

CALIFORNIA
ENERGY
COMMISSION

**PUBLIC INTEREST ENERGY
RESEARCH PROGRAM,
NATURAL GAS**

**Proposed Program Plan and Funding
Request for Fiscal Year 2008-2009**

STAFF REPORT

April 2008
CEC-500-2008-027



CALIFORNIA ENERGY COMMISSION

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Please use the following citation for this report:

Birkinshaw, Kelly, Gerald Braun, Michael Gravely, Ken Koyama, Martha Krebs, Promod Kulkarni, David Michel, Daryl Mills, Philip Misemer, Art Soinski. 2008. *Public Interest Energy Research Program, Natural Gas: Proposed Program Plan and Funding Request for Fiscal Year 2008-2009*. California Energy Commission, PIER Natural Gas Program. CEC-500-2008-027

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Abstract

This report is the budget plan for the Public Interest Energy Research Natural Gas Program for the fiscal year 2008-2009. The *2008-2009 Natural Gas Budget Plan* uses the framework of the five-year *PIER 2007-2011 Natural Gas Research Investment Plan*, which responds to and develops future state policy regarding natural gas issues. It also reflects recent state energy policy guidance from: Senate Bill 76 (Committee on Budget and Fiscal Review, Chapter 91, Statutes of 2005); Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007); Senate Bill 1250 (Perata, Chapter 512, Statutes of 2006); the *2007 Integrated Energy Policy Report*; and research and development recommendations from the *2008 Energy Action Plan Update*.

The PIER natural gas research 2008-2009 Budget Plan, the fourth since 2005, complements similar annual plans prepared by PIER for electricity research and was developed by Energy Commission. It represents the thoughts and opinions of environmental concerns; industry perspectives and dozens of other key stakeholders, both within and outside the Energy Commission obtained through meetings, interviews, workshops, and on-line requests for recommendations.

Keywords: Public Interest Energy Research, PIER, PIER NG, Public Interest Energy Research development and demonstration, natural gas, research investment plan, buildings, appliances, HVAC, environment, transportation, alternative fuels

Executive Summary

The Public Interest Energy Research—Natural Gas Program (PIER NG) was established in 2004 responding to Decision 04-08-010 from the California Public Utilities Commission (CPUC) to administer research and development activities that benefit California’s natural gas utility ratepayers. That decision also designated the California Energy Commission (Energy Commission) as administrator of PIER NG. This 2008-2009 *NG Budget Plan* defines the plan and budget for PIER NG efforts for fiscal year (FY) 2008-2009.

The budget plan described in this report is based¹ primarily on three guiding documents: the *2007-2011 Natural Gas Research Investment Plan*, the *2007 Integrated Energy Policy Report (2007 IEPR)*, and the *2008 Energy Action Plan Update*. The *2007-2011 Investment Plan* defines long-term strategic research objectives and is based on energy policy, energy trends and drivers, environmental policy, and stakeholder input. The *2007 IEPR* describes current state energy policy, including guidance on natural gas research issues that support near-term objectives and foundational science to formulate future energy policy. The *Energy Action Plan Update*, jointly prepared by the Energy Commission and the CPUC, identifies natural gas research and development priorities.

This budget plan is organized around five research areas that align the long-term objectives of PIER NG with the short-term annual research budget. The research areas are:

1. *Affordable, Comfortable, and Energy Smart Choices for Daily Life and a Strong California Economy*: Research in this area aims to improve the daily energy consumption practices of California ratepayers by addressing energy efficiency for utility operations, the food services sector, and heating systems in residential and commercial buildings. Research will also analyze energy policy to guide California’s long-term economic growth.
2. *Clean and Diverse Supply That Optimizes California’s Resources*: This area includes research to assess and develop technologies that enable renewable resource-fueled processes to be substituted for natural gas-using processes. Relevant technologies include solar thermal power plant storage, solar thermal cooling, solar process heating, and various biomass and geothermal energy applications that harness California’s renewable resources and reduce natural gas dependencies. Other research will focus on clean combustion technology, as follow-up to earlier PIER NG work.
3. *Clean and Diverse Transportation System*: The research in this area addresses transportation infrastructure, engine technology, and the use of alternative fuels, with the goal of reducing dependence on petroleum.
4. *Integrated Natural Gas System That Is Reliable and Secure*: This area includes research on sensors and controls to help optimize the industrial sector’s natural gas operations. It also includes research to develop tools and models that improve natural gas storage

¹ Other important energy policy guidance is derived from: Senate Bill 76 (Committee on Budget and Fiscal Review, Chapter 91, Statutes of 2005); Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007); Senate Bill 1250 (Perata, Chapter 512, Statutes of 2006).

infrastructure in California and increase storage capacity, ensuring a more reliable supply and temper price volatility.

