

SoCalGas RD&D
Public Workshop

April 27, 2022



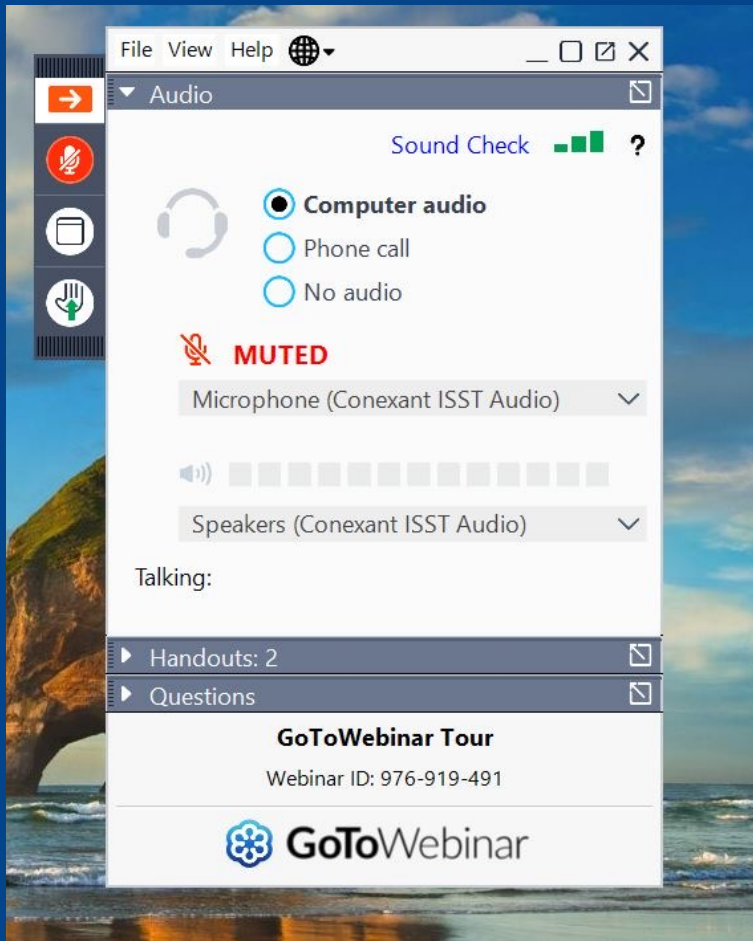
Renewal



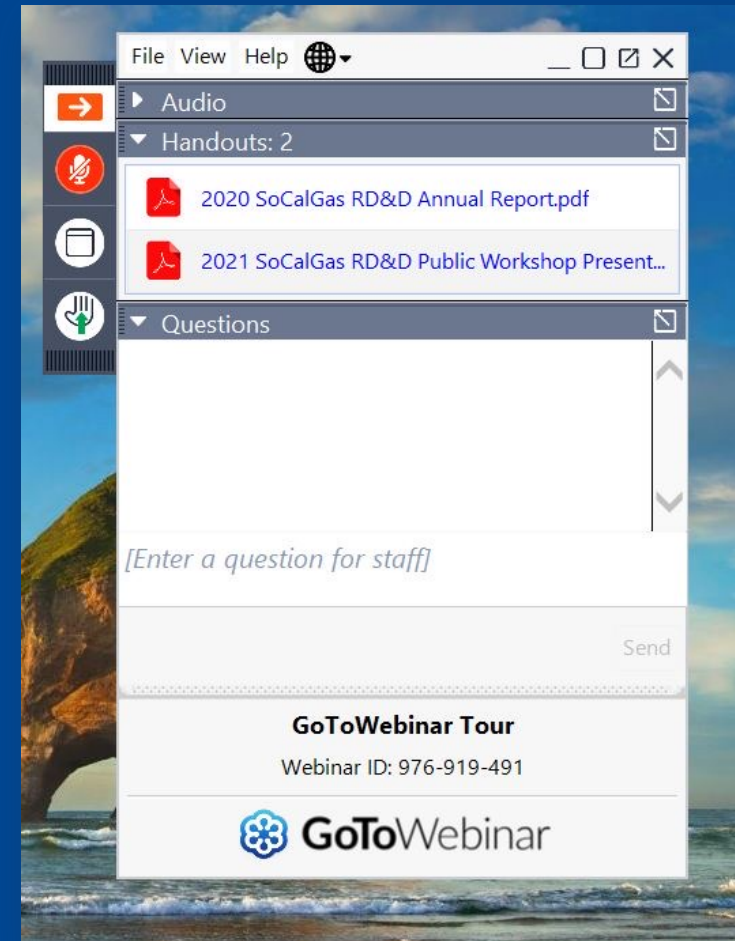
Meeting Notes

- Each topical session will end with time for questions and comments. We will also dedicate 30 minutes at the end of the day for additional questions and comments.
- A recording of today's workshop will be available for download.
- To pose a question, please raise your "hand" in the GoToWebinar controls. Please **limit your response to one minute**.
- We encourage you to provide written comments following the workshop. Please submit them to RDDinfo@socalgas.com by 5pm PDT, Friday, May 6, 2022.

GoToWebinar Tour



This screenshot shows the audio settings panel in the GoToWebinar interface. The panel is titled "Audio" and includes a "Sound Check" indicator with a green bar and a question mark. Below this, there are three radio button options: "Computer audio" (selected), "Phone call", and "No audio". A red "MUTED" indicator is visible, along with a microphone icon. The microphone is set to "Microphone (Conexant ISST Audio)" and the speakers to "Speakers (Conexant ISST Audio)". A volume slider is present below the speaker selection. At the bottom of the panel, it says "Talking:" and lists "Handouts: 2" and "Questions". The footer of the panel displays "GoToWebinar Tour" and "Webinar ID: 976-919-491" along with the GoToWebinar logo.



This screenshot shows the handouts and questions panel in the GoToWebinar interface. The panel is titled "Handouts: 2" and lists two PDF files: "2020 SoCalGas RD&D Annual Report.pdf" and "2021 SoCalGas RD&D Public Workshop Present...". Below the handouts is a "Questions" section with a text input field containing the placeholder text "[Enter a question for staff]". A "Send" button is located to the right of the input field. The footer of the panel displays "GoToWebinar Tour" and "Webinar ID: 976-919-491" along with the GoToWebinar logo.

Presentation Objectives & Structure

Share Successes

1. Introduction
2. 2021 in Review
3. 2022 in Brief
4. Testimonials

Explain RD&D

5. RD&D in Depth
6. Project Selection Process

Summarize 2023 Plans

7. 2023 Research Plan

Seek Stakeholder Input

8. Low Carbon Resources
9. Gas Operations
10. Clean Transportation
11. Clean Generation
12. Customer End-Use Applications

Agenda



	Start Time	Duration (mins) Total (presentation/Q&A)	Topic
Section 1 90 mins	9:00am	60 mins (45 pres. + 15 Q&A)	Introduction (1 → 7)
	10:30am	30 mins (15 pres. + 15 Q&A)	Low Carbon Resources (8)
11:00am			15 mins
			BREAK
Section 2 60 mins	11:15am	30 mins (15 pres. + 15 Q&A)	Gas Operations (9)
	11:45am	30 mins (15 pres. + 15 Q&A)	Clean Transportation (10)
12:15pm			45 mins
			LUNCH
Section 3 95 mins	1:00pm	30 mins (15 pres. + 15 Q&A)	Clean Generation (11)
	1:30pm	30 mins (15 pres. + 15 Q&A)	Customer End-Use Applications (12)
	2:00pm	35 mins (5 pres. + 30 Q&A)	Wrap-up + Q&A
2:35pm			ADJOURN

1. INTRODUCTION





SoCalGas Research, Development, & Demonstration

SoCalGas RD&D identifies and supports projects and technologies with the potential to:

- Save energy
- Reduce GHG emissions
- Improve air quality
- Increase the safety, reliability, and affordability of energy

2. 2021 IN REVIEW





RD&D Supported
Hundreds of
Projects in 2021

TOTAL ACTIVE
PROJECTS IN 2021

379

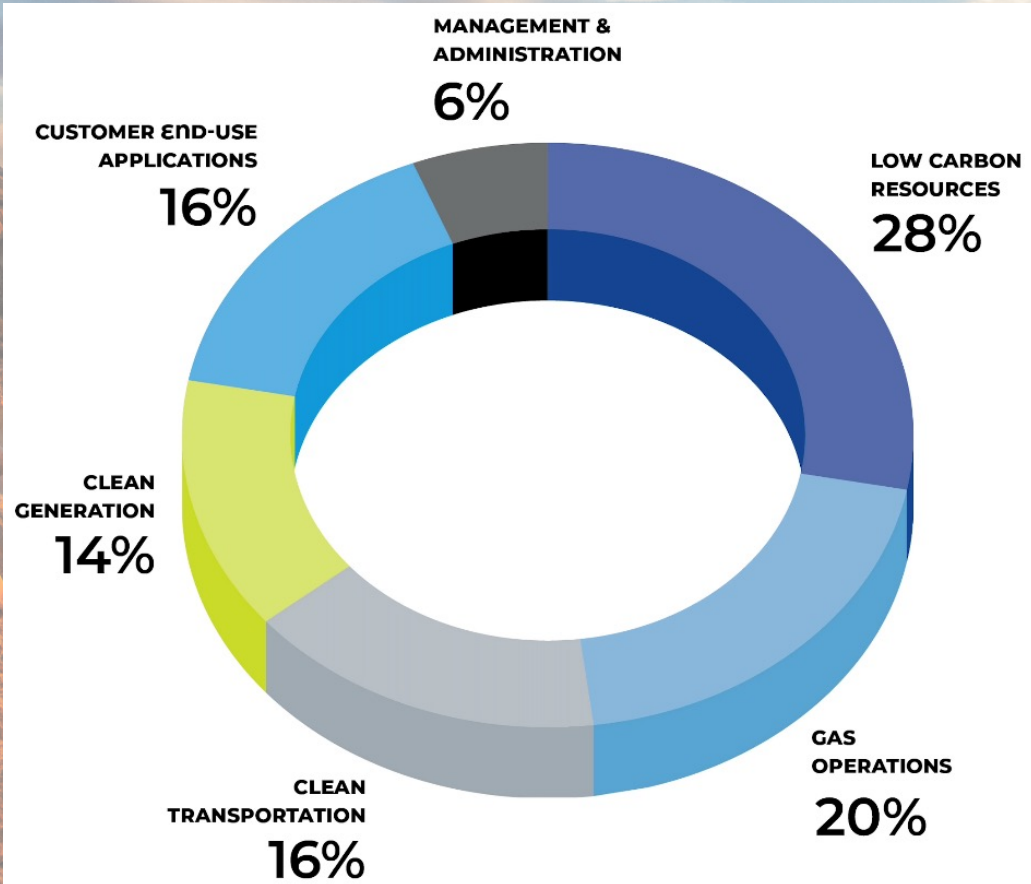
TOTAL PROJECTS
COMPLETED IN 2021

114

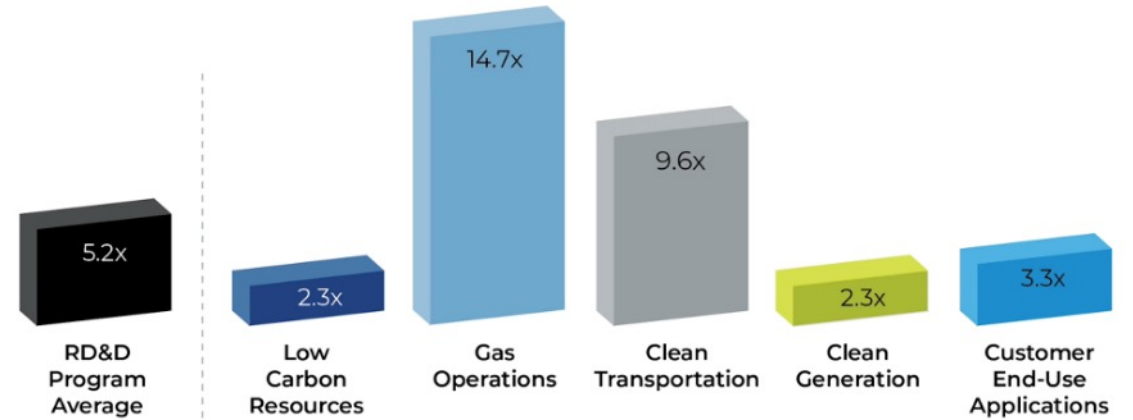
TOTAL PROJECTS
INITIATED IN 2021

72

Financial Highlights



PROGRAM	2021 ACTUALS
Low Carbon Resources	\$5,018,729
Gas Operations	\$3,561,049
Clean Transportation	\$2,844,666
Clean Generation	\$2,608,167
Customer End-Use Applications	\$2,944,863
SUBTOTAL	\$16,977,474
Management & Administration	\$1,057,195
TOTAL	\$18,034,669



RATIO OF OUTSIDE FUNDING TO SOCALGAS FUNDING

Significant 2021 Milestones

Equity

THE RD&D
PROGRAM SUPPORTED

27

PROJECTS LOCATED IN
SB 535 DISADVANTAGED
COMMUNITIES
IN 2021

SOCALGAS
SPENT

\$972.6M

WITH DIVERSE
FIRMS IN 2021

SOCALGAS
MET WITH

33 GROUPS

REPRESENTING
DISADVANTAGED
POPULATIONS

SOCALGAS
WORKED WITH

577

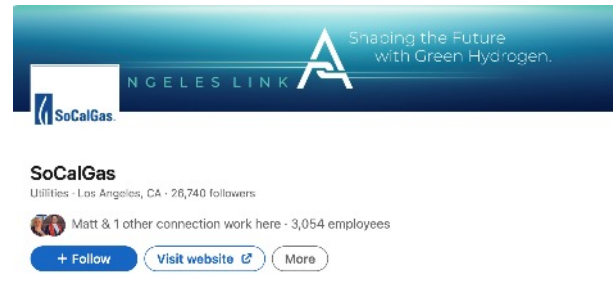
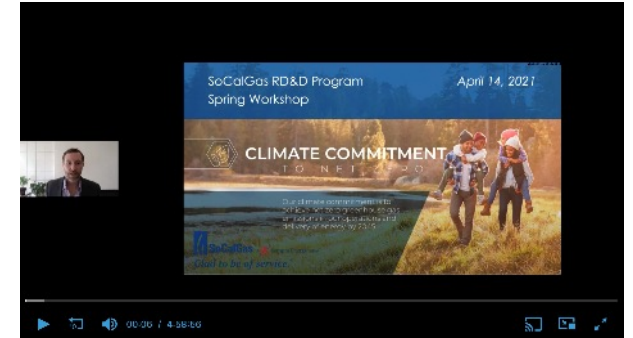
DIVERSE **SUPPLIERS**
IN 2021

Significant 2021 Milestones

Outreach

2021 Annual Workshop

On April 14, 2021, RD&D held its annual workshop, hosting 165 individuals from a wide variety of organizations. RD&D incorporated input received into its 2022 Research Plan.

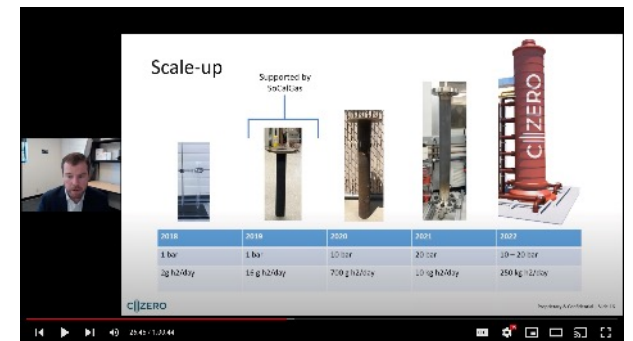


RD&D LinkedIn

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 2021, 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 2021 Milestones Publications & Awards

RD&D PROJECTS
FEATURED IN
40
REPORTS, BRIEFS,
AND JOURNALS



2021 Top Innovator
Public Utilities Fortnightly recognized the RD&D Program as a Fortnightly Top Innovator in 2021 and featured three RD&D staff members.



For more information, visit: <https://www.fortnightly.com/fortnightly/2021/10-0/top-innovators-eric-coenen-kent-matt-gregori>

Significant 2021 Milestones

Leverage

Public Funding Awards

RD&D supported 11 successful project proposals applying for public funding. These projects were awarded \$48,429,528 in research funding from the CEC and DOE.

5

PROJECTS WON A
TOTAL OF
\$12,999,620 FROM
THE CEC

Follow-On Funding

RD&D-supported companies received significant follow-on funding.



Baker Hughes buys 15% stake



Raises \$57 million in Series A



Fortesque Future Industries
acquires 60% stake



Enbridge invests CAN\$4,000,000

Significant 2021 Milestones

Real-World Deployment



Patents
Pending

14+
TECHNOLOGIES
AND PRODUCTS
WERE DEPLOYED
AS A DIRECT
RESULT OF RD&D
SUPPORT



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

The 2021 Annual Report



RESEARCH, DEVELOPMENT, AND
DEMONSTRATION PROGRAM
2021 ANNUAL REPORT

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. 2022 in Brief



2022 Update

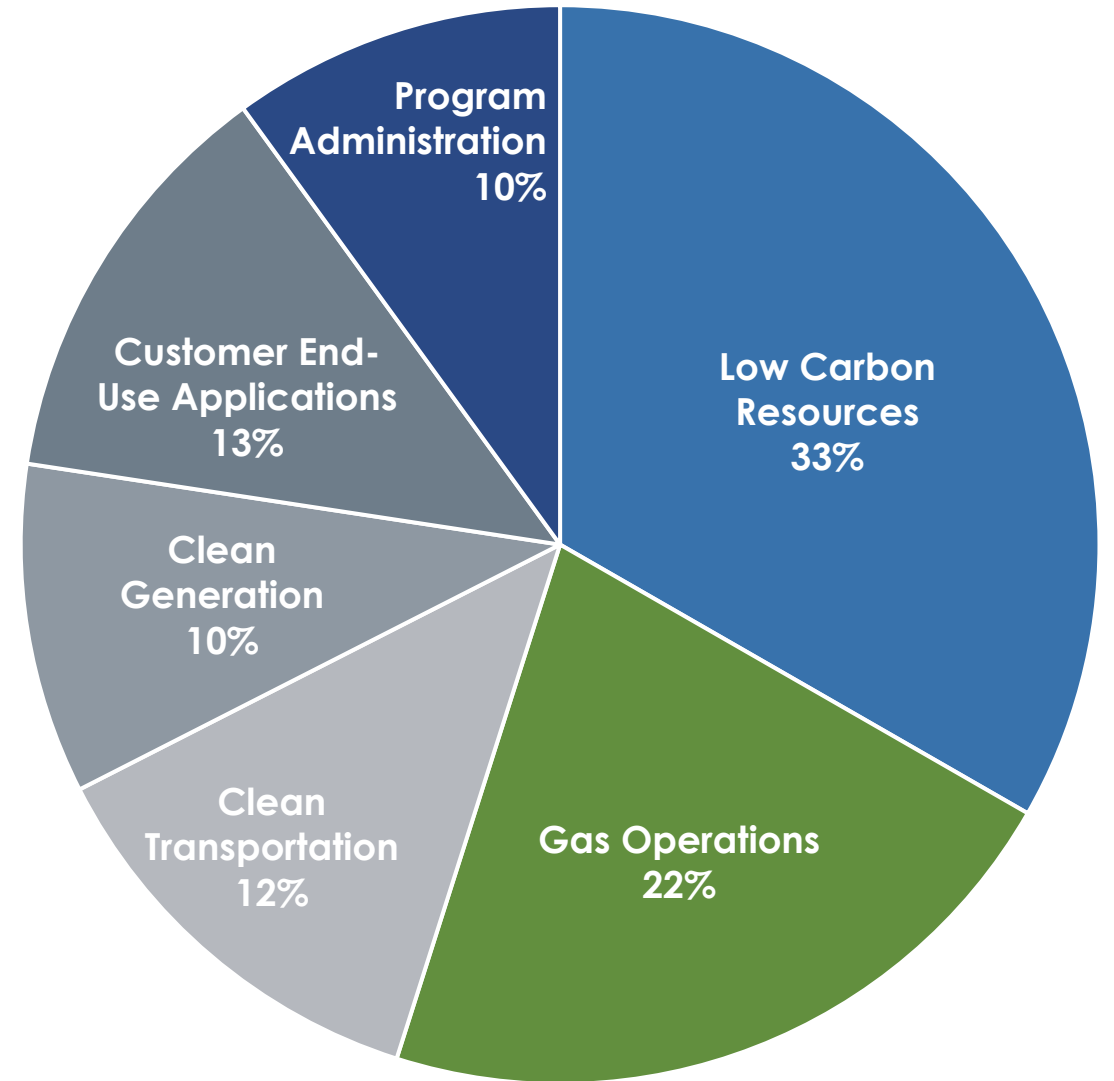
CPUC Resolution G-3586

On March 22, 2022, the CPUC issued Resolution G-3586 approving SoCalGas RD&D's 2022 Research Plan. The Resolution approved spending of up to \$16.94 million in 2022.

