CALIFORNIA
ENERGY COMMISSION

Energy Research and Development Division

STAFF REPORT

Natural Gas Research and Development Program

Proposed Budget Plan for Fiscal Year 2020-21: Appendices

Gavin Newsom, Governor

April 2021 | CEC-500-2020-081-APA-B

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APPENDIX A:
Staff Presentation January 21, 2020

FY 2020-2021 Proposed Natural Gas Research Initiatives

Stakeholders Workshop

Energy Research and Development Division

ERDD Staff

January 21, 2020

California Energy Commission

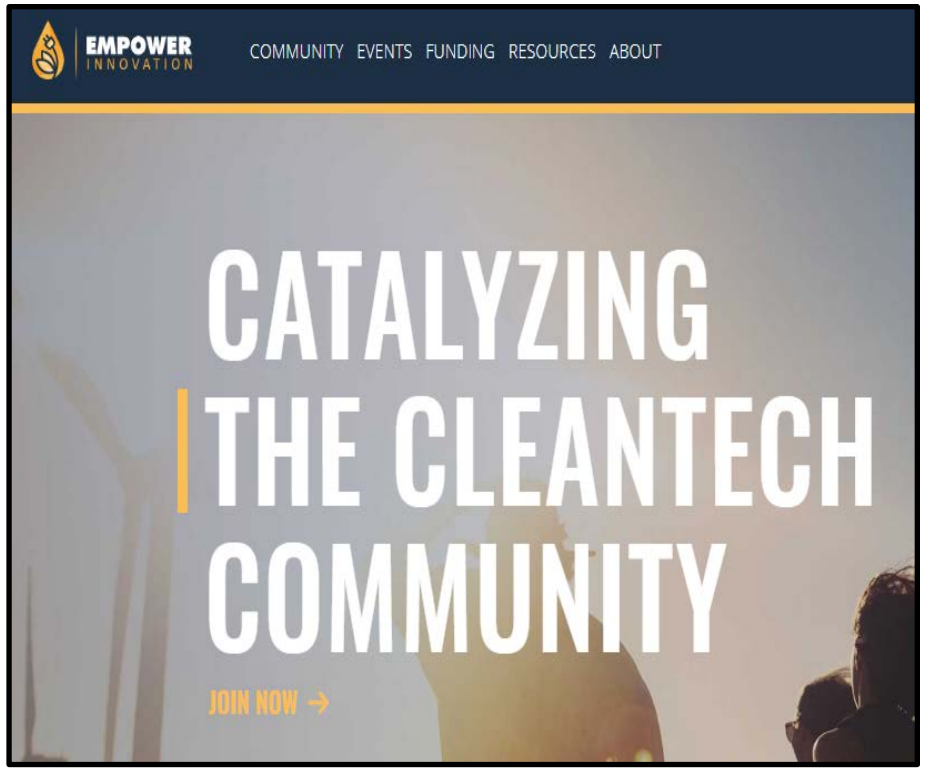
Agenda

Time	Item
9:00 am	Introduction and Purpose
9:30 am	Staff Presentations on Proposed Initiatives • Renewable Energy and Advanced Generation • Natural Gas Infrastructure Safety and Integrity • Energy Efficiency • Transportation Research • Energy-Related Environmental Research
11:30 am	Public Comments

Housekeeping

- In case of emergency
- Facilities
- Sign-in sheet

Connect With Us



Commitment to Diversity

The Energy Commission adopted a resolution strengthening its commitment to diversity in our funding programs. We continue to encourage disadvantaged and underrepresented businesses and communities to engage in and benefit from our many programs.

To meet this commitment, Energy Commission staff conducts outreach efforts and activities to:

- Engage with disadvantaged and underrepresented groups throughout the state.
- Notify potential new applicants about the Energy Commission's funding opportunities.
- Assist applicants in understanding how to apply for funding from the Energy Commission's programs.
- Survey participants to measure progress in diversity outreach efforts.

Introduction

- Energy Commission R&D Program staff are holding this workshop seeking stakeholder comments on natural gas research initiatives for the Natural Gas FY 2020-21 budget plan.
- Specific “Questions for Stakeholders” will be posed during the workshop.

General Approach

- Identify research gaps for research initiatives through:
  - Discussion with utilities, public stakeholders, state and federal governmental agencies, other CEC programs;
  - Roadmaps;
  - Public meetings with industry and trade associations; and
  - Research ideas submitted by the public
- Research projects are selected through competitive solicitations
- Energy research priorities are guided by policy directives
- Need clearly identified benefits

Policy Drivers

- **Energy Action Plan**
  - Establishes goals to ensure adequate, reliable, and reasonably-priced natural gas supplies are achieved through policies, strategies, and actions.
- **EO B-55-18**
  - Establishes statewide goal to achieve carbon neutrality as soon as possible and no later than 2045.
- **SB 32**
  - Reduce GHG emissions to 40% below 1990 levels by 2030.
- **SB 100**
  - Requires 100% of retail electricity sales be met by renewable and zero carbon resources.
- **SB 1250**
  - *Public Goods Utilities* surcharge to support public interest for research and development.
- **SB 1383**
  - Reduce emissions of short-lived climate pollutants, including those from dairies, organics disposal, and waste water treatment plants.

FY 2020-21 Initiative Development

FY 2020-21 Natural Gas proposed research initiatives are framed around ***decarbonization***.

<u>Three primary areas:</u>

- Hydrogen
- Decommissioning/Electrification
- Safety and Integrity

Research Initiative Feedback

Here at the California Energy Commission we're always working to make our research initiatives better. Now, that you're here we would like to hear your thoughts.

Please provide feedback to our questions after each research area initiative presentation or email your comments to Nicole Dani at nicole.dani@energy.ca.gov by Friday, **January 24, 2020.**

CALIFORNIA ENERGY COMMISSION

Renewable Energy & Advanced Generation

Renewable Energy & Advanced Generation

Program Goals:

Reduce barriers, increase the amount of renewable energy in the grid, and reduce dependence on fossil-derived natural gas by:

- Advancing the development and market availability of clean and efficient distributed generation (DG) and renewable combined heating, cooling and power (CCHP) technologies.
- Developing cost-effective hybrid generation, fuel-flexible, energy-efficient, and low-emission DG technologies for renewable alternatives and natural gas.
- Accelerating decarbonization by developing technologies for the conversion, cleanup, and upgrading of biogas to renewable gas as well as demonstrating diversified applications of advanced generation technologies that use renewable gas.

Renewable Energy & Advanced Generation

Research Portfolio

- **Clean and Efficient Distributed Generation/Combined Heat and Power, including Waste Heat to Power Systems**
  - High compression ratio free piston engine for CHP
  - Novel CHP systems for cost and efficiency improvements, e.g. solar-CHP for electricity, hot water and space heating
  - Small-scale CCHP systems with thermally-driven cooling and/or thermal energy storage
  - Waste heat to power systems at industrial facilities for efficient use of natural gas
- **Decarbonization Solutions via Biogas and Renewable Gas**
  - Advancing cost-effective biogas production, cleanup, and upgrading to renewable gas
  - Solid-state low-pressure upgrading of biogas; optimizing micronutrients and operating methods; using biogas for heat, power and vehicle fuel
  - Cost-effectively convert California's forest biomass into pipeline-quality renewable natural gas

Image of combined heat and power engine. Source: EtaGen, Inc.

Photograph of solar combined heat and power system. Source: UC Merced

Renewable Energy & Advanced Generation

Research Portfolio

Cost Reduction for Biogas Upgrading via a Low-Pressure Solid-State Amine Scrubber

- **Recipient:** Mosaic Materials, Inc.
- **Project Goal:** Develop a solid-state amine scrubbing technology for biogas upgrading that provides a 40% reduction in capital and operating costs compared to current state-of-the-art scrubbers; increase efficiency and reduce the cost of removing contaminants from biogas and upgrade to pipeline quality renewable natural gas.
- **Highlights:**
  - Formulated sorbent material (called metal organic framework or MOF); scaled up production; and tested over long term repeated cycling.
  - Removed CO2 down to ≤2% for 1000+ cycles without capacity loss
  - Process shows 38% reduction in OpEx, 14% reduction in CapEx vs. standard chemical scrubbing system
  - New technology will enhance biomethane production and support CPUC's NG R&D Guidance and Resolution
  - Mosaic received follow on funding from DOE to demonstrate the technology at a wastewater treatment plant

Sample of composite metal-organic framework pellets for exposure testing (top); tableted Gen-1 metal-organic framework adsorbent (bottom-left); Slipstream testing apparatus at the biogas site (bottom-right)

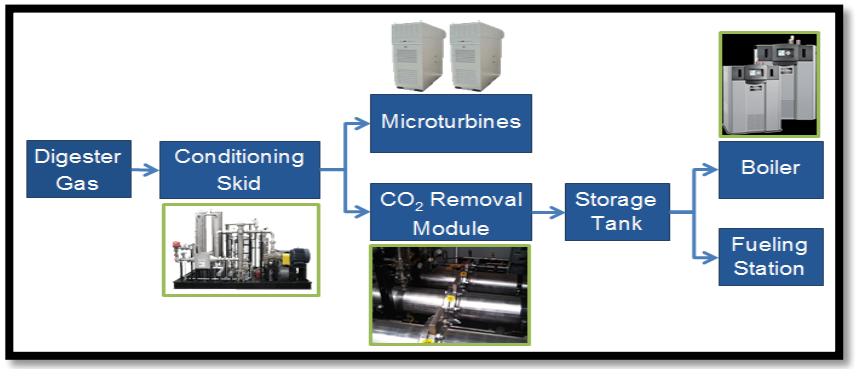
Source: Mosaic Materials, Inc.

