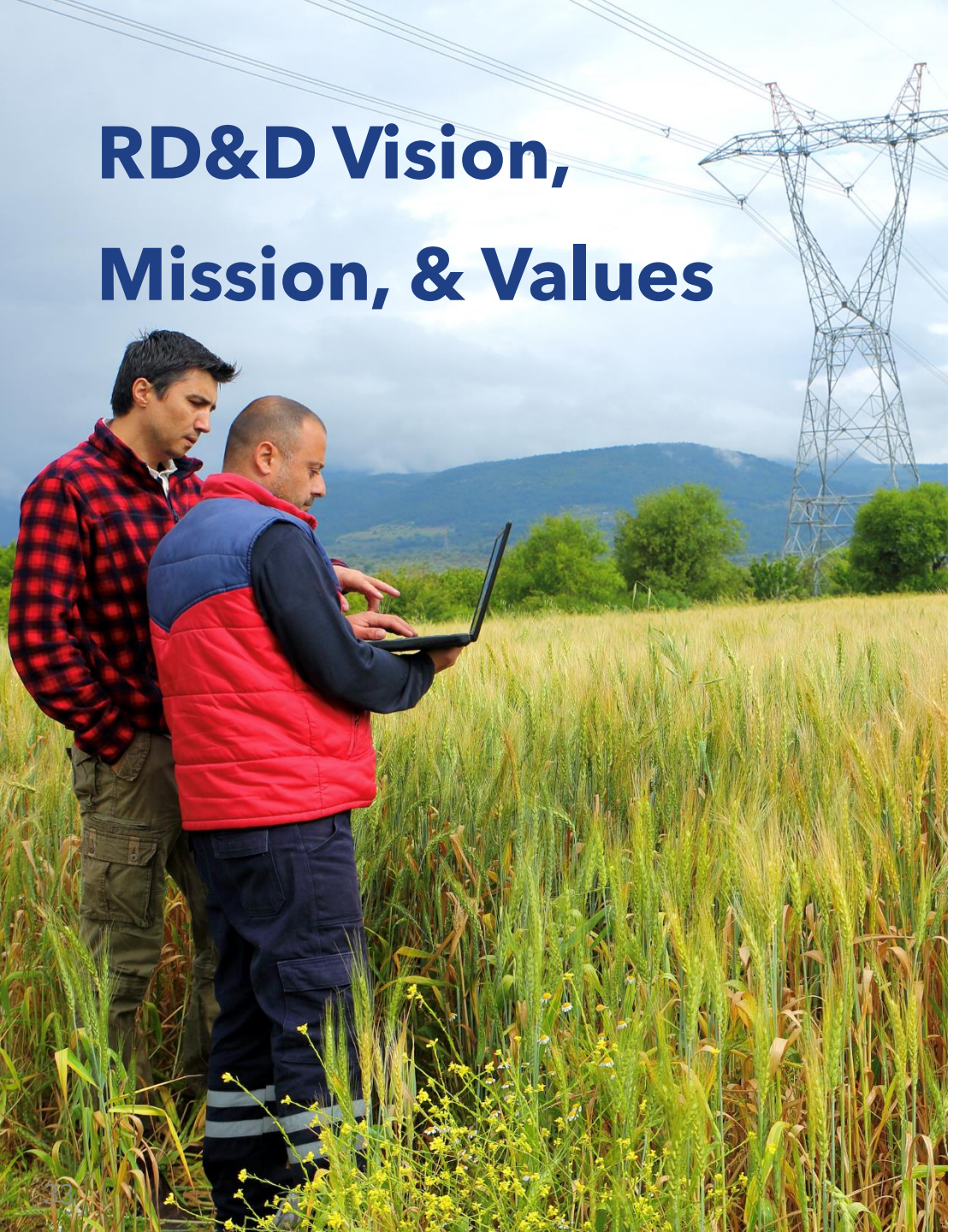









RD&D Vision, Mission, & Values



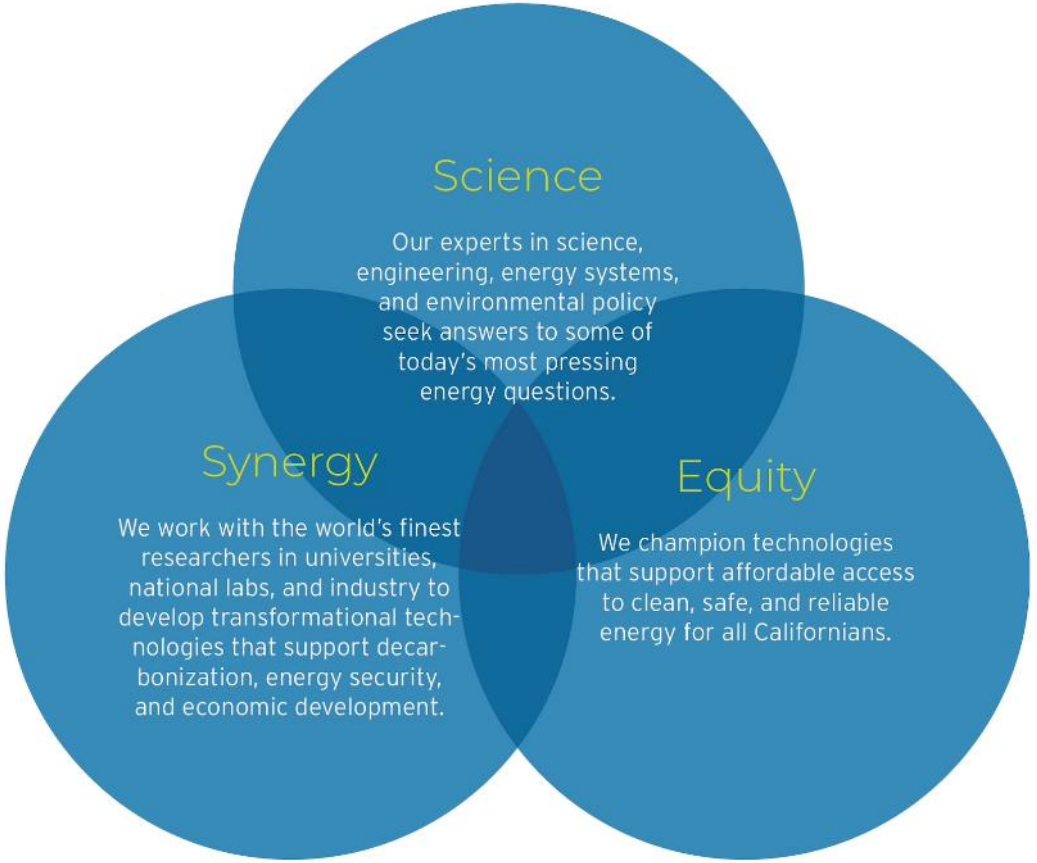
RD&D's VISION

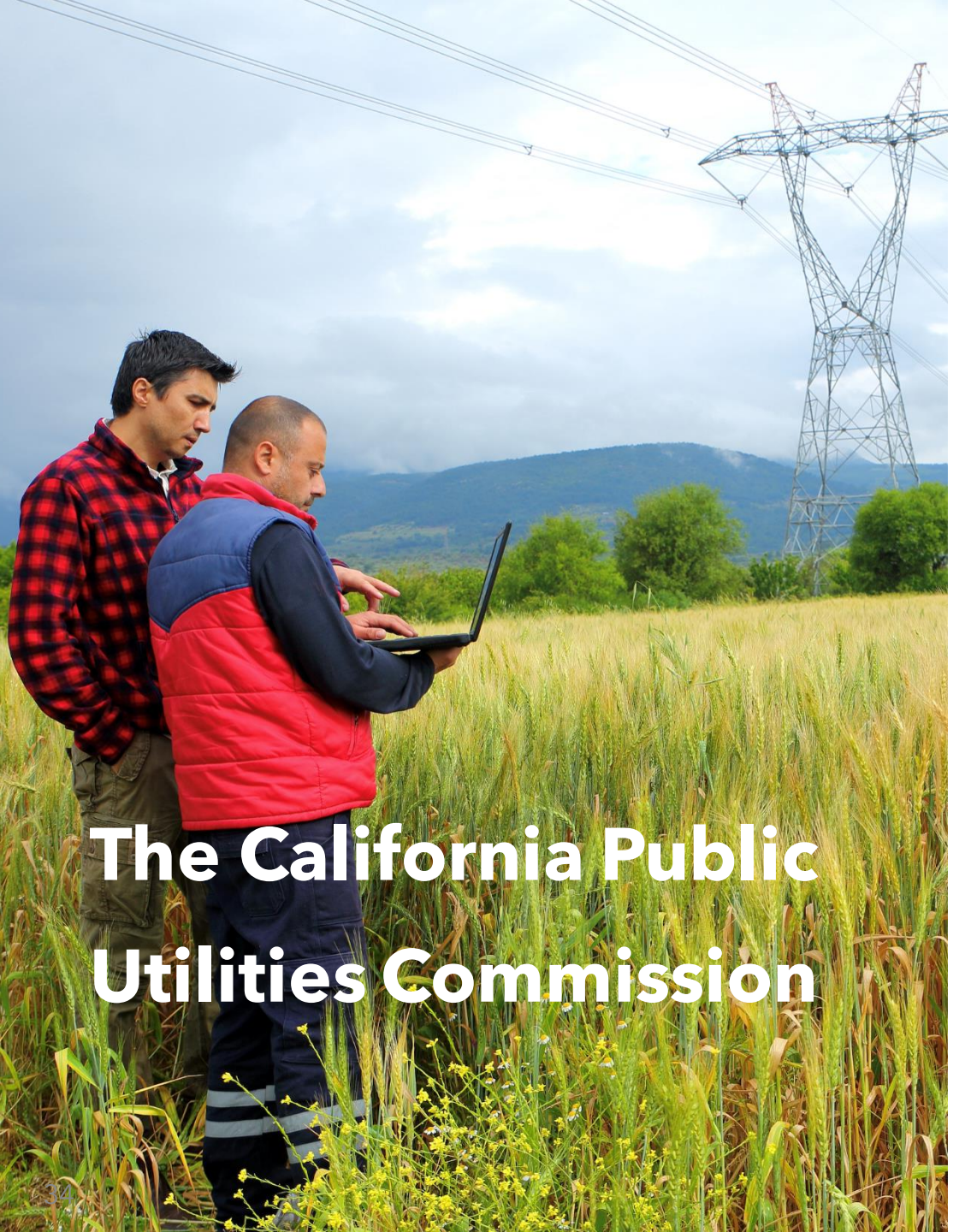
Advancing innovative technologies for safer, cleaner, and more reliable energy.

RD&D's MISSION

Identify transformational energy solutions. Build them. Share them with the world.

RD&D's VALUES



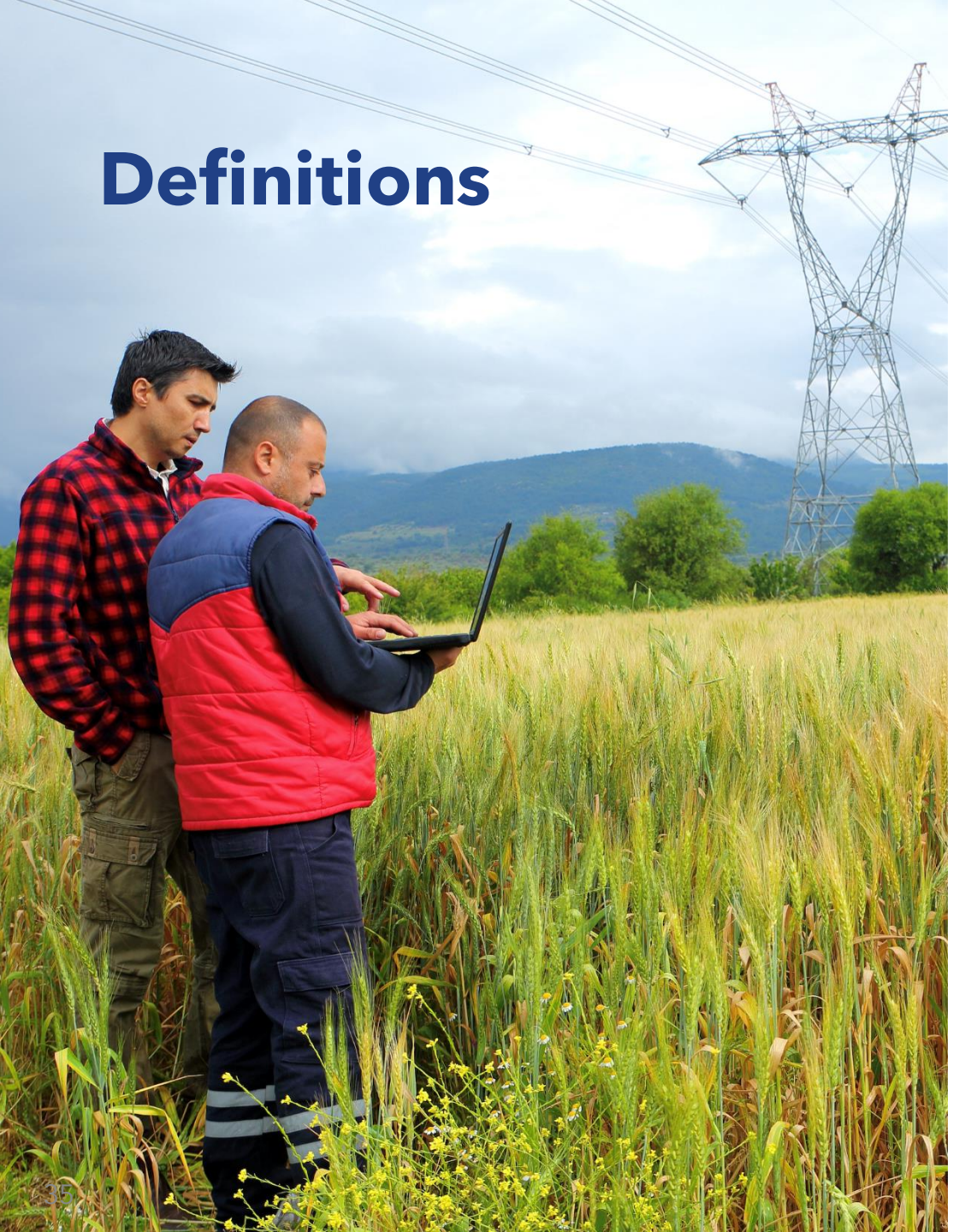


Public Utilities Code Section 740.1

SoCalGas operates in a manner consistent with the framework established in Public Utilities Code Section 740.1. Among other things, Section 740.1 requires projects supported by RD&D to support one or more of the following objectives:

- Environmental improvement
- Public and employee safety
- Conservation by efficient resource use or by reducing or shifting system load
- Development of new resources and processes, particularly renewable resources
- Improve operating efficiency and reliability or otherwise reduce operating costs

Definitions



SoCalGas RD&D

A department within SoCalGas focused on identifying, testing, and developing transformational technologies and products that promote California's energy goals.

Program

A division within SoCalGas RD&D focused on products and technologies united by a broad theme, such as Clean Transportation or Gas Operations.

Subprogram

A division within a Program focused on a subset of the program theme, such as On-Road transportation or Refueling Stations. Subprograms remain relatively constant but can change in response to industry developments, stakeholder input, or CPUC guidance.

Research Area

Each subprogram includes several research areas. These forward-looking categories suggest the types of projects RD&D hopes to fund. Staff evaluate research areas annually. Research areas are non-exhaustive.