Guidance from Resolution G-3586

- Explain RD&D portfolio selection process and how RD&D selects project areas.
- Develop, in consultation with the energy division, a framework for collecting and reporting estimates of project reliability, safety, environmental benefits, operational efficiencies, and benefits to underserved communities.
- Discuss how SoCalGas incorporated feedback from workshop stakeholders and Commission staff.

2022 Research Plan



Resolution G-3586 authorized a total RD&D budget of \$16,494,000

4. Testimonials

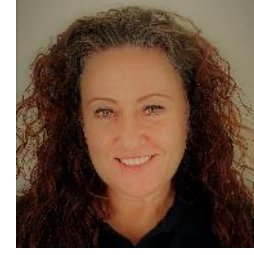
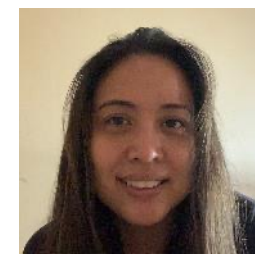
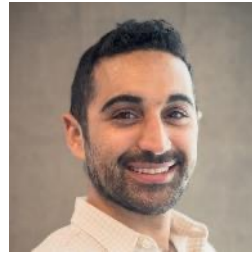
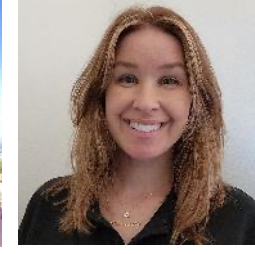
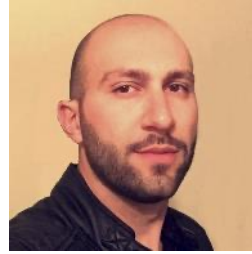


5. RD&D In Depth



What is SoCalGas RD&D?

SoCalGas RD&D is staffed with experts in science, engineering, industrial process technology, and environmental policy. In collaboration with researchers from some of the world's top institutions, they help identify, test, and develop transformational products that promote decarbonization.



Vision, Mission, & Values

OUR VISION

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

OUR MISSION

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

OUR VALUES

Science

Our experts in science, engineering, energy systems, and environmental policy seek answers to some of today's most pressing energy questions.

Synergy

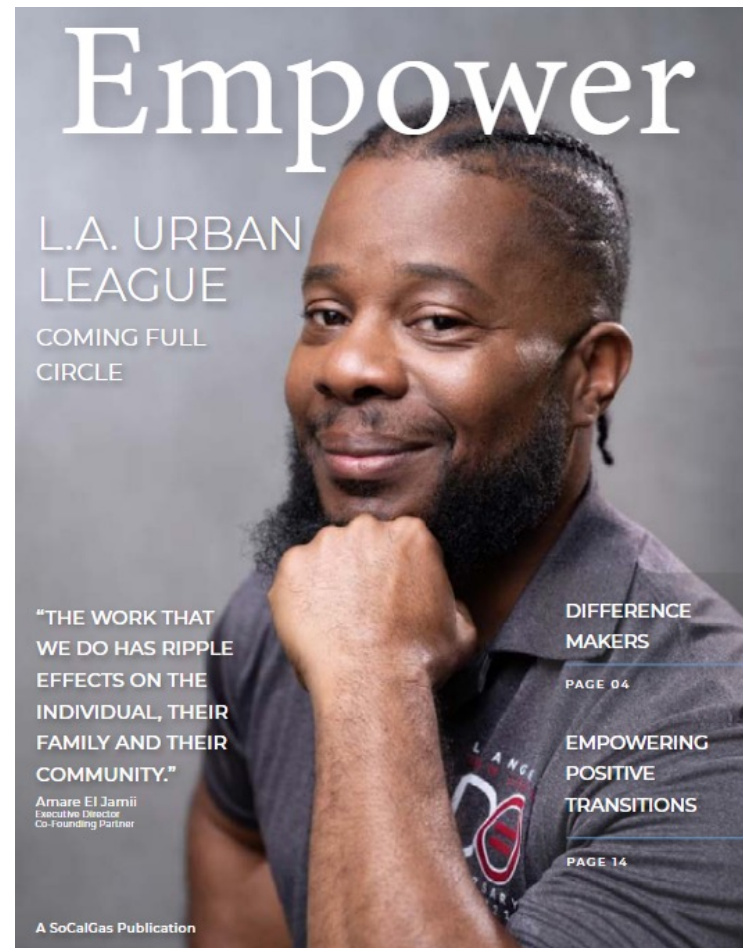
We work with the world's finest researchers in universities, national labs, and industry to develop transformational technologies that support decarbonization, energy security, and economic development.

Equity

We champion technologies that support affordable access to clean, safe, and reliable energy for all Californians.

Commitment to Diversity

SoCalGas is committed to providing safe, affordable, 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.



SUPPLIER DIVERSITY ADVANCING INCLUSION AS A PATHWAY TO A CLEAN ENERGY FUTURE

SUPPLIER DIVERSITY | 2021 ANNUAL REPORT | 2022 ANNUAL PLAN

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



The California Public Utilities Commission

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 decarbonization.

Program

A division within SoCalGas RD&D focused on products and technologies united by a broad theme, such as Clean Transportation. Programs remain constant year to year.

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 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.

RD&D Structure



Low Carbon Resources

Carbon Capture,
Utilization, and Storage
Renewable Gas Production



Gas Operations

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



Clean Transportation

Off-Road
Onboard Storage
On-Road
Refueling Stations



Clean Generation

Distributed
Generation
Integration
& Controls



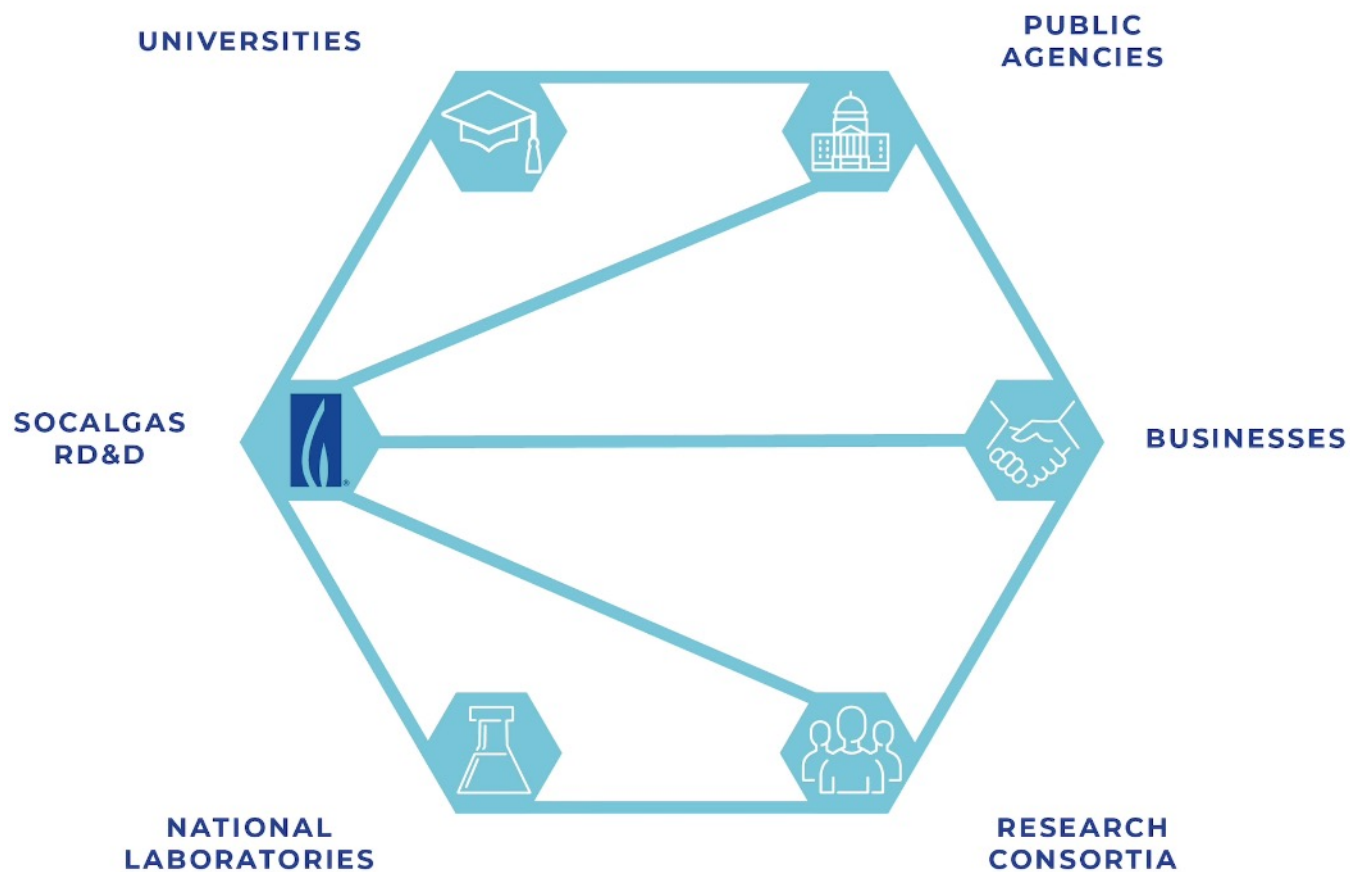
Customer End-Use Applications

Advanced Innovation
Commercial Applications
Commercial Food Service
Industrial Process Heat
Residential Appliances

Customer Benefits



Synergy Collaboration Ecosystem



Collaboration Ecosystem



Synergy

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.

6. Project Selection Process



Project Conception



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

Internal
Operations
Needs

Technology
Roadmap

Customer
Needs

Public
Workshop
& Outreach

Proposals
from
Research
Teams

Literature,
Surveys,
Conferences
and
Workshops

Policy
Drivers

External
Funding

Research
Consortia

Elements of a Good Project

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.

Benefit	Relevant Section of CPU Code 740.1	Relevant Language
Customer Benefit	740.1a	<p>“Projects should offer a reasonable probability of providing benefits to ratepayers.”</p> <p>“Each project should also support one or more of the following objectives:</p> <ul style="list-style-type: none"> (1) Environmental improvement. (2) Public and employee safety. (3) Conservation by efficient resource use or by reducing or shifting system load. (4) Development of new resources and processes, particularly renewable resources and processes which further supply technologies. (5) Improve operating efficiency and reliability or otherwise reduce operating costs.”
	740.1e	
Lead Investigator/Team Technical Feasibility Commercialization Potential	740.1b	“Expenditures on projects which have a low probability for success should be minimized.”
Alignment with California Policy	740.1c	“Projects should be consistent with the corporation’s resource plan.” SoCalGas also considers guidance from stakeholders and regulators to ensure that projects support California’s environmental goals.
Co-funding Collaborators	740.1d	“Projects should not unnecessarily duplicate research currently, previously, or imminently undertaken by other electrical or gas corporations or research organizations.”
Equity	N/A	SoCalGas included equity in response to feedback from multiple stakeholders and regulators and was guided in part by the CPUC’s ESJ Action Plan.

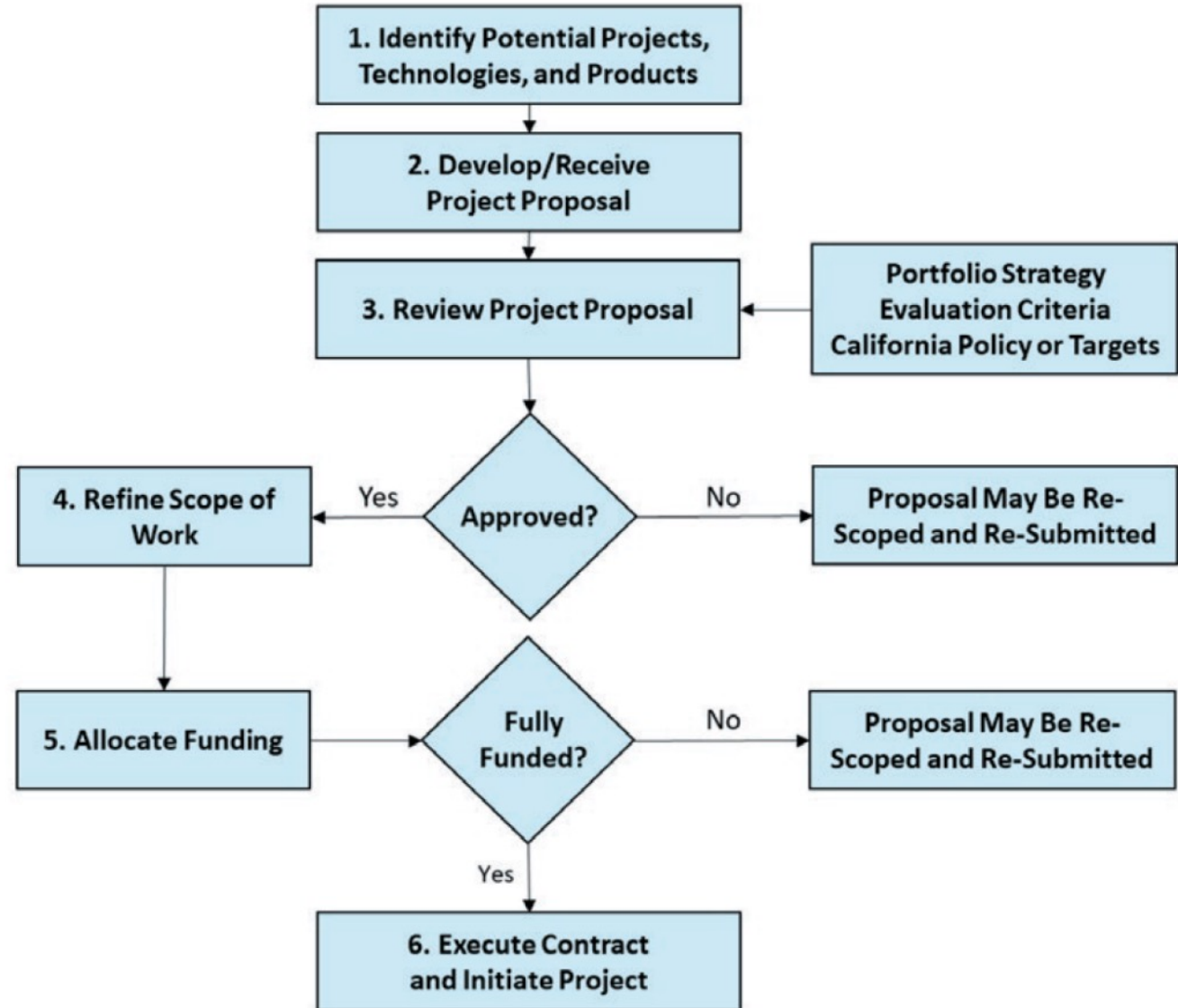
RD&D Proposal Review Process



SoCalGas RD&D takes a comprehensive yet flexible approach that enables us to:

- **Identify** potential projects most in alignment with RD&D Program goals, state and federal environmental policy, and industry demand.
- Accurately **assess** the likelihood of potential projects to succeed.
- **Work** with proven organizations and technologies over time.
- **Respond** nimbly to changing market, technology, and policy drivers.

RD&D Proposal Review Process



Next Steps



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

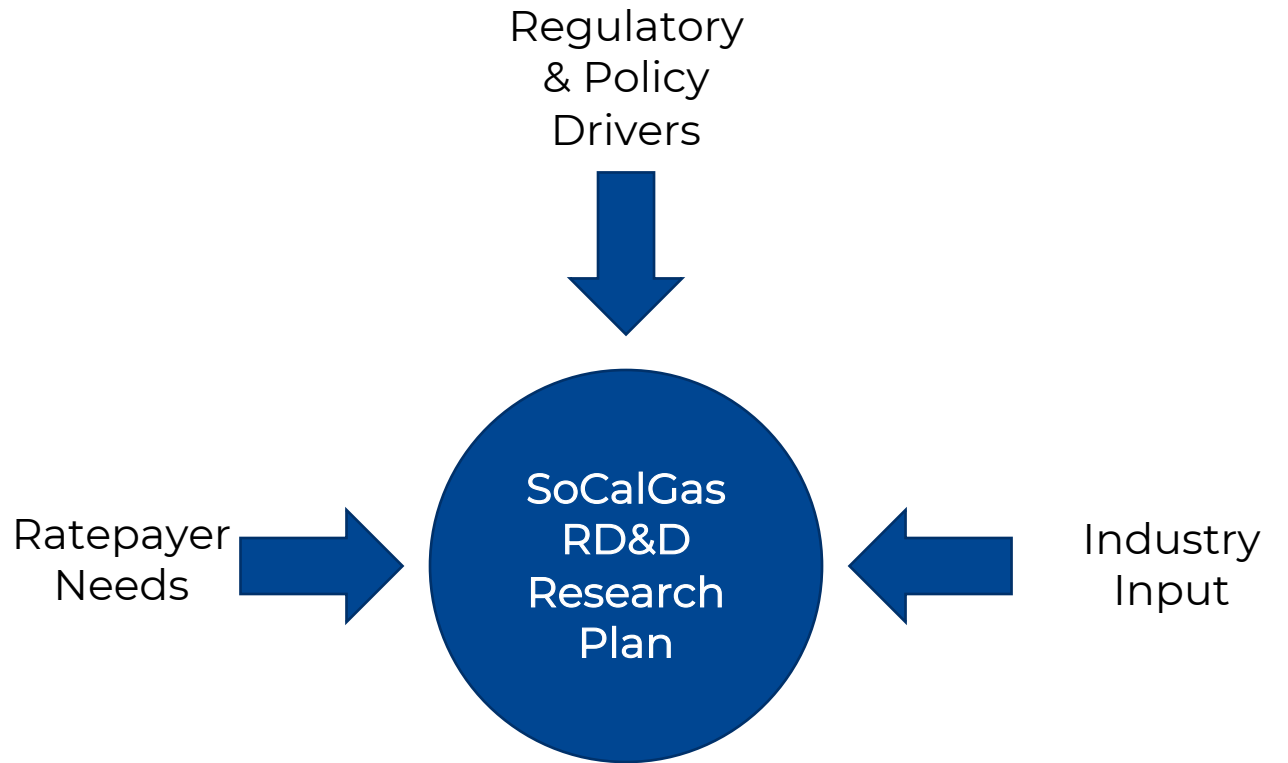
1. Connect with the relevant Program lead.
2. Evaluate your project, technology, or product against the elements of a good project.
3. Confirm alignment and refine your project in conversation with the relevant program lead.
4. Submit a Project Proposal.