Renewable Energy & Advanced Generation

Research Portfolio

Biogas Energy Recovery System

- **Recipient:** Las Gallinas Valley Sanitary District
- **Project Goal:** Install and operate a pre-commercial biogas energy recovery system at a small wastewater treatment plant (WWPT)
- **Highlight:**
  - Utilizes a biogas cleanup skid, microturbines, hydronic boiler, and a compressed natural gas (CNG) refueling station
  - New system replaces aging internal combustion engine and diesel-fueled vehicles with cleaner, more efficient technologies.
  - Combines existing technologies in a configuration new to California and at a small WWTP
  - Utilizes 100% of biogas produced by the existing digester to provide renewable electricity, heat, and transportation fuel
  - Replaces diesel vehicles with cleaner CNG vehicles



Simplified schematic of the biogas energy recovery system.

Photograph of microturbines, gas cleanup system, and digester.
Source: Las Gallinas Valley Sanitary District

Proposed Research Initiatives

Renewable Energy & Advanced Generation

- Decarbonization via Efficient and Cost-competitive Renewable hydrogen and Biomethane (DECARB)
  - Emerging Renewable Hydrogen Production
  - Emerging Gas Cleanup and Upgrading for Biomethane
- Demonstrate Geothermal Heating and Cooling for Low Income and Disadvantaged Communities

Renewable Energy & Advanced Generation

Proposed Research Initiative:

Emerging Renewable Hydrogen Production

Background:

- Hydrogen is clean alternative to fossil natural gas.
- Producing hydrogen through emerging electrolysis and renewable pathways remains costly.
- This initiative will advance the cost-competitiveness of producing renewable hydrogen.

Technology	Output Capacity (HHV basis)	Conversion Efficiency H2 out/Energy in (HHV)	Capital Cost ($/kW)	Levelized Costs ($/kg)
Steam methane Reforming (SMR)	400-700 MW	72%	380-480	1.7
Coal Gasification	160-820 MW	56%	940-1780	1.3-1.7
Biomass Gasification	32-320 MW	48%	700 -1200	2.1-2.3
Biogas via SMR	500-1000 MW	-	-	3.14-3.81
Water electrolysis Alkaline Photon Exchange Membrane Solid Oxide	 +150 MW +1 MW Lab Scale	 65-82% 65-78% 80-90%	 800-1500 1500-3800	 4.1-5.1 4.1-5.5 2.8-5.8

Hydrogen Production Costs for Different Technologies.

Source: Ogden, JM. 2018, https://escholarship.org/uc/item/52s28641

Purpose of Research

Emerging Renewable Hydrogen Production

Issues:

- California's industrial, commercial, and residential sectors consume two-thirds of natural gas and generate one-third of GHG emissions.
- Conventional method of hydrogen production.
  - Low cost, but emits GHGs
- Advance renewable hydrogen production to be competitive with conventional pathway(s).
  - Electrolysis and renewable hydrogen pathways need cost reductions to be competitive
  - Support new reforming methods using renewable feedstock, fermentation, and photolysis

Research Description

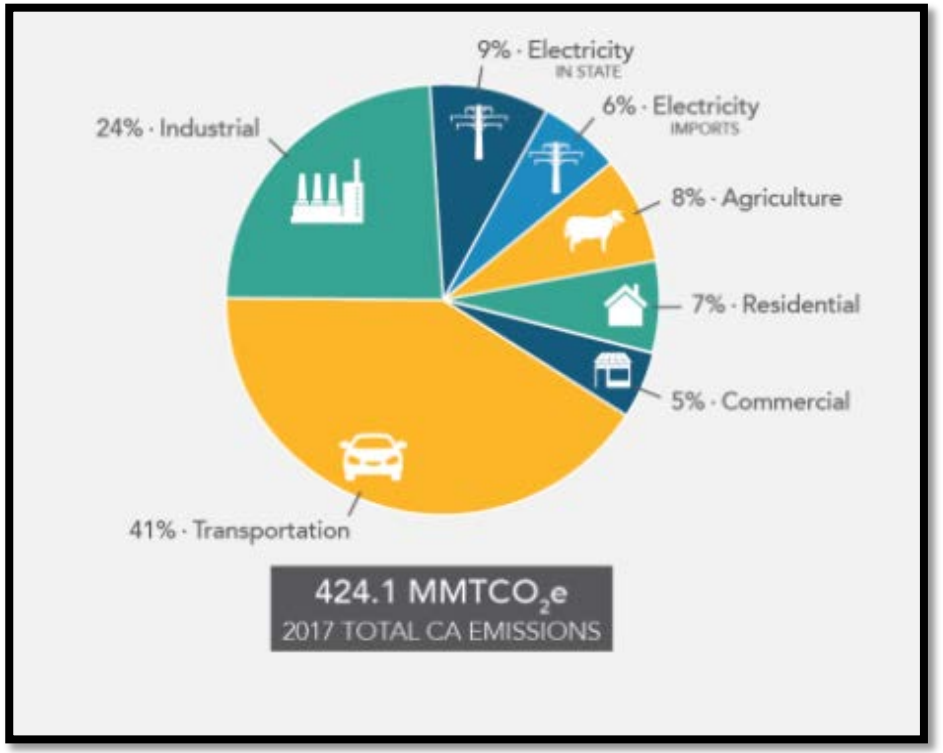
Emerging Renewable Hydrogen Production

- Advance H_2 production technology via emerging electrolysis or non-electrolysis solutions.
  - Using waste heat or renewable electricity to produce hydrogen; an example of such systems could include combinations of waste heat and Solid Oxide Electrolysis Cells (SOEC)
  - Hydrogen production from renewable methane (e.g., methane cracking into hydrogen with potential for carbon capture)
  - System integration that enables multiple product generation
- Investigate the potentials and readiness of early stage systems involving gas or liquid reforming, and emerging fermentation and photolysis for competitive renewable hydrogen production.

Projected Ratepayer Benefits

Emerging Renewable Hydrogen Production

- **Energy and Cost Savings.** Provide energy and cost savings through production of hydrogen as an alternative to natural gas.
- **Energy Sector.** Develop and support renewable pathways for hydrogen production that assist in meeting California's energy and emissions goals.
- **Environmental Benefits**. Reduce statewide consumption of natural gas and GHG emissions.



Pie chart of greenhouse gas emissions from different sectors in California.
Source: CARB, 2017. https://ww2.arb.ca.gov/ghg-inventory-data

Renewable Energy & Advanced Generation

Proposed Research Initiative:

Emerging Gas Cleanup and Upgrading for Biomethane

Background:

- Biomethane, an upgraded form of biogas, is now being produced in new dairy biogas projects.
- Other major sources of biogas, such as sewage and food processing wastes, require costly biogas cleanup and upgrading processes (e.g. need for siloxane removal).
- Contaminants in biomethane -- such as siloxane, hydrogen sulfide, and volatile organic pollutants, among others -- can create problems to commonly-used downstream equipment, including combustion engines and appliances.
- This initiative will demonstrate an emerging gas upgrading system, and investigate methods and standards for siloxane removal.

Purpose of Research

Emerging Gas Cleanup and Upgrading for Biomethane

Issues:

- Biomethane is sometimes left to evaporate or is flared when it does not meet end-use requirements (e.g. for combustion engines and the natural gas pipeline).
- Biogas cleanup and upgrading to biomethane are currently energy intensive and costly.
  - Existing gas cleanup technologies need to improve to make biogas more competitive with fossil-based natural gas.
- Cleanup processes for municipal organic wastes (e.g., siloxane removal) are challenging
  - Siloxane particles are difficult to remove and can have negative impacts on end-use equipment and health.
  - Methods and standards for effective reduction of these contaminants need to be established.

Research Description

Emerging Gas Cleanup and Upgrading for Biomethane

- Advance pre-commercial biomethane technologies and enabling strategies.
  - Emphasis on biogas and biomethane derived from municipal organic wastes and food processing wastes
- Demonstrate biogas-to-biomethane technology that has been proven at a pilot scale.
  - Lower the cost and improve process efficiency of biomethane production via sorbent-based technology
  - Demonstrate cost-effective and improved processes for the removal of siloxane and impurities
- Investigate emerging methods and possible standards for removal of siloxane.

Projected Ratepayer Benefits

Emerging Gas Cleanup and Upgrading for Biomethane

- **Energy Sector.** Enabling wide-scale production of biomethane (renewable gas) can support statewide reductions in the consumption of fossil natural gas.
  - Provides cleaner alternative to natural gas for various power generation, process heating, and fueling applications.
  - Provides a low-carbon gas option as the state moves towards decarbonization.
- **Environmental Benefits.** Driving reductions in GHG emissions and improvements in air quality, with benefits for public health, the environment, and the economy.

