

**California Energy Commission  
STAFF REPORT**

**THE NATURAL GAS RESEARCH,  
DEVELOPMENT, AND  
DEMONSTRATION PROGRAM**  
*Proposed Program Plan and Funding  
Request for Fiscal Year 2012–13*



CALIFORNIA  
ENERGY COMMISSION  
Edmund G. Brown, Jr., Governor

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# CALIFORNIA ENERGY COMMISSION

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## ABSTRACT

Assembly Bill 1002 (Wright, Chapter 932, Statutes of 2000) authorizes the California Public Utilities Commission to impose a surcharge on all natural gas consumed in California to fund energy efficiency programs and public interest research and development projects to benefit natural gas ratepayers. In 2004, the California Public Utilities Commission issued Decision 04-08-010, which designated the California Energy Commission as the administrator for the research funds. The Energy Commission manages the Public Interest Energy Research Natural Gas program, which supports energy-related research, development, and demonstration not adequately provided by competitive and regulated markets. The Energy Commission submits an annual proposed program plan and funding request to the California Public Utilities Commission for review and approval.

This staff report, *Natural Gas Research, Development, and Demonstration Program: Proposed Program Plan and Funding Request for Fiscal Year 2012-13*, describes the Energy Commission's proposed research initiatives in energy efficiency, renewable energy, and smart energy infrastructure. The recommendations are based on input from California stakeholders, research institutions, and governmental partners. These initiatives were vetted through a public process where members of three Public Interest Energy Research Advisory Groups and the public commented on staff recommendations. Staff considered all comments in preparing this document.

The proposed research funding for fiscal year 2012–13 is \$24 million, and the budget plan covers the period from July 1, 2012, through June 30, 2013.

**Keywords:** California Energy Commission, California Public Utilities Commission, Air Resources Board, natural gas research, PIER, energy research, RD&D, energy efficiency, renewable energy, smart energy infrastructure

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# TABLE OF CONTENTS

<b>Acknowledgements</b> .....	<b>i</b>
<b>ABSTRACT</b> .....	<b>iii</b>
<b>TABLE OF CONTENTS</b> .....	<b>iv</b>
<b>Executive Summary</b> .....	<b>1</b>
Research Vision and Goals .....	1
Research Approach and Stakeholder Participation .....	1
Coordinated Efforts for Natural Gas and Electricity Research Synergies in California .....	2
Achieve Long-Term Natural Gas Ratepayer Benefits.....	2
Natural Gas Research Budget Plan for Fiscal Year 2012-13 .....	2
<b>CHAPTER 1: Introduction</b> .....	<b>5</b>
Report Structure .....	6
<b>CHAPTER 2: Program Overview</b> .....	<b>7</b>
Importance of Natural Gas Research .....	7
Research Vision and Goals .....	8
Development of Research Initiatives.....	9
Research Policy Drivers .....	9
Stakeholder Participation and Strategic Partnerships .....	9
Research Area .....	10
Policy Drivers .....	10
Stakeholder Participation Through the Advisory Board and Program Advisory Groups ...	13
Stakeholder Participation Through Collaborative Roadmaps and Workshops.....	13
Natural Gas Research Benefits .....	14
<b>CHAPTER 3: Natural Gas Research Budget Plan for Fiscal Year 2012-13</b> .....	<b>15</b>
Proposed Budget.....	15
Proposed Research Initiatives .....	16
Energy Efficiency Research.....	16
Buildings End-Use Energy Efficiency .....	17

Proposed Research Initiative: Buildings End-Use Energy Efficiency .....	19
Industrial, Agriculture, and Water Efficiency .....	22
Proposed Research Initiative: Industrial, Agriculture and Water Efficiency .....	24
Renewable Energy Research.....	29
Renewable Energy and Advanced Generation.....	29
Smart Energy Infrastructure Research .....	36
Natural Gas Pipeline Integrity .....	36
Proposed Research Initiative: Smart Energy Infrastructure .....	37
Energy-Related Environmental Research.....	38
Proposed Research Initiative: Energy-Related Environmental Research .....	39
Natural Gas-Related Transportation.....	43
Proposed Research Initiative: Natural Gas-Related Transportation .....	44
Energy Innovations Small Grants Program .....	47
Proposed Research Initiative: Energy Innovation Small Grants Program.....	48
<b>CHAPTER 4: Quantifying Benefits of Research .....</b>	<b>49</b>
Recent Benefits Assessment Results.....	50
<b>Appendix A – Natural Gas Research Initiatives for 2012/13 Presentation .....</b>	<b>1</b>
<b>Appendix B – PIER Advisory Group Workshop – January 24, 2012 .....</b>	<b>1</b>

## LIST OF TABLES

Table 1: Natural Gas Budget Plan Summary FY 2012-13 .....	3
Table 2: Summary of Policy Drivers for Natural Gas Activities .....	10
Table 3: FY 2012-13 Natural Gas Research Budget Plan Summary .....	16
Table 4: FY 2012-13 Natural Gas Research Budget Plan Summary – Buildings End-Use Energy Efficiency .....	17
Table 5: FY 2012-13 Natural Gas Research Budget Plan Summary – Industrial, Agriculture, and Water Efficiency .....	22
Table 6: FY 2012-13 Natural Gas Research Budget Plan Summary – Renewable Energy and Advanced Generation.....	29

Table 7: FY 2012-13 Natural Gas Research Budget Plan Summary – Pipeline Integrity ..... 36

Table 8: FY 2012-13 Natural Gas Research Budget Plan Summary – Energy-Related  
Environmental Research ..... 38

Table 9: FY 2012-13 Natural Gas Research Budget Plan Summary –Transportation ..... 43

Table 10: FY 2012-13 Natural Gas Research Budget Plan Summary – Energy Innovations Small  
Grants Program ..... 47

**LIST OF FIGURES**

Figure 1: California’s Energy Sources ..... 7

Figure 2: Proposed Natural Gas Research Budget Categories..... 15

Figure 4: Commercial Natural Gas Use (2.5 billion therms/year-see footnote 34) ..... 18

Figure 3: Residential Natural Gas Use (5.1 billion therms/year-see footnote 34) ..... 18

Figure 5: Energy Use of Various Industries in California ..... 23

Figure 6: PIER Electricity-Related Small Grants Subsequent Funding ..... 48

# Executive Summary

The California Energy Commission's Energy Research and Development Division administers the Public Interest Energy Research Natural Gas (PIER NG) program with oversight by the California Public Utilities Commission (CPUC). The Energy Commission has administered this program for seven years and has funded 95 research agreements totaling more than \$73 million.

The PIER NG program staff develops proposed natural gas research initiatives based on state energy policies and legislative mandates and a public vetting process. These include CPUC Decision 04-08-010, the *Integrated Energy Policy Reports, Energy Action Plan, State Alternative Fuels Plan* for transportation, the *California Energy Efficiency Strategic Plan*, and Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006).

## Research Vision and Goals

The PIER Program focuses on identifying and addressing emerging natural gas-related themes and trends that are important to California's energy-smart future. These include opportunities to reduce statewide natural gas consumption through energy efficiency, use of natural gas alternatives, such as biogas and other renewables, and use of natural gas to diversify California's transportation fuel mix. Additionally, the program coordinates with the CPUC to respond to emerging research needs, such as natural gas pipeline integrity and safety research. The PIER NG program funds research that:

- Stimulates California's economic growth by attracting and developing businesses and creating and supporting jobs.
- Achieves long-term benefits to natural gas ratepayers through development of technologies and products that provide clean, diverse, and environmentally sound energy systems.
- Provides safe, reliable natural gas services by conducting research that focuses on the integrity and safety of the natural gas infrastructure.

## Research Approach and Stakeholder Participation

On January 24, 2012, the Energy Commission's RD&D program staff, in coordination with the CPUC, held a PIER NG public workshop with the PIER Advisory Group (PAG) members and the public to discuss the staff's proposed natural gas research initiatives. Recommendations from the workshop were considered and used to refine the *Natural Gas Proposed Program Plan and Funding Request (NG Budget Plan) for Fiscal Year (FY) 2012-13*. A summary of comments is included in Appendix A.

This PAG meeting complements similar meetings held on the PIER electric research program. As required by Senate Bill 1250 (Perata, Chapter 512, Statutes of 2006), the Energy Commission established a Public Interest Energy Research Advisory Board (Advisory Board) to provide strategic advice and feedback on program direction and electric research initiatives. In 2011, PIER also established three subcommittees called Program Advisory Groups (PAGs) to provide a public forum for reviewing budget plans and new program initiatives in the following research program areas:

- Energy Efficiency
- Renewable Energy
- Smart Energy Infrastructure

### Coordinated Efforts for Natural Gas and Electricity Research Synergies in California

The Energy Commission takes a holistic approach to the natural gas and electricity research programs to leverage and increase the effectiveness of research for the ratepayer. This reduces the potential of duplicative research in areas that affect both natural gas and electric use. Additionally, benefits from the synergistic gas and electric research projects are identified. For example, electric research on sensors originally developed for determining the condition of electric underground cable is now being applied to find welding defects in natural gas pipelines.

By coordinating natural gas and electricity RD&D efforts, the Energy Commission also leverages funding, expands partners, and shares knowledge to meet California's energy goals and increase benefits for all California ratepayers. Additionally, integrating direct natural gas applications with electricity energy efficiency improvements results in a reduction of total energy consumed and saves ratepayers money on their total natural gas and electricity bills. Though synergies are exploited for the benefit of ratepayers, separate accounting is maintained between the two programs.

### Achieve Long-Term Natural Gas Ratepayer Benefits

The Energy Commission will continue to evaluate and calibrate its natural gas research portfolio to maximize the benefits to California's natural gas ratepayers. Central to this effort is a renewed focus on measuring the benefits of the Energy Commission's research activities. While the costs and benefits of most commercially available products and technologies can be easily quantified, the same cannot be said for premarket emerging technologies. Calculating benefits associated with energy technology research can be especially challenging because not all benefits are readily quantifiable, such as the environmental benefits that impact greenhouse gas reduction and air quality improvements.

Three primary California ratepayer benefit categories have been identified from the activities of the PIER NG program: economic, environmental, and security. Economic benefits are principally lower energy bills. Environmental benefits include reduced impact from global climate change, reduced health risks related to poor indoor and outdoor air quality, and a smaller environmental impact from energy generation and use. Security benefits include a reliable and safe natural gas system.

### Natural Gas Research Budget Plan for Fiscal Year 2012-13

*The NG Budget Plan* divides the funding among primary research initiatives across four main research program areas shown in Table 1. The research plan follows the state's "loading order" led by energy efficiency and renewable energy resources. Roughly 10 percent of the total budget is allocated for administrative expenses, which includes personnel expenses and technical support.

**Table 1: Natural Gas Budget Plan Summary FY 2012-13**

<b>Research Program Areas</b>	<b>FY 2012-13 Budget</b>
Energy Efficiency	\$8 million
Renewable Energy	\$4 million
Smart Energy Infrastructure	\$8 million
Energy Innovation Small Grants	\$1.5 million
Program Administration	\$2.5 million
<b>TOTAL</b>	<b>\$24 million</b>

Source: California Energy Commission



# CHAPTER 1:

## Introduction

The Public Interest Energy Research (PIER) Program was created in 1996 when the State Legislature enacted Assembly Bill 1890 (Brulte, Chapter 854, Statutes of 1996), California's electric utility restructuring law. Recognizing the benefit of natural gas research to California, Assembly Bill 1002 (Wright, Chapter 932, Statutes of 2000) directed the California Public Utilities Commission (CPUC) to impose a surcharge on all natural gas consumed in California to fund public interest research and development activities specific to natural gas. AB 1002 also required the CPUC to designate an entity to administer the newly created Public Interest Natural Gas Research program (PIER NG program). In CPUC's Decision 04-08-010, the CPUC designated the Energy Commission as the administrator for the natural gas research program. The CPUC has allocated a funding level at \$24 million per year and defined public interest natural gas RD&D activities as those that "are directed towards developing science or technology, and 1) the benefits of which accrue to California citizens and 2) are not adequately addressed by competitive or regulated entities."<sup>1</sup> The decision also directs that natural gas RD&D projects meet the following criteria:

- Focus on energy efficiency, renewable technologies, conservation, and environmental issues.
- Support state energy policy.
- Offer a reasonable probability of providing benefits to the general public.
- Consider opportunities for collaboration and cofunding opportunities with other entities.

The Energy Commission's natural gas research is also governed by energy policies identified in the *Integrated Energy Policy Reports (IEPR)*, *California's Energy Efficiency Strategic Plan*, and the *Bioenergy Action Plan*.<sup>2</sup> To achieve the policy goals of Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006), the Energy Commission and California Air Resources Board (ARB) collaborate their research efforts and identify technologies that can help reduce greenhouse gas emissions.

The Energy Commission's PIER Program was updated by Senate Bill 1250 (Perata, Chapter 512, Statutes of 2006) to include research that results in safe and affordable services and research on advanced transportation that benefits electric and natural gas ratepayers. In addition, the CPUC established a specific state goal of reducing natural gas demand by 290 million therms from investor-owned utility customers between 2005 and 2014.<sup>3</sup>

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<sup>1</sup> CPUC Decision 04-08-010, p. 24.

<sup>2</sup> *California's Long-Term Energy Efficiency Strategic Plan*, (September 2008), <<http://www.californiaenergyefficiency.com/docs/EEStrategicPlan.pdf>>.

<sup>3</sup> California Public Utilities Commission. *Interim Opinion: Energy Savings Goals for Program Year 2006 and Beyond*. D.04-09-060. [http://docs.cpuc.ca.gov/published/Final\\_decision/40212-08.htm#TopOfPage](http://docs.cpuc.ca.gov/published/Final_decision/40212-08.htm#TopOfPage).

## Report Structure

This year's annual *NG Budget Plan* contains the following chapters and an appendix:

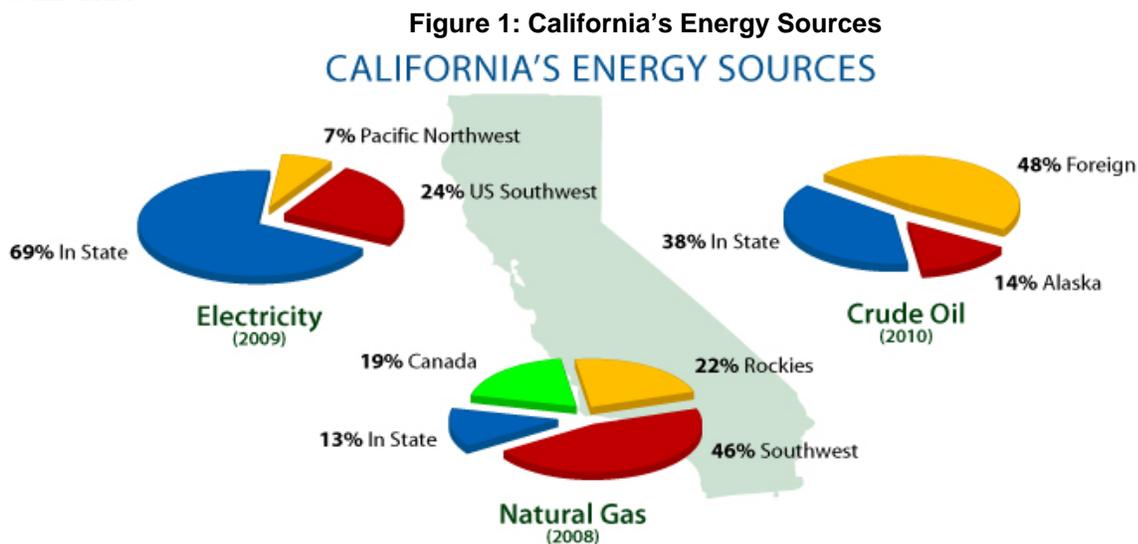
- Chapter 1: Introduction provides basic information about the program origins and major policy drivers.
- Chapter 2: Program Overview discusses how research initiatives are developed, the research vision, the long term ratepayer benefits.
- Chapter 3: Fiscal Year 2012-13 Research Plan details the Energy Commission's proposed research program areas and initiatives for energy efficiency, renewable energy, and smart energy infrastructure.
- Chapter 4: Quantifying the Benefits of Research describes how data is collected and analyzed to estimate benefits resulting from funded research.
- Appendices A and B include the January 24, 2012, PAG workshop materials including presentation, questions, answers, and comments.

## CHAPTER 2: Program Overview

This chapter provides an overview of the importance of natural gas research, natural gas research vision and goals, how the research initiatives were developed and benefits of research to California natural gas ratepayers.

### Importance of Natural Gas Research

In 2010, Californians consumed nearly 22.5 billion therms of natural gas in homes, commercial buildings, industry, vehicles, and for electric generation.<sup>4</sup> This resulted in about \$14.3 billion spent for natural gas and generation of 119 million metric tons of greenhouse gas emissions.<sup>5</sup> Combustion of natural gas is relatively clean; however, California will not meet its greenhouse gas reduction goals or air quality mandates without significant improvements and technology innovation. Efficiency gains are needed to control energy bills. Natural gas has become an increasingly important source of energy since more of the state's power plants rely on this fuel. However, only about 13 percent of natural gas used in California comes from in-state production, thus California's reliance on imported gas leaves the state vulnerable to price shocks and supply disruptions.<sup>6</sup> Figure 1 shows the origin of the energy sources serving California.



Source: California Energy Commission [http://energyalmanac.ca.gov/overview/energy\\_sources.html](http://energyalmanac.ca.gov/overview/energy_sources.html)

<sup>4</sup> [http://www.eia.gov/dnav/ng/NG\\_CONS\\_SUM\\_DCU\\_SCA\\_A.htm](http://www.eia.gov/dnav/ng/NG_CONS_SUM_DCU_SCA_A.htm). 2010 natural gas consumption without electricity generation is 12,700 million therms per 2011 Integrated Energy Policy Report: [www.energy.ca.gov/2011publications/CEC-100-2011-001/CEC-100-2011-001-CMF.pdf](http://www.energy.ca.gov/2011publications/CEC-100-2011-001/CEC-100-2011-001-CMF.pdf).

<sup>5</sup> Calculated from 2010 consumption data from the Energy Information Administration; Natural gas cost from the April 19, 2011, California Energy Commission Natural Gas Assessment Workshop; conversion factor for greenhouse gas assumes 0.0053 metric tons per therm from the California Air Resources Board [http://www.eia.gov/dnav/ng/NG\\_CONS\\_SUM\\_DCU\\_SCA\\_A.htm](http://www.eia.gov/dnav/ng/NG_CONS_SUM_DCU_SCA_A.htm), [http://www.energy.ca.gov/2011\\_energypolicy/documents/2011-0419\\_workshop/presentations/](http://www.energy.ca.gov/2011_energypolicy/documents/2011-0419_workshop/presentations/).

<sup>6</sup> <http://energyalmanac.ca.gov/naturalgas/index.html>.

Successful efficiency programs and increasing renewable sources can help slow the demand and reduce costs for natural gas. Since 2004, PIER has invested research funds to develop technologies, tools, and strategies that increase energy efficiency, reduce energy cost, reduce air pollutants and greenhouse gas emissions, and improve the safety of pipeline infrastructure. The California Energy Commission's *2011 Natural Gas Report to the California Public Utilities Commission* described how energy efficiency research for pipe insulation contributed to changes in the 2008 Building Efficiency Standards (Title 24). The report indicated that these changes would result in estimated net present value savings of \$230 million to California ratepayers with an approximate reduction of 300 million therms and 1.7 million metric tons of carbon dioxide.<sup>7</sup> The report also provided preliminary estimates from 38 natural gas research projects and the potential for these projects to reduce annual gas use by 1.4 billion therms, gas cost by \$1.7 billion, and carbon dioxide emissions by 8.7 million metric tons.<sup>8</sup> These cost savings are large compared to PIER's total natural gas research expenditures since 2005 of \$73 million.<sup>9</sup> The savings from just the pipe insulation project mentioned earlier is estimated to return to California ratepayers roughly \$3 for every dollar collected.<sup>10</sup>

PIER has also advanced renewable or alternative sources of natural gas, increased localized generation opportunities, reduced air emissions and improved indoor air quality, accelerated and improved the energy efficiency of natural gas vehicles, and improved the safety of pipeline infrastructure. These investments have saved natural gas ratepayers money while increasing safety, security, transportation fuel diversification, and environmental protection. For instance, research on improving natural gas system and infrastructure performance will increase safety and reliability of natural gas pipelines for all Californians. Research on natural gas combustion equipment will address impacts on indoor air quality. This becomes very important as buildings become tighter and the nexus between high efficiency and ambient air emissions, especially oxides of nitrogen (for example, NO<sub>x</sub>) and carbon monoxide (CO).