7. 2023 Research Plan



Overview

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



Regulatory & Policy Drivers

Category	Regulations & Policy Drivers
GHG Emissions	<p>AB 32: Reduce CO2 emissions 40% below 1990 levels by 2030</p> <p>SB 100: Zero-carbon electricity by 2045</p> <p>EO B-55-18: Carbon-neutral California economy by 2045</p> <p>AB 3232: Building decarbonization</p>
Pipeline Safety	<p>CPUC General Order 112F: Rules governing design, testing, operation, and maintenance of gas transmission and distribution systems</p> <p>DOT 49 CFR Part 192: Federal pipeline safety regulations</p> <p>AB 1900: Biomethane quality standards</p> <p>OIR R.13-02-008, Phase 4: Addresses injection of renewable hydrogen into gas pipelines</p>
Local Air Quality	<p>Clean Air Act: Air quality standards for NOx and PM</p> <p>AB 617: Pilot communities for air quality improvements</p>
Methane Emissions	<p>SB 1383: Reduce methane emissions from decomposition of organic wastes</p> <p>CARB Oil and Gas Rules: Requires new monitoring and repairs to reduce methane emissions</p> <p>Natural Gas STAR Program: Encourages adoption of methane-reducing technologies and practices</p> <p>EPA Methane Challenge Program: Recognizes oil and gas companies that take comprehensive action to reduce methane emissions</p> <p>SB 1440: Authorizes a state procurement program for biomethane</p>
Clean Transportation	<p>ARB Implementation Plan: Low-NOx standard for trucks</p> <p>AB 8: Development of 100 hydrogen fueling stations in California</p> <p>EO-B32-15: Sustainable freight action plan</p> <p>EO-B48-18: 200 hydrogen refueling stations by 2025</p> <p>EO N-79-20: 100% of medium- and heavy-duty vehicle be zero emission by 2045 for all operations where feasible</p> <p>LCFS: Reduce carbon intensity of fuels by 10% by 2020</p> <p>SB 1275: One million zero-emission and near-zero-emission vehicles by 2023</p>
Equity	<p>CPUC General Order 156: Encourages IOUs to procure or contract goods and services from women, minority, disabled veteran and/or LGBT owned business enterprises</p> <p>CPUC ESJ Action Plan: Increases investment in clean energy resources to benefit environmental and social justice communities (ESJ), especially to improve local air quality and public health</p>

Summary of Stakeholder Input

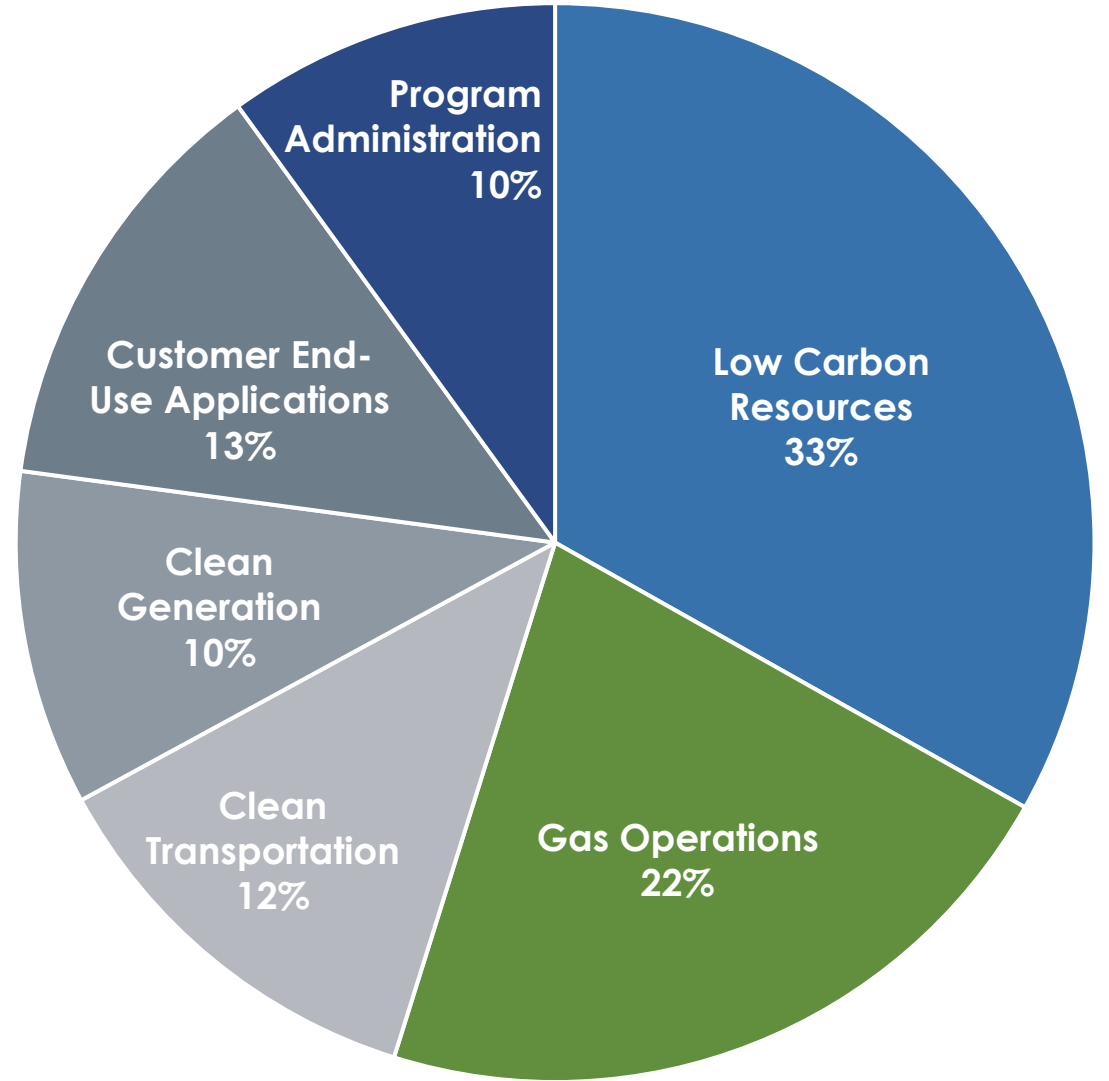
In early 2022, RD&D conducted outreach meetings with representatives from 11 industry organizations:

- CEC
- U.S. DOE
- GTI
- Stanford Natural Gas Initiative
- Cal State LA
- Cal State Long Beach
- Pipeline Research Council Int.
- NYSEARCH
- Bakersfield College
- Kern Oil
- National Renewable Energy Laboratory

Key Takeaways

- Collaborate with community-based organizations.
- Fund workforce development projects.
- Support projects that combine hydrogen production, distribution, and end uses.
- Develop gas heat pump technologies.
- Increase focus on clean transportation with renewable gases.
- Need more hydrogen fueling stations with onsite hydrogen production.
- Explore use of existing pipelines for transport of carbon dioxide.

Proposed 2023 Funding Allocations



*Any over/underspend from 2022 will be applied to 2023 in accordance with Resolution G-3586.

Questions & Answers

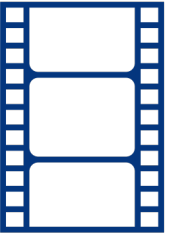


Safety Moment #2

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

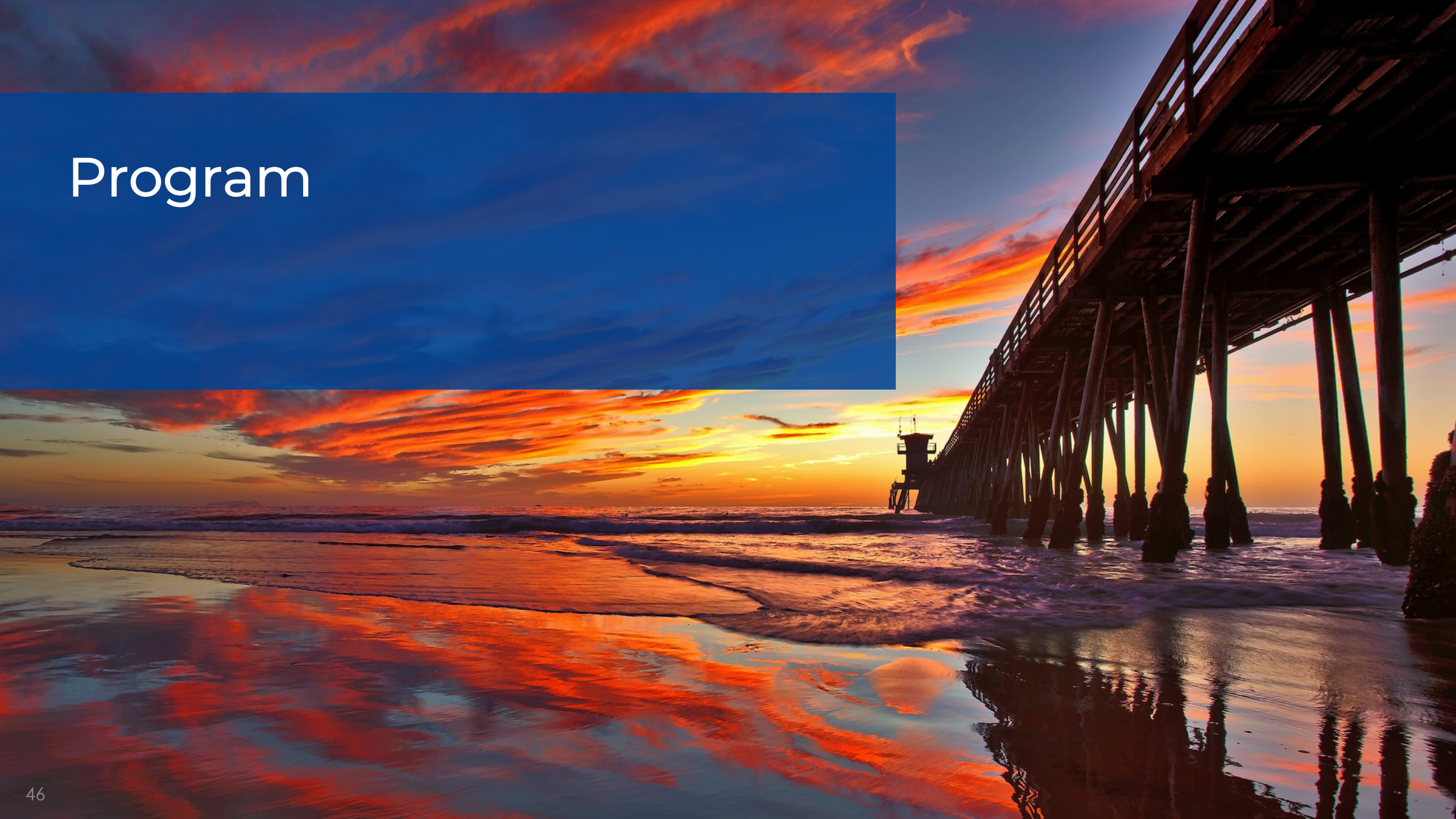
Call 8-1-1 before you dig

- Informational Video (30 sec)



https://youtu.be/qmuX4W_PkLQ

Program



8. Low Carbon Resources (10:30 – 11:00)

- Overview & Goals
- Project Report
- Subprograms Overview
 - Renewable Gas Production
 - Carbon Capture, Utilization, & Storage (CCUS)
- Proposed 2023 Funding Allocation
- Feedback

Overview

The Low Carbon Resources RD&D Program develops, promotes, and advances new technologies aimed at increasing the production of renewable gas to displace conventionally sourced pipeline gas, while also limiting or recycling GHG emissions.

Goals

- Increase the availability of renewable gas.
- Promote pipeline decarbonization solutions by advancing production technologies that diversify renewable gas feedstocks and pathways.
- Offset emissions from conventional natural gas use by capturing and permanently removing atmospheric GHG emissions through CCUS technologies.

Program Summary

In 2021, the Low Carbon Resources Program:

- Supported 42 projects with technical resources and \$5,018,729
- Completed 15 projects
- Initiated 7 new projects

For more details, please read the SoCalGas RD&D Program 2021 Annual Report.



Low Carbon Resources

Benefits

GHG Benefit



Pipelines can be decarbonized by displacing fossil-sourced gas to reduce, mitigate or eliminate GHG emissions. CCUS systems can permanently remove CO2 from the air, either directly or through waste diversion and carbon recycling.

Emissions Benefit



Replacement of fossil-sourced gas with renewable hydrogen can improve air quality, especially in industrial zones. Hydrogen production through methane pyrolysis can improve air quality.

Cost Savings Benefit



The development of technologies and innovations that produce renewable gas at the lowest possible cost would result in increased affordability and accessibility of renewable gas to ratepayers.

Reliability



Power-to-gas systems can improve renewable resource reliability by converting excess power produced during peak generation to fuels which can be injected into the gas grid for long duration storage.

Safety



Generation of hydrogen at point of use eliminates the need to transport hydrogen from centralized production points in high-pressure cylinders/ vessels and makes hydrogen adoption inherently safer.

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 and directly removing GHGs from the atmosphere, this program supports the following policies:

- AB 3232 (Building Decarbonization)
- 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)
- EO S-3-05 (GHG emission reduction targets)
- SB 1383 (CH4 emissions from organic waste)
- LCFS (Reduce carbon intensity of fuels)
- AB 8 (Development of 100 H2 Stations in CA)
- EO B48-18 (200 hydrogen refueling stations by 2025)

Equity

By decarbonizing the pipeline by replacing its fossil-sourced content with renewable gas and directly removing GHGs from the atmosphere, this program would reduce emissions and improve air quality in areas neighboring industrial facilities, most of which fall within low or disadvantaged communities,* in alignment with CPUC's ESJ Action Plan.

CPUC ESJ Action Plan Goal 2: Increases investment in clean energy resources to benefit environmental and social justice communities, especially to improve local air quality and public health.

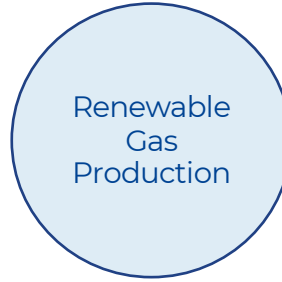
*According to CalEnviroScreen 4.0



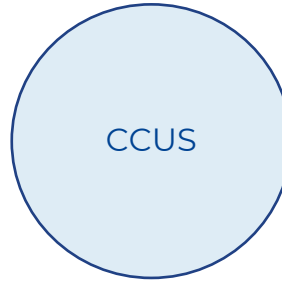


Subprograms

Low Carbon Resources



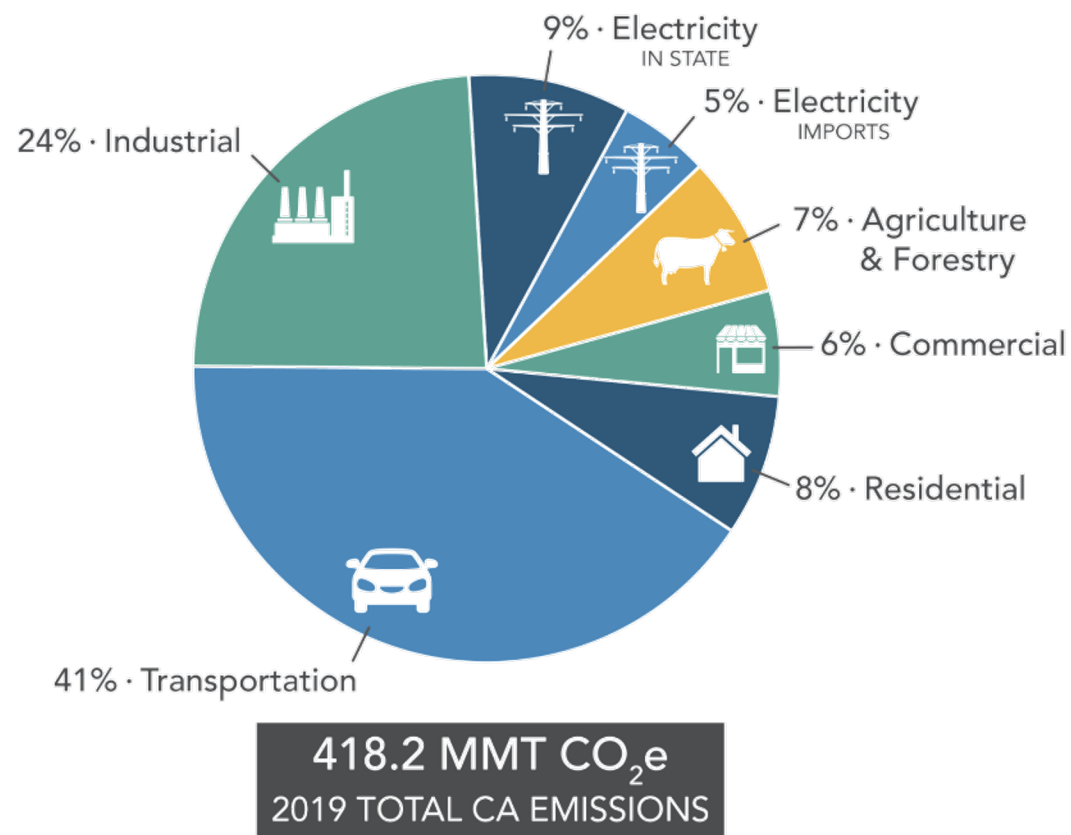
Low and net-negative carbon intensity production of renewable hydrogen and renewable natural gas (RNG).



Utilization and conversion of captured CO₂ to produce biofuels or durable products, including plastics or cement. Capture, compression, and geologic storage of CO₂ obtained directly from the air or ocean.

