

Natural Gas Research Initiatives for 2012/13

**Presented at the PIER Advisory Group Meeting
California Energy Commission
January 24, 2012
1:30-5:00 pm**

Agenda

Time	Topic
1:30	Introductions and Purpose – Laurie ten Hope
2:00	PIER Staff Presentations on Proposed Natural Gas Research Initiatives <ul style="list-style-type: none">• Energy Efficiency – Virginia Lew, Bradley Meister, Michael Lozano• Renewable Energy – Linda Spiegel, Rizaldo Aldas• Smart Infrastructure – Mike Gravely, Jamie Patterson, Guido Franco, Rey Gonzalez• Energy Innovation Small Grant Program – Mike Gravely, David Chambers
3:30	Advisory Group Presentations/Discussions <ul style="list-style-type: none">• Cherif Youssef, Sempra Energy• Ron Kent, Sempra Energy• Jorn Horner, Air Resources Board• William Miller, DOE-LBNL
4:30	Public Comments
5:00	Closing/Next Steps – Laurie ten Hope

Introduction

- In 2010, PIER expanded public vetting process with the PIER Advisory Groups for electric budget
- Today's meeting provides similar input for the natural gas research
- Role of Advisory Groups
 - 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 PIER budget look ahead
- Support State Energy Policies and Governor's priorities

PIER Natural Gas Advisory Program Areas

- **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
- **Smart Infrastructure**
 - Natural Gas Pipeline Integrity
 - Energy Related Environmental and Climate Change Research
 - Natural Gas Related Transportation

Energy Innovation Small Grant Program (EISG) supports all three program areas

Historic and Proposed -Natural Gas 2012/13 Budget

Areas	FY 2011/12 Natural Gas Budget	Proposed FY 2012/13 Natural Gas Budget	Percent of Grand Total for 2012/13
Building End Use Energy Efficiency	\$5,000,000	\$4,000,000	
Industrial, Agriculture and Water Efficiency	\$3,000,000	\$ 4,000,000	
Subtotal Energy Efficiency	\$8,000,000	\$8,000,000	33%
Renewable Energy	\$3,000,000	\$4,000,000	17%
Natural Gas Pipeline Integrity	\$1,000,000	\$1,000,000	
Energy-Related Environmental and Climate Change	\$3,000,000	\$3,000,000	
Natural Gas-Related Transportation	\$5,000,000	\$4,000,000	
Subtotal Smart Infrastructure	\$9,000,000	\$8,000,000	33%
Energy Innovation Small Grant Program (EISG)	\$1,500,000	\$1,500,000	6%
Technical Support	\$303,000	\$303,000	
Administration	\$2,197,000	\$2,197,000	
Subtotal Technical Support and Administration	\$2,500,000	\$2,500,000	10%
Grand Total	\$24,000,000	\$24,000,000	

Benefits Estimation of PIER 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 38 natural gas research projects*
 - 1.4 billion therms/yr saved (\$1.7 billion/yr)
 - 8.7 million metric tons of GHG reduced

* California Energy Commission, 2011 Natural Gas Report to the California Public Utilities Commission, October 2011

Workshop Format

- Each PIER team will make their presentation
- Questions related to the research initiatives will be posed to the PIER Advisory Group members at the end of each program area (e.g., efficiency, renewable energy and smart infrastructure)
- To ensure each team has time to complete their presentations, some questions may need to be deferred to the end
- After all staff presentations completed, we'll have presentations from advisory group members
- There will be a public comment period at the conclusion of the advisory group presentations

Questions for the PIER Advisory Group

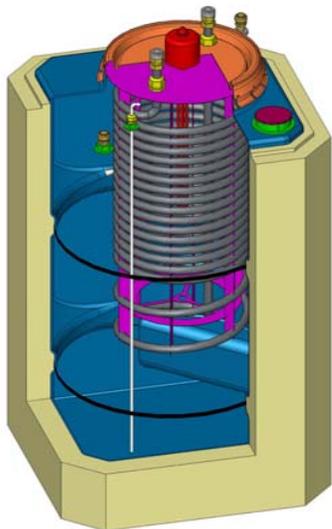
- Questions for each research area:
 - Are we emphasizing the right initiatives?
 - Are there any missing opportunities? If so, provide examples
 - Are there opportunities for collaboration or synergies? If so, with whom?

PIER Natural Gas Advisory Program Areas

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



I. Goals

Reduce energy use in buildings and communities

- **Advance efficient technologies, design tools, and operations.**
- **Demonstrate affordable, comfortable, energy-efficient buildings**
- **Improve information resources for sharing research results**

II. Policy Drivers

Integrated Energy Policy Reports

- Target research efforts in energy efficient technologies, techniques, building maintenance and commissioning
- Provide data to justify new building and appliance standards
- Support pilot programs for Zero Net Energy (ZNE) buildings
- Collaborate with utilities to improve energy efficiency programs

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

- Reduce greenhouse gas emissions in CA to 1990 levels by 2020

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

- Designates the Energy Commission to administer the PIER program.
- 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.

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

- Achieve greater energy savings in the state of California's existing residential and nonresidential building stock.



II. Policy Drivers

AB 531 (Saldana, Chapter 323, Statutes of 2009)

- Disclose commercial building energy use.

AB 1109 (Huffman and Feuer, Chapter 534, Statutes of 2007)

- Minimum efficiency standards for general purpose lights.