5. *Environmentally Sound Natural Gas System*: This area proposes research aimed at identifying and reducing environmental impacts of natural gas use including nonstandard gas supply (for example, liquefied natural gas). It includes methodological research to improve analytical methods for measuring pollutants. Examples include a field study to develop greenhouse gas emissions factors for natural gas distribution equipment (for example, pipeline, and compressors), an assessment of emissions measurement methods, and exploration of industrial process modifications to improve air quality and help meet greenhouse gas reduction targets set by Assembly Bill 32 (AB 32, Núñez, Chapter 488, Statutes of 2006, the California Global Warming Solutions Act of 2006).

The Energy Commission intends to spend \$21 million for PIER NG - related work for FY 2008-2009. Of this budget, \$16.9 million is allocated to the research outlined initiatives and while \$1 million is marked for the Energy Innovation Small Grants Program (ESIG), which funds feasibility studies for emerging natural gas technologies. The remaining \$3.1 million is provided for administration costs, including technical assistance and personnel.

The proposed FY 2008-2009 natural gas research budget is summarized in Table 1.

Table 1: FY 2008-2009 Program Budget Summary

Budget Item	2008-09 Budget
Research Areas	
1. Affordable, comfortable, and energy-smart choices for daily life	\$5,050,000
2. Clean and diverse energy supply that optimizes California's resources	\$2,950,000
3. Clean and diverse transportation system in California	\$6,000,000
4. Integrated natural gas system that is reliable and secure	\$675,000
5. Environmentally sound energy system in California	\$2,225,000
Sub-Total Research Areas	\$16,900,000
Energy Innovation Small Grants	\$1,000,000
Program Administration and Management	\$3,100,000
Total	\$21,000,000

Source: California Energy Commission Staff

CHAPTER 1:

2008-2009 NG Research Budget Plan Overview

The *Public Interest Energy Research – Natural Gas Program (PIER NG) 2008-2009 Budget Plan (NG Budget Plan)* uses the framework of the *2007-2011 Natural Gas Research Investment Plan (2007-2011 Plan)*, guidance provided by the *2007 Integrated Energy Policy Report (2007 IEPR)* and the *2008 Energy Action Plan Update*. The *2007-2011 Plan* defines the long-term strategic objectives for PIER NG, and is based on energy policy objectives, energy trends and drivers, and stakeholder input. The *2007 IEPR* describes current state energy policy, including direction on natural gas research issues to support near-term objectives and inform future energy policy. The *Energy Action Plan Update* makes natural gas research and development recommendations that will help the state meet long-term greenhouse gas goals.

The 2007-2011 NG Research Investment Plan Summary

Senate Bill 76² (Sections 901 [b] and [c]), requires the Energy Commission and California Air Resources Board (ARB) to jointly develop a strategic research plan. The *2007-2011 Plan* was developed to fulfill this legislative mandate and provide a framework for co-planning the program for future years. Moreover, ARB staff has a key role in implementing the annual plans within the *2007-2011 Plan*. ARB staff also provides advice and insights in workshops, the development of research roadmaps, defining the scope of research projects, and in some cases management of specific research projects on behalf of the Energy Commission. For example, ARB was a critical partner with the Energy Commission in developing a natural gas vehicle (NGV) research roadmap.

The Energy Commission coordinated the content and direction of the *2007-2011 Plan* with the *PIER Electricity Five-Year Plan*. The team responsible for the *2007-2011 Plan* consisted of eight key PIER staff members representing the relevant research and development (R&D) topic areas. Additional perspectives from key stakeholders, within and outside the Energy Commission, were obtained from numerous interviews and multiple workshops. For each R&D issue, PIER NG staff and constituents defined strategic objectives to accomplish during the next five years (Table 2).