Renewable Gas Production Background

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




Renewable Gas Production Background



NREL and SoCalGas' Power-to-Gas bioreactor where microbes are used to upgrade biogas to RNG

Renewable Gas Production Background




ENERGY
earthshots | Hydrogen
U.S. DEPARTMENT OF ENERGY

Hydrogen Energy Earthshot

“Hydrogen Shot”

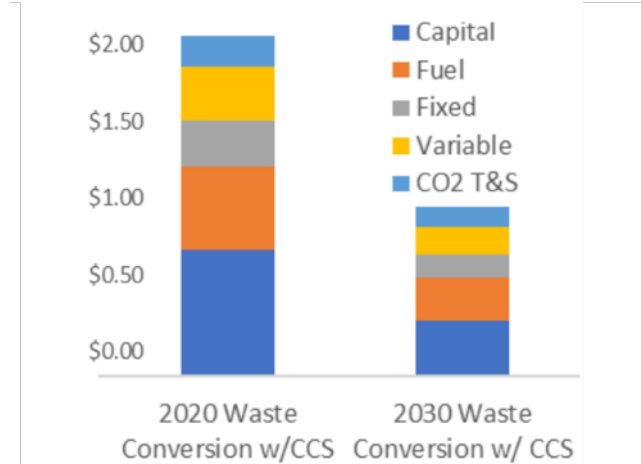
“1 1 1”
\$1 for 1 kg clean hydrogen
in 1 decade

Launched June 7, 2021
Summit Aug 31-Sept 1, 2021

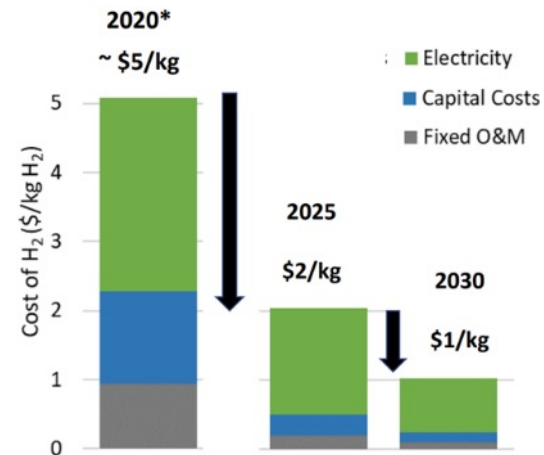


Renewable Gas Production Background

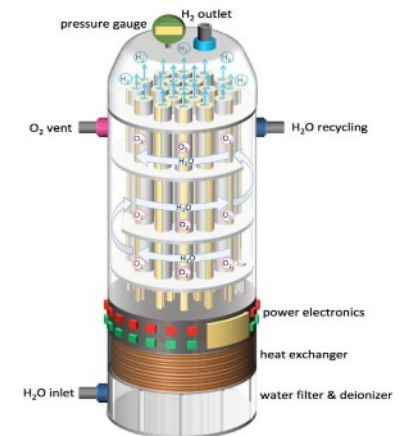
H₂ Cost from Waste Conversion + CCS



H₂ Cost from PEM Electrolysis



H2U's PEM Electrolyzer Design



U.S. Department of Energy (left), STARS (top right), H2U (bottom right)

Renewable Gas Production Research Areas

- Renewable hydrogen production via advanced water-splitting using Earth-abundant materials
- Electrochemical methods of pumping, separating, and compressing hydrogen to maximize production chain efficiency
- Renewable methane production via various methanation pathways
- Renewable gas production via biomass gasification
- Distributed hydrogen production via advanced Steam Methane Reforming (SMR) of biomethane
- Emissions-free hydrogen production via methane pyrolysis

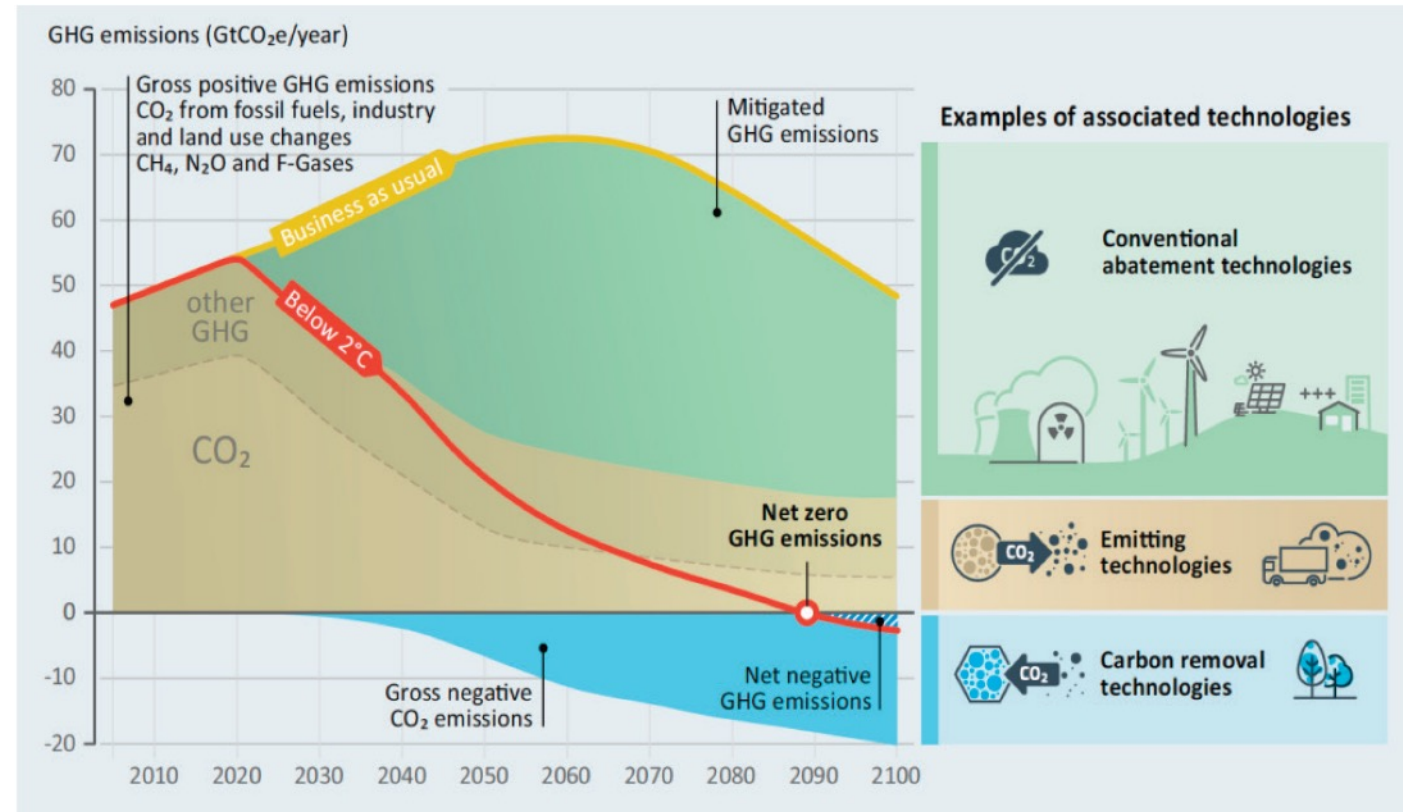


Recent Developments

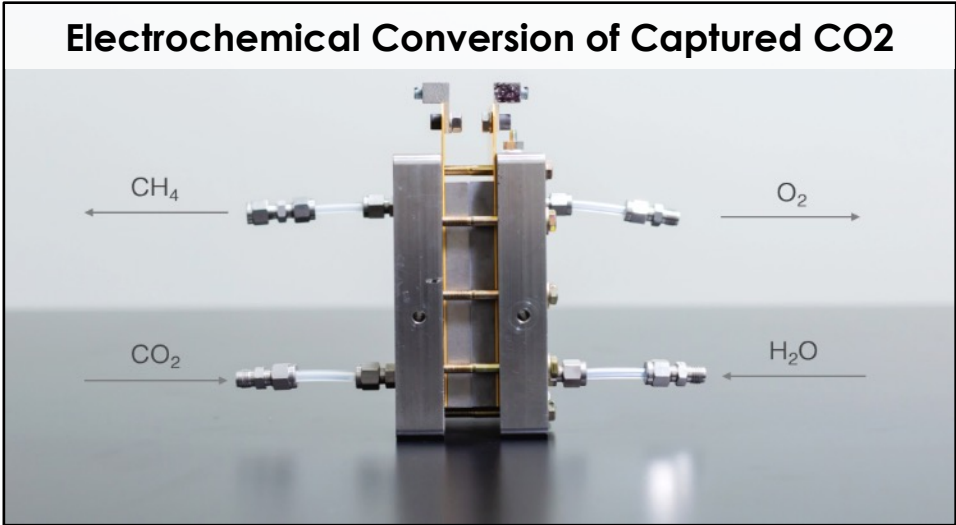
- The Bipartisan Infrastructure Law (BIL) mandates development of a national strategy and roadmap to facilitate wide-scale production, processing, delivery, storage, and use of clean hydrogen.
- BIL directs \$8 billion for development of 4+ regional clean hydrogen hubs; \$1 billion for electrolysis research, development, and demonstration; and \$500 million for clean hydrogen technology manufacturing and recycling R&D and demonstration projects.

Carbon Capture Utilization and Sequestration (CCUS) 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 emissions by capturing, utilizing or sequestering CO₂ from our atmosphere (negative emissions technologies), oceans, and industrial processes is critical to mitigating and reversing the effects of climate change.



Carbon Capture Utilization and Sequestration (CCUS) Background



Twelve (top), Caltech/Captura (bottom)



CCUS

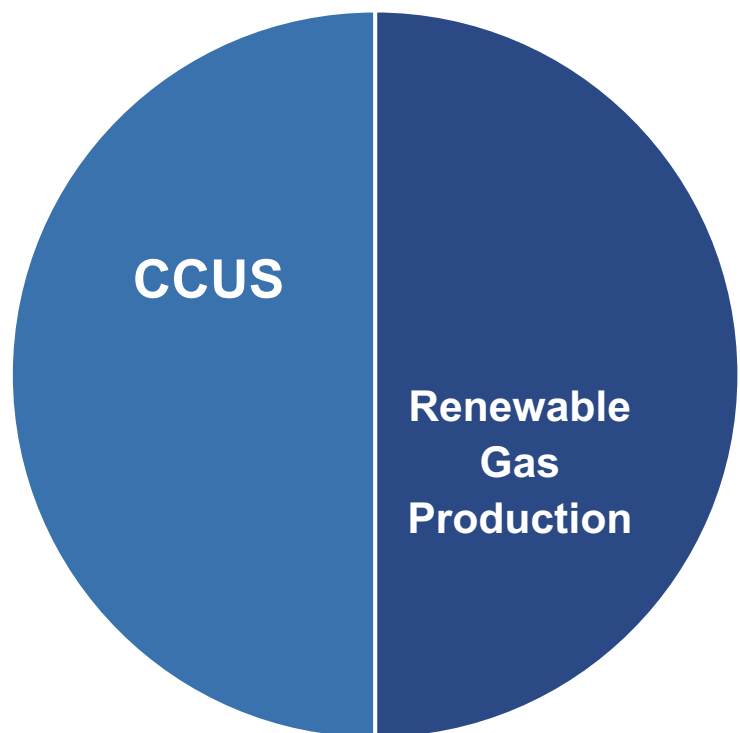
Research Areas

- Develop, optimize, and minimize costs of Direct Air Capture (DAC) or Direct Ocean Capture (DOC) systems to enable deployment at scale
- Conversion of captured CO₂ into plastics, cement, and biofuels that allows long-term carbon storage
- Production of renewable fuels for hard-to-decarbonize industries using captured CO₂ and hydrogen
- Point-source carbon capture technologies that take advantage of increased carbon content in industrial processes

Recent Developments

- The BIL appropriates \$3.5 billion for carbon capture demonstration projects and carbon capture large-scale pilot projects over the next five years.
- The BIL appropriates \$100 million for carbon capture FEED projects.

2023 Proposed Funding Allocation



Subprogram	Allocation
CCUS	50%
Renewable Gas Production	50%
Total	\$5,618,042




Feedback

1. What are the key obstacles to scaling up carbon capture technologies?
2. What are the most promising feedstocks to generate renewable hydrogen and renewable natural gas?
3. Which renewable gas production technologies integrate well with renewable resource intermittency?
4. In order to maximize efficiency, should we focus on centralized or distributed solutions for gas production technologies?
5. What are the new technologies emerging in the carbon capture space that we should consider?
6. Which carbon capture technologies pair best with hard-to-decarbonize industries?

A wide-angle photograph of a desert landscape during the "golden hour" of sunset or sunrise. The sky is filled with soft, textured clouds, with the sun low on the horizon to the left, casting a warm, golden glow. A dirt path, marked with small stones, leads from the foreground into the distance. The terrain is arid, with scattered rocks and sparse, dry vegetation including shrubs and small trees. In the background, there are prominent, rounded rock formations. The overall mood is serene and quiet.

15-Minute Break
(11:00 – 11:15)



9. Gas Operations (11:15 – 11:45)

- Overview & Goals
- Subprograms Overview
 - Environmental & Safety
 - Operations Technology
 - System Design & Materials
 - System Inspection & Monitoring
- 2023 Proposed Funding Allocation
- Feedback

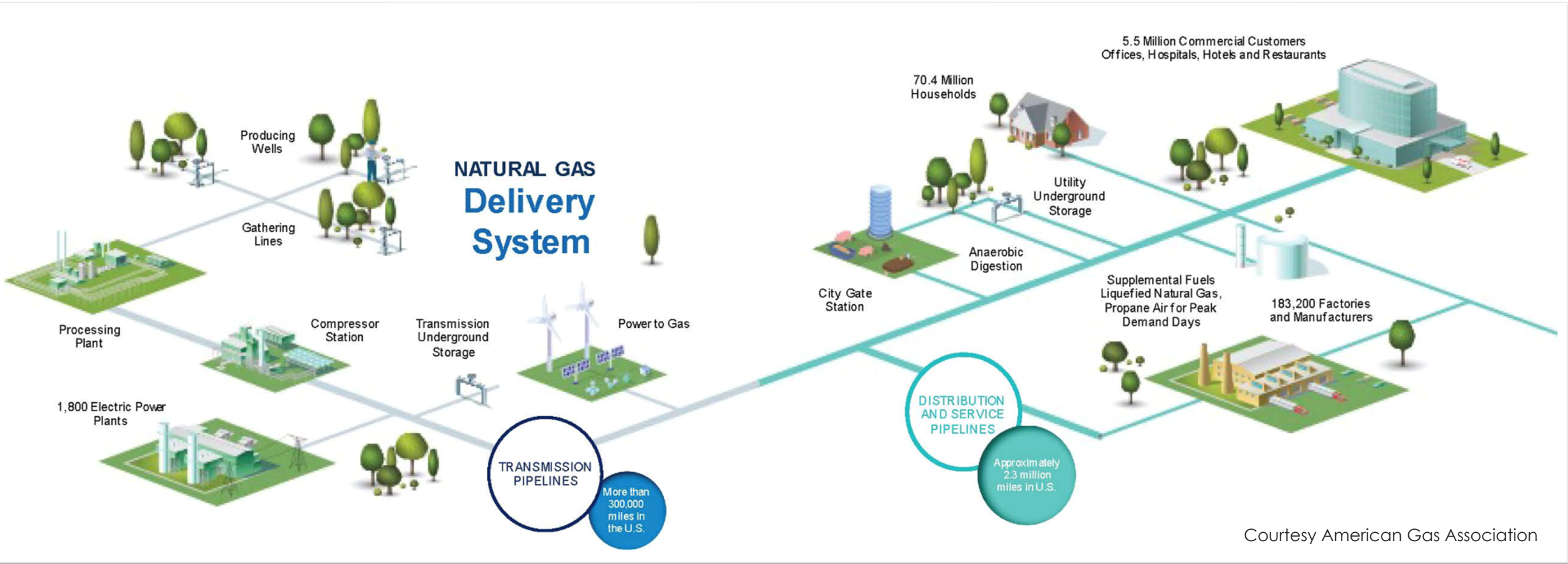
Overview & Goals

The Gas Operations RD&D Program works across the SoCalGas Transmission, Storage, and Distribution systems to develop, test, and introduce advancements in gas operations technologies, that also benefit 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

Gas Operations



SoCalGas

22 million Customers

3,440 miles of Transmission Pipelines

6 million+ Meters

101,603 miles of Distribution Mains and Services

Program Summary

In 2021, the Gas Operations Program:

- Supported 160 projects with technical resources and \$3,561,049
- Completed 49 projects
- Initiated 29 new projects
- Implemented 12 projects

For more details, please read the SoCalGas RD&D Program 2021 Annual Report.



Benefits

GHG Benefit



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

28%

Emissions Benefit



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

7%

Cost Savings Benefit



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

34%

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.

78%

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.

82%

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.

22%

Policy Alignment



This program supports the following policies:

- DOT 49 CFR Part 192: Federal pipeline safety regulations
- AB 32 (Reducing CO2 emissions)
- Clean Air Act (Air quality standards for NOx and PM)
- Various Air Quality Standards (federal and state)
- National Environmental Protection Act
- U.S. EPA Methane Challenge Program (oil and gas companies reducing CH4 emissions)
- CARB Oil and Gas Rule (reducing CH4 emissions)
- SB 1440: Authorizes a state procurement program for biomethane

Equity

"The true measure of our success will be the number of people touched and transformed by our success."

Angela Ahrendts



Subprograms

Gas Operations

Environmental & Safety

Advances the 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, such as efficiency of construction and operation of gas pipelines, data collection, and emerging interactive training.

System Design & Materials

Advances materials and materials science, materials tracking and traceability, and technical tools for designing pipeline systems and infrastructure for safety, reliability, efficiency, and maintainability throughout the lifecycle of pipeline assets

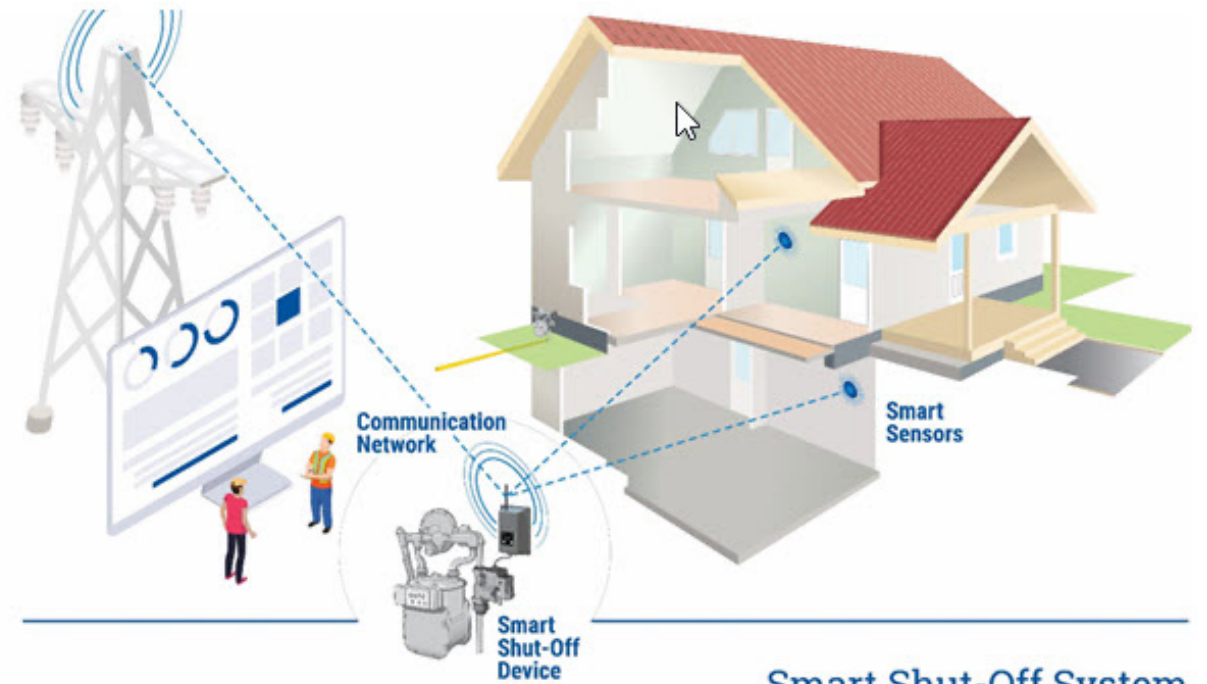
System Inspection & Monitoring

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

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 state goals
- Protect the pipeline from intentional and unintentional damage
- Explore the impact of blending hydrogen into the pipeline



Smart Shut-Off System

OTD 5.20.k

Environmental & Safety

Research Areas

- Advanced technologies to address post-combustion criteria air pollutant emissions and fugitive GHG emissions.
- Developing methods to prevent or mitigate contaminated water run-off or hazardous waste and preserve plants and endangered species during pipeline construction and repair within environmentally sensitive areas.
- Protecting the pipeline from intentional and unintentional damage. Projects include developing advanced sensors and automatic shutoff systems for above- and below-ground piping systems.