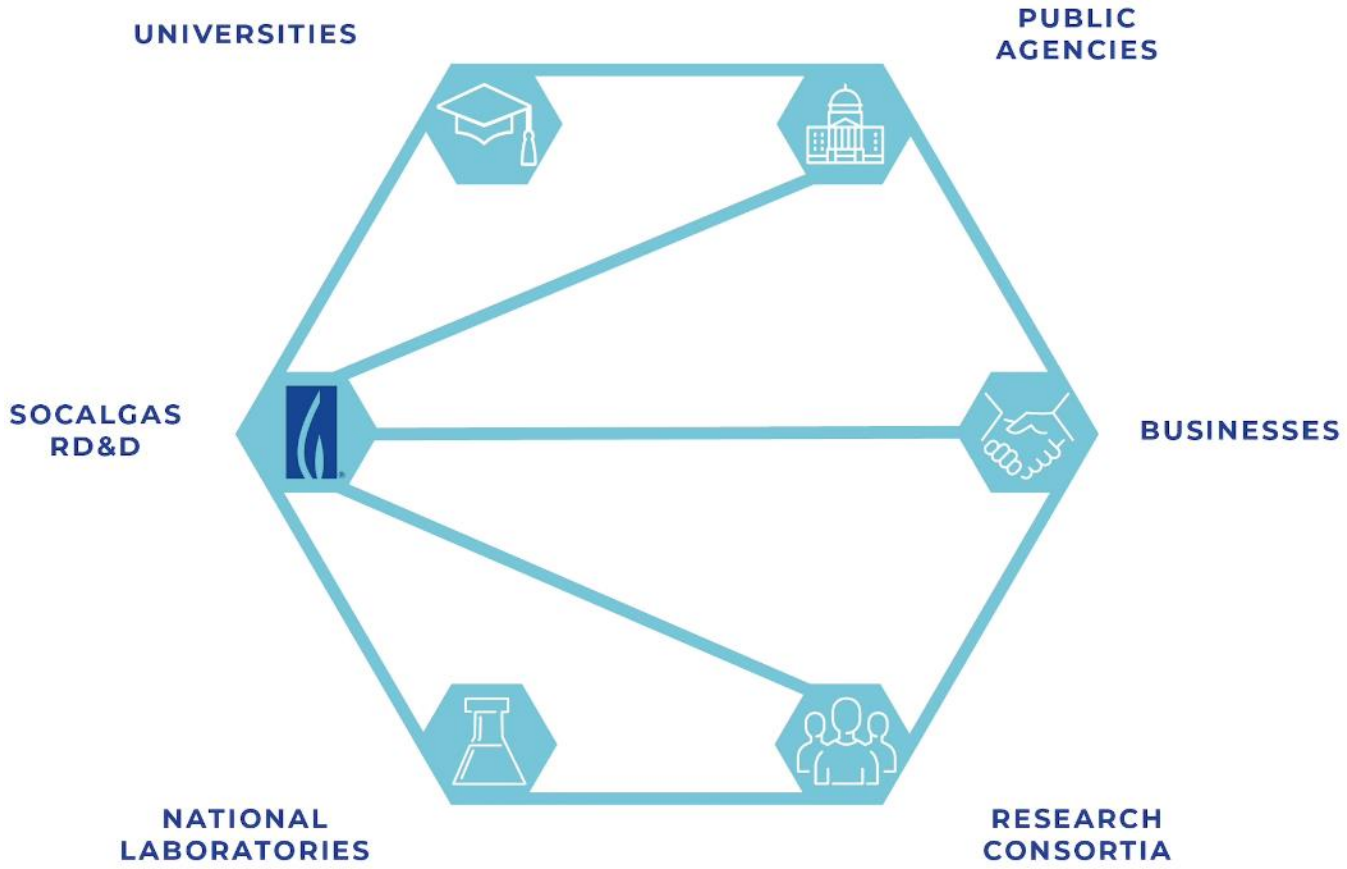
2024 Proposed RD&D Structure

Programs	Subprograms
Clean & Renewable Energy Resources	Carbon Management
	Renewable Gas Production
Gas Operations	Environmental & Safety
	Operations Technology
	System Design & Materials
	System Inspection & Monitoring
Clean Transportation	Off-Road
	On-Road
	Refueling Infrastructure
Clean Energy Applications	Energy Reliability
	Industrial Operations
	Residential & Commercial

Customer Benefits

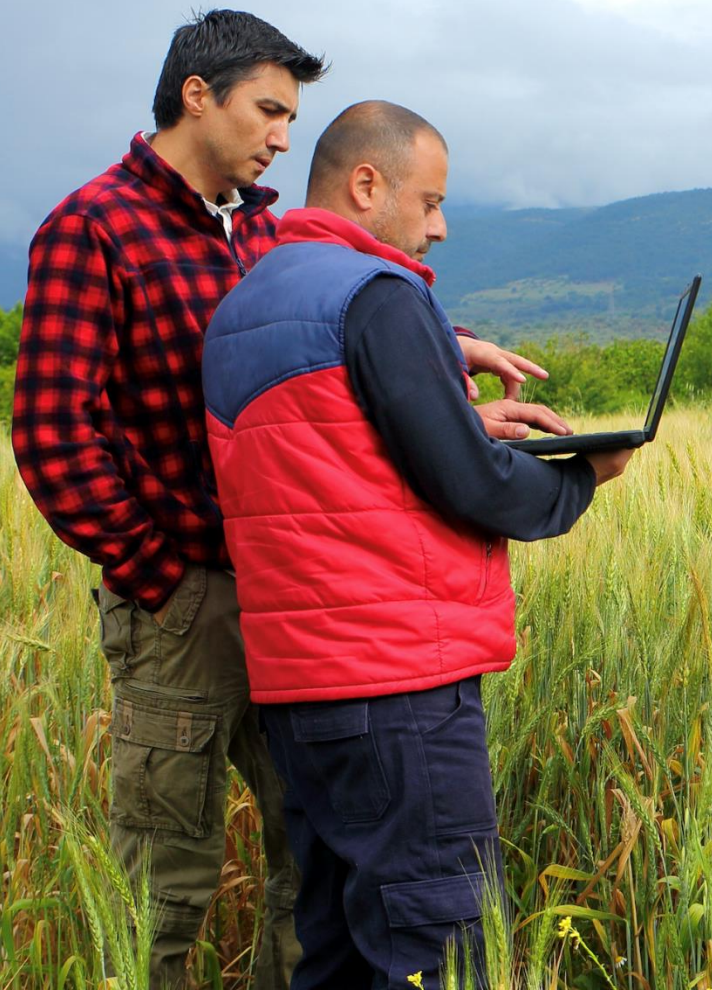
- RELIABILITY
- OPERATIONAL EFFICIENCY
- REDUCED GHG EMISSIONS
- IMPROVED AFFORDABILITY
- IMPROVED AIR QUALITY
- SAFETY

Collaboration Ecosystem



Collaboration Ecosystem

Complementary & Supplementary RD&D



Commercialization Partner for Industry

- Collaborate with successful research projects to drive eventual commercial success.
- Build project teams and leverage SoCalGas resources.

Leverage Diverse Sources of Funding

- Identify opportunities to co-fund RD&D projects and/or build collaborations to fully fund large projects.
- Target 3x leverage across RD&D.

Target Knowledge Gaps through Agile Approach

- SoCalGas RD&D funds projects at every stage of development and can do so where gaps exist in other funding opportunities or R&D programs.

5. Project Selection Process

Project Selection

RD&D seeks projects that:

1. Are in alignment with an RD&D program, subprogram, and research area.
2. Meet as many RD&D project evaluation criteria as possible.
3. Provide one or more ratepayer benefits.
4. Advance the state of the art.

RD&D Program area staff explore a variety of avenues to identify and conceive potential projects, including:

- Internal Operational Needs
- Technology Roadmap
- Customer Needs
- Public Workshop & Outreach
- Proposals from Research Teams
- Literature Surveys
- Conferences
- Workshops
- Policy Drivers
- External Funding
- Research Consortia

Next Steps

To seek support from SoCalGas RD&D for a project, technology, or product, pursue the following steps:

1. Connect with the relevant Program lead.

2. Evaluate your project, technology, or product against the elements of a good project.

3. Confirm alignment and refine your project in conversation with the relevant program lead.

4. Submit a Project Proposal.

6. 2024 Research Plan

2024 General Rate Case (GRC)

General Rate Case (GRC): a proceeding used to address the costs of operating and maintaining the utility system and the allocation of those costs among customer classes.

SoCalGas submitted the 2024 GRC application in 2022. A proposed decision is currently expected in Q2 of 2024.

The new GRC will cover 2024-2027 and will establish the overall budget for SoCalGas RD&D.

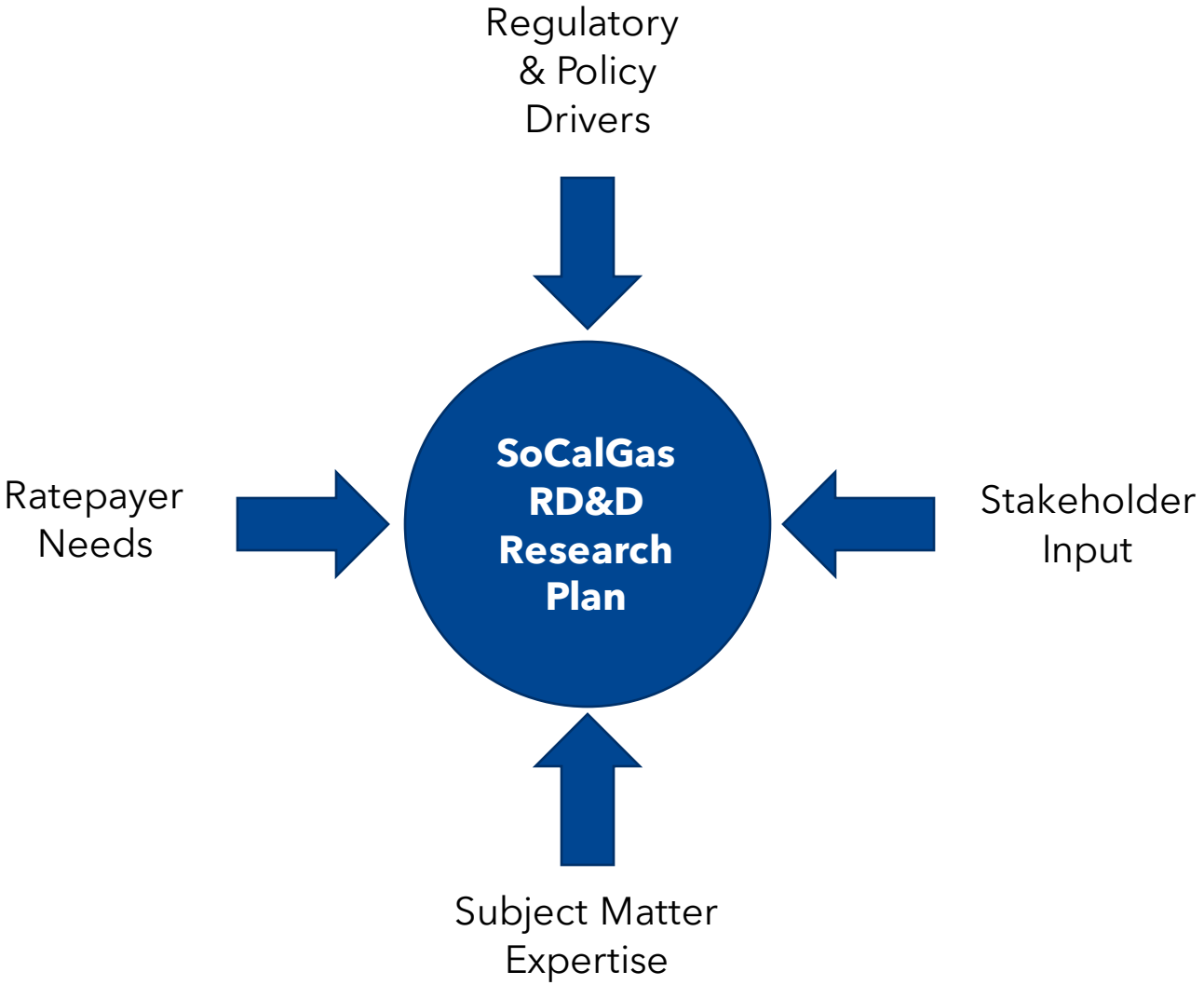
The 2024 Research Plan will outline how SoCalGas RD&D will allocate those funds.

For more information, visit:

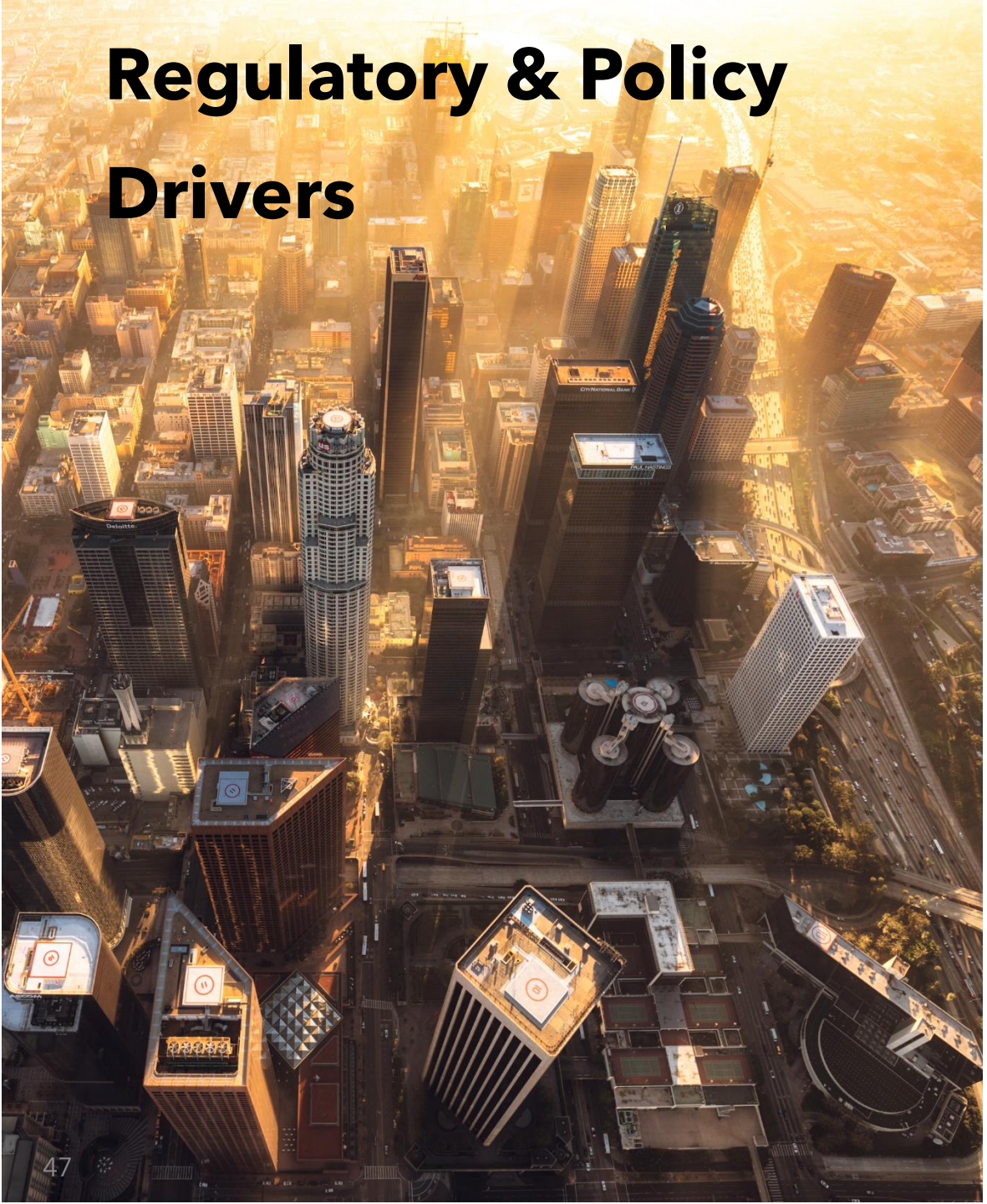
https://www.socalgas.com/regulatory/2024-general-rate-case

Overview

To build the RD&D Research Plan, staff consider multiple factors, including:



Regulatory & Policy Drivers



Category	Regulations and Policy Drivers
GHG Emissions	California Climate Commitment: Establishes plans and directs funding to achieve State goals regarding GHG emission reduction, improved air quality, energy affordability, and energy reliability. Assembly Bill (AB) 32: Reduce CO_2 emissions 40% below 1990 levels by 2030. Senate Bill (SB) 1101: Carbon Sequestration: Pore Space Ownership and Carbon Capture, Utilization, and Storage Program. AB 1279: By 2045, achieve a carbon-neutral California economy and reduce statewide anthropogenic GHG emissions to at least 85% below 1990 levels. AB 3232: Building decarbonization. SB 905: Establishes a regulatory framework for carbon removal and carbon capture, utilization, and sequestration.
Pipeline Safety	CPUC General Order 112F: Rules governing design, testing, operation, and maintenance of gas transmission and distribution systems. U.S. Department of Transportation (DOT) 49 Code of Federal Regulations (CFR) Part 192: Federal pipeline safety regulations. AB 1900: Biomethane quality standards. Order Institute Rulemaking (OIR) R.13-02-008, Phase 4: Addresses injection of renewable hydrogen into gas pipelines.
Local Air Quality	Clean Air Act: Air quality standards for NOx and PM. AB 617: Pilot communities for air quality improvements. SCAQMD Air Quality Management Plan (AQMP): Regional air quality plan to meet federal standards for stationary source emitters of air pollutants (e.g., GHG, NOx, PM).
Methane Emissions	SB 1383: Reduce methane emissions from the decomposition of organic wastes. CARB Oil and Gas Rules: Requires new monitoring and repairs to reduce methane emissions. Natural Gas STAR Program: Encourages adoption of methane-reducing technologies and practices. EPA Methane Challenge Program: Recognizes oil and gas companies that take comprehensive action to reduce methane emissions. SB 1440: Authorizes a state procurement program for RNG.
Clean Transportation	ARB Implementation Plan: Low-NOx standard for trucks. AB 8: Development of 100 hydrogen fueling stations in California. EO-B32-15: Sustainable freight action plan. EO-B48-18: 200 hydrogen refueling stations by 2025. EO N-79-20: Mandates 100% of passenger vehicle sales are zero emission by 2035, and 100% of medium- and heavy-duty vehicles are zero emission by 2045 for all operations where feasible. Low Carbon Fuel Standard (LCFS): Reduce carbon intensity of fuels by 20% by 2030. SB 1275: One million zero-emission and near-zero-emission vehicles by 2023.
Clean Power Generation	SB 100: 100% of all retail sales of electricity to California end-use customers must be renewable by 2045. SB 1020: 100% of electricity procured to serve all state agencies must be renewable by 2035.
Equity	CPUC General Order 156: Encourages investor-owned utilities (IOUs) to procure or contract goods and services from women, minority, disabled veteran, and/or LGBT owned business enterprises. CPUC ESJ Action Plan: Increases investment in clean energy resources to benefit environmental and social justice communities, especially to improve local air quality and public health.

