



# Natural Gas Research Program

2021-22 Budget Proposal

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# Program Genesis

- AB1002 (Chapter 932, Statutes of 2000)
  - created the program
  - recognized NG as a vital energy resource
  - imposed a surcharge on NG use
  - directed surcharge funds to public-interest research
- CEC administered since 2004.
- SB 76 (Chapter 91, Statutes of 2005) directed funds be spent under a joint plan between CARB and CEC
- SB 1250 (Chapter 512, Statutes of 2006) updated the program, changing how the research funds are encumbered and managed.







# Program Goals



The Natural Gas R&D program invests strategically to:

- Support state energy policy and transition to clean energy, greater reliability, lower costs, and increased safety.
- Focus on energy efficiency; renewable and advanced clean generation; transmission and distribution; energy-related environmental protection, and transportation.
- Provide complementary communitywide benefits including, but not limited to, job retention/creation, improved air quality, and economic stimulation.



# Adaptable Priorities

Then	Now
Using natural gas more efficiently in buildings and industries.	Decarbonizing buildings and increased focus on industrial applications.
Distributed generation and combined-heat-and-power systems for use with fossil natural gas or renewable gas.	Decarbonization through hydrogen and biomethane production, clean-up, and power generation.
Improve energy efficiency and performance of gaseous fueled vehicles.	Increase the use of hydrogen in rail, marine, and heavy-duty vehicle applications.
Safety, integrity, and reliability of the natural gas system.	Continued safety, integrity, and reliability but with planning for strategic decommissioning.
Understand climate change and impacts to the natural gas system.	Support planning for a more resilient gas system in the face of a changing climate.



# Total Investment & Research Areas

**\$278+**  
**MILLION**

in Natural Gas R&D Program  
funds invested to date on  
**more than 270 projects**



## **Industrial & Agricultural Innovation**

\$75 million invested



## **Resiliency, Health, & Safety**

\$76 million invested



## **Low-Emission Transportation**

\$50 million invested



## **Building Decarbonization**

\$55 million invested



## **Natural Gas System Decarbonization**

\$22 million invested



# Program Impact

Modest investments yield dramatic benefits that matter for Californians.

## INVESTMENTS

**\$278<sup>+</sup>**  
**MILLION**

in Natural Gas R&D Program funds invested to date on **more than 270 projects**

**\$4.4<sup>+</sup>**  
**BILLION**

in private investment received by awardees after being selected for a Natural Gas R&D Program award

**~65%**  
**OF NATURAL GAS R&D FUNDS**

invested in projects located in either a disadvantaged community, low-income community, or both\*

## BENEFITS

**20<sup>+</sup>**  
**PROJECTS**

informed codes, standards, proceedings, or protocols (adopted or under consideration), providing on average an **estimated \$65<sup>+</sup> million** per year in energy cost savings\*\*

**30<sup>+</sup>**  
**COMMERCIALIZED TECHNOLOGIES**

or products resulting from Natural Gas R&D projects and many more moving toward commercialization\*\*\*

**9,030<sup>+</sup>**  
**CITATIONS**

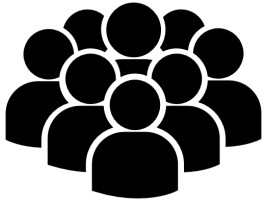
in publications referencing research results from CEC-funded natural gas projects (through June 2020)



# General Approach to R&D Program

## Identify research gaps and needs through

Utilities



Public stakeholders

Government agencies



Roadmaps

Industry and trade associations



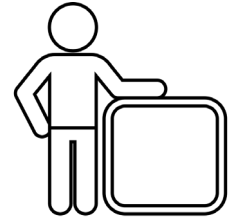
## Share Research Results



Workshops & forums



Posted Reports



Created by b farias from Noun Project

Showcase

### Energy research priorities guided by

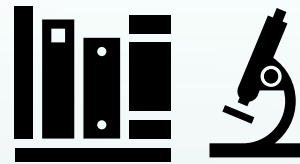


Policy directives



Equity

### Competitive Solicitations



### Research projects

### Ratepayer benefits





# New Requirements from Resolution G-3571 | November 12, 2020

- 1) More outreach with the DACAG and the public, with focus on disadvantaged communities.
- 2) More involvement and coordination with CPUC during the development of the budget plan
- 3) Procedural requests about how/where to share the proposed plan on CEC and CPUC websites and listservs.
- 4) CEC submit the final budget plan as a Tier 3 Advice Letter to facilitate public comment
- 5) Option of presenting the proposed plan at a CPUC Commissioner Committee Meeting