A full review of program achievements can be found in the *2011 Natural Gas Report to the CPUC*.<sup>11</sup>

## Research Vision and Goals

The PIER Program focuses on identifying and addressing emerging natural gas-related themes and trends that are important to California's energy-smart future. These include opportunities for use of nontraditional natural gas alternatives, such as biogas and other renewables, use of natural gas to diversify California's transportation fuel mix, reduction of statewide natural gas consumption through energy efficiency, efficient use of natural gas through combined heat and power, and pipeline integrity. Additionally, the PIER NG program funds research that:

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<sup>7</sup> <http://www.energy.ca.gov/2011publications/CEC-500-2011-029/CEC-500-2011-029.pdf>

<sup>8</sup> Ibid.

<sup>9</sup> Energy Commission.

<sup>10</sup> Calculated based on \$230 million/\$73million = \$3.

<sup>11</sup> <http://www.energy.ca.gov/2011publications/CEC-500-2011-029/CEC-500-2011-029.pdf>.

- Stimulates California’s economic growth by attracting and developing businesses and creating and supporting jobs. The program invests in innovative, energy-related research development and demonstration projects. Successful research projects lead to new companies or new products for existing companies.
- Achieves long-term benefits to natural gas ratepayers through development of technologies and products that provide clean, diverse, and environmentally sound energy systems.
- Provides safe, reliable natural gas services by conducting research that focuses on the integrity and safety of the natural gas infrastructure.

## Development of Research Initiatives

### Research Policy Drivers

The PIER Program is guided by state energy policy and state legislation, which over time have adjusted the scope of the research. In addition to the statutes and mandates described in this chapter, research direction is provided in CPUC Decision 04-08-010, the joint CPUC and Energy Commission’s *Energy Action Plan*, AB 32, SB 1250 codified as Public Resources Code Sections 25620 to 25620.15, Governor Brown’s *Clean Energy Jobs Plan*, *California Energy Efficiency Strategic Plan*, and the Energy Commission’s *Integrated Energy Policy Report (IEPR)*. The IEPR is released biannually and evaluates overall supply and demand trends for electricity, natural gas, and transportation fuels in California and issues associated with energy infrastructure, efficiency, reliability, and cost.<sup>12</sup> Table 2 describes these and the additional policy drivers unique to each of the research areas described in this report.

### Stakeholder Participation and Strategic Partnerships

The Energy Commission staff collaborates with CPUC staff to develop a research portfolio that responds to the challenges in the natural gas sector. For example, after the 2010 San Bruno pipeline explosion, coordination between the two agencies led to \$1 million of the FY 2011-12 budget being allocated to research on natural gas pipeline integrity and safety. The Energy Commission and CPUC staffs are developing the Research and Technology Action Plan for the *California Energy Efficiency Strategic Plan*. Once this action is plan is complete, the PIER Program will adjust its RD&D activities to meet these goals.

The Energy Commission also collaborates with California stakeholders, research institutions, governmental partners, industry, and utilities to develop public interest energy research projects. This partnership improves accountability, transparency, communication, and responsiveness to stakeholders. The Energy Commission relies on these strategic partnerships to help carry out its RD&D activities. Partnerships help avoid duplication, build on successful RD&D work, generate new ideas, leverage public and private investments, and ensure the RD&D portfolio provides benefits to the state’s natural gas ratepayers.

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<sup>12</sup> Copies of the *Integrated Energy Policy Reports*: <http://www.energy.ca.gov/energypolicy/index.html>.

**Table 2: Summary of Policy Drivers for Natural Gas Activities**

Research Area	Policy Drivers
Energy Commission’s Primary Natural Gas Policy Drivers	<ul style="list-style-type: none"> <li>• <i>Energy Action Plan</i><sup>13</sup></li> <li>• <i>Integrated Energy Policy Report (IEPR)</i><sup>14</sup></li> <li>• Assembly Bill 32 (Núñez, Chapter 488 Statutes of 2006)<sup>15</sup> – California Global Warming Solutions Act of 2006</li> <li>• Senate Bill 1250 (Perata, Chapter 512, Statutes of 2006)<sup>16</sup></li> <li>• Public Utilities Code Section 895 – provides statutory authority for the Energy Commission to administer the natural gas funds using the PIER statutes<sup>17</sup></li> </ul>
An Energy-Efficient California: Initiatives focus on buildings energy end-use efficiency; industrial, agriculture, and water efficiency; and energy efficiency-related environmental research.	<ul style="list-style-type: none"> <li>• Energy Efficiency Buildings Standards (Title 24, Part 6,)</li> <li>• Appliance Energy Efficiency Standards (Title 20, Division 2, Chapter 4, Article 4, Sections 1601-1608: Appliance Efficiency Regulations)</li> <li>• AB 758 (Skinner, Chapter 470, Statutes of 2009) achieves greater energy savings in existing residential and nonresidential buildings.</li> <li>• AB 531 (Saldaña, Chapter 323, Statutes of 2009) discloses commercial building energy use.</li> <li>• AB 2021 (Levine, Chapter 734, Statutes of 2006) sets energy efficiency target of reducing forecasted consumption by 10 percent.</li> <li>• California Energy Efficiency Strategic Plan<sup>18</sup> requires:</li> </ul>

<sup>13</sup> [http://www.energy.ca.gov/energy\\_action\\_plan/](http://www.energy.ca.gov/energy_action_plan/).

<sup>14</sup> [http://www.energy.ca.gov/2009\\_energypolicy/index.html](http://www.energy.ca.gov/2009_energypolicy/index.html).

<sup>15</sup> [http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab\\_0001-0050/ab\\_32\\_bill\\_20060927\\_chaptered.html](http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.html).

<sup>16</sup> [http://www.leginfo.ca.gov/pub/05-06/bill/sen/sb\\_1201-1250/sb\\_1250\\_bill\\_20060927\\_chaptered.pdf](http://www.leginfo.ca.gov/pub/05-06/bill/sen/sb_1201-1250/sb_1250_bill_20060927_chaptered.pdf).

<sup>17</sup> <http://www.leginfo.ca.gov/cgi-bin/displaycode?section=puc&group=00001-01000&file=890-900>.

<sup>18</sup> [http://www.energy.ca.gov/ab758/documents/CAEnergyEfficiencyStrategicPlan\\_Jan2011.pdf](http://www.energy.ca.gov/ab758/documents/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf).

Research Area	Policy Drivers
	<ul style="list-style-type: none"> <li>○ Zero Net Energy (ZNE) buildings: all new residential construction by 2020, 50 % of existing and 100% new commercial buildings by 2030.</li> <li>○ 40 percent reduction in energy consumption from a 2008 baseline for existing homes by 2020.</li> <li>○ Transformation of the heating, ventilation, and air-conditioning (HVAC) industry to optimize energy performance for California’s climate zones.</li> <li>○ Significant increases in the efficiency of natural gas use and on-site renewable energy use in the agriculture sector.</li> </ul>
<p>A Renewable Future: Renewable research initiatives target combined heat and power (CHP) and renewable energy related environmental research and are driven by renewable energy generation and greenhouse gas reduction goals.</p>	<ul style="list-style-type: none"> <li>• Senate Bill X1-2—Renewables Portfolio Standard<sup>19</sup>—Simitian, 2011) Renewables Portfolio Standard sets goals for 20 percent of retail sales from renewable by end of 2013, 25 percent by end of 2016, and 33 percent by end of 2020.</li> <li>• Assembly Bill 1613, the Waste Heat and Carbon Emissions Reduction Act (Blakeslee, Statutes of 2007)<sup>20</sup>—The Waste Heat and Carbon Emissions Reduction Act requires an electrical corporation to purchase excess electricity from combined heat and power systems that complies with sizing, energy efficiency and air pollution control requirements.</li> <li>• Governor Brown’s <i>Clean Energy Jobs Plan</i><sup>21</sup></li> <li>• <i>Bioenergy Action Plan</i><sup>22</sup> to implement Executive Order S-06-06, which set goals for the production and use of electricity and fuels made from biomass.</li> </ul>

<sup>19</sup> <http://www.energy.ca.gov/portfolio/>.

<sup>20</sup> [http://www.leginfo.ca.gov/pub/11-12/bill/asm/ab\\_1601-1650/ab\\_1613\\_bill\\_20120208\\_introduced.pdf](http://www.leginfo.ca.gov/pub/11-12/bill/asm/ab_1601-1650/ab_1613_bill_20120208_introduced.pdf).

<sup>21</sup> [http://gov.ca.gov/docs/Clean\\_Energy\\_Plan.pdf](http://gov.ca.gov/docs/Clean_Energy_Plan.pdf).

<sup>22</sup> [http://www.energy.ca.gov/bioenergy\\_action\\_plan/](http://www.energy.ca.gov/bioenergy_action_plan/).

Research Area	Policy Drivers
<p>A Reliable, Secure, and Smart Energy Infrastructure: Initiatives target natural gas infrastructure research associated with natural gas pipeline integrity, environmental and transportation research</p>	<ul style="list-style-type: none"> <li>• Public Resources Code 25620<sup>23</sup> — For the state to undertake public interest energy research, development and demonstration projects that are not adequately provided for by competitive and regulated energy markets and to advance energy science or technologies of value to California citizens through investments in advanced transportation technologies that reduce air pollution and greenhouse gas emissions beyond applicable standards, and benefit electricity and natural gas ratepayers.</li> <li>• Assembly Bill 1925, (Blakeslee, Chapter 471, Statutes of 2006)<sup>24</sup> to accelerate the adoption of cost-effective geologic sequestration strategies for the long-term management of industrial carbon dioxide.</li> <li>• Senate Bill 1368, (Perata, Chapter 598, Statutes of 2006)<sup>25</sup> to accelerate carbon capture sequestration for industrial carbon dioxide.</li> <li>• High Energy Efficiency, Low Emissions Combustion and Control Technology Development Program<sup>26</sup> — Addresses the goal to improve environmental quality while meeting the wide-ranging demand for energy per the 2003 <i>Integrated Energy Policy Report</i>.</li> <li>• Quantifying methane emissions from California’s natural gas energy infrastructure<sup>27</sup></li> <li>• <i>State Alternative Fuels Plan</i> — Assembly Bill 1007, (Pavley, Chapter 371, Statutes of 2005)<sup>28</sup> — Strategies and actions that California must take to increase the use of alternative natural gas transportation technologies.</li> </ul>

<sup>23</sup> [http://www.energy.ca.gov/renewables/documents/sb\\_1250\\_bill\\_20060927\\_chaptered.pdf](http://www.energy.ca.gov/renewables/documents/sb_1250_bill_20060927_chaptered.pdf).

<sup>24</sup> [http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab\\_1901-1950/ab\\_1925\\_bill\\_20060926\\_chaptered.pdf](http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_1901-1950/ab_1925_bill_20060926_chaptered.pdf).

<sup>25</sup> [http://www.leginfo.ca.gov/pub/05-06/bill/sen/sb\\_1351-1400/sb\\_1368\\_bill\\_20060929\\_chaptered.pdf](http://www.leginfo.ca.gov/pub/05-06/bill/sen/sb_1351-1400/sb_1368_bill_20060929_chaptered.pdf).

<sup>26</sup> <http://www.arb.ca.gov/planning/sip/sip.htm>.

<sup>27</sup> <http://arb.ca.gov/cc/scopingplan/scopingplan.htm>.

<sup>28</sup> [http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab\\_1001-1050/ab\\_1007\\_bill\\_20050929\\_chaptered.pdf](http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_1001-1050/ab_1007_bill_20050929_chaptered.pdf).

## Stakeholder Participation Through the Advisory Board and Program Advisory Groups

For the electricity budget, the Energy Commission formed Program Advisory Groups (PAGs), which provide a public forum to review budget plans, develop new program initiatives, and make recommendations to the PIER Advisory Board (PAB). The PAGs are focused on three research program areas – energy efficiency, renewable energy, and energy infrastructure. Membership of the PAGs includes the utilities, nongovernmental organizations, government agencies (for example, CPUC, ARB, and the California Independent System Operator), manufacturers, and end users of energy services and technologies, and representatives of the public.<sup>29</sup> The PAB, as required by statute, provides strategic advice and feedback on program direction and research initiatives. PAB membership includes Legislative members, energy agencies, utilities, and environmental, consumer, and business organizations. Their review and recommendation ensure relevancy of research initiatives, identify synergy and end-user opportunities, and avoid overlap and duplication.

On January 24, 2012, staff from the Energy Commission’s RD&D program, in coordination with the CPUC, held a PIER NG public workshop with PAG members to discuss research priorities and recommendations in the technical research areas of energy efficiency, renewable energy, and smart energy infrastructure.<sup>30</sup> Energy Commission staff presented overviews of the proposed research initiatives for FY 2012-2013. The presentations provided an overview of research policy drivers, project accomplishments, portfolio highlights, and a proposed budget plan. Additional research presentations were given by PAG members from Southern California Gas Company and Sempra Energy Utility, ARB, and U.S Department of Energy (DOE). Workshop participants included other investor-owned utilities, universities, private entities, members of the public, and other stakeholders. The comments from the workshop were considered in the development of the initiatives contained in Chapter 3 and are included in Appendix A.

## Stakeholder Participation Through Collaborative Roadmaps and Workshops

Natural gas roadmaps are a planning mechanism and a communication tool that establish a clear link between the priorities of research and key California energy policy goals. Research roadmaps define the topic area, significant issues and barriers, data gaps, information needs, research priorities, and potential collaborations. Energy Commission staff and external stakeholders participate in roadmapping activities in many program areas.<sup>31</sup> Participants have the chance to identify natural gas research needs where they overlap by program area. Collaborative thinking about energy solutions that cut across policy boundaries is integral to maximizing the research dollar value to the ratepayer. The end users of electricity and natural

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<sup>29</sup> Information on the PIER Advisory Board and PIER Advisory Committee can be found at: <http://www.energy.ca.gov/research/advisory/index.html>.

<sup>30</sup> Information on the January 24, 2012, PAG Meeting: <http://www.energy.ca.gov/research/notices/index.html#01242012>.

<sup>31</sup> Various roadmaps can be found at: <http://www.energy.ca.gov/publications/searchReports.php?title=roadmap>.

gas face a complex array of regulatory issues in which savings from one energy source is often offset by increased usage from other sources. Bringing natural gas and electricity stakeholders together in the roadmapping process minimizes resource shifting, encourages innovation, and yields outcomes that are more likely to successfully address challenges that involve both areas.

To identify emerging research trends and gaps, the Energy Commission obtains direct feedback and recommendations from utilities, other state agencies, academic experts, industry associations, and technology experts. These meetings, workshops, and working groups provide a vehicle for California stakeholders to understand past, present, and future research and to provide guidance, recommendations, and improvements for the current program. The Energy Commission will continue to conduct workshops and other activities with the public and stakeholders to identify program improvements.<sup>32</sup>

## **Natural Gas Research Benefits**

The Energy Commission will continue to evaluate and calibrate its natural gas research portfolio to maximize the benefits to California's natural gas ratepayers. Central to this effort is a renewed focus on measuring the benefits of the Energy Commission's research activities. While the costs and benefits of most commercially available products and technologies can be easily quantified, the same cannot be said for premarket emerging technologies. Calculating benefits associated with energy technology research can be especially challenging because not all benefits are readily quantifiable, such as the environmental benefits that impact greenhouse gas reduction and air quality improvement.

Three primary California ratepayer benefit categories have been identified from the activities of the PIER NG program: economic, environmental, and security. Economic benefits include lower energy bills. Environmental benefits include reduced impact from global climate change, reduced health risks related to poor indoor and outdoor air quality, and a smaller environmental impact from energy generation.

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<sup>32</sup> Listing of PIER workshops and meetings: <http://www.energy.ca.gov/research/notices/index.html>.

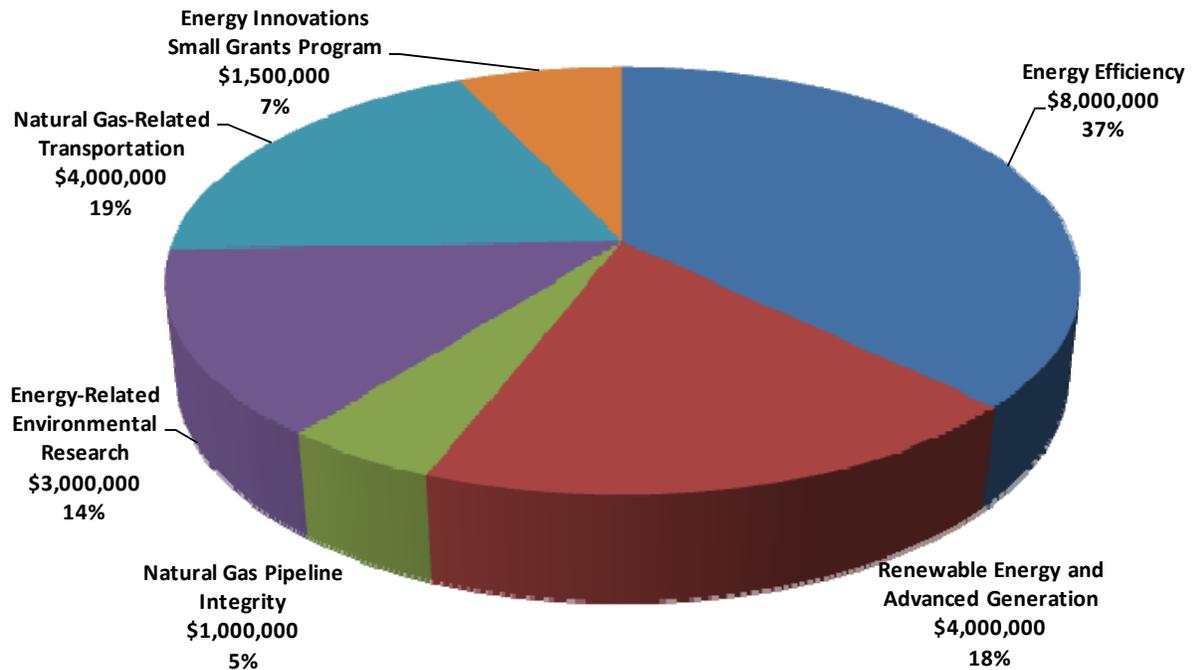
# CHAPTER 3: Natural Gas Research Budget Plan for Fiscal Year 2012-13

This chapter will discuss the proposed research budget by program area and the research initiatives, including a description of the program area, goals, policy drivers, and PAG workshop comments and details of the planned research.

## Proposed Budget

As shown in Table 3, the proposed \$24 million Natural Gas Budget Plan includes research funding for energy efficiency, renewable energy, smart energy infrastructure, the Energy Innovations Small Grant Program, and program administration. The Energy Commission research budget follows the loading order with the goal of maximizing ratepayer benefits and funding the best research in the areas listed in Figure 2.

Figure 2: Proposed Natural Gas Research Budget Categories



Source: California Energy Commission

The Energy Innovation Small Grant Program (EISG) supports all PIER program areas and provides funding for early development of promising new energy technology concepts and facilitates their commercialization.

**Table 3: FY 2012-13 Natural Gas Research Budget Plan Summary**

<b>Program Areas</b>	<b>Proposed Budget</b>
Energy Efficiency	\$8 million
Buildings End-Use Energy Efficiency	
Industrial, Agriculture, and Water Efficiency	
Renewable Energy	
Renewable Energy and Advanced Generation	\$4 million
Smart Energy Infrastructure	
Natural Gas Pipeline Integrity	\$1 million
Energy-Related Environmental Research	\$3 million
Natural Gas-Related Transportation	\$4 million
Energy Innovations Small Grants Program	\$1.5 million
Program Administration	\$2.5 million
<b>TOTAL</b>	<b>\$24 million</b>

Source: California Energy Commission

## **Proposed Research Initiatives**

A research initiative is comprised of one or more research projects, each of which is designed to resolve issues associated with a technology or area of science. The Energy Commission’s PIER NG budget process allocates funding to CPUC-approved initiatives that are subsequently acted upon by developing specific projects, mainly through competitive solicitations.

The research program areas are listed in Table 3. Additionally, at the direction of CPUC staff, the program has included safety and reliability research.

## **Energy Efficiency Research**

As California’s population grows and the demand for energy increases, energy efficiency continues to be an important strategy for containing energy demand and greenhouse gas emissions for the building and industrial, agriculture, and water sectors. Since “energy efficiency is the least cost, most reliable, and most environmentally sensitive resource and

minimizes our contribution to climate change,” it is the resource of first choice.<sup>33</sup> Continued development, enhancement, deployment, and operation of better energy efficiency-related technology for existing and planned buildings and industrial facilities and processes are essential to meeting the state’s energy efficiency and greenhouse gas reduction goals. RD&D is focused on developing technologies, strategies, models, or tools to reduce energy use in the buildings, industrial, agriculture, and water sectors.