Summary of Stakeholder Input

In early 2023, RD&D conducted outreach meetings with representatives from 11 industry organizations:

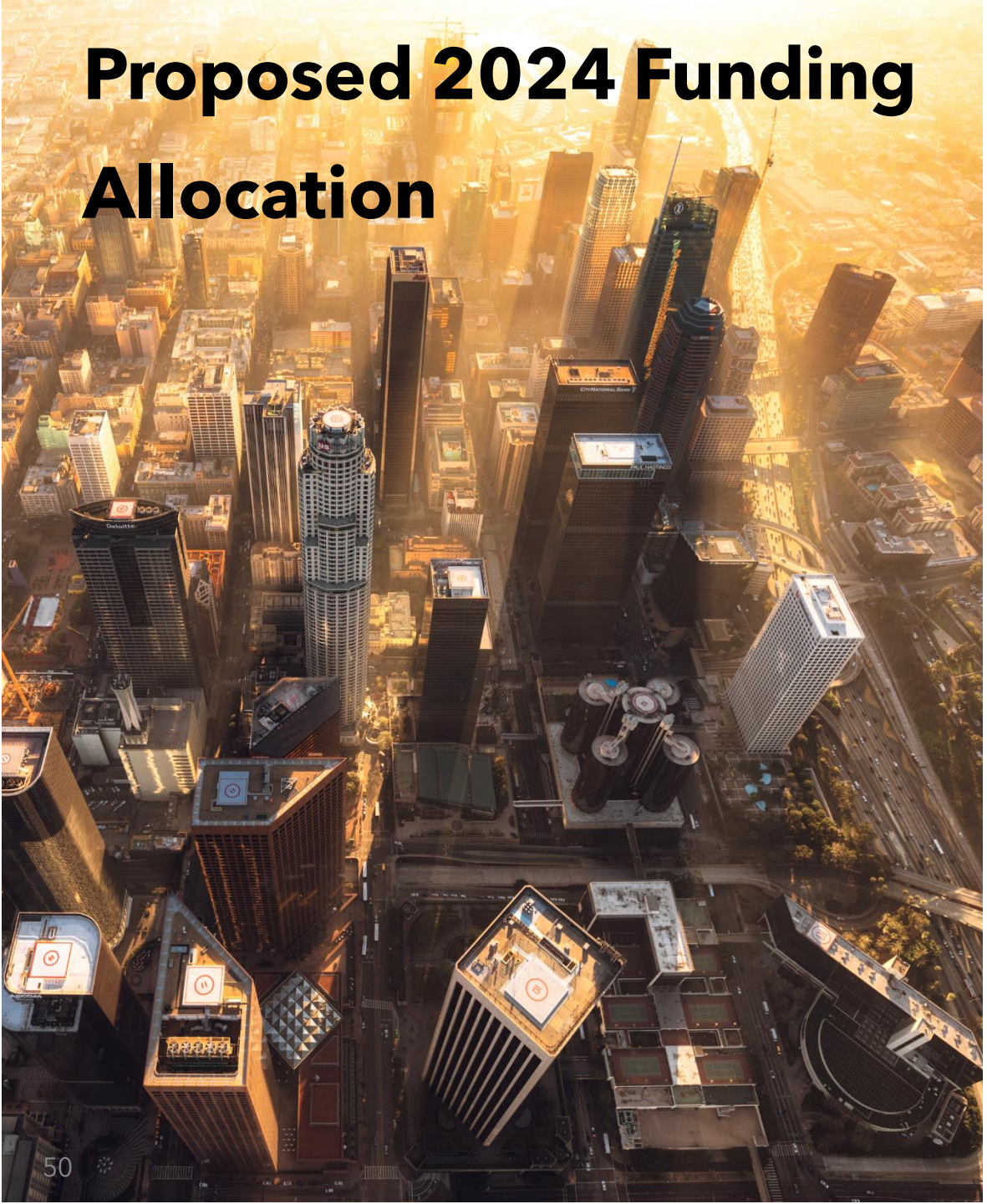
- 7th Generation Advisors
- California Energy Commission
- Darcy Partners
- Energy Independence Now
- GTI Energy
- Pacific Gas and Electric Company
- Pipeline Research Council International
- South Coast Air Quality Management District
- Stanford Doerr School of Sustainability
- University of California, Los Angeles
- U.S. Department of Energy

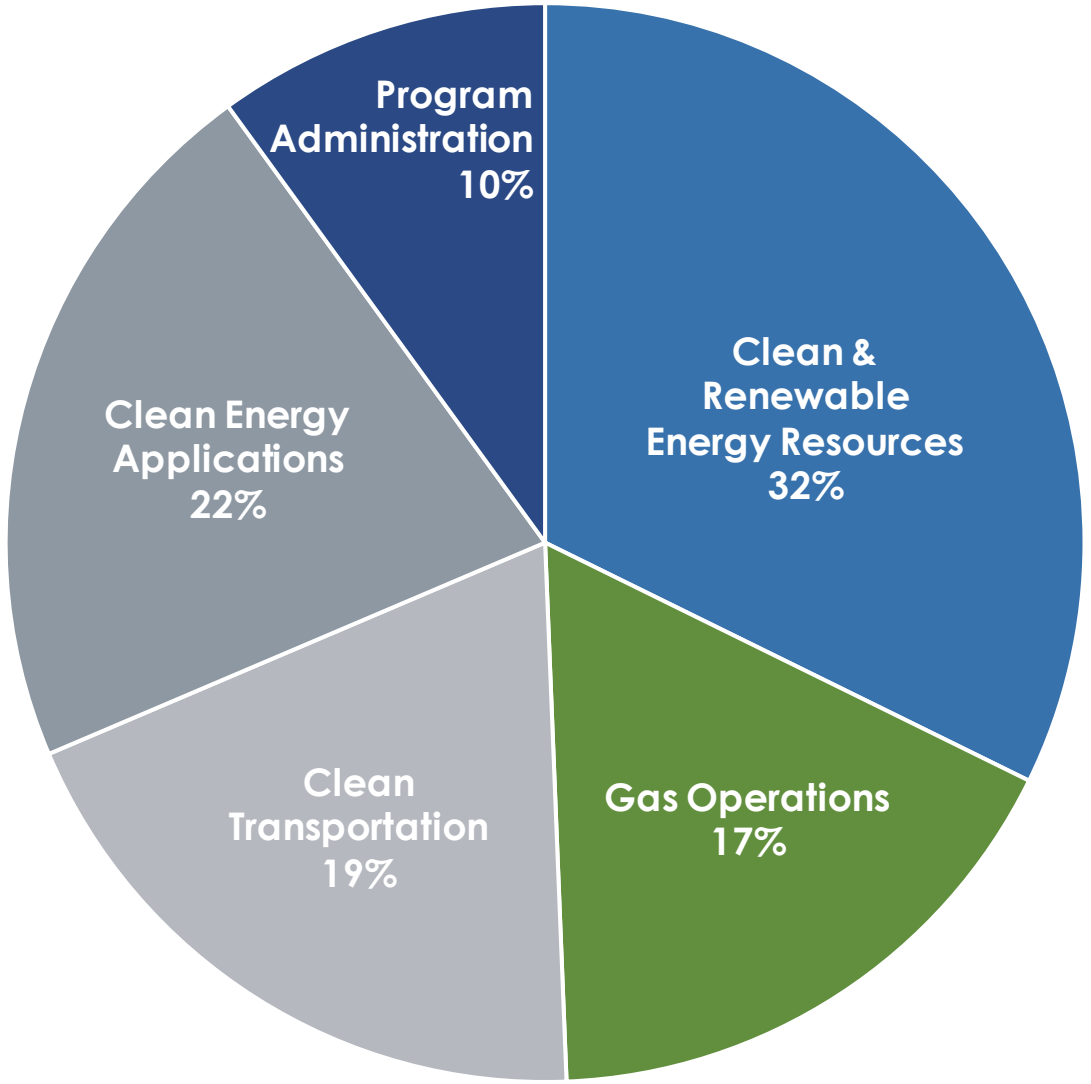
Summary of Stakeholder Input

Key Takeaways

- Partnering is essential so that this work complements and does not compete with work of other researchers.
- Focus R&D from the beginning on technologies that have real potential to scale.
- Involve under-resourced communities early and often to understand their concerns and needs.
- It is vital to learn how to turn electrons into infrastructure-compatible molecules.
- Standards development is critical.
- Leak detection—for both natural gas and other gases, such as hydrogen and CO_2—is very important.

Proposed 2024 Funding Allocation





Pending CPUC authorization of A. 22-05-015

Q&A and Feedback

- Please submit questions in the GoToMeeting questions box or raise your "hand" in the GoToWebinar controls. Please **limit your response to one minute**.
- Please submit comments by Friday, May 5, 2023.

https://forms.office.com/r/r4PMUE6RRD

Safety Moment #2

To learn more about safety, visit:
https://www.socalgas.com/stay-safe/safety-and-prevention

Call 8-1-1 before you dig

https://www.youtube.com/watch?v=SAKtePjYAKo

Program

SoCalGas

Clean & Renewable Energy Resources

Program Area

Introduction

2022 in Review

Subprograms Overview

- Carbon Management
- Renewable Gas Production

2024 Funding Allocation

Feedback

Ethan Simonoff

BIO

Ethan Simonoff joined SoCalGas RD&D in 2022 from Caltech where he worked as a Staff Scientist. Ethan currently helps to manage the Low Carbon Resources program supporting a wide range of technology development in the areas of renewable gas production and carbon management. Prior to joining the RD&D team, Ethan gained nearly 10 years of research experience leading projects aimed at improving efficiency in energy-related systems and authored multiple scientific journal articles. Ethan holds a B.A. in Chemistry from Northwestern University and a Ph.D. in Chemistry from Caltech.

Introduction

GOAL

Decarbonize the gas supply while maintaining its affordability and reliability.

OBJECTIVES

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.

2022 in Review

CAPTURA

Demonstration of Captura's ocean-based carbon removal technology deployed at Caltech's Kerckhoff Marine Laboratory in Newport Beach, CA.

- 33 Active Projects
- 7 Initiated Projects
- 8 Completed Projects
- $4,952,553

Benefits

Low Carbon Resources tracks benefits across the projects that it supports.

Operational Efficiency

Improved Affordability

Reduced GHG Emissions

Improved Air Quality

Policy Alignment

Low Carbon Resources aligns and conforms with California's decarbonization goals.

By reducing the carbon-intensity of the gas grid through gradual decarbonization, this sub-program supports the following policies:

- **California Climate Commitment**
- **EO B-55-18:** 2045 Carbon-neutral California economy
- **Assembly Bill (AB) 32:** Reduce CO_2 emissions 40% below 1990 levels by 2030.
- **AB 1279:** By 2045, reduce statewide anthropogenic GHG emissions to at least 85% below 1990 levels.
- **Clean Air Act:** Air quality standards for NOx and PM
- **EO S-3-05:** GHG emission reduction targets
- **SB 1383:** CH4 emissions from organic waste
- **LCFS:** Reduce carbon intensity of fuels
- **SB 905:** Establishes a regulatory framework for carbon removal and carbon capture, utilization, and sequestration.

2024 Subprograms

NEW

In 2024, SoCalGas RD&D proposes changing the program name from Low Carbon Resources to Clean & Renewable Energy Resources (C&RER).

Program staff also propose simplifying the subprogram Carbon Capture, Utilization, & Sequestration to Carbon Management.

Carbon Management

Focuses on carbon capture, utilization, and sequestration (CCUS) technologies that seek to capture, utilize, or sequester CO_2. Explores many approaches, including direct air capture coupled with either conversion into plastics, cement, and biofuels or sequestration into depleted oil fields and saline aquifers.

Renewable Gas Production

Focuses on the safe, reliable, and cost-effective production of renewable gaseous fuels–specifically RNG and hydrogen–from various feedstocks and multiple technological pathways.

Carbon Management

Background

CCUS is vital in the fight against climate change. Not only is it imperative to modify the production sources for gas and transition to renewable ones, but offsetting current emissions and removing historic emissions by capturing, utilizing or sequestering CO_2 from our atmosphere and industrial processes is critical to mitigating and reversing the effects of climate change.

Recent Developments

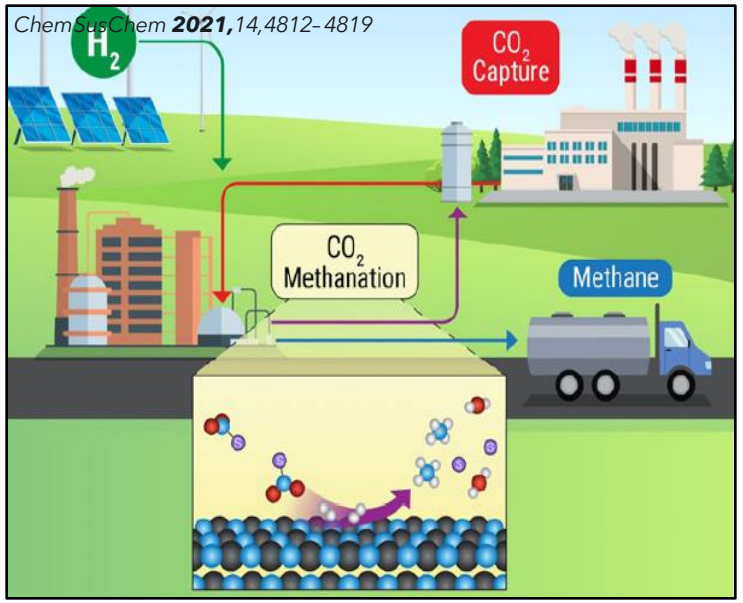
- **Inflation Reduction Act 45Q Tax Credit:**
  - Increases the US federal income tax credit under IRC Section 45Q available for US CCUS projects
  - Provides for a later beginning of construction deadline of before January 1, 2033
  - Lowers annual capture requirements
  - Introduces a limited, 5-year direct pay provision

- **Office of Clean Energy Demonstrations, Direct Air Capture Hubs Program:**
  - Provides $3.5B to develop four regional direct air capture hubs
  - Each hub has the capacity to capture and sequester, utilize, or sequester and utilize at least 1,000,000 metric tons of carbon dioxide from the atmosphere annually
  - Hubs demonstrate the capture, processing, delivery, and sequestration or end-use of captured carbon

Carbon Management

Research Areas

- **Carbon Capture and Utilization (CCU):** Includes Direct Air Capture (DAC) coupled with conversion of CO_2 into plastics, cement, and biofuels.
- **Carbon Capture and Sequestration (CCS):** Includes DAC coupled with compression and storage of CO_2 in depleted oil fields and saline aquifers.
- **Emissions-free hydrogen production via methane pyrolysis:** Includes bubbling methane into a molten solution to decompose it into hydrogen and solid elemental carbon for a variety of uses.

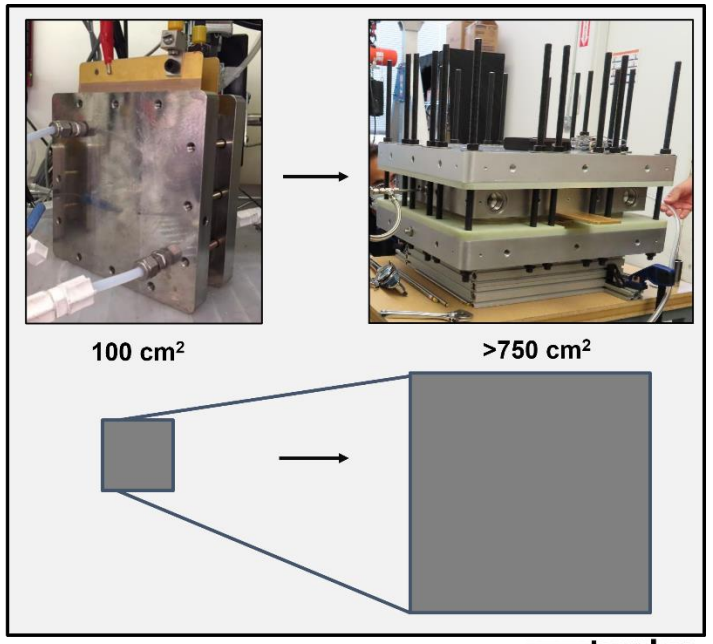


Pacific Northwest National Laboratory

PNNL Integrated Capture and Conversion of CO_2 to <u>X</u>

(***<u>X</u>*** *= Chemicals, Building Materials, etc.)*

Twelve PEM CO_2 Electrolyzer Scale-up to Enable MW-Scale Modules



twelve

Renewable Gas Production

Background

This subprogram focuses on the safe, reliable and cost-effective production of renewable gaseous fuels—specifically RNG and hydrogen—from various feedstocks and multiple technological pathways.