# Key Dates

Date	Item
11/12/20	CPUC Resolution G-3571
<b>12/04/20</b>	<b>Distribute outreach survey</b>
<b>12/28/20</b>	<b>Survey responses due</b>
1/08/21	Coordination meeting with CPUC staff
<b>1/22/21</b>	<b>DACAG meeting</b>
<b>1/29/21</b>	<b>Public workshop</b>
<b>2/08/21</b>	<b>Public comments due</b>
<b><u>4/01/21</u></b>	<b><u>Formal submission</u> (3/31 - <i>Caesar Chavez Day</i>)</b>
4/12/21	Discuss questions with CPUC staff
6/09/21	CPUC Emerging Trends Committee Meeting
TBD	CPUC approval
7/01/21	Start of fiscal year



# Outreach Survey

## DACAG and Community Member Survey on Natural Gas R&D Initiatives for 2021

- 20 question survey
- Responses from CBOs, Environmental Justice groups, non-profits, tribal reps, local government, and DACAG members
- Key interests for under-resourced communities
  - Reducing or eliminating natural gas and associated emissions
  - Addressing criteria air pollutants
  - Using renewable hydrogen
  - ***Must be balanced out by ensuring equity and not increasing costs***

# Program Portfolio

FY 2021-22



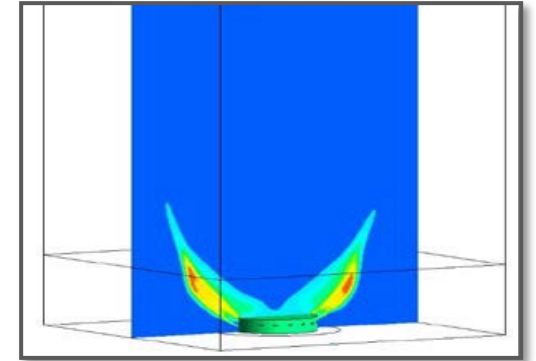
Presenter: David Stout, Supervisor,  
Energy Efficiency Research Office



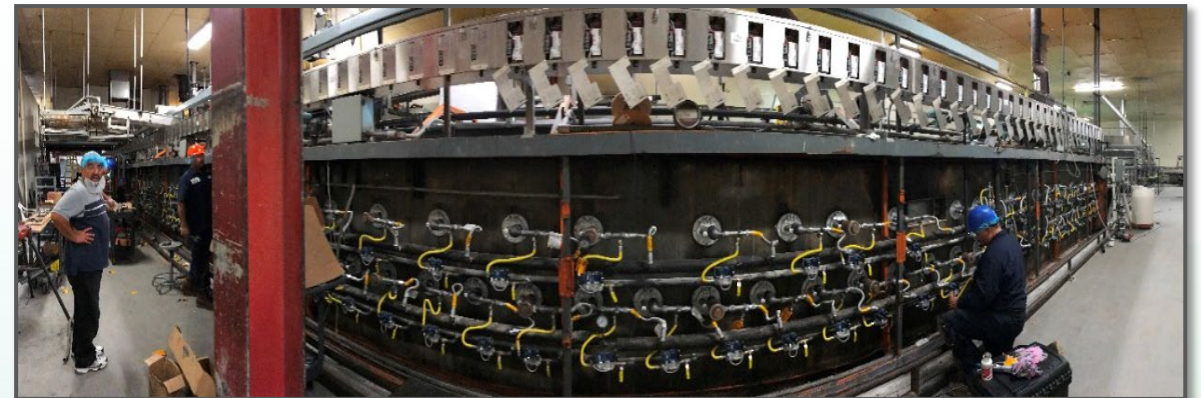
# Program Goals | Project Highlights

## Energy Efficiency Research Program

- Advance affordable strategies and technologies to support decarbonization in the building and industrial sectors.
- Increase energy efficiency while reducing operating costs, natural gas use, and GHG and other emissions.
- Focus on under-resourced communities.