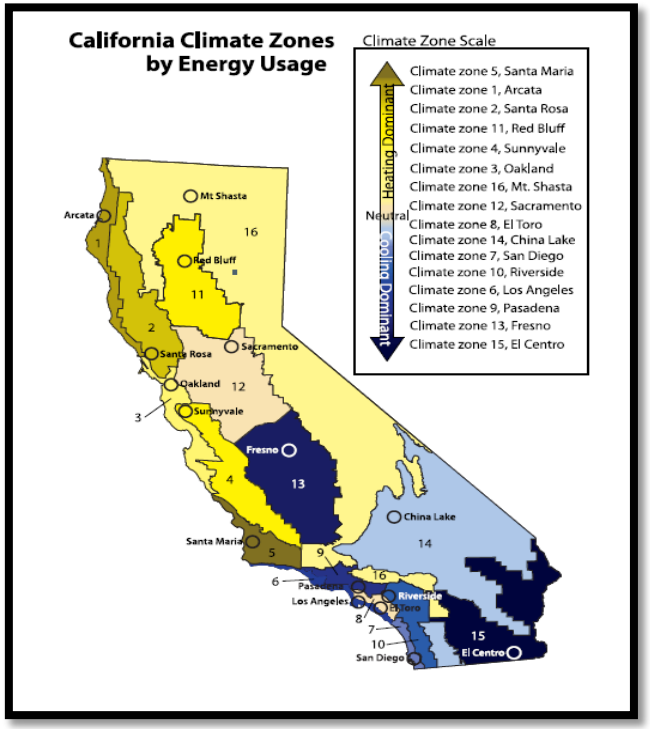
Renewable Energy & Advanced Generation

Proposed Research Initiative:

Demonstrate Geothermal Heating and Cooling for Low Income and Disadvantaged Communities

Background:

- A CEC-funded study on geothermal heat pump systems in 16 distinct climate zones in California showed reductions in energy and natural gas demand and emissions (between 20% and 70%).
- Costs and other barriers remain for the deployment of geothermal heat pump systems.
- This initiative will improve the viability of geothermal heat pumps and demonstrate in low income and disadvantaged communities.



Map of California showing energy usage by climate zone. Source: https://ww2.energy.ca.gov/2014publications/CEC-500-2014-060/CEC-500-2014-060.pdf

Purpose of Research

Demonstrate Geothermal Heating and Cooling for Low Income and Disadvantaged Communities

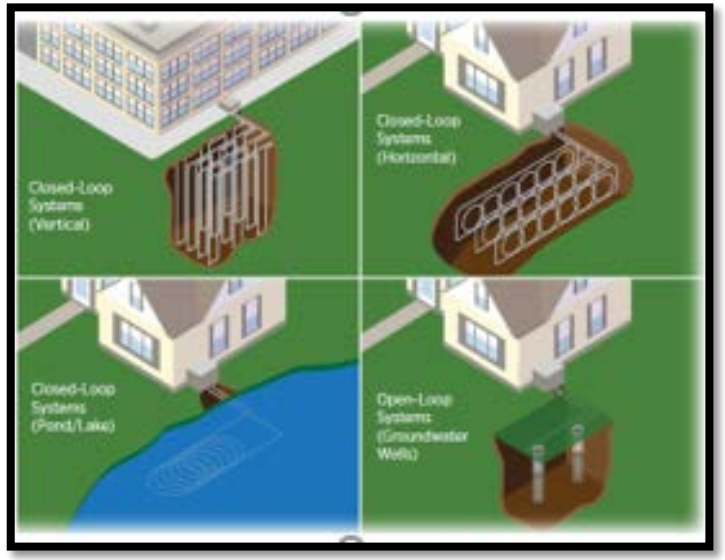
Issues:

- Barriers beyond regulatory and permitting inhibit deployment of geothermal heat pumps.
- High first cost of geothermal heat pump systems and lack of knowledge and confidence in these systems require new approaches to lower the cost and demonstrate benefits.
- Development in geothermal heat pump systems is slow, and design and installation infrastructure remain limited.
- Techniques to improve cost and performance are needed.

Research Description

Demonstrate Geothermal Heating and Cooling for Low Income and Disadvantaged Communities

- Deploy and demonstrate geothermal heat pumps in a low-income and/or disadvantaged community; document technological and operational parameters for future further development and deployment.
- Identify technological improvements for existing geothermal heating and cooling systems, with the goal of reducing upfront costs for installation and equipment.
- Improve ground loop technologies that can reduce the heat pump's overall electric consumption and increase the coefficient of performance.
- Leverage existing database on existing geothermal heat pump systems with the goal of identifying future design improvements and deploying more efficient systems.



Schematic of different geothermal heat pump design configurations. Source: https://www.energy.gov/eere/geothermal/downloads/geovision-harnessing-heat-beneath-our-feet

Project Ratepayer Benefits

Demonstrate Geothermal Heating and Cooling for Low Income and Disadvantaged Communities

- **Energy and Cost Savings.** Increase energy savings with an average of 44% in California's commercial and residential sectors.
- **Energy Sector.** The deployment and demonstration of technologies in this initiative are intended to support the reduction of natural gas consumption and GHG emissions.

Climate Zone	Conventional Energy [kWh]	GHP Energy [kWh]	Difference [kWh]	% Energy Reduction
1	17539.453	3926.300	-13613.153	77.61%
2	14674.521	5431.800	-9242.721	62.98%
3	9828.197	3462.000	-6366.197	64.77%
4	10213.580	4219.600	-5993.980	58.69%
5	11216.380	3979.700	-7236.680	64.52%
6	4288.449	3127.800	-1160.649	27.06%
7	4050.907	2942.900	-1108.007	27.35%
8	4659.066	3620.100	-1038.966	22.30%
9	7598.957	5308.100	-2290.857	30.15%
10	8692.673	5510.200	-3182.473	36.61%
11	15967.354	7845.400	-8121.954	50.87%
12	14706.879	6805.100	-7901.779	53.73%
13	13770.913	7775.400	-5995.513	43.54%
14	16161.329	9318.900	-6842.429	42.34%
15	10147.299	10650.900	503.601	-4.96%
16	15510.346	7666.800	-7843.546	50.57%
			Average =	44.26%

Table showing results of ground-source heat pump study, including a 44% average energy savings.
Source: https://ww2.energy.ca.gov/2014publications/CEC-500-2014-060/CEC-500-2014-060.pdf

Questions for the Stakeholders

Renewable Energy & Advanced Generation

- Are we effectively targeting research and technological development needs to support California's decarbonization goals and provide natural gas ratepayer benefits?
- Of the three technology areas presented -- renewable hydrogen, biomethane, and geothermal heating and cooling -- is it important to prioritize one in particular?
- Do you have suggestions for research and development needed to improve the technical and economic aspects of the proposed technologies?

CALIFORNIA ENERGY COMMISSION

Natural Gas Infrastructure Safety & Integrity Research

Natural Gas Infrastructure Safety & Integrity

Program Goals:

- Conduct research in natural gas infrastructure (pipelines and storage) to increase public safety, system integrity, and climate resiliency
- Enhance transmission and distribution capabilities of the natural gas system
- Address issues not adequately addressed by the regulatory and competitive markets

Natural Gas Infrastructure Safety & Integrity

Research Portfolio

- **Damage Prevention and Detection (*Pipeline*)**
  - In-line inspection technology
  - Excavator-mounted equipment
  - Low-cost pressure and flow sensors
- **Risk and Integrity Management (*Pipeline*)**
  - High accuracy mapping technology
  - Risk assessment tool
  - Pipeline right of way monitoring and notification system
- **Risk Assessment Model (*Storage*)**
  - Risk assessment model specific to wellheads
  - Storage system holistic risk model

Proposed Research Initiatives

Natural Gas Infrastructure Safety & Integrity

- Pilot Test and Demonstration of Hydrogen Blending to the Existing California Natural Gas Infrastructure
- Technologies for Microbiologically Influenced Corrosion Prevention of Natural Gas Pipelines and Storage Facilities
- Analytically-Grounded Plan for Pilot Demonstration of Strategic Electrification and Decommissioning of Natural Gas Infrastructure

Natural Gas Infrastructure Safety & Integrity

Proposed Research Initiative:

Pilot Test and Demonstration of Hydrogen Blending to the Existing California Natural Pipeline Network

Background:

Blending renewable hydrogen into NG and delivering it through existing infrastructure helps to decarbonize the gas industry and reduce GHG emission.

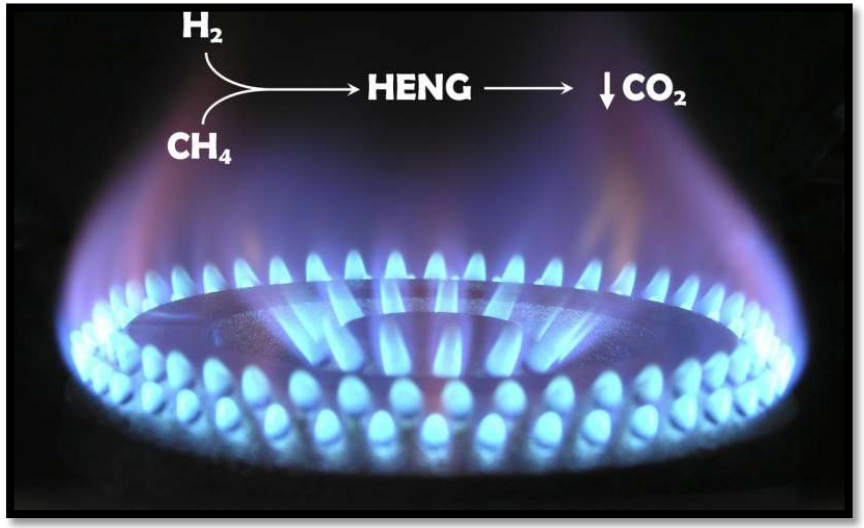


Image showing that hydrogen combined with methane can reduce CO2 emissions.
Source: https://scx1.b-cdn.net/csz/news/800/2018/30oftheuksna.jpg

Purpose of Research

Pilot Test and Demonstration of Hydrogen Blending to the Existing California Natural Gas Infrastructure

Issues:

- Hydrogen blending may cause issues to existing natural gas systems, including material embrittlement, gas permeation, sealant performance, system leak rate, etc.
- Existing case studies of hydrogen blending conducted in other states or countries may not be readily applicable to California natural gas network.
- It remains unclear how hydrogen blending affects the overall safety and integrity of the specific NG system in CA and the connected gas equipment.