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

- Sets energy efficiency target of reducing forecasted consumption by 10 percent

Governor's Clean Energy Job Plan

- A timeline to make new homes and commercial buildings zero net energy
- Make existing buildings more efficient
- 12,000 MW Distributed Generation, including Combined Heat Power
- Adopting stronger appliance efficiency standards

California Energy Efficiency Strategic Plan

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

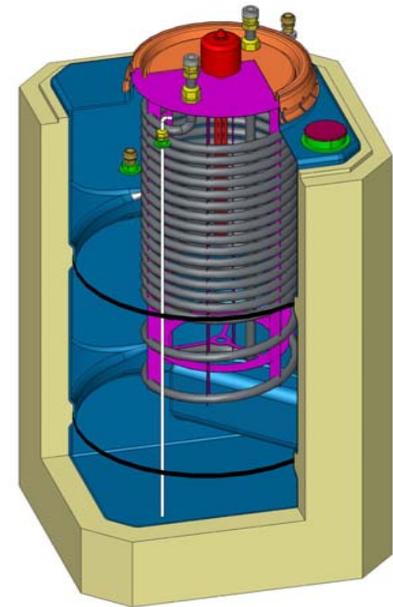
III. General Approach

- **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 meetings with stakeholders, utilities and industry
 - 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.
- **Most research developed through competitive solicitations**

IV. Major Accomplishments

Develop and demonstrate a low cost, high efficiency solar storage tank

- **Contractor:** Harpiris Energy, Eric Lee
- **PIER funding:** \$284,500 with \$54,000 match
- **Results:** Developed 125 gallon solar storage tank with drainback. 15 yr warranty; product commercially available . Can also be used for hydronic space heating systems.
- **Rate payer benefits:** Reduces natural gas consumption and greenhouse gas emissions (estimated 150 therms/year saved and 0.75 metric tons GHG reduced per system).
- **Next steps:** Company seeking capital to purchase rotational molding machine so tanks can be made in-house to lower cost. Potential for 6,000 installations/year.



IV. Major Accomplishments

Revised ASHRAE Service Hot Water Heating Tables based on laboratory heat transfer experiments

- **Contractor:** Applied Energy Technologies, Dr. Carl Hiller
- **PIER funding amount:** \$430,000
- **Results:** Updated tables are now in the ASHRAE 2011 HVAC Applications Handbook to guide building designers/engineers
- **Rate payer benefits:** 1.2 million therms/year and 6,000 metric tons of GHG reduction based on projected future building permits
- **Next steps:** PIER may fund future research to do testing on larger pipe sizes for commercial systems



IV. Major Accomplishments

Develop integrated water heating and distribution model and design manual for homes

- **Contractor:** Davis Energy Group and LBNL
- **PIER amount:** \$409,000
- **Results:** The public domain manual will shape residential hot water design
- **Rate payer benefits:** 550,000 therms/year and 2,750 metric tons GHG reduction based on future building permits
- **Next steps:** Build future model in Modelica format to expand capabilities (simultaneous water use, mixed flow) especially for advanced water heating systems



IV. Major Accomplishments

Measured emissions from 46 appliances and modeled indoor air quality impacts

- **Researcher:** LBNL
- **PIER funding amount:** \$700,000
- **Research results:** Cooking with natural gas without use of range hoods will cause pollutant concentrations to exceed health-based standards
- **Rate payer benefits:** Healthier indoor environments with proper venting of combustion gases in homes. As buildings become tighter it is even more important to identify and address these emissions.
- **Next steps:** Characterize combustion pollutant levels in homes and evaluate mitigation strategies.



V. Current Portfolio Highlights (NG)

Major Initiatives

Name of Initiative	Description	Status
Research for Commercial Facilities	Improve efficiency of food service appliances	Preliminary research completed, future research needed on burner efficiency and appliances. Focus of future solicitation.
Research for Residential and Commercial Facilities	Improve hot water generation and distribution systems	Preliminary research completed for food service and multi-family. Future research needed on better understanding residential hot water use and point of use water heaters.
Research for Residential and Commercial Facilities	Advanced energy efficient heating systems and building envelopes	Preliminary research started on phase change materials in hydronic systems. Future research on innovative envelope sealing system.
Clean Alternatives to Conventional Fossil Resources	Solar hot water heating	Preliminary research completed for solar storage tank, future research on various other solar options and configurations.
Reduce Environmental Footprint	Air quality implications of NG appliances, characterize combustion pollutant levels in homes and evaluate mitigation strategies	Preliminary research completed. Field study and roadmap in progress.

VI. Funding Opportunities for FY 12/13

Research initiative: Natural Gas Efficiency and Renewable Energy Heating Systems Research

- **Description:** Provide research in in Hot Water Heating and Distribution and Food Service Operations, Advanced HVAC and envelopes, Solar Energy Hot Water
 - Hot water:
 - Improved residential and commercial hot water distribution systems
 - Retro-fitting residential hot water distribution systems
 - Multi-tank systems for residential and commercial buildings
 - Improved shower heads to allow lower future flow rates (2 gpm or 1.5 gpm)
 - Distribution in conjunction with use of aerators in faucets to reduce flow
 - Additional pipe heat loss research on larger sizes
 - Advanced integrated hot water heating and distribution simulation models
 - Food service: Higher efficiency commercial cooking equipment
 - Advanced HVAC and envelopes: Innovative envelope sealing systems
 - Solar Energy: Next generation solar systems using lower cost high performance collector and improved performance tank
- **Potential partners:** Utilities, Contractors, Manufacturers, Trade Organizations, Designers, and residential and commercial customers
- **Estimated rate payer benefits:** Energy, water and cost savings

VI. Proposed 2012/13 Budget

Initiatives	Proposed FY 2012/13 Natural Gas Budget
Buildings Energy Efficiency Research Initiatives Natural Gas Efficiency and Renewable Energy Heating Systems Research (water heating and distribution, food service operations, advanced HVAC and envelopes, solar energy hot water)	\$4,000,000

Industrial, Agricultural and Water Efficiency



Presenter:

Michael Lozano, P.E.