Operations Technology Background

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

- Improve employee training
- Build pipelines more efficiently
- Facilitate safe and reliable pipeline operations
- Prevent gas leaks resulting from blending hydrogen into pipelines



Data Logger Evaluation

Operations Technology

Research Areas

- Develop cost-effective polyethylene (PE) pipe repair technologies that are easily applied over the damaged section of PE pipe.
- Improve pipeline locating and mapping technologies through, for example, further enhancement of acoustic, electromagnetic, and ground-probing radar systems to produce complete, accurate images of buried substructures.
- Validate the capabilities of state-of-the-art measurement equipment and devices for both natural gas and other constituents.

System Design & Materials

Background

Advance materials and materials science, materials tracking and traceability, and technical tools for designing pipeline systems and infrastructure for safety, reliability, efficiency, and maintainability throughout the asset lifecycle.

- 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 blending gas from non-traditional sources on natural gas quality and system integrity



Credit: NYSEARCH

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

System Design & Materials

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 of the implications of potential risk factors, such as stresses due to internal gas pressure, construction procedures, and environmental factors.
- Analyze state-of-the-art materials and coatings to identify those that can improve the longevity—and thus the reliability—of newly installed segments over that of legacy installations.



Hydrogen Blending Impact on
Aldyl-A and HDPE Pipes (OTD 5.21.j)

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 data management to identify precursors to failures or incidents
- Leverage AI, machine learning, and preventive/predictive maintenance technologies
- Explore tools for managing the potential impacts of blending hydrogen into the gas pipeline



System Inspection & Monitoring Research Areas

- Develop sensors using Electromagnetic Acoustic Transducer technologies with sensitivities capable of detecting cracks in the pipe wall and long-seam welds and measuring remaining wall thickness.
- Evaluate a number of remote inspection and monitoring systems.
- Monitor environmental threats, such as weather-related landslides and floods, as well as seismic ground faults impacting pipeline integrity.



- Alternate Crack Sensor (M2016-004 Ph IV)
- Electromagnetic Time Domain Reflectometry (EM-TDR) for Pipeline Integrity (M2021-004 Ph I)
- Explorer Wireless Range Extender (M2021-006)

Consortium Memberships



Members: 27 Natural Gas Utilities (North America)

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



Member Subset: 13 Natural Gas Utilities (North America)

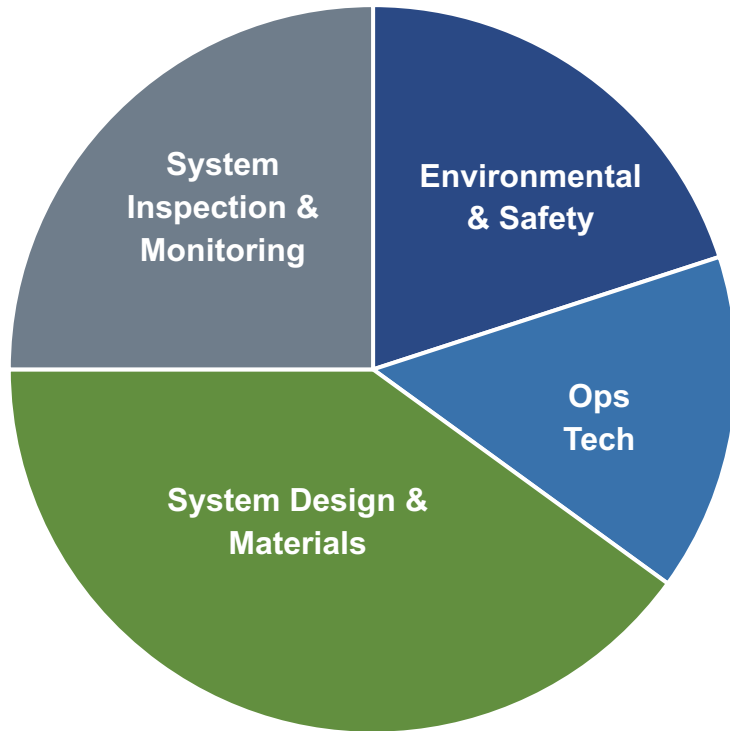
- Pipeline membership is open to companies operating natural gas transmission and other “energy pipelines” (Domestic & International)
- Mission: To collaboratively deliver relevant and innovative applied research to continually improve the global energy pipeline systems



Members: 25 Natural Gas Utilities (North America)

- 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.

Proposed 2023 Funding Allocation



Subprogram	Allocation
Environmental & Safety	20%
Operations Technology	15%
System Design and Materials	40%
System Inspection & Monitoring	25%
Total	\$3,644,784

Feedback

1. Can you identify any technology gaps that should be considered for research within the Gas Operations program?
2. Are there other regulatory drivers that could impact Gas Operations that should be considered?
3. In the area of Equity consideration, are there key priorities or research areas the Gas Operations RD&D program could focus on?
4. Are certain Gas Operations RD&D subprograms, or research areas within the subprograms, more important than others?
5. What types of projects would you like to see funded?

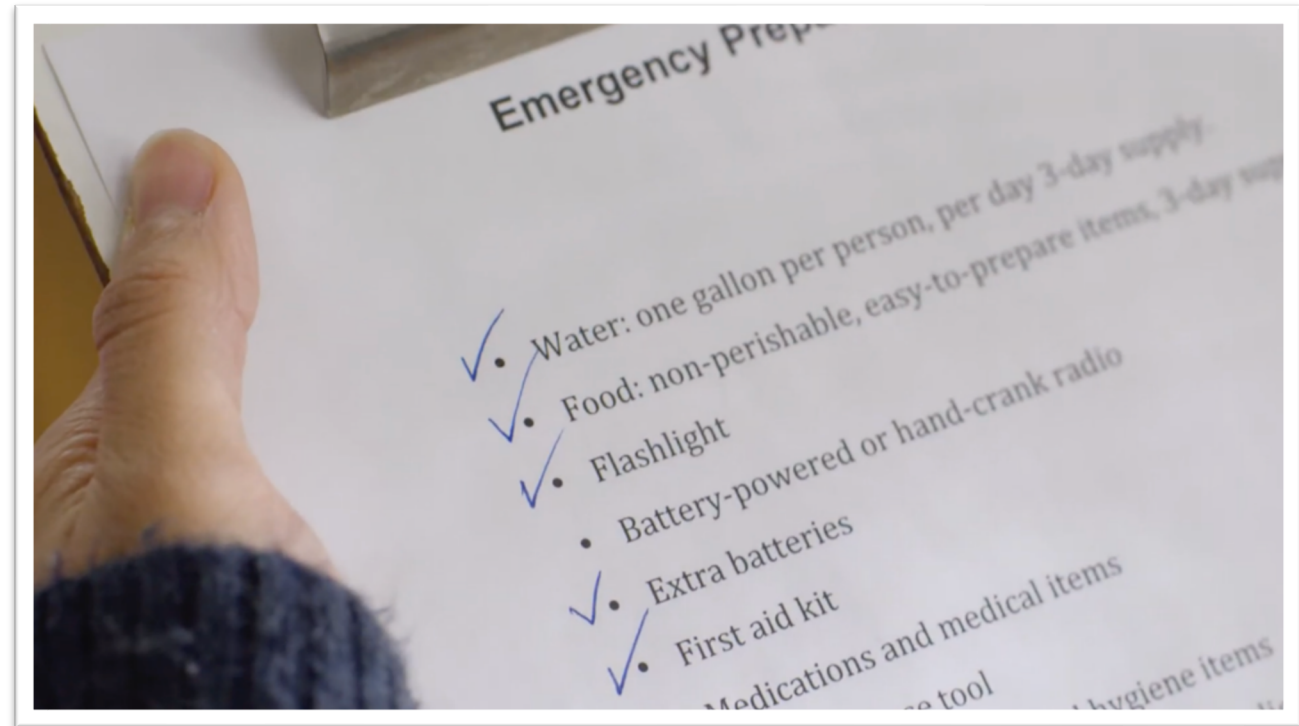
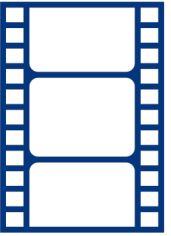
Safety Moment #3

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



Emergency Preparedness

❖ Informational Video (30 sec)



<https://youtu.be/lrllDXI4K8A>

10. Clean Transportation (11:45 – 12:15)



- Overview & Goals
- Subprograms Overview
 - Off-Road
 - Onboard Storage
 - On-Road
 - Refueling Stations
- 2023 Proposed Funding Allocation
- Feedback

Overview & Goals

The Clean Transportation RD&D Program focuses on minimizing environmental impacts related to the transportation sector, particularly through integration of hydrogen and renewable natural gas (RNG).

Goals

- Zero-emission transportation technologies
- Zero- and near-zero-emission fueling infrastructure
- Advanced on-board storage technologies

Program Summary

In 2021, the Clean Transportation Program:

- Supported 29 projects with technical resources and \$2.8M
- Completed 5 projects
- Initiated 9 new projects

For more details, please read the SoCalGas RD&D Program 2021 Annual Report.



Benefits

GHG Benefit



RNG and hydrogen fuel reduce greenhouse gases compared to diesel.

Emissions Benefit



Near-zero-emission technologies emit 90+% fewer NOx emissions than current diesel engines while zero-emissions technologies emit nothing.

Cost-Savings Benefit



Zero-emission vehicles can benefit from incentives such as the Low Carbon Fuel Standard.

Reliability



Zero-emission vehicles require less maintenance than their gasoline and diesel counterparts.

Safety



High-pressure and hydrogen storage tanks are subject to some of the highest safety requirements and to a thorough certification process.

Operational Efficiency



Zero-emission vehicles require less maintenance and can refuel in the same amount of time as their diesel counterparts.

Policy Alignment

This program aligns and conforms with California’s decarbonization goals and policies, including:

- EO N-79-20
 - 100% zero-emission off-road vehicles and equipment by 2035 where feasible
- CARB Clean Fleets Rule
 - Transition of California to zero-emission where feasible
- CARB At-Berth regulations will deliver a 90 percent reduction in pollution and result in a 55 percent reduction in potential cancer risk for communities near ports

2020	2021 and 2022	Ongoing
Heavy-Duty Omnibus Regulation	Advanced Clean Cars II	Incentivized Turnover of Vehicles & Equipment
Advanced Clean Trucks Regulation	Heavy-Duty Inspection and Maintenance Program	
OGV At Berth Regulation	Small Off-Road Engines	
	Zero-Emission TRU (Part I)	
	Zero-Emission Forklifts	
	Consumer Products	



* CARB 2020 Mobile Source Strategy

Equity

“In the United States, transportation and electricity generation are leading sources of unhealthy air and the pollutants that cause climate change.

Those living near highways, ports, railyards, warehouses, and other transportation hubs are at greater health risk, as are those impacted by fuel refining, electricity generation and processes.”

“Zeroing in on Healthy Air”
— American Lung Association



* CARB 2020 Mobile Source Strategy

Subprograms

Clean Transportation

An aerial photograph of a boat on the water, with a drone flying above it. The boat is moving, leaving a white wake. The drone is a small, white, multi-rotor aircraft. The water is a dark greyish-blue.

Off-Road

Zero emission off-road transportation solutions using RNG and renewable hydrogen.

Onboard
Storage

Technologies and systems that improve onboard storage for gaseous transportation fuels.

On-Road

Emissions reductions from medium- and heavy-duty on-road vehicles.

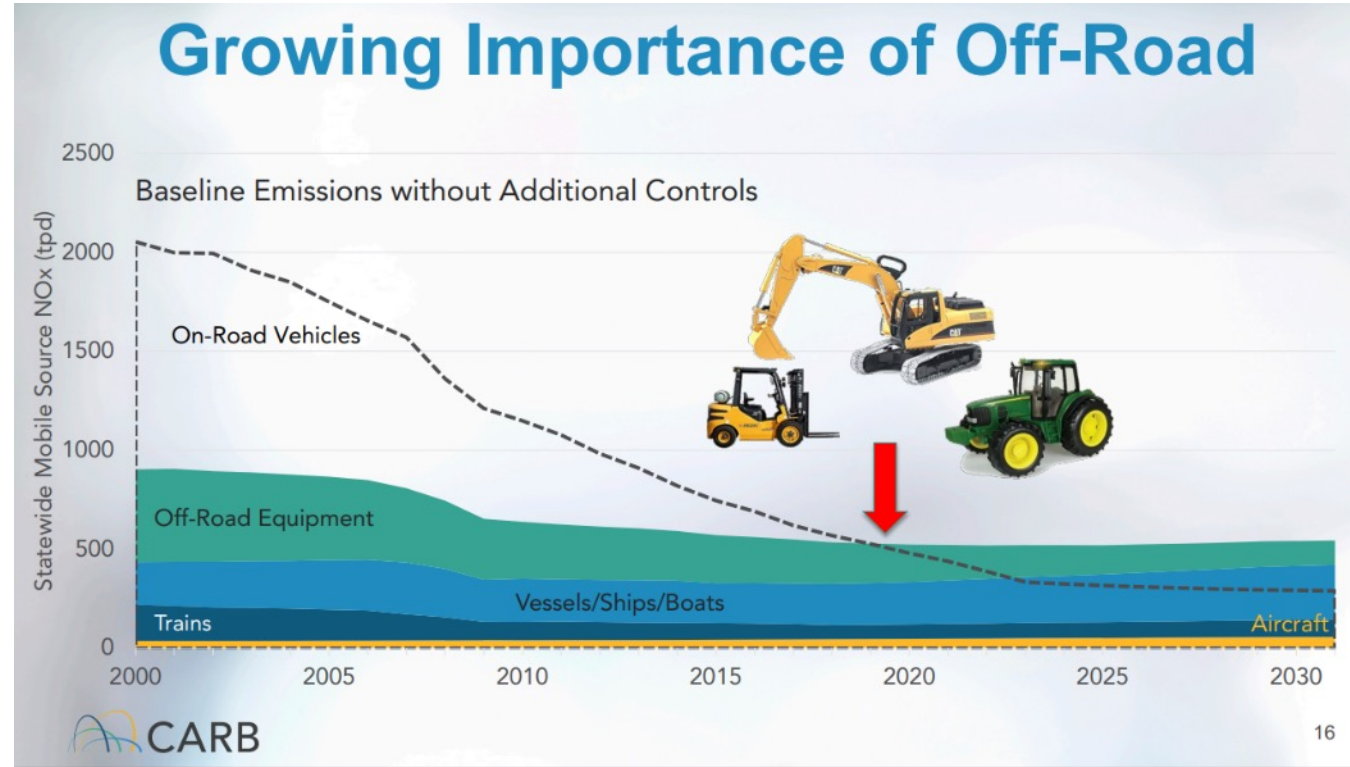
Refueling
Stations

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

Off-Road Background

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

- Achieve **emissions reductions** from off-road vehicles such as trains, ocean-going vessels, commercial harbor craft, construction equipment, and cargo handling equipment.
- Explore **aviation applications**, such as hydrogen fuel cell aircraft and drones.

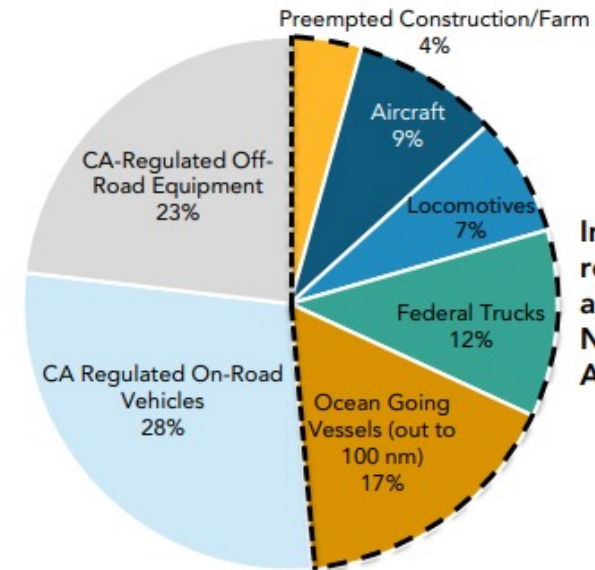


* CARB 2020 Mobile Source Strategy

Off-Road Research Areas

- Research how utilizing hydrogen as fuel for rail, marine, construction, and aviation will help reduce emissions
- Demonstrate new technology to help reduce emissions that meet or exceed regulatory requirements

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



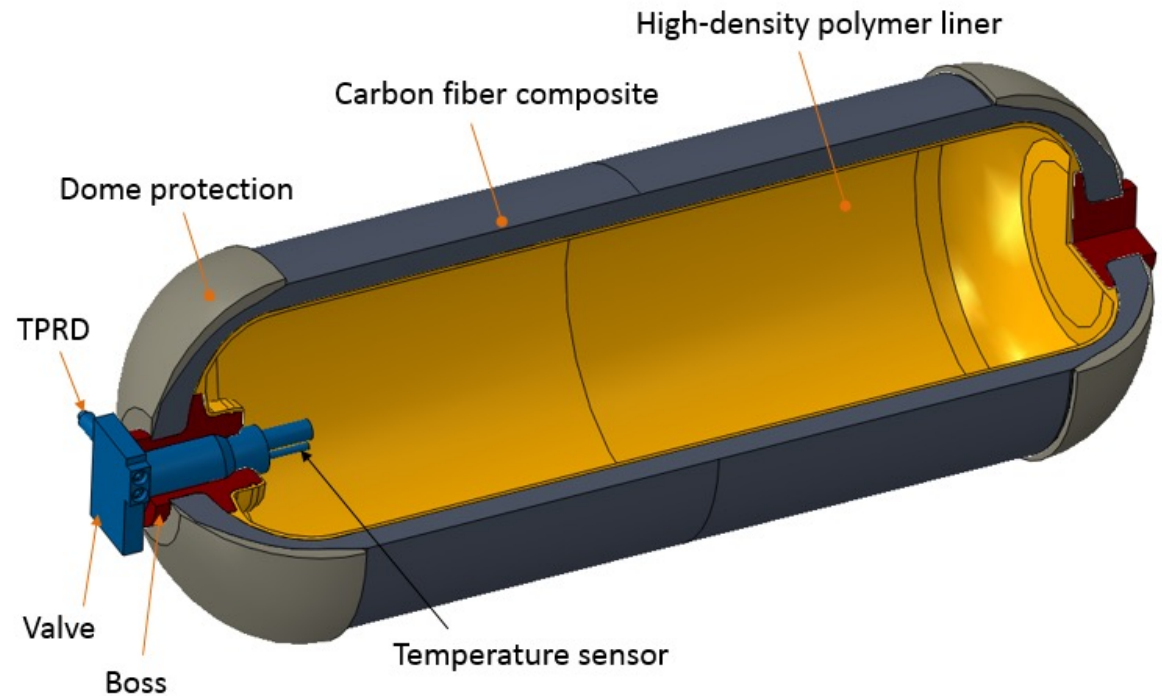
In 2023, primarily-federally regulated sources account for almost 50 percent of mobile source NOx emissions in the South Coast Air Basin

* CARB 2020 Mobile Source Strategy pg. 62

Onboard Storage Background

This subprogram targets the development, demonstration, and deployment of cost-effective technologies and systems that improve onboard storage for gaseous transportation fuels. Program projects seek to develop:

- Advanced materials
- Low-pressure systems
- Conformable tanks for hydrogen and RNG



TPRD = Thermally Activated Pressure Relief Device

Credit: Process Modeling Group, Nuclear Engineering Division, Argonne National Laboratory (ANL)

Onboard Storage Research Areas

- Researching improvements in capacity, conformability, safety, and cost of on-board storage of gaseous fuels through conformable and low-pressure tanks
- Research fueling protocols and applications to allow faster and fuller fills for renewable hydrogen

System Targets: Class 8 Tractor-Trailers

Characteristic	Units	Targets for Class 8 Tractors-Trailers	
		Interim (2030)	Ultimate ⁹
Fuel Cell System Lifetime ^{1,2}	[hours]	25,000	30,000
Fuel Cell System Cost ^{1,3,4}	[\$/kW]	80	60
Fuel Cell Efficiency (peak)	[%]	68	72
Hydrogen Fill Rate	[kg H ₂ /min]	8	10
Storage System Cycle Life ⁵	[cycles]	5,000	5,000
Pressurized Storage System Cycle Life ⁶	[cycles]	11,000	11,000
Hydrogen Storage System Cost ^{4,7,8}	[\$/kWh] (\$/kg H ₂ stored)	9 (300)	8 (266)

DOE Hydrogen Heavy Duty Truck Targets
<https://www.energy.gov/sites/prod/files/2020/02/f71/fcto-compressed-gas-storage-workshop-2020-adams.pdf>

On-Road Background

This subprogram targets emissions reductions from medium- and heavy-duty on-road vehicles fueled by renewable hydrogen

“From 2007 to 2017, NOx emissions in the U.S. dropped by more than 40 percent. But there is more work to be done. Heavy-duty vehicles are the largest contributor to mobile source emissions of NOx and will be one of the largest mobile source contributors to ozone in 2025.”