The research budget for energy efficiency is \$8 million, the largest of all categories. It is estimated that about half the funds will be for building energy efficiency research and half will be for industrial, agriculture, and water activities.

### Buildings End-Use Energy Efficiency

**Table 4: FY 2012-13 Natural Gas Research Budget Plan Summary – Buildings End-Use Energy Efficiency**

Program Area – Energy Efficiency Research	Proposed Budget
Buildings End-Use Energy Efficiency <ul style="list-style-type: none"> <li>• Natural Gas Efficiency</li> </ul>	\$4 million

Source: California Energy Commission

#### *Program Goals*

Reduce on-site natural gas use and address technology gaps hindering the achievement of improved efficiency and reduced natural gas use in buildings:

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

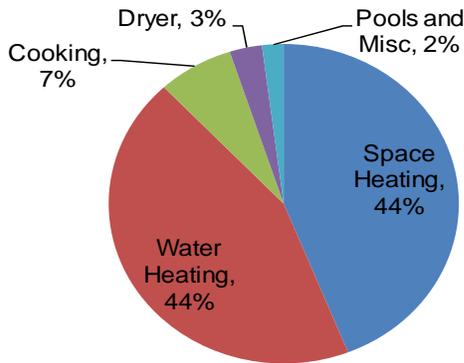
Roughly one-third of California’s natural gas consumption today is on-site gas use (for example, water heating, space heating, and cooking), with 23 percent of gas used in residential buildings and 11 percent in commercial buildings.<sup>34</sup> Most gas used in residential buildings is for water heating and space heating. Commercial natural gas use is more diverse, with the most gas used for space heating, water heating, and cooking, such as restaurants.

<sup>33</sup> *California Energy Efficiency Strategic Plan, 2011*

Update: [http://www.cpuc.ca.gov/NR/rdonlyres/A54B59C2-D571-440D-94773363726F573A/0/CAEnergyEfficiencyStrategicPlan\\_Jan2011.pdf](http://www.cpuc.ca.gov/NR/rdonlyres/A54B59C2-D571-440D-94773363726F573A/0/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf).

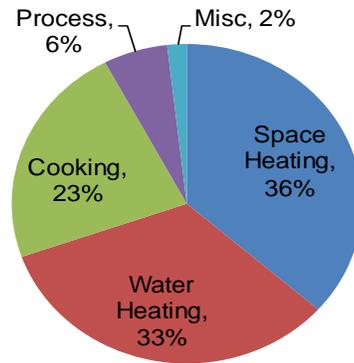
<sup>34</sup> Calculated from 2010 consumption data from Energy Information Administration, [http://www.eia.gov/dnav/ng/NG\\_CONS\\_SUM\\_DCU\\_SCA\\_A.html](http://www.eia.gov/dnav/ng/NG_CONS_SUM_DCU_SCA_A.html).

**Figure 3: Residential Natural Gas Use (5.1 billion therms/year-see footnote 34)**



Source: California Energy Commission  
[http://energyalmanac.ca.gov/naturalgas/residential\\_use.html](http://energyalmanac.ca.gov/naturalgas/residential_use.html)

**Figure 4: Commercial Natural Gas Use (2.5 billion therms/year-see footnote 34)**



Source: California Energy Commission

**Policy Drivers<sup>35</sup>**

In addition to the policy drivers already described in Chapter 2, the program also works in conjunction with the Energy Efficiency Buildings Standards (Title 24, Part 6) and with the Appliance Energy Efficiency Standards (Title 20, Division 2, Chapter 4, Article 4, Sections 1601-1608: Appliance Efficiency Regulations). PIER staff coordinates with the energy efficiency building and appliance efficiency staff to identify future research needs to help achieve the state’s energy policy goals, such as zero net energy buildings.

The following table summarizes comments on this research area from the PAG Workshop and the Energy Commission staff response.

**Main PAG Workshop Comments** (Complete list of comments is in Appendix B.)

PAG Comment	Energy Commission Staff Response
Need to include research on low-emission equipment/appliances-especially low NOx and improve energy efficiency	This has been included in our initiatives. The Energy Commission will include a project on combustion equipment and control technology that will lower air emissions while exceeding current energy efficiency standards.
Continue with natural gas water heater research	This is in the research plan.
Focus on research to help achieve zero net energy buildings	This has been included in our initiatives.

<sup>35</sup> Refer to Table 2 Summary of Policy Drivers for Natural Gas Activities, Page 10.

PAG Comment	Energy Commission Staff Response
Research on cost effective solar thermal	This is included in the research plan.

**Proposed Research Initiative: Buildings End-Use Energy Efficiency**

*Project: Natural Gas Efficiency Research (estimated project funding \$4 million)*

The Energy Commission’s future building research investments include improvements to water heating and distribution efficiency and determining ways to provide high efficiency hot water and space heating with low NOx production and low-cost, retrofit solutions, and developing ways to improve building envelopes to reduce the need for space heating. Reducing NOx levels is critical to providing high-efficiency water and space heaters in many areas of California, including those in the South Coast Air Quality Management District, which have the lowest NOx requirements in the country.

Another research area involves cross-cutting technologies associated with zero net energy buildings, low income housing, or whole building integration. These projects could involve demonstrations of advanced energy efficiency technologies, demonstrations, or strategies with renewable energy systems. The renewable energy systems could include developing next generation solar systems with low-cost and high-performance collectors and opportunities to advance thermal-driven cooling systems that use natural gas, solar, waste heat, or other sources. These hybrid natural gas and renewable energy systems will help achieve the state’s zero net energy building goals. These cross-cutting activities that involve renewable energy will be coordinated with the renewable energy research area.

- Hot Water

Figures 3 and 4 indicate that about 44 percent of the natural gas used by residents and 33 percent of the natural gas used by commercial facilities (e.g., restaurants) is for water heating. Thus, there are opportunities to reduce consumption and cost through research in the following areas:

- Improve hot water efficiency with an emphasis on high energy efficiency, low air emissions (for example, low NOx), and low cost.
- Improve residential and commercial hot water distribution systems: Examples of research include emphasis on: a) retrofitting existing residential hot water distribution systems; b) evaluating cost effective options for reducing water use and distribution energy losses, and; c) refining advanced integrated hot water heating and distribution simulation models, such as Modelica.
- Investigate potential energy savings and benefits associated with installing multiple water heating tank systems for residential and commercial buildings.

- Improve shower heads to allow lower future flow rates (2 or 1.5 gallons per minute) to reduce energy and water use in residential and commercial buildings (for example, hospitality).

Conduct heat loss research on larger size pipes. Pipes that are too large or pipes that are buried in the foundation contribute significantly to water and energy waste. Recently, PIER research significantly contributed to revising the *2011 ASHRAE Applications Handbook for Service Hot Water Heating*. An important subsequent research would be to perform the same type of laboratory heat transfer analysis in pipes of larger diameter.

- Food Service

Figure 4 shows that commercial cooking equipment accounts for about 23 percent of statewide natural gas consumption primarily in restaurants and institutions (for example, hospitals, schools, correctional facilities). Research is needed to develop higher efficiency commercial cooking equipment, to design and field test new burner technology, and to improve the efficiency and performance of commercial food service range tops.

- Advanced HVAC and Envelopes

Natural gas is the main space heating fuel for both residential and commercial buildings. At the January 24, 2012, workshop, one participant identified challenges in air quality and meeting criteria pollutant requirements, (for example, NO<sub>x</sub>, particulate matter), especially in Southern California. Research is needed to develop low cost, high energy efficiency systems that exceed current efficiency standards, while achieving low air emissions. This initiative will be done in collaboration with the Energy Related Environmental Research area on developing high energy efficiency, low emission combustion equipment and control measures.

There are limited field studies of innovative and cost effective building envelope sealing systems that may be able to reduce energy loss and energy costs for building operators. Research is needed to develop these systems.

- Cross-Cutting Areas : Zero Net Energy (ZNE) Buildings/Low Income Housing

This category is a cross-cutting area since many of the technologies described previously can also help contribute to zero net energy buildings, low-income housing, and whole building integration. A zero net energy building is one that does not consume more energy than can be produced from on-site renewable energy in a year.<sup>36</sup>

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<sup>36</sup> [http://www.energy.ca.gov/ab758/documents/CAEnergyEfficiencyStrategicPlan\\_Jan2011.pdf](http://www.energy.ca.gov/ab758/documents/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf).

This research category could involve integration of energy efficiency with renewable energy. Any research associated with renewable energy will be coordinated with the renewable energy research area.

Research in this area focuses on demonstrations, new technologies, and strategies. This can include newly commercialized pre-engineered and integrated products and/or field testing high-efficiency combined space and water heating equipment that will be suitable for single-family or multifamily homes and commercial buildings.

Other examples of research that are integral to ZNE buildings:

- **Solar Water Heating**

Research is needed to advance the design, development, and demonstration of next generation solar systems using a lower-cost, high-performance collector and/or improved performance tank. This can include an integrated roof system, optimized controls, or integrated hybrid solar systems. An important challenge for solar hot water systems is in lowering the cost of efficient equipment.

- **Thermally Driven Cooling**

Additional research is needed to advance thermally driven cooling when used with natural gas and solar, waste heat, or other renewable energy source. This includes developing a method for determining the appropriate compliance credit to be attributed to these systems. These systems provide an opportunity to use a renewable energy source for cooling buildings, but there is currently no method for determining the value in the energy efficiency standards process. This lack of credit reduces the commercial viability of this emerging technology that is a promising addition for buildings trying to achieve zero net energy.

### **Ratepayer Benefits**

Energy efficiency research has helped California residents and businesses reduce energy use and operating costs. This has translated into lower energy bills and reduced greenhouse gas emissions once the new technologies and strategies are implemented or become part of the energy code.

- **Energy and Cost Savings.** Both homes and businesses in California use an estimated 6.8 billion therms annually for space and water heating and commercial cooking (Figures 3 and 4). Staff estimates that research efforts being proposed for 2012–13 have the potential for reducing this consumption by 5-10 percent. Assuming a 10 percent market penetration of the technology, the annual energy savings, once these technologies are in the marketplace, is estimated to range from 33 million to 66 million therms or about \$33

million to \$66 million.<sup>37</sup> This results in approximate reductions of 175,000 to 349,800 metric tons of carbon dioxide.

- Environmental Benefits. Reduced natural gas consumption will contribute to improved air quality, such as lower NOx emissions. The production of oxides of nitrogen contributes to the formation of greenhouse gases and photochemical smog. The interaction of NOx with hydrocarbons from vehicle exhausts and sunlight can also form low-level ozone. Ozone is helpful in absorbing ultraviolet radiation of the sun in the stratosphere, but at ground level it has adverse public health effects.

### Industrial, Agriculture, and Water Efficiency

**Table 5: FY 2012-13 Natural Gas Research Budget Plan Summary – Industrial, Agriculture, and Water Efficiency**

Program Area – Energy Efficiency Research	Proposed Budget
Industrial, Agriculture, and Water Efficiency <ul style="list-style-type: none"> <li>• Natural Gas Efficiency Research for Industrial Use</li> <li>• Heat Recovery</li> <li>• Greenhouse Gas Reduction Through Capture and Sequestration</li> <li>• Process Measurement, Diagnostics, and Optimization</li> </ul>	\$4 million

Source: California Energy Commission

#### *Program Goals*

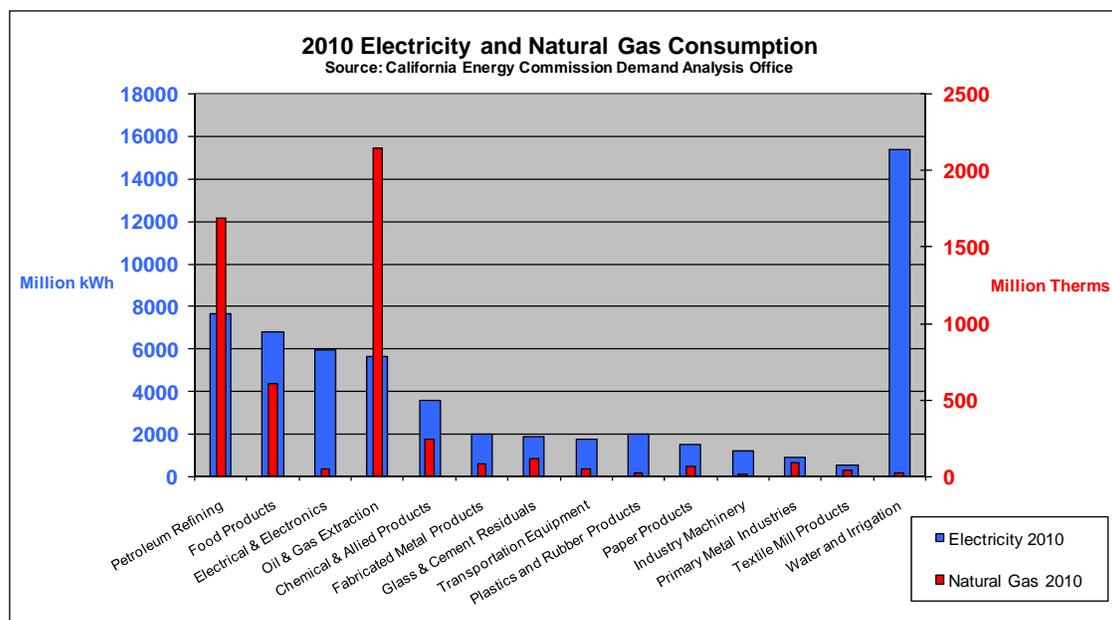
Conduct research, development, and demonstration projects to help the industrial, agriculture, and water sectors:

- Reduce energy use and costs.
- Increase 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 (for example, low NOx).

<sup>37</sup> 6.6 billion therms/year x 0.05 x 0.10 = 33 million therms; 6.6 billion therms/year x 0.10 x 0.10 = 66 million therms. Using 0.0053 metric tons/therm saved yields 175,000 to 349,800 metric tons of CO2 reduced.

The industrial sector is a major natural gas consumer in the state, accounting for about 32 percent of total use in 2010.<sup>38</sup> In 2009, the industries shown in Figure 4 used roughly 4,300 million therms.<sup>39</sup> Consequently, industry represents a logical target for improving the efficiency of natural gas use through the adoption of new technologies and improved energy management practices.

**Figure 5: Energy Use of Various Industries in California**



Source: California Energy Commission

The Energy Commission’s Industrial, Agriculture, and Water (IAW) research program focuses on improving energy efficiency in these sectors.

**Policy Drivers<sup>40</sup>**

- *Integrated Energy Policy Report (IEPR)*
- Assembly Bill 32 (Núñez, Chapter 488 Statutes of 2006)
- *California Energy Efficiency Strategic Plan*

**Main PAG Workshop Comments** (Complete list of comments is in Appendix B.)

<sup>38</sup> [http://www.eia.gov/naturalgas/annual/pdf/table\\_032.pdf](http://www.eia.gov/naturalgas/annual/pdf/table_032.pdf). For 2010, the natural gas consumption for California was approximately 22,500 million therms. This total consumption includes natural gas used for residential, commercial, industrial, electric generation, and combined heat and power applications at industrial and commercial facilities and vehicle use. Natural gas consumption for residential, commercial and industrial applications, excluding combined heat and power applications, is 12.7 billion therms (2011, *Integrated Energy Policy Report*, Chapter 8).

<sup>39</sup> California Energy Commission, Electricity Demand Analysis Division.

<sup>40</sup> Refer to Table 2 Summary of Policy Drivers for Natural Gas Activities, Page 10.

PAG Comment	Energy Commission Staff Response
Ensure research includes low emission equipment, especially low NOx equipment.	Staff agrees and notes that one of the goals of the IAW research program is to reduce energy consumption and air emissions (e.g., NOx). The flex flame burner that was funded in the IAW program is a good example. The burner reduced NOx emissions by 40 percent. <sup>41</sup>

**Proposed Research Initiative: Industrial, Agriculture and Water Efficiency**

*Project 1: Natural Gas Efficiency Research for Industrial Use (estimated project funding \$2 million)*

Nearly every industrial sector in California relies on natural gas. The use of natural gas in California industry is dominated, however, by a relatively small set of industrial sectors. The largest users include food processing, printing, and manufacture of electronics, transportation equipment, fabricated metals, furniture, chemicals, plastics, and machinery. These sectors represent prime areas of opportunity for reducing industrial natural gas use.

- Food Processing Industry

The food processing industry in California is highly diversified. It processes commodities that can be sourced from more than 75,000 farms.<sup>42</sup> About 240 commodity and trade associations<sup>43</sup> represent food and agricultural interests in California. Although agricultural and food processing activities occur throughout the state, these industries are concentrated in the Central Valley. The Central Valley is home to more than 3,000 factory sites<sup>44</sup> including the world’s largest factory sites for processing fluid milk (California Dairies, Inc.), cheese (Hilmar Cheese Company), milk powder/butter (California Dairies, Inc.), wine (E & J Gallo), and poultry (Foster Farms). California ranks 5th in the world in agricultural production (\$36.6 billion in 2007 and 12.8 percent of the total U.S. production), and first in the United States for total food processing output with a total value of shipments of \$73.1 billion in 2006, or 11.2 percent of the U.S. total.<sup>45</sup> Some of the promising energy efficiency opportunities involve the following processes:

- Blanching of fruits and vegetables.

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<sup>41</sup> <http://www.energy.ca.gov/publications/displayOneReport.php?pubNum=CEC-500-2008-090>, Flex Flame Burner final report, November 2008.

<sup>42</sup> <http://www.energy.ca.gov/publications/displayOneReport.php?pubNum=CEC-500-2011-035>, PIER Industrial, Agricultural, and Water Energy Efficiency Program RD&D Targets: Consolidated Roadmap - PIER Consultant Report, 2009, pg 113.

<sup>43</sup> Ibid.

<sup>44</sup> Ibid.

<sup>45</sup> US Census Bureau, 2006.

- Drying and dehydrating fruits.
- Evaporation of milk products.
- Pasteurization and sterilization of dairy products and canned vegetables.
- Peeling of fruits and vegetables such as potatoes, apples, pears, and carrots.
- Glass Industry

The U.S. glass industry includes establishments engaged in manufacturing flat glass, container glass, specialty glass, and fiberglass. Glass manufacturing in the United States is one of the most energy-intensive industries; in 2006, the industry used 219 trillion Btus of natural gas nationwide.<sup>46</sup> California has about 13 major glass plants<sup>47</sup>; each unique, yet together they have a significant potential for natural gas (and electricity) reduction by employing energy efficiency measures. The following are areas of interest due to their high energy use (this is not an exhaustive list):

- Glass melting, refining, and conditioning: Heating is used in the manufacturing, refining, and conditioning process. After the refining step, the glass is conditioned to the desired temperature and temperature distribution. Research is needed to improve the energy efficiency of the glass melting and conditioning process.
- Submerged combustion melting: In submerged combustion melting, fuels are fired directly into and under the surface of the batch material being melted. Research is needed on new and efficient combustion technologies.
- Oscillating combustion: This technology forces the oscillation of the burner fuel to create successive, fuel-rich, and fuel-lean zones within the flame. This increases heat transfer by enhancing flame luminosity and turbulence. Research is needed on new and efficient combustion technologies.
- Chemical Manufacturing Industry

The United States has the world's largest chemical industry. Within the chemical industry, more than 70,000 diverse compounds<sup>48</sup> are produced with production volumes ranging from a few grams to billions of pounds. The chemical industry also uses a significant amount of feedstock energy (petroleum derivatives and natural gas) as a raw material primarily for the production of organic chemicals and ammonia. The total

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<sup>46</sup> [http://www1.eere.energy.gov/manufacturing/pdfs/glass\\_footprint.pdf](http://www1.eere.energy.gov/manufacturing/pdfs/glass_footprint.pdf).

<sup>47</sup> <http://www.arb.ca.gov/cc/glass/docs/glasssurveys.pdf>.

<sup>48</sup> [http://www1.eere.energy.gov/manufacturing/intensiveprocesses/pdfs/energy\\_use\\_loss\\_opportunities\\_analysis.pdf](http://www1.eere.energy.gov/manufacturing/intensiveprocesses/pdfs/energy_use_loss_opportunities_analysis.pdf), pg 21.

natural gas used as a feedstock by the industry is 782 trillion Btus.<sup>49</sup> This is an important industrial sector for the U.S. and California. The chemical manufacturing industry has a large variety of opportunities to reduce energy consumption while maintaining or enhancing the productivity of the plant.