Recent Developments

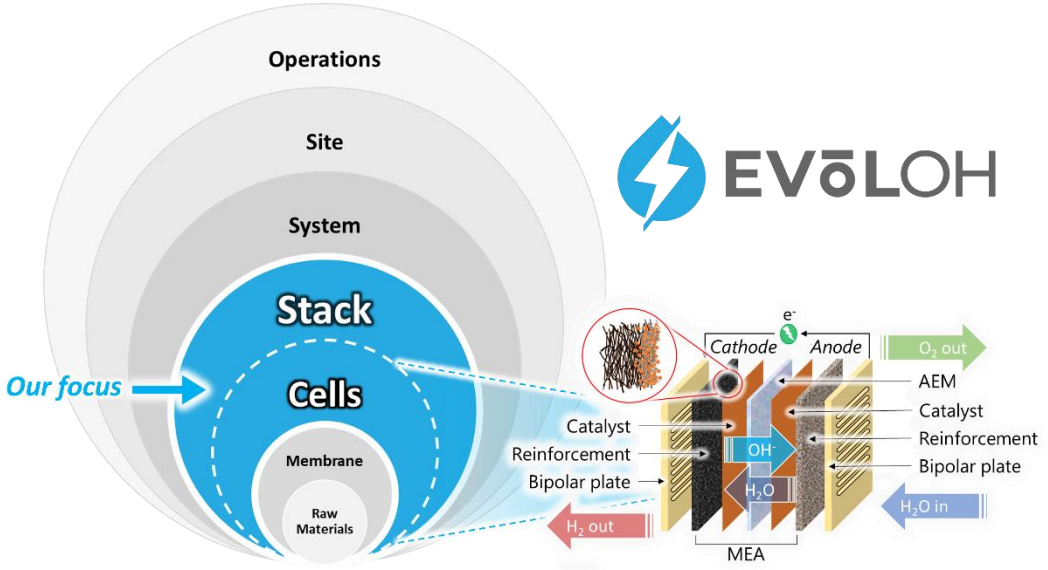
- **Inflation Reduction Act Production Tax Credit for Hydrogen Production**
  - Renewable electricity and clean hydrogen plants can receive a production tax credit of 2.6 cents per kWh and up to $3 per kg of hydrogen, respectively, for the first 10 years of operation
- **DOE's EERE/HFTO National Clean Hydrogen Strategy and Roadmap:**
  - Provides a snapshot of hydrogen production, transport, storage, and use in the United States today and explores the potential for clean hydrogen to contribute to national goals across multiple sectors.
- **Office of Clean Energy Demonstrations Regional Hydrogen Hubs:**
  - Includes up to $7 billion to establish six to 10 regional clean hydrogen hubs across America

Renewable Gas Production

Research Areas

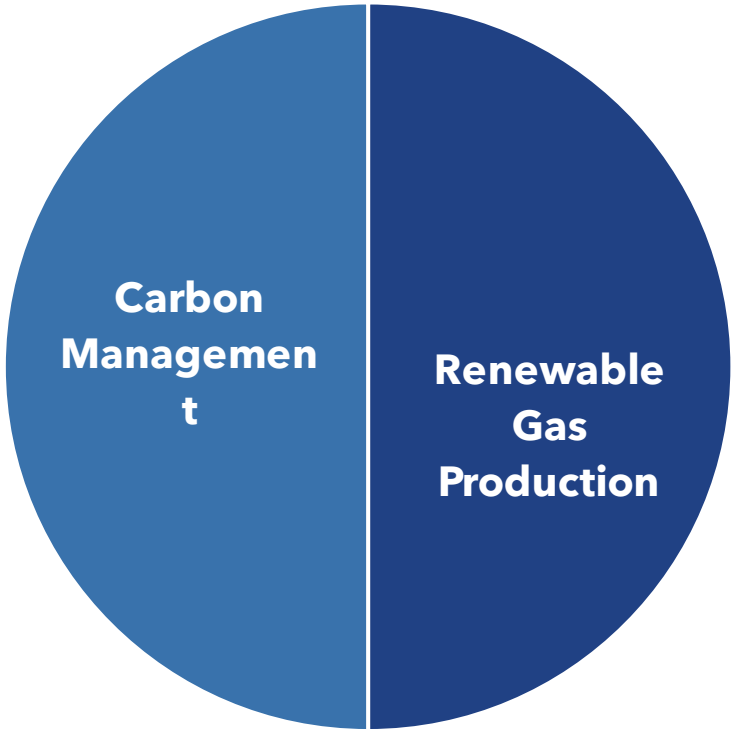
- Renewable hydrogen production via advanced water-splitting
- Renewable methane production via various methanation pathways
- Renewable gas production via biomass gasification
- Distributed hydrogen production via advanced Steam Methane Reforming (SMR) of biomethane
- Concentrated Solar Power (CSP) technology for renewable gas production

STARS Distributed Hydrogen Generation at SunLine Transit Agency



EvolOH High-speed AEM Electrolyzer Manufacturing

2024 Proposed Funding Allocation



Subprogram	Allocation
Carbon Management	50%
Renewable Gas Production	50%
Total	**$7,504,000**

Q&A and Feedback

- Please submit questions in the GoToMeeting questions box or raise your "hand" in the GoToWebinar controls. Please **limit your response to one minute**.
- Please submit comments by Friday, May 5, 2023.

https://forms.office.com/r/r4PMUE6RRD


10-Minute Break
(10:45 – 10:55)

SoCalGas

Gas Operations

Introduction

2022 in Review

Subprograms Overview

- Environmental & Safety
- Operations Technology
- System Design & Materials
- System Inspection & Monitoring

2024 Proposed Funding Allocation

Feedback

Ed Newton

BIO

Ed Newton, Gas Engineering Programs Manager, has worked in the Natural Gas Industry for 38 years, with the last 21 years working for Southern California Gas Company. Ed currently oversees four teams: 1) the Gas Operations RD&D Program; 2) the Leakage Abatement RD&D program; 3) the Aviation Services Department; and 4) the Plastic Piping Systems team.

Ed has led efforts around much of the groundbreaking technology in response to SB-1371, the 2014 California Senate bill requiring natural gas companies to adopt strategies to minimize emissions. He began evaluating new technologies to deploy in SoCalGas' system and oversaw the initial reports that were submitted to the California Public Utilities Commission.

In 2022, Ed received the American Gas Association (AGA) John B. McGowan Research Award for his pioneering efforts and outstanding contributions around innovation in the natural gas industry.

Introduction

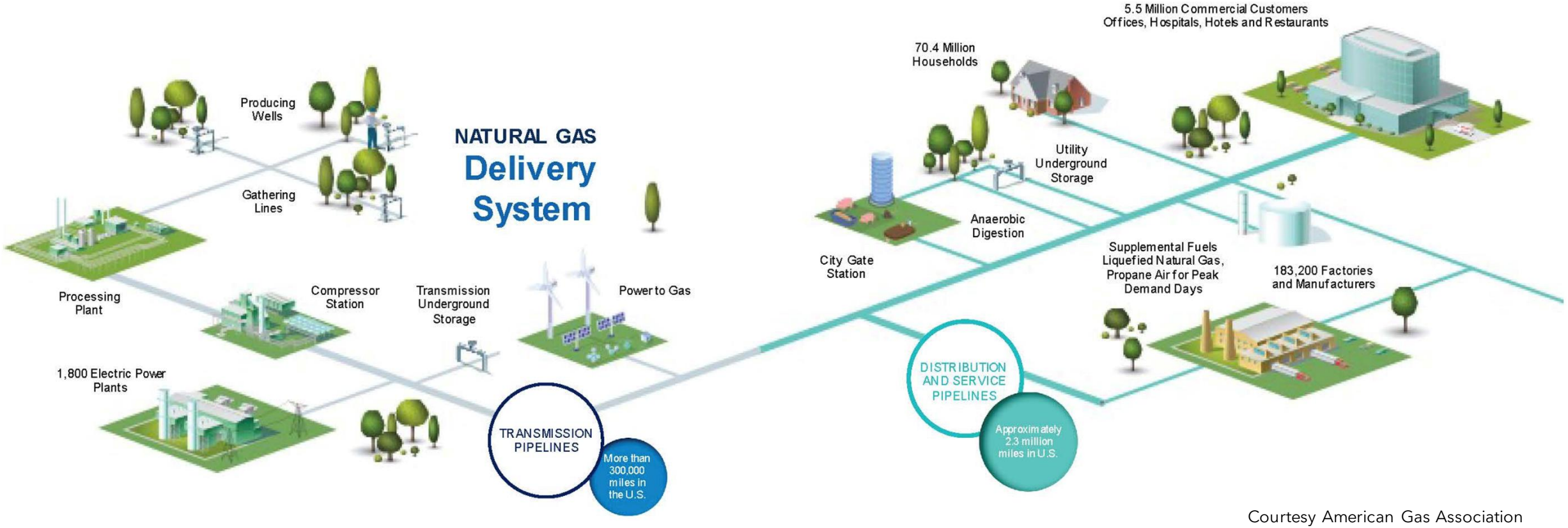
OVERVIEW

The Gas Operations RD&D program area supports pipeline gas delivery networks across the SoCalGas Distribution, Transmission, and Storage systems to research, develop, and test new gas operations technologies that are beneficial to ratepayers.

GOALS

- **Improve gas safety and system integrity**
- **Improve or enhance system reliability**
- **Advance system design and materials**
- **Increase operational efficiencies and effectiveness**
- **Reduce system emissions**

System Scope & Metrics



Courtesy American Gas Association

SoCalGas' Delivery System Metrics:

- More that 21 million Customers
- Over 6 million Meters
- 3,046 miles of DOT Gas Transmission lines
- 100,938 miles of DOT Gas Distribution Mains and Services pipelines

Consortium Memberships

OTD Operations Technology Development

Members:
28 Natural Gas Utilities

Pipeline membership is open to companies operating natural gas distribution systems (Domestic & International).

Mission: Identify, select, fund, and oversee research projects resulting in innovative solutions and the improved safety, reliability, and operational efficiency of natural gas systems.

PRCI Pipeline Research Council International LEADING PIPELINE RESEARCH

Members:
13 Natural Gas Utilities

Pipeline membership is open to companies operating natural gas transmission and other "energy pipelines" (Domestic & International).

Mission: To collaboratively deliver relevant and innovative applied research to continually improve the global energy pipeline systems.

NYSEARCH Natural Gas RD&D

Members:
23 Natural Gas Utilities

Pipeline membership is open to companies operating natural gas distribution systems (US & Canada).

Mission: To create and sustain collaborative consortia that are driven to innovate and deploy safe, efficient and reliable technologies that benefit customers, communities, and the natural gas industry.

2022 in Review

- 162 Active Projects
- 54 Completed Projects
- 31 Initiated Projects
- 2022 Expenditures $3,228,435

For more information, see SoCalGas RD&D 2022 Annual Report.

Benefits

Gas Operations tracks six program benefits across the projects that it supports.

78% Reliability

Develop methods and technologies for pipeline construction, alteration, and repair; minimize impacts to customers by avoiding service interruptions along with extending the service life of the pipeline infrastructure.

81% Safety

Develop advanced systems to identify and mitigate threats to the pipeline system, protect pipelines from damage, and other aspects related to the safety of the general public, company employees, and contractors working on or around the pipeline and system facilities.

29% Operational Efficiency

Consider operational efficiency as a driver when identifying and comparing technologies. For example, identify practices that leverage automation of data gathering and analytics to advance pipeline safety and regulatory compliance.

33% Improved Affordability

Drive development of technologies and innovations that reduce operational costs resulting in increased affordability for ratepayers.

26% Reduced GHG Emissions

Develop technologies and best practices for reducing GHG emissions and to mitigate the impacts of the gas system on climate change.

8% Improved Air Quality

Reduce environmental impact of the pipeline system and system operations including improving air quality by reducing emissions, such as post-combustion criteria pollutants.

Percentage of projects in 2022 delivering each customer benefit

Policy Alignment

Gas Operations RD&D program supports California's state policy goals such as: Safety, Decarbonization, and Long-Term System Planning.

- **CPUC General Order 112F:** Rules governing design, testing, operation, and maintenance of gas transmission and distribution systems
- **DOT 49 CFR Part 192:** Federal pipeline safety regulations
- **AB 32:** Reducing CO2 emissions 40% below 1990 levels by 2030
- **Clean Air Act:** Air quality standards for NOx and PM
- **Climate Adaptation OIR (R.18-04-019):** Integrate climate change adaptation matters in relevant CPUC proceedings
- **National Environmental Protection Act:** National framework for protecting the environment
- **SB 1440**: Authorizes a state procurement program for biomethane
- **Injection of renewable hydrogen into gas pipelines (OIR) R.13-02-008 Phase 4**
- **Joint H2 Blending Demonstration Projects (A.22-09-006):** Joint application of SoCalGas, San Diego Gas & Electric, and Southwest Gas to establish H2 blending demonstration projects
- **Cal/OSHA Title 8 CCR:** Injury and Illness Prevention Program

2024 Subprograms

The Gas Operations program area is divided into four subprograms.

Environmental & Safety

Advances environmental integrity of the pipeline network and the safety of those who live and work in proximity to it.

Operations Technology

Advancement of pipeline operations technologies, including construction, operation, and maintenance technologies, data collection, and emerging interactive training.

System Design & Materials

Advance pipeline materials and material science, component tracking and traceability, technical tools for designing pipeline systems and infrastructure for safety, reliability, operational efficiency throughout the lifecycle of pipeline assets.

System Inspection & Monitoring

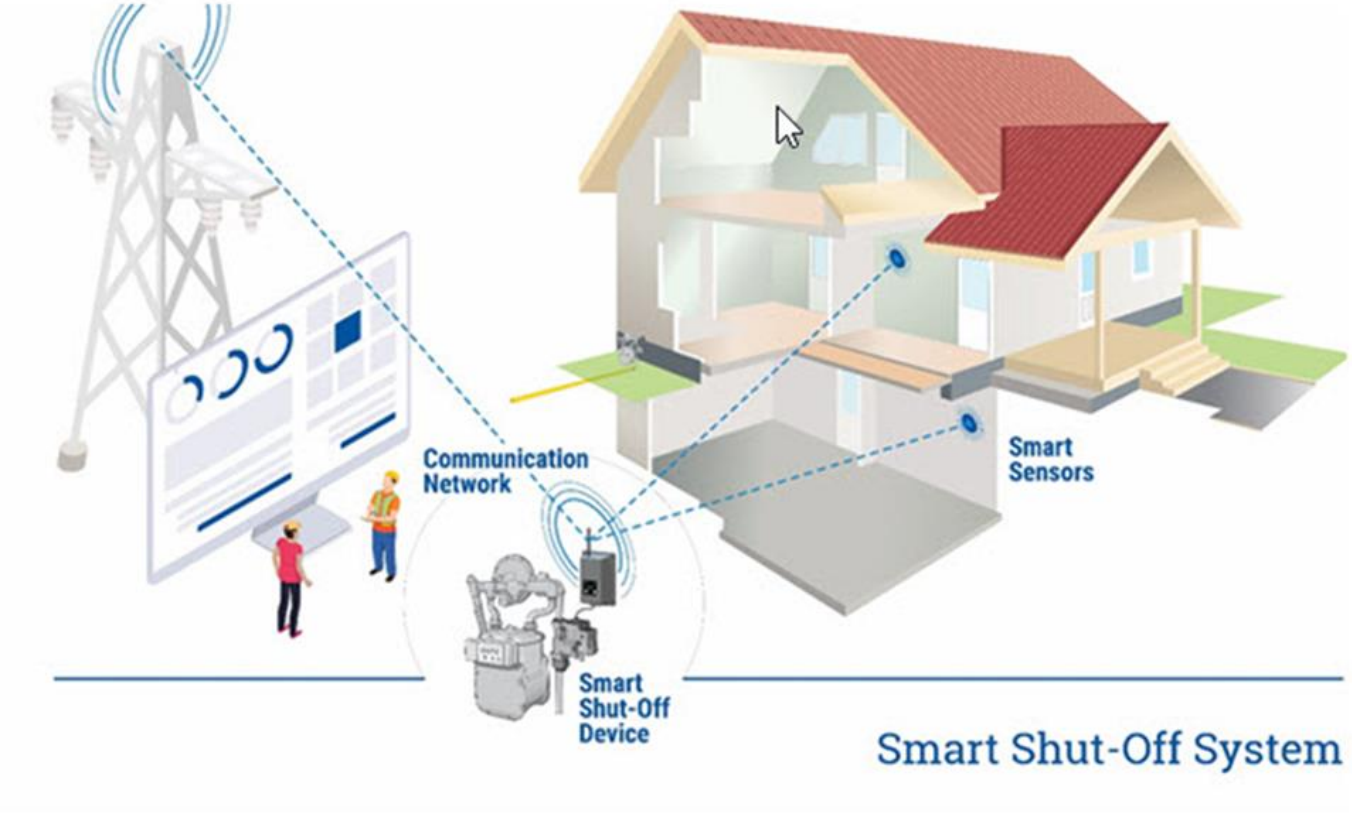
Develop technologies and methods for the inspection, data acquisition, and testing of pipelines to monitor and assess the condition and performance of pipeline systems.

Environmental & Safety

Background

Advances the environmental integrity of the pipeline network and the safety of those who live and work in proximity to it.

- Develop technologies that support California State goals
- Protect the pipeline from intentional and unintentional damage
- Explore the impacts of blending renewable fuels into the pipeline



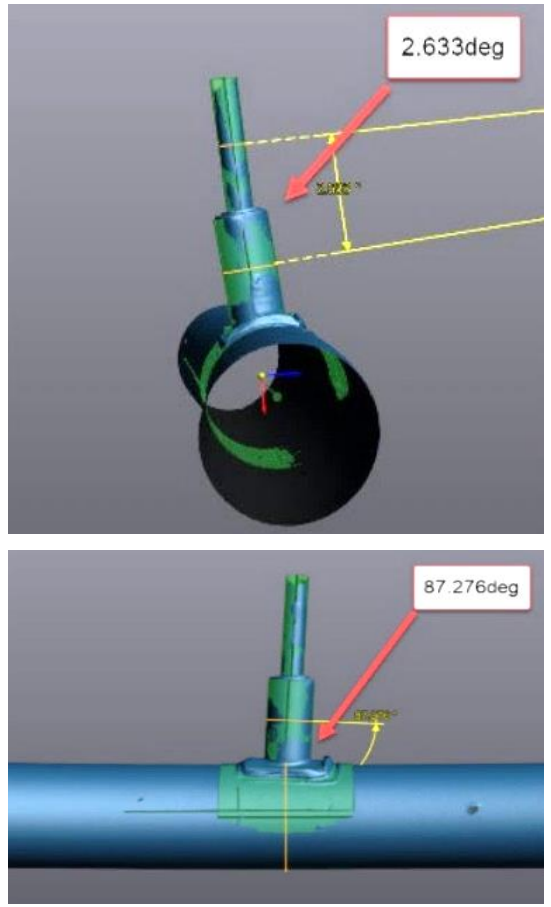
Smart Shutoff Technology for Commercial and Residential Buildings (OTD 5.20.k)(CEC GFO-19-502, group 2)

Environmental & Safety

Key Research Areas

- Research environmental concerns related to pipeline operations, such as the effects of increasing operating temperature due to climate change.
- Advanced technologies to address post-combustion criteria air pollutant emissions and fugitive GHG emissions.
- Protection from intentional and unintentional pipeline damage. Projects include developing advanced sensors and automatic shutoff systems for above- and below-ground piping systems.

