Natural Gas Research Initiatives for 2013/14

Presented at the Stakeholders Meeting
California Energy Commission
January 22, 2013
1:30 pm - 5:00 pm

Agenda

Time	Topic
1:30	Introductions and Purpose – Mike Gravely
2:00	Staff Presentations on Proposed Natural Gas Research Initiatives • Energy Efficiency – Virginia Lew, Bradley Meister, Michael Lozano • Renewable Energy – Linda Spiegel, Rizaldo Aldas • Energy Infrastructure – Fernando Piña, Jamie Patterson, Guido Franco, Aleecia Gutierrez • Small Grants Program – Fernando Piña, Raquel Kravitz
4:00	Public Comments
5:00	Closing/Next Steps – Mike Gravely

Introduction

- For the natural gas 2012-13 budget, the Energy Commission R&D Program included a public vetting process with the Stakeholders that included a public workshop

- For the natural gas 2013-14 budget, the Energy Commission R&D Program released a questionnaire to researchers to seek ideas for natural gas research initiatives
  - Received 121 proposed initiatives
  - Program staff evaluated each initiative and some have been incorporated in 2013-14 budget
  - A complete listing on research initiatives received can be found at http://www.energy.ca.gov/research/notices/index.html#01222013

Introduction

- Today's meeting provides similar input for the natural gas research

- Role of Stakeholders
  - Advice on initiatives
  - Alert staff to possible duplication of efforts
  - Highlight opportunities for synergies in research efforts
  - Assist in effective transfer of research results

Budget and Priorities

- Transparent budget process
- Priorities
  - Ratepayer benefits and California focus
  - Emphasis shift to development and demonstration
  - Enhanced outreach strategy
- Strategic Natural Gas budget look ahead
- Support State Energy Policies and Governor's priorities

Natural Gas Research Areas/Initiatives

- Energy Efficiency
  - Buildings Energy End-Use Efficiency
  - Industrial Agricultural & Water
  - Energy Efficiency Related Environmental Research
- Renewable Energy
  - Combined Heat and Power (CHP)
  - Renewable Energy Related Environmental Research
- Energy Infrastructure
  - Natural Gas Pipeline Integrity
  - Energy Related Environmental
  - Natural Gas Related Transportation
- Small Grants Program supports all three program areas

Prior Fiscal Year and Proposed - Natural Gas 2013/2014 Budget

Areas	Approved FY 2012/13 Natural Gas Budget	Proposed FY 2013/14 Natural Gas Budget	Percent of Grand Total for 2013/14
Buildings End Use Energy Efficiency	$4,000,000	$4,200,000	
Industrial, Agriculture and Water Efficiency	$ 4,000,000	$ 4,341,000	
Energy Efficiency	**$8,000,000**	**$8,541,000**	**36%**
Renewable Energy	**$4,000,000**	**$3,000,000**	**12.5%**
Natural Gas Pipeline Integrity	$1,000,000	$1,500,000	
Energy-Related Environmental	$3,000,000	$3,000,000	
Natural Gas-Related Transportation	$4,000,000	$4,000,000	
Energy Infrastructure	**$8,000,000**	**$8,500,000**	**35%**
Small Grants Program	**$1,500,000**	**$1,500,000**	**6%**
Technical Support	$303,000	$100,000	**.5%**
Administration	$2,197,000	$2,359,000	**10%**
Grand Total	**$24,000,000**	**$24,000,000**	

Benefits Estimation of Natural Gas Research Projects

- Improve tracking and developing a comprehensive benefits methodology
  - Follow-up on commercialized products and job creation

- Preliminary estimates of potential savings from 26 natural gas research projects*
  - 429 million therms/yr saved ($338 million/yr)
  - 2.3 million metric tons of GHG reduced

* California Energy Commission, 2012 Natural Gas Report to the California Public Utilities Commission, October 2012

Workshop Format

- Each Natural Gas team will make their presentation
- Questions related to the research initiatives will be posed to the Stakeholders at the end of each program area (e.g., efficiency, renewable energy and energy infrastructure)
- To ensure each team has time to complete their presentations, some questions may need to be deferred to the end
- There will be a public comment period at the conclusion of the presentations

Questions for the Stakeholders

Questions for each research area:

- Are we emphasizing the right initiatives?
- Are there any missing opportunities? If so, provide examples.
- Are there opportunities for collaboration or synergies? If so, with whom?

Natural Gas Research Areas/Initiatives

Energy Efficiency

- Buildings Energy End-Use Efficiency
- Industrial, Agricultural and Water Efficiency
- Energy Efficiency Related Environmental Research

Buildings Energy End-Use Efficiency

Presenter:
Bradley Meister, P.E.

I. Goals

Reduce energy use in buildings and communities:

- Advance energy efficient technologies, design tools, and operations
- Demonstrate affordable, comfortable, energy-efficient buildings
- Maintain or increase productivity while reducing energy consumption and emissions (e.g., low NOx)
- Improve information resources for sharing research results

II. Policy Drivers

Governor's Clean Energy Jobs Plan (2010)

- Adopt timeline to achieve ZNE in homes and commercial buildings in building standards
- Make existing buildings more efficient
- Adopt stronger appliance efficiency standards

Integrated Energy Policy Reports/Energy Action Plan

- Target research in energy efficient technologies, techniques, building operations/commissioning for newly constructed and existing buildings
- Research to support new/updated building and appliance efficiency standards
- Support pilot programs/demonstrations of Zero Net Energy (ZNE) buildings
- Collaborate with utilities to improve energy efficiency programs

California Energy Efficiency Strategic Plan (2008/2011)

- All new residential construction in California will be ZNE by 2020.
- All new commercial construction in California will be ZNE by 2030 and 50% of existing buildings will be equivalent to ZNE
- 40% reduction in energy consumption for existing homes (2008 baseline) by 2020
- HVAC industry and market to be transformed to ensure that energy performance is optimal for California's climate

SB 1250 (Perata and Levine, Chapter 512, Statutes of 2006)

- Undertake public RD&D projects that are not adequately provided for by competitive and regulated energy markets and that advance energy science or technologies of value to California citizens

II. Policy Drivers (continued)

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

AB 758 (Skinner, Chapter 470, Statutes of 2009)

- Achieve greater energy savings in the state's existing buildings

AB 549 (Longville, Chapter 905, Statutes of 2001)

- Improve energy efficiency of existing buildings

AB 2021 (Levine, Chapter 734, Statutes of 2006)

- Decrease peak electricity demand for air conditioners across the state

AB 1103 (Saldaña, Chapter 533, Statutes of 2007) and
AB 531 (Saldaña, Chapter 323, Statutes of 2009)

- Benchmark existing building energy use and provide public disclosure

California's Clean Energy Future Initiative

- Advance carbon-cutting energy efficiency innovation

Public Utilities Code Section 25402.8

- Consider impacts to indoor air pollution when assessing new building standards relating to conservation of energy

III. General Approach

Major Issues Considered in Planning New Research:

- **Policy** –Does it address an important California Policy?
- **Research gaps analysis** – Is there a significant gap in knowledge/products?
  - Identified through roadmaps, meetings with stakeholders, utilities and industry and research ideas submitted by the public
  - Near-term research to address market barriers
  - Longer-term research for more challenging, high-potential technologies
- **Energy** – Are probable energy saving impacts significant?
- **Market** – Is there a market connection for new technologies?
  - Engage commercial partners and end-users at an early stage of research
  - Increase program efficiency by collaborating with utilities, and state, federal and other governmental agencies, public/private research groups

Most research developed through competitive solicitations

IV. Major Accomplishments

Pipe Material and Insulation Tests Results
Lead to 2013 Residential Building Efficiency Standard

- **Contractor**: Applied Energy Technologies (Dr. Carl Hiller)
- **PIER funding**: Approximately $95,000
- **Description**: Conducted a variety of heat transfer tests, under various conditions and on a variety of materials and pipe sizes
- **Results**: Significant savings possible by adding insulation to buried and unburied hot water pipes ≥ ¾ inch in diameter

- **Rate payer benefits**: The cumulative savings for the period 2014 to 2020 is projected to be nearly 9.4 million therms with a reduction of nearly 50,000 metric tons (MT) of GHG. Assuming an average natural gas cost of $0.96/therm for residential customers, these improvements can save Californians over $9 million for the period 2014 to 2020.