Areas of interest are listed below (this is not an exhaustive list):

- Energy Management Programs and Control Systems
- Distillation Process (Vacuum and atmospheric): Heat is used to separate different products based on their respective boiling points.
- Heating, Cooling, and Process Integration

### **Ratepayer Benefits**

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 three years of completion of the projects. A 5 percent penetration of targeted markets is a reasonable goal for these technologies. The following are the estimated benefits:

- Energy and Cost Savings. The annual natural gas consumption by the industrial sector is estimated at 4.3 billion therms.<sup>50</sup> Based on past natural gas savings percentages for the super boiler and the drum dryer, advanced technologies were able to reduce gas consumption by an average of 10 percent. If staff assumes this same gas reduction for the proposed activities described previously and assuming a 5 percent penetration rate, this would mean annual natural gas savings of 22 million therms annually or about \$22 million saved, assuming \$1/therm.<sup>51</sup> This amount could help manufacturing companies be competitive in California.

#### *Project 2: Heat Recovery (estimated project funding \$1 million)*

There are opportunities for heat recovery from combustion systems and natural gas burners. Technical and economical feasibility depends on finding the right combination of technology and an industrial partner who can use the waste heat in its process operations. As the industrial sector is very risk averse, widespread implementation of heat recovery systems will depend on demonstration of technical and economic viability.

Research opportunities include very low-grade (-40 to 250 degrees F) heat recovery, low-grade (250 to 500 degrees F) heat recovery, mid- to high-grade (500 to 1400 degrees F and higher) heat

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<sup>49</sup>[http://www1.eere.energy.gov/manufacturing/intensiveprocesses/pdfs/energy\\_use\\_loss\\_opportunities\\_analysis.pdf](http://www1.eere.energy.gov/manufacturing/intensiveprocesses/pdfs/energy_use_loss_opportunities_analysis.pdf), pg 21, figure 3-1.

<sup>50</sup> California Energy Commission, Electricity Demand Analysis Division.

<sup>51</sup> 4.3 billion therms x 0.10x0.05 = 22 million therms/yr saved.

recovery, heat loss reduction, enhanced heat transfer, combustion systems improvement, advanced natural gas burners, and fuel flexibility.<sup>52</sup> Potential target areas:

- Oil and Gas Extraction and Refining Industry

Petroleum refineries are the largest industrial users of natural gas and electricity in California. In 2001, oil and gas extraction and refining industry in California consumed nearly 500 trillion Btus of energy, over 67% in the form of natural gas or other fuels.<sup>53</sup> “The industry is also a major contributor to the California economy, employing more than 13,000 people and accounting for 15 percent of the total value of manufacturing shipments from the state. In addition, California’s refineries account for 12.5 percent of the workforce and value of shipments of the U.S. petroleum refining industry”.<sup>54</sup> Areas of interest include (not an exhaustive list):

- Process control, optimization, and integration sensors to better fine tune the refining process.
- Recovery of heat produced in the separation of oil into component parts.
- Advanced combustion technology including air emission improvements. Some refining processes involve the combustion of waste gases in flares. New, cleaner technologies to combust waste gases are needed.

### Ratepayer Benefits

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 three years of completion of the projects.

For the oil and gas extraction and refining industry, a 5 percent penetration of targeted markets is a reasonable goal for these technologies. Also, based on previous projects in industrial heat recovery by the industry/agricultural/water team, staff estimates a 5 percent heat recovery opportunity. Using these assumptions results in an estimated annual savings of 1.25 trillion therms or \$1.25 trillion for the oil and gas/refining industries.<sup>55</sup>

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<sup>52</sup> <http://www.energy.ca.gov/publications/displayOneReport.php?pubNum=CEC-500-2011-035>, PIER Industrial, Agricultural, and Water Energy Efficiency Program RD&D Targets: Consolidated Roadmap - PIER Consultant Report, 2009, pg 44-63.

<sup>53</sup> Worrell 2003) Worrell, E., and C. Galitsky. 2003. Profile of the Petroleum Refining Industry in California (Draft). Energy Analysis Department, Environmental Energy Technologies Department, Lawrence Berkeley National Laboratory, Berkeley, CA.

<sup>54</sup> <http://www.energy.ca.gov/publications/displayOneReport.php?pubNum=CEC-500-2011-035>, PIER Industrial, Agricultural, and Water Energy Efficiency Program RD&D Targets: Consolidated Roadmap - PIER Consultant Report citing EIA 2006, pg 81.

<sup>55</sup> 500 trillion therms x (0.05)x (0.05) = 1.25 trillion therms.

*Project 3: Greenhouse Gas Reduction Through Capture and Sequestration (estimated project funding \$800,000)*

Research is needed to investigate opportunities for capture and sequestration of greenhouse gas (for example, CO<sub>2</sub>) from high CO<sub>2</sub>-generating industries (for example, cement production). Solutions include advanced software, compressor technology improvements, and improved deep-well injection methods. Potential target area:

- **Cement Industry**

The production of cement is energy-intensive. The production of cement results in the emission of carbon dioxide from both the consumption of fuels and from the calcination of limestone. California is the largest cement producing state in the United States, accounting for between 10 and 15 percent of U.S. cement production.<sup>56</sup> Energy efficiency and carbon capture and sequestration strategies include:

- Carbon Capture Technology Improvements in the Cement Industry: Low-drag coatings for pipelines, improvements to compressor technology, and optimization software with real-time pipeline monitoring sensors.
- Advanced concrete additives to reduce the amount of cement required for the concrete mix. This could result in improvements in both greenhouse gas emissions reduction and energy efficiency.

### **Ratepayer Benefits**

Roughly one pound of CO<sub>2</sub> is emitted for every pound of finished cement produced.<sup>57</sup> California is the largest cement producing state in the U.S., accounting for between 10% and 15% of U.S. cement production and cement industry employment. The cement industry in California consists of 31 sites (U.S. Census Bureau 2000) that consume large amounts of energy, annually: 1,600 GWh of electricity, 22 million therms of natural gas, 2.3 million tons of coal, 0.25 tons of coke, and smaller amounts of waste materials, including tires (USGS various years). Eleven of these sites are involved in full-scale cement production, while the remainder of the facilities provides grinding and mixing operations only. The eleven full-operation sites account for over 90% of the California cement industry's electric use and 80% of the natural gas use".<sup>58</sup> California is the largest state producer of cement; so adoption of new technologies could progress quickly if a relatively small number of stakeholders buy into the process.

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<sup>56</sup> <http://ies.lbl.gov/iespubs/59938.pdf>, Case Study of the California Cement Industry, Fred Coito and Frank Powell, KEMA, Ernst Worrell and Lynn Price, Lawrence Berkeley National Laboratory, Rafael Friedmann, Pacific Gas and Electric Company, 2005, pg 1.

<sup>57</sup> <http://www.concretethinker.com/technicalbrief/Concrete-Cement-CO2.aspx>.

<sup>58</sup> <http://ies.lbl.gov/iespubs/59938.pdf>, Case Study of the California Cement Industry, Fred Coito and Frank Powell, KEMA, Ernst Worrell and Lynn Price, Lawrence Berkeley National Laboratory, Rafael Friedmann, Pacific Gas and Electric Company, 2005, pg 2.

*Project 4: Process Measurement, Diagnostics, and Optimization (estimated project funding \$200,000)*

Existing research roadmaps are outdated. It's important to update the roadmaps to capture new opportunities, reprioritize initiatives, and ensure stakeholder input on proposed research.

Opportunities include optimization of energy management technologies, energy metering and monitoring, energy efficiency assessment and analysis tools, financial analysis tools, process/product innovation and optimization, advanced controls, innovative processes, and nonthermal energy alternatives.

## Renewable Energy Research

Renewable resources are essential for reducing greenhouse gas emissions and reaching state energy goals. The PIER Renewable Energy program conducts research that addresses the barriers to increased penetration of renewable energy including distributed generation and combined heat and power (CHP) systems. Strategies include developing innovative systems based on performance and environmental attributes, developing hybrid generation, and demonstrating CHP systems using renewable natural gas systems.

### Renewable Energy and Advanced Generation

**Table 6: FY 2012-13 Natural Gas Research Budget Plan Summary – Renewable Energy and Advanced Generation**

Program Area – Renewable Energy Research	Proposed Budget
Renewable Energy and Advanced Generation <ul style="list-style-type: none"> <li>• Localized Efficient and Advanced Power and Heat Systems (LEAPS)</li> <li>• Combined Heat and Power Applications for Associated Gas From Oil and Gas Production Fields</li> </ul>	\$4 million

Source: California Energy Commission

### Program Goals

Reduce barriers and increase penetration of renewable energy:

- 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.

*Policy Drivers*<sup>59</sup>

- Senate Bill X1-2 - Renewables Portfolio Standard
- Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006)-California Global Warming Solutions Act of 2006
- Assembly Bill 1613, the Waste Heat and Carbon Emissions Reduction Act
- Governor Brown’s *Clean Energy Jobs Plan*
- *Bioenergy Action Plan* to implement Executive Order S-06-06, which set goals for the production and use of electricity and fuels made from biomass

**Main PAG Workshop Comments** (Complete list of comments is in Appendix B.)

PAG Comment	Energy Commission Staff Response
<p>Combined Heat and Power Applications for Associated Gas from Oil and Gas Production Fields. Staff received a draft white paper from the ARB that covers distributed generation using associated gas (for example, off-spec gas) to address air quality issues.</p>	<p>Staff provided comments to ARB and will coordinate research.</p>
<p>Localized Efficient and Advanced Power and Heat Systems (LEAPS). The comment received related to why biofuel and biomethane were not funded by the Renewable Energy Research Program.</p>	<p>Biofuel and biomethane projects are actually included in three PIER program areas: industrial, agriculture, and water (IAW); transportation research; and renewable energy. The first two are associated with customer applications and fuel substitutes. The renewable energy element focuses on advancing biomass power generation, biochemical conversion processes, and on biogas cleanup technology. Two project examples under this program were provided during the PAG workshop presentation (Gills Onion and SMUD project on siloxane). For clarification, one of the projects has been reworded to emphasize biofuels.</p>
<p>Include funding for kelp research.</p>	<p>Past solicitations have been broad enough to include kelp as a biomass resource. Funding amounts are specified in competitive solicitations and these solicitations do not single out specific feedstocks such as kelp. Future solicitations will depend on the CPUC’s decision on project scope for renewable and transportation research.</p>

<sup>59</sup> Refer to Table 2 Summary of Policy Drivers for Natural Gas Activities, Page 10.

## Proposed Research Initiative: Renewable Energy and Advanced Generation

### *Project 1: Localized Efficient and Advanced Power and Heat Systems (LEAPS) (estimated project funding \$3 million)*

Energy-efficient, durable, and reliable distributed generation systems are a promising solution to California's need for cost-effective, safe, and clean energy technologies. In particular, combined heat and power, as well as combined cooling, heating, and power (CHP/CCHP), offers high system efficiency (thermal and electricity) and will be a critical technology solution going forward. However, a major deterrent for CHP/CCHP technologies in California, particularly the reciprocating internal combustion engines, is the poor air emissions performance and inconsistent ability to cost-effectively achieve and sustain compliance with the state's stringent distributed generation air emission standards. Other challenges for CHP/CCHP technologies include efficient design, ability to match the load with potential end-use applications, and the flexibility to use alternative fuels and varying operational profiles. Advanced generation technologies such as gas turbine, including microturbines, and fuel cells do not have the air emission issues but have other challenges.

The project will address the RD&D needs in at least the following areas:

- Clean, efficient, cost-effective, localized, and advanced CHP/CCHP systems in industrial, commercial, and institutional applications, such as food processing, manufacturing, retail, hotels, and hospitals
- Biogas and other local renewable resources, such as biogas from wastewater or food processing facilities, to augment natural gas fired heating and power systems
- CHP for waste heat and low-energy-value waste gas and alternative fuels from industrial sources

Prior research, development, and demonstration of CHP have addressed some of the implementation barriers such as emission controls, durability, and performance improvements in limited market applications. Current CHP challenges focus on reliability, affordability, maintainability, and durability. Cost-effective solutions for a broad range of advanced generation technology deployment activities, including design, development, permitting, installation, operation, and maintenance, are still lacking.

The actual deployment of DG/CHP/CCHP has fallen short of the goals and opportunities as demonstrated by slow market adoption and installation. This is despite the many perceived CHP/CCHP benefits such as reduction in energy use, criteria pollutant, and greenhouse gas emission, as well as support to utility grid network.

The research will emphasize improvements in overall system performance, including increased fuel-to-electricity efficiency beyond the current efficiencies, reduced cost, emissions that are in compliance with state regulations, and increased use of renewable resources and otherwise

wasted heat and off-gas which refer to usable gas that are by-product of industrial processes including combustion products from burners and engines.<sup>60</sup>

### **Ratepayer Benefits**

Efficient and reduced consumption of natural gas through the applications of advanced generation technologies at the local level, including CHP, has documented economic, environmental, and societal benefits. The ability to efficiently use natural gas and alternatives, such as biogas, off-gas, or industrial waste gas and hydrogen, will permit placement of the advanced localized CHP systems in various installations. Projected long-term benefits include:

- Reduced fuel use as compared to current consumption levels for power generation and process needs, with an associated reduction in emissions of carbon dioxide and NOx.
- Mitigated deterioration of basinwide air quality while meeting increased energy demands as compared to construction of additional central power plants.
- Improved reliability and/or reduced costs from additional choices in acquisition of energy, which can trickle down to reduced costs for consumers.
- Deferred installation of new power generation, transmission, and distribution lines, which has an estimated value of more than \$300 per kilowatt (kW)<sup>61</sup> per year; if applied to the projected 5,400 megawatt (MW) DG/CHP installed capacity statewide, this represents a value of about \$1.6 billion.

Other related benefits from localized efficient and advanced power and heat systems include:

- Providing ultra-high natural gas use efficiencies, conserving natural gas, and enhancing usage of California gas distribution system.
- Achieving combined electric and thermal efficiencies of 80 percent or more.
- Eliminating transmission and distribution losses and reducing or eliminates grid congestion.
- Boosts power reliability for business adopters.
- Energy Sector. DG/CHP/CCHP deployed in industry, commercial, government facilities, and residential communities will offset electricity and heating fuel purchases and reduce energy costs. Localized generation targets efficient use and reduction in natural gas consumption of all those sectors.

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<sup>60</sup> Compliance with state regulations: California Air Resources Board (ARB) 2007 emissions standards for DG and DG/CHP).

<sup>61</sup> Klein, Joel. 2009. *Comparative Costs of California Central Station Electricity Generation Technologies*, California Energy Commission, CEC-200-2009-017-SD. p.3, levelized cost of simple cycle, averaged for the three sectors (merchant, IOU and POU).

- **Market Connection.** The base technology for CHP is mostly commercialized. Innovations addressing performance, efficiency, durability, and economics, if successful, can have immediate market presence due to the technology's existing market structure. For instance, Tecogen's<sup>62</sup> premium power and emissions control was commercialized quickly because of high industrial and commercial interests. Development of innovations, however, may take several years but estimated to be at least within the term of this project.
- **Technology Potential.** According to an Energy Commission-sponsored study<sup>63</sup>, the technical potential for CHP systems less than 5 MW is about 10,800 MW by 2029. The projected penetration of CHP is about 2,400 MW<sup>64</sup> or 22 percent, of which rich-burn internal combustion engines are estimated to provide 62 percent or about 1,500 MW, and the balance will be from advanced generation technology such as gas turbines, fuel cells, and Stirling engines.
- **Energy and Cost Savings.** A 2005 California Energy Commission report<sup>65</sup> projected societal benefits of new CHP through 2020 could range from \$200 million to \$7 billion. The majority of these benefits were projected to come from systems less than 5 MW in size, dominated by reciprocating engines, which are proving to be cost effective. The annual savings potential is 340,000 billion BTUs of natural gas and reduction of 18 million metric tons of CO<sub>2</sub>.<sup>66</sup> Estimates for rich-burn engine CHP systems, prevalent in systems less than 1 MW in size, will account for roughly 1,100 MW by 2029 according to Energy Commission's CHP Market Assessment. Based on this level of penetration (1,100 MW), the estimated annual savings, resulting from this advanced emission feature, is 35,000 billion BTUs of natural gas.

*Project 2: Combined Heat and Power Applications for Associated Gas from Oil and Gas Production Fields (estimated project funding \$1 million)*

The goal of this project is to deploy clean and efficient CHP to use associated gas from petroleum fields. The use of associated gas, also called "off-spec" or "stranded" gas, from oil and gas fields for CHP technologies can provide extensive research opportunities to replace

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<sup>62</sup> Tecogen is a Massachusetts-based company that through PIER-funding and partnership with a California-based entity, developed an inverter-based 100 kW combined heat and power and emission control technology that are suitable for California. Two CHP systems were tested and demonstrated in Chatsworth, CA and San Fernando, CA. Three commercial units are now deployed in Sacramento, CA.

<sup>63</sup> Darrow, Ken, Bruce Hedman, Anne Hampson. 2009. *Combined Heat and Power Market Assessment*. California Energy Commission, PIER Program. CEC-500-2009-094-D. Table 37, p.65.

<sup>64</sup> *Ibid.*, base-case penetration for 2029, p.83 and p.91.

<sup>65</sup> *Assessment of California CHP Market and Policy Options for Increased Penetration*, EPRI, Palo alto, CA, California Energy Commission, Sacramento, CA: 2005. CEC-500-2005-060-D. p. XIV and p. 4-3.

<sup>66</sup> Assumes 75 percent capacity factor, CHP efficiency of 75 percent and projected penetration of 2,400 MW.

natural gas for electrical generation, enhance oil recovery, and hybridizing with geothermal binary power production while reducing air emissions and greenhouse gases.

Work initiated by PIER staff has shown that oil and gas producing regions in California hold high promise for CHP technologies using associated gas for electricity production.

Generation of associated gas from oil fields is a significant air pollution problem in California. This low-BTU value gas must be disposed to allow continued production of the higher value petroleum products. Off-spec gas that cannot be economically conditioned to a pipeline quality gas must be suppressed, flared, or vented. In the Los Angeles Basin, venting is not acceptable because of the potential impact on nearby dwellings and businesses; even flaring is increasingly limited due to emissions limitations. The practice of suppressing or re-injecting off-spec gas into an injection well is not the preferred method of disposal since it can affect oil production.

Production wells also bring up vast amounts of hot water. The transport and reinjection of produced fluids are by far the most power consuming operation of oil production. The ratio of oil to water production varies by oilfield. The Division of Oil and Gas and Geothermal Resources estimates that the average oil to water production ratio is about 10 barrels of water to 1 barrel of oil.

Innovative applications may provide an opportunity to demonstrate operational flexibility of a CHP system by using the waste heat to augment the temperature of hot water that is coproduced from productive mature or abandoned oil fields. Application of CHP in oil and gas wells complements thermal-enhanced oil recovery (TEOR), carbon dioxide-enhanced oil recovery (CO<sub>2</sub>-EOR), and geothermal coproduction with a CHP system.

### **Ratepayer Benefits**

This research project proposes to explore the development of associated gas as a replacement for natural gas. The use of associated gas can reduce air emissions and greenhouse gases and result in coordinating power production to minimize variability in output, especially in small to medium sized CHP systems for onsite, distributed applications. Specific applications could potentially reduce permitting costs and land use and environmental impacts through use of existing infrastructure at existing industrial sites and brownfields. The potential also exists for leveraging recent and current PIER research in ultra-low NO<sub>x</sub> CHP systems.

- **Market Potential.** The California Department of Conservation (CDC), Division of Oil and Gas' *2009 Annual Report of the State Oil and Gas Supervisor* indicates that, in 2009, more than 193 Billion cubic feet (Bcf) of associated gas was produced from petroleum fields. Of the 193 Bcf, PIER staff estimated that if 20 percent (38 Bcf) is used for CHP applications, it would provide enough energy to power about 3,600, 100-kW CHP units for one year. Historical data from the CDC provides assurance of reliable future supply.

Using the estimate of 3,600, 100-kw CHP units, and considering that there are more than 20,000 oil production wells in the State, this could be tremendous distributed generation opportunity. However, limitations include availability of sites with suitable technical characteristics and willing owner/operators.

Only three or four locations identified in a PIER-funded demonstration project currently use associated gas at the distributed generation level.<sup>67</sup> Potential users would in theory be all producers in most oil fields in the state.

- **Market Connection.** Thermal-enhanced oil recovery and carbon dioxide enhanced oil recovery at the industrial scale are proven technologies; however, adoption and industry acceptance of CHP technologies are a novelty and could be slow to adopt. But with attractive economic benefits and the reduction of greenhouse gases, oil operators may be willing to take the risk.

Staff estimates that if a site could use off-the-shelf technology, and taking into consideration time for permitting, budgeting, system designs, and incentives, an operational system could result in less than two years. Development and demonstration of new systems will require added time and analysis. On average it would take an estimated five years to get to market.