I. Goals

Conduct research, development and demonstration projects to help the industrial, agriculture and water sectors:

- Reduce energy use and costs
- Increase energy efficiency
- Develop measures to meet environmental challenges while maintaining or enhancing energy efficiency
- Advance technologies that reduce or eliminate consumption of water or other finite resources or increase use of renewable energy
- Maintain or increase productivity while reducing energy consumption and emissions

II. Policy Drivers

- **Integrated Energy Policy Report**
 - Pursue energy efficiency improvements through increased electricity and natural gas research and development to reduce energy cost and green house gas emissions (2007/2009)
 - Conduct research to better understand the interaction of water and energy and identify new technologies for achieving energy and water efficiency savings (2005)
- **AB 32**
 - Reduce greenhouse gas emissions in CA to 1990 levels by 2020
- **California Energy Efficiency Strategic Plan**
 - Support California industry's adoption of energy efficiency
 - Achieve significant increases in the efficiency of electricity and natural gas use and on-site renewable energy utilization in the agriculture sector

III. General Approach

- Possible research initiatives:
 - Road maps (9 prepared since inception of PIER)
 - Focus groups meetings with industry and trade associations
 - Discussions with utilities, governmental agencies and stakeholders
- Primary implementation method is through competitive solicitations such as Request for Proposals or Program Opportunity Notices.
- Increase program efficiency through collaboration with other PIER programs and outside agencies.

IV. Major Accomplishments

Reduce energy costs and air emissions with Super Boiler

- **Purpose:** Develop and demonstrate a two-stage burner system with internal recirculation with an integrated heat recovery system to extract maximum energy from the flue gas.
- **Contractor/Partner:** Gas Technology Institute and Clement Pappas (juice manufacturer).
- **PIER Funding:** \$239,969, matched with \$319,030 in private funding.
- **Results:** 12% energy efficiency improvement for boiler
- **Ratepayer Benefit:** Estimated annual natural gas savings of 13,336 therms, or about \$13,336 in cost savings.
- **Next steps:** Inform private sector of research results. Published results available on CEC website.



IV. Major Accomplishments

Reduce energy costs high efficiency Drum Dryer

- **Purpose:** Develop and demonstrate a high efficiency gas-fired drum dryer concept based on the combination of ribbon flame and advanced heat transfer enhancement techniques.
- **Contractor/Partners:** Gas Technology Institute with Groupe Laperrier & Verreault USA Inc., Flynn Burner, and Con Agra
- **PIER funding:** \$950,458, matched with \$561,710 in private funding.
- **Results:** Gas-fired drum drying (GFDD) has much higher energy efficiency (up to 75-90 percent) compared to conventional steam-heated dryers (about 60-70 percent).
- **Ratepayer benefit:** Applicable industries consume 145 million therms/year in California, with a potential to save over 7 million therms/year (at 5% market penetration).
- **Next steps:** Results published on CEC website.



Ongoing Efforts

Demonstrate Liquid/Supercritical CO2 Industrial & Commercial Laundry Machine

- **Description:** Each industrial laundry machines can use over 300,000 gallons of water per year. CO2Nexus developed a commercial prototype liquid/supercritical carbon dioxide-based laundry system for industrial/commercial laundry facilities that will reduce water consumption and significantly reduce energy use through the elimination of the associated dryers and natural gas for steam/hot water generation.
 - This project will demonstrate and conduct the necessary measurement and verification (M&V) to document performance, energy and water savings.
- **Partners:** CO2Nexus (Prime) with technology demonstration ARAMARK's LA laundry facility
- **M&V partners:** SCE, SDG&E and LADWP
- **Ratepayer benefit:** Substantial water savings and eliminates the need for gas and electric dryers.



V. Current Portfolio Highlights

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.	Phase I abstract grading complete. Awaiting full proposals due January 20 th .
Ongoing Industrial Research	Ongoing industrial and food processing projects include research into areas such as: solar thermal for NG substitution, latent heat recovery, on-line calculator development, boiler efficiency improvements.	Various stages of completion. Projects, for the most part, are in the first year of research. Results anticipated in 2013-14 timeframe.
Research for Industrial Use	Sector specific research (e.g., cement, food processing, glass, chemical, pharmaceutical)	IAW continually reevaluates and researches most attractive areas to fill in our portfolio
		30

VI. Funding Opportunities for FY 12/13

Industrial, Agriculture and Water Initiatives (not all inclusive)

- Industrial efficiency: Food processing, printing, and manufacture of electronics, transportation equipment, fabricated metals, furniture, chemicals, plastics, and machinery
 - Low Grade Heat Recovery: latent heat recovery, high tech coatings
 - Greenhouse Gas Reduction through capture and sequestration: cement industry, pipeline industry, compressor manufacturers
 - Process Measurement, Diagnostics, and Optimization and roadmaps: sensors, software, consolidated roadmap
-
- Adoption time varies depending on the nature of the industry. In general, IAW research in the area of efficiency looks for the ability to commercialize within 3 years of completion of the projects. 5% penetration of targeted markets is a reasonable goal for these technologies.
 - Major Partners are numerous: all IOUs, major equipment manufacturers, public and private labs, the industries themselves.
 - Ratepayer benefits: Energy and cost savings to affected industries.