Modeling and Assessing PE Assets with 3D Scanning Technology



3D scans after asset removal

Operations Technology

Background

Seeks to advance and develop techniques for pipeline construction, operation, maintenance, rehabilitation, and testing of gas pipelines and systems that facilitate continued safe and reliable service.

- Improve employee training
- Construct pipelines more efficiently
- Advance efficiency and reliability of pipeline operations
- Prevent system leaks resulting from operation and maintenance activities

Enhanced Locating Technologies for Underground Pipelines with Better Accuracy (OTD 8.20.I)(CEC GFO-19-502, group 3)

Operations Technology

Key Research Areas

- Advance technologies for operation and repair of aging pipeline infrastructure.
- Develop data acquisition systems to capture essential variables related to polyethylene (PE) pipe joining methods.
- Improve pipeline locating and mapping technologies such as enhancement of acoustic, electromagnetic, and ground-probing radar systems to produce spatially accurate images of buried pipelines and substructures.
- Validate the capabilities of state-of-the-art gas sampling devices and measurement equipment to monitor natural gas composition and constituents.

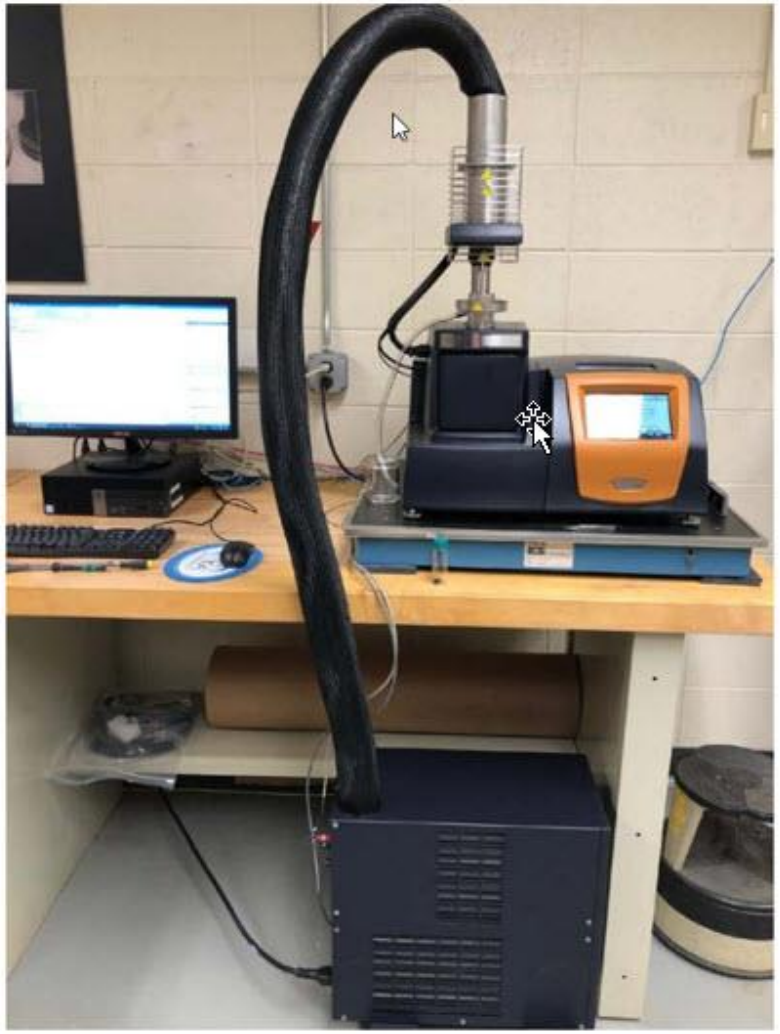
3D Visualization Software for Mapping Underground Pipelines and Improving Pipeline Asset Management (OTD 8.20.m)(CEC GFO-19-502, group 4)

System Design & Materials

Background

Advance pipeline materials and material science, component tracking and traceability, technical tools for designing pipeline systems and infrastructure for safety, reliability, operational efficiency throughout the lifecycle of pipeline assets.

- Advance engineering design standards and models
- Develop risk analytical tools to comply with pipeline integrity regulations
- Model operational efficiencies of gas storage and compressor station assets
- Assess effects of blended gas from non-traditional sources on system design and materials



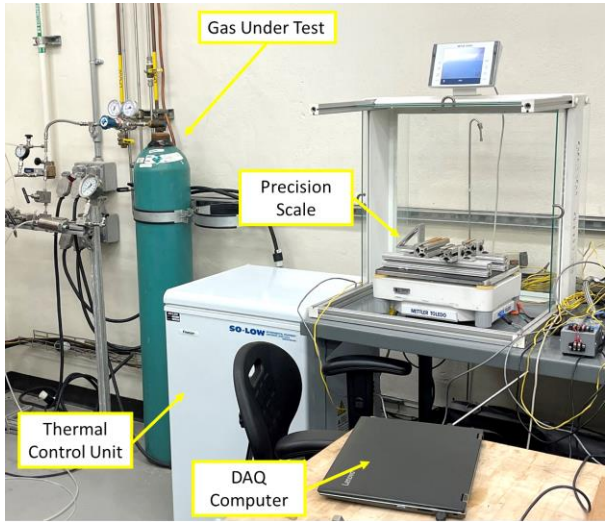
Courtesy: NYSEARCH

Impact of Hydrogen/Natural Gas Blends on LDC Infrastructure Integrity (M2020-002) Phase II

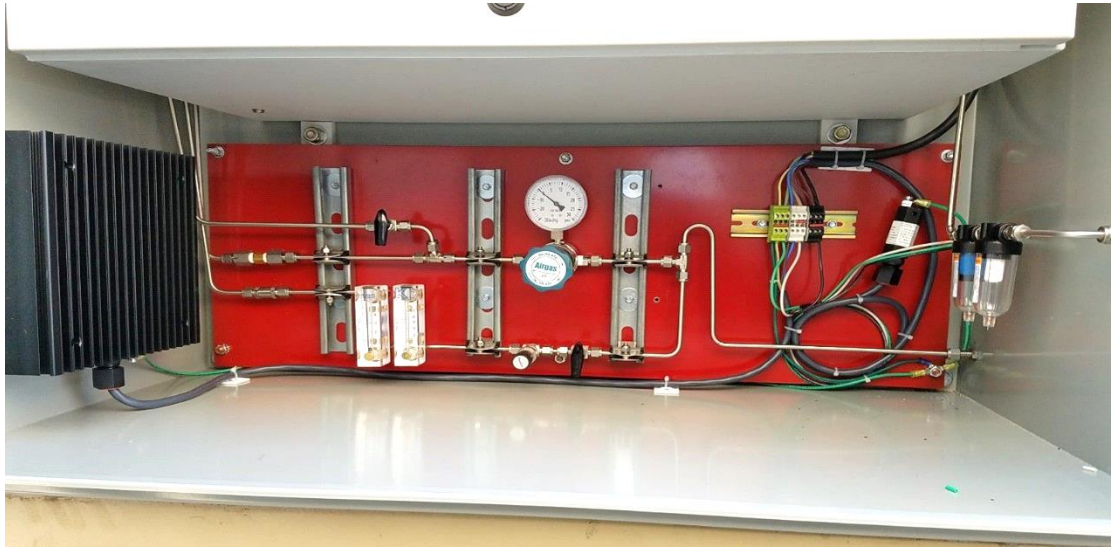
System Design & Materials

Key Research Areas

- Identify trace constituents and support establishment of upper limits for accepting RNG. Identify barriers that could prevent the introduction and blending of 10%-20% hydrogen into existing pipeline infrastructure.
- Improve understanding and implications of potential risk factors, such as stresses due to external forces, construction procedures, and operating environment.
- Analyze state-of-the-art materials and coatings to identify those that can improve the longevity, and thus the reliability of both newly installed and legacy pipelines.



Study on Changing Accuracy and Variability of Therm Zones Affecting Metering of New Gas Supplies (NYSEARCH M2022-002)



Evaluation of Commercially Available On-Line Analyzers for Measurement of Multiple Gas Contaminants (PRCI MEAS-9-01)

System Inspection & Monitoring

Background

Leverage sensors and data science to monitor, analyze, and inspect SoCalGas systems to prevent and/or rapidly respond to system issues.

- Develop technologies and methods for inspection, monitoring, and testing of pipelines and pipeline components
- Apply advanced data analytics to identify precursors to failures or incidents
- Leverage AI and machine learning for predictive & preventive maintenance
- Explore tools for managing the potential impacts of blending hydrogen into the gas pipeline

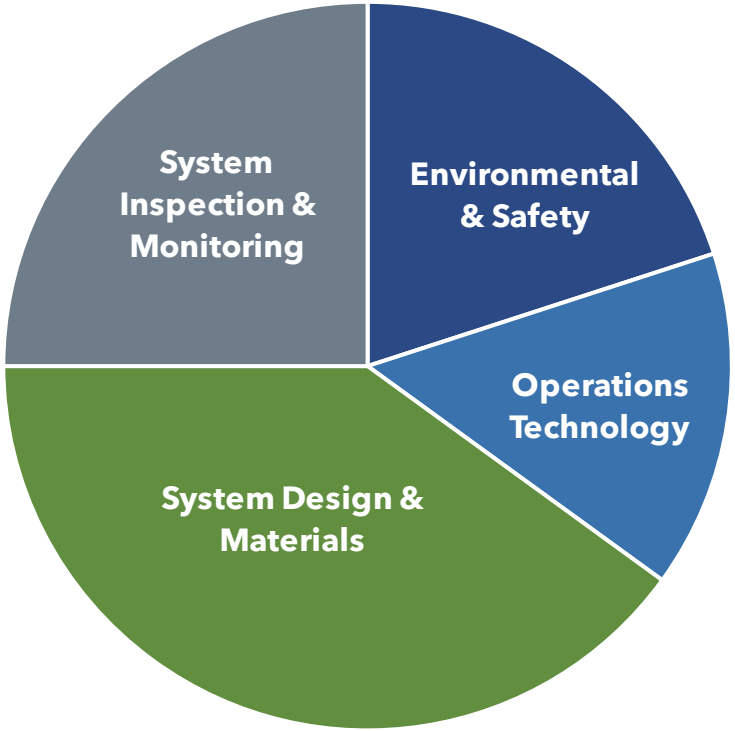
System Inspection & Monitoring

Key Research Areas

- Improve sensitivity of Electromagnetic Acoustic Transducer technology capabilities for detecting cracks in pipe wall and long-seam welds and to measure remaining wall thickness.
- Evaluate remote inspection and monitoring systems.
- Improve monitoring of natural force damage threats; such as landslides, floods, and seismic induced impacts on pipeline integrity.
- Develop analytical models to support predictive and preventive system management objectives.

Obtaining fluid samples from storage reservoirs to monitor composition

Proposed 2024 Funding Allocation



Subprogram	Allocation
Environmental & Safety	20%
Operations Technology	15%
System Design and Materials	40%
System Inspection & Monitoring	25%
Total	**$3,973,000**

Q&A and Feedback

- Please submit questions in the GoToMeeting questions box or raise your "hand" in the GoToWebinar controls. Please **limit your response to one minute**.
- Please submit comments by Friday, May 5, 2023.

https://forms.office.com/r/r4PMUE6RRD

SoCalGas

Clean Transportation

Program Area

- Introduction
- 2022 in Review
- Subprograms Overview
  - Off-Road
  - On-Road
  - Refueling Infrastructure
- 2024 Funding Allocation
- Feedback

Jeff Chase

BIO

Jeff Chase manages the Clean Transportation Program. Jeff joined SoCalGas in 2011 and has held a variety of engineering, project management, and supervisory roles. Jeff has been part of the RD&D team for the past four years, previously managing the Clean Power Generation Program before transitioning to his current role. Jeff has his Bachelor's in Mechanical Engineering from Cal Poly Pomona and is a registered Professional Engineer in the State of California.

Introduction

OVERVIEW

The Clean Transportation RD&D Program focuses on minimizing environmental impacts related to the transportation sector, particularly through integration of hydrogen.

GOALS

- Develop cost competitive zero-emission transportation technologies that meet robust operating requirements
- Advance on board fuel storage capabilities and re-fueling infrastructure for alternative fuels

2022 in Review

SoCalGas RD&D supported the development and demonstration of two zero-emission hybrid hydrogen fuel cell yard trucks at the Port of Los Angeles. For more information, see SoCalGas RD&D 2022 Annual Report.

- 32 Active Projects
- 6 Initiated Projects
- 3 Completed Projects
- $1,778,809

ZECAP is part of California Climate Investments, a statewide initiative that puts billions of Cap-and-Trade dollars to work reducing greenhouse gas emissions, strengthening the economy, and improving public health and the environment—particularly in disadvantaged communities.

www.calclimateinvestments.ca.gov

Benefits

Clean Transportation tracks six benefits across the projects that it supports.

Reliability

Safety

Operational Efficiency

Improved Affordability

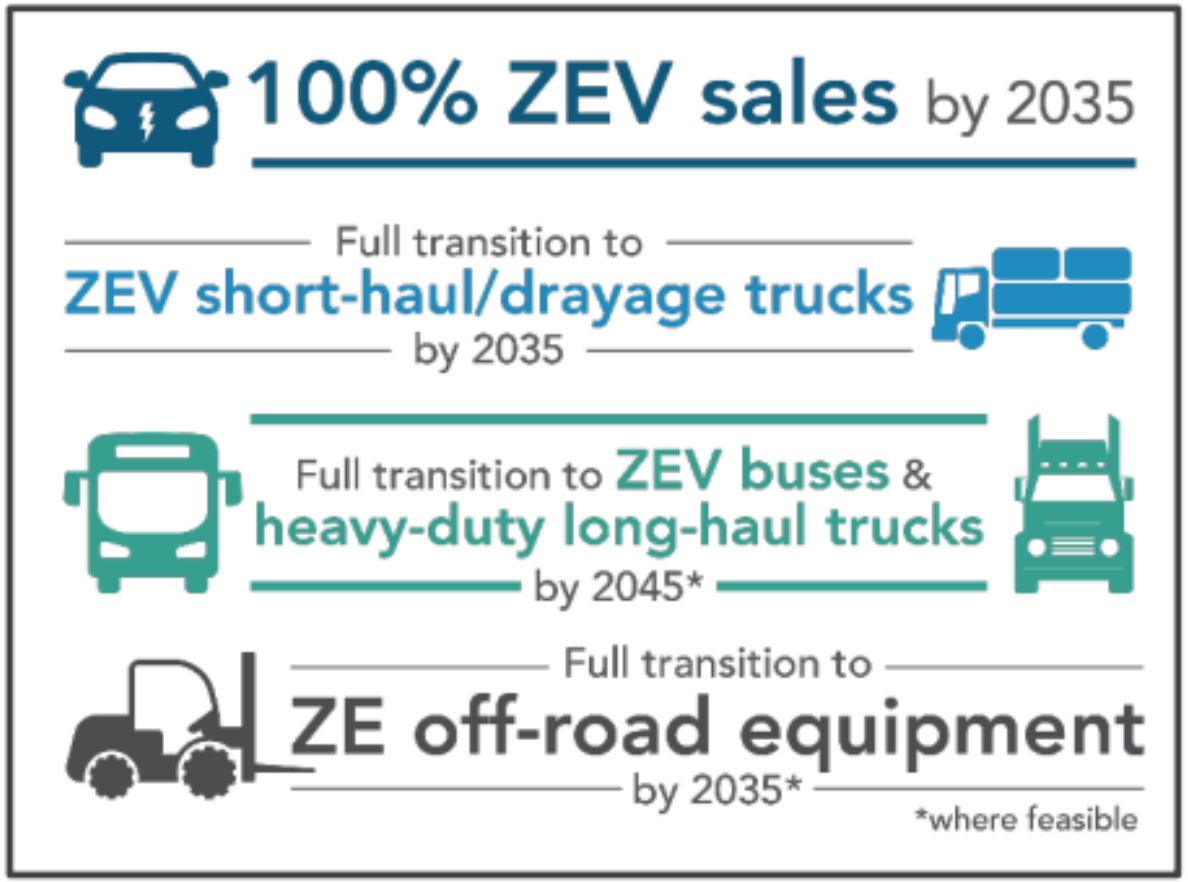
Reduced GHG Emissions

Improved Air Quality

Policy Alignment

Clean Transportation aligns and conforms with California's decarbonization goals, including:

- EO N-79-20
- Advanced Clean Cars II
- Advanced Clean Fleets
- Advanced Clean Trucks
- Ocean-Going Vessels At-Berth Regulation



* CARB 2020 Mobile Source Strategy

2024 Subprograms

NEW

In 2024, SoCalGas RD&D proposes consolidating two 2023 subprograms—Onboard Storage and Refueling Stations—into a single subprogram, Refueling Infrastructure

Zero emission technologies for medium- and heavy-duty on-road vehicles.