- **Technology Potential.** Possible penetration rate of 10 percent or 360 units in the next five years.
- **Energy and Cost Savings.** In a white paper, ARB staff in 2011 estimated that the statewide emissions reductions in clean DG units from combustion of associated gas could support 14-28 MW of DG generating about 100,000 to 210,000 megawatt hour (MWh) per year. Such estimate is for 88 facilities where clean DG units may be suitable but does not include other facilities with control devices (for example, flares, thermal oxidizers, incinerators, carbon adsorbers, and so forth.). Additional cost benefits to the producer could occur with the use of CHP units to heat water or coproduce brines for injection in enhanced oil recovery operations. Energy produced on-site would displace some energy imported to the site from the utility grid. Applying ultra-low NOx CHP units would add emissions reduction.
- **Environmental.** ARB staff estimates that statewide emissions reduction from combustion of associated gas could reduce NOx emissions by 50-75 tons per year, volatile organic compounds by up to 12 tons per year and GHG emissions by 20,000 to 122,000 metric tons per year. Additional emissions reductions could be achieved if using gas that would be normally reinjected into the ground.
- **Cross-Cutting Projects with Energy Efficiency.** As mentioned in the energy efficiency research section, there may be opportunities to integrate energy efficiency and renewable energy in research projects involving ZNE buildings or industrial processes. If the opportunity occurs for joint integration, the Renewable Energy and Energy

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<sup>67</sup> California Oil Producers Electric Cooperative, *Offgases Project Oil-Field Flare Gas Electricity System*, Final PIER Report, Contract Number 500-02-016, December 2008. [http://www.energy.ca.gov/2008publications/CEC-500-2008-084/CEC-500-2008-084\\_no\\_appendices.PDF](http://www.energy.ca.gov/2008publications/CEC-500-2008-084/CEC-500-2008-084_no_appendices.PDF).

Efficiency teams will coordinate their respective work to ensure technical and economic feasibility of recommendations.

## Smart Energy Infrastructure Research

To fully realize all the benefits of the PIER research and demonstrations in energy efficiency, renewable generation, and other areas, the critical link to the energy infrastructure needs to be addressed to ensure the entire system operates effectively. The Smart Energy Infrastructure area includes research associated with natural gas pipeline integrity, energy-related environmental and climate, and natural gas related transportation. All these areas are related to energy infrastructure and the research is focused on successful and cost-effective integration.

### Natural Gas Pipeline Integrity

**Table 7: FY 2012-13 Natural Gas Research Budget Plan Summary – Pipeline Integrity**

Program Area – Smart Energy Infrastructure Research	Proposed Budget
Natural Gas Pipeline Integrity	\$1 million

Source: California Energy Commission

#### Program 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.
  - Emphasis on enhancing the safety and integrity of the natural gas pipeline.

#### Policy Drivers<sup>68</sup>

- Public Resources Code 25620

#### Main PAG Workshop Comments (Complete list of comments is in Appendix B.)

PAG Comment	Energy Commission Staff Response
Need for coordination with Sempra and others.	Staff agrees. Natural gas pipeline integrity research project has members from Sempra and other IOUs on the Project Advisory committees.
Need to avoid duplication of work.	PIER staff coordinates with Gas Technology Institute, utilities, and others to ensure no research duplication. PIER staff encourages participation and monitoring by other stakeholders to additionally inform staff of any related research efforts.
Need for integration of pipeline monitoring and safety.	Safety is included in policy drivers.

<sup>68</sup> Refer to Table 2 Summary of Policy Drivers for Natural Gas Activities, Page 10.

PAG Comment	Energy Commission Staff Response
Need for more funding.	The \$1 million proposed for FY 12–13 will be combined with the \$1 million from FY 11–12 for a total of \$2 million. More funding could be considered if further research is needed and warranted.

**Proposed Research Initiative: Smart Energy Infrastructure**

*Project: Natural Gas Pipeline Integrity (estimated project funding \$1 million)*

The state’s natural gas system consists of a complex network of pipelines designed to quickly and efficiently transport natural gas from its origin to areas of demand. The safety and security of the natural gas system infrastructure are important priorities for California, especially the prevention of catastrophic events on the natural gas pipelines. In the interest of enhancing the safety, operation, and management of the overall natural gas pipeline infrastructure, public interest research is needed to demonstrate innovative technologies and approaches to inspect, monitor, and report on the status of natural gas pipelines.

There are more than 60 available or emerging technologies for managing pipeline integrity and safety and can be categorized as hardware, software, and processes.<sup>69</sup> Some of the technologies are in current use, while others are not. Significant benefits can be achieved by overcoming gaps to increase the use of currently available technologies for:

- External assessment and inspection
- Long term condition monitoring
- Risk modeling and incident prediction

Safety benefits in the state should be greatly improved by: (a) leveraging the Advanced Metering Infrastructure (AMI) backbone, (b) using a combination of sensors and two-way communications capable of detecting and reporting events such as leaks or ruptures, stresses, and strains or right-of-way (ROW) encroachment, and (c) using an artificial intelligence system to identify and alert operators of abnormal operating conditions. Applying these methods and technologies to high consequence areas will decrease risk and increase public safety.

About 70 percent of the natural gas transmission pipeline mileage in-service was designed and built before 1980, before there was a realization of the need for internal inspection.<sup>70</sup> Certain technologies would have benefits limited to only piggable pipelines—those that are designed to

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<sup>69</sup> Preliminary results from contract 500-10-050, Natural Gas Pipeline Research - Best Practices in Monitoring Technology.

<sup>70</sup> Preliminary results from contract 500-10-050, Natural Gas Pipeline Research - Best Practices in Monitoring Technology.

use standard inspection tools. Other technologies can only be applied on a regional basis. However, every improvement that provides an added measure of safety has intrinsic value.

### Ratepayer Benefits

Preliminary results indicate that pipeline assessment technologies in use in California could be improved. The project outcome will:

- Protect the safety of our California residents and reduce property damage.
- Expand the exposure and use of commercially available technologies.
- Result in deployment of new emerging technologies.
- Identify gaps in research.

## Energy-Related Environmental Research

**Table 8: FY 2012-13 Natural Gas Research Budget Plan Summary – Energy-Related Environmental Research**

Program Area – Smart Energy Infrastructure Research	Proposed Budget
Energy-Related Environmental Research <ul style="list-style-type: none"> <li>• Air Quality Implications of Biogas to Replace Natural Gas</li> <li>• Quantifying Methane Emissions From California’s Natural Gas Energy Infrastructure</li> <li>• High Energy Efficiency, Low Emissions Combustion and Control Technology Development Program</li> </ul>	\$3 million

Source: California Energy Commission

### Program Goals

- Develop effective approaches to evaluating and resolving environmental effects of energy production, delivery and use; 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

### Policy Drivers<sup>71</sup>

- High Energy Efficiency, Low Emissions Combustion and Control Technology Development Program addresses the goal to improve environmental quality while meeting the wide-ranging demand for energy per the 2003 *Integrated Energy Policy Report*.

<sup>71</sup> Refer to Table 2 Summary of Policy Drivers for Natural Gas Activities, Page 10.

- Quantifying Methane Emissions from California’s Natural Gas Energy Infrastructure has a direct connection the California Air Resources Board AB 32 Scoping Plan, which contains strategies California will use to reduce greenhouse gases.

**Main PAG Workshop Comments** (Complete list of comments is in Appendix B.)

PAG Comment	Energy Commission Staff Response
Need to include research on low emission equipment/appliances- especially low NOx and improving energy efficiency.	A new project has been included titled “high efficiency, low emissions combustion and control technology development.” This project will be coordinated with the Building Energy Efficiency Research area.
Need to clarify why environmental research is under smart infrastructure.	Energy-related environmental research is cross-cutting and currently included in all three research program areas: energy efficiency, renewable energy and smart infrastructure. For example, indoor air quality is under energy efficiency, while outdoor air quality is under smart infrastructure. Smart infrastructure includes environmental research that is directly related to energy infrastructure, such as reducing methane emissions from natural gas pipelines.

**Proposed Research Initiative: Energy-Related Environmental Research**

*Project 1: Air Quality Implications of Biogas to Replace Natural Gas, Phase 1 (estimated project funding \$1.5 million)*

*The 2011 Bioenergy Action Plan* finds that biomass is an abundant resource that can help the state achieve clean energy goals, but aggressive actions are needed to increase biomass use. Increasing the state’s bioenergy production (including biogas) will help California achieve the state’s waste reduction, renewable energy, and climate change goals with a sustainable and dependable resource. Increasing the use of bioenergy is, therefore, a high priority.

Biogas from sources such as landfills, anaerobic digesters from dairies, and wastewater treatment plants provide the potential of adding thousands of gigawatt hours of renewable energy generation. However, the air quality and safety implications of directly using biogas in combustion equipment designed to burn on natural gas is not known, and the best uses for the various sources of biogases from an environmental aspect need to be better understood. PIER-funded research to determine the air quality and safety implications of using gas with a higher Wobbe index than traditional natural gas in combustion equipment, but has not evaluated the implications of using lower Wobbe gases<sup>72</sup> (for example, digester gas). This research is needed

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<sup>72</sup> The Wobbe Number is equal to the higher heating value in Btu/cubic foot (or MJ/cubic meter) divided by the square root of the gas specific gravity and represents how many BTUs go through an aperture at a given pressure.

to advise decision makers on the air quality and safety implications of combusting biogas in a variety of burners. This program will investigate the increase or decrease in air pollutant emissions from the use of biogas as a fuel in comparison with natural gas and any potential issues associated with the use of biogas. Potential operational issues of air pollution control devices will be investigated. This project will investigate these issues for multiple sources of biogas.

In addition, previous PIER research on natural gas interchangeability found a high variability in air quality emissions from commercial cooking equipment and identified that further investigation is needed on the air quality implications of using higher Wobbe gas in this equipment. Staff will be closely coordinating this project with Southern California Gas.<sup>73</sup> Currently, Southern California Gas is supporting research on how to clean biogas to make it compatible with natural gas by separating and eliminating the low heating value components of biogas. The Energy Commission's research will compliment Southern California Gas's research by concentrating on how to reduce emissions for the direct use of biogas, the potential operational issues associated with use of low heating value gas, and post combustion control technologies.

This program will advance science and provide policy makers, industry and end users much needed information on how to use biogas and other nontraditional gases in a safe and environmentally sound way. This will help identify the breadth of burners that biogas can be used in and from an environmental perspective the best uses of those gases.

### **Ratepayer Benefits**

Information developed can be used to diversify natural gas supplies through the safe and environmentally friendly use of nontraditional gases, including biogas and thus could help accelerate the use of biogas and other nontraditional gases.

- Energy Sector. Biogas could supply up to 5 percent of current levels of natural gas consumption in California.<sup>74</sup> The actual economic and regulatory feasible potential may be much lower. Treated biogas can be used for all the applications currently using natural gas.
- Market Connection. Control technologies often take two to three years to develop. Afterward, market adoption can take another several years depending on multiple factors such as the cost of natural gas, economic incentives, and laws and regulations.
- Energy and Cost Savings. ARB has estimated allowances/offset would be valued at \$20 per ton of CO<sub>2</sub> equivalent when the cap-and-trade program is fully implemented. If all the theoretical potential of biogas is used to offset GHG emissions from other sectors or

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<sup>73</sup> Phone conversation with Cherif Youssef, March 20, 2012.

<sup>74</sup> "A Technoeconomic Analysis of Biomethane Production from Biogas and Pipeline Delivery." Presentation by Ali Jalalzadeh-Azar from NREL at the Renewable Resources for Fuel Cells Workshop. San Antonio, Texas. October 18, 2010.

to reduce net emissions from the combustion of natural gas, this would translate to about \$100 million/year. Actual numbers would be lower.

This program will provide information to policy makers, industry, and end users that could help accelerate the use of biogas and other nontraditional gases.

*Project 2: Quantifying Methane Emissions From California's Natural Gas Energy Infrastructure (estimated project funding \$750,000)*

The Scoping Plan adopted by ARB to implement the emission reduction requirements mandated by AB 32 contains a measure designed to reduce fugitive methane emissions from the natural gas system. ARB plans to develop regulations in the near future, but there is limited information. PIER funded earlier research to measure fugitive methane emissions from different components of the natural gas system to develop new emission factors. The goal was to improve the current estimation of fugitive methane emissions from the natural gas system. The measurements show that some components of the natural gas system emit much more than anticipated while others seem to emit much less than assumed. At the same time, developing technically sound average emissions factors does not seem to be plausible because the emission for a given component can vary by one or two orders of magnitude.

Therefore, there is a need to better quantify fugitive methane emissions from the natural gas system and to develop methods to confirm any emission reductions from measures that may be required by future regulations.

This initiative will use “tracers of opportunity” to see if emissions of natural gas can be uniquely identified. Natural gas methane contains odorants to allow humans to detect dangerous levels in homes and buildings. Tracking and measuring emissions using these tracers of opportunity have not been done for the natural gas system. This initiative will measure ambient concentrations both near natural gas facilities and in a tall communication tower and use different methods to try to apportion the measurements to the natural gas system.

### **Ratepayer Benefits**

The goal of the research is to obtain the actual emissions of the natural gas system so any control measures developed will be based on actual information. Otherwise, control measures may be more costly than necessary and may not result in actual environmental benefits.

- **Energy and Cost Savings.** California spent about \$15.4 billion in 2010 for the purchase of natural gas (see footnote 5). Even modest reductions of fugitive methane emissions would result in significant savings. For example, if emissions are reduced to only 0.6 percent of current levels of consumption (in effect, from the 1.6 percent of total consumption now to only 0.6 percent), there would be net saving of \$154 million saving per year (1 percent of \$15.4 billion).
- **CO<sub>2</sub> Savings.** Fugitive methane emissions from the natural gas transmission system are estimated to reach up to 1.7 million metric ton of carbon dioxide equivalent in 2020 (*ARB Scoping Plan*). This does not take into account the fugitive emissions associated with

extraction and processing of natural gas, which should be substantial. Assuming a conservative value of \$20 per ton and that 50 percent of the emissions could be reduced, this would represent a savings of about \$17 million a year. There is a substantial level of uncertainty in these numbers for several reasons, including the fact that actual emissions are not known.

*Project 3: Energy Efficient, Low Emissions Combustion and Control Technology Development Program- Phase 1 (estimated project funding \$750,000)*

Most California residents live in areas that are classified as nonattainment for the federal ozone (O<sub>3</sub>) and PM<sub>2.5</sub> standards. The California Air Resources Board and air districts are spending considerable resources to find ways to reduce ozone and PM<sub>2.5</sub> pollution.

To attain federal air quality standards, the South Coast Air Quality Management District (AQMD) will need to cut emissions by more than 75 percent and similar reductions would be needed in other areas in California. Proposed tougher federal air quality standards for ozone and particulates, if adopted, would require even more reductions.

As the pressure intensifies to reduce emissions of air pollutants, it is clear that high energy efficiency and ultra low emissions combustion technologies and emission control devices will be needed for a variety of appliances (for example, hot water heaters, furnaces, boilers).

This program will advance science by developing very high-energy-efficiency, ultra-low NO<sub>x</sub> combustion and/or control technologies to reduce the emissions. This research will be done in coordination with new technology development under the Building Energy Efficiency Research Program area. The first phase of this scoping study would include research for one or two promising combustion and/or control technologies.

### **Ratepayer Benefits**

- Without the development of high-energy-efficiency, and ultra-low NO<sub>x</sub> technologies and/or control devices, some combustion sources may no longer be allowed in the worst air quality areas of the state. The noncombustion alternatives are often more expensive and not suited for all applications, especially industrial processes. This research is critical for environmental and public health benefits as well as industry competitiveness. These high-energy-efficiency and low-emission technologies will help to improve regional air quality and lead to better public health while also reducing cost to consumers.

## Natural Gas-Related Transportation

**Table 9: FY 2012-13 Natural Gas Research Budget Plan Summary –Transportation**

Program Area – Smart Energy Infrastructure Research	Proposed Budget
Natural Gas-Related Transportation <ul style="list-style-type: none"> <li>• Natural Gas Vehicle Efficiency</li> <li>• Natural Gas Vehicle On-Board Storage</li> <li>• Renewable Natural Gas Research Roadmap</li> </ul>	\$4 million

Source: California Energy Commission

### *Program Goals*

As a transportation fuel, natural gas could:

- Offset more than 885 million gallons of diesel per year by 2022.<sup>75</sup>
- Reduce annual GHG emissions by 4.4 million metric tons by 2022.<sup>76</sup>
- Save the state about \$1.35 billion annually in fueling costs.<sup>77</sup>

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.

### *Policy Drivers*<sup>78</sup>

- Senate Bill 1250—Perata
- *State Alternative Fuels Plan*- Assembly Bill 1007, (Pavley, Chapter 371, Statutes of 2005)
- *Integrated Energy Policy Report*
- Public Resources Code 25620 – For the state to undertake public interest energy research development and demonstration projects that are not adequately provided for by competitive and regulated energy markets and to advance energy science or technologies of value to California citizens. Investments in advanced transportation

<sup>75</sup> State Alternative Fuels Plan (AB 1007), Page 34, Refer to Table 4.

<sup>76</sup> Ibid.

<sup>77</sup> Transportation Energy Forecasts and Analyses for the 2011 Integrated Energy Policy Report (Pub #CEC600-2011-007-SD), Forecasted fuel price differential based on Figures B-3 and B-6, Pages B-5 and Figure B-10 , respectively. <http://www.energy.ca.gov/2011publications/CEC-600-2011-007/CEC-600-2011-007-SD.pdf>.

<sup>78</sup> Refer to Table 2 Summary of Policy Drivers for Natural Gas Activities.

technologies that reduce air pollution and greenhouse gas emissions beyond applicable standards, and that benefit electricity and natural gas ratepayers.

**Main PAG Workshop Comments** (Complete list of comments is in Appendix B.)

PAG Comment	Energy Commission Staff Response
More research is needed in infrastructure opportunities in gas compression. There have been advancements in technologies that could be applied to compressors used at natural gas stations.	PIER research is actively pursuing these opportunities as identified in the Natural Gas Vehicle Research Roadmap (NGVRR).
More research needed to expand to medium-and light-duty applications for natural gas.	The Advanced Natural Gas Tank research included in the 2012–13 Natural Gas Budget Plan will specifically target light-duty vehicle application.
Look into home refueling appliances.	Home refueling is identified in the NGVRR as a midterm priority, and PIER will pursue those opportunities as staff works through the higher priority research initiatives.

**Proposed Research Initiative: Natural Gas-Related Transportation**

*Project 1: Natural Gas Vehicle Efficiency (estimated project funding \$2 million)*

Hybrid natural gas vehicles (NGVs) offer a significant promise for clean transportation using a domestic fuel. Because of their inherently increased fuel economy, hybrids increase the overall engine efficiency and require less total fuel storage to achieve acceptable driving range. This project will focus on improving NGV efficiency by incorporating battery power to minimize engine idle and low-load engine operation resulting in a highly efficient medium- and heavy-duty NGV design, particularly beneficial in stop-and-go urban traffic.

Research is needed to build on the current technology by developing and demonstrating the improved efficiency of a hybrid NGV concept. The deployment of advanced and efficient NGV technologies will further improve the economics of NGVs, lower greenhouse gas emissions, and significantly benefit natural gas ratepayers.

**Ratepayer Benefits**

- Energy Sector. The transportation natural gas demand forecast represents three primary sectors: residential and commercial light-duty vehicle transportation and urban public transit. The current total natural gas demand for transportation is roughly 130 million

gasoline gallon equivalents (GGEs) annually, and by 2020, demand is forecasted to exceed 200 million GGEs or 228 million therms.<sup>79</sup>

Hybrid-natural gas vehicle technology can be applied to almost all classifications of NGVs but fit well within the urban public transit and urban delivery vehicles. This sector currently represents about 90 percent of the total transportation natural gas demand.<sup>80</sup>

- **Market Connection.** The hybrid-electric NGV concept could make market penetration in less than five years. Once a prototype vehicle is developed and demonstrated, the vehicle requires California Air Resources Board certification. The process to certify is no more than a year from the time demonstrations are complete. This relatively quick deployment is due in part to the mature electric-hybrid technology currently pursued by diesel engine platforms.
- **Technology Potential.** If successful, the project could enable 20 percent market penetration by 2020.<sup>81</sup>
- **Energy and Cost Savings.** Improvement in fuel economy could result in an estimated annual natural gas savings of up to 60 million GGEs, or 7.6 million Mcf (thousand cubic feet).<sup>82</sup>
- **Public Health.** Significant air quality benefit from higher penetration of natural gas vehicles versus petroleum-or diesel-fueled transportation.