VI. Proposed 2012/13 Budget

Initiatives	Proposed FY 2012/13 Natural Gas Budget
Industrial, Agriculture and Water Efficiency Natural Gas Efficiency Research for Industrial Use, Heat Recovery (specific cross industry basic research), Greenhouse Gas Reduction through capture and sequestration, Process Measurement, Diagnostics, and Optimization, Update to IAW Consolidated Roadmap.	\$4,000,000

Questions for the PIER Advisory Group on Energy Efficiency 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?

PIER Natural Gas Advisory Program Areas

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 retail 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
 - Stakeholder, utilities and industry input through workshops
 - Vet with PIER Advisory Board and PIER Advisory Group
- Emphasize core renewable technologies while focusing on cross-cutting initiatives for diversified applications
- Initiatives include:
 - Localized renewable energy systems
 - Utility-scale renewable energy
 - Hybrid generation and CHP

IV. Major Accomplishments -Gills Onions

Production and Conditioning of High Sulfur Biogas for Fuel Cell Combined Heat and Power Generation

- **Project Description:** Converted onion process wastes to biogas; demonstrated biogas cleaning and conditioning to fuel cell gas quality levels and generate CHP from fuel cells
- **Contractor/Partner:** Gas Technology Institute/Gills Onions
- **PIER funding amount:** \$499,921 with a match of \$3,542,000
- **Rate payer benefits:** Energy and cost savings and GHG reduction:
 - Reduce natural gas use: 112,000 scf/day
 - Reduce GHG emissions: 14,500 metric tons/yr
 - Model for California food processing industry: ~40 mil. tons/yr of ag. waste could replace 26 billion scf of natural gas



IV. Major Accomplishments-Biogas Treatment

Removal of Siloxane and H₂S from Biogas Using Microwave Technology

Description: Developed and demonstrated a biogas treatment system combining media adsorption and microwave treatment that can:

- remove siloxanes and H₂S from biogas to allow post combustion technologies on engines, turbines and boilers to meet 2007 CARB emission standards, and
- regenerate and reuse spent media at a cost less than existing disposal and replacement methods

Contractor/Partners: Sacramento Municipal Utility District (SMUD)/CHA Corporation/Applied Filter Technology

PIER funding amount: \$267,381 with match of \$205,425

Rate payer benefits:

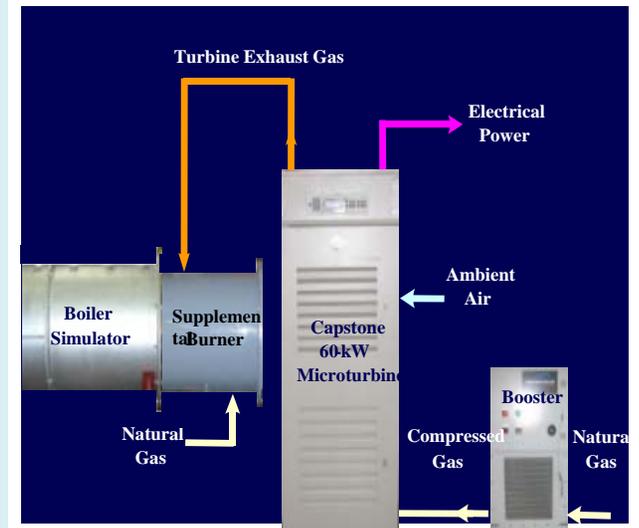
- More economical biogas treatment systems can help achieve CHP and renewable energy goals, and help reduce natural gas use in California by 85 million ft³/day.
- Reduce poisoning catalytic emission control systems due to prevention of corrosive acid formation due to H₂S in the biogas.



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; on-going system refinement
- **Benefits:** 10 to 25% reduction in capital cost of small DG/CHP systems, making them more cost effective for 10 MW or less applications.
- **Next steps:** Field demonstration in Riverside County



V. Current Portfolio Highlights

Major Initiatives

Name of Initiative	Description	Status
1. Combined heat and power and distributed energy resources technologies	<p>Develop low-emissions technology CHP applications</p> <p>Utilize alternative fuels with low carbon intensity such as biogas, flared gas and natural gas</p>	Near completion of research on emission control technology and biogas for fuel cell; completed designs and conducting field tests on biomass power generation systems
2. Hybrid generation and fuel flexible DG/CHP/CCHP	Integrate emerging multiple DG/CHP/CCHP technologies and fuel flexibility, in diversified applications	Solicitation released in Jan. 6; proposals due on Feb. 29th

VI. Funding Opportunities for FY 12/13

Localized Efficient and Advanced Power and Heat Systems (LEAPHS)

- Accelerate deployment of advanced combined heat and power (CHP) systems in industrial, commercial, institutional and other new areas not currently addressed by existing CHP technology in the following areas:
 - A. Localized and advanced CHP/CCHP in industrial, commercial and institutional applications, such as food processing, manufacturing, retail, hotels and hospitals**
 - B. Local renewable resources to augment NG fired heating and power systems, such as wastewater from processing industry or local waste treatment facilities**
 - C. CHP for waste heat and gas from industrial sources**

Potential Partners: technology developers; manufacturers and providers; governmental agencies, universities; utilities, building owners

Ratepayer Benefits:

- Societal benefits of new CHP through 2020: ranges from \$200 million to \$7 billion depending on the policy scenario (CEC, 2009 assessment)
- Provide customer solutions that reduce costs and use waste products for fuel and reduce environmental footprint.

