DOCKETED	
Docket Number:	23-ERDD-02
Project Title:	Gas Research and Development Program
TN #:	254044
Document Title:	Southern California Gas Company Comments - on the CEC Gas R&D FY 2024-2025 Budget Plan
Description:	N/A
Filer:	System
Organization:	Southern California Gas Company
Submitter Role:	Public
Submission Date:	1/19/2024 4:57:00 PM
Docketed Date:	1/19/2024

Comment Received From: Southern California Gas Company
Submitted On: 1/19/2024
Docket Number: 23-ERDD-02

SoCalGas Comments on the CEC Gas R&D FY 2024-2025 Budget Plan

Additional submitted attachment is included below.

Eric Coene
Group Manager
Research, Development and Demonstration
555 West 5th Street
Los Angeles, CA 90013
Tel: (213) 231-3231
Ecoene1@socalgas.com

January 19, 2024

Jonah Steinbuck, Deputy Director
Energy Research and Development Division
California Energy Commission
Docket Unit, MS-4
Docket No. 23-ERDD-02
715 P Street
Sacramento, CA 95814-5512

Subject: Comments on the CEC FY 2024-25 Gas R&D Budget Plan Workshop

Dear Mr. Steinbuck,

Southern California Gas Company (SoCalGas) appreciates the opportunity to provide comments on the December 15, 2023, California Energy Commission (CEC) Fiscal Year (FY) 2024-25 Gas Research and Development (R&D) Budget Plan Workshop. SoCalGas looks forward to continuing our collaborative relationship with the CEC. Coordination with the California research community, including the CEC Gas R&D team, SoCalGas Research Development and Demonstration (RD&D), and other investor-owned utilities (IOUs) is important to complement parallel programs and reduce chances of duplicating work.

SoCalGas provides the following input in response to the CEC's questions posed during the workshop.[1]

General Questions

2. Do you have recommended research approaches or resources?

SoCalGas RD&D can be a valuable resource for CEC. We have conducted projects to demonstrate or de-risk a number of technologies that are aligned with the CEC's proposed initiatives, including fuel-flexible distributed generation (e.g. the Bloom Energy and Caltech coupled electrolyzer and

[1] CEC, "Gas R&D Program FY 2024-2025 Budget Plan" presentation at FY 2024-25 Gas R&D Budget Plan Workshop, December 15, 2023, slide 38, available at: https://efiling.energy.ca.gov/GetDocument.aspx?tn=253632.

fuel cell[2] and various projects with the University of California, Irvine (UCI) on hydrogen blending[3]) and hydrogen deblending and purification (for example, SoCalGas has also conducted a hydrogen de-blending project with HyET Hydrogen at the SoCalGas' Engineering Analysis Center in Pico Rivera, California).[4]

5. Are there other priority areas that the Gas R&D Program should consider? If so, please provide the proposed scope and a justification, including the urgency for the topic.

There are three priority areas that SoCalGas recommends the CEC's Gas R&D program consider, including Carbon Management, Clean Transportation, and Industrial Processes. Regarding carbon management, legacy carbon dioxide emissions from industrialization and transportation in the past century need to be addressed by industry and regulators as a priority with the help of carbon dioxide (CO_2) removal (CDR) technologies. In particular, direct air capture (DAC) offers a pathway to create negative emissions. Research and development of this technology is essential to accelerate scaling and reduce capital and operating costs[5]. Deployment of large, centralized DAC systems can directly benefit environmental and social justice (ESJ) communities by providing an opportunity to shape projects that address community needs, reducing GHGs, generating employment and presenting workforce development opportunities.[6]

Within CDR technologies, there is an innovative pathway where carbon dioxide is removed from the ocean, called direct ocean capture (DOC). The principle of this technology is that, once carbon dioxide is removed from the sea, the CO_2-depleted seawater will further absorb carbon dioxide from the atmosphere, in turn accelerating the CDR process from the atmosphere[7]. This is recognized at the federal level as a viable strategy to significantly mitigate legacy carbon dioxide emissions,[8] and may be a viable opportunity for deployment in California.

---

[2] PR Newswire, "SoCalGas and Bloom Energy Powering Caltech with Innovative Campus Hydrogen Project," December 14, 2023, available at: https://www.prnewswire.com/news-releases/socalgas-and-bloom-energy-powering-caltech-with-innovative-campus-hydrogen-project-302014891.html.