- **Next steps**: This research led to a 2013 Residential Building Energy Efficiency Standard (Title 24, part 6) requiring that insulation be used on hot water residential piping systems ≥ ¾ inch in diameter. The new Standard will take effect on January 1, 2014. The next step is to investigate savings with even larger pipes.

IV. Major Accomplishments

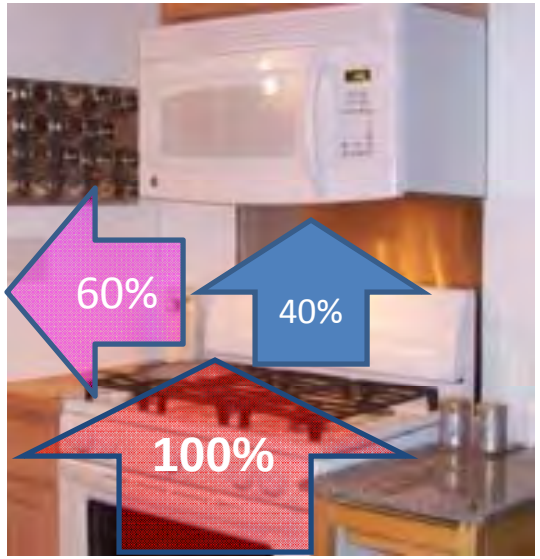
Improve the Energy Efficiency of Commercial Cooking Equipment

- **Contractor**: Gas Technology Institute
- **PIER funding amount**: $1,985,502 ($917,875 match)
- **Description:** Research to improve the efficiency of commercial gas appliances and water heaters through data collection and product design/development
- **Results:** Comprehensive test plans and equipment modifications were developed to improve the efficiency of a variety of commercial cooking equipment by the following amounts: Open top range (15%), conveyor oven (12%), convection oven (14%), wok (20%), under-fire broilers (23%), over-fire broilers (17%) and water heater system performance (15%).
- **Ratepayer benefits:** Projected savings of 29.7 million therms/year and 173,800 MT of GHG reduction, assuming 1% change in current gas usage in commercial cooking.
- **Next steps**: Field test improved equipment in 2013 to document energy savings.

IV. Major Accomplishments

Use of Range Hoods to Control Exposure to Pollutants from Natural Gas Cooking Equipment

- **Contractor:** Lawrence Berkeley National Laboratory
- **PIER funding amount**: $450,000
- **Description:** Project identified key factors for range hoods to control in-home exposures to pollutants from natural gas burners and cooking equipment.
- **Research results**: Gas burners and cooking without venting causes pollutant levels to exceed standards. Experiments identified key factors for current range hood effectiveness, R&D and standards needs.



- **Rate payer benefits:** Better range hoods and appropriate use will greatly reduce exposures to unhealthful pollutant levels and related health costs.
- **Next steps**: Develop a standard test method for capture efficiency; link energy standards to capture; automatic operation technology; increase public awareness; product rating system for consumers.

V. Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
Research for Commercial Facilities	**Improve efficiency of food service appliances**	• **Preliminary research underway** to improve efficiency of convection ovens, range tops, broilers and conveyor ovens. • Solicitation released in November 2012 • Future research : improve burner efficiency and other commercial appliances.
Research for Residential and Commercial Facilities	**Improve hot water generation and distribution systems**	• **Preliminary research completed** for food service, residential and multi-family. Also solicitation released in November 2012 • Future research: understand residential hot water use, combined heating options and point of use water heaters and cost effective options for existing buildings.
Research for Residential and Commercial Facilities	**Advanced energy efficient heating systems and building envelopes**	• **Preliminary research started** on innovative envelope sealing methods. Also, solicitation released in November 2012 • Future research: high efficiency and low NOx space heating systems and cost effective envelope retrofits.
Research for Residential and Commercial Facilities	**Cross-Cutting-ZNE and Low Income Housing**	• **Solicitation Released in November 2012**
Reduce Environmental Footprint	**Improve indoor environmental quality**	• **Completed key factors** for range hoods to control in-home exposures to NG cooking pollutants • **Roadmap in progress**. • Future research : understand indoor air quality and ventilation characteristics in new homes and strategies to improve and control ventilation rates in commercial buildings and classrooms.

VI. Proposed Funding Initiatives for FY 13/14

Buildings End Use Energy Efficiency Initiatives - Develop, demonstrate advanced and new technologies, tools and strategies to reduce natural gas use and cost that also lead to improvements in environmental quality in the following areas:

- **Water heating and Distribution** (44% residential and 33% commercial use)**:**
  - Develop and demonstrate advanced integrated hot water heating systems (emphasis on low NOx and low cost)
  - Improved residential and commercial hot water distribution systems
  - Improved shower heads to allow lower future flow rates (2 gpm or 1.5 gpm)
  - Additional pipe heat loss research on larger sizes (≥ 1 inch)
- **Food service** (23% of commercial gas use)**:** Higher efficiency commercial cooking equipment , especially burners.
- **Adv. HVAC (low NOx units) and envelopes** (44% residential and 36% commercial use):
  - Develop and demonstrate high efficiency systems that exceed current standards with emphasis on low NOx and low cost
  - Analyze technical/economic potential for energy recovery ventilators
- **Cross cutting – ZNE/Low Energy Use Buildings** (ZNE for new residential construction by 2020)**:**
  - Whole building integration of advanced energy efficiency technologies with renewable energy
  - Solar water heating: Low cost, high performance collectors and improved performance tanks
  - Thermally driven cooling: advance systems using NG , waste heat, or renewable energy

VI. Proposed Funding Initiatives for FY 13/14 (continued)

- **Indoor Environmental Quality** (As buildings get tighter, more care is needed for indoor environment)**:**
  - Field study to measure indoor air quality and ventilation in new homes
  - Develop/deploy technologies to improve ventilation rates in commercial buildings
- **Potential partners:**
  - Utilities
  - Contractors
  - Manufacturers
  - Trade Organizations
  - Designers
  - Governmental agencies
  - Public/private research organizations
  - Residential and commercial customers
- **Estimated rate payer benefits:**
  - Energy, water and cost savings
  - Environmental benefits (e.g., improved air quality)- in general more efficiency equals less emissions

VII. Proposed FY 2013/14 Budget

Initiatives	Proposed FY 2013/14 Natural Gas Budget
Buildings End Use Energy Efficiency Research ▪ Water heating and distribution ▪ Food service ▪ Advanced HVAC and envelopes ▪ Cross-cutting (ZNE and low energy buildings) ▪ Indoor environmental quality	**$4,200,000**

Questions for the Stakeholders on Buildings End Use Energy Efficiency Initiatives

- Are we emphasizing the right initiatives?
- Are there any missing opportunities? If so, provide examples.
- Are there opportunities for collaboration or synergies? If so, with whom?

Industrial, Agricultural and Water Efficiency

Presenter:
Michael Lozano, P.E.

