



CALIFORNIA ENERGY COMMISSION

FY 2016-17 Natural Gas Research Initiatives

Presented at the Stakeholders Workshop

California Energy Commission

January 25, 2016

1:30 pm – 5:00 pm



Agenda

Time	Topic
1:30	Introduction and Purpose – Mike Gravely
2:00	Staff Presentations on Proposed Natural Gas Research Initiatives <ul style="list-style-type: none">▪Energy Efficiency – Leah Mohney▪Renewable Energy and Advanced Generation – Kevin Uy▪Energy Infrastructure – Avtar Bining & Guido Franco▪Natural Gas-Related Transportation – Pilar Magaña
4:00	Public Comments
4:45	Closing/Next Steps – Mike Gravely



Introduction

- For the Natural Gas FY 2015-16 budget, the Energy Commission R&D Program included a public vetting process with Stakeholders that included a public workshop.
- For the upcoming Natural Gas FY 2016-17 budget, the Energy Commission R&D Program has included “Questions for Stakeholders” seeking for ideas for natural gas research initiatives during the workshop.



General Approach

- Identify research gaps to develop research initiatives through:
 - Discussion with utilities, governmental agencies and stakeholders
 - Road maps
 - Public meetings with industry and trade associations
 - Research ideas submitted by the public
- Research projects selected through competitive solicitations
- Collaborate with internal and external stakeholders (e.g., other Energy Commission research areas, state and federal agencies, utilities)
- Energy research priorities guided by policy directives
- Clearly identified benefits



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:

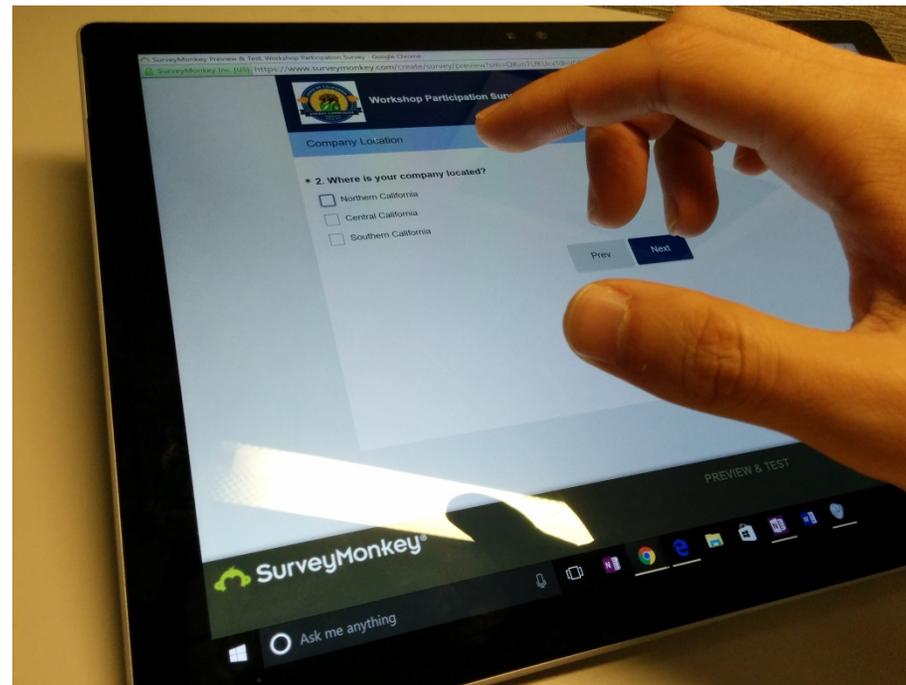
- Engage with disadvantaged and underrepresented groups throughout the state.
- Notify potential new applicants about the Energy Commission's funding opportunities.
- Assist applicants in understanding how to apply for funding from the Energy Commission's programs.
- Survey participants to measure progress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



We Want to Hear From You!

1 Minute Survey

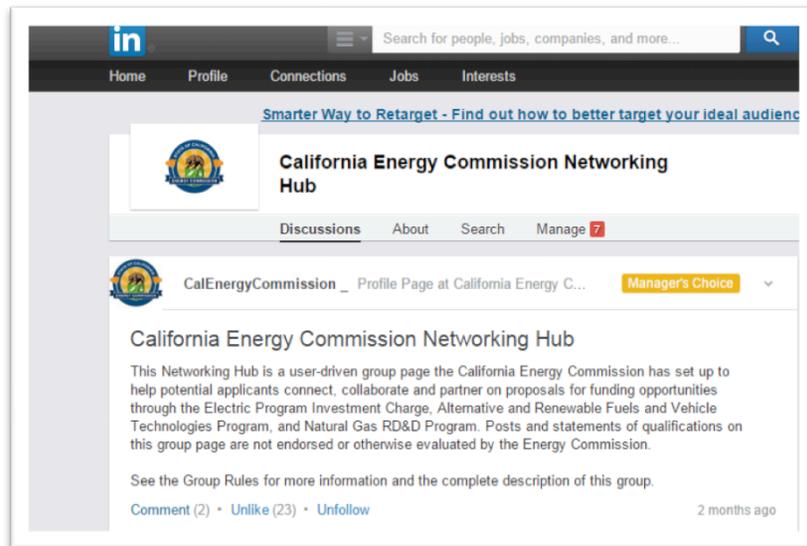
- The information supplied will be used for public reporting purposes to display anonymous overall attendance of diverse groups.
- Does your company identify as an underrepresented group?
- Where is your company located?
- How did you hear about the workshop?
- **Online survey for WebEx Participants:**
 - <https://www.surveymonkey.com/r/CKQML8K>





CALIFORNIA ENERGY COMMISSION

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<http://calenergycommission.blogspot.com/2016/01/instructional-videos-help-public.html?platform=hootsuite>



Find Partners via LinkedIn

- The Energy Commission has created a user-driven LinkedIn group page to help potential applicants **connect, collaborate** and **partner** on proposals for funding opportunities.
- Participants can join the “California Energy Commission Networking Hub” by:
 - Searching for the “California Energy Commission Networking Hub” group; or
 - Entering this link into your browser:(bit.ly/CalEnergyNetwork)
- Once there, find various subgroups that relate to specific funding opportunities by checking the “About this group” section of the Networking Hub.



Role of Stakeholders

- Advice and comments on the initiatives
- Alerting Energy Commission staff to possible duplication of efforts
- Advising Energy Commission staff on opportunities to gain synergies in research efforts including partnering on funding to increase scale of research
- Facilitating the effective transfer and use of research results
- Identify missing initiatives



Budget and Priorities

- Transparent budget process
- Priorities
 - Safety
 - Climate Preparedness
 - Loading Order
 - Ratepayer benefits and California focus
- Support State Energy Policies and Governor's priorities
- Issues of Elevated Importance in 2015
 - Governor's Executive Orders on climate and drought
 - Greenhouse Gas Emission Reduction (AB 32)
 - CPUC Natural Gas Safety Policy Statement (July 2014)
 - "Leak Detection"



Natural Gas Research Areas

- **Energy Efficiency**
 - Industrial, Agriculture and Water Efficiency
- **Renewable Energy and Advanced Generation**
 - Combined Cooling, Heat and Power (CCHP)
- **Energy Infrastructure**
 - Infrastructure Integrity & Safety
 - Energy-Related Environmental Research
- **Natural Gas-Related Transportation**



Prior Fiscal Year and Proposed Natural Gas 2016-17 Budget

Research Areas	Approved FY 2015-16 Natural Gas Budget	Proposed FY 2016-17 Natural Gas Budget
Energy Efficiency	\$7,100,000	\$7,100,000
Buildings End-Use Energy Efficiency	\$7,100,000	\$0
Industrial, Agriculture and Water Efficiency (1)	\$0	\$7,100,000
Renewable Energy and Advanced Generation	\$5,800,000	\$4,400,000
Energy Infrastructure	\$4,300,000	\$6,600,000
System Integrity	\$1,000,000	\$4,000,000
Energy-Related Environmental Research	\$3,300,000	\$2,600,000
Natural Gas-Related Transportation	\$4,400,000	\$3,500,000
Program Administration	\$2,400,000	\$2,400,000
Total	\$24,000,000	\$24,000,000

(1) Energy Efficiency Program areas will alternate funding each year between building efficiency and industrial efficiency research.. For FY 2016-17, the focus will be on the industrial, agriculture and water efficiency sector. In FY 2017-18, the natural gas research will focus on building end use efficiency This approach will allow the funding of multiple projects in each research area



Workshop Format

- Each Natural Gas R&D team will discuss their presentation
- Questions related to the research initiatives will be posed to the Stakeholders at the end of each research area
- To ensure each team has time to complete their presentations, some questions may need to be deferred to the public comment period
- There will be an additional public comment period at the conclusion of the presentations



Industrial, Agricultural and Water Efficiency



Presenter:
Leah Mohny



Goals

Conduct RD&D to help the Industrial, Agricultural and Water (IAW) sectors:

- Increase energy efficiency
- Reduce costs
- Develop measures to meet environmental challenges while maintaining or enhancing energy efficiency including:
 - Reduce water or other finite resource consumption
 - Maintain or increase productivity while reducing energy consumption and emissions (e.g., low NO_x)
- Commercialize technologies within 5 years of project completion with a minimum 1% penetration/year for targeted markets
- Increase the industry's competitiveness in the global economy by reducing energy costs and GHG emissions



Policy Drivers

Integrated Energy Policy Report/Energy Action Plan

- Improve energy efficiency through increased R&D to reduce energy cost and GHG emissions (2007/2009)
- Conduct research to identify new technologies for achieving energy and water efficiency savings (2005)
- Identifies energy efficiency as the first priority in the State's "loading order"

California Public Utilities Commission - Energy Efficiency Strategic Plan (2008/2011)

- Integrate energy efficiency with achievement of GHG goals for the industrial sector
- Increase energy efficiency and on-site renewable energy use in the agricultural sector
- Address water-energy nexus issues for the industrial/agricultural sectors (e.g., energy savings related to the water-energy nexus (Industrial Action Plan – 2014 proceeding))