[3] SoCalGas Newsroom, "SoCalGas and the University of California, Irvine Announce Hydrogen Blending Project to Promote Clean Energy and Resiliency Goals," September 9, 2022, available at: https://newsroom.socalgas.com/press-release/socalgas-and-the-university-of-california-irvine-announce-hydrogen-blending-project.

[4] PR Newswire, "SoCalGas to Test Technology that Could Transform Hydrogen Distribution and Enable Rapid Expansion of Hydrogen Fueling Stations," December 16, 2020, available at: https://www.prnewswire.com/news-releases/socalgas-to-test-technology-that-could-transform-hydrogen-distribution-and-enable-rapid-expansion-of-hydrogen-fueling-stations-301194342.html.

[5] U.S. DOE, "Fossil Energy and Carbon Management," accessed on January 17, 2024, p.6, available at: https://www.energy.gov/sites/default/files/2022-07/Carbon-Dioxide-Removal-FAQs_7.8.22.pdf.

[6] *Ibid.*, p.8.

[7] Advanced Research Projects Agency – Energy (ARPA-E), "Direct Removal of Carbon Dioxide from Oceanwater," accessed on January 17, 2024, available at: https://arpa-e.energy.gov/technologies/exploratory-topics/direct-ocean-capture.

[8] U.S. DOE, "DOE Announces $36 Million To Advance Marine Carbon Dioxide Removal Techniques and Slash Harmful Greenhouse Gas Pollution," October 26, 2023, available at: https://www.energy.gov/articles/doe-announces-36-million-advance-marine-carbon-dioxide-removal-techniques-and-slash.

Potential opportunities for carbon dioxide transport as a gas are precluded by the lack of regulation and data regarding impacts of CO_2 on existing and new CO_2 pipeline infrastructure. Research and development in this area is needed to define the technical requirements for the unpinning of a CO2 pipeline management regulatory framework. This will set the foundation of safely and reliably transporting carbon dioxide.

Regarding clean transportation, mobile sources account for 39 percent of greenhouse gas (GHG) emissions[9] and 75 percent of nitrogen oxide (NO_x)[10] emissions in California. The NO_x (and other criteria pollutant) emissions disproportionately impact ESJ communities. Fleets that operate medium- and heavy-duty on-road vehicles do not have suitable zero-emission options to fulfill their range and duty cycle requirements.[11] Development and demonstration of hydrogen fuel cell vehicles that can meet operator's needs should be prioritized to help meet the needs of the medium and heavy-duty transportation sectors. New refueling station technologies need to be developed and demonstrated in order to better serve fuel cell vehicle users. These projects could include station technologies that help improve station throughput and/or reliability. Mobile refueling technology should also be prioritized.

Finally, the decarbonization of industrial energy supply in California offers emission reduction potential of approximately 9 to 22 million metric tons of carbon dioxide equivalent ($MMTCO2_e$)[12] by 2035 and 2045, respectively, according to the California Air Resources Board (CARB) 2022 Scoping Plan. SoCalGas RD&D recently completed a study of this sector to identify the most promising decarbonization technologies. A webinar presenting the results is available on the SoCalGas YouTube channel.[13] That study, conducted by Darcy Partners, identified three priority technology areas: point-source CCUS, distributed hydrogen production & storage, and thermal energy storage. SoCalGas recommends the CEC consider exploring the aforementioned technologies through the Gas R&D program.

[9] CARB, "Current California GHG Emission Inventory Data," accessed on January 17, 2024, available at: https://ww2.arb.ca.gov/ghg-inventory-data.
[10] CARB, "Statewide Emissions," accessed on January 17, 2024, available at: https://ww2.arb.ca.gov/applications/statewide-emissions.
[11] CARB announces that is does not plan to enforce the drayage or high-priority fleet provisions of the Advanced Clean Fleet. See article for more information: https://ww2.arb.ca.gov/resources/fact-sheets/advanced-clean-fleets-regulation-vehicle-delivery-delay-extension.
[12] CARB, "2022 Scoping Plan," December 2022, p. 138, available at: https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf.
[13] SoCalGas, "Industrial Decarbonization – Priority Technical Spaces," YouTube, November 16, 2023, available at: https://www.youtube.com/watch?v=DiOUU1wAI1g.

Fuel-Flexible Distributed Power Generation

3. What are the most promising innovations, applications, and technology priorities for fuel-flexible distributed generation?