Photograph of hydrogen mixed into natural gas pipelines. *Source: https://scx1.b-cdn.net/csz/news/800/2018/1-30oftheuksna.jpg*

Research Description

Pilot Test and Demonstration of Hydrogen Blending to the Existing California Natural Gas Infrastructure

- Demonstration of hydrogen blending to identify optimal use cases, validate pilot test results, and develop replicable implementation strategies.
- Assessment of natural gas system modifications required to maximize hydrogen blending levels.
- Modifications of integrity management and system maintenance practices for natural gas infrastructure to accommodate delivery of hydrogen.
- Development of hydrogen blending methodology and deployment strategies based on the lessons learned from the pilot test and demonstration.

Projected Ratepayer Benefits

Pilot Test and Demonstration of Hydrogen Blending to the Existing California Natural Gas Infrastructure

- **Energy Sector.** The research helps to increase renewable hydrogen production and better prepare the energy sector for a clean energy future while protecting the integrity and safety of the natural gas pipeline infrastructure.
- **Market Connection.** Sectors and user groups of interest in the proposed initiative include natural gas utilities, pipeline owners, gas operators, and hydrogen producers.
- **Energy and Cost Savings.** Using existing natural gas network to deliver hydrogen avoids the cost of building dedicated infrastructure specific for hydrogen.
- **Environmental Benefits.** Blending hydrogen into natural gas can significantly reduce GHG emission if the hydrogen is produced from renewable energy sources.

Natural Gas Infrastructure Safety & Integrity

Proposed Research Initiative:

Technologies for Microbiologically Influenced Corrosion Prevention of Natural Gas Pipelines and Storage Facilities

Background:

The natural gas infrastructure in CA is aging and becoming more vulnerable to corrosion damage.

Photograph of internal corrosion in pipelines.
Source:https://cdn.corrosionpedia.com/images/uploads/tunnel.jpg?height=580&width=940

Purpose of Research

Technologies for Microbiologically Influenced Corrosion Prevention of Natural Gas Pipelines and Storage Facilities

Issues:

- Microbiologically influenced corrosion is one of the common modes for pipeline corrosion, which is one of the leading causes of pipeline failure.
- Microbiological corrosion is estimated to cost the gas industry $2 billion per year.
- Inspection of pipelines and storage is extensive and costly.
- Existing management methods require the pipeline to be shut down, resulting in revenue losses for the utility and disruption to consumers.

Photogaph of corrosion damage to a pipeline.
Source: https://blog.applus.com/wp-content/uploads/2016/04/corrosion-management-300x200.jpg

Research Description

Technologies for Microbiologically Influenced Corrosion Prevention of Natural Gas Pipelines and Storage Facilities

- Address microbiological corrosion risks to natural gas pipeline and storage facilities.
- Develop advanced coatings or chemical treatment to prevent microbiologically influenced corrosion.
- Demonstrate advanced inspection and repair technologies for both internal and external corrosion.
- Perform cost effectiveness analysis of technology application to specific pipeline or storage facilities.

Projected Ratepayer Benefits

Technologies for Microbiologically Influenced Corrosion Prevention of Natural Gas Pipelines and Storage Facilities

- **Energy Sector.** The technologies are to improve safety and reliability and prevent failure of natural gas infrastructure by reducing the probability of incidents due to microbial corrosion.
- **Technology Potential.** The use of the technology helps to assess, repair, and prevent microbial corrosion damage in underground pipelines and storage wells.
- **Energy and Cost Savings.** The technology from this initiative will reduce failures from corrosion of pipelines and storage facilities and decrease down time and associated costs.
- **Environmental Benefits.** Addressing potential corrosion can reduce the chances of GHG leaks.

Natural Gas Infrastructure Safety & Integrity

Proposed Research Initiative:

Analytically-Grounded Plan for Pilot Demonstration of Strategic Electrification and Decommissioning of Natural Gas Infrastructure

Background:

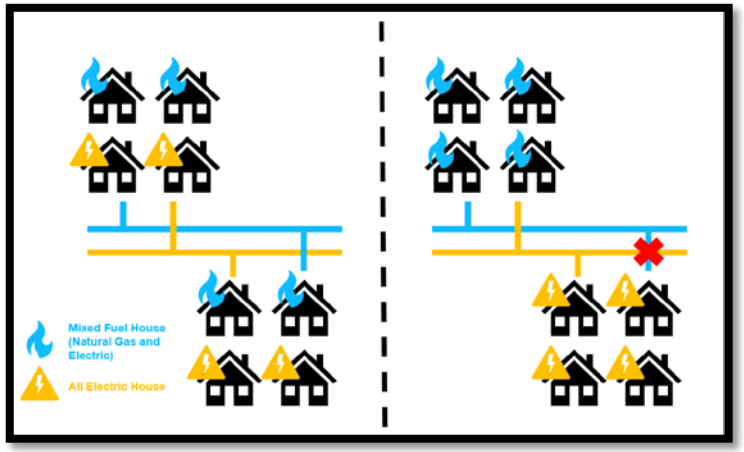
There is increasing interest in accelerating replacement of aging natural gas pipelines for safety, reliability and environmental benefits. Electrification is a potential option that can support a carbon neutral future.

Purpose of Research

Analytically-Grounded Plan for Pilot Demonstration of Strategic Electrification and Decommissioning of Natural Gas Infrastructure

Issues:

- Replacement of aging natural gas pipelines can be costly and average cost per mile to replace pipelines varies from $1 to $5 million.
- Utilities are unlikely to undertake replacement programs without some prior guarantee of timely cost recovery.
- Low-income and disadvantaged communities are most vulnerable to the high ratepayer impact.
- Electrification and decommissioning are viable options, which need strategic planning and pilot demonstration.



Schematic of electrification and natural gas decommissioning. Source: E3

Research Description

Analytically-Grounded Plan for Pilot Demonstration of Strategic Electrification and Decommissioning of Natural Gas Infrastructure

- Develop criteria and guidelines to determine the best use cases for pilot demonstration including low-income or disadvantaged communities
- Develop an analytically-grounded plan for a pilot demonstration, which includes engaging and coordinating among community groups, customers and utilities, conduct surveys, collect user acceptance data, etc.
- Perform short term and long term cost-benefit analysis for both customers and utilities
- Summarize the impacts of electrification and decommissioning on electric and gas infrastructure

Projected Ratepayer Benefits

- **Energy Sector.** The transition from natural gas to electricity would move the energy sector towards the low carbon future, and decarbonize the energy sector.
- **Market Connection.** The research will engage and connect community groups, gas and electric utilities, rate payers, and technology vendors.
- **Energy and Cost Savings.** The research will collect data and perform cost benefit analysis for ratepayers and utilities.
- **Environmental Benefits.** Decommissioning part of the natural gas system brings down gas consumption and reduces methane leaks.

Questions for the Stakeholders

Natural Gas Infrastructure Safety & Integrity

Hydrogen Blending

- What would be the most suitable use cases for a demonstration project? For instance, a power plant or isolated community.
- What would be the challenges to demonstrate hydrogen blending in the existing CA natural gas system?
- Are there any recommendations on research approach(es)?

Corrosion Prevention

- What are the most desirable improvements on current technologies for microbial corrosion detection, monitoring and prevention?
- Given the limited research funds, are there components of gas pipeline and storage assets that are most vulnerable to corrosion damage during the degradation process, which we should focus on?

Electrification and Decommissioning

- Best practices in surveying customer engagement on gas-to-electricity transition?
- Recommendations on how to minimize the cost impacts and ensure equity on energy accessibility?
- How will the gas-to-electricity transition impact the energy (gas & electricity) supply and demand at community or regional level?

CALIFORNIA ENERGY COMMISSION

Energy Efficiency

Energy Efficiency

Program Goals:

- Conduct research, development, and demonstration to advance strategies and technologies to support decarbonization in the building and industrial sectors.
- Enhance outreach and demonstration opportunities with low income or disadvantaged communities.
- Increase energy efficiency while reducing operating costs, natural gas use and greenhouse gases and other air emissions (for example low NOx).
- Develop and demonstrate affordable energy-efficiency technologies, processes, and strategies.

Energy Efficiency

Research Portfolio

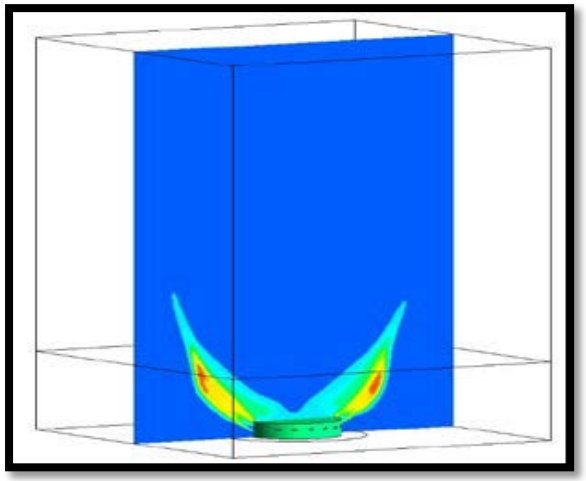
- Past research focused on using natural gas more efficiently in buildings and industries.
- Our proposed initiatives focus on supporting decarbonization, evaluating future transition needs, and enhancing efforts in low income or disadvantaged communities.
- Proposed initiatives targets **two areas**:
  - Implications on the use of hydrogen blends in existing end use appliances
  - Reduce the cost of solar thermal applications in low income or disadvantaged communities

Energy Efficiency

Research Portfolio

- **Project Highlight:** PIR-16-017, Implications of Increased Renewable Natural Gas on Appliances
- **Research Goal:** evaluate the stability, operational, and emissions implications of operating dual fuel appliances (natural gas + CO_2 or H_2)
  - Experimentally tested **4 appliances** and applied simulation methodologies to 9
- **Key Findings:**
  - For these un-modified appliances, when H_2 concentration increases above 10% by volume, probability of combustion instability increases (e.g. flashback)
  - At 10% H_2 level, NO_x and CO level decrease in general
  - Modelling approach shows a lot of variance—needs to be anchored in more experimental testing
  - There is a need for more standardized testing procedures

(a) Photograph of experiment setup.