AB 32 (Núñez, Chapter 488, Statutes of 2006)

- Reduce GHG emissions in CA to 1990 levels by 2020 - Scoping Plan emphasizes energy efficiency to slow the rate of GHG emissions with focus on large industrial customers

SB 350 (De Leon, Chapter 547, Statutes of 2015)

- Require a cumulative doubling of statewide energy efficiency savings in electricity and natural gas final end uses of retail customers by January 1, 2030

Executive Order B-29-15

- Establish a statewide goal to save water
- Increase enforcement to prevent wasteful water use
- Streamline the state's drought response and invest in new technologies that will make California more drought resilient

Executive Order B-30-15

- Establishes a statewide goal to reduce greenhouse gas emissions 40 percent below 1990 levels by 2030



Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
2011 Emerging Technology Demonstration Grant Solicitation (ETDG II)	Competitive grant solicitation that funded industrial energy efficiency demonstrations associated with wastewater treatment, datacenters, agricultural processing and Energy Storage.	<ul style="list-style-type: none"> • \$19.8M (E+NG) allocated to 14 projects • Projects completed– Final reports on CEC website (for most projects)*
2013 Natural Gas Emerging Technology Demonstration Grant Solicitation (ETDG III)	Competitive grant solicitation that funded industrial energy efficiency demonstrations associated with improvements in food processing, waste water treatment, and burner efficiencies.	<ul style="list-style-type: none"> • 5 projects underway (\$7.9M) • Projects are in the design and build phase • Results 2.5 years away
2014 Industrial Natural Gas Energy Efficient Grant Solicitation	Competitive grant solicitation that funded efficiency technology demonstrations that resulted in funding an industrial bakery efficiency project.	<ul style="list-style-type: none"> • 1 Project awarded and kicked-off mid-2015 (\$950K)
2015/16 Industrial Natural Gas Energy Efficiency Grant Solicitation	Competitive grant solicitation targeting industrial energy efficiency demonstrations. Projects proposed for funding are addressing the areas of waste heat recovery, solar thermal and advanced metals melting.	<ul style="list-style-type: none"> • GFO released August 2015 • NOPA released December 2015 with proposed funding for four projects (\$4.3M) • Re-released GFO in December 2015 to solicit additional projects

* IAW final reports posted at: <http://www.energy.ca.gov/research/iaw/publications.html>



Program Highlights

Demonstrate Liquid CO₂ Industrial & Commercial Laundry Machine

- **Contractors:** CO₂Nexus (Prime); ARAMARK's LA laundry facility (demo site); SCE, SDG&E and LADWP (M&V)
- **R&D Funding:** \$396,200 (over \$1M in match)
- **Location:** Los Angeles, California
- **Term:** 10/11/2010 – 3/11/2014
- **Technology:** Industrial laundry machines can annually use >300,000 gallons of water. A prototype liquid CO₂ based laundry system will eliminate water consumption and eliminate need for the garment drying step.
- **Key Features**
 - Tests show an energy use reduction of 50% annually saving an estimated 2 million gallons of water per machine at full load capacity.
 - The process is much gentler on fabric, resulting in increased clothing life
- **Next Steps:** Project has been completed and is being marketed globally under the TERSUS brand to textile manufacturers:
 - <http://www.tersussolutions.com/>
 - www.energy.ca.gov/2014publications/CEC-500-2014-083/CEC-500-2014-083.pdf
 - CEC funded project with US Navy to demonstrate and validate CO₂ based cleaning of military garments and textiles



Completed Q2 2014



Program Highlights

Demonstration and Commercial Implementation of Energy Efficient Drying for Walnuts

- **Contractors:** UC Davis (prime contractor), Wizard Manufacturing Inc., Emerald Farms
- **R&D Funds:** \$1.118M (Match \$280K)
- **Location:** Emerald Farms, Maxwell, CA
- **Term:** 8/20/2014 – 03/31/2018
- **Technology:** Walnut drying is the most energy intensive processing step and is a large consumer of natural gas and electricity. Infrared (IR) drying is estimated to be 50% more energy efficient because IR quickly removes most of the surface and shell moisture from walnuts before they are sent to the bins. Hot air is still required for the final drying process but it is needed for a much shorter period of time.





Program Highlights *(cont.)*

Demonstration and Commercial Implementation of Energy Efficient Drying for Walnuts

- **Key Features:**
 - This project is in the early stages, preliminary tests show:
 - Walnuts dried through the IR process have a more uniform moisture content
 - Decreased product loss from over/under drying
 - IR energy is generated through a catalytic chemical reaction, so the IR emitters do not produce any NO_x or greenhouse gases, making this technology environmentally friendly
- **Next steps:** Review data from testing different IR drying temperatures to determine the most efficient IR settings and optimize IR drying process.





FY 2016-17 Proposed Funding Initiatives

Natural Gas Efficiency Research and Demonstration

Research Description:

- R&D to advance energy efficiency of emerging/underutilized technologies to help energy intensive industries cost effectively reduce energy and water demand and reduce emissions.
 - A few areas of interest
 - Drying, roasting, frying, sterilization, eliminate steam sparging
 - Glass melting, refining and conditioning

Industries targeted: Food processing, glass, cement, chemical manufacturing, oil and gas extraction and refineries.

Potential Partners and Customers: Industry, utilities, major equipment manufacturers public/private research organizations and governmental agencies

Estimated Ratepayer Benefits: Reduce energy use, greenhouse gas emissions and costs to affected industries.



FY 2016-17 Proposed Funding Initiatives

Heat Recovery and Improved Combustion Processes

Research Description:

- RD&D on advanced technologies with the potential to cost-effectively recover waste heat from combustion systems and downstream industrial processes.
 - A few areas of interest
 - Low-grade (250 to 500 degrees F) heat recovery
 - Advanced heat transfer (shapes, materials, coatings, etc).
 - Combustion system improvements to increase efficiency and reduce emissions
 - Heat recovery to provide non-power production reuse

Industries targeted: Food processing, glass, cement, chemical manufacturing, oil and gas extraction and refineries.

Potential Partners and Customers: Industry, utilities, major equipment manufacturers public/private research organizations and governmental agencies

Estimated Ratepayer Benefits: Reduce energy use, greenhouse gas emissions and costs to affected industries.



FY 2016-17 Proposed Funding Initiatives

Roadmap Update

Research Description:

- Develop roadmap to identify energy efficiency research gaps and targets to reduce natural gas use in the industrial, agriculture and water sectors.

Potential Partners and Customers: Industry, utilities, major equipment manufacturers public/private research organizations and governmental agencies

Estimated Ratepayer Benefits: The roadmap will focus on the key technologies and industries that can benefit from specific research identified in the roadmap.



Proposed FY 2016-17 Budget

Initiatives	Proposed FY 2016-17 Natural Gas Budget
<p>Industrial, Agriculture and Water Efficiency</p> <ul style="list-style-type: none">▪ Natural Gas Efficiency Research and Demonstration▪ Heat Recovery and Improved Combustion Processes▪ Roadmap Update	<p>\$7,100,000</p>



Questions for the Stakeholders on Industrial, Agricultural and Water Efficiency

- We are proposing to limit the potential industries targeted to food processing, glass, cement, chemical manufacturing, oil and gas extraction and refineries. Are these the right targets?
- Are we emphasizing the right energy efficiency initiatives for these targeted industries that would result in commercial technologies within 5 - 10 years? Are there other initiatives?
- Given the current low price of NG, what specific energy efficiency research and technologies should be targeted?
- What recommendations do you have to more effectively:
 - Engage stakeholders?
 - Encourage researchers and industry groups to apply for research funding?
 - Expand the adoption of demonstrated technologies by industry?
- Besides grants, what other services or assistance can be provided to the industrial sector to increase energy efficiency?
- What additional opportunities exist for leveraging our funding with others?



Renewable Energy and Advanced Generation



**Presenter:
Kevin Uy**



Goals

With funding under the EPIC and the Natural Gas R&D programs, the Renewable Energy and Advanced Generation R&D Program area conducts research that reduce barriers and increase penetration of renewable energy.

Under the Natural Gas research program, our goal is to reduce dependence on fossil-derived natural gas by:

- Advancing the development and market availability of clean and efficient distributed generation (DG) and combined heat and power (CHP) technologies
- Developing hybrid, fuel-flexible, energy efficient, and low emission DG technologies for natural gas and alternative fuels including biogas
- Developing and demonstrating technologies for the conversion, cleanup, and upgrading of biogas to renewable natural gas



Policy Drivers

AB 32 (Núñez, Chapter 488, Statutes of 2006), Global Warming Solutions Act of 2006

- Reduce GHG emissions to 1990 levels (~25% reduction from BAU) by 2020
- All emissions from new base load generation must be at or below emissions from a natural gas combined cycle plant by 2020

Executive Order B-30-15

- Reduce GHG emissions to 40% below 1990 levels by 2030 and 80% below 1990 levels by 2050

Governor Brown's Clean Energy Jobs Plan (2011)

- Introduced goals of 12,000 MW of renewable distributed generation by 2020 and 6,500 MW of additional CHP capacity by 2030

Assembly Bill 1613 (Blakeslee, Chapter 713, Statutes of 2007), Waste Heat and Carbon Emissions Reduction Act

- The CHP Feed-in Tariff requires electrical utilities to purchase excess electricity delivered by a CHP system that complies with certain sizing, energy efficiency and air pollution control requirements

Bioenergy Action Plan (2012)

- Recommends actions to increase the sustainable use of organic waste, expand research and development of bioenergy facilities, reduce permitting and regulatory challenges, and address economic barriers to bioenergy development.



Policy Drivers

SB X1-2 (Simitian, Chapter 1, 2011), Renewable Portfolio Standard

- 20 percent of retail sales from renewables by the end of 2013, 25 percent by the end of 2016, and 33 percent by the end of 2020

SB 350 (De León, Chapter 547, Statutes of 2015), Clean Energy and Pollution Reduction Act of 2015

- 40 percent of retail sales from renewables by the end of 2024, 45 percent by the end of 2027, and 50 percent by the end of 2030
- Double statewide energy efficiency savings in electricity and natural gas final end uses for retail customers by the beginning of 2030

AB 1900 (Gatto, Chapter 602, Statutes of 2012), Renewable Energy Resources: Biomethane

- Establishes a process to promote and facilitate the injection and use of renewable natural gas into common carrier pipelines to meet the state's renewable energy goals.