Zero emission technologies for off-road transportation applications.

Technologies and systems that support refueling for alternative fuels, including gaseous and liquid hydrogen.

On-Road

Background

The purpose of this subprogram is to develop zero-emission on-road transportation solutions. Projects seek to:

- Help fleets and individual occupational vehicle operators achieve emission reductions
- Develop technologies that meet the robust duty cycles required for many use cases

1 icon represents limited long-term opportunity 2 icons represents large long-term opportunity 3 icons represents greatest long-term opportunity	BATTERY/ELECTRIC	HYDROGEN	SUSTAINABLE LIQUID FUELS
Light Duty Vehicles (49%)*		–	TBD
Medium, Short-Haul Heavy Trucks & Buses (~14%)			
Long-Haul Heavy Trucks (~7%)			
Off-road (10%)			
Rail (2%)			
Maritime (3%)		†	
Aviation (11%)			
Pipelines (4%)		TBD	TBD
Additional Opportunities	• Stationary battery use • Grid support (managed EV charging)	• Heavy industries • Grid support • Feedstock for chemicals and fuels	• Decarbonize plastics/chemicals • Bio-products
RD&D Priorities	• National battery strategy • Charging infrastructure • Grid integration • Battery recycling	• Electrolyzer costs • Fuel cell durability and cost • Clean hydrogen infrastructure	• Multiple cost-effective drop-in sustainable fuels • Reduce ethanol carbon intensity • Bioenergy scale-up

* All emissions shares are for 2019

† Includes hydrogen for ammonia and methanol

Figure 7. Summary of vehicle improvement strategies and technology solutions for different travel modes that are needed to reach a net-zero economy in 2050 (more details provided in Section 5).

*The U.S. National Blueprint for Transportation Decarbonization

On-Road

Research Areas

- Zero-emission hydrogen medium- and heavy-duty trucks to serve demanding duty cycles and longer routes
- Zero-emission light-duty hydrogen vehicles to meet the demands of utility and emergency service fleets
- Autonomous vehicles and/or advanced routing solutions to reduce emissions and increase safety and reliability

Table 12. Simple Cost of Ownership Estimate

Class 8 Long Haul	Diesel Status (2019)	Hydrogen Status (2019)	Diesel Ultimate (2050)	Hydrogen Ultimate (2050)
Fuel Cost ($/gal diesel or $/kg H_2)	2.78	16	4.09	5.00
Fuel Economy (mpg or mpkg)	10	11	15.6	17.0
Lifetime Fuel Cost	$ 278,000	$ 1,496,000	$ 315,000	$ 353,000
Total Tractor Cost	$ 134,000	$ 266,000	$ 131,000	$ 129,000
Lifetime Fuel and Capital Cost	**$ 412,000**	**$ 1,762,000**	**$ 446,000**	**$482,000**
Fuel Cost ($/mile)	*$ 0.28*	*$ 1.50*	*$ 0.26*	*$ 0.29*
Tractor Cost ($/mile)	*$ 0.13*	*$ 0.27*	*$ 0.11*	*$ 0.11*
Maintenance Cost ($/mile)	*$ 0.17*	*$ 0.25*	*$ 0.17*	*$ 0.17*
Total Fuel and Capital Cost ($/mile)	**$ 0.58**	**$ 2.0**	**$ 0.54**	**$ 0.57**

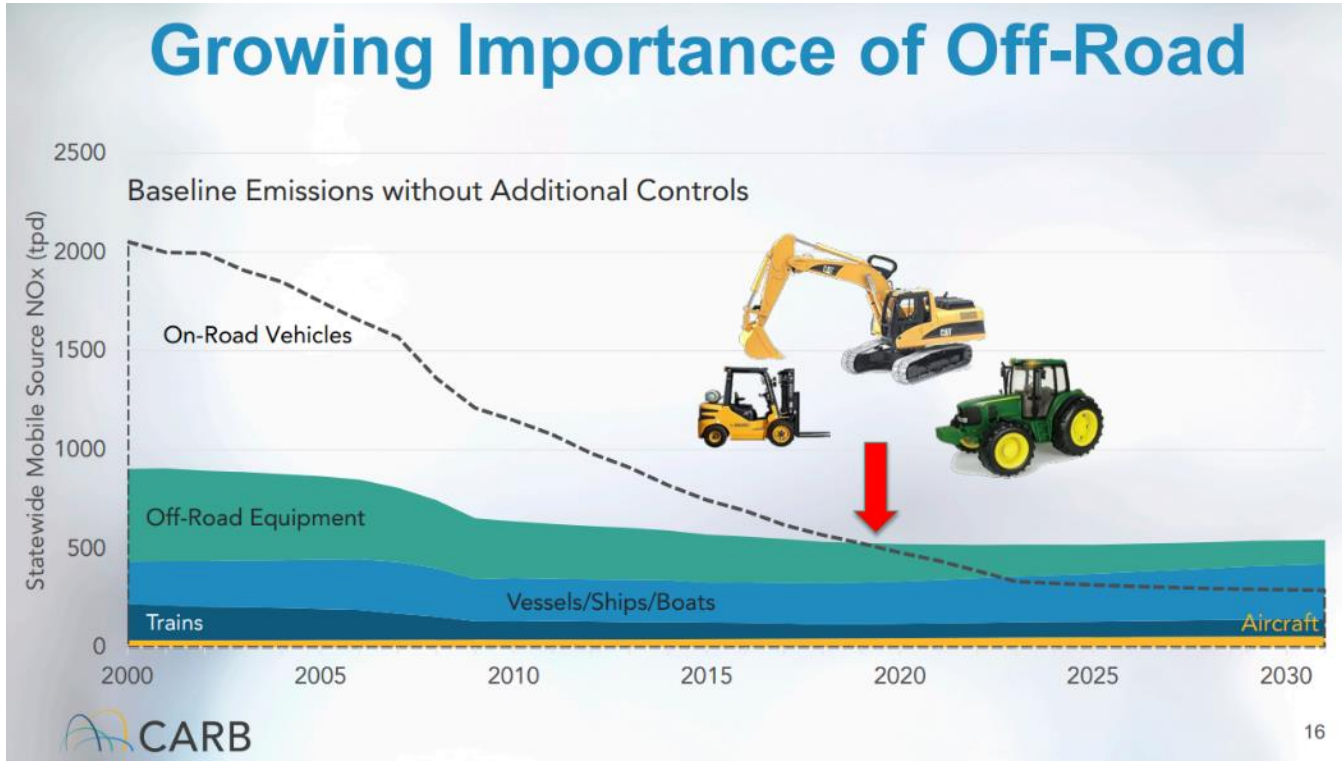
*DOE Hydrogen Class 8 Long Haul Truck Targets

Off-Road

Background

The purpose of this subprogram is to develop zero-emission off-road transportation solutions. Projects seek to:

- Achieve emissions reductions from off-road vehicles such as trains, ocean-going vessels, construction equipment, and cargo handling equipment.
- Explore opportunities for hydrogen fueled aviation applications.



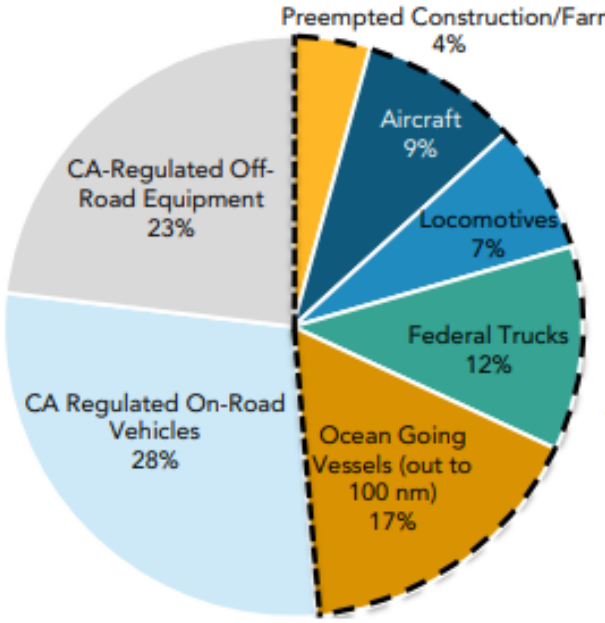
* CARB 2020 Mobile Source Strategy

Off-Road

Research Areas

- Zero-emission locomotives for goods and people movement
- Zero-emission ocean going vessels and harbor craft
- Zero-emission construction and agricultural equipment
- Zero-emission aircraft and ground service equipment for airports

Figure 5 - NOx Emission Contributions from Primarily Federally Regulated Sources in South Coast Air Basin in 2023



In 2023, primarily-federally regulated sources account for almost 50 percent of mobile source NOx emissions in the South Coast Air Basin

* CARB 2020 Mobile Source Strategy

Refueling Infrastructure

Background

This subprogram targets the development, demonstration, and deployment of technologies and systems that support refueling with alternative fuels, including gaseous and liquid hydrogen.

Refueling Infrastructure

Research Areas

- Fast-fill refueling technologies to achieve hydrogen fill rates comparable to diesel
- Easily deployable hydrogen fueling solutions to enable new vehicle demonstrations
- Advanced on-board hydrogen storage technologies to improve fuel storage capacity, weight, performance, and safety

Storage Related Targets – Fill Rate

Characteristic	Units	Targets for Class 8 Tractors-Trailers	
		Interim (2030)	Ultimate[9]
Hydrogen Fill Rate	[kg H_2/min]	**8**	**10**

Ultimate Goal: 10 kg/min

- 6 minutes to fuel 60 kg (10 kg/min)
- 60 kg would equate to ~750 miles assuming fuel economy of 12.4 miles/kg

Interim Goal: 8 kg/min - still allows for:

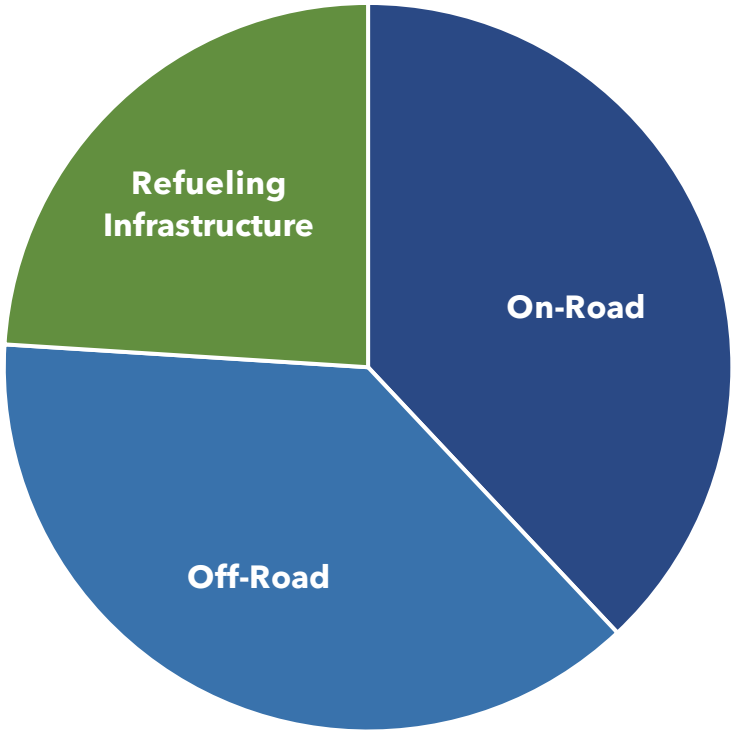
- >750 mile range
  - 10 minute fill
  - fuel economy of 11.1 miles/kg
- ~600 mile range
  - 6 minute fill
  - fuel economy of 12.4 miles/kg

* DOE Hydrogen Heavy Duty Truck Targets

Target Metric	Research Goal
Flow rate (average)	>8 kg/min
Hydrogen delivery and refueling costs	$2 – 4/kg
Reliability (uptime)	>90%
Energy efficiency of hydrogen delivery (after production to vehicle tank) including losses from conditioning, distribution, and storage	>80%

* CEC GFO-22-502 – Innovative Hydrogen Refueling Solutions for Heavy Transport

Proposed 2024 Funding Allocation

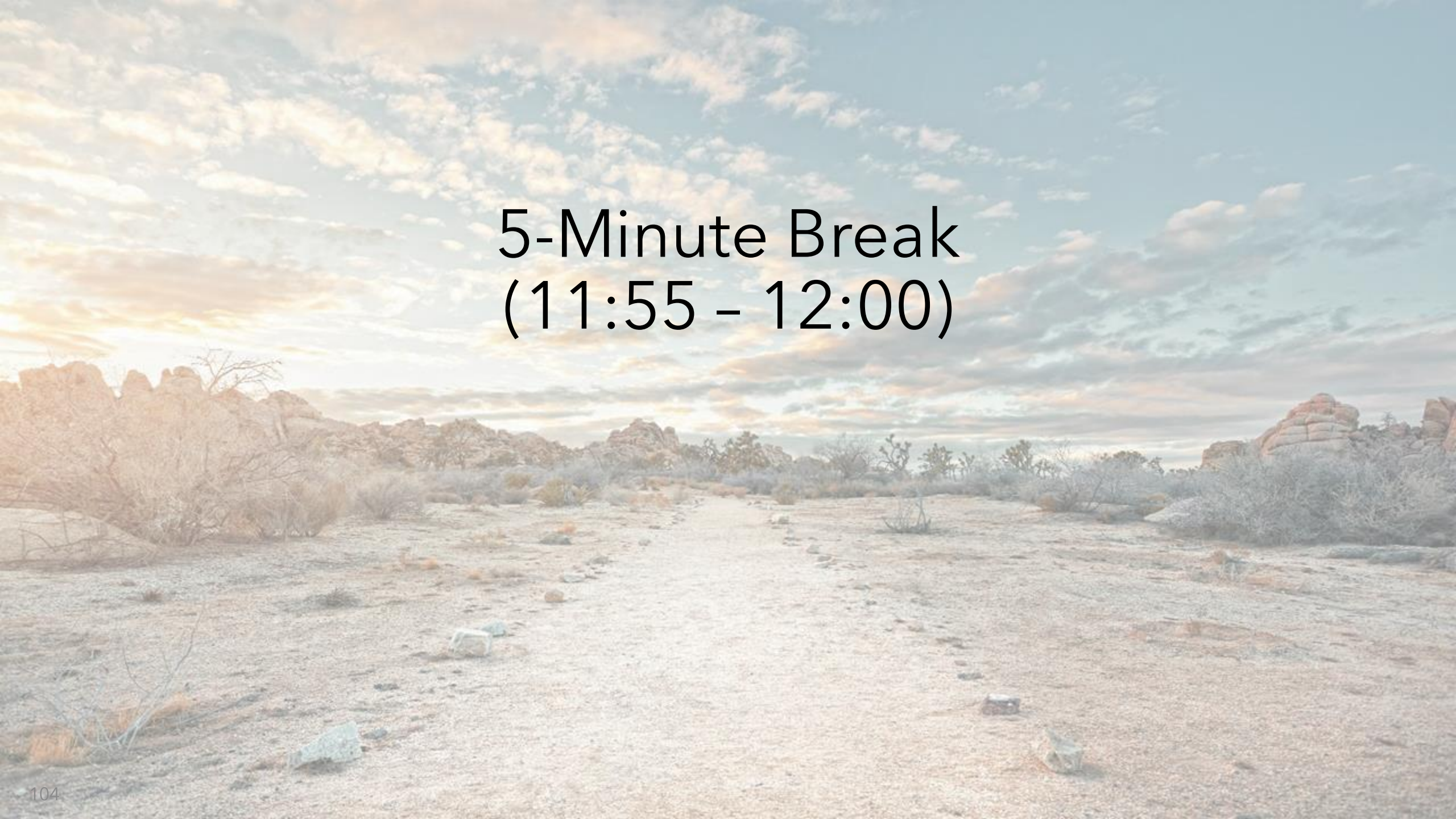


Subprogram	Allocation
On-Road	38%
Off-Road	38%
Refueling Infrastructure	24%
Total	**$4,470,000**

Q&A and Feedback

- Please submit questions in the GoToMeeting questions box or raise your "hand" in the GoToWebinar controls. Please **limit your response to one minute**.
- Please submit comments by Friday, May 5, 2023.

https://forms.office.com/r/r4PMUE6RRD


5-Minute Break
(11:55 – 12:00)

SoCalGas

Clean Energy Applications

Program Area

- Introduction
- 2022 in Review
- Subprograms Overview
  - Energy Reliability
  - Residential & Commercial
  - Industrial Operations
- 2024 Funding Allocation
- Feedback

Alan Leung

BIO

Alan Leung leads the Clean Energy Applications (CEA) Program. Alan joined SoCalGas in 2020 from the California Air Resources Board (CARB) where he spent six years leading agency wide compliance and enforcement activities concerning vehicle emissions regulations, test procedures, and case developments in coordination with the US Environmental Protection Agency (EPA).

Alan has been part of the RD&D team for the past three years specializing on residential, commercial, and industrial applications.

Alan holds a Bachelor of Science in Environmental Engineering from the University of California Merced (UCM), a Master of Science in Civil Engineering from the University of Southern California (USC), and a Master in Business Administration (MBA) from the University of North Carolina (UNC) Kenan-Flagler Business School with a double concentration in Strategy Consulting and Entrepreneurship and Innovation.