(b) Figure from 3-D model for cooktop burner

Proposed Research Initiatives

Energy Efficiency

- Examining the Effects of Hydrogen in End-Use Appliances
- Accelerating Adoption of Next Generation Modular Solar Water Heating

Energy Efficiency

Proposed Research Initiative:

Examining the Effects of Hydrogen in End-Use Appliances

Background:

- Hydrogen blending with natural gas could be used as a fuel in residential and commercial buildings applications
  - Reduce natural gas consumption
  - Reduce greenhouse gas emissions
  - Provide pathway for decarbonization
- End-use appliances combustion safety and stability are critical for the blending process

Purpose of Research

Examining the Effects of Hydrogen in End-Use Appliances

Issues:

- Research needs to:
  - Identify the maximum upper limit (MUL) of hydrogen blended with natural gas that could be “safely” used in end-use appliances
  - Understand the impact of hydrogen in appliances without any modifications to the existing equipment
  - Gather sufficient data to adequately characterize the potential impacts of hydrogen-blending

Research Description

Examining the Effects of Hydrogen in End-Use Appliances

- Conduct experimental work in a laboratory setting to determine the maximum upper limit (MUL) of hydrogen blended with natural gas that can be safely used in end-use appliances.
  - Develop methodology for categorizing and selecting a sample of unmodified end-use appliances.
  - Explore appliance retrofits or modifications that could enable higher blends of hydrogen beyond the MUL (e.g., controls, burner modifications).
  - Identify specific new appliances and process equipment specifications needed to enable higher blends of hydrogen at or beyond the MUL

Research Description

Examining the Effects of Hydrogen in End-Use Appliances

Continued…

- Research focuses on residential and commercial natural gas appliances
- Establish criteria to define “safe” in the context of a hydrogen-blended natural gas supply
- Evaluate fuel composition that reduces emissions (e.g. NOx, CO) and maximizes efficiency
- Estimate the cost of retrofitting appliances to accommodate higher blends of hydrogen
- Quantify the impact of varying levels of hydrogen blends on the carbon intensity of natural gas-fueled appliances and its overall contribution to state climate and energy goals

Projected Ratepayer Benefits

Examining the Effects of Hydrogen in End-Use Appliances

- **Technology Potential.** Increasing the amount of hydrogen that can replace a portion of natural gas in end-use appliances may be a cost-effective way of reducing CO2 emissions.
- **Environmental Benefits.**
  - Could reduce GHG emissions due to large numbers of existing natural gas fueled appliances.
  - Potential for criteria air pollutant reductions, for example NOx and CO, which are known to be harmful to human health and the environment.

Energy Efficiency

Proposed Research Initiative:

Accelerating Adoption of Next Generation Modular Solar Water Heating

Background:

Water heating accounts for approximately 40 percent of natural gas used by California households and 32 percent used by the commercial building sector. Solar thermal water heating can significantly reduce natural gas consumption in the building sector. However uptake of these systems has been slow, even with incentives.

Purpose of Research

Accelerating Adoption of Next Generation Modular Solar Water Heating

Issues:

- Current solar thermal water heating systems have high cost due to the need for customized installations, high maintenance, and the requirement for large backup systems. A modular and standardized approach is needed.
- Competition with solar photovoltaics, especially in single-family settings, makes solar thermal systems less desirable.
- Resources for both solar thermal installers and potential buyers are limited.
- Disadvantaged and low-income communities with higher energy cost burden need pathways for decarbonization. Modular solar water heating is one potential pathway.

Research Description

Accelerating Adoption of Next Generation Modular Solar Water Heating

The initiative would fund the demonstration of modular solar water heating systems in low-income and/or disadvantaged communities and include an analysis of the building applications and climate zones where it would be most cost-effective.

- The selected applications should be representative of those with high market potential and hot water needs, such as multi-family residential, community centers, retirement communities, laundries, and schools.
- Achieve a minimum of 70% reduction in natural gas use for water heating.
- Achieve a minimum 20% cost reduction compared to conventional solar thermal.
- Document system performance that includes but is not limited to energy bill savings, system energy efficiency, and customer satisfaction.

Research Description

Accelerating Adoption of Next Generation Modular Solar Water Heating

Continued…

- Develop modular, plug-and-play methods for designing each system so that they can be easily replicated to other buildings to minimize cost.
- Prepare and distribute case studies based on documented performance.
- Coordinate with Community-Based Organizations to determine community needs and barriers related to adoption of solar water heating in low income/disadvantaged communities.
- Create guides for solar water heating system installers which provide information on design methods, tools, and commercially-available systems with a focus on disadvantaged and low-income community applications.
- Develop guides to help customers understand the benefits and costs of solar water heating systems, available incentives, and resources to find installers.
- Explore opportunities for demand response with there systems.

Projected Ratepayer Benefits

Accelerating Adoption of Next Generation Modular Solar Water Heating

- **Energy and Cost Savings.** Provide decarbonization pathway for natural gas ratepayers, especially low-income communities with natural gas-fired water heating systems.
- **Environmental Benefits.** Reduce greenhouse gas emissions.
- **Energy Sector.** Increase system resilience.

Questions for the Stakeholders

Energy Efficiency

Hydrogen Blending

- What should be the targeted building sectors, such as residential, commercial offices, retail, restaurants, institutional, etc.? And why?
- What should be the targeted appliances and why?
- Are there sectors or appliances to avoid?

Solar Thermal

- How can our research to help create replicable solutions?
- What are the targeted building types and climate zones or other factors that are the best candidates for cost effective solar thermal?
- What technological improvements are needed to reduce cost, space requirements, and backup system sizing of solar thermal systems?

CALIFORNIA ENERGY COMMISSION

Transportation Research

Transportation Research

Program Goals:

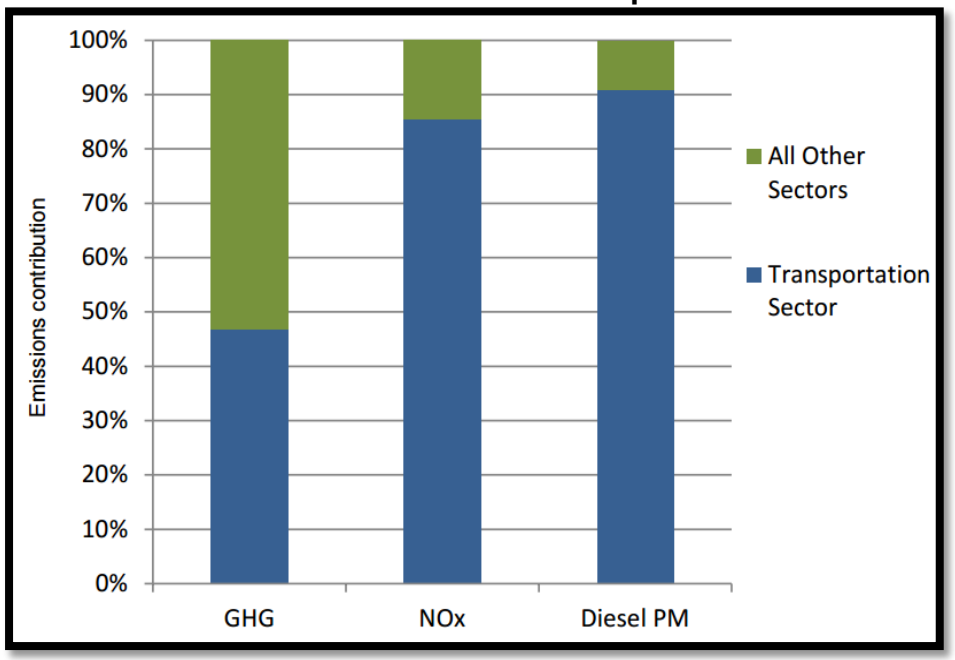
- Accelerate the beneficial commercial adoption of near-zero and zero emission gaseous fueled vehicles to improve air quality.
- Improve the energy efficiency and performance of gaseous fueled vehicles to reduce carbon emissions and improve competitiveness with conventional fuel vehicles.
- Increase the use of renewable gas to reduce the GHG emissions of the transportation sector.
- Improve fueling infrastructure technology capabilities to promote the further adoption of low-carbon gaseous fueled vehicles.