I. Goals

Conduct RD&D to help the industrial, agricultural and water sectors:

- Reduce energy use and costs
- Increase energy efficiency
- Develop measures to meet environmental challenges while maintaining or enhancing energy efficiency
- Reduce water consumption or other finite resources or increase use of renewable energy
- Maintain or increase productivity while reducing energy consumption and emissions (e.g., low NOx)
- Commercialize technologies within 3 years of project completion with a 1% penetration/year for targeted markets

II. 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)

California 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

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

III. General Approach

- Possible research initiatives are identified through:
  - Discussions 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
- Increase program efficiency by collaborating with internal and external stakeholders (e.g., other Energy Commission research areas, state and federal agencies, utilities)

IV. Major Accomplishments

Demonstrate Liquid/Supercritical CO2 Industrial & Commercial Laundry Machine

- **Partners:** CO2Nexus (Prime); ARAMARK's LA laundry facility (demo site); SCE, SDG&E and LADWP (M&V)
- **PIER Funding:** $396,200 (over $1M in match)
- **Description**: Industrial laundry machines can annually use > 300,000 gallons of water. A prototype liquid/ supercritical CO2 based laundry system will reduce/ eliminate water (steam/cold/hot water) consumption and eliminate need for the garment drying step.
- **Results**:
  - Initial test runs show equal/better performance over baseline water-based machines
- **Ratepayer benefits (projected)**:
  - 22 million therms/yr
  - Payback of 3-4 yrs (w/o rebates)
- **Next Steps**: Machine will begin washing customer garments starting early this year

V. Current Portfolio Highlights and Major Initiatives

Name of Initiative	Description	Status
2011 Emerging Technology Demonstration Grant (ETDG II)	Competitive Grant Solicitation with Industrial Energy Efficiency as one of the targeted research tracks	• $19.8M allocated to 14 passing projects. • Project started with results expected in 12-18 months.
Ongoing Industrial/Food Processing Research	Research projects include: • on-site solar thermal • latent heat recovery • on-line tools to identify/ improve energy efficiency • boiler efficiency improvements.	• Most projects in second year of research • M&V starting/in progress • Results anticipated in 6-12 months.
Research for Industrial Use	Sector-specific research (e.g., cement, food processing, pharmaceutical, chemical, glass) and road maps	Staff continually reevaluates and researches most attractive research areas to complete research portfolio

VI. Proposed Funding Initiatives for FY 13/14

Industrial, Agricultural and Water (IAW) Initiatives:

- **Natural Gas Efficiency Research and Demonstration for IAW:** RD&D to advance energy efficiency emerging/under utilized technologies to help energy intensive industries reduce energy and water demand and air and water emissions cost effectively. Potential industries include:
  - Food processing, glass, chemical manufacturing, cement, metals processing and general manufacturing .

- **Heat Recovery:** RD&D to capture opportunities for heat recovery from combustion systems and natural gas burners. Potential industries include oil and gas, food processing, glass, cement, metals manufacturing. Examples include:
  - Heat recovery and enhanced heat transfer
  - Combustion/burner system improvements

- **Roadmap**: Update roadmap to capture new opportunities, reprioritize and guide future research initiatives.

VI. Proposed Funding Initiatives for FY 13/14 (continued)

- **Potential partners:**
  - Industry
  - Utilities
  - Major equipment manufacturers
  - Public/private research organizations
  - Governmental agencies

- **Estimated ratepayer benefits:**
  - Energy, water and cost savings
  - Environmental benefits (e.g., improved air quality)- in general more efficiency equals less emissions

VII. Proposed FY 2013/14 Budget

Initiatives	Proposed FY 2013/14 Natural Gas Budget
Industrial, Agriculture and Water Efficiency ▪ Natural Gas Efficiency Research and Demonstration ▪ Heat Recovery ▪ Roadmap Update	**$4,341,000**

Questions for the Stakeholders on Industrial, Agricultural and Water Efficiency

- Are we emphasizing the right initiatives?
- Are there any missing opportunities? If so, provide examples.
- Are there opportunities for collaboration or synergies? If so, with whom?

Natural Gas Research Areas/Initiatives

Renewable Energy

- Combined Heat and Power (CHP)
- Renewable Energy Related Environmental Research

Renewable Energy

Presenter:
Rizaldo Aldas

I. Goals

The Program area goal is to reduce barriers and increase penetration of renewable energy. Following are goals related directly to natural gas research:

- Advance the science, technology, and market availability of combined heat and power (CHP) and other renewable processes
- Develop hybrid generation, fuel-flexible systems and other energy efficient and low emission natural gas technologies for distributed generation
- Develop and demonstrate diversified applications of advanced generation technologies that use renewable natural gas

II. Policy Drivers

AB 32, the California Global Warming Solutions Act of 2006

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

Governor Brown's Clean Energy Jobs Plan

- 6,500 MW Additional CHP Capacity (2030)

Senate Bill X1-2 (Simitian, 2011), Renewable Portfolio Standard

- 20 percent of retails sales from renewables by the end of 2013, 25 percent by the end of 2016, and the 33 percent requirement being met by the end of 2020

AB 1613 (Blakeslee, Statutes of 2007), the Waste Heat and Carbon Emissions Reduction Act

- Require an electrical corporation to purchase excess electricity delivered by a CHP system that complies with certain sizing, energy efficiency and air pollution control requirements.

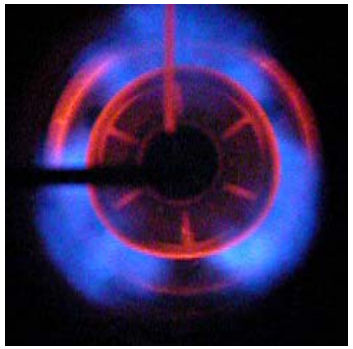
III. General Approach

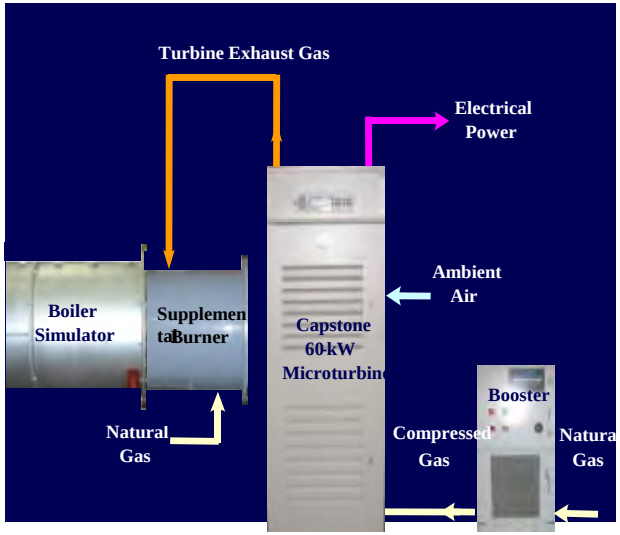
- Identify research gaps
  - With input from various stakeholder, utilities and industry through workshops and roadmaps process
- Emphasize research and development on clean technologies and approaches for a highly efficient use of natural gas and increased role of renewable natural gas for heat and power applications
- Implement research mostly through competitive solicitation

IV. Major Accomplishments

Integrated CHP Using Ultra-Low-NOx Supplemental Firing

- **Goal**: Develop a cost effective, highly efficient, ultra-low NOx, packaged CHP system with a small to medium sized gas turbine and boiler and an innovative natural gas-fired supplemental burner, to meet 2007 CARB standards without catalytic exhaust gas treatment.
- **Contractor/Partners**: Gas Technology Institute; CARB, Utilization Technology Development; Gas Research Institute, Accuchem Corp.
- **PIER funding**: $501,437
- **Status**: Design completed; setting up for field demonstration in Riverside County
- **Ratepayer Benefits (Projected)**: 10 to 25% reduction in capital cost of small DG/CHP systems, making them more cost effective for 10 MW or less applications.