**Implications of Increased Renewable Natural Gas on Appliances**  
Evaluate the operation of dual fuel appliances (natural gas and H<sub>2</sub>)



**Demonstration of Advanced Low NO<sub>x</sub> Ribbon Burner Combustion System for Industrial Bakeries**





# Program Goals | Project Highlights

## Natural Gas Infrastructure Safety & Integrity Program

Research in natural gas infrastructure (pipelines and storage) to increase:

- public safety
- system integrity
- climate resiliency

**Sensors and Monitoring Technologies for Detecting and Preventing Damages**  
Excavation Encroachment Notification System to increase excavator situational awareness



### Risk Assessment

Open-source tools to analyze seismic risk to prioritize mitigation measures and prevent failures of vulnerable system components

**Information Management**  
High Accuracy Mapping System to accurately map subsurface pipelines and trace component features



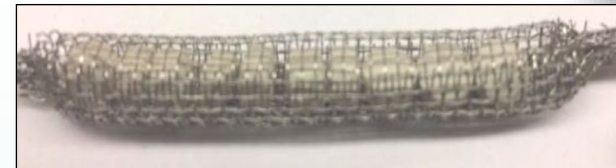


# Program Goals | Project Highlights

## Renewable Energy & Advanced Generation Program

- Advance production of and power generation applications for renewable gas (biomethane and hydrogen)
- Cost-effective, fuel-flexible, energy-efficient, low-emission, and hybrid energy generation.
- Advance clean and efficient distributed generation and renewable combined heating, cooling, and power.

**Production of Pipeline Grade Renewable Natural Gas and Value-Added Chemicals from Forest Biomass Residue**



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



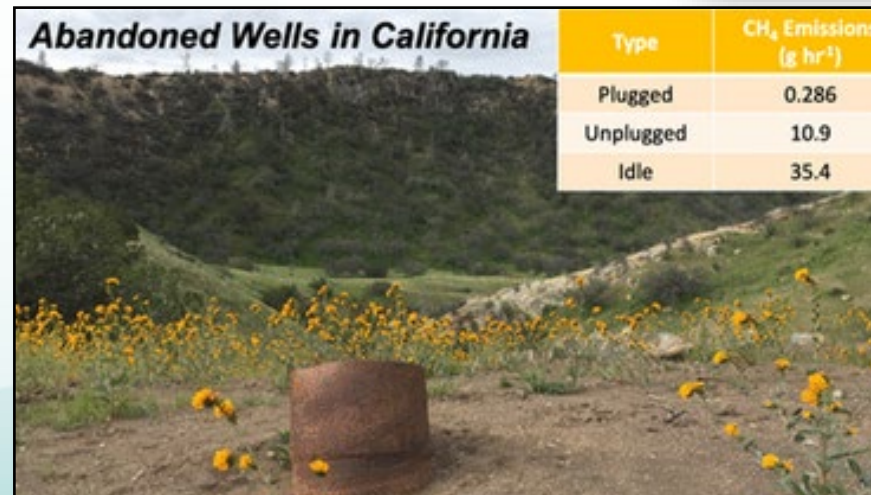
# Program Goals | Project Highlights

## Energy-Related Environmental Research Program

- Evaluate and resolve environmental and human health impacts of energy production, delivery, and use.
- Strategic planning and management to meet energy and environmental goals.
- Support climate adaptation and resilience planning.

### Effective Kitchen Ventilation for Healthy ZNE Homes with Natural Gas Appliances

Inform residential codes and standards that protect indoor air quality and health