Transportation Research

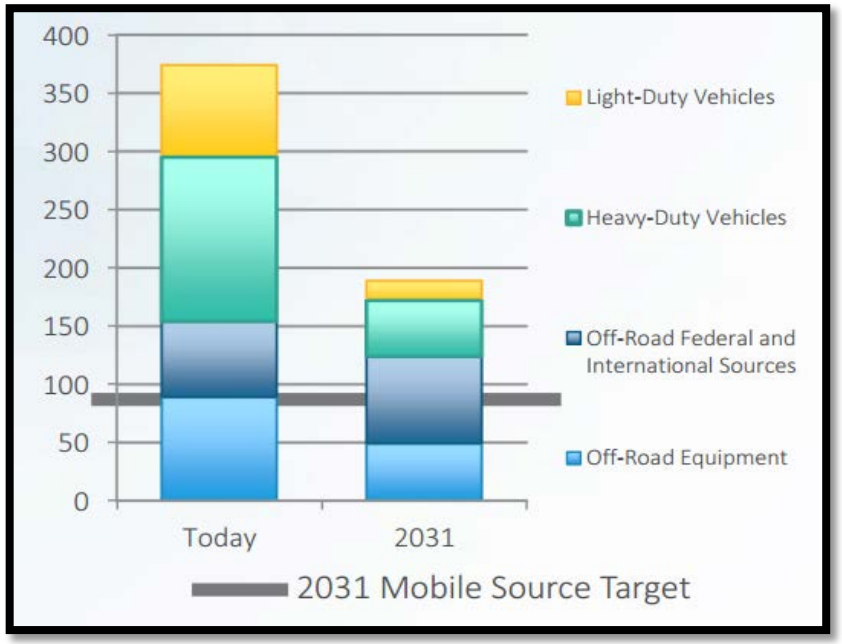
Research Portfolio

- Heavy-duty trucks and buses emit 20% of GHG emissions from the transportation sector, 28% of statewide NOx emissions, and 23% of statewide PM emissions.
- The South Coast needs an additional ~70% reduction in NOx emissions from heavy-duty vehicles to attain to federal ambient air quality standards by 2031.

Emission Contributions from the Transportation Sector



NOx Emission Reductions Needed in the South Coast



Transportation Research

Research Portfolio

- **Natural Gas Engine Efficiency Research**
  - Demonstrated >12% efficiency improvement in 12-liter natural gas engine using dedicated exhaust gas recirculation.
  - Demonstrated pathway to increasing efficiency by 20% using transient plasma ignition technology on a commercially available low NOx engine.
- **Natural Gas Vehicle Research Consortium**
  - 9 projects kicked off with ~$16M in co-funding from DOE VTO and SCAQMD.
  - Advancing engine technology and hybridization to enable high efficiency natural gas vehicles capable of performance beyond forthcoming 2024 GHG Phase 2 and Low NOx Standards.
- **Expansion to Focus on Fuel Cell Technologies**
  - Integrate and demonstrate fuel cell technologies in rail and commercial harbor craft.
  - Leverage opportunities at ports to achieve scaled hydrogen fuel demand.
  - Focus on vehicle/vessel integration and demonstrate ability to meet duty cycle, reliability, maintainability, and operating range.

Proposed Research Initiative

Transportation Research

- Technology Integration and Demonstration of Hydrogen Fuel Cell Trucks and Buses

Transportation Research

Proposed Research Initiative

Technology Integration and Demonstration of Hydrogen Fuel Cell Trucks and Buses

Background:

Hydrogen fuel cell electric vehicles (FCEV) are zero emission technology options with comparable operational flexibility to conventional vehicles such as long range, fast refueling times, and resiliency to ambient temperature extremes.

Transportation Research

Continued…

- SB 1505 and the Low Carbon Fuel Standard provide drivers for increasing renewable hydrogen production to support growing demand from the transportation sector.
- Achieving scaled renewable hydrogen production can support decarbonizing other end uses, including the natural gas system through pipeline blending.
- Forthcoming zero emission fleet rules will transition California truck and bus fleets to zero emission vehicles. R&D to advance the state of fuel cell vehicle and hydrogen infrastructure technology can assist in accelerating this transition.

Purpose of Research

Issues:

- Although heavy-duty FCEVs are estimated to achieve cost parity with conventional diesel vehicles by 2030, this can be accelerated with additional reductions in total cost of ownership.
- Fleets have limited data on fuel cell durability and performance in duty cycles relevant to their operations. Demonstrations are needed to inform fleet adoption.
- There are few commercially available fuel cell trucks and buses and a low number of deployed vehicles.
- Current hydrogen refueling technology contributes to the high cost of dispensed hydrogen.

Research Description

This initiative will fund the demonstration of heavy-duty hydrogen fuel cell trucks and buses that integrate pre-commercial vehicle or fueling infrastructure technologies to improve economics, performance, and durability.

- Address weight and space constraints, route and range requirements, and other vehicle integration barriers.
- Target vehicles that operate near hydrogen production facilities or industrial centers already using hydrogen.
- Demonstrate in real world fleet operation.

Research Description

Continued…

- Advance pre-commercial technologies that can improve total cost of ownership. Examples include but are not limited to:
  - Improved fuel cell system diagnostics.
  - Advanced on-board storage tanks.
  - Improved fuel cell system components and integration strategies.
  - Improved hydrogen fueling infrastructure technologies.

Projected Ratepayer Benefits

- **Energy Sector.** Increasing demand for renewable hydrogen in the transportation sector can drive scaled production of renewable hydrogen for a variety of end uses, including grid energy storage, industrial processes, and pipeline blending for gas system decarbonization.
- **Environmental Benefits.**
  - Reduce greenhouse gas, NOx, and particulate matter emissions from medium and heavy-duty vehicles.
  - Prioritizing zero emission vehicle demonstrations at industrial facilities can improve air quality and public health in nearby disadvantaged and/or low income communities.

Questions for the Stakeholders

Transportation Research

- What are some vehicle uses that should be targeted by this initiative?
- What are some pre-commercial FCEV or hydrogen fueling infrastructure technologies that will be ready for real world demonstration in the near term?
- What are some opportunities for this research to inform component standardization for further cost reductions?
- How can the value of these demonstrations be maximized?

CALIFORNIA ENERGY COMMISSION

Energy-Related Environmental Research

Energy-Related Environmental Research

Program Goals:

- Develop cost-effective approaches to evaluating and resolving environmental effects of energy production, delivery, and use in California;
- Explore how new energy applications and products can solve or reduce environmental problems;
- Identify climate- and environment-related vulnerabilities and resilience options for the energy system.

Energy-Related Environmental Research

Research Portfolio

SUper eMitters of Methane Detection Using Aircraft, Towers, and Intensive Observational Network (SUMMATION)

- **Goal**: Establish a continuous, cost-effective regional-scale methane emissions monitoring network in the southern San Joaquin Valley.
- Project responds to AB 1496 by improving monitoring and measurement of methane emissions, particularly high-emission methane hot spots (super emitters).
- Development of scalable methane monitoring approach will support cost-effective infrastructure investments and monitoring.
- Project will decrease GHG emissions, reduce resource losses, and may lower maintenance costs.

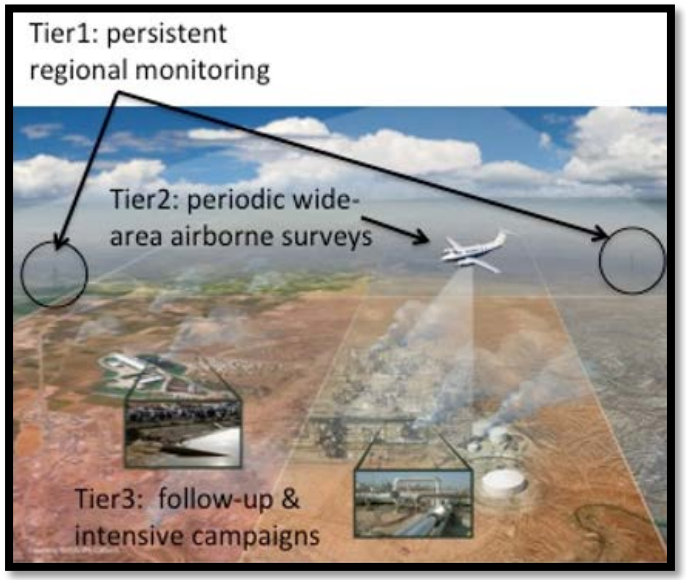


Figure: Proposed design for a regional, continuous methane emissions monitoring network in the southern San Joaquin Valley.

Energy-Related Environmental Research

Research Portfolio

Using Chemical and Isotopic Analyses to Improve Life-Cycle Assessments of the Natural Gas Consumed in CA

- **Goal**: Collaborate to characterize chemical and isotopic composition of natural gas samples from 20+ production basins and develop methodology to identify the basin of origin of the natural gas consumed in California.
- PG&E collecting and providing regular samples from at least seven critical locations within their delivery network.
- Researchers plan to sample at all identified locations by summer of 2020.
- Research will enable accounting for full fuel cycle impacts of natural gas consumed in California, including fugitive emissions from originating basins.

Figures: PG&E technician using a standardized procedure for sampling (*top*). Conditioned gas canisters await pressure testing (*bottom*).

Proposed Research Initiative

Energy-Related Environmental Research

- Development of Data-Driven, Actionable Tool and Case Studies to Support Strategic and Equitable Natural Gas Decommissioning

Energy-Related Environmental Research

Proposed Research Initiative:

Development of Data-Driven, Actionable Tool and Case Studies to Support Strategic and Equitable Natural Gas Decommissioning

Background:

Prior NG-funded work indicates that managing the evolution of the retail gas distribution system as the state transitions to a low-carbon future is imperative to ensure equitable access to energy services, a safe gas distribution system, and cost-effective ratepayer investments.

Purpose of Research

Development of Data-Driven, Actionable Tool and Case Studies to Support Strategic and Equitable Natural Gas Decommissioning

Issue:

Although prior research indicates that a strategic transition of the retail gas system is desirable, data and tools available at present do not enable spatial planning of decommissioning with consideration of cost and equity issues.