IV. Major Accomplishments

Engine CHP Emission Control Technology

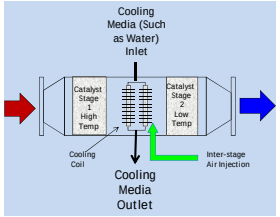
- **Goal**: Develop and test ultra-clean emission technology for small to medium (60 – 1,000 kilowatt (kW)) engine CHP systems that complies with the ARB 2007 emission guidelines on a sustainable basis and that have a cost premium of below 10% of existing CHP systems

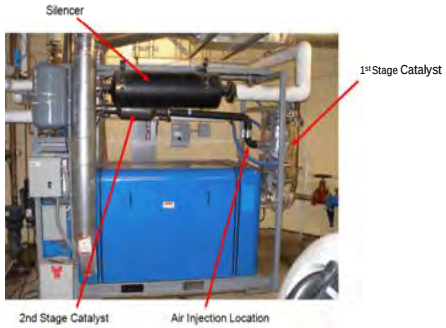
- **Results:** Successfully developed, designed and tested an ultra-low emission control system for rich burn engines for CHP applications; key innovation is a two stage exhaust after-treatment catalyst which decouples NOx and CO treatment; Successful field test program

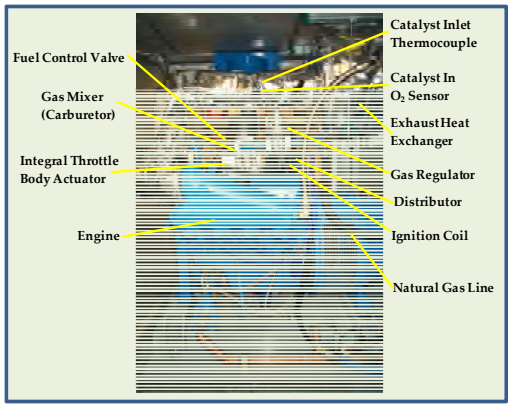
- **Contractor/Partners**: DE Solutions, Inc., Tecogen, Inc.

- **PIER funding**: $749,013

- **Benefits**: Enable engines to fill CHP targets at small to medium scale, resulting to avoided CO2 emissions and natural gas consumption, reduce or eliminate T&D and grid congestion, provides options to curb energy costs and boost power reliability







V. Current Portfolio Highlights
Major Initiatives

Name of Initiative	Description	Status
1. Combined heat and power and distributed energy resources technologies	Develop low-emissions technology CHP applications Utilize alternative fuels with low carbon intensity such as biogas, flared gas and natural gas	Completed emissions control and biogas-fuel cell research; conducting field tests on two other projects
2. Hybrid generation and fuel flexible DG/CHP/CCHP	Integrate emerging multiple DG/CHP/CCHP technologies and fuel flexibility, in diversified applications. Implementing four projects: • Novel Flex Fuel Oxidation for Distributed Generation • Combined Heat and Power with Thermal Storage for Modern Greenhouses • Fuel-Flexible, Hybrid CHP at San Bernardino Municipal Water Department • Tri-generation Energy System Technology	Started with the release of solicitation on Jan. 6, 2012; Projects started in Summer 2012
3. Localized Efficient and Advanced Power and Heat Systems (LEAPS)	Advanced CHP in opportunity areas not currently benefitting from existing CHP, includes specific industrial and commercial facilities, biofuels sources, and waste heat and gas sources Demonstrate CHP applications in by-product gas field locations	Solicitation planned for Winter 2013

VI. Proposed Funding Initiatives for FY 13/14

Biogas and Renewable Natural Gas Advancement for on-site and remote DG/CHP Applications

- Address technical challenges in three areas: Biogas production, biogas upgrading into RNG, on-site or remote use for emissions-compliant energy applications
- Replace or augment NG for energy systems (e.g. power, heat and vehicle) from landfills, wastewater, animal waste and food waste digesters, and other remote generators.
- Advances science and technology associated with renewable natural gas production, gas upgrading, quality assurance and impacts, and biogas-fired energy technologies

- **Potential Partners and Customers:** Local, state and federal agencies, facility owners and operators, technology manufacturers and providers, universities, utilities

- **Ratepayer Benefits:**
  - Increased energy security by increasing domestic production of non-fossil fuels, improved fuel accessibility, and reduced cost of production and transport
  - Reduced use of natural gas leading to financial savings in the long term, conservation of limited resource, and mitigation of greenhouse gas emissions
  - Increased economic opportunity by converting waste into revenue source, with further environmental benefits, e.g. improved waste management, nutrient control, prevention of run-off into local waterways, and reduces groundwater contamination

VI. Proposed Funding Initiatives for FY 13/14

Natural Gas and Renewable Energy Dynamics and Integration at Local and Regional Scale

- Investigate NG scenarios, operational impacts and planning implications at regional and local levels considering high penetration goals of renewable energy and NG-fueled power generation and vehicle technologies
- Provide decision support tools and models to assess NG parameters such as supply, pipeline capacity and storage, reliability, costs, and air emissions
- Advances science and technology by providing critical sets of tools and information on the role of NG at projected high penetration of renewable energy and advanced generation and transportation technology

▪ **Potential Partners and Customers:** National labs, universities, utilities, local governments and other governmental agencies, facility owners and system operators

▪ **Ratepayer Benefits:**

- Enable cost-efficient investment in natural gas infrastructure and technology that meets the needs of end use markets
- Effective and efficient NG power generation systems providing firming support for high penetration renewable energy
- Allow reduction in consumption of NG, accrue savings in the long term, and alleviate deterioration of air quality

VII. Proposed FY 2013/14 Budget

Initiatives	Proposed FY 2013/14 Natural Gas Budget
Renewable Energy ▪ Biogas and Renewable Natural Gas Advancement for on-site and remote DG/CHP Applications ▪ Natural Gas and Renewable Energy Dynamics and Integration at Local and Regional Scale	**$3 Million**

Questions for the Stakeholders on Renewable Energy Research Initiatives

- Are we emphasizing the right initiatives?
- Are there any missing opportunities? If so, provide examples.
- Are there opportunities for collaboration or synergies? If so, with whom?

Natural Gas Research Area/Initiatives

Energy Infrastructure

- Natural Gas Pipeline Integrity
- Energy Related Environmental and Climate Change
- Natural Gas Related Transportation

Natural Gas Pipeline Integrity

Presenter: Jamie Patterson

I. Goals

- Conduct research in natural gas infrastructure not covered by the regulatory and competitive markets
- Research 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

II. Policy Drivers

Research to meet our Energy Policy Goals

Public Resources Code 25620

- Provide environmentally sound, safe, reliable and affordable energy services and products
- 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

III. General Approach

Device Development	System Development	System Demonstration

3 Phase Approach

1. Develop & Improve Devices
2. Integration of Devices into Systems
3. Utility Scale Demonstrations

Benefits

- Pipelines more reliable, efficient, & secure
- Workforce to implement these technologies

Focus: Make available new technologies to aid operators in determining the condition of natural gas pipelines

IV. Current Portfolio Highlights
Major Initiatives

Name of Initiative	Description	Status
Natural Gas Pipeline Integrity	**Innovative Monitoring Technologies** • Found and developed new technologies to inspect, monitor and report on the condition of natural gas pipelines	Finalizing MEMS sensor package designs Next Steps: 1. Fabrication and lab testing of final sensor designs 2. Utility scale demonstration
	Best Practices in Monitoring Technology • Developed a baseline assessment of technologies currently used nationwide and in California to manage pipeline integrity and safety • Identified emerging technologies • Developing implementation plan to bring emerging technologies to California	Finalizing implementation plan to introduce new pipeline integrity assessment and monitoring technologies in California Next Steps: 1. Identify most promising new technologies for future research 2. Provide report to TAC members for review and begin the publication process