VI. Funding Opportunities for FY 12/13

Combined Heat and Power Applications in By-product Gas Field Locations

- Demonstrate use of low-BTU value, unmarketable “off-spec” gas in combined heat and power applications--opportunities from oil and gas fields such as in LA basin
- Demonstrate operational flexibility of a CHP system, e.g. augment the temperature of hot water that is co-produced from productive or abandoned oil fields.
- **Advances science and technology** by exploring and demonstrating operational flexibility of CHP systems CHP in new opportunity areas

Potential Partners and Customers: Petroleum producing companies; universities; IOUs; local governments; local landowners and institutions; technology manufacturers and providers

Ratepayer Benefits

- Reduce or replace onsite use of natural gas; offset some of the power taken from the utility grid with impacts on lowering production costs
- Reduce emissions from vented gas, reduce NOx from flared gas, and reduce CO₂ by offsetting generation elsewhere

VI. Proposed 2012/13 Budget

Initiatives	Proposed FY 2011/12 Natural Gas Budget
Renewable Energy Total <ul style="list-style-type: none">• Localized Efficient and Advanced Power and Heat Systems• Combined Heat and Power Applications in By-product Gas Field Locations	\$4 Million

Questions for the PIER Advisory Group 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?

PIER Advisory Program Area

Smart 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 enhance transmission and distribution capabilities of the natural gas system.

II. Policy Drivers

Research to meet our Energy Policy Goals

- Greenhouse Gas Emission Reduction - AB 32
- 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



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: Determining the condition of natural gas pipelines

IV. Major Accomplishments

Innovative Monitoring Technologies

- Find new technologies to inspect, monitor and report on the condition of natural gas pipelines
- **Contractor:** UC -CIEE
- **Cost:** \$478,457
- **Status:** Benchmarking existing diagnostic parameters
- **Benefits:** improving the safety and security of natural gas pipelines. The proposed sensors being developed will allow for notification of any damage or corrosion that occurs to the pipelines.
- **Next Steps:**
 1. Document in a Benchmark report for TAC review.
 2. Identify new technologies for future research and demonstration

IV. Major Accomplishments

Current Diagnostic Practices

- Develop a baseline assessment of technologies currently used in California to manage pipeline integrity and safety. It will include what is being done to prevent, detect, and react to incidents such as leaks and ruptures.
- **Contractor:** Gas Technology Institute
- **PIER Cost:** \$480,000
- **Status:** Benchmarking existing diagnostic parameters
- **Benefits:** improve the safety and security of natural gas pipelines.
- **Next Steps:**
 1. Document in a Benchmark report for TAC review.
 2. Identify new technologies for future research and demonstration

V. Funding Opportunities for FY 12/13

- Field demonstrate and further research promising technologies identified by UC-CIEE and GTI
- Pipeline safety and reliability
- Utilities and industry
- \$1 Million FY12/13
- CPUC, Utility and Industry feedback validates the need and will help determine which technologies will go forward
- Increased safety and reliability of natural gas infrastructure

VI. Proposed 2012/13 Budget

Categories	Proposed FY 2012/13 Natural Gas Budget
Natural Gas Pipeline Integrity	\$1,000,000

Energy Related Environmental and Climate Change 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

Executive Orders

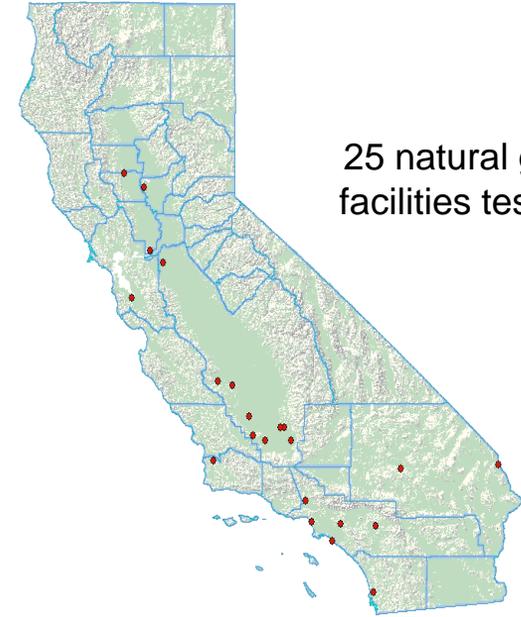
III. General Approach

- **Research Gap – Identified in Roadmaps, subject workshops, advisory board meetings**
- **Strong Policy Connection and linked to energy issues**
- **Public Benefit: (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
- **Increasing partnerships**

IV. Major Accomplishments

Estimation of Methane Emissions from the CA Natural Gas System

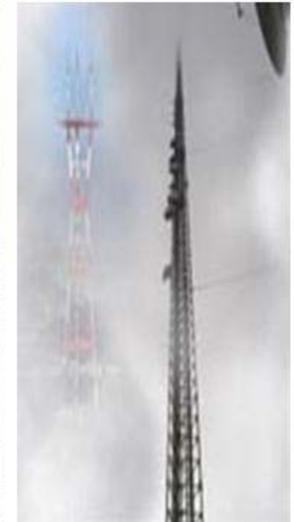
- Measuring fugitive methane emissions to develop improved emission factors – Partnership with ARB
- **Contractor:** CA State University Fullerton
- **PIER funding amount:** \$600K
- **Results:** Testing of hundreds of components at 25 NG facilities. Measurements revealed discrepancies with prior estimated emissions for some sources. Emission Factor method may not work
- **Rate payer benefits:** up to \$140 million/year – Informing Scoping Plan