 **100% ZEV sales** by 2035

Full transition to **ZEV short-haul/drayage trucks** by 2035 

Full transition to **ZEV buses & heavy-duty long-haul trucks** by 2045*  

Full transition to **ZE off-road equipment** by 2035*  *where feasible

* CARB 2020 Mobile Source Strategy

On-Road Research Areas

- Research advanced hydrogen fuel cell electric vehicles (FCEV) and zero-emission technologies for medium- and heavy-duty freight and people transportation
- Demonstrate zero-emission vehicles to help improve and assist in the adoption of the technologies

System Cost - Simple Total Cost of Ownership check

Class 8 Long Haul	Diesel Status (2019)	Hydrogen Status (2019)	Diesel 2050	Hydrogen 2050
Fuel Cost (\$/gal diesel or \$/kg H2)	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 Heavy Duty Truck Targets
<https://www.energy.gov/sites/prod/files/2020/02/f71/fcto-compressed-gas-storage-workshop-2020-adams.pdf>

Refueling Stations Background

This subprogram targets the development, demonstration, and deployment of technologies and systems that support refueling for alternative fuels, including gaseous and liquid hydrogen and RNG. Also seek to identify and manage concerns and issues related refueling, including:

- Storage
- Safety
- Standardization



<https://www.dailybreeze.com/2021/06/07/port-of-la-debuts-new-hydrogen-powered-trucks-fueling-stations/>

Refueling Stations

Research Areas

- Research advanced full-fill technologies to resolve issues in CNG and hydrogen fuel cell vehicles.
- Optimization of hydrogen refueling stations looking at improving hydrogen compressors, increasing the efficiency of overall refueling stations, and alternative technologies.

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

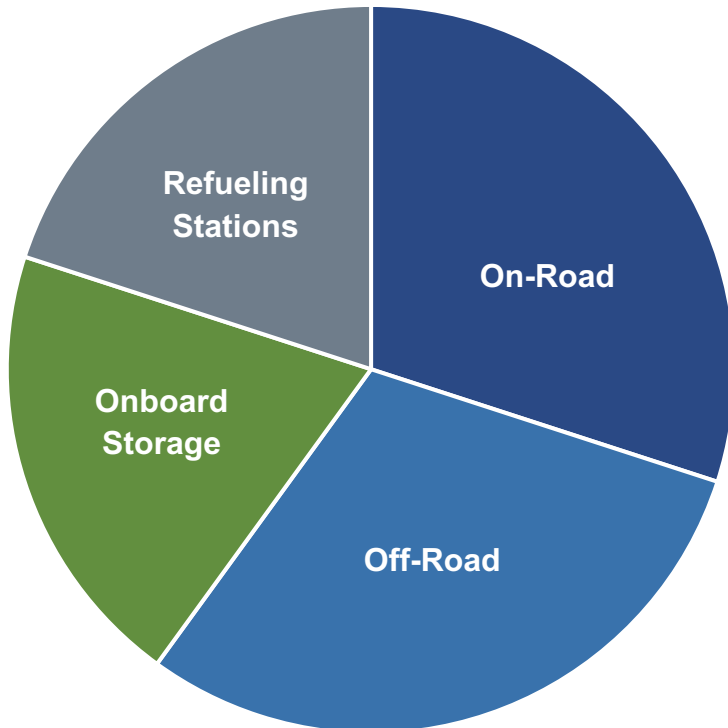
- 6 minutes to fuel 60 kg (10 kg/min)
- 60 kg would equate to ~750 miles assuming fuel economy of 12.4 miles/kg

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
<https://www.energy.gov/sites/prod/files/2020/02/f71/fcto-compressed-gas-storage-workshop-2020-adams.pdf>


Proposed 2023 Funding Allocation



Subprogram	Allocation
Off-Road	30%
Onboard Storage	20%
On-Road	30%
Refueling Stations	20%
Total	\$2,126,124

Feedback

1. What technical hurdles are most urgent to address in order to meet DOE's hydrogen fuel cell tractor technical targets and TCO?
2. For on-board storage, which class of technology (low-pressure, conformable, liquid hydrogen, etc.) should we prioritize to best advance the ZEV market?
3. Which sectors in off-road applications (rail, marine, construction, aviation, etc.) should be priorities for our near-term research?
4. Are other technologies, such as hydrogen combustion engines or ammonia as a fuel, suitable for the Clean Transportation RD&D Program? If so, are there specific applications where these technologies hold the most promise?

A wide-angle photograph of a desert landscape during the "golden hour" of sunset or sunrise. The sky is filled with soft, textured clouds, with the sun low on the horizon to the left, casting a warm, golden glow. A dirt path, marked with small stones, leads from the foreground into the distance. The terrain is rocky and sparsely vegetated with dry shrubs and small trees. In the background, there are prominent rock formations, including a large, rounded boulder on the right side. The overall mood is serene and quiet.

Lunch Break
(12:15 – 1:00)

11. Clean Generation (1:00 – 1:30)

- Overview & Goals
- Subprograms Overview
 - Distributed Generation
 - Integration & Controls
- Proposed 2023 Funding Allocation
- Feedback



Overview & Goals

The Clean Generation RD&D Program focuses on supporting the development and demonstration of high-efficiency, low-emissions power generation technologies for the residential, commercial, and industrial market segments.

Goals

- Improve energy reliability and resiliency
- Reduce emissions of distributed generation (DG) technologies
- Reduce customer energy costs
- Improve integration of emerging distributed generation technologies and renewable fuels in microgrids

Program Summary

In 2021, the Clean Generation Program:

- Supported 32 projects with technical resources and \$2,608,167
- Completed 3 projects
- Initiated 9 new projects

For more details, please read the SoCalGas RD&D Program 2021 Annual Report.



Benefits

GHG Benefit



Improving the efficiency of gas fueled distributed generation (DG) and enabling the utilization of renewable fuels can reduce CO2 emissions.

Emissions Benefit



Projects in this program strive to develop and integrate power generation technologies that can meet or exceed CARB-DG certification requirements.

Cost-Savings Benefit



This program aims to develop DG technologies that are cost-competitive with other technologies of similar resilience levels, and to reduce microgrid implementation costs.

Reliability



DG technologies and microgrids help to ensure customer energy reliability and resilience.

Safety



When energy reliability and resilience are increased, customer safety is improved due to the ability to keep critical equipment (e.g., HVAC, medical equipment, etc.) operating during grid outages.

Operational Efficiency



Projects in this area aim to develop technologies that can optimize onsite energy production and consumption, potentially improving customer energy efficiency.

Policy Alignment

This program strives to reduce emissions from power generation technologies. Projects in this program are in alignment with numerous public policies, including:

- 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 economy by 2045)
- SB 1298 (Distributed generation regulation)
- Self-Generation Incentive Program (SGIP)
- SB 1339: Microgrids for increased electricity reliability
- CA Title 24: Buildings Energy Efficiency

Equity

Low-emissions distributed generation technologies and microgrids improve energy resilience for vulnerable populations.

In addition, deployment of clean generation technologies that replace higher-emission alternatives improves air quality, impacting the health of disadvantaged communities.

“‘It’s not just spoiled food,’ said Samuel Jain, a staff attorney at Disability Rights California. ‘The impact of these power shut offs is great, particularly on the disabled community.’

The RAND Corporation estimated in 2019 that there were at least 176,483 people in California dependent on electricity for their medical treatment.”

- Sacramento Bee

Subprograms

Clean Generation

Distributed
Generation

Develop and enhance low-emission and renewably fueled distributed generation technologies.

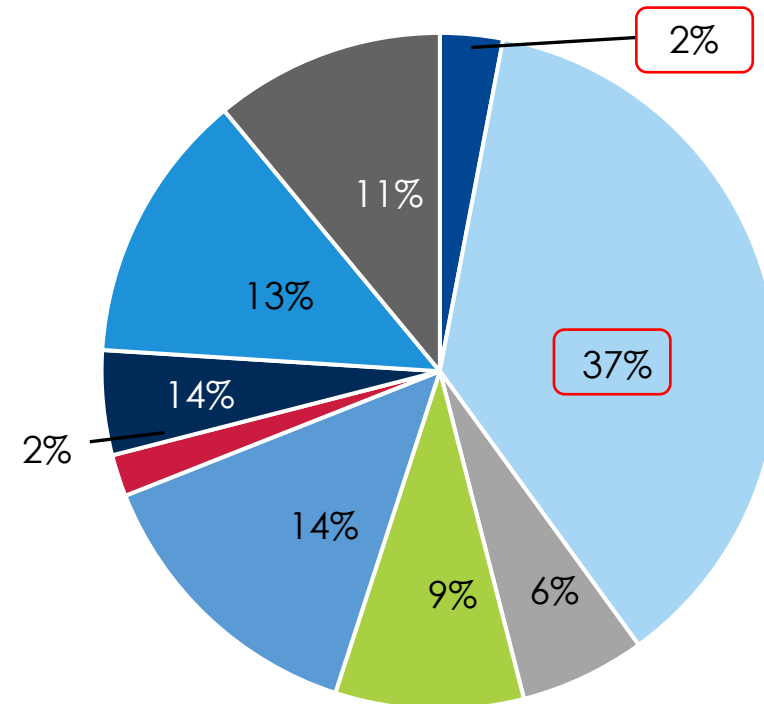
Integration
& Controls

Develop and enhance technologies and control systems that integrate distributed generation and renewable fuels with the electric grid and customer energy systems.

Distributed Generation Background

Develop and enhance low-emission and renewably fueled distributed power generation technologies.

2020 Total System Electric Generation



- Coal
- Natural Gas
- Other
- Nuclear
- Hydro
- Biomass
- Geothermal
- Solar
- Wind

California Energy Commission

Distributed Generation Research Areas

- Developing, testing, and demonstrating small scale (<50kW) fuel cell systems
- Developing, testing, and demonstrating hydrogen blending capabilities in existing natural gas fueled power generation technologies
- Developing, testing, and demonstrating new, low-emissions backup generation technologies

SoCalGas and Bloom Energy Showcase Technology to Power Hydrogen Economy With Gas Blending Project

0 Comments 2 0

By FuelCellsWorks | December 14, 2021 | 5 min read (880 words)

POWERING A HYDROGEN FUTURE Decarbonizing Natural Gas Infrastructure



Table 1: Population and excess emissions from the use of electricity power generators during October 2019 PSPS events.

Generator Type		NOx (tons)	PM (tons)	Diesel PM (tons)	Additional Generators Running in PSPS
Portable	Gasoline Less than 25 hp	24.3	10.6		122,000
	Diesel above 25 hp Non-Rental Generator	7.3	0.30	0.30	381
	Diesel above 25 hp Rental Generator	9.1	0.30	0.30	582
Permitted Stationary Back-Up Generators (Assuming 30% Load Factor)		125.7	8.3	8.3	1,810
Non-permitted generators ²		N/A	N/A	N/A	N/A
Total		166.4	19.4	8.9	124,774

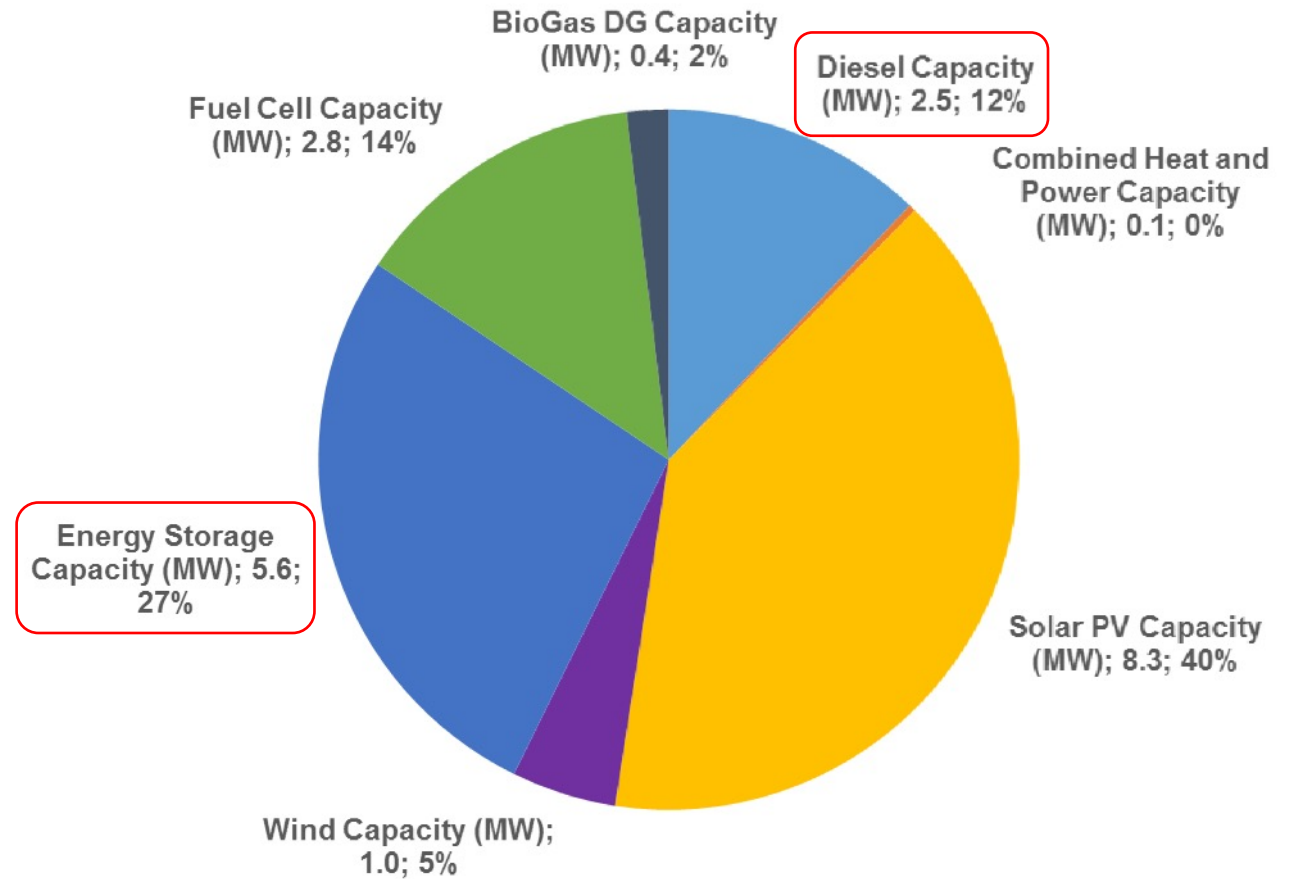
²“Emission Impact: Additional Generator Usage Associated with Power Outage”, CARB, January 2020

Integration & Controls

Background

Develop and enhance technologies and control systems that integrate distributed generation and renewable fuels with the electric grid and customer energy systems.