IV. Current Portfolio Highlights
Major Initiatives

Name of Initiative	Description	Status
Natural Gas Pipeline Integrity	**Active NG Pipeline Integrity Technology Demonstration Grant Solicitation** • $2M solicitation sought utility scale demonstrations targeting four technology areas: 1. Enhanced operational awareness using low cost/low power sensors 2. Improvements to currently available pipeline inspection technology 3. Methods to reduce operating costs and optimize field data collection 4. Enhanced integrity management practices through risk analysis, prediction, and decision based methodology	Proposals are currently undergoing evaluation Next Steps: 1. Awards expected to be posted in February, 2013 2. Develop agreements from highest scoring proposals

V. Proposed Funding Initiatives for FY 13/14

Natural Gas Pipeline Integrity:

- **Description:** Continue system development and utility scale demonstrations of emerging pipeline integrity technologies. Assist in market facilitation of technologies to increase tools available to California pipeline operators.
- **Potential partners/customers:** NG Utilities, Pipeline Industry, Research Institutions, Policymakers & Regulators
- **Advances science and technology:** Increased accuracy of pipeline inspection technologies, provide operators more precise data on current status of pipeline network
- **Rate payer benefits**: Improve the safety and security of NG pipelines, improve reliability of NG pipeline network, market facilitation of emerging technologies that will enhance current pipeline integrity management practices

VI. Proposed FY 2013/14 Budget

Initiatives	Proposed FY 2013/14 Natural Gas Budget
Natural Gas Pipeline Integrity	$1,500,000

Questions for the Stakeholders on Natural Gas Pipeline Integrity

- Are we emphasizing the right initiatives?
- Are there any missing opportunities? If so, provide examples.
- Are there opportunities for collaboration or synergies? If so, with whom?

Energy Related Environmental Research

Presenter:
Guido Franco

I. Goals

- Develop cost-effective approaches to evaluating and resolving environmental effects of energy production, delivery and use in California; and explore how new energy applications and products can solve/mitigate environmental problems.
- 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 aquatic resources

II. Policy Drivers

Warren-Alquist Act: CEQA equivalent environmental evaluations for power plants

SB1250: 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

IEPR: Energy-related Environmental Research Priorities

Title 24: Promote Energy Efficiency through Building Standards

AB 32: Reduce GHG to 1990 levels by 2020

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: RPS, 33% by 2020

AB 1925/SB 1368: accelerate CCS for industrial CO2

III. General Approach

- **Research Gap – Identified in Roadmaps, subject workshops, advisory board meetings**
- **Strong Policy Connection and linked to energy issues**
- **Identify Public Benefits:** (examples)
  - Reduce GHG and criteria pollutant emissions
  - Reduce consumption of finite resources
  - Increase opportunities for renewable and distributed energy development
  - Increase options to improve indoor/outdoor air quality while increasing efficiency
  - Inform the adoption of policies, laws, executive orders, guidelines, and regulations
  - Decrease the number of environmental issues related to permitting and operating energy systems and facilitate permitting
- **Work very closely with other state agencies and stakeholders**

IV. Major Accomplishments

Estimation of Methane Emissions from the CA Natural Gas System

- Measuring fugitive methane emissions to develop improved emission factors – Partnership with ARB
- **Contractor**: CA State University Fullerton
- **PIER funding amount**: $600K
- **Results**: Testing of hundreds of components at 25 NG facilities. Measurements revealed discrepancies with prior estimated emissions for some sources. Emission Factor method may not work
- **Rate payer benefits:** Informing regulatory activities in ARB but the study did not resolve major uncertainties

IV. Major Accomplishments

Atmospheric GHG Measurement and Verification of AB32

- Using ambient measurements of GHG to "verify" the ARB inventory and to track emissions
- **Contractor**: Lawrence Berkeley National Laboratory. ARB support
- **PIER funding amount**: $500K
- **Results**: Ambient measurements suggest that actual methane emissions may be 1.5 times higher than the ARB inventory. Similar situation for N2O
- **Rate payer benefits:** Natural gas utilities will be part of the cap-and-trade program. Improved emission estimates are essential for the environmental integrity of AB32 and post 2020 GHG targets. ARB is now funding part of this work

V. Current Portfolio Highlights
Major Initiatives

Name of Initiative	Description	Status
Reduce environmental footprint of applications using natural gas	1) PM emissions from power plants; 2) Characterize emissions & performance impacts of hot gases on combustion systems; 3) impacts of geol. seq. on aquifers and seismicity.	1) Project on-going; 2) Laboratory & field tests complete. Completing final analysis; 3) to start in four months
Investigating options that could reduce net GHG emissions from the NG system and/or provide offsets	1) Investigation of the use of biochar in agricultural soils; 2) options to reduce CH4 emissions from the NG system; 3) offsets for the NG systems	1) Field testing on-going; 2) Project just started; 3) design stage
Climate projections and impacts and adaptation options for the natural gas system	1) Effect of small particles on precipitation levels (research aircraft); 2) Vulnerability of the NG system in the Sac/SJ Delta	1) Field study took place in 2011. Some of research results may be published in *Science* ; 2) Study just started

VI. Proposed Funding Initiatives for FY 13/14

Assessment of Residential Fugitive CH4 Emissions: Phase 1

- **Description:** Measure fugitive methane (CH4) emissions from about 50 to 100 homes in California to determine their contribution to CH4 emissions from the natural gas system. Our homes may account for most of the current underestimates of fugitive methane emissions, potentially, eliminating the climate change benefits of natural gas.
- **Potential partners/customers:** ARB, End Users, Industry, Policymakers & Regulators
- **Advances science and technology:** Currently there is only anecdotal evidence about potentially large emissions from this source.
- **Rate payer benefits**: Eventually inform the development of technically sound and cost-effective regulations (e.g., revisions to the Scoping Plan). Annual expenditures in CA for natural gas in the residential sector is about $5 billion a year. If the residential sector emits about 3% and future regulations/programs reduce emissions by 80% the net savings could be up to $120 million/year (order of magnitude estimation).

VI. Proposed Funding Initiatives for FY 13/14

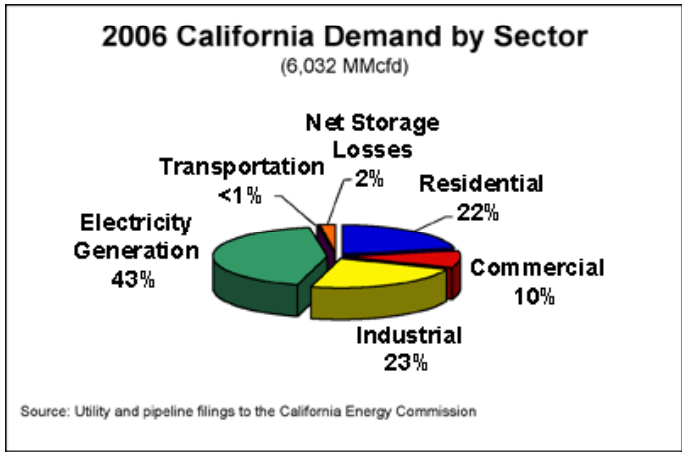
Improvement of Airborne Natural Gas Leak-Detection System Natural Gas Energy Infrastructure

- **Description:** A promising natural gas leak detection system for natural gas pipelines has been developed by UC Davis. The system uses an aircraft to measure ppb levels of methane downwind of the leak. This could substantially reduce leak detection costs.
- **Potential partners/customers:** PG&E submitted a letter of support and is financially supporting UC Davis. Natural gas utilities.
- **Advances science and technology:** This is a novel technique not used before. Improvements on how to more accurately identify the location of the leaks is needed. The research team will also investigate how to distinguish methane from the natural gas system from other sources (e.g., landfills, dairy farms).
- **Rate payer benefits**: Reduction of costs for leak detection and reductions of methane emissions should benefit rate payers.