IV. Major Accomplishments

Atmospheric GHG Measurement and Verification of AB32

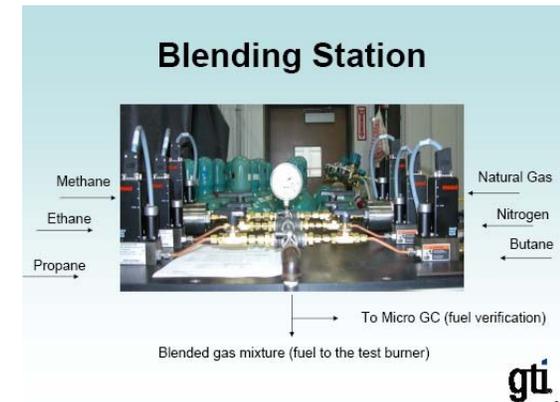
- Using ambient measurements of GHG to “verify” the ARB inventory and to track emissions
- **Contractor:** Lawrence Berkeley National Laboratory. ARB support
- **PIER funding amount:** \$500K
- **Results:** Ambient measurements suggests that actual methane emissions may be 1.5 times higher than the ARB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



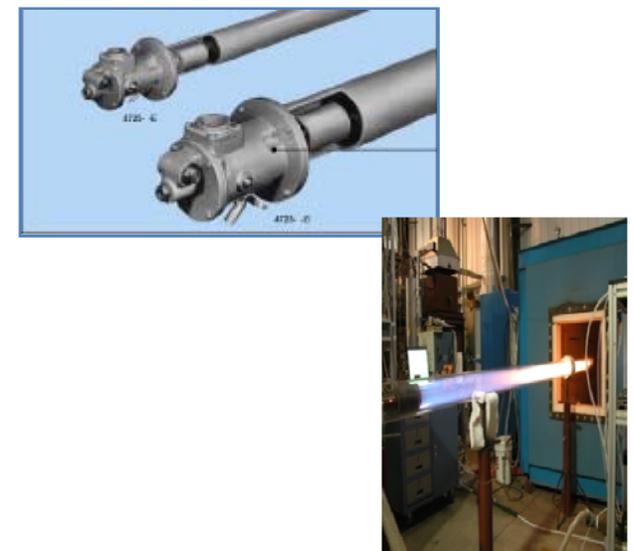
IV. Major Accomplishments

Natural Gas Variability in CA: Environmental Impacts and Device Performance

- Measured emissions and performance on 9 industrial combustion systems and 10 foodservice appliances using range of hot gases.
- **Contractor:** Gas Technology Institute
- **PIER Amount:** \$ 4.3 million
- **Results:** Within fuel range most systems perform fine. Some need adjustments. Some need more evaluation.
- **Ratepayer Benefit:** Facilitates use of wider range of gas in California in safe, energy efficient, & environmentally sound manner.



Radiant Tube Burner



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 just started no data available yet; 2) Laboratory & field tests complete. Some applications need further testing; 3) in the final design stage
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) A Public Opportunity Notice (PON) released in December; 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. ; 2) Study to start in May 2012

VI. Funding Opportunities for FY 12/13

Air Quality Implications of Biogas to Replace Natural Gas: Phase 1

- **Description:** Investigate increase or decrease in air pollutant emissions from use of biogas compared with NG & potential issues associated with use of biogas. Investigate potential operational issues of air pollution control devices. Evaluate multiple sources of biogas.
- **Potential partners/customers:** ARB, End Users, Industry, Policymakers & Regulators
- **Advances science and technology:** Provides much needed information on how to use biogas & other non-traditional gases in a safe & environmentally sound way.
- **Rate payer benefits:** Information developed can be used to diversify natural gas supplies through the safe and environmentally friendly use of non-traditional gases, including biogas. Biogas could replace from 1 percent to 5 percent of current consumption of natural gas. This would translate in < \$100 million /year (assuming \$20 ton of carbon)

VI. Funding Opportunities for FY 12/13

Quantifying Emissions from California's Natural Gas Energy Infrastructure

- **Description:** Use of natural gas CH₄ isotopic signatures, absence of radiocarbon ¹⁴C, and source-specific add-mixtures of other volatile organics and sulfur based odorants to estimate emissions.
- **Potential partners/customers:** ARB, End Users, Industry, Policymakers & Regulators
- **Advances science and technology:** This is a novel technique not used before.
- **Rate payer benefits:** Informing the developing of technically sound and cost-effective regulations (Scoping Plan). Annual expenditures in CA for natural gas is about \$14 billion a year. If the rules and regulations reduce emissions by 50% the net savings could be up to \$140 million/year (order of magnitude estimation).

VI. Funding Opportunities for FY 12/13

Reclaimed Water and particulate matter (PM) emissions from cooling towers

- **Description:** It is assumed that water droplets containing dissolved salts in cooling towers evaporate, resulting in PM emissions, but no measurement data exists showing that this is the case.
- **Potential partners/customers:** ARB, Air Districts, Energy Commission, Proponents of new power plants
- **Advances science and technology:** Data of actual PM emissions from cooling towers are not available in part because of the difficulties associated with these measurements. This project would fill this void.
- **Rate payer benefits:** Power plants consume about 43% of the natural gas combusted in CA. PM10 and PM2.5 offsets can cost thousands of dollars per ton and create problems in the siting of new natural gas burning power plants.

VI. Proposed 2012/13 Budget

Initiatives	Proposed FY 2012/13 Natural Gas Budget
Energy Related Environmental and Climate Change Research Air Quality Implications of biogas to replace natural gas: Phase 1 (see Note), quantifying emissions from California's natural gas energy Infrastructure, reclaimed water and particulate matter (PM) emissions from cooling towers	\$3,000,000

Note: This project also belongs in the Renewable Energy element in PIER

Transportation Research Area



NGV
NATURAL GAS VEHICLE



Presenter: Rey Gonzalez

I. Goals

As a transportation fuel, natural gas could:

- *Offset more than 885 million gallons of 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.*

The goals of transportation-related PIER projects are to:

- *Accelerate the commercial viability 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.*

II. Policy Drivers

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

Senate Bill 1250: *Enabled PIER funds to be used for advanced transportation technologies that:*

- *Reduce air pollution and GHG emissions beyond applicable standards.*
- *Benefit natural gas ratepayers.*

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

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 in 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

Liquefied Natural Gas Heavy-Duty Natural Gas Truck Field Demonstration

Purpose: To develop and demonstrate an advanced liquefied natural gas heavy-duty engine with equivalent diesel engine performance that meets or exceeds CARB/EPA 2010 Emission Standards.