Introduction

NEW

In 2024, SoCalGas RD&D proposes to combine two program areas—Clean Generation and Customer End-Use Applications—into a single, new program, Clean Energy Applications.

OVERVIEW

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.

GOALS

For residential, commercial, and industrial customers, this program seeks to:

- Improve efficiencies
- Reduce emissions
- Lower costs
- Improve reliability

2022 in Review

SoCalGas RD&D supported the breakdown of industrial data silos at The Gill Corporation. For more information, see SoCalGas RD&D 2022 Annual Report.

- 112 Active Projects
- 13 Initiated Projects
- 25 Completed Projects
- $3,470,467

Benefits

Clean Energy Applications tracks six benefits across the projects that it supports.

Reliability

Safety

Operational Efficiency

Improved Affordability

Reduced GHG Emissions

Improved Air Quality

Policy Alignment

Clean Energy Applications aligns and conforms with California's decarbonization goals, including:

Energy Reliability:

- CPUC R.19-09-009 (Microgrids and Resiliency proceeding)
- SB 1339: Microgrids for increased electricity reliability
- SB 1298 (Distributed generation regulation)
- Self-Generation Incentive Program (SGIP)
- SB 100 (Zero-carbon electricity by 2045)

Residential & Commercial:

- AB 3232 (Building Decarbonization)
- CA Title 24 (Buildings Energy Efficiency)
- CA Title 20 (Appliance Energy Efficiency)
- 2022 AQMP (Air Quality Management Plan, NOx and PM emissions regulation)

Industrial Operations:

- Bipartisan Infrastructure Law
- Inflation Reduction Act

Overarching:

- 2022 CARB State Implementation Plan (SIP)
- SB 32 (Reduce CO2 emissions 40% below 1990 levels by 2030)
- Clean Air Act (Air quality standards for NOx and PM)
- EO B-55-18 (Carbon neutral economy by 2045)
- AB617 (Disadvantaged communities for air quality improvements)
- CPUC ESJ Action Plan

2024 Subprograms

NEW

In 2024, with the creation of the CEA program area, SoCalGas RD&D also proposes three new subprograms:

- Energy Reliability
- Residential & Commercial
- Industrial Operations

Develops and enhances distributed generation technologies and the control systems that integrate diverse distributed generation resources and thermal loads.

Develops and enhances technologies and advancements related to gas consumption and end uses in the residential and commercial applications, including the commercial food service sector.

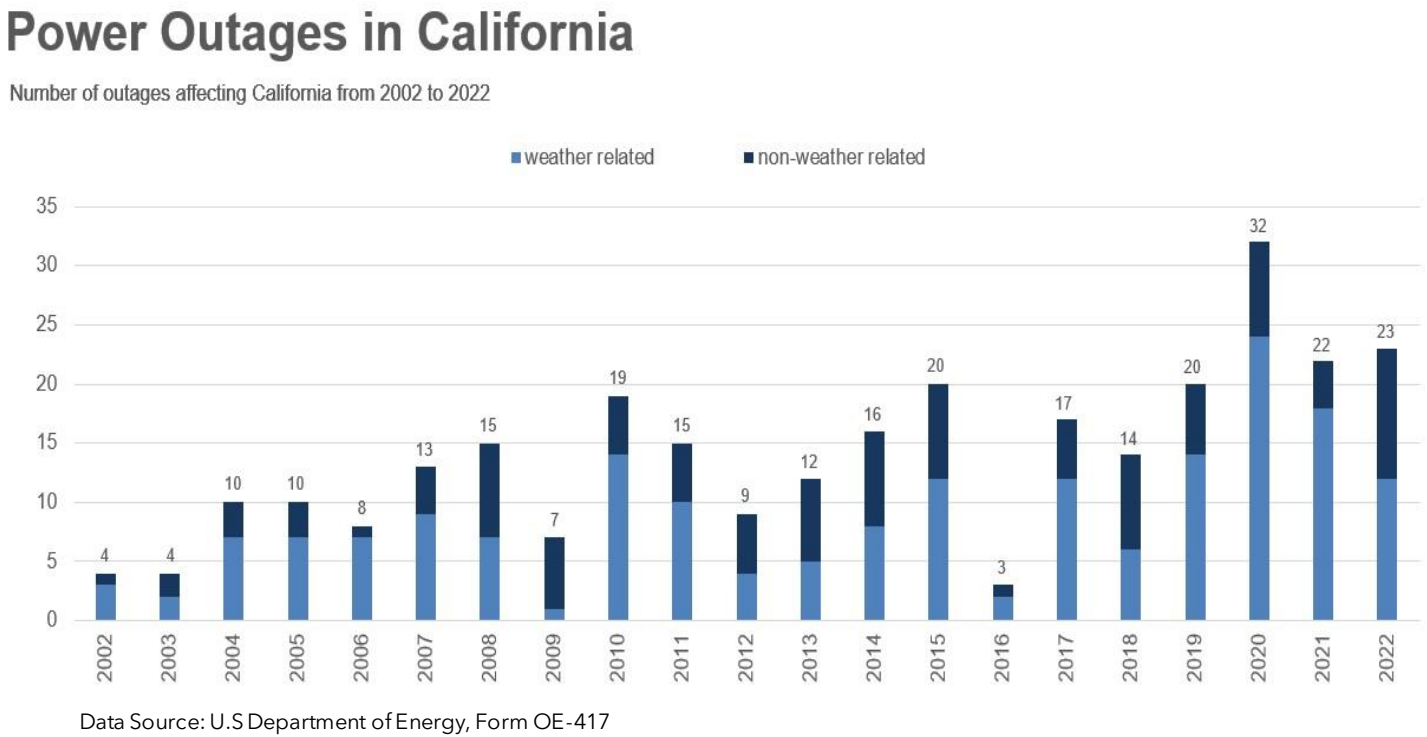
Develops advanced heating technologies and systems for use in the industrial sector. Examples include food processing, manufacturing, cement production, chemical processing, textile drying, and agriculture.

Energy Reliability

Background

This subprogram develops and enhances distributed generation technologies and the control systems that integrate diverse distributed generation resources and thermal loads.

The focus is on microgrids using RNG and hydrogen and on enabling low-emissions, distributed generation, and storage technologies to provide energy resilience and affordability to customers.

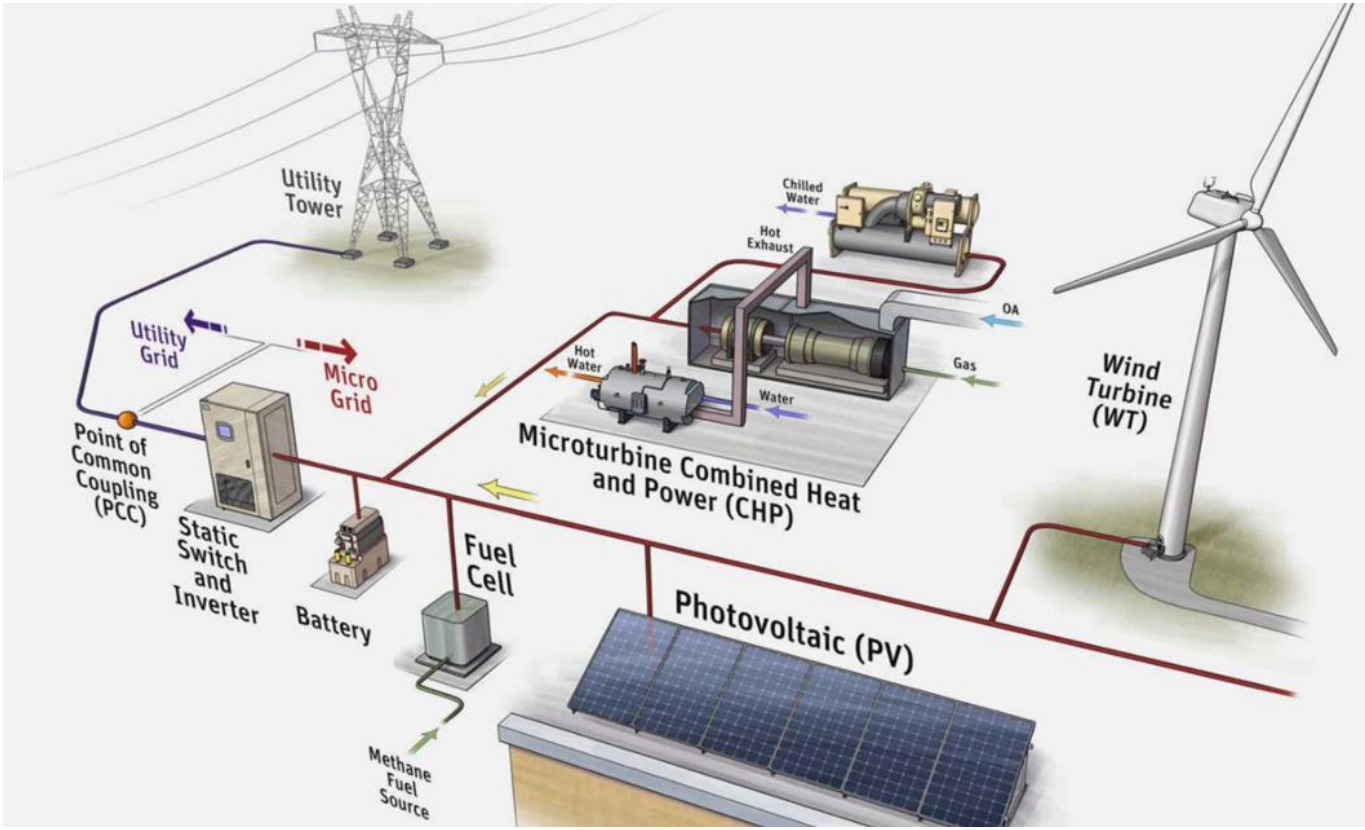


Data Source: U.S Department of Energy, Form OE-417

Energy Reliability

Research Areas

- Develop and demonstrate small scale fuel cell systems (<50kW)
- Develop and demonstrate low-emission backup generation
- Integration of hydrogen blends in existing power generating technologies
- Develop and demonstrate hydrogen energy storage integration
- Identify and address cybersecurity concerns with integrated energy systems



* Adapted from Affiliated Engineers, Inc https://aeieng.com/news/economic-and-sustainability-benefits-of-smart-grids-and-microgrids

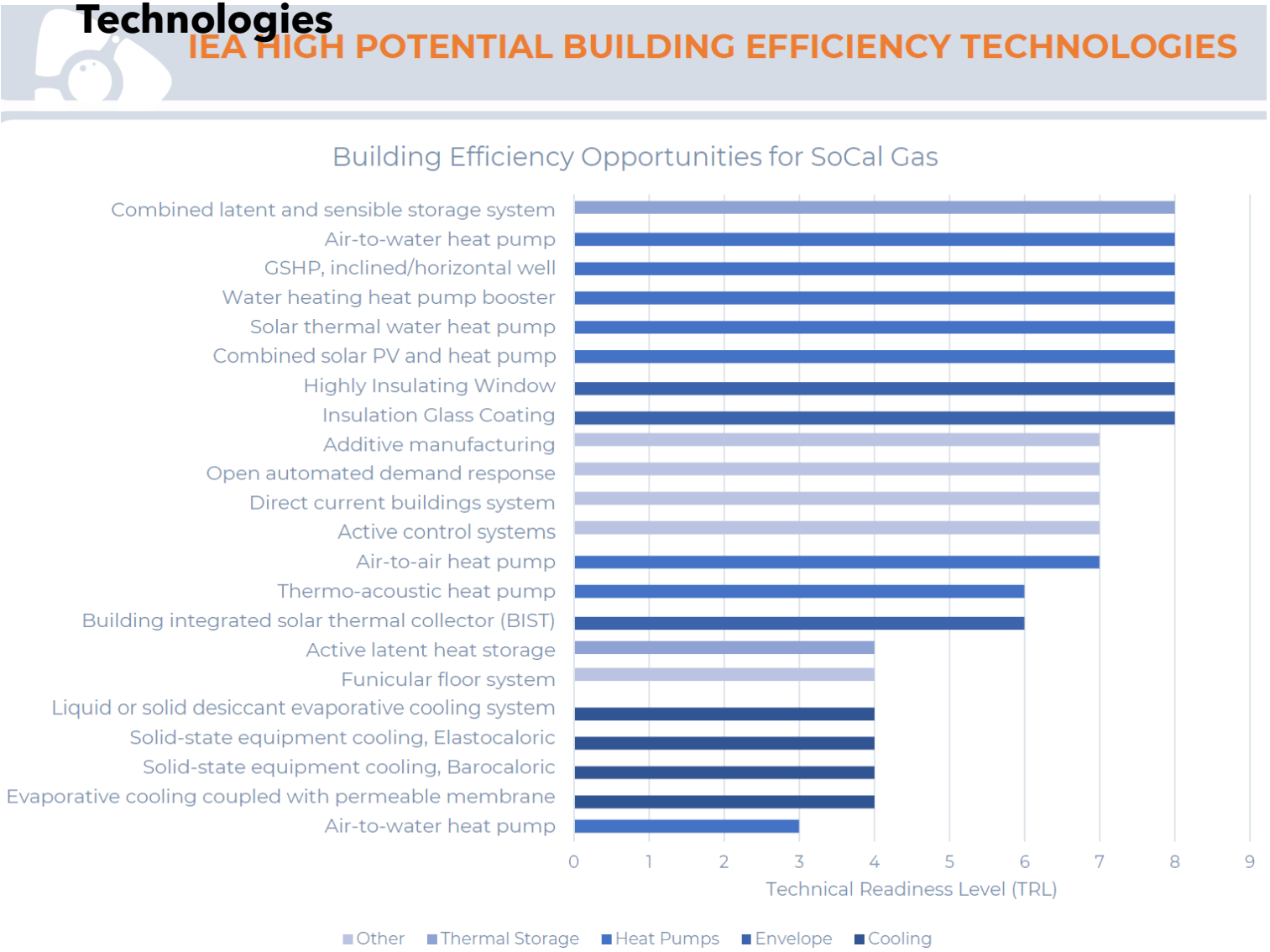
Residential & Commercial

Background

This subprogram develops and enhances technologies and advancements related to gas consumption and end uses in the residential, commercial, and commercial food service sectors.

Relevant applications include furnaces, hot water heaters, stoves, ovens, dryers, laundry, and commercial heating, ventilation, and air conditioning (HVAC).

Figure: IEA High Potential Building Efficiency Technologies



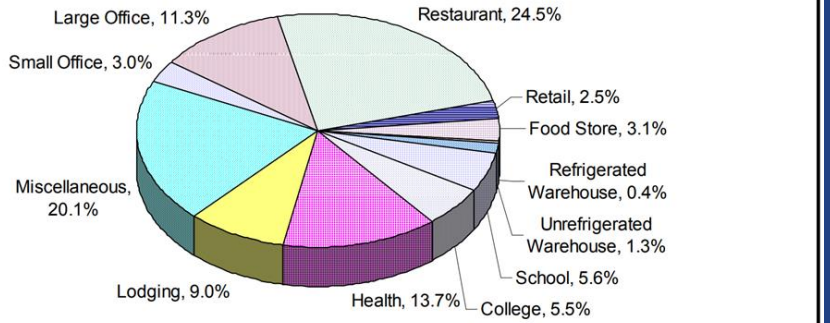
Source: Darcy Partners – Proprietary Material (Shared with Consent & Approval)

Residential & Commercial

Research Areas

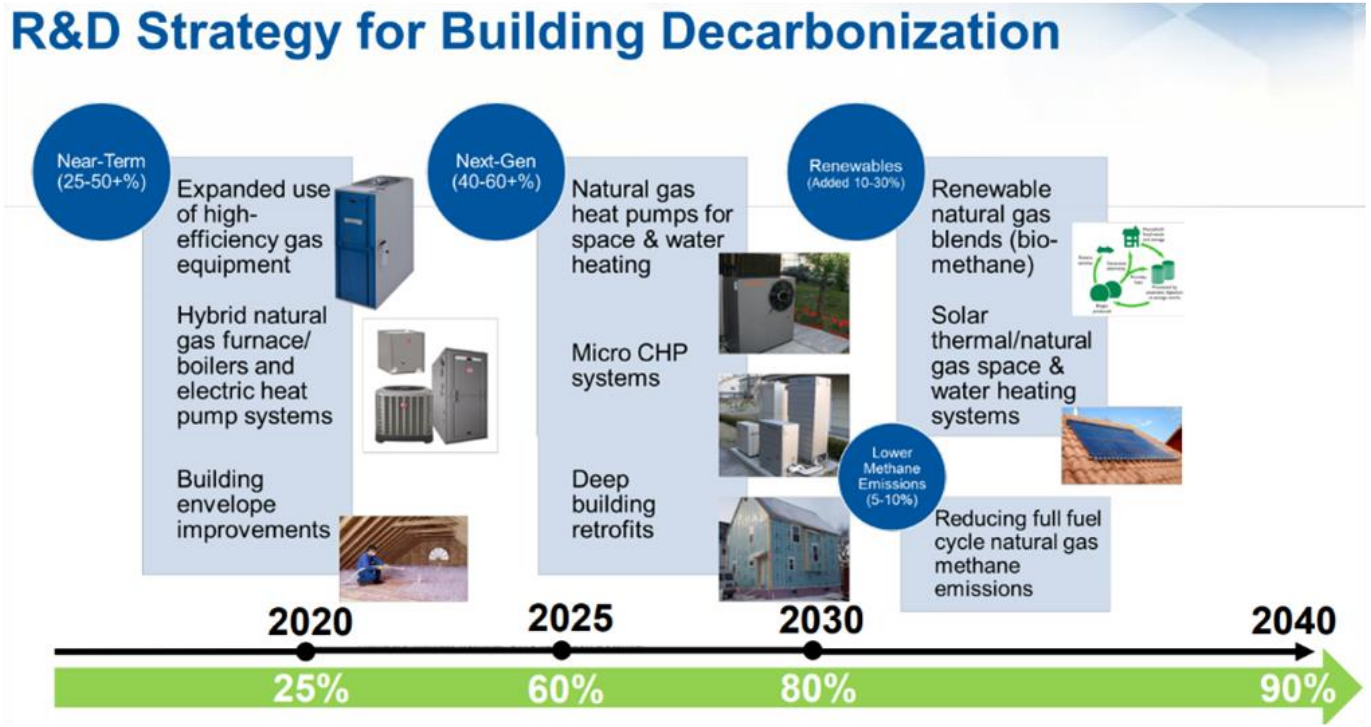
- Commercial Food Service Burner Improvements
- Hydrogen Blending Applications
- Catalytic Burner for Near-Zero Emissions
- Building Envelope Improvements

Figure E-2: Commercial Gas Usage by Building Type



Source: 2006 California Commercial End-Use Survey

Figure: Commercial Applications Building Decarbonization



Source: GTI-UTD Material Shared With Permission

UTD
Utilization Technology Development

Residential & Commercial

Research Areas (Cont.)