California Public Utilities Commission Energy Efficiency Strategic Plan (2008/2011)

- New residential and commercial construction will be ZNE by 2020, and 2030, respectively

Governor Brown's Proclamation of a State of Emergency (10-30-2015)

- State of emergency issued in response to historic drought, wildfires, and tree mortality rates
- Directs the Energy Commission to prioritize grant funding from the EPIC program towards woody biomass-to-energy technology development and deployment



Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
Hybrid Generation and Fuel Flexible DG/CHP/CCHP Systems	<ul style="list-style-type: none"> ▪ Integrate emerging multiple DG/CHP/CCHP technologies and fuel flexibility • Novel flex fuel oxidation for distributed generation • CHP with thermal storage for modern greenhouses • Fuel-flexible, hybrid CHP at a municipal water treatment plant • Tri-generation energy system technology for CCHP 	<ul style="list-style-type: none"> ▪ Projects completed in 2015 or 2016; ▪ Many successful projects, final reports available online (for most projects)
Localized Efficient and Advanced Power and Heat Systems (LEAPS)	<ul style="list-style-type: none"> ▪ Advancing CHP in opportunity areas in specific industry and commerce, biofuels and waste heat sources • High compression ratio free piston engine for CHP • CCHP system with multi function absorption cycle ▪ Supporting reliable power through accelerated demonstration and deployment of DG/CHP in southern California • Piloting a DG/CHP system powered by anhydrous ammonia • Low cost micro DG/CHP for use in laundry facilities • Multi-MW renewable biogas fuel cell and absorption chiller CCHP system at a university campus ▪ Novel emissions control systems for biogas fueled CHP • Pre- and Post-combustion NOx control for biogas engines with microwave energy at a food waste digester facility 	<ul style="list-style-type: none"> ▪ Projects started in summer 2014; ▪ Conducting bench-scale testing in preparation for pilot-scale demonstrations



Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
<p>Advancing Clean Energy through Biogas, Biomethane, and Natural Gas</p>	<ul style="list-style-type: none"> ▪ Advancing cost-effective biogas production, cleanup, and upgrading to renewable natural gas (RNG) • Novel biogas cleanup for conversion of landfill gas to RNG • Gasification and methanation methods for conversion of woody biomass to RNG • Solid-state, amine-appended metal organic frameworks for low-pressure upgrading of biogas to RNG • Demonstrating conversion of wastewater treatment plant biogas to renewable heat, power, and vehicle fuel • Improving biogas production by optimizing micronutrients and operating methods at a food waste digester facility ▪ Demonstrating waste heat to power systems at industrial facilities for efficient use of natural gas • Cost effective, packaged Organic Rankine Cycle system at an industrial facility ▪ Supporting development of micro-scale CHP/CCHP systems • Field demonstration of a 25 kWe low-emission reciprocating engine CHP system 	<ul style="list-style-type: none"> ▪ Projects started in summer 2015; ▪ Conducting preliminary design, development, and demonstration preparations



Program Highlights

CHP with Thermal Energy Storage for Modern Greenhouses

- **Contractor:** Southern California Gas Company
- **R&D Funds:** \$1,502,699 (Match \$3,901,080)
- **Location:** Camarillo, CA
- **Term:** 6/29/2012 – 3/31/2015
- **Goal:** Demonstrate economical operation of CHP with thermal energy storage at a modern greenhouse facility
- **Technology:**
 - 4.3 MW reciprocating natural gas engine generator
 - 1 million gallon hot water thermal energy storage
 - Grid interconnection agreement with SCE, consistent with Rule 21, for sellback of excess power
 - Power Purchase Agreement (PPA) with SCE through AB 1613 feed-in-tariff implemented by the CPUC
- **Key features:**
 - Measured electrical efficiency of 36-39%, overall efficiency of 85-90%
 - Robust after-treatment system resulted in 2-3.3 ppm NO_x and <1 ppm CO
 - Simple payback period of approximately 3.7 years



Thermal storage: 1 million gallons, hot water
Greenhouse: Glass structure with climate controls to optimize daytime and seasonal temperatures, humidity, light, and CO₂ levels.



CHP: 4.3 MW IC engine, natural gas fueled, sized and operated to meet the thermal load with excess electricity sold back to the grid



Program Highlights

Integration of Absorption Chiller and Fuel Cell Technology

- **Contractor:** University of California, San Diego
- **R&D Funds:** \$390,533 (Match \$360,000)
- **Location:** San Diego, CA
- **Term:** 6/30/2014 – 3/31/2017
- **Goal:** Analyze the performance of an absorption chiller driven by waste heat from a molten carbonate fuel cell
- **Technology:**
 - “Ultraclean” 47% efficient molten carbonate fuel cell integrated with exhaust-fired absorption chiller
 - Expected to raise the system’s efficiency from 47% to 68+%
 - Exhaust temperature of 700 °F able to support a two-stage absorption chiller with Coefficient-Of-Performance (COP) of approximately 1.2
- **Key features:**
 - Will displace a 224 kW electric chiller load
 - Will collect ample performance data
 - Project represents global and national firsts for CHP fuel cells



MCFC: 2.8 MW molten carbonate fuel cell supplies 8% of campus baseload power with directed biogas renewable fuel



Absorption chiller: 330 ton absorption chiller will convert waste heat to chilled water for campus cooling loads



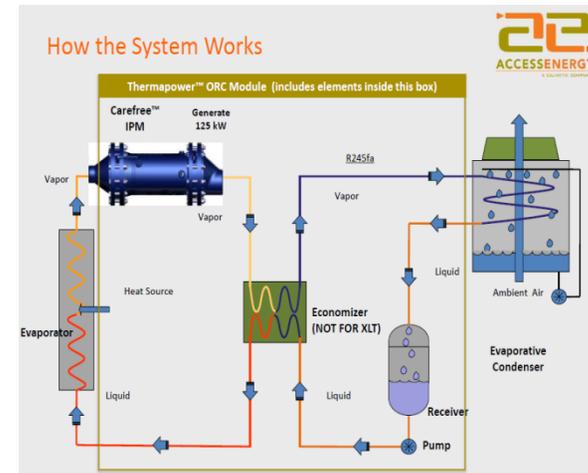
Program Highlights

Conversion of Industrial Waste Heat to Power

- **Contractor:** Electric Power Research Institute
- **R&D Funds:** \$999,889 (Match \$269,000)
- **Location:** Hawthorne, CA
- **Term:** 6/29/2015 – 7/31/2018
- **Goal:** Evaluate the application of ORC technology to cost-effectively generate electricity by recovering waste heat
- **Technology:**
 - Organic Rankine Cycle system whose working fluid enables flexibility in evaporator temperature
 - A packaged solution that includes turbine, pump, refrigerant management system, and economizer
 - Frictionless magnetic bearings improve efficiencies
 - A fluid with a lower boiling point enables power extraction from lower temperature heat sources
- **Key features:**
 - System converts waste heat to power
 - No emissions (uses waste heat instead of fuel)
 - High potential for reproducibility across California's industries



Industrial driers: Large driers at the American Apparel textile dying factory will provide the required waste heat to the ORC



ORC: The 125 kW Organic Rankine Cycle system uses R-245fa as a working fluid to harvest power from low temperature waste heat



FY 2016-17 Proposed Funding Initiatives

Removing Distributed Generation Barriers through Cost Effective Emissions Control and Other Novel Strategies

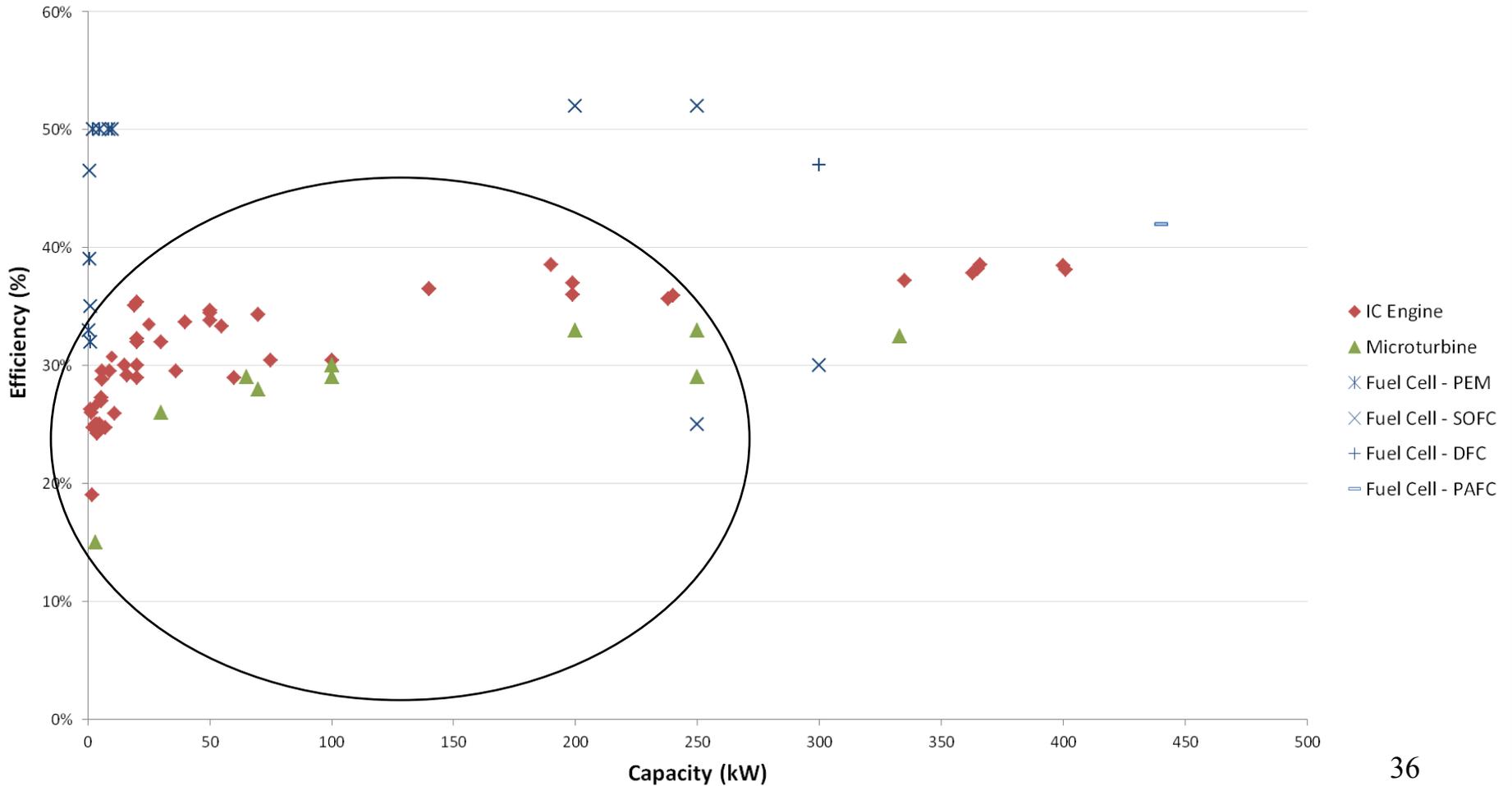
Background:

- Leverages and follows developments made under prior initiatives (e.g. emissions control and high efficiency, fuel-flexible systems)
- Supports earlier studies and input from stakeholders recommending emissions control
- Targets the 25 to 250 kWe “size” for light industrial, small commercial, and multi-family residential applications (other justifiably small ranges could also be considered)



FY 2016-17 Proposed Funding Initiatives

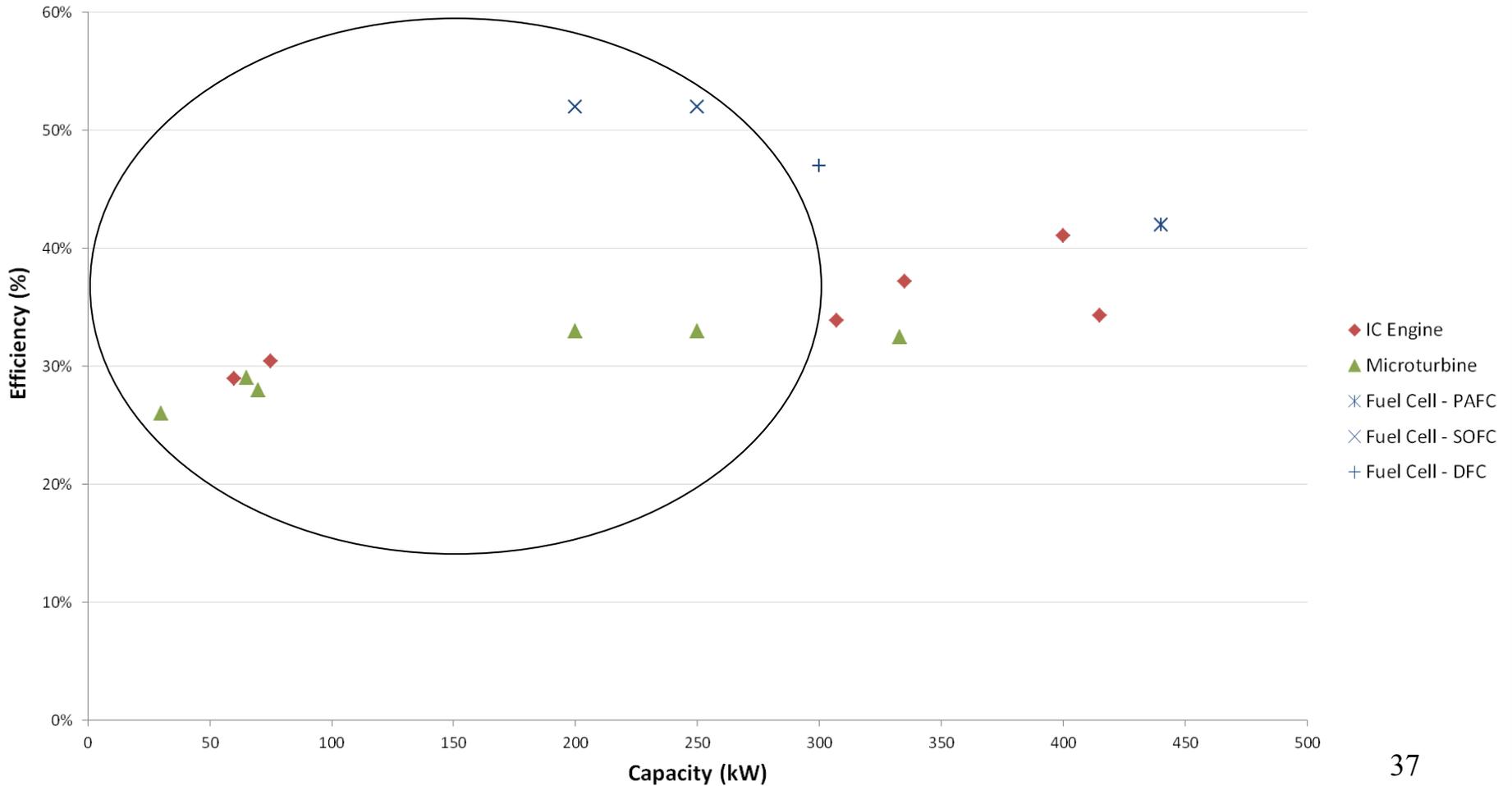
Surveyed DG Systems, Technologically Available (Global)





FY 2016-17 Proposed Funding Initiatives

Surveyed DG Systems, Commercially Available (US)





FY 2016-17 Proposed Funding Initiatives

Removing Distributed Generation Barriers through Cost Effective Emissions Control and Other Novel Strategies (Cont.)

Research Description:

- Research will address the technical and economic barriers related to the deployment of DG, CHP, and CCHP in commercial, light industrial and multi-family residential applications
- Develop and demonstrate small and micro-scale DG, CHP, and CCHP systems or enabling technologies with emphasis on 2 R&D areas:
 - **Cost-Effective Emissions Control Systems to meet state emissions standards and enable a pathway to CARB certification**
 - Develop cost-effective control technologies and strategies to reduce emissions from existing DG prime movers
 - Develop cost-effective fuel pre-treatment or exhaust after-treatment systems to significantly reduce emissions from existing DG prime movers
 - Develop cost-effective, “out-of-the-box” emissions compliant DG, CHP, and CCHP systems



FY 2016-17 Proposed Funding Initiatives

Removing Distributed Generation Barriers through Cost Effective Emissions Control and Other Novel Strategies *(Cont.)*

Research Description (Cont.):

▪ Novel systems and strategies for small- and micro-scale DG/CHP/CCHP

- Introduce breakthrough advances in internal combustion engine, microturbine, and fuel cell technology which drastically increase performance, efficiency, and/or cost-effectiveness
- Develop hybrid or cascaded DG systems where heat from one generator drives another
- Develop other breakthrough DG technologies outside the internal combustion engine, microturbine, and fuel cell paradigm

Potential Partners and Customers: Facility owners and operators, technology manufacturers and providers, universities, utilities, and local, state and federal agencies

Estimated Ratepayer Benefits:

- Reduce heating and electric bills through self-generation by providing an option better tailored to higher electric to thermal load applications
- Improve air quality by reducing criteria pollutant emissions with beneficial impacts on health
- Increase energy security, conserve limited fossil fuel resources, and help mitigate GHG emissions

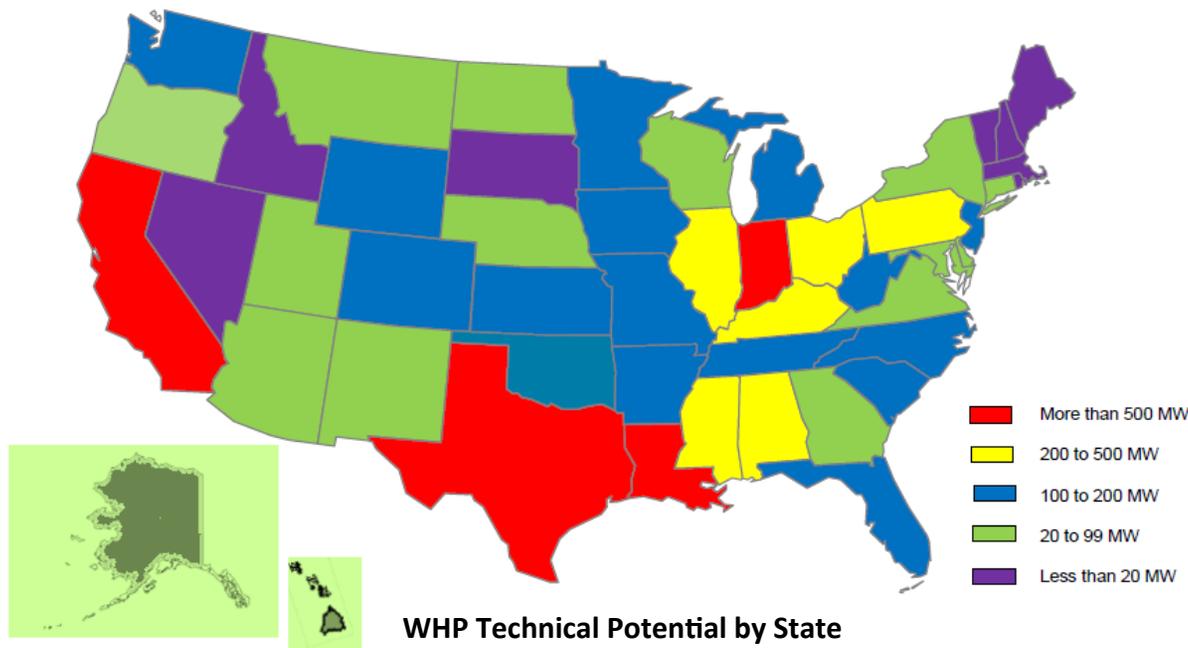


FY 2016-17 Proposed Funding Initiatives

Cost-Effective Waste Heat to Power Systems for California Industries

Background:

- Follow on to previous waste heat to power demonstration funding
- Capitalizes on abundant and virtually untapped waste heat in California's industries
- Only 18 MW of WHP is installed in CA compared to 763 MW of technical potential and 402 MW of economic potential*



*Waste Heat to Power Market Assessment. 2015. ICF International.