Contractor: Westport Power, Inc

Partners: South Coast Air Quality Management District, Port of LA, Port of Long Beach

PIER Funds: \$500,000 with \$1.5M in match share

Results: Completed certification to CARB 2010, and performed demonstrations & field trials.

Rate Payer Benefits: As of Sep. 2011, early launch totals include 119 trucks shipped alone displacing 500K gallons of diesel annually and 1650 tonnes of CO₂e.

Next Steps: Grant award of \$1M for improving performance while also reducing cost.

IV. Major Accomplishments

Develop and demonstrate an ultra low emissions, high performance spark ignited natural gas engine



Purpose: Develop a 12 to 13 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 /Partners: Gas Technology Institute teamed with Cummins Westport, Inc.

PIER Funds: \$1M with \$1.4M in match share

Results: Successfully met the project objectives: criteria emission pollutants lower than CARB 2010, 400 HP & 1350 ft lbs torque, and up to 40% reduction in GHG emissions over current Class 8 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: Continue development into beta-stage (pre-commercialization), chassis integration, and field demonstration.

IV. Major Accomplishments

Advanced Natural Gas (ANG) Fuel Tank Project

Purpose: Develop low-pressure storage technology for natural gas vehicles, adsorbent materials (carbon made from waste corncob). Design a flat-panel tank assembly, construct prototype, and evaluate performance.

Contractor: University of Missouri

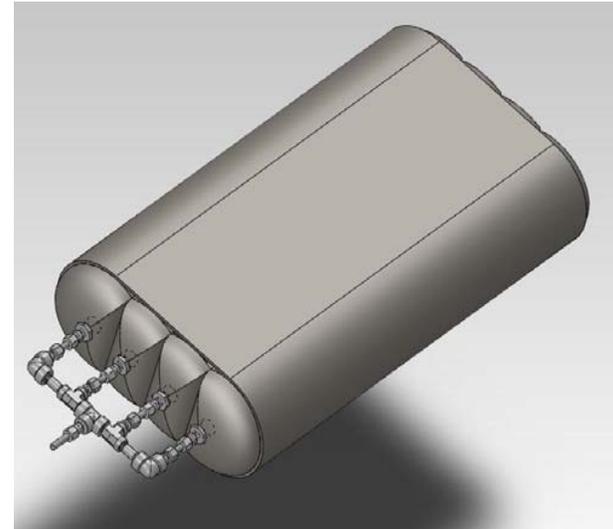
Partner: Southern California Gas Company

PIER Funds: \$1M with \$618K in match share

Results: Performance evaluation of 1st generation ANG tank, completed design for 2nd generation tank, development completed for high performance carbon from corncob waste, and light-weight ANG tank assembly started.

Rate Payer Benefits: Increased performance and reduce cost for NGV and cost reduction for fueling infrastructure (station and home refueling). Increasing market viability of NGVs will result in improved air quality as NG is the cleanest of fossil fuels.

Next Steps: Release solicitation for next phase of research into pre-commercialization.



IV. Major Accomplishments

Demonstrate Process to use Landfill Gas for Transportation Fuel

Purpose: Demonstrate and test a patented process at the Altamont Landfill to clean and convert landfill gas into liquefied natural gas (LNG) for use as transportation fuel.

Contractor: Gas Technology Institute

Partners: CARB, SCAQMD, California Integrated Waste Management Board

PIER Funds: \$1M with \$11.2M in match share

Results: This successful project has received several awards including the:

- *California Governor's Environmental and Economic Leadership Award*
- *Breathe California Clean Air Award*
- *East Bay Clean Cities Recognition*
- *Climate Change Business Journal*

Rate Payer Benefits: This fully operational facility produces over 4 million gallons of LNG biofuel annually to power the Waste Management, Inc. fleet of trucks resulting in cost savings and environmental benefits.

Next Steps: AB 118 has pursued advancing the landfill gas concept to further commercialization



V. Current Portfolio Highlights

Major Initiatives

Name of Initiative	Description	Status
<ul style="list-style-type: none"> Natural Gas Vehicle Efficiency 	NREL/SCAQMD joint project: <ul style="list-style-type: none"> Engine development Chassis Integration Vehicle Demonstration 	<ul style="list-style-type: none"> Contract start date of 6/30/11 and completion 6/30/14
<ul style="list-style-type: none"> Natural Gas Vehicle Efficiency 	<ul style="list-style-type: none"> Engine Development 	<ul style="list-style-type: none"> Project on schedule to complete on 6/30/2012
<ul style="list-style-type: none"> NG Infrastructure 	<ul style="list-style-type: none"> LNG Infrastructure improvement R&D 	<ul style="list-style-type: none"> RFP Released 1/6/2012 Proposals due 2/17/2012
<ul style="list-style-type: none"> Advanced Bio Fuels 	<ul style="list-style-type: none"> Advanced Biosynthetic Transportation Fuel Production 	<ul style="list-style-type: none"> On schedule to complete 12/1/2012
<ul style="list-style-type: none"> Advanced Bio Fuels 	<ul style="list-style-type: none"> Enable an oil biomanufacturing process to use sustainable, non-food, cellulosic feedstocks. 	<ul style="list-style-type: none"> Project completed awaiting final report

VI. Funding Opportunities for FY 12/13

Initiative: Natural Gas Vehicle Efficiency

Description: This project will focus on improving Natural Gas Vehicle efficiency using battery power to minimize idle and low-load engine operation contributing a cost-effectiveness heavy-duty NGVs particularly in stop-and-go urban service. Research is needed to develop and demonstrate the a hybridization design for a given application or vocation.