Figure ES-1: DER Mix of Nine California Case Studies, by Capacity

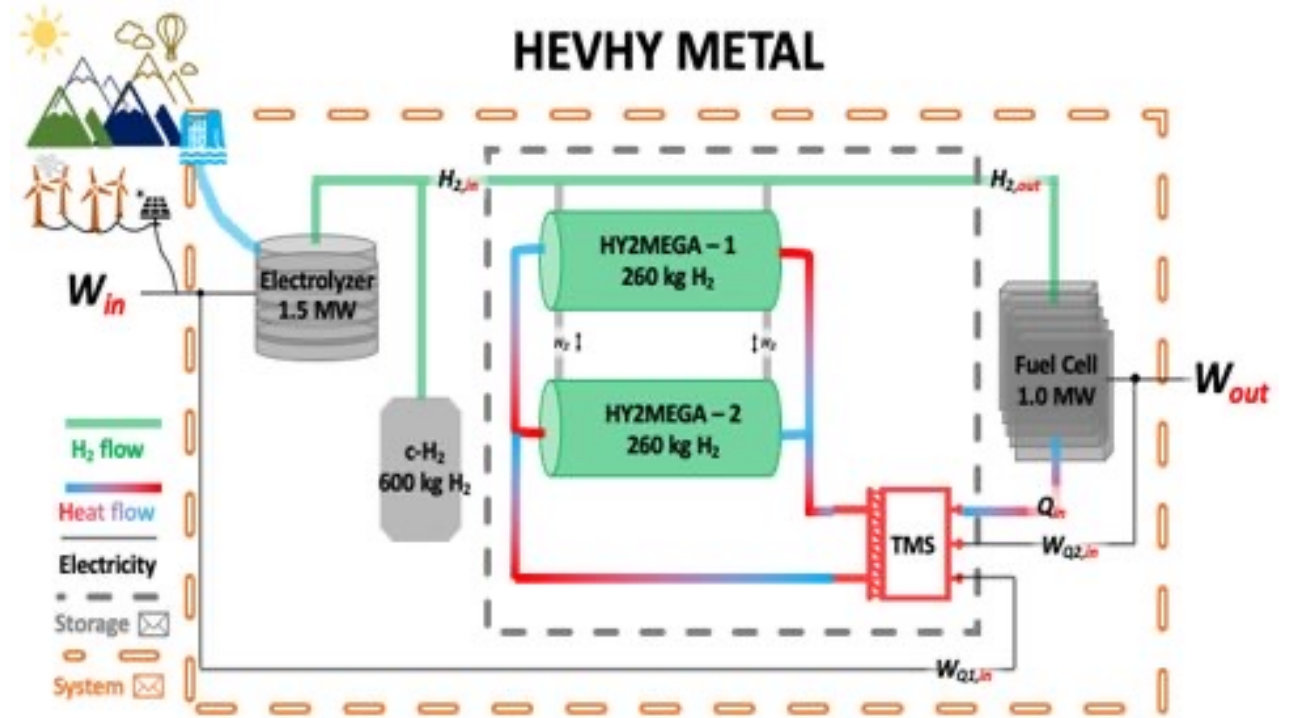


CEC: Microgrid Analysis and Case Studies Report

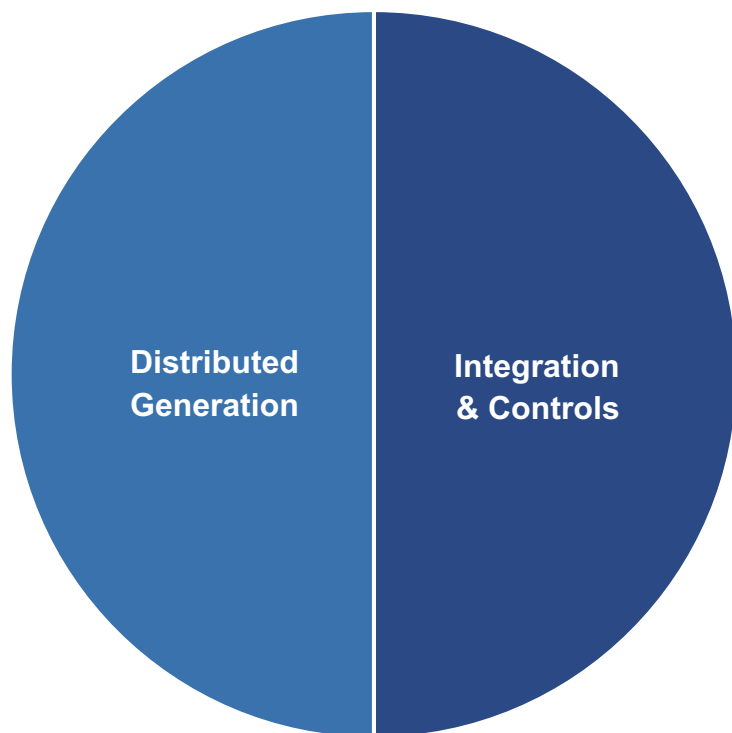
Integration & Controls

Research Areas

- Identify and address challenges with integrating fuel cells with customer energy systems
- Identify and address challenges with integrating backup power with customer energy systems
- Develop and test technologies that increase the overall efficiency and value of CHP systems
- Identify and address cybersecurity concerns with integrated energy systems
- Develop and demonstrate hydrogen energy storage integration



Proposed 2023 Funding Allocation



Subprogram	Allocation
Distributed Generation	50%
Integration & Controls	50%
Total	\$1,670,526

Feedback

1. What specific size should be prioritized for small scale (0–50 kW) fuel cell research?
2. What power generation technologies should we prioritize for hydrogen blending?
3. How should we value resilience when developing technical targets for the Integration & Controls subprogram?
4. What types of customers would benefit most from microgrid demonstrations?
5. What technical specifications would be needed from a hydrogen backup power generation system to fully replace the current functionality of diesel generators?
6. How can this program improve energy equity? What metrics should we use to measure possible improvements?

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

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- ✓ 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.
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12. Customer End-Use Applications (1:30 – 2:00)

- Overview & Goals
- Subprograms Overview
 - Advanced Innovation
 - Commercial Applications
 - Commercial Food Service
 - Industrial Process Heat
 - Residential Applications
- Proposed 2023 Funding Allocation
- Feedback

Overview & Goals

The Customer End-Use Applications RD&D Program focuses on developing, demonstrating, and commercializing technologies that:

Goals

- Cost-effectively improve the efficiency and reduce the environmental impacts of gas end-use applications
- Support the development and deployment of technologies that meet air emissions and energy efficiency goals
- Increase safety and performance while reducing costs for our customers

Program Summary

In 2021, the Customer End-Use Applications Program:

- Supported 95 projects with technical resources and \$2,944,863
- Completed 36 projects
- Initiated 24 new projects

For more details, please read the SoCalGas RD&D Program 2021 Annual Report.

Benefits

GHG Benefit



By reducing energy usage and focusing on solutions that improve air quality, these innovations provide environmental benefits by reducing associated GHG emissions.

Emissions Benefit



By reducing energy usage and focusing on solutions that improve air quality, these innovations provide environmental benefits by reducing associated NOx and PM emissions.

Cost Savings Benefit



Developing new technologies that provide energy efficiency results in lower customer energy costs.

Safety



These innovations increase customer safety by monitoring for equipment failures (e.g., leaks, performance degradations, emissions increases). Reduced fuel consumption, smart air monitoring, and advanced ventilation also improve local air quality.

Operational Efficiency



These innovations aim to provide operational efficiencies by directly targeting building performance and optimizing energy systems to yield the highest total efficiency.

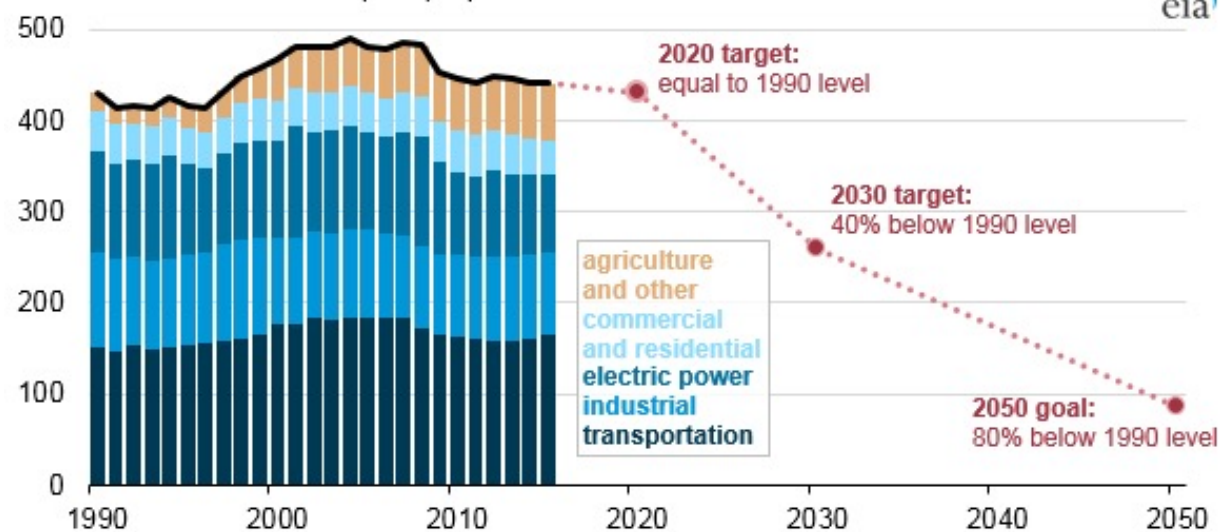
Policy Alignment

This program supports the following policies:

- 2016 AQMP (Air Quality Management Plan, NOx and PM emissions regulation)
- CA Title 24 (Buildings Energy Efficiency)
- CA Title 20 (Appliance Energy Efficiency)
- AB3232 (Building Decarbonization)
- SB32 (Reduce CO2 emissions 40% below 1990 levels by 2030)
- EO B-55-18 (Carbon-neutral California economy by 2045)
- AB617 (Disadvantaged communities for air quality improvements)
- CPUC ESJ Action Plan

Decarbonization Goals

California greenhouse gas emissions by sector (1990-2015) and targets through 2050
million tons carbon dioxide (CO₂) equivalent



Source: <https://www.eia.gov/todayinenergy/detail.php?id=34792>

Equity

Industrial and commercial facilities typically neighbor low-income or disadvantaged communities.¹ Therefore, the Customer End-Use Applications RD&D program aims to improve energy efficiency, develop emissions after treatment, and replace conventional fuels with renewable natural gas and hydrogen, which can significantly reduce the carbon footprint of these facilities and improve regional air quality.

1. <https://www.scientificamerican.com/article/pollution-poverty-people-color-living-industry/>



Source: <https://ww2.arb.ca.gov/our-work/topics/industry-manufacturing>

Subprograms Customer End-Use Applications

Advanced
Innovation

Develops new, non-traditional technologies to improve energy efficiency and decrease emissions.

Commercial
Applications

Develops and enhances technologies and advancements related to gas consumption and end uses in the commercial sector.

Commercial
Food
Service

Develops and enhances technologies and advancements related to commercial food service.

Industrial
Process
Heat

Develops advanced heating technologies and systems for use in the industrial sector.

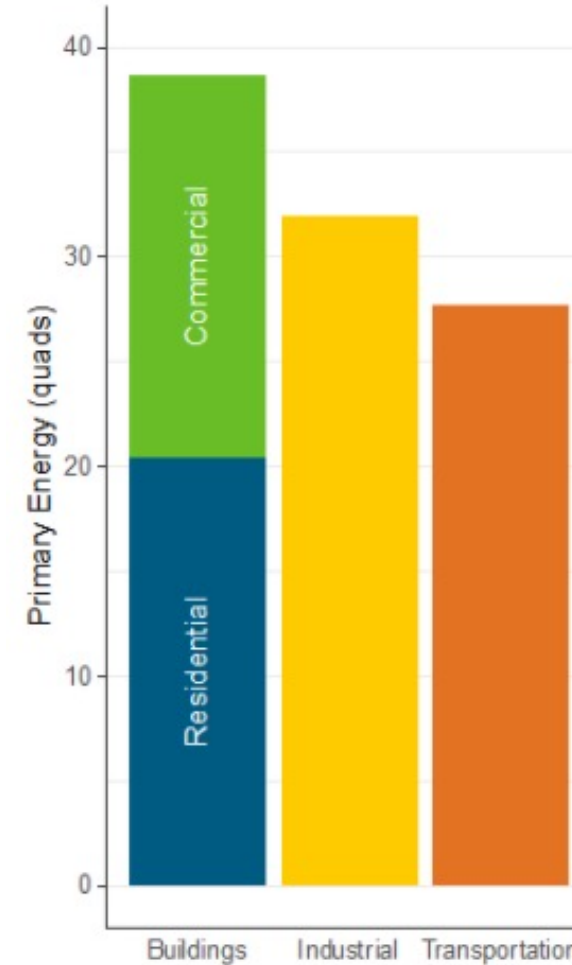
Residential
Appliances


Develops, demonstrates, and enhances technologies and advancements related to gas-consuming appliances in residences.

Advanced Innovation Background

This subprogram seeks to develop new, non-traditional, technologies to improve energy efficiency and decrease emissions. Relevant applications include:

- Smart energy management systems
- Advanced construction technologies
- Machine learning, block-chain, and AI



 **Figure 1: Primary energy consumption in 2018 from residential and commercial buildings was greater than consumption from the industrial or transportation sectors.**

Source: EIA Annual Energy Outlook 2019

Advanced Innovation Research Areas

- Investigating the use of smart technology (smart thermostats, sensors, etc.) to optimize energy efficiency and reduce gas consumption.
- Investigating advanced construction technologies and building materials (e.g., phase change polymers) that can improve energy efficiency in buildings.
- Assess new innovations such as machine learning, block-chain, 3D multi-sensor transmitters, robotics, or augmented reality, for applicability to emissions reduction, increased efficiency, and improved safety.

Technical Targets

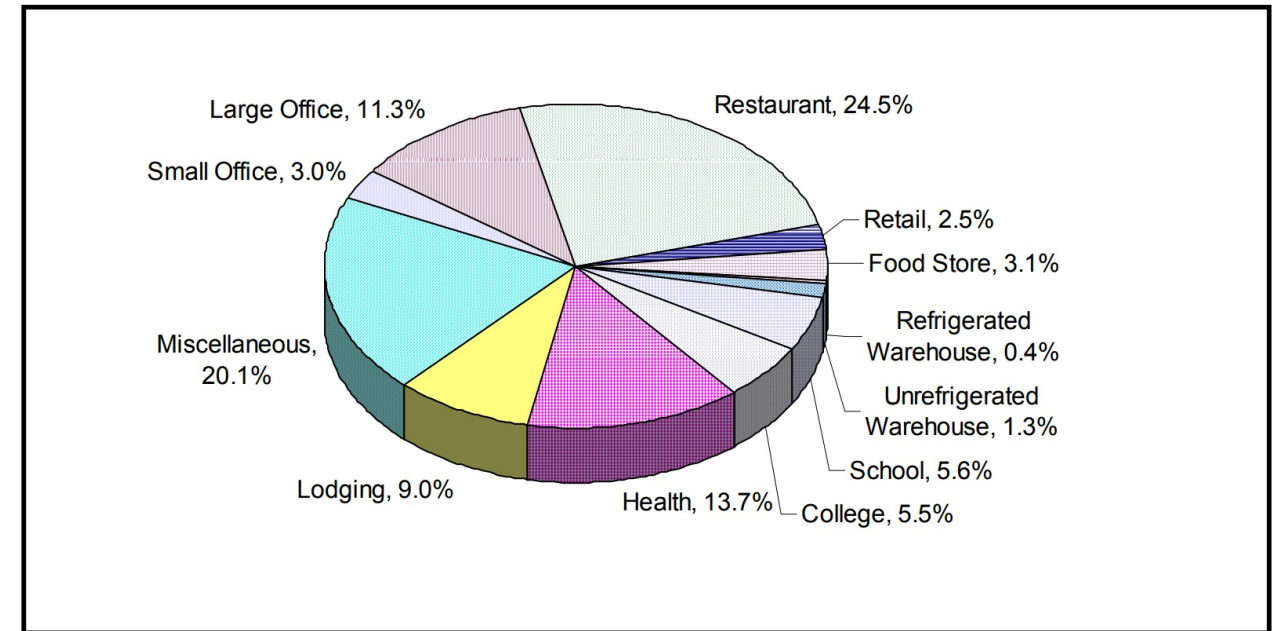
- Highly energy-efficient with low carbon footprints
- Affordable to developers and consumers
- Faster renovation and construction, with less disruption to building occupants
- Added value, such as better indoor air quality, improved comfort, and reduced maintenance

Commercial Applications Background

This subprogram develops and enhances technologies and advancements related to gas consumption and end uses in the commercial sector. Relevant applications include:

- Commercial HVAC
- Hot water service
- Commercial laundry

Figure E-2: Commercial Gas Usage by Building Type

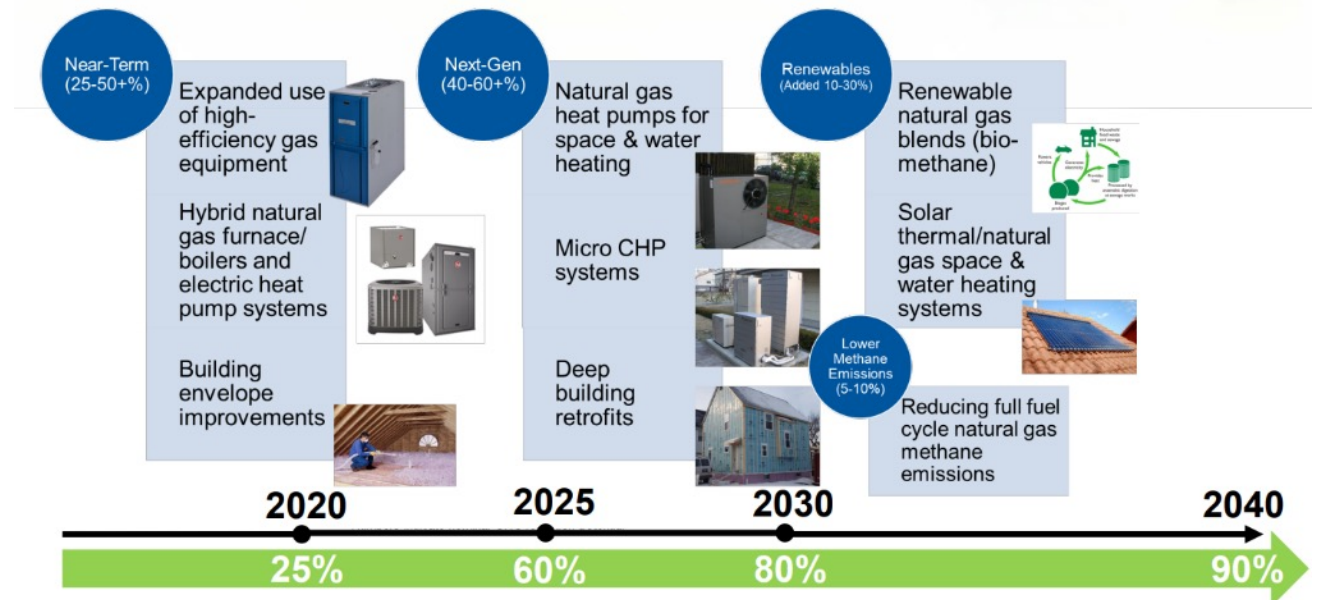


Source: 2006 California Commercial End-Use Survey

Commercial Applications Research Areas

- Hydrogen blends in commercial equipment
- Solar and ground-source heating in commercial applications
- Commercial water heating, space conditioning, and process equipment (e.g., heating, cooling, refrigeration).
- Integrated systems. For example, water heating and space conditioning can be cost-effectively coupled to reduce energy consumption for both (combi functionality).
- Interchangeability between residential and commercial technologies.