FY 2016-17 Proposed Funding Initiatives

Cost-Effective Waste Heat to Power Systems for California Industries *(Cont.)*

Research Description:

- Research will address cost reductions and efficiency improvements in collecting and managing waste heat, improving its quality for power generation, and improving the power generation systems
- Development of emerging technologies that show promise in reducing the cost of WHP by increasing efficiency or reducing complexity
- Systems based on the Kalina cycle, supercritical CO₂ Rankine/Brayton cycle, solid state thermoelectric, or other emerging technologies

Potential Partners and Customers: Facility owners and operators, technology manufacturers and providers, industrial facilities with abundant waste heat

Estimated Ratepayer Benefits:

- Reduce consumption of natural gas and increase on-site power generating capacity resulting in reduced electricity imported from the grid
- Increase energy security, conserve limited fossil fuel resources, and help mitigate GHG emissions



Proposed FY 2016-17 Budget

Initiatives	Proposed FY 2015/16 Natural Gas Budget
<p>Renewable Energy and Advanced Generation</p> <ul style="list-style-type: none">▪ Removing Distributed Generation Barriers through Cost-Effective Emissions Control and Other Novel Systems and Strategies▪ Cost-Effective Waste Heat to Power Systems for California Industries	<p>\$4,400,000</p>



Questions for the Stakeholders on Renewable Energy and Advanced Generation Research Initiatives

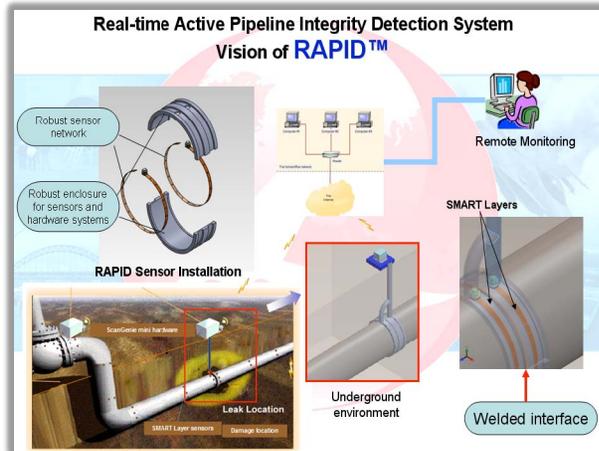
- Are we targeting the right research areas to advance DG and CHP deployment in California? What aspects of technological R&D in DG/CHP should be prioritized?
- Specifically, will emissions control, novel DG systems, and waste heat to power provide long term benefits to California ratepayers and play a key role in achieving the state's energy goals?
- Are there others sectors or opportunities not addressed in the initiative but will provide dramatic natural gas ratepayer benefits?
- What other research is needed to improve technical, economic and environmental aspects of distributed renewable and natural gas power generation?

Other general questions:

- Are there opportunities for partnerships to avoid duplication and generate new ideas to ensure research provides benefits to natural gas ratepayers?
- Are there opportunities for collaboration or synergies? If so, with whom?
- Are there any federal cost share opportunities related to this research? If so, what are they?



Natural Gas Infrastructure Integrity



Presenter:
Avtar Bining



Goals

- Conduct research in natural gas infrastructure not adequately addressed by the regulatory and competitive markets
- Provide research that results in tangible benefits to utility customers
 - Focus is on projects that have the potential to increase safety and enhance transmission and distribution capabilities of the natural gas system



Policy Drivers

Research to meet our Energy Policy Goals

Public Resources Code 25620

- The program goal is to develop and bring to market technologies that provide greater system reliability, increased environmental benefits and lower system costs

2011 Integrated Energy Policy Report

- “The state needs public interest energy research to explore opportunities and apply new and emerging technologies that provide innovative options for natural gas pipeline integrity, operations, and safety.”

Greenhouse Gas Emission Reduction – AB 32

CPUC Natural Gas Safety Action Plan (April 2013)

- More research is needed to develop cost-effective natural gas safety inspection equipment and tools for risk analysis.

Executive Order B-30-15

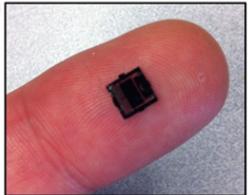
- Reduce GHG emissions to 40% below 1990 levels by 2030 and 80% below 1990 levels by 2050

SB 1371

- CPUC to develop strategies to reduce leaks from transmission and distribution lines



Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
<p>Innovative Monitoring Technologies</p> 	<p>Contractor: The Regents of the University of California – UC Berkeley – CITRIS/CIEE R&D Funds: \$855,835 Term: 6/30/2011 – 1/1/2015</p> <p>Purpose: To explore innovative sensor and communication technologies and approaches for inspecting and monitoring natural gas pipelines, and develop a testbed for testing sensors under simulated field conditions in the lab</p> 	<p>Accomplishments</p> <ul style="list-style-type: none"> •Designed and developed an <u>innovative low-cost, miniature</u> Micro Electro-Mechanical Sensor (MEMS) system prototype to inspect, monitor and report on the operating condition of natural gas pipelines •Designed and fabricated a <u>safe and convenient</u> pipeline sensor test bed •Tested sensors for reliability and refined sensor designs •Prototyped wireless communication package for <u>inexpensive real-time data</u> transfer •Results presented to NG Pipeline Integrity and Safety stakeholders at several workshops <p>Current Status</p> <ul style="list-style-type: none"> •Final Report published <p>http://www.energy.ca.gov/2014publications/CEC-500-2014-104/index.html</p>

Natural gas pipeline sensors testbed at UC Berkeley

Miniaturized sensor



Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
<p>Innovative Monitoring Technologies</p>  <p>Straight pipe installation</p>  <p>Bend Pipe Installation</p>	<p>Contractor: Acellent Technologies, Inc. PON-12-505 R&D Funds: \$622,622 Term: 6/20/2013 – 9/30/2015</p> <p>Purpose: To develop and demonstrate a continuous integrity monitoring system for natural gas pipeline for providing operators with increased information on the current status of the pipeline networks.</p> 	<p>Accomplishments</p> <ul style="list-style-type: none"> •Developed a prototype pipeline corrosion monitoring system meeting the PG&E specifications •Installed the system at PG&E test lab with complete remote monitoring capability and active 24-7 ongoing testing •The system, in blind tests, detected accurately and consistently multiple corrosion damages induced by PG&E •The entire system can be miniaturized , mass produced and deployed in the gas industry in a cost effective manner <p>Current Status</p> <ul style="list-style-type: none"> •Final Report published. <p>http://www.energy.ca.gov/2015publications/CEC-500-2015-095/CEC-500-2015-095.pdf</p>

Acellent’s RAPID system deployed at PGE for testing 48



Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
<p>Innovative Monitoring Technologies</p>	<p>Contractor: Diakont Advanced Technologies, Inc. PON-12-505 R&D Funds: \$1,000,000 Match Funds: \$1,600,000 Term: 6/30/2013 – 4/1/2015</p> <p>Purpose: To demonstrate and commercialize a multi-channel electromagnetic acoustic transducer sensor module for pipeline (in-line) inspection crawler for accurately detecting, locating, and measuring natural gas pipeline girth weld defects</p>	<p>Accomplishments</p> <ul style="list-style-type: none"> •Completed design and manufacturing of hardware components and developed control and signal conversion software •Completed hardware and software integration. •Demonstrated sensor on PG&E pipeline in south Bay Area near San Francisco •Reduced cost of inspections •Non-destructive and requiring minimum digging (1/75th of the excavation sites typically required for the inspection with current methods) •Faster inspection times <p>Current Status</p> <ul style="list-style-type: none"> •Test data analysis and further evaluation in progress • Final Report is published. <p>http://www.energy.ca.gov/publications/displayOneReport.php?pubNum=CEC-500-2015-028</p>

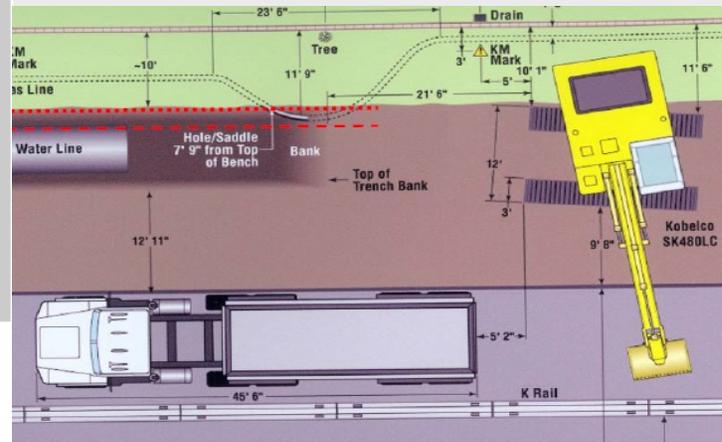


Diakont's Robotic Operational Defect Inspection System (RODIS) at the pipeline entry



Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
<p>Natural Gas Pipeline Safety and Damage Prevention - Technologies to Monitor and Report Encroachments on the Pipeline Right of Way</p>	<p>Contractor: Gas Technology Institute (PIR-14-014) PON-14-503-1 R&D Funds: \$1,049,978 Term: 6/30/2015 – 3/30/2018</p> <p>Purpose: To deploy and demonstrate a system that alerts operators to the presence of threats in the pipeline ROW. The system wirelessly monitors vibration and electrical potentials on a pipeline at regular intervals; it also monitors the status of excavation machinery. The system will process this data to infer when digging equipment or other threats to the pipeline are present in the ROW prior to damage occurring.</p>	<p>Accomplishments</p> <ul style="list-style-type: none"> • Identified long-range, low-power radio systems for capturing pipe sensor data • Secured commitments from PG&E and SoCal Gas for technology test sites • Identified and secured a partner, Acellent, to provide pipe vibrations sensors <p>Current Status</p> <ul style="list-style-type: none"> • The project was recently initiated • Technical coordination between GTI, wireless equipment, and sensor providers is underway • Site planning will be starting soon

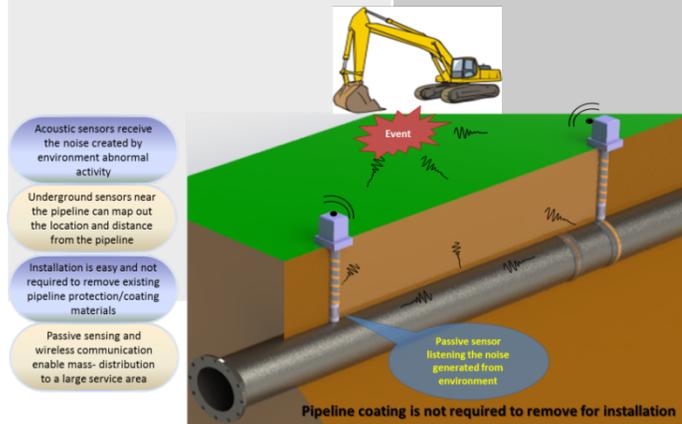




Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
<p>Natural Gas Pipeline Safety and Damage Prevention</p> <p>- Technologies to Monitor and Report Encroachments on the Pipeline Right of Way</p>	<p>Contractor: Acellent Technologies, Inc. (PIR-14-015) PON-14-503</p> <p>R&D Funds: \$1,736,093</p> <p>Term: 6/30/2015 – 3/30/2018</p> <p>Purpose: To develop and demonstrate a combined active damage detection and passive pipeline encroachment detection system for ensuring the natural gas pipeline safety</p>	<p>Accomplishments</p> <ul style="list-style-type: none"> • RAPID+ system provides improved capabilities for early detection of incidental or intentional encroachment events that threaten the gas pipeline network in the ground and support the near field measurement of the severity of damage caused by the encroachment events. • The developed RAPID+ system will improve the safety and risk management techniques for utility companies and gas pipeline industries. • Integrating the RAPID+ system for deploying in the field <p>Current Status</p> <ul style="list-style-type: none"> • Developing multi-state acoustic and vibration sensors for encroachment detection • Continuous testing developed system in the underground simulation environment in progress • Finalize the encroachment detection system requirements and specification by end of 2015 • Start to work with utilities for field test planning • Engineering system to be ready for field testing in the Summer of 2016

Acellent Encroachment Detection System





Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
<p>Natural Gas Pipeline Safety and Integrity Management</p> <p>Group 1: Technologies that Improve Situational Information; Group 2: Technologies that Enhance Integrity Management Practices through Risk Analysis; and Group 3: Natural Gas Pipeline Safety Integrity Monitoring Technologies Assessment</p>	<p>Develop and demonstrate natural gas pipeline safety and integrity management technologies that improve situation information and communication, enhance integrity management practices through risk analysis, and assess the status of various technologies.</p>	<ul style="list-style-type: none">• Future Solicitation



Program Highlights

Natural Gas Pipeline Research - Best Practices in Monitoring Technology

Contractor: Gas Technology Institute

R&D Funds: \$480K

Term: 06/20/2011 – 06/30/2013

Technology: Developed a baseline assessment of technologies currently used nationwide and in California to manage natural gas (NG) pipeline integrity and safety, Identify emerging technologies, and develop an implementation plan to bring emerging technologies to California.

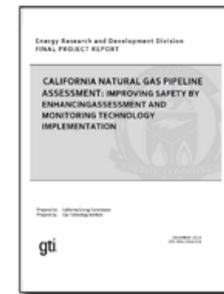
Key Features:

- Successfully completed a baseline assessment of technologies
- Identified emerging technologies
- Developed an implementation plan to advance emerging technologies
- The Final Report (CEC-500-2014-024) has been published

and is available at:

<http://www.energy.ca.gov/2014publications/CEC-500-2014-024/CEC-500-2014-024.pdf>

The results were presented at public workshops. The information has been used to develop FY 2014-15 and FY 2015-16 NG pipeline integrity research initiatives, develop solicitations and fund research projects.





FY 2016-17 Proposed Funding Initiatives

Enhanced Methods and Tools for Natural Gas Pipeline Safety and Integrity Management

- **Research Description:** Develop new approaches that make use of application of advanced methods, technologies and high-speed, high-power computers for real-time pipeline damage and flaw detection, risk assessment, hot spot identification, and corrective action planning and implementation.
- **Potential Partners and Customers:** Natural Gas Utilities, Pipeline Industry, Research Institutions, Policymakers & Regulators.
- **Advances in Science and Technology:** Increase the accuracy of pipeline monitoring and inspection technologies, provide operators more precise data on current status of pipeline network in nearly real-time.
- **Estimated Ratepayer Benefits:** Improve the safety and security of natural gas pipelines, improve reliability of natural gas pipeline network.



FY 2016-17 Proposed Funding Initiatives

Enhanced Methods and Tools for Natural Gas Well Safety and Integrity Management

- **Research Description:** Develop new approaches that make use of advanced methods and technologies for natural gas well damage and flaw detection, risk assessment, hot spot identification, and corrective action planning and implementation.
- **Potential Partners and Customers:** Natural Gas Production and Processing Industry, Research Institutions, Gas Associations, Policymakers and Regulators.
- **Advances in Science and Technology:** Increase the effectiveness of gas well monitoring and inspection technologies, provide operators more precise data on current status of gas production and processing infrastructure in nearly real-time.
- **Estimated Ratepayer Benefits:** Improve the safety and security of natural gas wells and improve reliability of natural gas production and processing infrastructure.



FY 2016-17 Proposed Funding Initiatives

Detection of Potential Failure Modes of Underground Natural Gas Storage

- **Research Description:** Develop advanced technologies for early detection of potential failure modes of injection well pipelines of underground natural gas storage in California including pipeline damage and flaw detection, risk assessment, hot spot identification, and corrective action planning and implementation.
- **Potential Partners and Customers:** Natural Gas Utilities, Pipeline and Gas Storage Industry, Research Institutions, Policymakers, and Regulators.
- **Advances in Science and Technology:** Increase the capabilities of technologies for early detection of failure modes of injection well pipeline and develop corrective actions.
- **Rate Payer Benefits:** Improve the safety and integrity of natural gas storage, improve reliability of natural gas pipeline and storage infrastructure.



Proposed FY 2016-17 Budget

Initiatives	Proposed FY 2016-17 Natural Gas Budget
<p>Natural Gas Pipeline Safety and Integrity</p> <ul style="list-style-type: none">▪ Enhanced Methods and Tools for Natural Gas Pipeline Safety and Integrity Management▪ Enhanced Methods and Tools for Natural Gas Well Safety and Integrity Management▪ Detection of Potential failure Modes of Underground Natural Gas Storage	<p>\$4,000,000</p>



Questions for the Stakeholders on Natural Gas Infrastructure Safety and Integrity

- Are we emphasizing the right initiatives and technologies that can improve safety and integrity management of natural gas infrastructure?
- Are there any missing opportunities to further improve the safety and integrity of natural gas infrastructure?
 - Emerging Technologies
 - Technology Potential
 - Market Connection Commercialization and Deployment Potential
 - Inspection cost reductions
 - Minimizing intrusion and damage
 - Energy and Cost Savings
 - Environmental Benefits
- Are there opportunities for partnerships to avoid duplication and generate new ideas to ensure research provides benefits to natural gas ratepayers?
- Are there opportunities for collaboration or synergies? If so, with whom?
- Are there any federal cost share opportunities related to this research? If so, what are they?



Energy-Related Environmental Research



Presenter: Guido Franco



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/mitigate environmental problems; identify vulnerabilities of the energy system to climate change and develop cost-effective approaches to ensure reliable energy services.
- Complement research efforts by producing California-specific products that also inform policy formulation, in these areas:
 - Energy – related climate change
 - Energy – related air quality
 - Energy – related terrestrial resources
 - Energy – related aquatic resources



Policy Drivers

Warren-Alquist Act

- CEQA equivalent environmental evaluations for power plants

IEPR

- Energy-related Environmental Research Priorities

Safeguarding California

- An update to the Adaptation Strategy that was adopted by the Governor in 2009; identifies adaptation measures that state agencies should implement

SB 1250

- Increased energy efficiency, reduce or eliminate consumption of water and other finite resources, increase renewable energy

Loading Order

- Increase energy efficiency, renewable energy, clean fossil generation, infrastructure improvements

Title 24

- Promote energy efficiency through building standards

AB 32

- Reduce GHG to 1990 levels by 2020



Policy Drivers

Governor Brown's State Energy Plan

- 12,000 MW localized Generation, 8,000 MW Large Scale Renewable, 6,500 MW CHP

SB X 1-2, SB 350

- RPS, 33% by 2020 and 50% by 2030

AB 1496

- Life cycle analysis for natural gas

Delta Reform Act of 2009

- Delta Stewardship Council to update priorities for State investments in the Delta levee system. Work with CEC on energy related issues.