Potential partners: Funding partners may include SCAQMD and So Cal Gas Company

How it advances science and technology: To date there are no commercially available hybridization technologies for Natural Gas Vehicles.

The deployment of advanced and efficient natural gas vehicle technologies will further improve the economics in natural gas vehicles, lower greenhouse gas emissions, and significantly benefit natural gas ratepayers.

Estimated Ratepayer Benefits: Improve fuel efficiency by up to 5%

VI. Funding Opportunities for FY 12/13

Initiative: Natural Gas Vehicle On-Board Storage

Description: To enable broader market penetration of Natural Gas Vehicles, research is needed to demonstrate the operational and manufacturing viability of the Advanced Natural Gas (ANG) Fuel Tank design in a vehicle. This low-pressure, light-weight, conformable design addresses key barriers to full adoption in NGVs due to range limit and storage tank cost & size.

Potential partners: Funding partners may include SCAQMD and So Cal Gas Company

How it advances science and technology and not duplicative of previous research: This research will take a laboratory tested tank design from earlier research, and drive towards pre-commercialization by conducting vehicle integration and testing.

Estimated Ratepayer Benefits: The low-pressure tank design will reduce cost of NGVs, and reduce fueling-station costs—both public stations and home fueling appliances—by significantly reducing the energy needed for compression.

VI. Funding Opportunities for FY 12/13

Initiative: Transportation Renewable Natural Gas (RNG) Research Roadmap

Description: This initiative will develop a stakeholder-driven research roadmap. This roadmap will identify research opportunities for PIER funding to advance RNG production and implementation for transportation applications. The roadmap will include research initiatives along with recommended funding amounts. As part of the roadmap development, a gaps analysis will be performed to identify research needs and assess various technologies.

Potential partners: Utilities, CPUC, CARB, Research Institutions, DOE, Private Industry.

How it advances science and technology and not duplicative of previous research: This roadmap will ensure that future PIER-funded projects for Transportation RNG advance science and technology and are not duplicative of previous research.

Estimated Ratepayer Benefits: The roadmap will help ensure that PIER funded RD&D actions provide the greatest acceleration of cost effective RNG technologies in the market to help meet the state's renewable goals. It also ensures that the highest priority, stakeholder vetted initiatives are given funding priority.

VI. Proposed 2012/13 Budget

Initiatives	Proposed FY 2012/13 Natural Gas Budget
Natural Gas Related Transportation Research Research, develop, and demonstrate hybrid natural gas vehicles and advanced natural gas tank, develop renewable natural gas roadmap	\$4,000,000

Questions for the PIER Advisory Group on Smart Infrastructure 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?

Energy Innovation Small Grant Program

**Supports all three PIER Advisory Program
Areas**

Energy Innovation Small Grant Program

Presenter: David Chambers

I. Goals

The Energy Innovation Small Grant (EISG) 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, a niche not covered by PIER general solicitations
- Facilitate the commercialization of energy technologies that can have an impact on achieving state energy policy while providing tangible benefits to natural gas utility customers

II. General Approach

- San Diego State Research Foundation administers the EISG Program
- Conduct three competitive solicitations annually seeking innovative Natural Gas concepts
- Grants must target one of PIER's 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
- As of October 31, 2011, the EISG program held 12 solicitations, funded 21 Natural Gas grants for a total of \$1.8 million

III. Current Portfolio Highlights

Major Initiatives

Name of Initiative	Description	Status
Innovative Concepts for Natural Gas	Natural Gas Energy Efficiency, Natural Gas Environmental Impacts, Renewable Energy Technologies, Advanced Generation Concepts, Alternative Fuels, Vehicle Technologies, and Transportation Systems	<ul style="list-style-type: none">• 21 research projects approved, 15 complete and 6 active• \$1,890,210 invested in innovative concepts

IV. Funding Opportunities for FY 12/13

- Three solicitations per year for natural gas grant proposals
- Accelerated approval process design to get results in the marketplace quickly
 - Grants are approved by Energy Commission within 20 weeks of a particular solicitation cutoff date
 - Execute grant agreements on average 4 weeks after approval
- Individuals, business, non-profit organizations and academic institutions can apply for grants
- EISG welcomes entrepreneurs at early stages of development
- Heavy focus on California entities

V. Proposed 2012/13 Budget

Initiatives	Proposed FY 2012/13 Natural Gas Budget
Energy Innovations Small Grant Program	\$1,500,000

Questions for the PIER Advisory Group on Energy Innovation Small Grant 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?

Advisory Group Presentations and Discussions

- Cherif Youssef, Sempra Energy
- Ron Kent, Sempra Energy
- Jorn Herner, Air Resources Board
- William Miller, Building Technologies Program, DOE-LBNL

Public Comments

Closing Comments

- Submit additional written comments to: Jesse Rosales (jrosales@energy.ca.gov) by 5:00 pm on February 2, 2012
- 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, 2012
- Copies of presentations , public comments and responses to questions from today's workshop will be posted under January 24, 2011 at:
<http://www.energy.ca.gov/research/notices/index.html#01242012>
- Copies of past budget documents can be found at:
http://www.energy.ca.gov/research/annual_reports.html