### Quantification of Methane Emissions from California's Abandoned and Plugged Gas Wells



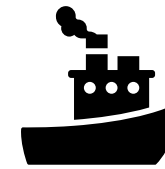


# Program Goals | Project Highlights

## Transportation Research Program

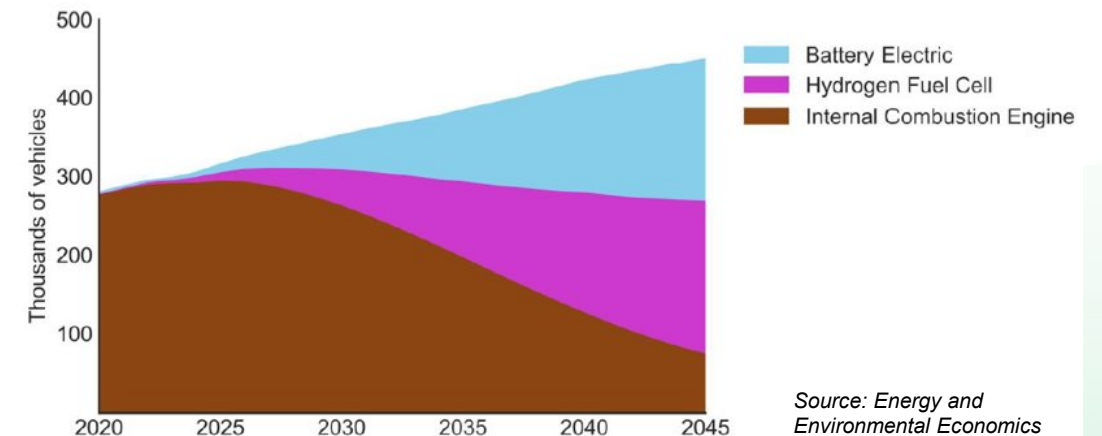
- Improve the energy efficiency and performance of gaseous fueled vehicles
- Increase the use of renewable gas
- Improve fueling infrastructure to promote adoption of low-carbon and zero-carbon vehicles.
- Support state strategies for reducing emissions from heavy-duty vehicles and off-road mobile sources

**Optimized natural gas, plug-in hybrid electric drayage truck with geofencing capabilities.**



**Recent solicitation on hydrogen fuel cells for rail and marine applications.**

**Heavy-Duty Vehicle Stocks in a Balanced Carbon Neutrality Scenario**



Source: Energy and Environmental Economics



# Proposed Research Initiatives



Presenter: David Stout, Supervisor,  
Energy Efficiency Research Office



# Research Initiative Development

FY 2021-22 Natural Gas proposed research initiatives are framed around ***decarbonization***.

## Primary areas:

- Indoor Air Quality
- Industrial Decarbonization
- Hydrogen
- Decommissioning
- Safety and Integrity





# FY2021-22 Proposed Budget

Program	\$	Initiatives
<b>Energy Efficiency</b>	\$6.1 M	1. Industrial Carbon Capture and Utilization
<b>Natural Gas Infrastructure Safety &amp; Integrity</b>	\$4.0 M	2. Technologies for Monitoring Ground Movement Around Pipelines and Mitigating Natural Force Damages
		3. Technology Development and Demonstration for Plastic Pipeline Repair and Integrity Improvement
<b>Renewable Energy and Advanced Generation</b>	\$4.0 M	4. Developing and Demonstrating Hydrogen-Based Power Generation Systems
<b>Energy-related Environmental Research</b>	\$3.5 M	5. Quantify Exposures to Indoor Pollutants in Multi-Family Homes that Cook with Natural Gas or Alternatives
		6. Location-Specific Analysis of Decommissioning to Support Long-Term Gas Planning
<b>Transportation</b>	\$4.0 M	7. Advanced Hydrogen Refueling Infrastructure Solutions for Heavy Transport



# Industrial Carbon Capture & Utilization

**Description:** Improve the energy efficiency and economics of existing and emerging technologies that capture CO<sub>2</sub> and convert it into higher-value commodities.

- Develop a roadmap for carbon capture and utilization (CCU) in California's industrial sector
- Establish an energy baseline of existing CCU technologies
- Increase effectiveness of capturing and purifying carbon dioxide
- Develop novel chemical and biological conversion technologies or improve existing ones

**Goal:** Reduce greenhouse gas (GHG) emissions from natural gas fueled industrial process heating and high-temperature processes that are difficult or costly to electrify or otherwise decarbonize.

**Equity Considerations:** Many industrial facilities are in under-resourced communities. For technical reasons CC requires removal of impurities and particulates. Reductions of criteria air pollutants and particulates would improve air quality and reduce associated health affects in these communities.





# Technologies for Monitoring Ground Movement Around Pipelines & Mitigating Natural Force Damages

**Description:** Develop and demonstrate remote sensing and monitoring technologies and mitigation strategies to reduce the risk of potential damages due to natural force damages.

- A “whole system approach” from data collection to integration with utility integrity management system and risk assessment tools
- Advance technology and commercial readiness level by optimizing device performance, improving cost effectiveness, and demonstrating the technologies at full-scale in the field

**Goal:** Enable utilities and pipeline operators to conduct real-time, continuous, and comprehensive monitoring of ground movement around pipelines and mitigate the risk of natural force damages, service disruption, and GHG emissions.

**Equity Considerations:** Under-resourced communities are usually more vulnerable to natural disasters. This research will pilot engineering measures in place to protect these communities from being negatively impacted by natural force damages.