Table 2: Key Issues and Objectives for the 2007-2011 Natural Gas Research Investment Plan

² <http://www.leginfo.ca.gov/bilinfo.html>

Key Energy Issue	Strategic Objectives
1. Affordable, comfortable, and energy-smart choices for daily life and a strong California economy	<ul style="list-style-type: none"> a) Reduce cost and improve performance of efficiency systems for buildings and industrial processes. b) Develop energy-efficient technologies for unique California conditions. c) Develop knowledge base for future decision-making and informed end-use policy relative to natural gas.
2. Clean and diverse natural gas supply that optimizes California's resources	<ul style="list-style-type: none"> a) Facilitate and encourage importation of liquefied natural gas (LNG). b) Facilitate and encourage the increase of in-state natural gas supplies. c) Develop technologies to produce natural gas from alternative sources. d) Develop renewable energy technologies to replace use of natural gas. e) Develop knowledge base for future decision-making and informed supply policy relative to natural gas.
3. Clean and diverse transportation system in California	<ul style="list-style-type: none"> a) Identify advanced transportation research opportunities that optimize the goals of reducing petroleum dependence, enhancing energy and economic security, and expanding environmental and public health benefits. b) Develop and demonstrate technologies to improve efficiency within the transportation system. c) Develop and demonstrate alternative fuels, vehicles and fueling infrastructure. d) Develop the knowledge base and advanced analytical tools for future decision-making and informed transportation policy.
4. Integrated natural gas system that is reliable and secure	<ul style="list-style-type: none"> a) Develop natural gas storage technologies. b) Improve safety and security of production, storage, delivery, and use. c) Develop tools and analysis to improve efficiency of natural gas markets. d) Reduce peaks for improved asset use. e) Understand and address impacts of LNG on natural gas infrastructure and related interchangeability issues. f) Develop knowledge base for future decision-making and informed delivery, integration, and infrastructure policy relative to natural gas.
5. Environmentally sound natural gas system in California	<ul style="list-style-type: none"> a) Understand the nature/significance of climate change and its relationship to natural gas and develop strategies for greenhouse gas reduction and impacts mitigation/adaptation. b) Develop solutions for reducing biological, land use, air quality, and water-related impacts of natural gas production, storage, delivery, and use and contribute to a sustainable energy future. c) Develop emission control technologies for gas combustion. d) Develop knowledge base for future decision-making and informed environmental policy relative to natural gas.

Source: California Energy Commission Staff

The PIER NG Program supports state energy policy and technology development and, as such, is legislatively mandated to perform only public interest energy research. To meet this mandate, PIER developed a set of screening criteria³ for electricity and natural gas research that could be used in selecting potential projects across the different program areas. These criteria are consistent with Energy Commission and CPUC definitions used in electricity R&D funding.

The PIER NG Program and its portfolio of research and development investments should bring substantial benefits to Californians, including lower energy costs achieved through more efficiency, the improved use and performance of the NG delivery system, and a cleaner, more environmentally friendly energy system, based on renewable and alternative energy sources, that is cost-competitive with traditional natural gas resources.

³ There are three tests designed to make research consistent with SB 76: (1) Does the research seek to improve the affordability of energy services and products? Or (2) Does the research seek to improve the safety and/or reliability of energy services and products? Or (3) Does the research seek to reduce the environmental impact of energy services and products? As noted in a talk given by Dr. Martha Krebs in December 2005. For more info go to <http://www.cpuc.ca.gov/puc/energy/electric/energy+action+plan>