Hydrogen Blending Applications

- Continued interest in H2 blending research for the Res/Com market segment as a pathway toward decarbonization
  - Smaller scale systems afford flexibility (e.g., equipment sizing, footprint, scale-up vs. scale-down) and cost-benefits
  - Lessons learned can be extrapolated into industrial applications
- Seeking feedback to ensure that we are aligned with CA decarbonization goal
  - Building Decarbonization

Figure: H2 Blending - Recent Research

energies

MDPI

Article

Impact of Hydrogen/Natural Gas Blends on Partially Premixed Combustion Equipment: NO_x Emission and Operational Performance

Paul Glanville *, Alex Fridlyand, Brian Sutherland, Miroslaw Liszka, Yan Zhao, Luke Bingham and Kris Jorgensen

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Abstract: Several North American utilities are planning to blend hydrogen into gas grids, as a short-term way of addressing the scalable demand for hydrogen and as a long-term decarbonization strategy for 'difficult-to-electrify' end uses. This study documents the impact of 0–30% hydrogen blends by volume on the performance, emissions, and safety of unadjusted equipment in a simulated use environment, focusing on prevalent partially premixed combustion designs. Following a thorough literature review, the authors describe three sets of results: operating standard and "ultra low NO_x" burners from common heating equipment in "simulators" with hydrogen/methane blends up to 30% by volume, in situ testing of the same heating equipment, and field sampling of a wider range of equipment with 0–10% hydrogen/natural gas blends at a utility-owned training facility. The equipment was successfully operated with up to 30% hydrogen-blended fuels, with limited visual changes to flames, and key trends emerged: (a) a decrease in the input rate from 0 to 30% H_2 up to 11%, often in excess of the Wobbe Index-based predictions; (b) NO_x and CO emissions are flat or decline (air-free or energy-adjusted basis) with increasing hydrogen blending; and (c) a minor decrease (1.2%) or increase (0.9%) in efficiency from 0 to 30% hydrogen blends for standard versus ultra-low NO_x-type water heaters, respectively.

Keywords: hydrogen; natural gas; combustion; partially premixed; water heater; furnace; appliances; NO_x emissions; hythane; hydrogen-blended gas

1. Introduction

The interest in hydrogen in North America on the part of the energy industry is growing rapidly, as a means of supporting climate change mitigation goals with this flexible low-carbon energy carrier. As an energy vector, not unlike electricity, low-carbon hydrogen can be generated in multiple ways, as a means of storing renewable energy ("green" H_2) or decarbonizing fossil natural gas with integrated carbon capture ("blue", "turquoise" H_2). This flexibility has driven a rapid scale up in investment and interest, from numerous utilities initiating programs to inject hydrogen into natural gas networks to Canada's national hydrogen strategy and the U.S. Dept. of Energy's Earthshot program to reach a goal of USD 1/kg H_2 [1,2].

The scale of the decarbonization challenge is not trivial, with a combined U.S./Canadian natural gas network of 5.4 million km serving 85 million homes and businesses, where natural gas combustion in U.S. and Canadian buildings and industry are responsible for a combined 1077 Mt CO_2e/year [3–6]. However, with significant potential as a decarbonized energy vector, blending hydrogen into gas grids serving buildings and industry can serve as both an important short-term way of addressing the scalable demand for hydrogen, driving down costs of generation, storage, and distribution and an important long-term

Energies 2022, 15, 1706. https://doi.org/10.3390/en15051706 https://www.mdpi.com/journal/energies

Source: https://www.mdpi.com/1996-1073/15/5/1706;
Recently published GTI paper highlighting early laboratory/field measurements up to 30% H2

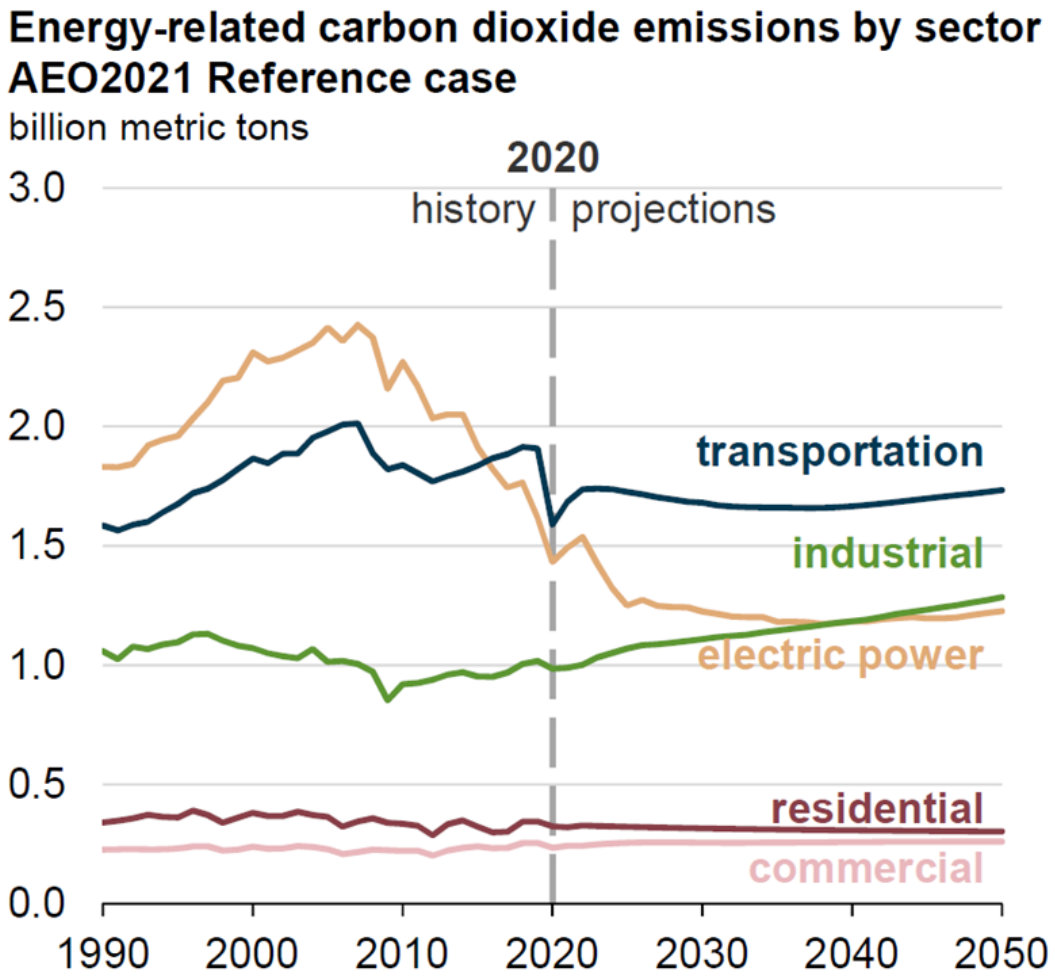
Industrial Operations

Background

This subprogram develops advanced heating technologies and systems for use in the industrial sector. In particular, the industrial process heat end-use sector represents some of the largest users of gaseous fuels and the most difficult applications to decarbonize via electrification.

Examples include food processing, manufacturing, cement production, chemical processing, textile drying, and agriculture.

Figure: CO2 Emissions By Sector



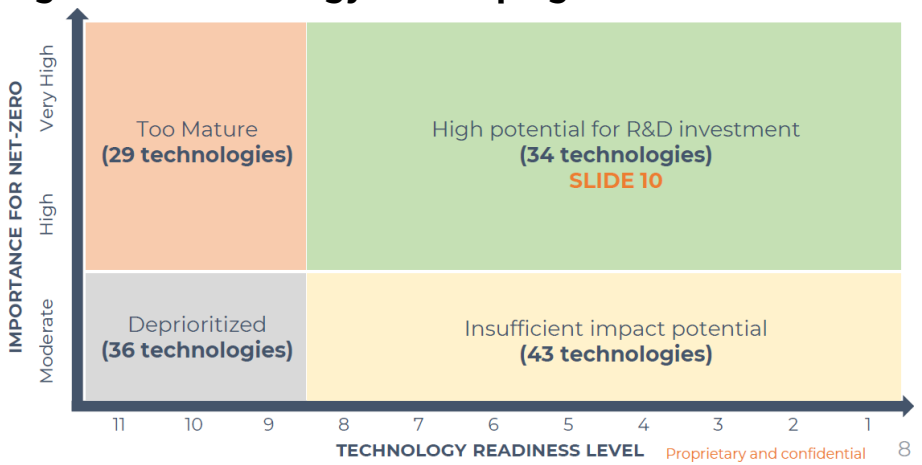
Source: https://www.eia.gov/energyexplained/energy-and-the-environment/outlook-for-future-emissions.php

Industrial Operations

Research Areas

- Point Source Carbon Capture
- Distributed Hydrogen Production for Industrial Applications
- Thermal Energy Storage
- Combustion Enhancement (e.g., burner development, waste heat recovery)
- Industrial Process Innovation (e.g., novel raw materials, additive manufacturing)
- Combined Heat and Power systems

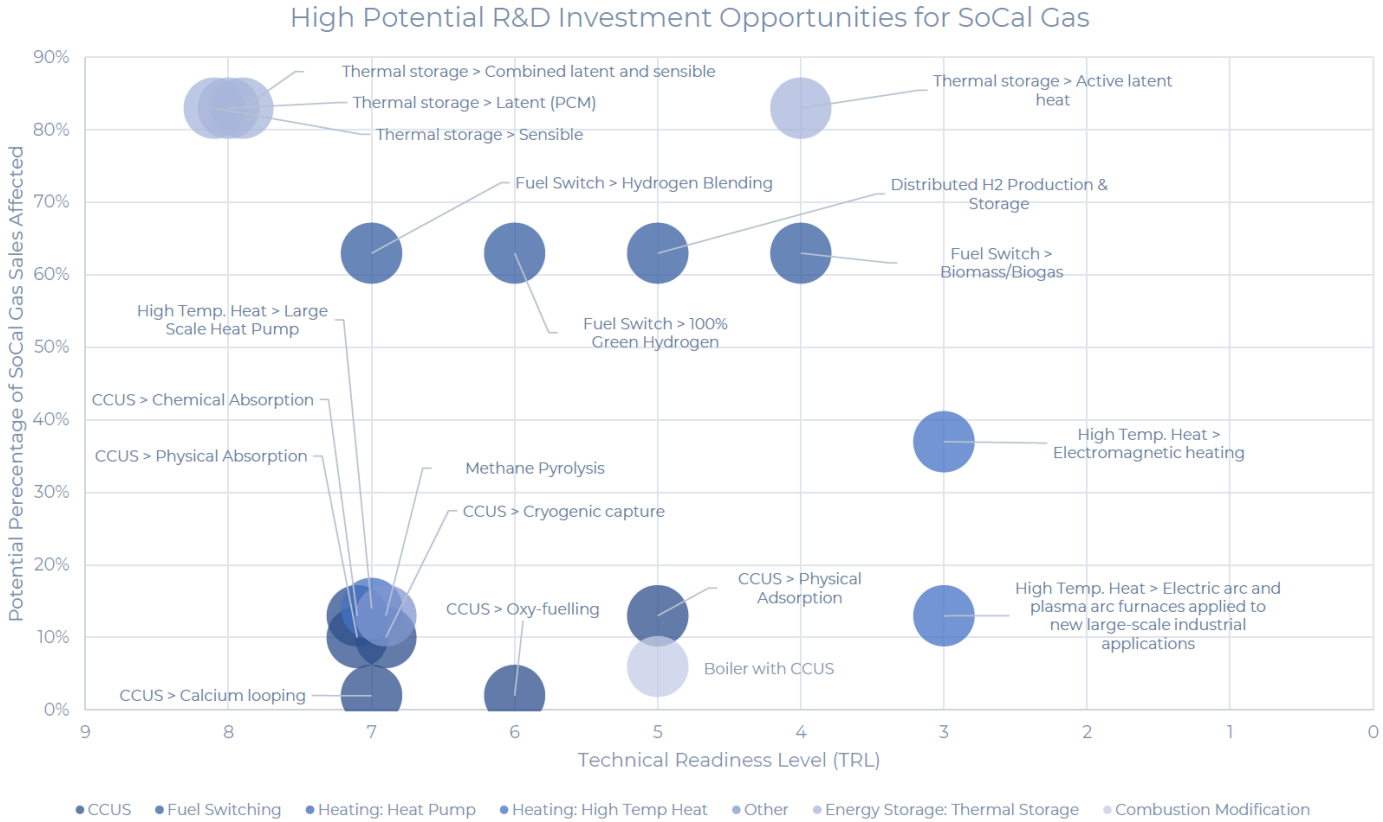
Figure: IEA Technology Landscaping



Source: Darcy Partners – Proprietary Material (Shared with Consent & Approval)

Clean Energy Applications

Figure: High Potential R&D Research Areas



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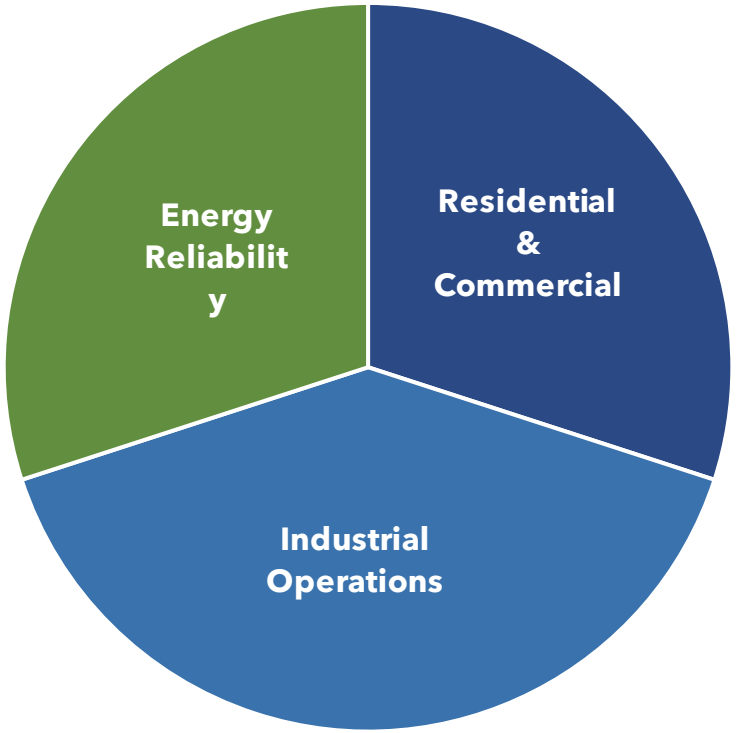
Proposed 2024 Funding Allocation



Subprogram	Allocation
Energy Reliability	30%
Residential & Commercial	30%
Industrial Operations	40%
Total	**$4,977,000**

Q&A and Feedback

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- Please submit comments by Friday, May 5, 2023.

https://forms.office.com/r/r4PMUE6RRD

STRETCH BREAK!

Upper body and arms stretch

- ✓ Clasp hands together above the head with palms facing outward.
- ✓ Push your arms up, stretching upward.
- ✓ Hold the pose for 10 seconds.

Neck stretches

- ✓ Relax and lean your head forward.
- ✓ Slowly roll toward one side and hold for 10 seconds.
- ✓ Repeat on other side.
- ✓ Relax again and lift your chin back to starting position.

Torso stretch, or trunk rotation

- ✓ Keep your feet firmly on the ground, facing forward.
- ✓ Twist your upper body to the left, place your left arm on the back of your chair (if applicable), place your right hand on your left knee, and stretch.
- ✓ Hold pose for 10 seconds, repeat on other side.

Questions & Comments (12:30 – 12:45)

- Please submit questions in the GoToMeeting questions box or raise your “hand” in the GoToWebinar controls. Please **limit your response to one minute**.
- Please submit comments by Friday, May 5, 2023.

https://forms.office.com/r/r4PMUE6RRD

- For questions, email us: RDDinfo@socalgas.com

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