VI. Proposed Funding Initiatives for FY 13/14

Low-Emissions Combustion and Control Technology Development Program: Residential and Commercial Sectors

- **Description:** As pressure intensifies to reduce emissions of air pollutants, even lower emissions combustion technologies and emission control devices will be required. NOx emission reductions in the order of 80% will be needed by 2023.
- **Potential partners/customers:** ARB, Air Districts, Energy Commission, and industry.
- **Advances science and technology:** Will make advances through developing ultra low emissions combustion and/or control technologies that will reduce emissions from stationary combustion sources in the residential and commercial sectors.
- **Rate payer benefits**: Without the development of ultra low NOx technologies and/or control devices, some combustion sources may no longer be allowed in the worst air quality areas of the state.



VII. Proposed FY 2013/14 Budget

Initiative	Proposed FY 2013/14 Natural Gas Budget
Energy Related Environmental Research ▪ Assessment of Residential Fugitive CH4 Emissions: Phase 1 ▪ Improvement of Airborne Natural Gas Leak-Detection System Natural Gas Energy Infrastructure ▪ Low-Emissions Combustion and Control Technology Development Program: Residential Sector* ▪ Indoor Environmental Quality Research for Commercial Buildings - Ventilation Control Phase 1 * ▪ Indoor Environmental Quality Research for the Residential Sector *	**$3,000,000**

* Note: These projects will be coordinated and co-funded with the Building Energy Efficiency Research area

Questions for the Stakeholders on Energy Related Environmental Research

- Are we emphasizing the right initiatives?
- Are there any missing opportunities? If so, provide examples.
- Are there opportunities for collaboration or synergies? If so, with whom?

Transportation Research Area

NGV
NATURAL GAS VEHICLE

Presenter:
Aleecia Gutierrez

I. Goals

The goals of transportation-related research projects are to:

- Accelerate the commercial availability of natural gas vehicles
- Improve energy efficiency of natural gas vehicles
- Advance the clean and cost-effective production of renewable natural gas for transportation use.

Heavy-duty vehicles consume approximately 3 billion gallons of gasoline and diesel annually.

As a transportation fuel, natural gas has potential to:

- Offset more than 885 million gallons of gasoline and diesel per year by 2022.
- Reduce annual GHG emissions by 4.4 million metric tons by 2022.
- Save the state approximately $1.35 billion annually in fueling costs.

II. Policy Drivers

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

State Alternative Fuels Plan: Presents strategies and actions California must take to increase the use of alternative transportation fuels including natural gas.

2011 Integrated Energy Policy Report: Consumption for natural gas as a transportation fuel is expected to compound at a rate of 3% annually.

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% of the state's 2020 GHG reduction targets to come from the transportation sector.

III. General Approach

Natural Gas Vehicles: The Natural Gas Vehicle Research Roadmap recommends RD&D on the following topics:

- Engine Development and Vehicle Integration
- Fueling Infrastructure and Storage
- Technical and Strategic Studies

Renewable Transportation Fuel: Develop and demonstrate innovative technologies that utilize California's waste streams to produce renewable natural gas for transportation use.

IV. Major Accomplishments

Natural Gas Engine and Vehicle Integration Research

- **Purpose:** Further development, integration, and demonstration of the 11.9 liter, heavy-duty stoichiometric spark-ignited natural gas engine with performance and emission attributes suitable for Class 8 regional haul and vocational truck applications.
- **Contractor:** NREL
- **Partners**: Cummins Westport, Inc.
- **PIER Funds:** $4.25M with $13.1M in match share
- **Results:** Previous alpha development project successfully met the objectives: criteria emission pollutants lower than CARB 2010, 400 HP and 1350 ft. lbs. torque, and up to 40% reduction in GHG emissions over current Class 8 diesel engines.

- **Rate Payer Benefits:** Approximately 97,500,000 gallons of diesel and 13 MMT of CO2e can be displaced per year based on 10% market penetration.
- **Next Steps:** The Cummins Westport, Inc. ISX12 G will be released and available in limited quantities in 2013.

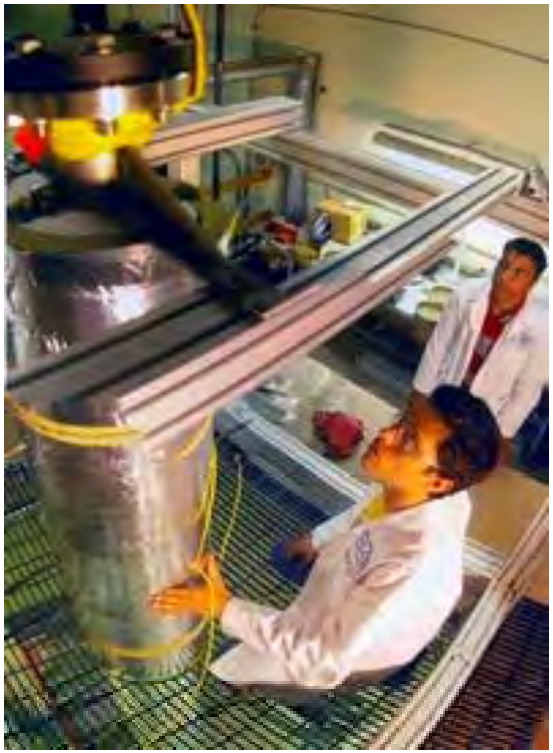
IV. Major Accomplishments

Natural Gas Optimized Advanced Heavy Duty Engine Concept

- **Purpose:** To improve the operating fuel efficiency and power output of natural gas engines by incorporating advanced direct injection technology leading to lower incremental cost of natural gas vehicles.
- **Contractor:** Volvo Technology North America
- **Partners:** Westport Innovations Inc.
- **PIER Funds:** $999,970 with $390,259 in match share
- **Results:** The results from this project show a 6% fuel efficiency improvement over comparable diesel engines, and 22 to 30% reduction in GHGs (up to 90% with RNG).
- **Rate Payer Benefits:** Project results show the potential to further lower fuel consumption and decrease engine emissions for heavy-duty natural gas engines. Reduced emissions from heavy-duty vehicles improves air quality, particularly for communities heavily impacted by emissions from heavy-duty vehicles.
- **Next Steps:** In May 2012, Volvo announced the commercial release of the engine in 2014.

IV. Major Accomplishments

Production of Substituted NG (SNG) from Wet Organic Waste by utilizing PDU-scale Steam Hydrogasification (SHR) Process



- **Purpose:** Demonstration of SHR using variety of biosolids and biomass feedstock in a bench scale Process Demonstration Unit (PDU) and preliminary modeling evaluation and design for a 5 tons/day pilot scale facility.
- **Contractor:** UC Riverside
- **Partner:** Food Recycle Science, Inc.
- **PIER Funds:** $649,214 M with $200,000 match share
- **Results:** Completed a preliminary design of a pilot plant with 5 tons per day capacity using the PDU technology. Completed an economic analysis for a 3,500 BDT/day SNG plant, as well as a block flow diagram with process mass and energy balance diagram.
- **Rate Payer Benefits:** The estimated potential (83 MMcf) of SNG produced using the proposed process accounted for approximately 7.2% of total natural gas consumed in California in 2009.
- **Next Steps:** Additional funding was awarded to include a carbon-capture component. If successful, additional investment may be pursued to support larger scale deployment.