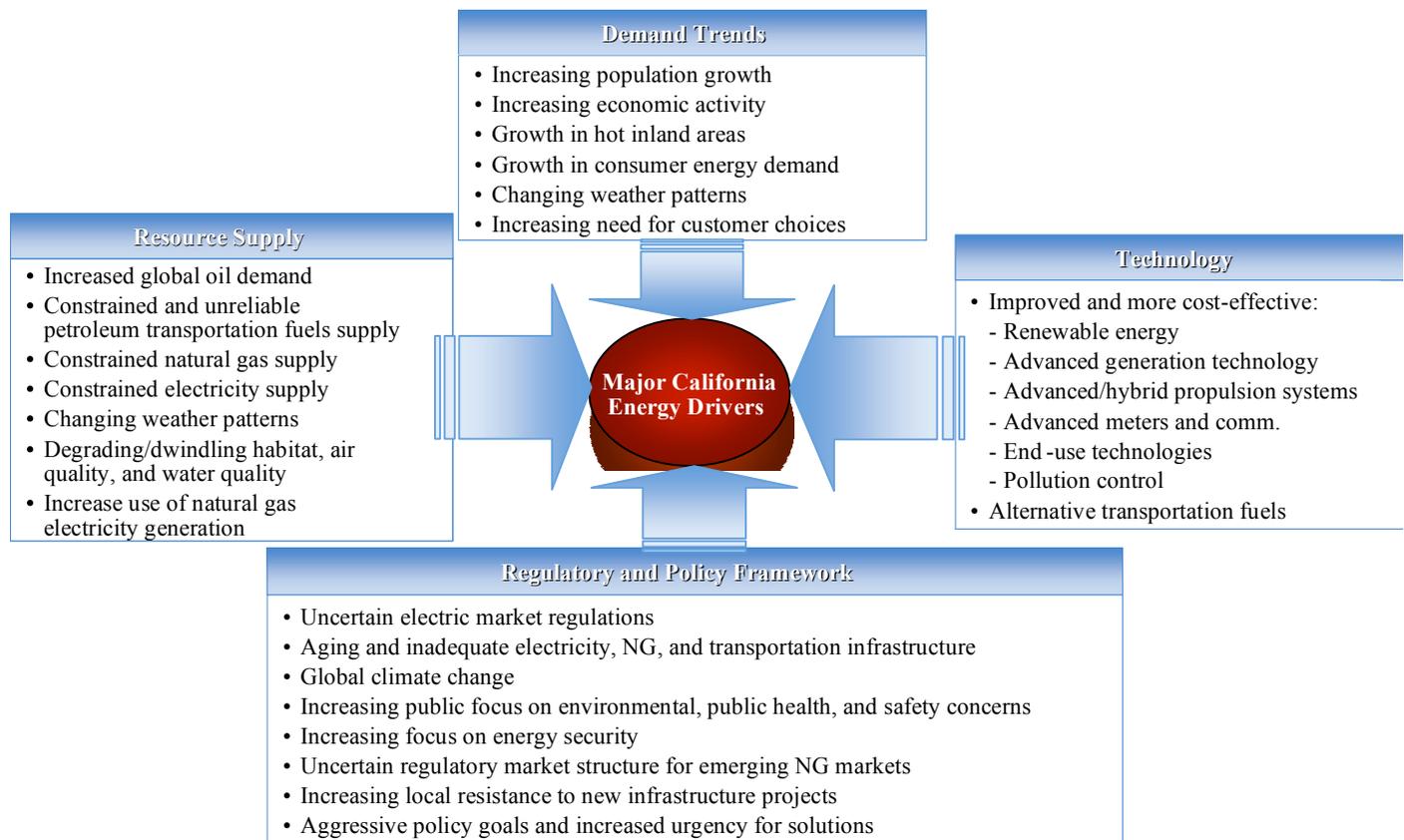
Other potential benefits include more reliable energy service, reduced health risks from poor indoor and outdoor air quality, a reduced environmental footprint from the energy infrastructure, reduced biological impacts, and reduced impacts from climate change.

Stakeholders Help Define Trends and Drivers

The 2007-2011 Plan is a culmination of hundreds of stakeholder interviews and meetings and reflects the knowledge and opinions of dozens of individuals from a broad range of groups.

Their perspectives defined several societal and technical trends and drivers (Figure 1).

Figure 1: California Energy Trends and Drivers



Source: 2007-2011 Natural Gas Investment Plan – 500-2006-017-CMF

The PIER NG staff and constituents were as systematic and inclusive as possible in defining the program’s strategic objectives and selection of specific projects with emphasis on the major trends and driving forces likely to shape energy supply and demand over the next 15 to 20 years.

The 2007 IEPR Guides NG Research

Energy Commission staff incorporated recommendations made in the 2007 IEPR⁴ to the FY 2008-2009 PIER NG R&D priorities. The 2007 IEPR was written in response to Senate Bill 1389 (Bowen, Chapter 568, Statutes of 2002) requiring the Energy Commission prepare a biennial integrated energy policy report containing an assessment of major energy trends and issues facing the state's electricity, natural gas, and transportation fuel sectors. In addition, the 2007 IEPR offered recommendations on major issues facing the California energy sector such as climate change, increasing demand, and policy targets. The 2007 IEPR, adopted by the Energy Commission on December 5, 2007, reflects the input of numerous public and private stakeholders and federal, state, and local agencies that participated in the IEPR proceeding. The Energy Commission held nearly 50 public workshops and hearings where staff and participants presented information and recommendations. Approximately 70 supporting reports were published on the Energy Commission Web-site and received hundreds of public comments.