A technical priority for fuel-flexible distributed generation is NO_x emission control. One specific example of this priority involves pursuing retrofittable solutions for fielded microturbines. The goal is to enable the operation of dispatchable, flexible combustion distributed generation with up to 100 percent hydrogen while achieving NO_x emission levels comparable to those of existing commercial natural gas-fueled systems. Supported by SoCalGas RD&D, ongoing hydrogen blending research at UCI seeks to investigate the impact of various parameters on NO_x emissions in microturbines. Preliminary findings may indicate a correlation between poor mixing and elevated NO_x levels. Notably, modified injector geometries may produce significant improvements in mixing and subsequent reductions in NO_x levels.[14] Additionally, the research has produced a time-efficient modeling tool designed to guide injector design and optimization efforts toward the realization of low-emission concepts. Further research and testing are necessary to validate the promising NO_x reduction results obtained with the modeling tool.

Fuel-flexible distributed generation holds promise as another innovative solution to decarbonize the current gas grid. Currently, a project underway at Caltech and supported by the SoCalGas RD&D program illustrates the potential of hydrogen to serve as a robust solution for long-duration clean energy storage and dispatchable power generation. This initiative highlights the possibility of utilizing existing gas infrastructure by blending hydrogen with electrolyzers and fuel cell technology, thereby creating microgrids capable of delivering resilient and decarbonized power.[15] Another promising innovation on the horizon involves zero-emission stationary generators. With the backing of SoCalGas RD&D, Noble Thermodynamic Systems is spearheading the development of a retrofit for existing stationary engine reciprocating engine plants. This retrofit holds significant potential to enhance plant efficiency by eliminating both greenhouse gas (GHG) and NO_x emissions. The promising nature of this zero-emission technology is underscored by its recent selection for funding by the CEC to participate in the HyBLOX program (GFO-22-504). This financial support will be instrumental in advancing and showcasing the technology's capacity to operate efficiently on high blends of hydrogen while effectively mitigating emissions.

4. To what extent are you seeing combustion vs. non-combustion technologies as part of fuel flexible distributed generation in the near- and medium-term?

SoCalGas believes a viable near-term strategy is to retrofit existing combustion technologies to accommodate blends of hydrogen in the fuel supply. These retrofits are comparatively less costly than replacing entire generation units with new technology, and the upgrades can be made relatively quickly, helping to advance decarbonization of existing assets. In the medium-term, we expect more non-combustion technologies to become available (*e.g.*, fuel cells). Examples of this

[14] Research results are currently under scientific review.

[15] *Supra,* PR Newswire, "SoCalGas and Bloom Energy Powering Caltech with Innovative Campus Hydrogen Project."

can be seen in the work SoCalGas RD&D has completed with Bloom Energy at Caltech, with fuel cells for data centers at UCI[16], and with the residential fuel cell assessment at Gas Technology Institute (GTI) Energy[17].

5. What gaps are there from private sector investment for advancing fuel-flexible generation that are best addressed by the state?

Large-scale field demonstrations require that the infrastructure accept large amounts of trucked-in hydrogen and the infrastructure to blend that hydrogen with natural gas. Given the absence of private sector investment in this area, the CEC is well positioned to provide the hydrogen blending infrastructure and to provide funding for the large quantities of hydrogen required for these projects.

Hydrogen De-blending and Purification

1. Should this research be pursued in the near term? Or wait for clearer policy direction regarding hydrogen blending on a broader scale?

This type of research is needed today in order to help the State meet its pressing goals of carbon neutrality by 2045, as well as SB 100 and SB 32. In fact, conducting the research can help to inform the regulators setting policies, analyzing possible scenarios that are economically and technically feasible. R&D helps to inform more robust policymaking and better policy decisions.

3. Is there additional demand for this technology, aside from the use cases discussed in previous slides?

Electrochemical hydrogen separation can also be used for hydrogen compression, for example at a hydrogen fueling station with on-site electrolysis. Solid state compression could improve fueling station reliability. Some natural gas customers use methane as a feedstock for chemical production processes. These customers are known as "feedstock customers," and often cannot utilize hydrogen in their operations. These customers would benefit from deblending upstream from their meters. Also, consider distributed power generation using hydrogen fuel cell power generators. These units could use hydrogen de-blended from the pipeline to produce zero emissions (GHG and NOx) power for microgrids or backup power applications.