*Project 2: Natural Gas Vehicle On-Board Storage (estimated project funding \$1.9 million)*

Limited driving range, storage capacity, and weight of conventional tanks continue to be barriers to commercial viability of NGVs. The PIER Program funded research to develop a replacement for the bulky cylindrical, heavy-walled compressed natural gas tanks currently used in NGVs. This laboratory-tested tank design results in a flat, solid-state, lightweight tank that stores natural gas in adsorbed form by using carbon-activated briquettes, manufactured from spent corn cobs. If commercialized, this low-pressure tank design will reduce NGV costs and increase driving range, making NGVs a more attractive consumer choice. In addition, this low-pressure tank design will lower compressor requirements, reducing fueling-station costs for both public stations as well as home refueling appliances. To help bring this technology to

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<sup>79</sup> Transportation Energy Forecasts and Analyses for the 2011 Integrated Energy Policy Report (Pub #CEC-600-2011-007-SD), Refer to Table 3-11 on Page 83.

<sup>80</sup> Ibid, Page 82.

<sup>81</sup> Staff estimate based on preliminary research conducted by the California Hybrid, Efficient, and Advanced Technology Research Center, Pasadena, CA.

<sup>82</sup> Staff estimate based on forecasted fuel usage in transportation sector and efficiency improvement of technology.

market, this project will demonstrate the operational and manufacturing viability of the advanced natural gas fuel tank design in a vehicle.

### Ratepayer Benefits

- Energy Sector. In California, light-duty vehicles consume about 16 billion gallons of gasoline, which amounts to roughly 144 metric tons of CO<sub>2</sub> greenhouse gas emissions per year.<sup>83</sup>

According to the Natural Gas Scenario (May 2007) of the *State Alternative Fuels Plan*, Assembly Bill 1007 (2005), California will take action to increase its use of natural gas as motor fuel from 1 percent currently to 19 percent of the state's on-road transportation fuel by 2050.

- Market Connection. The estimated path to market is about 5 to 10 years, but government-funded research could further accelerate the deployment.
- Technology Potential. This research targets all compressed natural gas vehicles.
- Energy and Cost Savings. The advanced natural gas tank design could result in a weight savings of 300 lbs., improving fuel economy by 6 percent. Using the present fuel demand for light-duty vehicles and projected market penetration from the *State Alternative Fuels Plan*, the weight reduction alone could save about 182 million gasoline gallon equivalents, which is more than 23 million Mcf of natural gas.
- Public Health. Significant air quality benefit from higher penetration of natural gas vehicles verses petroleum or diesel fueled transportation.

#### *Project 3: Renewable Natural Gas Research Roadmap (estimated project funding \$100,000)*

In 2011, PIER Transportation began refocusing its Alternative Fuels subject area exclusively toward renewable natural gas (RNG). RNG is chemically identical to conventionally sourced natural gas, in that it contains the same composition of hydrocarbons found in gas that comes from the ground, such as mostly methane with small quantities of heavier hydrocarbons and impurities. To be introduced into California's pipeline transportation and distribution system, the RNG must conform to the same quality standards as conventional natural gas, as detailed in utility tariff books (Rule 21 in PG&E, and Rule 30 for SoCalGas and SDG&E).

The refocusing of this effort requires updating the Alternative Fuels Research Roadmap to accurately identify research gaps in a rapidly developing technological environment. The goal of this project is to conduct a comprehensive and public process to determine the optimal direction for the RNG research, development, and demonstration efforts. The roadmap will be initially put together by UC Riverside's Bourns College of Engineering's Center for Environmental Research and Technology (CE—CERT), vetted by a stakeholder group and the public.

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<sup>83</sup> Transportation Energy Forecasts and Analyses for the 2011 Integrated Energy Policy Report (Pub #CEC-600-2011-007-SD), Refer to Figure 2-4 on Page 38.

This Renewable Natural Gas Research Roadmap will provide the state with a scientifically and publicly vetted direction for the RD&D efforts moving forward. It will identify and develop alternative renewable sources of natural gas and recommend those promising enough to warrant public investment in research, development, and demonstration consistent with PIER’s mission.

**Ratepayer Benefits**

This project develops alternative renewable sources of natural gas. It is expected that the Renewable Natural Gas Research Roadmap will identify and prioritize the research opportunities with the greatest benefits to ratepayers and the greatest improvements to the environment.

**Energy Innovations Small Grants Program**

**Table 10: FY 2012-13 Natural Gas Research Budget Plan Summary – Energy Innovations Small Grants Program**

<b>Program Area</b>	<b>Proposed Budget</b>
Energy Innovations Small Grants Program	\$1.50 million

Source: California Energy Commission

*Program Goals*

- Support the early development of promising new natural gas technology concepts.
- Promote the commercialization of natural gas technologies that can have an impact on achieving state energy policy while providing tangible benefits to natural gas utility customers.

**Main PAG Workshop Comments** (Complete list of comments is in Appendix B.)

<b>PAG Comment</b>	<b>Energy Commission Staff Response</b>
What is the basis for the project funding limits?	The \$95,000 limit for hardware projects is set by the Energy Commission and was increased to this amount several years ago. The idea is to be high enough to generate interest, but low enough so as not to be high risk since these are proof of concept projects. The amount can be reevaluated in the future.
What is the EISG solicitation process for electricity and natural gas funding?	The EISG program runs separate solicitations for electricity and natural gas projects. Projects must be submitted for either electric or natural gas. There is no split funding of projects (e.g., 50% electric and 50% natural gas).

## Proposed Research Initiative: Energy Innovation Small Grants Program

### *Energy Innovation Small Grants Program (EISG), Natural Gas*

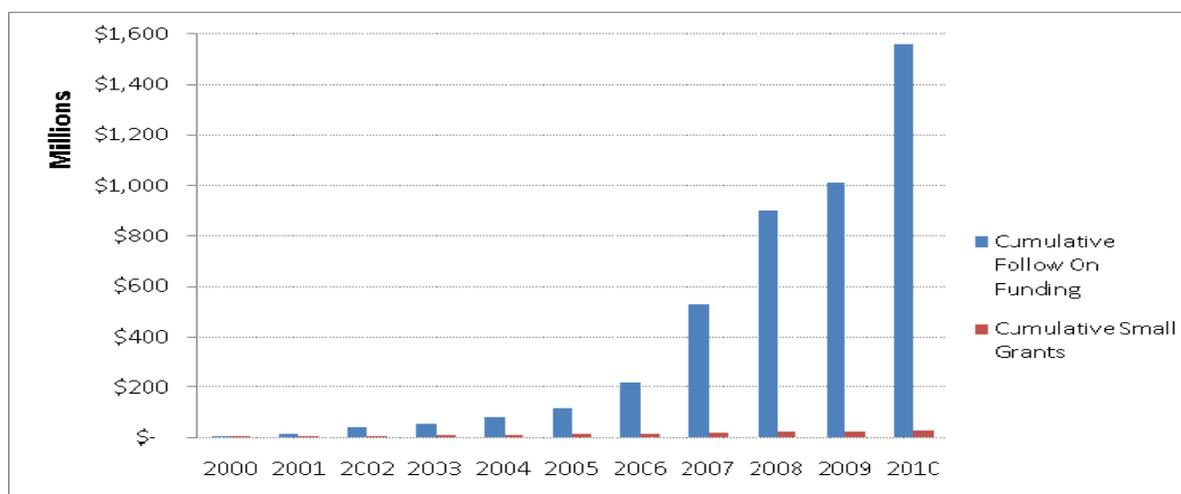
The Energy Commission's Energy Innovations Small Grants Program provides research grants to businesses, nonprofit organizations, individuals, national laboratories, utilities, academic institutions, and other qualifying entities for research that establishes the feasibility of innovative natural gas energy concepts.

The EISG program supports the early development of promising new energy technology concepts, a niche not covered by PIER general solicitations that focus primarily on development and deployment of more mature concepts. The EISG awards offer innovative thinkers the opportunity to prove the feasibility of their technology solutions, both technically and economically, to address California's energy problems.

Research conducted under PIER EISG address California's critical energy issues, from increasing building end-use efficiency to bringing down the cost of renewable generation development. Once vetted through this early stage research program, researchers have the opportunity to market their technology to the next stage of investment for both private and public sector investment.

The benefits to natural gas ratepayers are likely to follow the benefits to electricity ratepayers as displayed in Figure 6. The small grants were not initiated until eight years after electric grants began. Figure 6 shows the rapid growth of cumulative subsequent funding as mature projects attracted increasingly more funds. PIER research results in publicly available knowledge that fosters additional innovation by the private sector. This innovation frequently results in new products that create new jobs and output. EISG case studies are highlighted in the publication titled "PIER Contributes to Job Growth."<sup>84</sup>

**Figure 6: PIER Electricity-Related Small Grants Subsequent Funding**



Source: California Energy Commission

<sup>84</sup> <http://www.energy.ca.gov/2011publications/CEC-500-2011-048/CEC-500-2011-048-BR.pdf>.

## CHAPTER 4: Quantifying Benefits of Research

Any public interest energy RD&D program that is funded using ratepayer dollars needs to demonstrate a reasonable probability of achieving ratepayer benefits in the RD&D projects funded. The PIER Program developed a programwide approach to benefit and cost assessment, which includes integrating benefits assessment elements into work plans and databases, evaluating interviews and surveys, identifying required benefits metrics, and requiring researchers to report on these metrics. A public workshop in 2011 was held to vet the methods and brought together benefits analysts and practitioners from state and federal agencies, academia, research institutions, and the public.

*Any public interest energy RD&D program that is funded using ratepayer dollars needs to demonstrate a reasonable probability of achieving ratepayer benefits in the portfolio of RD&D funded projects.*

The PIER staff's benefits assessment method involves collection and evaluation of data at various stages: solicitation development and proposal submittal, research project management and post-project completion follow-up. These evaluations are coupled with staff assessments of market potential, adoption time, and discussions with industry experts. The general steps used are:

### **Before Solicitation**

- Staff documents energy use by sector.
- Staff evaluates potential for benefits in choosing project ideas to fund. Benefits include energy and cost savings; projected cost-effectiveness of technologies; benefits to the economy; benefits to the system such as safe, secure and reliable energy supply; and an array of environmental benefits including but not limited to reduced emissions, ecosystem protection, and improved public health.
- Staff identifies the research stage (for example, basic research, technology development, technology demonstration, market support).
- Staff evaluates whether public funding is needed to avoid wasting funds on projects that would proceed anyway.

### **Solicitation/Agreement Development**

- Bidders must provide articulation of the California ratepayer benefits of their projects, including supporting data.
- Bidders must describe the market for their product and how the product is expected to move forward into that market after the research, providing a technology transfer plan.
- Bidders must demonstrate their project is both beneficial to ratepayers and would not occur without public research dollars, or without public dollars it would not occur in a timely manner or in a manner beneficial to California ratepayers.

- The above factors are incorporated into project scoring criteria and evaluated by expert reviewers.

### **Research Project Management**

- PIER awardees provide PIER staff additional data needed for evaluation of benefits and costs.
- PIER awardees and PIER contract managers consult with project advisory committees which review and comment on project features, benefits, and progress. This input often shapes the project and improves the end product, bringing higher value returns to ratepayers.
- PIER awardees report on progress of their technology transfer plan.
- The final report will include an assessment of research benefits to ratepayers.

### **Post Project Completion Follow-up**

- PIER awardees are expected to continue to provide PIER staff data needed for evaluation of benefits and costs such as market penetration of their technology. Benefits estimates are revised accordingly.
- PIER staff will survey and interview a selection of awardees and people knowledgeable about the research field to promote benefits evaluation and revise estimates. Qualitative and quantitative information with both will be collected.
- PIER staff performs independent analysis on market potential, for selected projects:
  - For a large group of projects, PIER analyzes market potential, combined with expert review of awardees' market penetration projects, to develop rough estimates of potential benefits that are independent of contractor-submitted estimates.
  - For a smaller group of projects, PIER staff performs more detailed benefits evaluation, involving considerable research and including peer review.

### **Recent Benefits Assessment Results**

In the *October 2011 Natural Gas Annual Report*, staff provided preliminary estimates of energy benefits from 38 natural gas-funded research projects.<sup>85</sup> Using many of the assessment activities just described, staff estimated that these projects could save more than 1,400 million therms annually or the equivalent of 7.6 million metric tons of carbon dioxide.<sup>86</sup> PIER staff plans to expand the analysis to additional projects in the *October 2012 Natural Gas Annual Report*.

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<sup>85</sup> Copies of the Annual Natural Gas reports can be found at:  
[http://www.energy.ca.gov/research/annual\\_reports.html](http://www.energy.ca.gov/research/annual_reports.html).

<sup>86</sup> <http://www.energy.ca.gov/2011publications/CEC-500-2011-029/CEC-500-2011-029.pdf>.

## **Appendix A – Natural Gas Research Initiatives for 2012/13 Presentation**

### **Natural Gas Research Initiatives for 2012/13**

**With Workshop Participant Questions and Comments and PIER  
Staff Response**

**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"><li>• Energy Efficiency – Virginia Lew, Bradley Meister, Michael Lozano</li><li>• Renewable Energy – Linda Spiegel, Rizaldo Aldas</li><li>• Smart Infrastructure – Mike Gravely, Jamie Patterson, Guido Franco, Rey Gonzalez</li><li>• Energy Innovation Small Grant Program – Mike Gravely, David Chambers</li></ul>
3:30	Advisory Group Presentations/Discussions <ul style="list-style-type: none"><li>• Cherif Youssef, Sempra Energy</li><li>• Ron Kent, Sempra Energy</li><li>• Jorn Horner, Air Resources Board</li><li>• William Miller, DOE-LBNL</li></ul>
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
  - 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	
<b>Subtotal Energy Efficiency</b>	<b>\$8,000,000</b>	<b>\$8,000,000</b>	<b>33%</b>
<b>Renewable Energy</b>	<b>\$3,000,000</b>	<b>\$4,000,000</b>	<b>17%</b>
Natural Gas Pipeline Integrity	\$1,000,000	\$1,000,000	
Energy-Related Environmental	\$3,000,000	\$3,000,000	
Natural Gas-Related Transportation	\$5,000,000	\$4,000,000	
<b>Subtotal Smart Infrastructure</b>	<b>\$9,000,000</b>	<b>\$8,000,000</b>	<b>33%</b>
<b>Energy Innovation Small Grant Program (EISG)</b>	<b>\$1,500,000</b>	<b>\$1,500,000</b>	<b>6%</b>
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%
<b>Grand Total</b>	<b>\$24,000,000</b>	<b>\$24,000,000</b>	

## 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

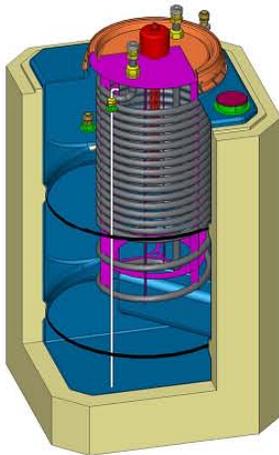
- Questions for each research area:
  - Are we emphasizing the right initiatives?
  - Are there any missing opportunities? If so, provide examples
  - Are there opportunities for collaboration or synergies? If so, with whom?

## **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**



# 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](http://www.energy.ca.gov/research/annual_reports.html)

# I. Goals (revisions in green)

## Reduce energy use in buildings and communities

- Advance 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

### **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

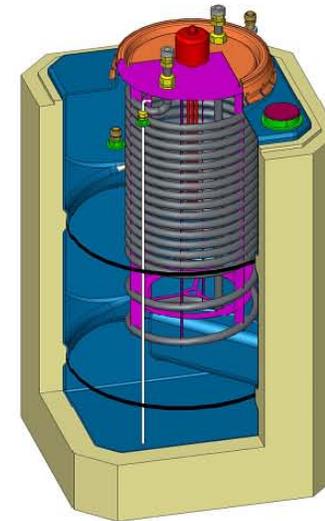
## III. General Approach

- **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. Workshop Participant Questions (CEC staff response in green)

- **Why is solar water heating in energy efficiency and not renewable energy research?**

The solar collector is part of larger system including alternate hot water generation, distribution and space heating is logical to include with building energy use systems.

- **Are there funding opportunities for building efficiency appliances, specifically in the areas of stoves, ovens, and dryers?**

Possibly. A February 23 workshop will provide information on potential research topics. A solicitation is planned in the spring. There may be research and funding opportunities for building efficiency appliances, such as stoves and ovens.

- **How should policy be effected by technology? For example, Title 24.**

Data from research could be used in future standard proceedings (Title 24 or Title 20). For instance, results of PIER research have supported some aspects of the 2005 and 2008 building energy efficiency standards and the 2007 and 2010 appliance standards.

## VI. Workshop Participant Questions (CEC staff response in green)

- **What is the behavioral component of energy use? For example, hot water usage.**  
We have current research involving how hot water is used in homes; the effects of technologies, policies, community education and media campaigns to determine their influence on energy use behavior by individuals and households; and developing next generation models to improve understanding of residential natural gas demand. We have planned behavioral R&D on the use/programming of thermostats in homes.
- **Energy modeling fits in small grants. Where does development of educational materials come from?**  
Training falls under utility incentive programs. Energy Commission's PIER program does not fund training. It has funded curriculum development for advanced energy efficiency technologies for HVAC technicians and operators, building commissioning technicians and managers; lighting curriculum for contractors, electricians, architects and engineers.

## VI. Workshop Participant Comments (CEC staff response in green)

- Goals and objectives for energy efficiency need to include research on low emission equipment/appliances, especially NOx and CO. Reduce NOx emissions is the #1 priority for Southern California. **Already included and will continue. In addition, the Energy Related Environmental Research area plans to include a study to address this area with combustion equipment that exceeds current energy efficiency standards (please see slide 73).**
- Indoor and outdoor air quality issues should both be addressed. We need to pay attention to improving energy efficiency while improving air emissions. **Will include**
- Natural gas water heater research within the residential market should be encouraged. Low cost and low emissions would be nice. **Already included**
- One of the major focus areas should include achieving net zero energy buildings. **Agree**
- Would like to see more research on cost effective solar thermal for water heating and space heating (low emission, high efficiency and reasonable cost-should be the goals). **Already included**

## VII. Proposed Funding Opportunities for 12/13 (updates in green)

### **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 (**emphasis on low NOx and low cost**)
  - Food service: Higher efficiency commercial cooking equipment
  - Advanced HVAC and envelopes: Innovative envelope sealing systems (**low NOx units**)
  - Solar Energy: Next generation solar systems using lower cost high performance collector and improved performance tank
  - **Zero Net Energy : demonstrations, technologies, strategies**
- **Potential partners:** Utilities, Contractors, Manufacturers, Trade Organizations, Designers, and residential and commercial customers
- **Estimated rate payer benefits:** Energy, water and cost savings

## VIII. Proposed 2012/13 Budget (updates in green)

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

# Industrial, Agricultural and Water Efficiency



**Presenter:**  
**Michael Lozano, P.E.**

# I. Goals (updates in green)

***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 (**e.g., low NOx**)

## 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 CO<sub>2</sub> Industrial & Commercial Laundry Machine

- **Description:** Each industrial laundry machines can use over 300,000 gallons of water per year. CO<sub>2</sub>Nexus 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:** CO<sub>2</sub>Nexus (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.	Scoring complete and NOPA prepared.
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
		33

## VI. Workshop Participant Questions and Comments (CEC staff response in green)

- **Why is solar thermal not renewable energy research?**

**Solar thermal research projects that impact customers directly are in the energy efficiency research program.**

- **Low emission units** –Goals and objectives for energy efficiency need to include research on low emission equipment/appliances, especially NOx and CO. Reduce NOx emission reductions is #1 priority in Southern California. **Already included-one of the goals if the industrial energy efficiency research program is to reduce energy consumption and air emissions**

## VII. Proposed Funding Opportunities for FY 12/13 (updates in green)

### **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 **(including low NOx combustion equipment)**
  - 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.
  - Lowered emissions and outdoor air quality are factored into the decision making process. In general, more efficiency equal less emissions.