Chapter 6 of the 2007 IEPR covers the natural gas resource constraints in California and outlines several major issues of California's natural gas sector including dependence on imports, growing demand, price fluctuations, and AB 32 policy goals. The *NG Budget Plan* addresses these concerns when allocating its R&D budget. It also addresses specific 2007 IEPR recommendations regarding policy, renewable energy resources, energy efficiency, demand, and meeting greenhouse gas reduction targets.

Natural Gas Supply

The 2007 IEPR advocates policies that allow California to secure alternative and diverse sources of natural gas to meet growing demand and energy security options, such as, liquefied natural gas (LNG) facilities on the West Coast. As a result, PIER NG is working to assess the quality and interchangeability of LNG to determine environmental and performance impacts.

Energy Efficiency

The 2007 IEPR supports all cost-effective energy efficiency measures for natural gas and encourages pursuing energy efficiency improvements through increased natural gas R&D. As a result of this, PIER NG is looking to increase the energy efficiency of existing building systems and industrial processes. Examples include the reduction and optimization of hot water use in residential, commercial, and industrial operations. PIER NG is also working to develop energy efficient end-use technologies and strategies for unique California conditions and industries.

Renewable Energy Sources

The 2007 IEPR adopts a "loading order" that encourages utilities to consider low-carbon fuels before conventional sources of natural gas, including renewable sources of energy to generate electricity, and sources that directly displace natural gas (for example, solar for water and space heating, and pipeline-quality injected biogas). PIER NG is working to reduce the cost of and improve the performance of solar thermal, biogas, and geothermal technologies to replace natural gas.

⁴ http://www.energy.ca.gov/2007_energypolicy/index.html

GHG Emission Reduction Targets

The 2007 IEPR recommends incorporating new analytical tools such as scenario planning and portfolio analysis in assessing and forecasting the state's natural gas supplies and demand to meet reduced greenhouse gas emission targets. PIER NG is supporting this effort by funding research to understand consumer behavior and market issues.

The 2008 Energy Action Plan Update Guides NG Research

The *NG Budget Plan* incorporated recommendations from the *2008 Energy Action Plan Update*⁵. In 2003, the Energy Commission, the CPUC, and the California Power Authority adopted an Energy Action Plan that was a post-energy-crisis call-to-action. It articulated a single, unified approach to meeting California's electricity and natural gas needs. In 2005, the Energy Commission and the CPUC adopted a second plan, Energy Action Plan II, to reflect the policy changes and actions of the next two years. In February 2008, using the information and analysis prepared for the 2007 IEPR, and the recent CPUC decisions, the Energy Commission and the CPUC prepared an "update" that examines the state's ongoing actions in the context of global climate change.

The *2008 Energy Action Plan Update* concludes that to meet long-term greenhouse gas goals, California will likely require the development of new technologies in the following areas:

- Energy efficiency technologies
- Renewable generation
- Clean fossil generation (including carbon capture and sequestration)
- Transportation fuels and vehicles
- Bioenergy

The *2008 Energy Action Plan Update* emphasizes that it is necessary to demonstrate the feasibility of these new technologies. It also expects PIER NG to conduct R&D in other areas, including: LNG quality and interchangeability, solar thermal technologies, natural gas storage impacts and conditions necessary for investment, efficient interface of electricity and natural gas infrastructure, improved technologies and tariffs for demand response, and reducing greenhouse gas emissions associated with natural gas.

Developing the 2008-2009 NG Budget Plan

The Public Interest Energy Research (PIER) Program defined research priorities for the *NG Budget Plan* that reflected the *2007-2011 Plan* objectives, policy guidance defined in the 2007 IEPR and R&D recommendations included in the *2008 Energy Action Plan Update*. As part of the annual budgeting process, PIER revisited and adjusted its portfolio of short-medium-and long-term research projects to reflect these priorities. Additionally, detailed roadmaps were developed that translate research plans into solicitations and research projects.