SB 1371

- CPUC to develop strategies to reduce leaks from transmission and distribution lines

Executive Order S-01-07

- Low Carbon Fuel Standards shall be measured on a full cycle basis

Executive Order B-30-15

- Sets a greenhouse gas (GHG) emissions target for 2030 at 40 percent below 1990 levels



Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
Investigations of Potential Induced Seismicity Related to Geologic Carbon Dioxide Sequestration in California	Reducing the risk of seismic events <ul style="list-style-type: none"> ▪ Analyze information depicting the occurrence of oil and gas production-related induced seismicity ▪ Conduct laboratory measurements of the fracture permeability of natural cap rock samples 	<ul style="list-style-type: none"> ▪ Analyzed information on the occurrence of oil and gas production-related seismicity ▪ Conducting simulations of induced seismicity at King Island
Evaluation and Improvement of Particulate Matter Measurement from NG Power Plants	Existing regulatory methods may be overestimating PM emissions <ul style="list-style-type: none"> ▪ Evaluate current methods for measuring PM emissions from power plants ▪ Conduct pilot-scale study of PM measurements 	<ul style="list-style-type: none"> ▪ Study completed. ▪ Measured PM emissions depend on how they are measured. ▪ Emissions are extremely low.
Investigating Options that Could Reduce Net GHG Emissions from the NG System	Investigation of methods to reduce GHG emissions in cost effective manner <ul style="list-style-type: none"> ▪ Survey of methane emissions from key subsectors of the NG system ▪ Improvement of an airborne system for leak detection 	<ul style="list-style-type: none"> ▪ Measurements at storage facilities, wells, distribution system, homes, and fueling stations. ▪ Results suggest that emissions may be higher than expected for extraction and distribution. ▪ Airborne system works very well with the addition of an ethane analyzer.



Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
Assessment of Residential Natural Gas Emissions	<ul style="list-style-type: none"> ▪ Design the study and conduct building leakage measurements in approximately 75 sample houses. ▪ Prior study sampled 10 homes. 	<ul style="list-style-type: none"> ▪ Equipment that will be used in the field measurements is being tested during laboratory experiments
Air Quality Implications of using Biogas (AQIB) to Replace Natural Gas in California	<ul style="list-style-type: none"> ▪ Measure the biological and chemical composition of biogas/biomethane and the composition of their combustion emissions 	<ul style="list-style-type: none"> ▪ Analytical equipment for measurements has been prepared ▪ Preliminary samples of raw biogas have been collected
Research and Development of Natural Draft Ultra Low Emissions Burners for Gas Appliances	<ul style="list-style-type: none"> ▪ Develop and characterize a natural draft burner suited to residential and commercial cooking appliances that significantly reduces NO_x emissions. 	<ul style="list-style-type: none"> ▪ The final report is being prepared ▪ PI is working on the commercialization of the technology



Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
Vulnerability of the Natural Gas System to Climate Change: Initial Studies	<ul style="list-style-type: none"> ▪ Estimate subsidence of levees ▪ Improve sea level rise projections ▪ Conduct regional vulnerability studies 	<ul style="list-style-type: none"> ▪ Project on-going ▪ One selected study for the San Diego region. Two more studies would be added in the near future.
Characterize the Impact of California Drought-Related Subsidence on Natural Gas System	<ul style="list-style-type: none"> ▪ Estimate impacts of subsidence on pipelines and underground NG storage facilities ▪ Characterize the impact of subsidence on methane emissions from abandoned/plugged natural gas wells 	<ul style="list-style-type: none"> ▪ Future Solicitation
Long Term Strategic View of the Use of Natural Gas in a Carbon-Constrained Water-Efficient Environment	<ul style="list-style-type: none"> ▪ Develop long-term scenarios for natural gas taking into account GHG reduction programs. ▪ Explore options to decarbonize the natural gas system ▪ Explore issues related to the injection of hydrogen which may damage the natural gas pipelines 	<ul style="list-style-type: none"> ▪ Future Solicitation

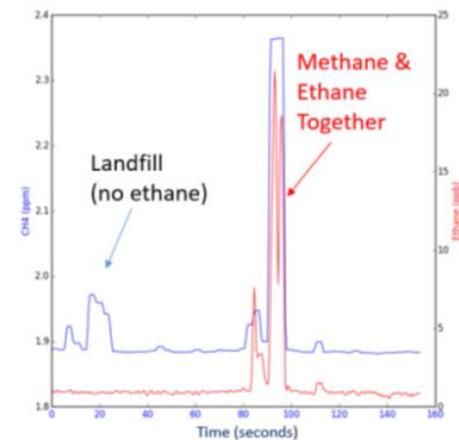


Program Highlights

Using a Research Aircraft to Identify and Quantify Emissions from Natural Gas Facilities

- **Contractor:** University of California, Davis
- **R&D Funds:** \$300,000
- **Term:** 03/17/2014 – 06/16/2017
- **Technology:** Use an aircraft equipped with methane and ethane sensors to detect and quantify methane emissions from California's natural gas pipeline infrastructure.
- **Key Features:** The ethane analyzer allows the identification of pipeline leaks from other sources of methane. Quantification of leaks was a success during controlled releases executed by PG&E.
- **Highlight:** On 11/7 and 11/10 of 2015, the research team deployed its aircraft to make measurements of a natural gas leakage incident in Aliso Canyon. By measuring methane and ethane downwind from the methane plume at several elevations, the researchers can distinguish the methane plume associated with Aliso Canyon from a nearby landfill, then calculate the methane flux. Results from the flights are presented in a preliminary report released by the Air Resources Board.

Google Images

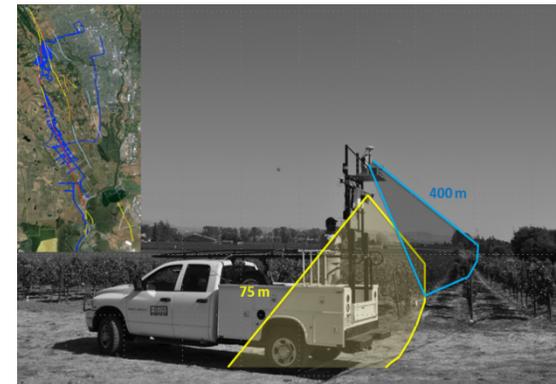




Program Highlights

Monitoring Levee Stability Using Mobile Laser Scanning

- **Contractor:** US Geological Survey (USGS)
- **R&D Funds:** \$325,000
- **Location:** Sacramento-San Joaquin Delta
- **Term:** 10/08/2014 – 07/31/2017
- **Technology:** Field team used mobile, ground-based method (LiDAR) to characterize subsidence in areas of the Sacramento-San Joaquin Delta that are of interest with respect to natural gas infrastructure. Data was acquired to map subsidence over parts or all of the following islands and levees: Joice, Grizzly, Chipps, Van Sickle, Spinner, Montezuma, Brown's, Winter, Chain, Kimball, West, Sherman, Jersey.
- **Key Features:** After the August 2014 Napa earthquake, team leveraged additional resources through USGS to conduct monitoring of time-varying seismic risks at an enhanced level of precision, in addition to ongoing subsidence mapping that was targeted by original scope of work.
- **Ratepayer Benefits:** State-funded research to map Delta and levee subsidence and identify vulnerable areas is key ensuring the resilience of California's natural gas system.





FY 2016-17 Proposed Funding Initiatives

Exploratory Study of Innovative Methods to Assess Structural Integrity of Levees Protecting Natural Gas Infrastructure in the Sacramento-San Joaquin Delta

- **Research Description:** The research goal is to develop innovative non-invasive/non-destructive method(s) for assessing the structural integrity of levees in Delta area that directly or indirectly protect natural gas infrastructure. The technical and economic viability of the method(s) shall be evaluated. Results originating from this work shall be used to make a decision about future implementation of the selected method(s) at a large scale to the levees directly or indirectly protecting critical natural gas infrastructure in Delta.
- **Potential Partners and Customers:** Natural Gas Utilities, Delta Stewardship Council, DWR, Environmental Groups, Policymakers, and Regulators.
- **Estimated Ratepayer Benefits:** Improvement of methods for assessing stability of an area of critical importance to natural gas generation reliability and safety in California. Addressing potential infrastructure problems early would help to avoid later costs related to clean up, emergency response, and challenging repairs. This research will provide the necessary foundation to improve the protection of delicate ecosystem as well as human health by preventing flooding in Delta area.



FY 2016-17 Proposed Funding Initiatives

Improved Characterization of the Climate Implications of Natural Gas Consumption in California

- **Research Description:** The proposed research continues extensive field studies to detect and quantify GHG emissions of interest to California's natural gas system using innovative methods. This builds on research supported by ARB and Energy Commission. Potential and otherwise unanticipated large releases of methane that may pose a safety or public health concern shall be identified. Collected data shall be sufficient to validate models capable of accurately estimating the climate benefits of biomethane.
- **Potential Partners and Customers:** NG Utilities, RNG Producers, Environmental Groups, ARB, Policy Makers and Regulators, End Users, and CalRecycle
- **Advances in Science and Technology:** Innovative methods for detection and quantification of methane emissions will help to characterize climate implications of NG consumption in California.
- **Estimated Ratepayer Benefits:** Identification and quantification of methane emissions from the natural gas system, and in particular from super emitters would support California's efforts to effectively manage the climate and air quality impacts of methane emissions and to determine climate benefits associated with the use of biomethane vs. natural gas.



FY 2016-17 Proposed Funding Initiatives

Chemical and Isotopic Fingerprints of Natural Gas Basins to Support Full Fuel Cycle Accounting

- **Research Description:** The research goal is to develop method(s) to analyze the chemical and isotopic composition of natural gas samples from different basins and to explore the feasibility of differentiating between basins. This is important because emission rates differ in a substantial way between basins. The evaluated experimental results shall be compiled in a database so that they can be used in assessments of the life-cycle greenhouse gas emissions of natural gas imported to California. A preliminary estimation of GHG emission contributions from NG depending on its origination based on published studies on GHG emissions from different basins.
- **Potential Partners and Customers:** Natural Gas Utilities, Environmental Groups, ARB, Policy Makers, and Regulators.
- **Advances in Science and Technology:** Breakthrough identification of natural gas provenance.
- **Estimated Ratepayer Benefits:** Distinguishing between different natural gas mixtures based on their chemical composition and isotope distribution among the constituents would allow determination of the life-cycle GHG emissions from natural gas imported to California. This will allow the preparation of technical sound life cycle analyses for natural gas.