4. What are some resources that can help further inform this research initiative?

The CEC can refer to SoCalGas's HyET demonstration which field tested a technology that can simultaneously separate and compress hydrogen from a blend of hydrogen and natural gas. At

[16] SoCalGas, "2019 Annual Report Fostering Breakthrough Innovation Research, Development, And Demonstration Program," accessed on January 17, 2024, available at: https://www.socalgas.com/sites/default/files/2021-10/2019-SoCalGas-RDD-Annual-Report.pdf#page=[27].

[17] Utilization Technology Development (UTD), "Research Project Summaries 2022-2023, accessed on January 17, 2024," available at: https://www.utd-co.org/wp-content/uploads/2024/01/UTD-Annual-Report-Research-Project-Summaries-2022-2023.pdf#page=[65].

scale, the technology would allow hydrogen to easily be transported via the natural gas pipeline system, then extracted and compressed at fueling stations that provide hydrogen for fuel cell electric vehicles (FCEVs).[18]

HyET's technology can be designed to achieve simultaneous purification and deblending (from mixtures of nitrogen (N_2), hydrocarbons (C_xH_y) and trace amounts of carbon monoxide and carbon dioxide) and compression of hydrogen, up to >900 bar. The SoCalGas RD&D demonstration ran for approximately 9 months and tested a variety of blending percentages (2 to 20 percent hydrogen in methane) at a flow capacity of 10 kilograms (kg) of hydrogen per day operating at an approximately 6000 pounds per square inch gauge (PSIG). Depending on blend level, extraction typically consumed 4 to 8 kilowatt hours (kWh) per kg hydrogen and compression consumed 2 to 8 kWh per kg hydrogen. HyET and Baker Hughes also have a collaboration to combine HyET's electrochemical hydrogen compression technology with Baker Hughes' compression technology across a variety of pressure applications to grow and accelerate the hydrogen market.[19] The insights and experiences gained by SoCalGas RD&D through these demonstrations can be used to inform future research and projects.

5. What are some promising innovations that can further improve separation efficiency, durability, and performance with low hydrogen concentrations?

SoCalGas RD&D is supporting a project, directed by Caltech researchers and funded by Advanced Research Projects Agency- Energy (ARPA-E), that seeks to develop a hybrid electrochemical/catalytic approach for direct generation of high-pressure hydrogen. Caltech's proposed system has the potential to reach <$2 per kg of hydrogen produced and compressed at 700 bar using renewable energy sources. The proposed catalytic compression is estimated to require lower capital expenditures and operating expenses and has much better scalability than incumbent technologies. The team estimates a cost of $0.19 per kg hydrogen for compression to 700 bar, representing a >80 percent reduction compared with state-of-the-art.[20]

Networked Geothermal District Heating Study

2. What are the major obstacles that prevent wider adoption of geothermal heating in California?

The two major obstacles that prevent wider adoption of geothermal heating in California are brine production and seismic concerns. Geothermal wells often produce brine contaminated with materials that are potentially toxic (e.g., heavy metals) and costly to dispose of. Drilling to geothermal depths in populated areas could raise seismic concerns.

[18] *Ibid.,* PR Newswire, SoCalGas Hydrogen Distribution Technology.
[19] HYET, "HyET Hydrogen and Baker Hughes Sign Strategic Collaboration Agreement," December 20, 2023, https://hyethydrogen.com/news/hyet-hydrogen-and-baker-hughes-sign-strategic-collaboration-agreement/.
[20] ARPA-E, "California Institute of Technology (Caltech)," accessed on January 17, 2024, available at: https://arpa-e.energy.gov/technologies/projects/improving-solar-generation-efficiency-solar-modules.

4. What type of business models (e.g., gas utilities) could best leverage these (>120 degrees F) geothermal heating resources?

Gas utilities are already positioned to provide fuel for heating purposes (customers are billed per therm of energy delivered). Utilities are also skilled at deploying, maintaining, and operating large infrastructure projects and would be well positioned to provide this type of product.

Conclusion

SoCalGas provides our feedback in the hopes of helping to advance the CEC Gas R&D Research Program's goals. We believe the insights and experiences we have gained through our demonstration projects can help inform and support the CEC's targeted research areas. In addition, we believe it is important for the California research community to coordinate in order to complement each other's programs, reduce the chance of duplicating efforts, and maximize ratepayer value. We look forward to continued work with the CEC on research efforts. Thank you for your consideration of our comments.

Respectfully,

/s/ Eric Coene

Eric Coene
Group Manager
Research, Development and Demonstration