⁵ Available on-line at <http://www.energy.ca.gov/2008publications/CEC-100-2008-001/CEC-100-2008-001.PDF>

The PIER NG Program continuously monitors the trends and drivers that shape the energy sector. It also follows emerging policy and technology issues by adjusting its short- and long-term research objectives accordingly. As a result, the *NG Budget Plan* altered its investment priorities to mirror these trends within the framework of environmentally sound, safe, reliable, and affordable energy.

CHAPTER 2:

The 2008-2009 Budget Plan and Research Areas

The proposed 2008-2009 *NG Budget Plan* (*NG Budget Plan*) is \$21 million, and includes program administration, small grants, and research project funding. Of this amount, \$16.9 million will be spent on the specific research areas (Table 3).

Table 3: FY 2008-2009 Natural Gas Research Program Plan Budget Summary

Budget Item	'08-09 Budget
Research Areas	
1. Affordable, comfortable, and energy-smart choices for daily life	\$5,050,000
2. Clean and diverse energy supply that optimizes California's resources	\$2,950,000
3. Clean and diverse transportation system in California	\$6,000,000
4. Integrated natural gas system that is reliable and secure	\$675,000
5. Environmentally sound energy system in California	\$2,225,000
Sub-Total Research Areas	\$16,900,000
Energy Innovation Small Grants	\$1,000,000
Program Administration	\$3,100,000
Total	\$21,000,000

Source: California Energy Commission Staff

The *NG Budget Plan* reflects current state energy policy and incorporates emerging issues from energy trends and drivers, as identified in the *2007-2011 Plan*, including the same five research areas:

1. Affordable, comfortable, and energy-smart choices for daily life.
2. Clean and diverse energy supply that optimizes California's resources.
3. Clean and diverse transportation system in California.
4. Integrated natural gas system that is reliable and secure.
5. Environmentally sound energy system in California.

Similarly, under each research area, the strategic objectives cited in the *2007-2011 Plan* were used as the basis for proposed research solutions.

Affordable, Comfortable, and Energy Smart Choices for Daily Life and a Strong California Economy

The *2007-2011 Plan* assigns a high priority to this research area since it addresses goals set by government officials and legislative mandates. The Governor's directive⁶ and the CPUC's demand reduction goals provided key guidance for conducting research on achieving affordable, comfortable, and energy-smart choices for daily life and a strong California economy. Specifically, the CPUC established the state goal of reducing natural gas demand by 290 million therms from investor-owned utility customers between 2005 and 2014 (CPUC D04-09-060), from a 2004 baseline of 13,436 million therms (*Energy Commission Staff Energy Forecast 2006-2016*, September 2006).

Increasing population growth will lead to increased demand for natural gas unless it can be reduced by further efficiency gains. A significant portion of the state's population growth is occurring in inland areas with greater weather variability (as compared to coastal California), increasing energy consumption and peak electricity demand. Changing weather patterns, the constrained supply of natural gas, and an increased demand for energy management and control system technologies also require higher investment in this research area.

The *2007 IEPR* forecasts supply energy and price volatility will continue to be major concerns for California's economy in future years. The *2007 IEPR* also outlines how these two issues depend on one another since increasing demand often leads to higher prices. Higher prices of natural gas can potentially weaken the California economy and, in particular, sectors that depend on stable energy costs for daily activities. Investment in natural gas efficiency research is necessary to curb the growing demand for natural gas and protect California ratepayers from higher and unstable natural gas prices. Moreover, the *2008 Energy Action Plan Update* defines developing energy efficiency technologies as a high priority.

There are valuable benefits to reducing natural gas use in homes and businesses, including reduced use of fossil fuels, reduced natural gas energy costs for consumers, improved air quality, reduced green house gas emissions, and reduced reliance on imported gas supplies. The proposed research initiatives described in Table 4 address several strategic objectives of this research area. For example, the energy-efficient food services initiative develops energy-efficient technologies for California's food-service industry, such as refrigeration heat recovery. Similarly, the economic research on state gas energy policy issues will contribute to the knowledge base for future decision-making and informed end-use policies pertaining to natural gas. Other projects deal with reducing the cost and improving the performance of efficiency systems for buildings and industrial processes.