Proposed FY 2016-17 Budget

Initiative	Proposed FY 2016-17 Natural Gas Budget
<p>Energy-Related Environmental Research</p> <ul style="list-style-type: none">▪ Exploratory Study of Innovative Methods to Assess Structural Integrity of Levees Protecting Natural Gas Infrastructure in the Sacramento-San Joaquin Delta▪ Improved Characterization of the Climate Implications of Natural Gas Consumption in California▪ Chemical and Isotopic Fingerprints of Natural Gas Basins to Support Full Fuel Cycle Accounting	<p>\$2,600,000</p>



Questions for the Stakeholders on Energy-Related Environmental Research

- Are we addressing the most important environmental issues that would affect the natural gas system in the next 5 to 10 years?
- Is our long-term research perspective of factors that may affect the natural gas industry in the next 36 years (from now to 2050) adequate?
- Are there additional opportunities for collaboration or synergies? If so, with whom?
- Are there any federal cost share opportunities related to this research? If so, what are they?



Natural Gas Transportation Research



Presenter: Pilar Magaña



Goals

The goals of transportation-related projects are to:

- Reduce carbon emissions
- Improve infrastructure capacity, reliability, and sustainability
- Improve air quality
- Increase the use of transportation renewable fuels



Policy Drivers

The following legislation and policy guide the Natural Gas-Related Transportation research area on meeting California's challenges:

Governor's Executive Order B-32-15

- Directs improvement of freight efficiency, transition to zero-emission technologies, and increase competitiveness of California's freight system.

2013 Integrated Energy Policy Report

- Growth scenario shows six fold increase in natural gas vehicles between 2012 and 2020.

Senate Bill 1250

- Enables PIER funds to be used for advanced transportation technologies that:
 - Reduce air pollution and GHG emissions beyond applicable standards.
 - Benefit natural gas ratepayers.

Assembly Bill 32

- Calls for approximately 36 percent of the state's 2020 GHG reduction targets to come from the transportation sector.
- Low Carbon Fuel Standard-designed to encourage the use of cleaner low-carbon fuels in California, encourage the production of those fuels, and, therefore, reduce GHG emissions.

Assembly Bill 118 & 8 (Alternative and Renewable Fuel and Vehicle Technology Program)

- Authorizes the Energy Commission to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies

Executive Order B-30-15

- Establishes a statewide goal to reduce greenhouse gas emissions 40 percent below 1990 levels by 2030



Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
Develop and Demonstrate an Ultra Low Emissions, High Performance Spark Ignited Natural Gas Engine	GTI is partnering with Cummins Westport, Inc. (CWI) to develop and validate an Alpha engine design for a new, high-performance, spark-ignited, dedicated natural gas 6.7 liter engine for use in applications such as school buses and parcel delivery vehicles	<ul style="list-style-type: none"> Initial development (Alpha version) of engine completed 2015 Final development (Beta version) of engine to be completed with new agreement. Work starting 2016 Potential for AB118 to fund fleet demonstration
Near-Zero Emission Technology Research for Heavy-Duty Natural Gas Vehicles	Reduce NOx levels by 90% through advanced engine technologies. Objective is to obtain near-zero NOx levels while continuing to meet or exceed other emission standards without incurring a fuel economy penalty	<ul style="list-style-type: none"> Research In progress. Expected project completion in 2016. Cummins Westport project team completed certification of near-zero NOx levels. <i>AB118 funding fleet demonstration</i>
Natural Gas Vehicle On-Board Storage	Develop and demonstrate advanced natural gas tank technologies providing a safe, low-pressure, high-density, conformable storage system that enables cost-effective home refilling of NG vehicles	<ul style="list-style-type: none"> In Progress Project started in November 2014



Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
Natural Gas Vehicle Hybridization	Develop and demonstrate hybridization designs that use battery power to minimize emissions, idle, and low-load engine operation	<ul style="list-style-type: none"> ▪ In Progress ▪ Three projects were awarded: <ol style="list-style-type: none"> 1. Efficient Drivetrains, Inc. 2. TransPower 3. Gas Technology Institute ▪ Expected completion 2017
Natural Gas Fueling Infrastructure Improvements	Develop technology that improves the fueling method in natural gas vehicles so that a true “full fill” of compressed natural gas can be achieved.	<ul style="list-style-type: none"> ▪ In Progress ▪ One project awarded for full-fill improvements: <ol style="list-style-type: none"> 1. Gas Technology Institute ▪ Expected Completion 2017
Advanced Ignition Engine Research	Develop advanced ignition methods to improve engine efficiency while reducing emissions	<ul style="list-style-type: none"> ▪ In Progress ▪ Three projects awarded: <ol style="list-style-type: none"> 1. Gas Technology Institute 2. North American Repower 3. Olson Ecologic ▪ Expected completion 2017/18



Current Portfolio Highlights and Major Initiatives

Initiative	Description	Status
Development and Demonstration of Off-Road Natural Gas Applications	Natural gas engine development, integration and demonstration for off-road vehicle applications	<ul style="list-style-type: none">▪ Solicitation Release Summer 2016
On-Road, In-Use Emissions and Fuel Usage Assessment	On-road, in-use emission and fuel usage testing for heavy-duty natural gas vehicles	<ul style="list-style-type: none">▪ Expected Start Summer 2016



Program Highlights

Natural Gas 8.9 Liter Engine Achieves 'Near-Zero' NOx Emissions

- **Contractor:** South Coast Air Quality Management District
- **R&D Funds:** \$2 M (Match approximately \$2M)
- **Location:** Diamond Bar, California
- **Term:** 06/30/2013 – 06/30/2016
- **Partners:** Cummins Westport, Inc., Southern California Gas Company
- **Technology:** Development, integration, and demonstration of an advanced low NOx 8.9 liter, heavy-duty stoichiometric spark-ignited natural gas engine with performance suitable for vocational applications such as refuse trucks and transit buses.
- **Key Features:** Successfully met and exceeded the project objectives to reduce NOx levels by 90% while maintaining other emission levels. The Cummins Westport 8.9 Liter engine was certified at 0.02g/bhp-hr of NOx in October 2015 and exceeded the target level, measuring at 0.01g/bhp-hr NOx. On-road fleet demonstrations are in progress. First heavy-duty natural gas engine in North America to achieve certification at optional CARB NOx level.
- **Estimated Ratepayer Benefits:** Local communities will benefit from improved health from reduced emissions of particulate matter from heavy-duty natural gas vehicles over diesel-fueled vehicles in this sector, which encompasses intensive urban deployment, particularly for both refuse and transit sectors. Additional emission reduction benefits can be realized through the use of renewable natural gas.



FY 2016-17 Proposed Funding Initiatives

Improving the Economics of On-Board Compressed Natural Gas Storage Research and Development

- **Research Description:** Research to improve the economics of lightweight gas storage by developing more cost-effective and fuel efficient compressed natural gas storage options.
- **Potential Partners and Customers:** Partners may include research institutions, national labs, other governmental agencies, and private industry
- **How it Advances Science and Technology:** Using alternative materials and strategies for developing cost-effective on-board compressed natural gas tanks will support efforts to increase fuel efficiency and vehicle range for natural gas vehicles. The industry has developed lighter alternatives, however the cost is a significant barrier for commercial adoption. This research will address this by developing low-cost, lightweight CNG storage options for natural gas vehicles.
- **Estimated Ratepayer Benefits:** Weight reduction in vehicle is a particularly important strategy for improved efficiency and emission reductions. Research and demonstration of a viable low cost tank option will accelerate the adoption of natural gas vehicle applications for emission reductions in local communities.



FY 2016-17 Proposed Funding Initiatives

Improving Heavy-Duty Natural Gas Engine Operating Efficiency Research

- **Research Description:** Develop and demonstrate new medium- and heavy-duty natural gas engine technologies with a particular emphasis on increasing efficiency and reduced emissions. This research will build on previous Transportation Research into advanced technologies such as cylinder deactivation, advanced ignition and combustion methods.
- **Potential Partners and Customers:** Partners may include research institutions, national labs, other governmental agencies, and private industry OEMs
- **How it Advances Science and Technology:** By advancing technology development of improved natural gas engine that close the performance gap between spark-ignited natural gas and diesel engines, while simultaneously supporting emission reduction in heavy-duty vehicles. This research will accelerate the deployment of high-performance competitive natural gas engine technologies needed to meet emission reduction goals in the heavy-duty sector.
- **Estimated Ratepayer Benefits:** California will benefit from expanded natural gas vehicle operation by reducing criteria pollutants, petroleum use, and greenhouse gas emissions, resulting in improved air quality in local communities.



Proposed FY 2016-17 Budget

Initiatives	Proposed FY 2016-17 Natural Gas Budget
<p>Natural Gas-Related Transportation</p> <ul style="list-style-type: none">▪ Improving the Economics of On-Board Compressed Natural Gas Storage Research and Development▪ Improving Engine Efficiency for Heavy-Duty Natural Gas Engines Research and Development	<p>\$3,500,000</p>



Questions for the Stakeholders on Natural Gas-Related Transportation

- Are we emphasizing the right initiatives?
- Are there any missing opportunities?
 - Energy Sector
 - Technology Potential
 - Market Connection
 - Energy and Cost Savings
 - Environmental Benefits
- Are there any recommendations to reallocate funding?
- Are there opportunities for partnerships to leverage additional funding? What are the priority areas that require more emphasis?
- Are there opportunities for collaboration or synergies? If so, with whom?
- Are there any federal cost share opportunities related to this research? If so, what are they?



Public Comments (General Questions)



Closing Comments

- Submit additional written comments to: Rosa Vazquez (rosa.vazquez@energy.ca.gov) by 5:00 pm on January 29, 2016
- Final draft to be submitted to the California Public Utilities Commission by March 31, 2016
- Copies of presentations , public comments and responses to questions from today's workshop will be posted at: <http://www.energy.ca.gov/research/notices/index.html#XXX>
- Copies of past budget documents can be found at: http://www.energy.ca.gov/research/annual_reports.html