# Technology Development and Demonstration for Plastic Pipeline Repair and Integrity Improvement

**Description:** Development and demonstration of technologies to assess, repair, and prevent damages to plastic pipes widely used in natural gas mains and service lines.

- Technologies for early notification of potential risks
- Robotic internal inspection and repair technologies
- New and cost-effective technologies to repair plastic pipe damages
- Technologies to measure the performance of repaired plastic pipe systems
- Emerging technologies that minimize or avoid service interruption during pipeline repair

**Goal:** Improve the safety and integrity of California's natural gas plastic pipelines and prevent pipe failures, gas service interruption, and leaks while reducing maintenance costs.

**Equity Considerations:** The research will enhance the safety, reliability and resiliency of gas service including in disadvantaged and low-income communities, which are more vulnerable to natural gas incidents such as gas leaks, pipe ruptures and explosions.



# Developing and Demonstrating Hydrogen-Based Power Generation Systems

**Description:** Development and demonstration of power generation technologies that can run efficiently on high blends of hydrogen in the fuel stream.

- Advance and demonstrate generation system efficiency, emissions reductions (GHG and NO<sub>x</sub>), and safe operation (e.g., operating without leaks, maintaining system integrity); with applications for small-scale to large-scale systems
- Demonstrate integrated production of hydrogen-rich fuel from renewable gas and power generation.

**Goal:** Increase hydrogen adoption and reduce the use of, and emissions from, natural gas in power generation.

**Equity Considerations:** Fossil fuel generators are typically in under-resourced communities. Improve local air quality through reductions of natural gas combustion byproducts (NO<sub>x</sub>) that present health risks.



# Quantify Exposures to Indoor Pollutants in Multi-Family Homes that Cook with Natural Gas or Alternatives

**Description:** Address critical gaps in our understanding of health impacts of cooking with residential natural gas and possible benefits of electric cooking appliances, including:

- Exposure assessment of California residents to NO<sub>2</sub> in residential environments;
- Assessment of indoor exposures to PM<sub>2.5</sub> associated with cooking and characterization of the chemical constituents, size distribution, or other attributes that factor into health impacts.

**Goal:** Inform a more realistic assessment of health implications from exposures to pollutants associated with residential cooking and assessing health benefits of decarbonization measures. May inform low-cost strategies for monitoring PM and ventilation in residential kitchens.

**Equity Considerations:** Research will focus on health-damaging pollutants in multi-family homes in low income and disadvantaged communities, with an emphasis on capturing exposures of those most vulnerable to air pollution exposures (e.g., children, elderly).





# Location-Specific Analysis of Decommissioning to Support Long-Term Gas Planning

**Description:** Deliver location-specific analysis of promising candidate sites for decommissioning (e.g., those with known pipe integrity and corrosion issues), examining the implications of decommissioning on the remaining gas system.

- Prioritize examining natural gas decommissioning and electrification opportunities in under-resourced communities.
- Scope and approach to inform effective and equitable implementation of strategic pruning.

**Goal:** Bridge the gap between high-level gas system planning and local decommissioning pilots, providing stakeholders with a valuable tool for assessing the technical and economic feasibility of decommissioning specific segments of the gas system.

**Equity Considerations:** The proposed analysis will focus on examination of natural gas decommissioning opportunities, including in under-resourced communities. The overarching goal is to inform an equitable and cost-effective gas system transition.



# Advanced Hydrogen Refueling Infrastructure Solutions for Heavy Transport

**Description:** Develop and demonstrate advanced hydrogen refueling station components and systems for high-capacity stations to support heavy transport applications transitioning to hydrogen fuel cell technology (e.g., heavy-duty fuel cell electric vehicles).

- Demonstrate innovative station designs with on-site production, integrated use with other sectors to drive scale, and/or use of chemical hydrogen carriers to reduce distribution costs.
- Reduce dispensing costs, support larger vehicles, and improve infrastructure reliability.

**Goal:** Increase availability of low-cost hydrogen to help decarbonize difficult-to-abate end-uses. Develop reliable, low-cost, and high-capacity hydrogen fueling infrastructure to expand heavy-duty fuel cell electric vehicle adoption and station deployment in California.

**Equity Considerations:** Expanding availability of hydrogen fueling infrastructure will improve air quality and zero-emission transportation accessibility, especially in under-resourced communities that are heavily impacted by these mobile sources.



# Thank You!

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