Table 4: Research Area 1 Budget for 2008-2009 NG Budget Plan

Research Solution	Budget
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⁶ <http://gov.ca.gov>

Develop energy-efficient end-use technologies and strategies for unique California conditions and industries (climate, construction practices, state standards, industrial processes).	\$1,200,000
Reduce and optimize the hot water use in residential, commercial, and industrial operations by developing technologies that conserve water or provide cost-effective alternate thermal energy sources.	\$1,400,000
Increase efficiency of existing building systems and industrial processes (develop replacement / retrofit products, improve operational strategies, identify intervention tactics).	\$1,050,000
Develop sustainable technologies, designs and systems for buildings and industrial applications (sustainable building construction practices, use of industrial waste as an energy resource).	\$650,000
Improve understanding of consumer behavior and market issues.	\$750,000
Total	\$5,050,000

Source: California Energy Commission

Californians will benefit in several ways as the PIER NG program works to advance affordable, comfortable, and energy-smart everyday life choices and a strong economy. The most important benefit is lower energy costs achieved through the more efficient use of energy. Efficient use of energy results in lower energy consumption, as well as lower energy prices and reduced price volatility through a shift in the supply / demand equilibrium market price. Other benefits include: increase in the state's competitive position to attract industry and create jobs; increased security of supply; improved environmental quality; and progress toward emission reduction goals.

Clean and Diverse Supply That Optimizes California's Resources

This research area aims to alleviate California's natural gas dependency by substituting natural gas imports with local resources. The *2007-2011 Plan* describes this research area in more detail and outlines policies such as *Energy Action Plan II*⁷ which guided its definition. *Energy Action Plan II* identified the need for a clean and diverse supply of energy resources in California. It also promoted the increase of R&D that improved natural gas infrastructure and production from alternative sources. The *2008 Energy Action Plan Update* defined the need to research LNG quality and interchangeability issues, and to further develop and demonstrate solar thermal technologies.

The availability and stability of natural gas supply affects prices and price volatility. The demand for natural gas is increasing for electricity generation and commercial and residential heating applications. Moreover, more research is necessary to guide future policy on how to regulate new natural gas markets and maintain infrastructure quality. Resource availability, demand trends, and regulatory framework are key drivers in this area.

The *2007 IEPR* calls for increasing the diversity of the natural gas supply portfolio and supports an expansion of LNG imports. More information is required on the environmental impacts, energy efficiency, safety and performance of LNG systems to safely accommodate

⁷ http://www.energy.ca.gov/energy_action_plan/index.html

these changes. In addition, supplemental technology development is required to promote alternatives and reduce the growing demand for natural gas in California.

The 2007 IEPR also calls for meeting California’s demand growth for natural gas by substituting it with alternative resources such as solar power, wind, biomass, and geothermal. Two of the three research initiatives in this research area, listed in Table 5, promote the increased development of clean processes and technologies. For example, one research initiative deals with substituting solar energy for natural gas-fired process heating. This initiative should bring multiple benefits to California ratepayers by simultaneously reducing California’s natural gas demand and promoting the use of local resources.

Table 5: Research Area 2 Budget for 2008-2009 NG Budget Plan

Research Solution	Budget
Reduce the cost and improve the performance of solar thermal, biogas, and geothermal technologies for NG replacement (for example, space heating and industrial applications) as well as hybrid systems (for example, solar/gas hybrids).	\$1,500,000
Improve the performance and reduce the cost of clean combustion technologies.	\$1,000,000
Assess the quality and interchangeability of LNG to determine its environmental and performance impact.	\$450,000
Total	\$2,950,000

Source: California Energy Commission Staff

California ratepayers will see numerous benefits from PIER NG efforts in this research area. The most significant benefit of a clean and diverse natural gas supply is the long-term stability of such a system that is cost-competitive with traditional fossil-fueled technologies. In addition, investment in local resources promotes the growth of the local economy. Other benefits include reduced dependence on out-of-state/international resources and reduced volatility of energy prices as a diversified portfolio of resources is more resilient against supply constraints and price shocks.