## VIII. Proposed 2012/13 Budget

Initiatives	Proposed FY 2012/13 Natural Gas Budget
<b>Industrial, Agriculture and Water Efficiency</b> Natural Gas Efficiency Research for Industrial Use, Heat Recovery , Greenhouse Gas Reduction through capture and sequestration, Process Measurement, Diagnostics, and Optimization, Update to IAW Consolidated Roadmap.	<b>\$4,000,000</b>

## 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 H<sub>2</sub>S from Biogas Using Microwave Technology

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

- remove siloxanes and H<sub>2</sub>S 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:**

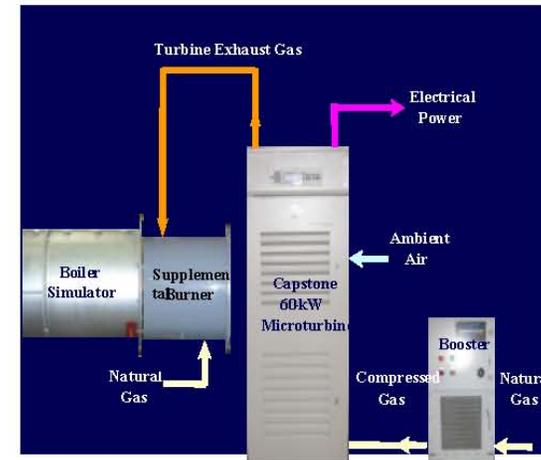
- More economical biogas treatment systems can help achieve CHP and renewable energy goals, and help reduce natural gas use in California by 85 million ft<sup>3</sup>/day.
- Reduce poisoning catalytic emission control systems due to prevention of corrosive acid formation due to H<sub>2</sub>S in the 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



45

## 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 Jan. 6; proposals due Feb. 29th

## VI. Workshop Participant Questions (CEC staff response in green)

- **Which program area does biofuel and biomethane clean-up fall under?**  
Biofuel and biomethane projects are in three different PIER program areas: industrial, agriculture and water (IAW); transportation research, and renewable energy. The first two are associated with customer applications and fuel substitutes. The renewable energy element focuses on advancing biomass power generation, biochemical conversion processes and on biogas cleanup technology. Two project examples under this program were provided during the presentation (Gills Onion and SMUD project on siloxane)
- **Has there been funding opportunities emphasizing in-state-directed biogas?**  
Last year, one of the Industrial Agriculture and Water efficiency solicitation areas was advanced biogas technologies for agriculture and wastewater operations.

## VI. Workshop Participant Questions (CEC staff response in green)

- In regards to the SMUD/CHA project, what level of siloxane is being reduced? Is it a pilot program? Any other locations where technology is installed?

The concentration of siloxanes in the biogas varied from 18.25 ppm to 3.55 ppm. This project was able to remove 79% of the siloxanes in the biogas; during the field test they were able to reduce the siloxane concentration from 7.3 ppm to 1.53 ppm. By making a few changes including change in the biogas flow rate, it is possible to potentially remove 99% of the siloxanes. This is a bench-scale system, not a commercial ready product. We are unaware of any other installations.

## VI. Workshop Participant Comment (CEC staff response in green)

- **I would like to see co-funding partners listed in these presentations.**  
Projects funded by the PIER program receive co-funding from many different entities, including SoCalGas. For the specific projects highlighted during the presentations, project partners were shown.
- **I recommend that the California Energy Commission provide funding for kelp.**  
Our past solicitations have been broad enough to include kelp as a biomass resource. Funding amounts are specified in competitive solicitations and these solicitations do not single out specific feedstocks, such as kelp. Future solicitations will depend on the CPUC's decision on project scope for Renewable and Transportation research.

## VII. Funding Opportunities for FY 12/13

### **Localized Efficient and Advanced Power and Heat Systems (LEAPS)**

- 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. Biofuels and other local renewable resources to augment NG fired heating and power systems, such as biogas from wastewater or food processing 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.

## VII. 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 (associated 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 CO<sub>2</sub> by offsetting generation elsewhere

## VIII. Proposed 2012/13 Budget

Initiatives	Proposed FY 2012/13 Natural Gas Budget
<b>Renewable Energy Total</b> <ul style="list-style-type: none"><li>• Localized Efficient and Advanced Power and Heat Systems</li><li>• Combined Heat and Power Applications in By-product Gas Field Locations</li></ul>	<b>\$4 Million</b>

## 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



55

# 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

## 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

## V. Current Portfolio Highlights Major Initiatives

Name of Initiative	Description	Status
Natural Gas Pipeline Integrity	<p><b>Innovative Monitoring Technologies</b></p> <ul style="list-style-type: none"> <li>Find new technologies to inspect, monitor and report on the condition of natural gas pipelines</li> </ul>	<p>Benchmarking existing diagnostic parameters</p> <p>Next Steps:</p> <ol style="list-style-type: none"> <li>1. Document in a Benchmark report for TAC review.</li> <li>2. Identify new technologies for future research and demonstration</li> </ol>
	<p><b>Current Diagnostic Practices</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	<p>Benchmarking existing diagnostic parameters</p> <p>Next Steps:</p> <ol style="list-style-type: none"> <li>1. Document in a Benchmark report for TAC review.</li> <li>2. Identify new technologies for future research and demonstration</li> </ol>

## V. Workshop Participant Questions (CEC staff response in green)

- **How coordinated is PIER with Sempra's program? Are other stakeholders included?**

We are coordinated with Sempra, especially with pipeline integrity research. Sempra and others are involved in our PIER contracts' Technical Advisory and Project Advisory Committees.

- **How is duplication of work avoided?**

Gas Technology Institute (GTI) is PIER and utility contractor. PIER staff coordinates with GTI, utilities and others to ensure no research duplication. PIER staff encourages participation and monitoring by stakeholders.

- **What is the status and timeline on the Gas Technology Institute and University of California pipeline integrity projects?**

Expect completion of work in 1<sup>st</sup> quarter of 2013. The Commission will hold a public workshop in early summer of 2012 to get feedback on the research and provide direction. A second workshop will be held in the 1<sup>st</sup> quarter of 2013 to share the results of this research.

## V. Workshop Participant Comments (CEC staff response in green)

- Pipeline monitoring and safety needs to be integrated. **We agree. Safety is included in policy drivers.**
- Gas industry and the Energy Commission should coordinate together. \$1M is not enough funding. **We are coordinated (see previous responses on slide 60). The \$1 million proposed for FY 12/13, will be combined with the \$1 million from FY 11/12 for a total of \$2 million. We would like to see where \$2 million gets us before requesting additional funds.**

## VI. Proposed Funding Opportunities for FY 12/13

- Field demonstrate and further research promising technologies identified by UC-CIEE and GTI
- Natural gas pipeline integrity continues
- Working with utilities and industry
- \$1 Million FY12/13
- CPUC, Utility and Industry feedback validates the need and will help determine which technologies will go forward
- Benefit: Increased safety and reliability of natural gas infrastructure

## VII. Proposed 2012/13 Budget

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

# 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 CO<sub>2</sub>

**Executive Orders**

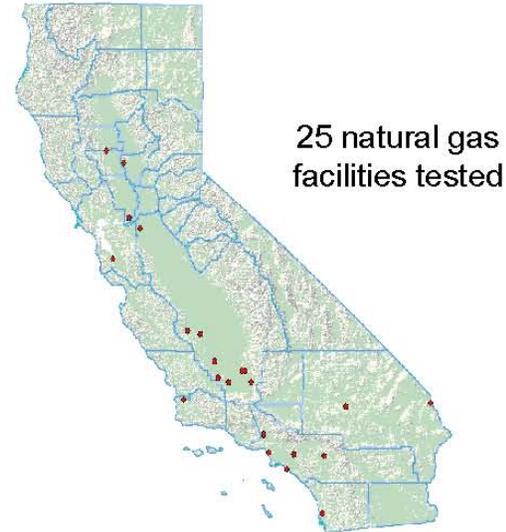
## III. General Approach

- **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

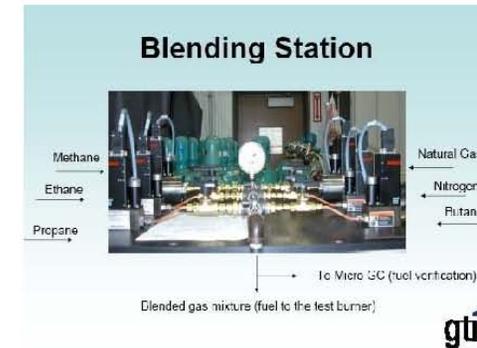
- Using ambient measurements of GHG to “verify” the ARB inventory and to track emissions
- **Contractor:** Lawrence Berkeley National Laboratory. ARB support
- **PIER funding amount:** \$500K
- **Results:** Ambient measurements suggests that actual methane emissions may be 1.5 times higher than the ARB 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



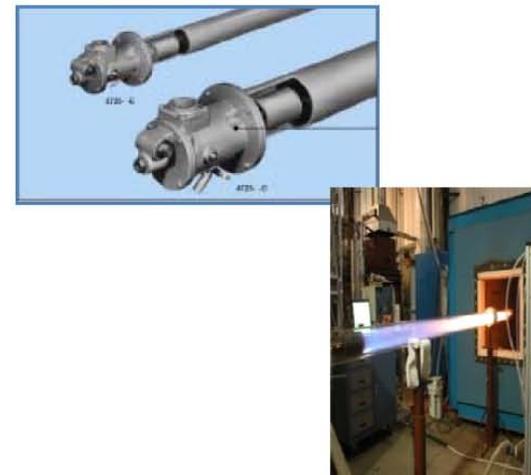
# IV. Major Accomplishments

## 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. Workshop Participant Question (CEC staff response in green)

- **Is the research on greenhouse gas emissions (e.g., climate change) correctly classified as smart infrastructure?**

The Environmental research area is cross cutting and currently is in all three areas: energy efficiency, renewable energy and smart infrastructure. For example, indoor air quality is under energy efficiency, while outdoor air quality is under smart infrastructure. Smart Infrastructure includes environmental research that is directly related to energy infrastructure, such as reducing methane emissions from natural gas pipelines.

- **Will the PIER advisory groups be expanded to include environmental or other areas?**

If deemed appropriate, a PIER Advisory Group or subgroup devoted to environmental research or other areas (e.g., transportation) could be assembled.

## VI. Workshop Participant Question (CEC staff response in green)

- The Goals and objectives for energy efficiency need to include research on low emission equipment/appliances, especially NOx and CO. Reduce NOx emissions is the #1 priority for Southern California.

**The Energy Related Environmental Research area plans to include a study to address this area. Please see slides 23 and 76.**

## VII. Proposed Funding Opportunities for FY 12/13 (project will be coordinated with Renewables Research area)

### **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)

## VII. Proposed Funding Opportunities for FY 12/13

### Quantifying Emissions from California's Natural Gas Energy Infrastructure

- **Description:** Use of natural gas CH<sub>4</sub> isotopic signatures, absence of radiocarbon <sup>14</sup>C, 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).

## VII. **NEW** Proposed Funding Opportunities for FY 12/13 (project to be coordinated with the Energy Efficiency Research)

### High Energy Efficiency, Low Emissions Combustion and Control Technology Development Program, Phase 1

- **Description:** As pressure intensifies to reduce emissions of air pollutants, even lower emissions combustion technologies and emission control devices will be required that are energy efficient.
- **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 while being energy efficient.
- **Rate payer benefits:** High efficiency and low emission units will result in energy savings for customers and will help improve air quality. 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.

## VIII. Proposed 2012/13 Budget

Initiative	Proposed FY 2012/13 Natural Gas Budget
<p><b>Energy Related Environmental Research</b></p> <ul style="list-style-type: none"> <li>• Air Quality Implications of biogas to replace natural gas: Phase 1 (see Note 1 ),</li> <li>• Quantifying emissions from California’s natural gas energy (see Note 2)</li> <li>• Infrastructure, High Energy Efficiency, Low Emissions Combustion and Control Technology Development –Phase 1 (see Note 3)</li> </ul>	<p><b>\$3,000,000</b></p>

Note 1: This project will be coordinated with the Renewable Energy Research area

Note 3: This project will be coordinated with the Smart Infrastructure Research area

Note 2: This project will be coordinated with the Building Energy Efficiency Research area

# 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 CO<sub>2</sub>e.

**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 CO<sub>2</sub>e 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

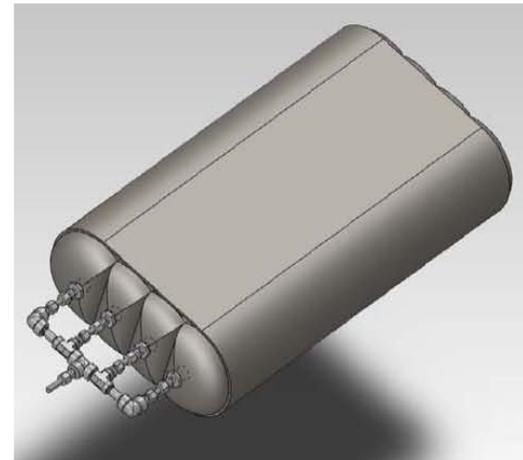
**Partner:** Southern California Gas Company

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

**Results:** Performance evaluation of 1<sup>st</sup> generation ANG tank, completed design for 2<sup>nd</sup> 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"> <li>Natural Gas Vehicle Efficiency</li> </ul>	NREL/SCAQMD joint project to develop, integrate, and demonstrate CNG engines.	<ul style="list-style-type: none"> <li>Contract start date of 6/30/11 and completion 6/30/14</li> </ul>
<ul style="list-style-type: none"> <li>Natural Gas Vehicle Efficiency</li> </ul>	Volvo Technology to develop a natural gas optimized advanced heavy duty engine concept.	<ul style="list-style-type: none"> <li>Project on schedule to complete on 6/30/2012</li> </ul>
<ul style="list-style-type: none"> <li>NG Infrastructure</li> </ul>	LNG Infrastructure improvement R&D Solicitation.	<ul style="list-style-type: none"> <li>RFP Released 1/6/2012</li> <li>Proposals due 2/17/2012</li> </ul>
<ul style="list-style-type: none"> <li>Advanced Bio Fuels</li> </ul>	NASA Ames researching growing algae in offshore membrane enclosures in ocean. Advances biosynthetic transportation fuel production.	<ul style="list-style-type: none"> <li>On schedule to complete 12/1/2012</li> </ul>
<ul style="list-style-type: none"> <li>Advanced Bio Fuels</li> </ul>	Solazyme develops the use of cellulosic biomass in algal biofuel. Enables an oil biomanufacturing process to use sustainable, non-food, cellulosic feedstocks.	<ul style="list-style-type: none"> <li>Project completed awaiting final report</li> </ul>

## VI. Workshop Participant Questions (CEC staff response in green)

- **Is there a minimum amount of natural gas funding for Natural Gas Vehicle research in SB 1250?**  
**No. SB 1250 states that PIER funds can be used to advance transportation technologies that reduce air pollution and greenhouse gas emissions beyond applicable standards, and that benefits electricity and natural gas ratepayers.**
- **Is there any effort being made to partner with the University at the state and community college level as well as automotive manufactures for projects?**  
**We currently have partners at UC Riverside, UC Berkeley, other California universities and the automotive industry.**

## VI. Workshop Participant Comments

(CEC staff response in green)

- **More research is needed in infrastructure opportunities in gas compression.**  
**PIER research is actively pursuing those opportunities as identified in the Natural Gas Vehicle Research Roadmap (NGVRR).**
- **More research needed to expand to medium and light duty. Look into home refueling appliances.**  
**The Advanced Natural Gas Tank research included in the 2012/13 Natural Gas Budget Plan will specifically target light duty vehicle application.**  
  
**Home refueling is identified in the NGVRR as a midterm priority, and PIER will pursue those opportunities as we work through the higher priority research initiatives.**

## VII. Proposed 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%

## VII. Proposed 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.

## VII. Proposed 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.

## VIII. Proposed 2012/13 Budget

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

## 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

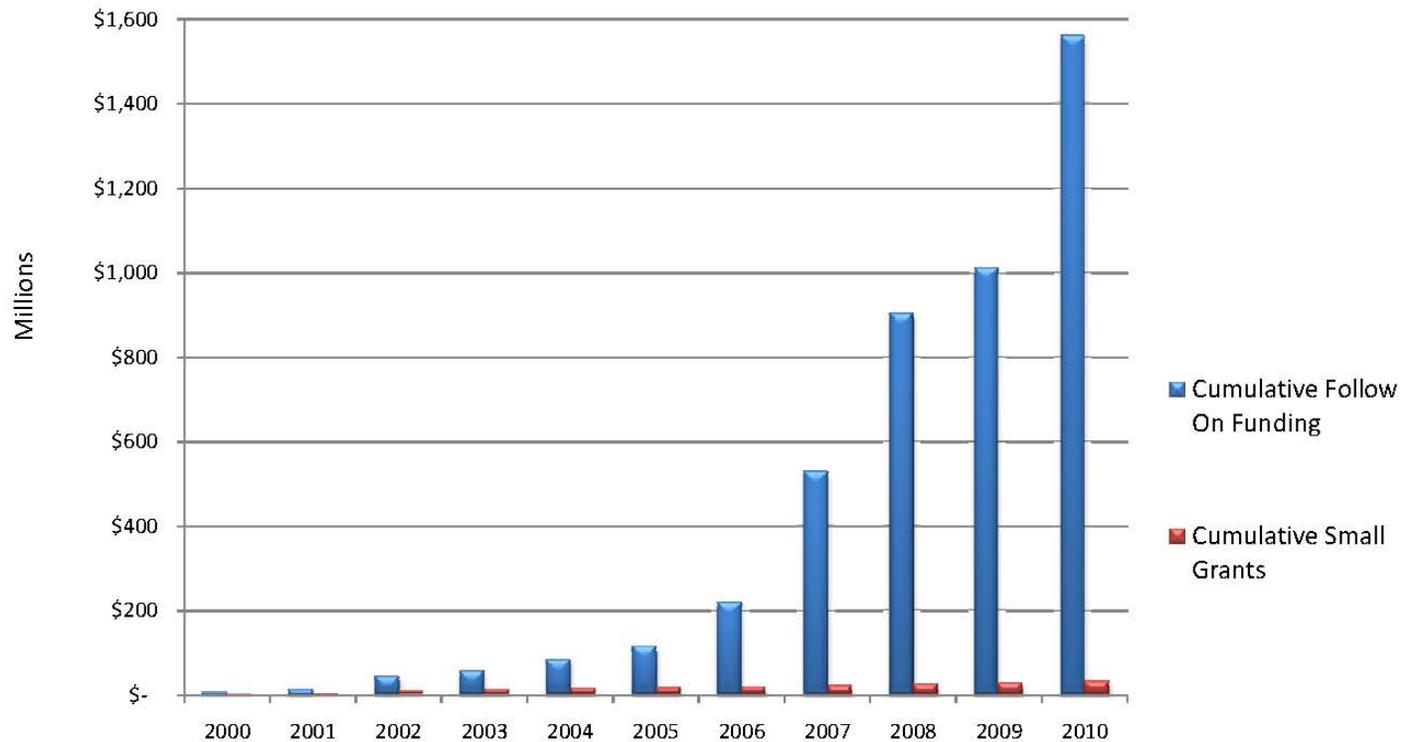
## II. General Approach

- 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

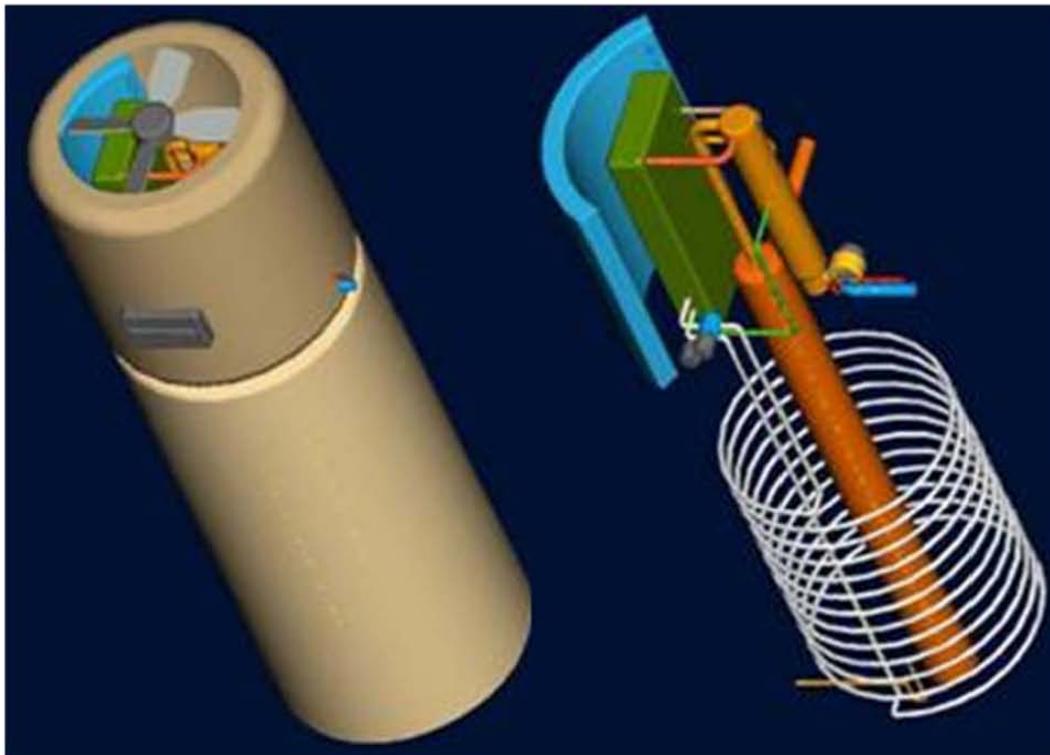
Name of Initiative	Description	Status
Innovative Concepts for Natural Gas	Natural Gas Energy Efficiency, Natural Gas Environmental Impacts, Renewable Energy Technologies, Advanced Generation Concepts, Alternative Fuels, Vehicle Technologies, and Transportation Systems	<ul style="list-style-type: none">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

## EISG has a History of Success in Helping to Attract Follow-on Funding for Grant Awardees



PIER Electricity-Related Small Grants Follow-on Funding

# Residential Gas-Fired Heat Pump Water Heater



Concept Heat Pump

Photo Credit: Stone Mountain Technologies, Inc.