Commercial Applications Building Decarbonization R&D Strategy for Building Decarbonization

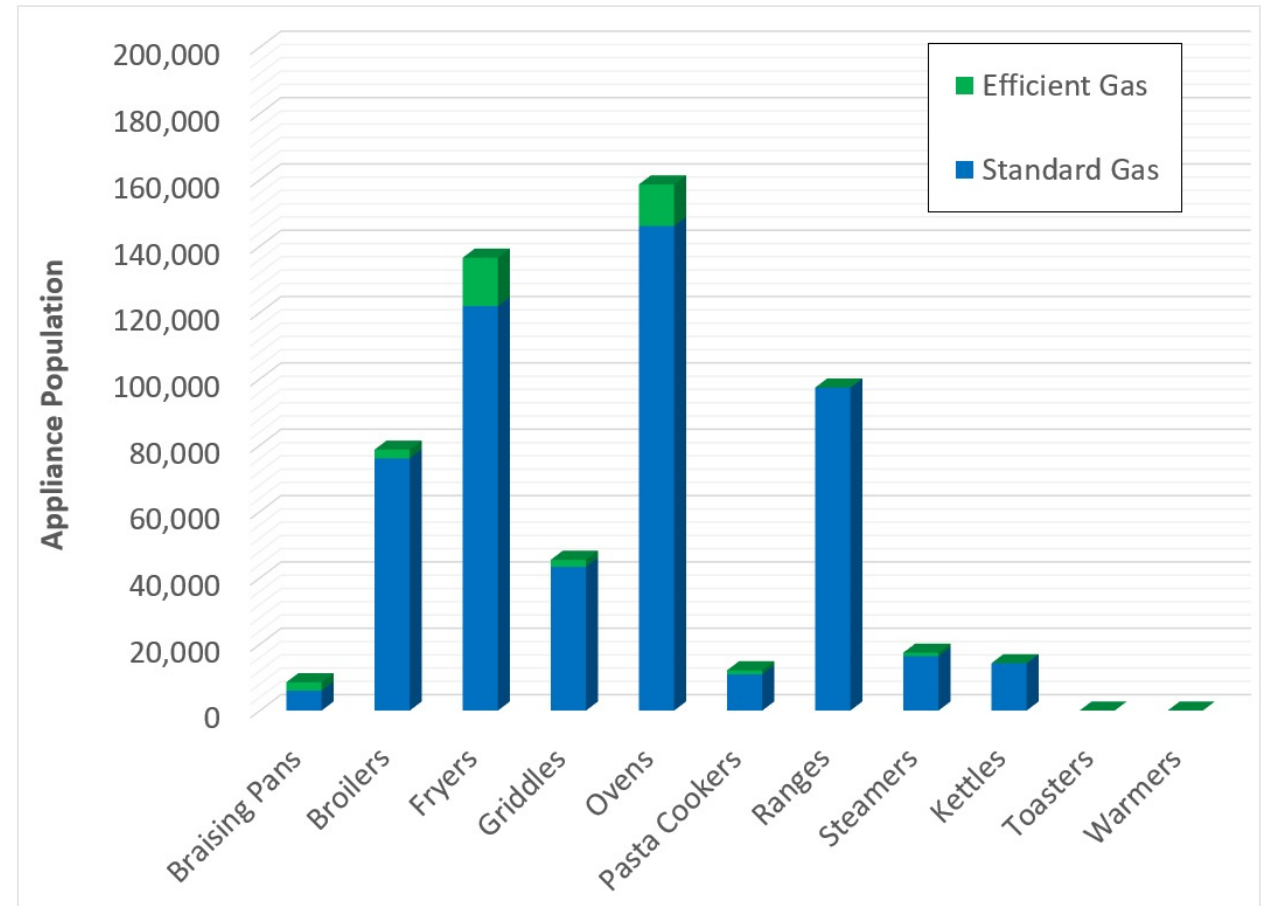


Source: GTI-UTD Material Shared With Permission

Commercial Food Service Background

This subprogram develops and enhances technologies and advancements related to commercial food service. Includes restaurants, catering services, and institutional kitchens that primarily rely on fuel supplied by SoCalGas.

CA Appliance Population vs. Type



Source: GTI CFS Working Group

Commercial Food Service Research Areas

- Hydrogen blends CFS
- Develop next-generation burners, gas heat pump water heaters, and kitchen ventilation systems.
- Increase adoption of new high-efficiency equipment through demonstrations and supporting restaurant operators with educational opportunities, including:
 - Webinars
 - Conferences
 - Journal publications

CFS Appliance Efficiency Table

Appliance Efficiency Table	Standard (%)	Medium (%)	High (%)
Fryer	35	50	57
Griddle	30	38	46
Combi	35	44	56
Steamer	15	38	45
Convection Oven	30	46	52

Source: Frontier Energy Food Service Technology Center (FishNick)

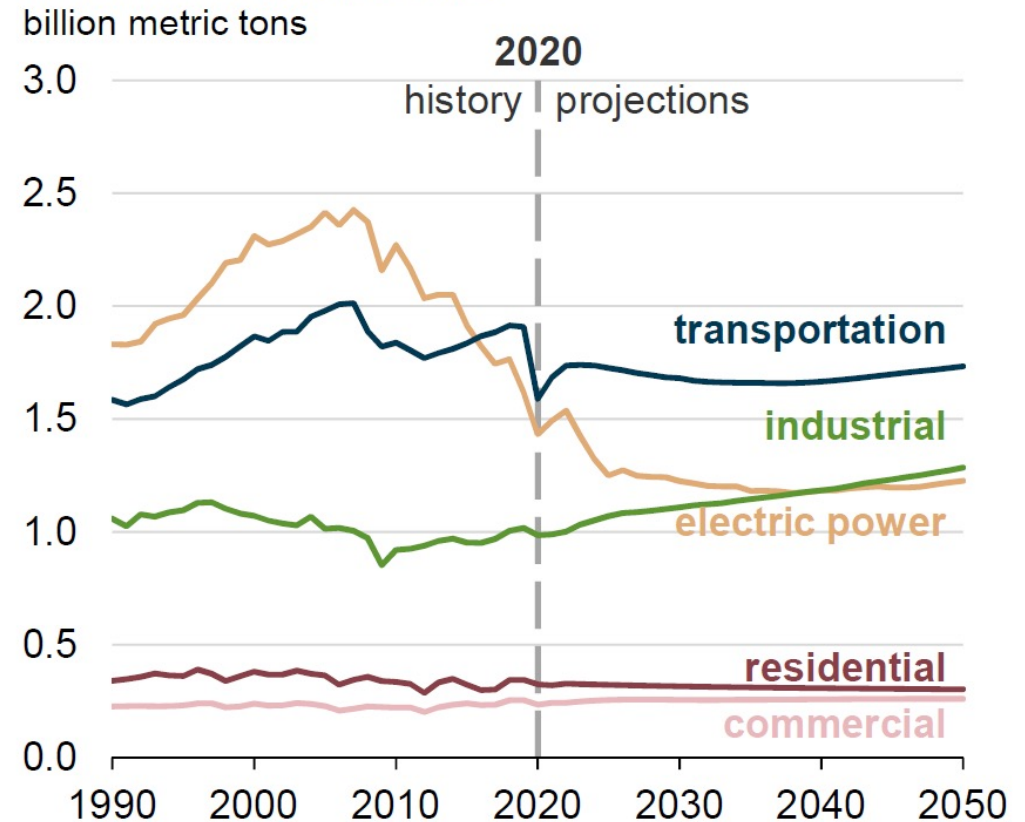
Industrial Process Heat Background

Develop advanced heating technologies and systems for use in high-emissions industrial sectors, which represent some of the largest users of gaseous fuels and the most difficult applications to decarbonize. Example subsectors include:

- Manufacturing
- Cement production
- Chemical processing
- Agriculture

CO2 Emissions By Sector

Energy-related carbon dioxide emissions by sector AEO2021 Reference case



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

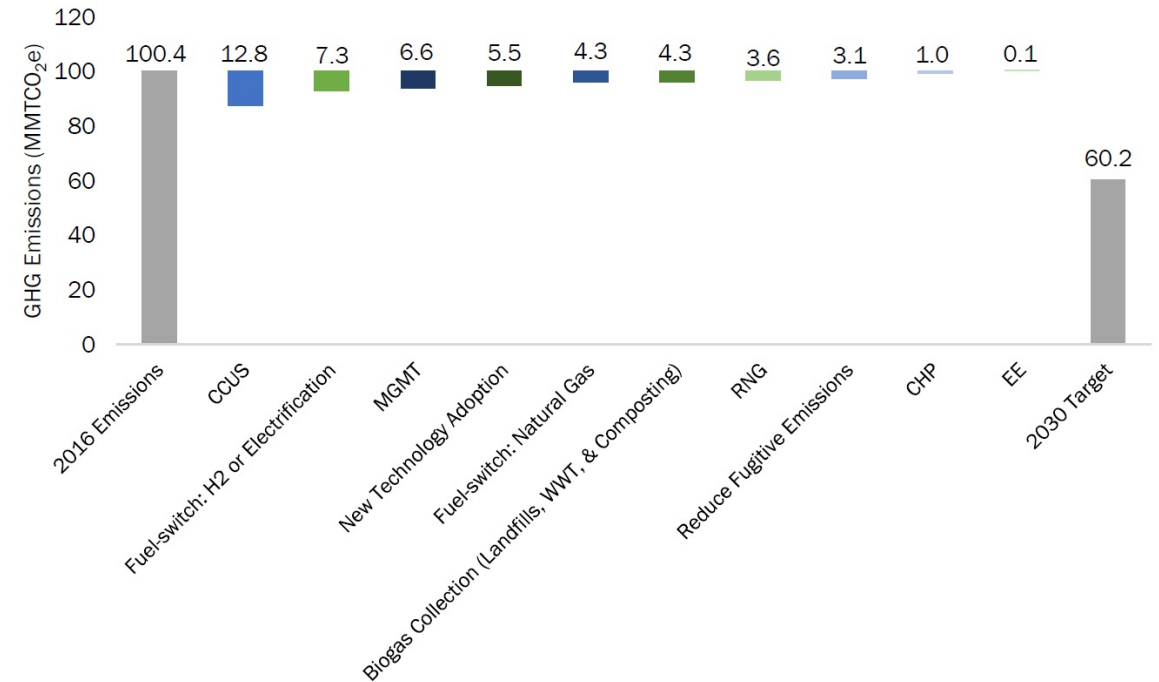
Industrial Process Heat Research Areas

- Hydrogen blends for industrial process heat applications
- Advanced combustion burners, waste heat recovery devices, carbon capture and utilization, energy management systems, and sensors.
- Adoption of new high-efficiency equipment or retrofit options through site demonstrations
- Support industrial customers with education and outreach such as webinars, conferences, and virtual presentations

GHG Emission Reduction Pathway

Figure 4-13

Illustrative Mitigation Portfolio Pathways by Industry Subsector



It is estimated that an emissions reduction of 48.6 MMTCo₂e could be possible by 2030 through a combination of CCUS, fuel-switching, facility best management practices, new technology adoption, biogas collection, RNG, reducing fugitive emissions, CHP, and energy efficiency. Source: EFI, 2019. Compiled using data from CARB, 2018.

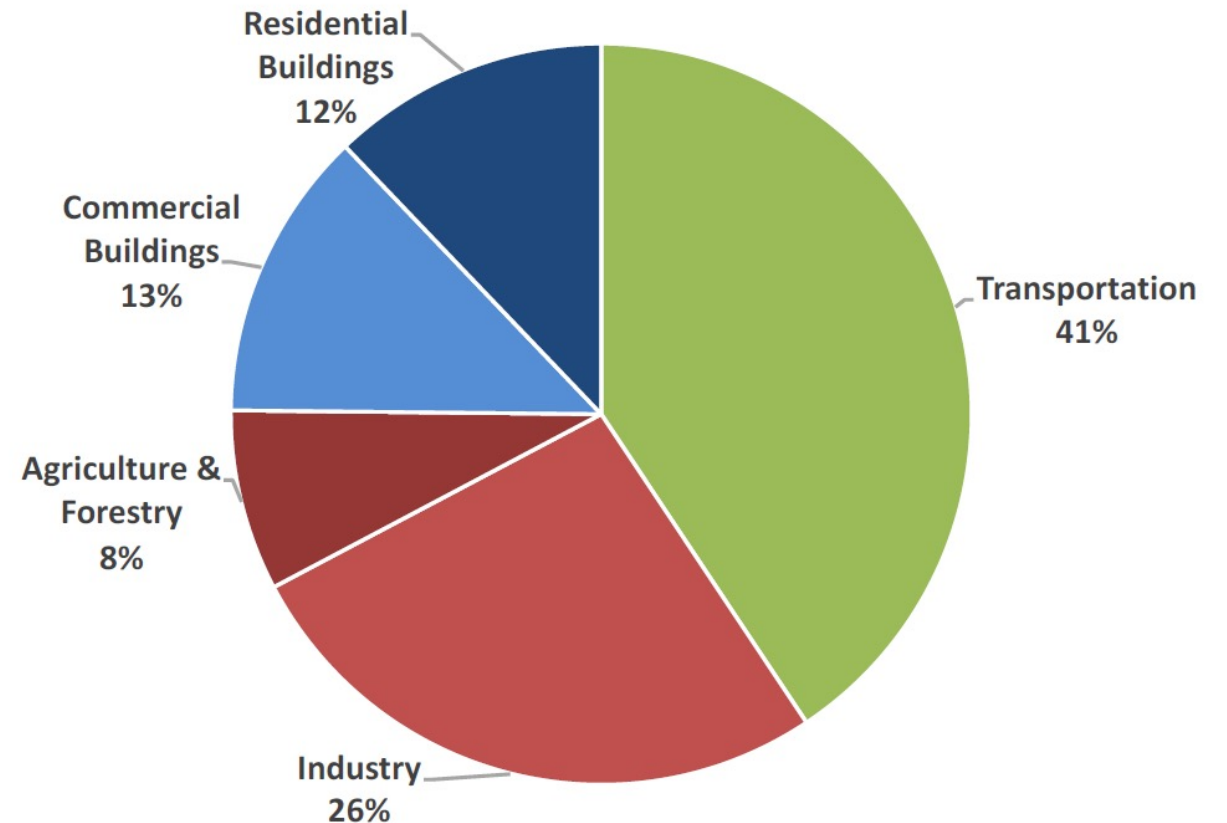
Source: EFI 2019

Residential Appliances Background

This subprogram seeks to develop, demonstrate, and enhance technologies and advancements related to gas-consuming appliances in residences. Relevant appliances include:

- Furnaces
- Hot water heaters
- Stoves
- Ovens
- Dryers

2016 CA GHG Emissions



Source: California Air Resources Board - 2018 Edition California Greenhouse Gas Inventory for 2000-2065 — by Sector and Activity

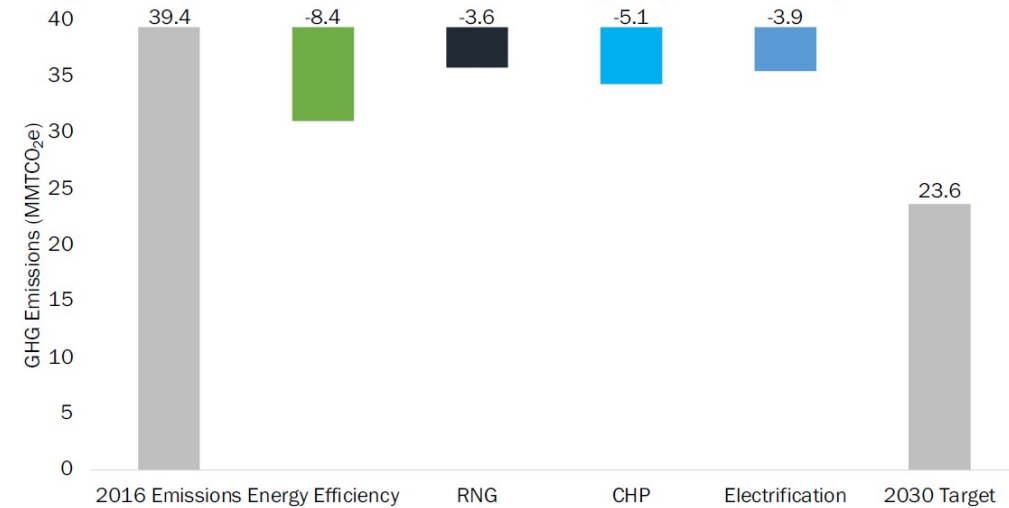
Residential Appliances

Research Areas

- Hydrogen blends for residential appliances
- Develop residential water heating, space heating, and cooking appliances with focus on:
 - Energy Efficiency Improvements 1.0 > UEF
 - Achieve NO_x reduction requirements
- Peripheral Appliances (e.g., outdoor grills, pool heaters, and dryers)

Technical Targets

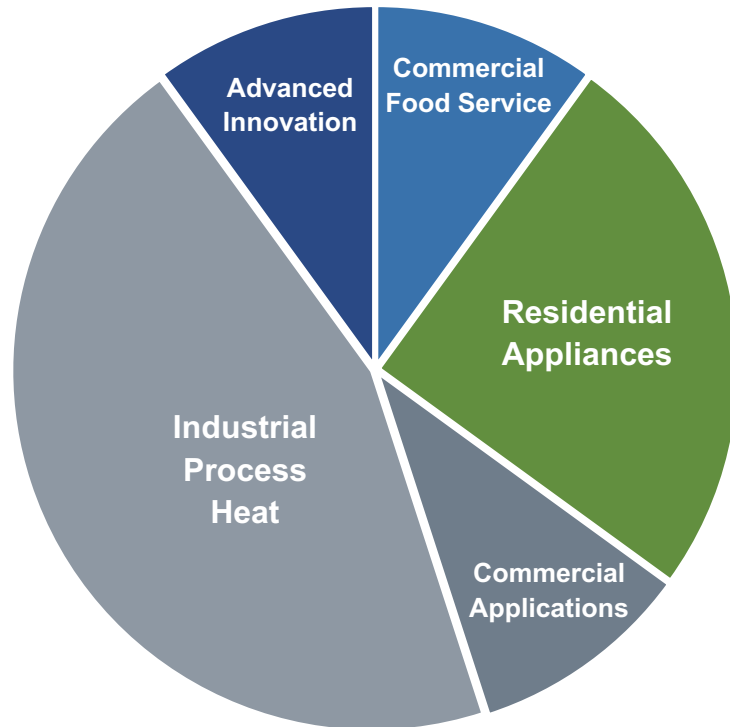
Figure 5-14
Buildings Sector Pathways and 2030 Target (MMTCO_{2e})



The Buildings sector could meet a 40 percent reduction in emissions by 2030 by pursuing energy efficiency measures and utilizing RNG, CHP, and electrification for various commercial and residential end uses. Source: EFI, 2019.

Source: EFI 2019

Proposed 2023 Funding Allocation



Subprogram	Allocation
Advanced Innovation	6%
Commercial Applications	15%
Commercial Food Service	7%
Industrial Process Heat	40%
Residential Applications	32%
Total	\$2,126,124

Feedback

1. What type of appliance or equipment would be valuable to hybridize (i.e., operating on both natural gas and electricity)?
2. What type of application or sector should we consider for point source-carbon capture and utilization?
3. What hydrogen blend levels should we focus on (i.e., 50%+ or pure hydrogen)?
4. What type of industrial sector, equipment, or process should SoCalGas prioritize?
5. Given the breadth of technology that falls under CEUA, are you aware of projects or funding opportunities that SoCalGas could collaborate on and support?
6. Within Advanced Innovation, are there new innovations that we should be aware of and support?

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Questions & Comments (2:00 – 2:35)

- Remaining workshop time will be used for addressing questions and comments.
- Please submit questions in the GoToMeeting questions box or raise your “hand” in the GoToWebinar controls. Please **limit your response to one minute.**
- We encourage you to provide written comments following the workshop. Please submit them to RDDinfo@socalgas.com by Friday May 6, 2022.

A scenic landscape at sunset or sunrise. In the foreground, there are several stalks of purple lupine flowers with green foliage. The middle ground features a rocky shoreline with large, smooth boulders. Beyond the rocks is a calm body of water, likely a lake or reservoir, reflecting the sky. The background shows rolling hills and mountains under a sky filled with soft, white and grey clouds. The sun is positioned low on the horizon, creating a bright sunburst effect with rays of light extending across the scene.

ADJOURN