V. Current Portfolio Highlights
Major Initiatives

Name of Initiative	Description	Status
• Natural Gas Vehicle Efficiency	Develop optimized natural gas engines with little to no performance or efficiency penalties relative to conventional fuel engines. Develop and demonstrate hybridization designs that use battery power to minimize emissions, idle, and low-load engine operation.	Developed and demonstrated optimized 12L, 13L, and 15L natural gas engines. Active solicitation for optimized 6 to 8 liter engine. Solicitation to be released in 2013.
• Natural Gas Vehicle On-board Storage	Demonstrate the manufacturing viability and performance of on-board advanced natural gas fuel tanks.	Solicitation to be released in 2013.
• RD&D for Advanced Renewable Natural Gas Production Technologies	Develop efficient processes and technologies for RNG production from waste-based feedstocks.	Two active projects and an active solicitation to develop and demonstrate RNG production technologies and methods.

VI. Proposed Funding Initiatives for FY 13/14

- **Initiative:** Near-Zero Emission Technology Research for Heavy-Duty Natural Gas Vehicles
- **Description:** The research aims to further advance engine emission technologies by driving to a NOx reduction target of 90%. The project objective is to obtain near-zero NOx levels while continuing to meet or exceed other emission standards without incurring a fuel economy penalty. Examples of technologies could include emission controls, engine tuning, and engine management practices.
- **Potential partners:** SCAQMD and So Cal Gas Company; may include Department of Energy, and SJVAPCD
- **How it advances science and technology:** The near-zero NOx engine technology can be a near-term and cost effective solution to mitigate health and environmental issues in areas that are severely impacted by air pollution from heavy-duty vehicles.
- **Estimated Ratepayer Benefits:** Improved air quality, 90% NOx reductions in heavy-duty natural gas vehicle sector

VI. Proposed Funding Initiatives for FY 13/14

- **Initiative:** Advanced Natural Gas Engine Ignition Systems Research
- **Description:** Research and development of advanced ignition technologies to improve fuel combustion that is limiting progress towards increased engine efficiency. Technologies can include but are not limited to: improved spark methods, on-board catalytic reforming technologies, and advanced pilot ignition concepts.
- **Potential partners:** Partners may include research institutions and private entities.
- **How it advances science and technology and not duplicative of previous research:** Technology advancements from this research can be applied to multiple natural gas applications including stationary engines used for power generation and combined heat and power systems.
- This research is also intended to remove barriers for deployment of natural gas vehicles to help meet future, more-stringent air quality regulations.
- **Estimated Ratepayer Benefits:** This research will lead to improved efficiency, reduced emissions, and improved air quality.

VI. Proposed Funding Initiatives for FY 13/14

- **Initiative:** Natural Gas Fueling Infrastructure Improvements
- **Description:** Development, demonstration, and testing of cost effective and advanced natural gas fueling infrastructure technologies and systems with effective mitigation of methane leakages. The research will improve technologies and systems including moisture content control, contamination control, natural gas compression, natural gas storage, and fuel dispensing.
- **Potential partners:** Partners may include research institutions, DOE, and private industry.
- **How it advances science and technology:** These improved technologies and systems will improve reliability and performance of natural gas fueling infrastructure as it goes through a rapid expansion.
- This research will also help ensure the acceleration of cost-effective natural gas infrastructure technologies in the market by lowering initial capital investment risk.
- **Estimated Ratepayer Benefits:** Lower technology costs should accelerate the build out of natural gas infrastructure.

VII. Proposed FY 2013/14 Budget

Initiatives	Proposed FY 2013/14 Natural Gas Budget
Natural Gas Related Transportation Research Research, develop, and demonstrate near-zero emission heavy-duty vehicles, advanced natural gas engine ignition systems research, and fueling infrastructure improvements	**$4,000,000**

Questions for the Stakeholders on Transportation Research Area

- Are we emphasizing the right initiatives?
- Are there any missing opportunities? If so, provide examples.
- Are there opportunities for collaboration or synergies? If so, with whom?

Small Grants Program

Supports Natural Gas Research Areas

Presenter:
Raquel Kravitz

I. Goals

The Small Grants program's goal is to fund research in new and innovative energy concepts that, if proven feasible, will provide new paths to achieve California Natural Gas ratepayer benefits.

- Support the early development of promising new energy technology concepts
- Facilitate the commercialization of energy technologies that can help achieve state energy policy goals while providing tangible benefits to natural gas utility customers

II. Policy

The Small Grants program Supports energy policies for all natural gas research areas:

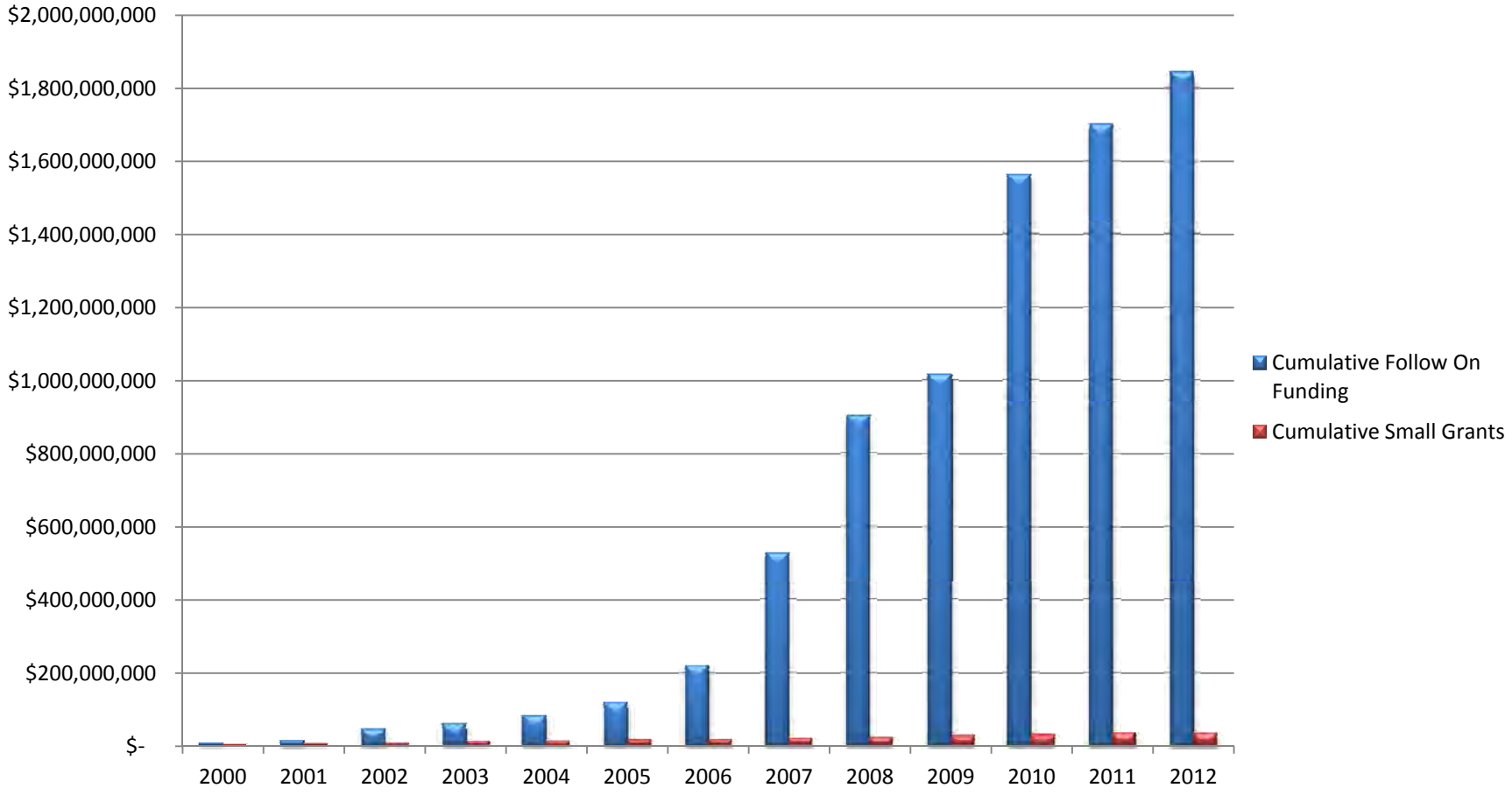
- Energy Efficiency
- Renewable Energy
- Energy Infrastructure