Research Description

Development of Data-Driven, Actionable Tool and Case Studies to Support Strategic and Equitable Natural Gas Decommissioning

- FY 20-21 funds would develop a data-driven, actionable tool to support strategic, equitable decommissioning of retail natural gas (*primarily buildings*).
- Leverage a methodological framework developed through FY 19-20 funds to illuminate strategic pathways to a low-carbon energy future.
- Tool will illuminate geospatially-specific cost and equity issues with broad regional coverage.
- Application of the tool to analyze specific groups of buildings and/or facilities will deliver case studies that inform decommissioning options and impacts.
- Local communities, potentially disadvantaged and low-income, will be engaged to inform the analysis and ensure research results are actionable.

Projected Ratepayer Benefits

Development of Data-Driven, Actionable Tool and Case Studies to Support Strategic and Equitable Natural Gas Decommissioning

- **Energy and Cost Savings**. Provide support for cost-effective, equitable transition of the retail gas distribution system.
- **Energy Sector.** Facilitate strategic decommissioning informed by analyses of infrastructure status and safety concerns.
- **Environmental Benefits**. Support achievement of state decarbonization goals, with associated health, environmental, and economic benefits.

Questions for the Stakeholders

Energy-Related Environmental Research

- How can California's natural gas IOUs be effectively engaged in this study? What synergies with IOU priorities and planning could be leveraged to enhance the study?
- What other natural gas sector stakeholders (e.g., other state agencies, CCAs, community-based organizations, jurisdictions with electrification ordinances) could serve important roles in ensuring the study delivers useful results?
- Are there externally funded efforts that might provide fruitful collaborations?

Comments & Questions

- Please introduce yourself by stating your name and affiliation.
- Keep questions under 3 minutes to allow time for others.
- Note that our official response will be given in writing and posted on: https://ww2.energy.ca.gov/research/annual_reports.html

Additional Comments & Questions

Please send all questions related to the FY 2020-21 Natural Gas R&D Budget Plan to:

Nicole Dani

nicole.dani@energy.ca.gov

Deadline to submit questions:

Friday, January 31, 2020 5:00 PM

APPENDIX B:
Public Comments

The CEC appreciates the thoughtful and helpful comments from stakeholders received in response to CEC's January 21, 2020 staff workshop on proposed initiatives for the FY 2020-21 Natural Gas R&D Program. The CEC requested comments at the January 21, 2020 workshop and via notifications on the CEC website, listservs, and docket. A summary of the comments and CEC's responses are provided below. Please note that, for brevity, footnotes included in public comments are not included in this summary.

CEC staff also appreciate continued coordination with CPUC staff to increase the expected impact of the research plan, including for the research initiatives on strategic decommissioning and pipeline corrosion and assessment (e.g., expanding the research initiative on corrosion to include desert mineral corrosion).

Energy Efficiency

CEC Initiative and Question:

Examining the Effects of Hydrogen in End-Use Appliances: What should be the targeted building sectors, such as residential, commercial offices, retail, restaurants, institutional, etc.? And why?

SoCalGas Comment:

The residential market has the largest number of equipment units deployed and the greatest throughput. Therefore, serving the existing equipment stock with a decarbonized fuel supply consisting of hydrogen-natural gas blends can have the greatest GHG emissions reduction impact with the lowest amount of consumer cost and inconvenience.

Industrial equipment is the most difficult (if not impossible) to electrify. Hydrogen blending is a promising decarbonization solution for industrial applications, e.g. food processing, textiles, chemical refining, manufacturing.

Finally, hydrogen-natural gas blends delivered through our existing natural gas system represents a very compelling method for meeting California's winter heating demand while reducing GHG emissions. In 2017, California's peak demand was 8,380 Mms per day. Electrifying that demand would require 2,544 GWh/day of electric power and conservatively, more than 100 GW of new wind, solar, and back-up generation capacity, depending on assumptions for electric system efficiencies (transmission and distribution power losses) and availability.

CEC Initiative and Question:

Examining the Effects of Hydrogen in End-Use Appliances: What should be the targeted appliances and why?

SoCalGas Comment:

For hydrogen blending to work at scale and across the natural gas system, we need to understand the potential impacts on all appliances. Recognizing the need for a comprehensive assessment, work is underway by SoCalGas and others to understand hydrogen concentration limits and performance for appliances across the board. Current research suggests that appliances are not the limiting factor as most appliance can accept 10-20% hydrogen today without modification.

Compressed natural gas (CNG) vehicle limits are setting the system hydrogen blend levels. For example, Germany has two blend limits, one for areas with CNG fueling and a higher limit for those without fueling infrastructure. SoCal Gas's RD&D Program is conducting research with the University of California, at Riverside and Cummings Westport Inc. to understand what is driving CNG blend limits and how to increase the tolerance of CNG engines for hydrogen blended fuels.

CEC Initiative and Question:

Examining the Effects of Hydrogen in End-Use Appliances: Are there sectors or appliances to avoid?

SoCalGas Comment:

No, please see above. A comprehensive understanding is required to advance hydrogen blending in the natural gas system. The CEC is well positioned to coordinate various research efforts across the State, nation, and globe to help advance hydrogen blending in California.

CEC Response:

For the FY20-21 budget plan, we are focusing on a targeted set of appliances in the residential and commercial sectors given funding limitations. Available funding will target specific appliances prioritized based on analysis of impact potential during solicitation development. We will consider research on additional sectors and appliances in future years. We are aware of existing research initiatives in this area led by natural gas IOUs and others and are interested to collaborate on these topics.

CEC Question:

Examining the Effects of Hydrogen in End-Use Appliances: What should be the targeted building sectors, such as residential, commercial offices, retail, restaurants, institutional, etc.? And why?

PG&E Comment:

Consider testing hydrogen blending on CNG engines. Heavy duty trucking is a promising end-use for natural gas going forward and knowing the impact of hydrogen blending on truck engines would be valuable.

CEC Response:
For the FY20-21 budget plan, we are focusing on the residential and commercial sectors given funding limitations. We will track research on hydrogen blend limits for CNG engines (e.g., in SoCalGas's RD&D Program) and consider this research area in a future budget plan.

CSA Group Comment:
Is the CEC aware of a research program for hydrogen blending and the impact on end use appliances?

There is an on-going project that Appliance Engineering Inc. is conducting that is funded by the CSA Group, AGA, and AHRI. At this point, there is no public results available. However, the focus appears to be similar to what ongoing research is being conducted and we would be interested in aligning efforts with the CEC.

CEC Response:
The CEC will consider all publicly available research results pertaining to hydrogen blends for appliances in solicitation development. The CEC will continue to collaborate with CSA group and others to leverage results of existing studies.

Renewable Energy and Advanced Generation

CSA Group Comment:
What is the timing of these proposed projects being initiated?

CEC Response:
The timing is dependent on CPUC approval of the initiatives and CEC issuance of solicitations. Typically, the funding for this program needs to be awarded to a project within two fiscal years (for the FY20-21 budget plan, that would be before the end of June 2022).

CEC Question:
Of the three technology areas presented – renewable hydrogen, biomethane, and geothermal heating and cooling – is it important to prioritize one in particular?

SoCalGas Comment:
Yes, hydrogen should be the top priority. While hydrogen technologies have the broadest and most impactful applications, they are in the earliest stages of development and require the most support. Biomethane is also important to help California decarbonize, however, biogas technology is commercially available and the market is developing.

Geothermal heating and cooling is not a suitable technology for funding through the natural gas research and development program as it relies on electrification. There are sufficient funds under Electric Program Investment Charge program to support electric heating and

cooling technologies. It is not appropriate to have gas ratepayers fund electric technology development.

CEC Response:
Hydrogen remains a priority research area given the noted broad applications and research need, with initiatives on hydrogen production, pipeline blending, and end use. Biomethane upgrading is included in the proposed initiatives. The initiative on geothermal heating and cooling has been removed.

PG&E Comment:
Geothermal heat pump system should not be included in Natural Gas Research priorities. Developing and demonstrating decarbonization solutions such as hydrogen, biomethane and Renewable Natural Gas should be put first.

CEC Response:
Hydrogen and biomethane are included in the proposed initiatives. The initiative on geothermal heating and cooling has been removed.

T2M Global Comment:
Burners and boilers typically generate low level waste heat that is vented or wasted. Technologies that can upgrade these to higher value such as electricity or hydrogen or RNG should be prioritized and recognized as a valuable tool for CA to meet its GHG goals.

CEC Response:
Waste heat-assisted hydrogen or RNG production is within the scope of the proposed DECARB research initiatives and will be considered in solicitation development. We note also that the CEC has included research on the use of waste heat from burners and boilers in previous years of the Natural Gas R&D Program.

CEC Research Initiative:
Emerging Gas Cleanup and Upgrading for Biomethane

PG&E Comment:
PG&E recommends including small scale cleanup process solutions for removing hydrogen sulfide, often found in dairies. The smaller scale processes need to be cost competitive. For example, membranes are a promising solution, however, membranes may be poisoned by hydrogen sulfide. Having an upgrading system that can handle hydrogen sulfide directly would be more cost effective and efficient.

CEC Response:
Hydrogen sulfide removal is included as part of the biomethane upgrading initiative. We will consider the cost-competitiveness of small-scale processes in the solicitation development. We agree that biogas cleanup processes need to be cost competitive and

that effective removal of hydrogen sulfide is essential in achieving high-quality biomethane.

PG&E Comment:

Consider adding woody biomass, especially forest waste as a source of biomethane thorough gasification and methanation.