## Advanced Low Temperature Natural Gas Combustion Using Turbulent Jet Ignition



**MAHLE Powertrain Engine Manufacturing Facility**

Photo credit: Advanced Low Temperature Natural Gas Combustion Using Turbulent Jet Ignition Grant Solicitation.

101

## IV. Workshop Participant Questions

(CEC staff response in green)

- **Where did the \$95,000 limit come from? I don't think \$95,000 is enough.**

The \$95,000 limit for hardware projects is set by the Energy Commission and was increased to this amount several years ago. The idea is to be high enough to generate interest, but low enough to minimize risk since these are proof of concept projects. The amount can be reevaluated in the future.

- **Is there a separate EISG solicitation for electricity and natural gas projects?**

Yes. We run separate solicitations for each. Projects must be submitted for either electric or natural gas. There is no split funding of projects (e.g., 50% electric and 50% natural gas)

## IV. Workshop Participant Comments

(CEC staff response in green)

- There is no research funding provided for projects between \$95,000 and \$1 million—lots of administrative paperwork can eat up to 1/3 of the money. **The proposals and application process are much more simplified than the normal PIER process. San Diego State University helps with the application process.**
- I had the opportunity to review proposals for the EISG program before and was impressed by the ideas I saw. I fully support this program. **Good to hear. This program gives small companies and individuals a chance for funding.**

## V. 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

## VI. Proposed 2012/13 Budget

<b>Initiatives</b>	<b>Proposed FY 2012/13 Natural Gas Budget</b>
<b>Energy Innovations Small Grant Program</b>	\$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

# Other Workshop Participant Comments/ Questions

(CEC staff response in green)

- Happy to see where PIER is going
- Like to see more graphics in the presentation
- Should encourage new companies in California to get involved
- Utilities should be involved in demonstrations, and co-planning **(Smart grid, renewables, energy storage, transportation and energy efficiency programs have involved utilities)**
- Need to describe the benefits methodology **(will include in the FY 12-13 Natural Gas Budget Report)**
- Difficult to find programs on website **(future reports on CEC website)**
- Does California preference extend beyond the EISG Program? **Yes**
- How does the California preference work? **Each solicitation requires minimum funding for California Based Entities and minimum funds to be spent in California. These are pass/fail requirements. If proposers specify higher amounts, then the scoring criteria allows us to provide higher scores for those that exceed the minimum levels.**

# 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](http://www.energy.ca.gov/research/annual_reports.html)

# **Appendix B – PIER Advisory Group Workshop – January 24, 2012**

## **Natural Gas Research Initiatives for 2012/13 Summary of Workshop Participant Questions and Comments with Energy Commission Staff Responses**

### **Energy Efficiency**

#### **Buildings Energy End-Use Efficiency/Industrial, Agricultural, and Water**

- 1. Why is solar thermal and solar water heating in energy efficiency and not renewable energy research?**

CEC Staff Response: The solar collector is part of a larger system including alternate hot water generation, distribution and space heating and is logical to include with building energy use systems.

- 2. When is the next funding solicitation for Building Efficiency? Will a workshop be held soon? Are there research and funding opportunities for building efficiency appliances, specifically in the areas of stoves, ovens and dryers?**

CEC Staff Response: A workshop is scheduled for February 23 to provide information on potential research topics. A solicitation is planned in the spring. Efficiency research targets new and improved products, energy efficient design, techniques and tools and improved performance and standards for buildings and equipment with a focus on benefits to electric and/or natural gas ratepayers. There may be research and funding opportunities for building efficiency appliances, such as stoves and ovens.

- 3. How should policy be affected by technology? For example, Title 24.**

CEC Staff Response: Data from research could be used in future standard proceedings (Title 24 or Title 20). For instance, results of PIER research have supported some aspects of the 2005 and 2008 building energy efficiency standards and the 2007 and 2010 appliance standards. PIER research results have identified ways to increase the energy and water efficiency of residential water heaters and hot water distribution systems. The research results for kitchen and underground pipe insulation were directly responsible for changes in the 2008 Residential Building Energy Efficiency Standards.

4. **What is the behavioral component of energy use? For example, hot water usage.**

CEC Staff Response: We have current research involving how hot water is used in homes; the effects of technologies, policies, community education and media campaigns to determine their influence on energy use behavior by individuals and households; and developing next generation models to improve understanding of residential natural gas demand. We have planned behavioral R&D on the use/programming of thermostats in homes.

5. **Energy modeling fits in small grants. Where does development of educational materials come from?**

CEC Staff Response: Training falls under utility incentive programs. Energy Commission's PIER program does not fund training. It has funded curriculum development for advanced energy efficiency technologies for HVAC technicians and operators, building commissioning technicians and managers; lighting curriculum for contractors, electricians, architects and engineers.

6. **Workshop participant comments on the presentation with CEC staff  
Comments, as appropriate:**

a) Goals and objectives for energy efficiency need to include research on low emission equipment/appliances, especially NO<sub>x</sub> and CO. Reduce NO<sub>x</sub> emission is #1 priority for Southern California.

CEC Staff Response: Already included and will continue. We have had discussions with the South Coast Air Quality Management District on low NO<sub>x</sub> furnaces. With respect to the industrial research program, one of the goals is to reduce energy consumption and air emissions (e.g., NO<sub>x</sub>). In addition, the Energy Related Environmental Research area plans to add project to address this area with combustion equipment that exceeds current energy efficiency standards.

b) Indoor and outdoor air quality issues should both be addressed. We need to pay attention to improving energy efficiency while improving air emissions.

CEC Staff Response: Agree. We believe it important to pay attention to emissions when we are looking at energy efficiency. The flex flame burner in the industrial efficiency research program is a good example. This burner reduced NO<sub>x</sub> emissions by 40%.

- c) I am concerned that credit isn't given for emissions reduction from energy efficiency. For instance no credit in emissions reduction is given to reducing Btus due to increased energy efficiency.
- d) Natural gas water heater research within the residential market should be encouraged. Low cost and low emissions would be nice.  
CEC Staff Response: Already included. For instance, the hybrid tankless water heater slide from the presentation is a product that is now coming onto the market which in part came out of PIER technical advisory group process.
- e) One of the major focus areas should include achieving net zero energy buildings  
CEC Staff Response: Agree
- f) Would like to see more research on cost effective solar thermal for water heating and space heating (low emission, high efficiency and reasonable cost-should be the goals)  
CEC Staff Response: Already included in both the building energy efficiency and the industrial, agriculture and water efficiency research areas. However, cost effectiveness for solar water heating is very challenging at today's energy cost.

## **Renewable Energy**

### **7. Which program area does biofuel and biomethane clean-up fall under?**

CEC Staff Response: Biofuel and biomethane projects are in three different PIER program areas: industrial, agriculture, and water (IAW); transportation research, and renewable energy. The first two are associated with customer applications and fuel substitutes. The renewable energy element focuses on advancing biomass power generation, biochemical conversion processes and on biogas cleanup technology. Two project examples under this program were provided during the presentation (Gills Onion and SMUD project on siloxane).

### **8. Has there been funding opportunities emphasizing in-state-directed biogas?**

CEC Staff Response: Last year, one of the Industrial Agriculture and Water efficiency solicitation areas was advanced biogas technologies for agriculture and wastewater operations.

9. **In regards to the SMUD/CHA project, what level is being reduced, such as parts per million level of siloxane? Is it a pilot program? Any other locations where technology is installed? Size of facility in terms of cubic feet per day?**

CEC Staff Response: The concentration of siloxanes in the biogas varied from 18.25 ppm to 3.55 ppm. This project was able to remove 79% of the siloxanes in the biogas; during the field test they were able to reduce the siloxane concentration from 7.3 ppm to 1.53 ppm. By making a few changes including change in the biogas flow rate, it is possible to potentially remove 99% of the siloxanes. This is a bench-scale system, not a commercial ready product. We are unaware of any other installations.

10. **Comments on Presentation:**

- a) I would like to see cofunding partners listed in these presentations.

CEC Staff Response: Projects funded by the PIER program receive co-funding from many different entities, including SoCalGas. For the specific projects highlighted during the presentations, project partners were shown.

- b) I recommend that the California Energy Commission provide funding opportunities for the development of kelp as a biomass resource.

CEC Staff Response: Our past solicitations have been broad enough to include kelp as a biomass resource. Funding amounts are specified in competitive solicitations and these solicitations do not single out specific feedstocks such as kelp. Future solicitations will depend on the CPUC's decision on project scope for Renewable and Transportation research.

## **Smart Infrastructure**

### **Natural Gas Pipeline Integrity**

11. **How coordinated is PIER with Sempra's program? Are other stakeholders included?**

CEC Staff Response: We are coordinated with Sempra, especially with pipeline integrity research. Sempra and others are involved in our PIER contracts' Technical Advisory and Project Advisory Committees.

12. **I am glad to see safety and reliability research being done. I agree that PIER would want to see results before pouring more money in. How is duplication of work avoided?**

CEC Staff Response: PIER staff coordinates with GTI, utilities and others to ensure no research duplication. PIER staff encourages participation and monitoring by stakeholders to additionally inform us of any related research efforts.

13. **What is the status and timeline on the Gas Technology Institute and University of California pipeline integrity projects?**

CEC Staff Response: Expect completion of work in 1<sup>st</sup> quarter of 2013. The Commission will hold a public workshop in early summer of 2012 to get feedback on the research and provide direction. A second workshop will be held in the 1<sup>st</sup> quarter of 2013 to share the results of this research.

14. **Comments on Presentation:**

- a. Pipeline monitoring and safety needs to be integrated.

CEC Staff Response: We agree. Safety is included in policy drivers.

- b. Gas industry and the Energy Commission should coordinate together. \$1M is not enough funding.

CEC Staff Response: We are coordinated (see response to questions 11 and 12). The \$1 million proposed for FY 12/13, will be combined with the \$1 million from FY 11/12 for a total of \$2 million. We would like to see results from \$2 million before requesting additional funds.

## **Energy Related Environmental and Climate Change Research**

15. **Is Greenhouse gas (GHG) emissions properly classified as smart infrastructure?**

CEC Staff Response: The Environmental research area is cross cutting and currently is in all three areas: energy efficiency, renewable energy and smart infrastructure. For example, indoor air quality is under energy efficiency, while outdoor air quality is under smart infrastructure. Smart Infrastructure includes environmental research that is directly related to energy infrastructure, such as reducing methane emissions from natural gas pipelines.

16. **Will the PAG be expanded to separate out Environmental and other areas?**

CEC Staff Response: If deemed appropriate, a PIER Advisory Group or subgroup devoted to environmental research or other areas (e.g., transportation) could be assembled.

17. **The goals and objectives for energy efficiency need to include research on low emission equipment/appliances, especially low NOx and CO. Reduce NOX emissions is #1 priority for Southern California.**

CEC Staff Response: As a result of the workshop, the Energy Related Environmental Research area plans to include a study to address this area. See response to question 6.

### **Natural Gas Related Transportation**

18. **Is there a minimum amount of natural gas funding for Natural Gas Vehicle research in SB 1250?**

CEC Staff Response: No. SB 1250 states that PIER funds can be used to advance transportation technologies that reduce air pollution and greenhouse gas emissions beyond applicable standards, and that benefits electricity and natural gas ratepayers.

19. **Is there any effort being made to partner with the University at the state and community college level as well as automotive manufactures for projects?**

CEC Staff Response: We currently have partners at UC Riverside, UC Berkeley, other California universities and the automotive industry.

Automotive Original Equipment Manufacturers (OEMs) often participate on Project Advisory Committee (PAC) teams for PIER funded transportation projects. For instance, Ford Motor Company has two members on the Advanced Natural Gas Tank project which was included in the presentation.

20. **Comments on Presentation:**

a. More research is needed in infrastructure opportunities in gas compression.

CEC Staff Response: PIER research is actively pursuing those opportunities as identified in the Natural Gas Vehicle Research Roadmap (NGVRR).

- b. More research needed to expand to medium and light duty. Look into home refueling appliances.

CEC Staff Response: The Advanced Natural Gas Tank research included in the 2012/13 Natural Gas Budget Plan will specifically target light duty vehicle application.

Home refueling is identified in the NGVRR as a midterm priority, and PIER will pursue those opportunities as we work through the higher priority research initiatives.

### **Energy Innovation Small Grant (EISG) Program**

21. **Where did the \$95,000 limit come from? I don't think \$95,000 is enough.**

CEC Staff Response: The \$95,000 limit for hardware projects is set by the Energy Commission and was increased to this amount several years ago. The idea is to be high enough to generate interest, but low enough to minimize risk since these are proof of concept projects. The amount can be reevaluated in the future.

22. **Are all EISG projects related to natural gas? It is important that all projects are properly tracked. Is there a separate solicitation for Electricity and Natural Gas?**

CEC Staff Response: Yes. We run separate solicitations for each. Projects must be submitted for either electric or natural gas. There is no split funding of projects (e.g., 50% electric and 50% natural gas)

23. **Comments on the presentation:**

- a. There is no research funding provided for projects between \$95,000 and \$1 million—lots of administrative paperwork can eat up to 1/3 of the money.

CEC Staff Response: The proposals and application process are much more simplified than the normal PIER process. San Diego State University helps with the application process.

- b. I had the opportunity to review proposals for the EISG program before and was impressed by the ideas I saw. I fully support this program.

CEC Staff Response: Good to hear. This program gives small companies and individuals a chance for funding.

## Comments on Guest Presentations

24. **What is the best way to collaborate with DOE?**

William Miller of DOE stated that Alexis Abramson, Acting Supervisor for Emerging Technologies would be the best choice and to send him courtesy copy email as Alexis Abramson wants him involved.

25. **Is the \$10M identified by Sempra for any research or just cost-sharing for PIER projects?**

Both. Sempra funds independent projects and helps support PIER projects.

## General Comments

- I am happy to see where PIER is going.
- I would like to see some graphics for visual learners at the end of each presentation.
- You should encourage new companies in California to get involved.
- Demonstrations and involvement of utilities is good. Would like to see more co-planning with utilities.

CEC Staff Response: Smart grid, renewable, energy storage, transportation and energy efficiency programs have involved utilities.

- Need to describe the benefits methodology

CEC Staff Response: Will include in 2012/13 *Natural Gas Budget Report*

- Difficult to find Natural Gas Budget and Annual Report on website.

CEC Staff Response: Future reports will be available on the CEC website

## Questions and Comments received by February 2, 2012

26. **Does California preference extend beyond EISG?**

CEC Staff Response: Yes. Our current solicitations require at least 60 percent of the PIER funds go to a California Based Entity and that at least 60 percent of the funds be spent in California. An example is PON-11-507: Hybrid Generation and Fuel-flexible Distributed Generation/Combined Heat and Power/Combined Cooling, Heat and Power (DG/CH&P/CCH&P) Systems. You can view the application at: <http://www.energy.ca.gov/contracts/pier.html#adGeneration>

27. **How does the California preference work?**

CEC Staff Response: Each solicitation requires minimum funding for California Based Entities and minimum funds to be spent in California. These are pass/fail requirements. If proposers specify higher amounts, then the scoring criteria allows us to provide higher scores for those that exceed the minimum levels. To see how this is handled in the scoring criteria and the assigned weighting factor, please see Attachment G of the above referenced solicitation which can be viewed at:

[http://www.energy.ca.gov/contracts/PON-11-507/07-ATTACHMENT G Proposal Screening and Scoring Criteria \(skw 12-29-11\).pdf](http://www.energy.ca.gov/contracts/PON-11-507/07-ATTACHMENT G Proposal Screening and Scoring Criteria (skw 12-29-11).pdf)

28. **Are the FY 12/13 Natural Gas funding opportunities in each presentation for future, proposed areas or is it related to currently funded research?**

CEC Staff Response: The Funding Opportunities PowerPoint slides are proposed funding for FY 12/13. To learn more about upcoming solicitations, please register on the Energy Commission's listserve page (<http://www.energy.ca.gov/listservers/index.html>) and select the areas of interest (e.g., Opportunities under the Commission General List, Research and Development List).

29. **Funding opportunities for the development of kelp (see response to item 10 c, page 5):**

Through WebEx, I observed the workshop on Natural Gas Research Initiatives held on January 24, 2012. Thank you to the staff for making the workshop remotely accessible and for providing the power point presentations.

The workshop devoted very little time to discussing methods to replace fossil natural gas with carbon-neutral substitutes, which, based on the legislation cited, is an important priority.

Our company, Marine BioEnergy, Inc., is researching and developing California giant kelp (*Macrocystis pyrifera*) as a biomass feedstock. If grown in the open ocean, enough kelp will be available to replace the natural gas now used by the State of California and most of the nation.

Kelp was extensively researched by the U.S. Navy (working with the American Gas Association, Caltech Professor Wheeler North and others) during the 1970s. In particular, the U.S. Navy research showed that kelp left in huge vats will naturally degrade to biogas that can be processed into biomethane.

I recommend that the California Energy Commission provide funding opportunities in the range of \$2 million. These opportunities need to be broad enough to include the development of kelp as a biomass resource.

The Pacific Northwest National Laboratory (U.S. Dept of Energy Laboratory) did a 2008 literature survey of kelp as a potential biomass feedstock. The Abstract finishes with, "In conclusion, macroalgae, i.e., seaweeds, represent an unrealized biomass potential to meet future societal needs for renewable energy and biobased products."(1)

Because of our proximity to the Pacific Ocean, California has the potential to meet its own energy needs and to become a major exporter of carbon-neutral energy. The following summarizes the key attributes of California giant kelp that make it an attractive biomass feedstock.

### **Why choose California giant kelp (*Macrocystis pyrifera*) as a biomass feedstock?**

California giant kelp has numerous advantages when farmed in the open ocean:

- Does not compete with agriculture for land.
- Does not compete for fresh water.
- Does not compete for fertilizer since deep ocean nutrients are used.<sup>87</sup>
- Is relatively easy to process because it has no lignin and little cellulose.<sup>88</sup>
- Is fast-growing<sup>89</sup> at ~30 cm/day, and average photosynthetic efficiency of aquatic biomass is 6-8 percent, which is higher than terrestrial biomass at 1.8-2.2 percent.<sup>90</sup>
- Has a nondestructive harvest, leaving the base of the plant in place to grow further.
- Is not seasonal, and can be harvested 3-4 times per year.<sup>91</sup>

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<sup>87</sup> Roesijadi, G., A.E. Copping, M.H. Huesemann, J. Forster, and J.R. Benemann, *Techno-Economic Feasibility Analysis of Offshore Seaweed Farming for Bioenergy and Biobased Products*, Independent Research and Development Report, IR Number PNWD-3931, Battelle Pacific Northwest Division, March 31, 2008, pp 4-5.

<sup>88</sup> Ross, A.B, J.M. Jones, M.L. Kubacki, and T. Bridgeman, "Classification of macroalgae as fuel and its thermochemical behavior", *Bioresource Technology* 99, 2008, pp6494-6504. See p 6497, and 6500-6501.

<sup>89</sup> North, Wheeler J., ed. *The Biology of Giant Kelp Beds (Macrocystis) in California*, Verlag Von J. Cramer, publishers, Lehre, Germany 1971, Chapter 4 - Photosynthesis and general development in *Macrocystis* by Clendenning, K.A., p189.

<sup>90</sup> Ross, 2008, page 6494.

<sup>91</sup> Bird, K.T. and Benson, P.H. Eds, *Seaweed Cultivation for Renewable Resources Developments in Aquaculture and Fisheries Science*, Vol 16, Elsevier Amsterdam NL, 1987, p83.

- Demonstrated yields at >15 dry ash free tons per acre per year with individual plants producing three times the average 15 ton yield.<sup>92</sup>
- Has coproducts such as potash, iodine and bromine with commercial value that can contribute to early revenue streams.<sup>93</sup>
- By converting approximately 1 watt/m<sup>2</sup> of sunlight into stored chemical energy (24/7 average), can expand to supply all the energy requirements of the projected peak world population at the current U.S. per capita rate of consumption.

CEC Staff Response: See response to question 10 b.

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<sup>92</sup> Tompkins, A.N., Marine Biomass Program, Annual Report, January - December 1982, for Gas Research Institute Contract No. 5081-323-0452, March 1983, page 6-1/6-2.

<sup>93</sup> Tompkins, A.N., 1983, page 5.5-12.