III. General Approach

- Conduct three competitive solicitations annually
- Grants must target one of the RD&D technology areas
- Award grants up to $95,000 for hardware and $50,000 for modeling
- Successful projects receive assistance from EISG Program's technology transfer initiative toward market placement

IV. Major Accomplishments

Follow-on Funding for Grant Awardees

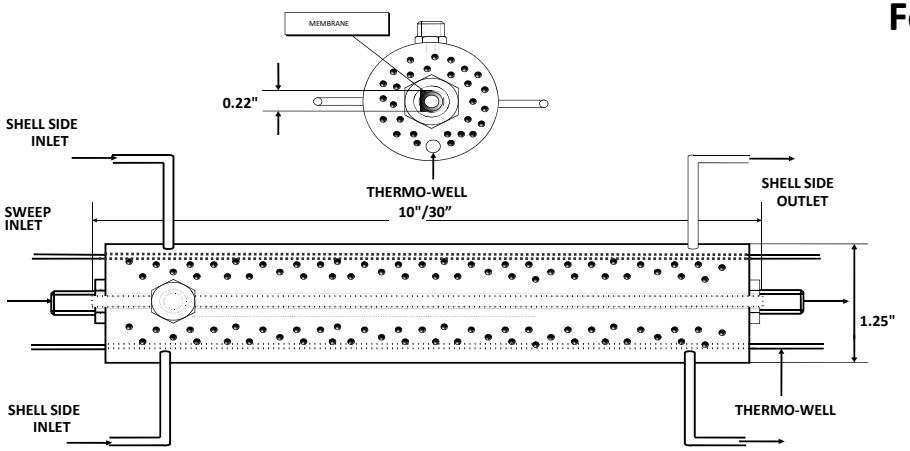


PIER Natural Gas and Electricity-Related Small Grants Follow-on Funding

IV. Major Accomplishments

A Pore-Flow Reactor for Landfill Gas Clean-Up

Contractor: Contractor Name: USC, Theodore T. Tsotsis
Amount: $95,000
Results: Deposited a platinum catalyst on membranes designed to function in pore-flow mode to treat simulated landfill gas containing six representative non-methane organic compounds.
Rate payer benefits: Reduce environmental impacts of the California energy supply and distribution system. If scaled to commercial size, the reactor could remove non-methane organic compounds from currently utilized and potential landfill gas supplies. This could reduce capital costs, operating costs and potential discharge of toxic compounds.



Membrane Module
Source: Tsotsis Proposal

Follow-on Funding:

- DOE has provided multi-million dollars on Small Grants funded technology.
- The Department of Defense provided approximately $1 million dollars to further develop Small Grants funded technology.

IV. Major Accomplishments

Development of Energy Efficient De-hulling and Drying Methods for Walnuts

Contractor: Contractor Name: UC Davis, PI Griffisths Atungulu

Amount: $92,995

Results: Developed and evaluated new walnut treatment approaches aimed at improving energy use by the walnut industry and growers.

Rate payer benefits: Increased affordability of energy in California. If fully developed and commercialized, the new approach could provide significant saving of natural gas and propane in the walnut industry and transportation fuel for walnut hauling. The process may be useful in other tree nut industries in California. This method could save substantial, electricity, and fuel cost.

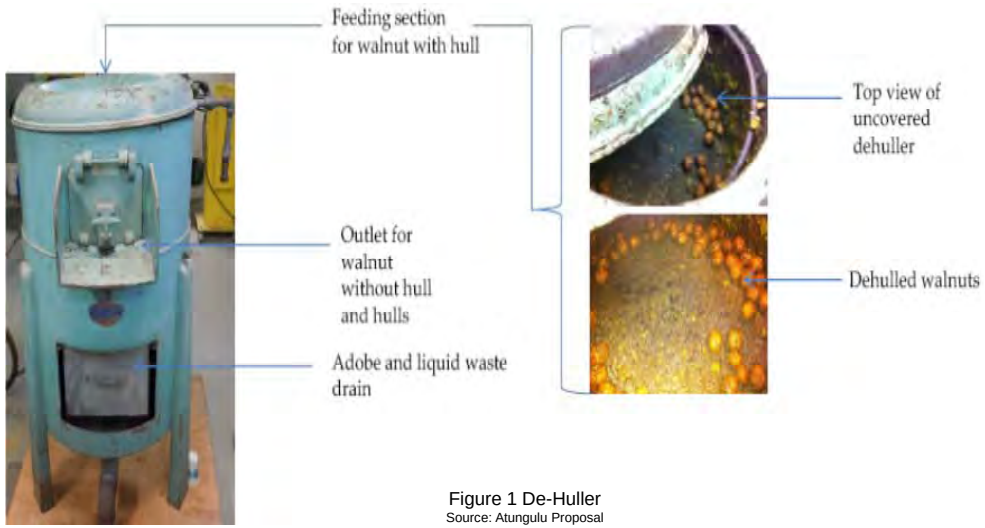


Figure 1 De-Huller
Source: Atungulu Proposal

Next Steps:

- Project ended in March 2012.
- Actively seeking follow-on funding and currently being assisted by the Tech Transfer Program.

IV. Major Accomplishments

High Efficiency Heat and Power System for Combined Cooling Heating Power Applications

Contractor: Altex Technologies, John Kelly

Amount: $94,915

Results: Identified and defined the High Efficiency Heat and Power System (HEHPS), which uses turbine cooling, heat exchanger, and working fluid innovations that can raise small gas turbine Combined Cooling Heating and Power Systems (CCHPS) power generation efficiencies to 45%.

Rate payer benefits: Increased affordability of energy in California. Public benefits for High Efficiency Heat and Power System can be substantial after ten years of deployment. Cost savings to the ratepayer could total $210 million/yr, with a fuel savings of 12.6 million MMBtu/yr.

Combined Heat and Power
Altex Technologies

Next Steps:

This Small Grants funded technology is currently being commercialized by Leva Energy.

V. Current Portfolio Highlights
Major Initiatives

Name of Initiative	Description	Status
Innovative Concepts for Natural Gas	Natural Gas Energy Efficiency, Natural Gas Environmental Research, Renewable Energy Technologies, Vehicle Technologies, and Transportation Systems	▪ 8 new research projects approved , 7 were completed and 11 remain active ▪ For 2012, $759,253 was invested in innovative concepts

VI. Proposed FY 2013/14 Budget

Initiatives	Proposed FY 2013/14 Natural Gas Budget
Future Small Grants Program Natural Gas Research: ▪ Energy Efficiency ▪ Renewable Energy ▪ Energy Infrastructure	$1,500,000

Questions for the Stakeholders on Small Grants Program

- Are we emphasizing the right initiatives?
- Are there any missing opportunities? If so, provide examples.
- Are there opportunities for collaboration or synergies? If so, with whom?

Public Comments

Closing Comments

- Submit additional written comments to: Rosa Vazquez (rosa.vazquez@energy.ca.gov) by 5:00 pm on February 1, 2013
- Staff will consider comments and prepare draft natural gas research budget
- Final draft to be submitted to the California Public Utilities Commission by March 31, 2013
- Copies of presentations , public comments and responses to questions from today's workshop will be posted under January 22, 2013 at: http://www.energy.ca.gov/research/notices/index.html#01222013
- Copies of past budget documents can be found at: http://www.energy.ca.gov/research/annual_reports.html