CEC Response:

Last year, CEC issued a grant funding opportunity on this topic under the natural gas research and development program (GFO-18-501), resulting in two research projects (PIR-18-001 and PIR-18-004 – both concluding in 2023) that will demonstrate gasification and methanation of woody biomass to high-quality renewable gas. The proposed initiatives do not include woody biomass given these recent investments.

PG&E Comment:

Consider pairing emerging methods for removal of siloxane with the technology development for an online siloxane analyzer. Specifically, the online analyzer could be installed at an upgrading site as a field test. The data can be compared to traditional methods of siloxane analysis.

CEC Response:

A range of methodologies – including an online analyzer – will be considered in the solicitation development for the biomethane initiative.

Natural Gas Infrastructure Safety & Integrity

CEC Research Initiative:

Pilot Test and Demonstration of Hydrogen Blending to the Existing California Natural Gas Infrastructure

PG&E Comment:

PG&E is interested in partnering on this initiative. The pilot test could be using a portion of the natural gas system or designing a new system for the test.

CEC Response:

The CEC appreciates PG&E's interest in coordinating. The pilot tests and demonstrations of hydrogen blending would benefit from collaboration with California natural gas utilities.

CEC Research Initiative:

Analytics for Pilot Demonstration of Strategic Electrification and Decommissioning of Natural Gas Infrastructure

Earthjustice, Sierra Club, California Environmental Justice Alliance Comment

Earthjustice, Sierra Club and the California Environmental Justice Alliance write to support the proposed Pilot Demonstration of Strategic Electrification and Decommissioning of Natural Gas Infrastructure as part of the California Energy Commission ("CEC") Natural Gas Research Initiative for Fiscal Year 2020-2021. Studies examining the future of the gas system in California have found that building electrification can be the most feasible and cost-effective path to zero emission buildings and that a managed transition from the gas system will be critical to lower cost, protect vulnerable Californians and provide a just transition for workers. These studies also make clear that a managed transition requires data, analysis and intentionality, where the gas system is mapped to identify those areas where targeted electrification would have the greatest impact on reducing future capital expenditures. The proposed Pilot Demonstration is therefore critical research that will provide valuable insights into executing strategic electrification and decommissioning of gas infrastructure. The Pilot will also will yield climate and air quality benefits through reduced gas combustion and ratepayer savings by avoiding future capital expenditures and stranded assets on the gas system.

We also support the pilot's intended focus on low-income and disadvantaged communities. As observed in the Gridworks report, California's Gas System in Transition, "[o]ne of the greatest equity concerns that arises in the context of declining use of the gas system is that economically disadvantaged customers could be 'left behind' and remain dependent on increasingly expensive gas service." Developing experience in transitioning low-income customers from gas will be critical to ensuring equitable decarbonization. To develop best practices, we recommend starting with the outreach and the bill protections in the California Public Utility Commission proceeding that approved pilot projects for San Joaquin Valley Disadvantaged Communities.

Finally, we encourage the CEC to coordinate with the California Public Utilities Commission ("CPUC"), particularly on ensuring data on the gas system transition is as public and transparent as possible. Data gathering on the gas system in now contemplated under the Proposed Decision Establishing Building Decarbonization Pilot Programs ("Building Decarbonization PD"). The Building Decarbonization PD requires each gas corporation to "release downloadable planned natural gas infrastructure extension maps on a publicly accessible website" on July 1 of each year as well as "non-confidential downloadable map-based data that shows the book value, age, and location of existing natural gas distribution and transmission infrastructure." For an effective pilot, the CEC will likely need more information, such as the condition of pipes, leakage rates, asset depreciation schedules and planned and foreseeable future investments to identify preferred locations for targeted electrification efforts. Utility-imposed restrictions on data access to consultants retained by the CEC can impede the effectiveness of the Pilot Program and thwart meaningful public participation. Because the CPUC has jurisdiction over California's investor owned gas utilities, it can help ensure necessary data is provided to the CEC and CEC consultants and define the categories of information that have a legitimate basis for confidentiality to maximize transparency in gas system planning.

CEC Response:
The final budget plan includes the initiative to support a pilot demonstration for strategic electrification and decommissioning, as well as the initiative on a data-driven actionable tool for strategic decommissioning. We will consider the recommended resources in the solicitation development process. Coordination of CEC and CPUC on access to needed infrastructure data is underway.

CEC Initiative and Question:
Pilot Test and Demonstration of Hydrogen Blending into Existing California Natural Gas Pipelines: Challenges/limitations to demonstrating hydrogen blending in the existing CA natural gas system?

PG&E Comment:

- Consider a section that could be isolated and controlled so that the data is clear on direct impacts from hydrogen (no outside influences)
- Consider a sufficiently representative infrastructure in the demonstration (i.e. range of pipeline materials, assets and end user equipment)
- Consider a control group with duplicate infrastructure and operating conditions with only natural gas

CEC Response:
The suggestions are helpful and will be considered in the development of the solicitation.

CEC Initiative and Question:
Pilot Test and Demonstration of Hydrogen Blending into Existing California Natural Gas Pipelines: Recommendations on research approach(es)?

PG&E Comment:
PG&E recommends a connection with the HyDeploy project in the UK to learn about how the team is implementing their pilot demonstration. The California demonstration may be able to use the same or a similar approach.

CEC Response:
The proposed research initiative will be informed by and leverage existing research and demonstrations in the United States and other countries.

CEC Research Initiative:
Technologies for Microbiologically Influenced Corrosion Prevention of Natural Gas Pipelines and Storage Facilities

PG&E Comment:

The largest gap pertains to our limited understanding of the relationship between Cathodic Protection and Microbiologically Influenced Corrosion. PG&E recommends focusing on this aspect.

CEC Response:

The proposed research will address the link between cathodic protection and microbiologically influenced corrosion.

Energy-Related Environmental Research

CEC Research Initiative:

Development of Data-Driven, Actionable Tool and Case Studies to Support Strategic and Equitable Natural Gas Decommissioning

SoCalGas Comment:

Natural gas ratepayer funding should not be used to fund research into decommissioning the natural gas system. Decommission portions of the natural gas system will adversely impact rates for the remaining ratepayers using the system. This research does not provide ratepayer benefit and, in fact, will increase energy costs generally.

This research needs to include a cost-effectiveness study (i.e., determine the cost per unit of GHG emissions eliminated) of multiple decarbonization options, including using the natural gas system to deliver: 1) renewable natural gas, 2) hydrogen blended fuel, and 3) pure hydrogen, as well as 4) to provide long-duration, utility scale energy storage to support wind and solar resources.

CEC Response:

Research on natural gas decommissioning will be important to effectively manage impacts to ratepayers and utilities. The proposed research on a pilot demonstration and data-driven tool to support strategic decommissioning does include analysis of cost and can inform evaluation of cost-effectiveness. The proposed initiative builds on previous research under the Natural Gas R&D Program on options for decarbonization in the natural gas system.

The proposed research also includes initiatives on the production of renewable gas (which could be delivered in part through the natural gas system) and hydrogen blending in the natural gas system.

CEC Initiative and Questions:

Development of Data-Driven, Actionable Tool and Case Studies to Support Strategic and Equitable Natural Gas Decommissioning: How can California's natural gas IOUs be effectively engaged in this study? What synergies with IOU priorities and planning could be leveraged to enhance the study?

SoCalGas Comment:
The research should include a detailed analysis of electric utility impact:

What transmission and distribution upgrades will be required to the electric grid to support electrification and how will this affect retail rates and customer bills?

- How will reliability be impacted if residential energy supplies are reduced to a single energy currency, especially given increased wildfire risk, public safety power shutoffs, and seismic issues?
- What will be the GHG emissions impact of decommissioning natural gas systems given the marginal electricity production mix?
- How can renewable gas driven microgrids be used to enhance energy resilience and reliability?

CEC Response:
We recognize the need for examination of the electricity system as well as the natural gas system. In solicitation development, we will take into consideration the need to work with electricity IOUs as well as natural gas IOUs to gain detailed insight into impacts of changes to the energy system to either system.

Transportation Research

CEC Initiative and Question:

Technology Integration and Demonstration of Hydrogen Fuel Cell Trucks and Buses: What are some vehicle uses that should be targeted by this initiative?

SoCalGas Comment:
Fuel cell electric vehicles (FCEVs) are well suited to help electrify transit fleets. For example, the Sunline Transit Agency in Riverside County is demonstrating a number FCEV buses due to their ability to serve long-range routes, function effectively under extreme temperature conditions, and refuel quickly.

SoCalGas also recommends that service fleets also be targeted. The California Department of Transportation (Caltrans) operates a fleet of over 3,300 light- and medium-duty trucks that are required to travel long distances to support California roads and infrastructure projects and, as such, cannot be served by current battery electric vehicle technology. Development of FCEV products for these applications would provide significant environmental benefit given the size of the fleet and vehicle miles traveled.

CEC Response:
The proposed initiative focuses on heavy-duty fuel cell electric vehicles (FCEVs) and infrastructure, and we agree that FVECs may be well suited zero emission options for vehicle uses that require long operating ranges, effectiveness under extreme temperature

conditions, and quick refueling times. We will consider transit and service fleets in the development of the solicitation.

CEC Initiative and Question:

Technology Integration and Demonstration of Hydrogen Fuel Cell Trucks and Buses: How can the value of these demonstrations be maximized?

SoCalGas Comment:

SoCalGas recommends partnering with large fleets, including the Los Angeles County Metropolitan Transportation Authority, the Los Angeles Department of Transportation, and Caltrans, so that the technology demonstrations also serve to de-risk the technology for these potential customers.

CEC Response:

We will consider opportunities to partner with large fleets and to target demonstrations that are relevant to large fleets in the development of the solicitation.