Clean and Diverse Transportation System

California’s transportation system requires substantial investment over the coming years; it currently accounts for half of all energy used in the state and is responsible for nearly 40 percent of all greenhouse gas emissions in the state. Transportation also is the largest source of air pollution, emitting nearly 70 percent of smog-forming pollutants, and gasoline and diesel demand has grown nearly 50 percent in the past 20 years. Population growth, less efficient vehicles, increasing traffic congestion and driving distances, lack of alternative fuels, and adequate mass transit options are contributing to this fuel demand. Since California is almost entirely dependent on oil for transportation and imports more than 60 percent of its supply, the state is increasingly vulnerable to the economic impacts caused by the growing global competition for petroleum. Moreover, the state’s increasing reliance on imported gasoline to meet demand exacerbates fuel price volatility.

To meet the requirements of SB 76, PIER NG will spend up to one-third of its total budget on transportation research. Such research must be co-planned with the Air Resources Board and

intends to invest in projects that both improve California’s transportation system and reduces energy prices for natural gas ratepayers.

The 2007 IEPR further highlights California’s dependency on gasoline and points out that transportation is the single largest contributor to greenhouse gas contributions. It also makes several recommendations for future policy and research supporting alternative fuels. To meet the Assembly Bill 1007 (Pavley, Chapter 371, Statutes of 2005)⁸ requirement to reduce petroleum fuels use and greenhouse gas emissions, the 2007 IEPR set a goal to increase alternative fuels use to 9 percent by 2012, 11 percent by 2017, and 26 percent by 2022. Moreover, the 2008 Energy Action Plan Update identified transportation fuels and vehicles as a priority research area for PIER NG. The more recent Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007)⁹, Alternative Fuels and Vehicle Technologies, also will guide the research projects in this section.

All of the proposed research initiatives in this area, as described in Table 6, address the need to develop and demonstrate alternative fuels, vehicles, and fueling infrastructure. For example, one technology development initiative aims to expand the use of alcohol-fueled vehicles through research. Another project with a similar objective assesses the feasibility of using California-produced energy crops for biofuel. The life-cycle assessment of LNG also aims to reduce petroleum dependence through analysis on the implications of importing LNG.

Table 6: Research Area 3 Budget for 2008-2009 NG Budget Plan

Research Solution	Budget
Develop and demonstrate advanced fuel efficient transportation technologies and fuel switching strategies that result in a cost-effective reduction of on-road and off-road petroleum fuel use in the short & long term.	\$2,000,000
Develop and demonstrate technologies for the in-state production of renewable and non-petroleum transportation fuels that can augment transportation fuel supplies, provide state economic and ratepayer benefits, reduce air pollutant and greenhouse gas emissions, and increase on- and off-road transportation fuel diversity.	\$4,000,000
Total	\$6,000,000

Source: California Energy Commission Staff

The Energy Commission is conducting an integrated analysis of the costs and benefits of alternative transportation fuel pathways and its effects on electricity and natural gas sectors, greenhouse gas emissions, tailpipe emissions, gasoline consumption, cost-effectiveness, technical challenges, infrastructure issues, safety issues, and policies. The findings from this research are expected to provide policy makers with a comprehensive view of relative costs and benefits from an energy system perspective.

As the PIER Program work advances a clean and diverse transportation system, Californians gain important benefits that include reduced impact from global climate change, reduced health

⁸<http://www.leginfo.ca.gov/bilinfo.html>

⁹<http://www.leginfo.ca.gov/bilinfo.html>

risks related to poor air quality, reduced volatility of transportation fuel prices, and reduced economic impact from dependence on petroleum.

Integrated Natural Gas System That Is Reliable and Secure

This research area intends to increase the safety and security of the natural gas infrastructure, improving natural gas markets, and increasing natural gas storage. As described in the *2007-2011 Plan*, this research area was created to support goals of the *2005 Energy Action Plan* and Governor Schwarzenegger’s request for a more resilient natural gas system that can withstand short-term supply shortages and potential terrorist attacks. Achieving these objectives requires further investment in natural gas storage and pipeline capacity. Existing infrastructure capacity must also be optimized to respond to future supply constraints.

Regulatory framework and technology advances have significant impact in this area. Outdated infrastructure, lack of collaboration, and regulatory constraints to developing new infrastructure result in reduced capacity and higher energy prices. There is also increasing focus on energy security and protection against natural and terrorist threats to energy infrastructure.

The *2007 IEPR* highlights the importance of California’s natural gas infrastructure in providing a stable and reliable supply of gas. Since only 15 percent of California’s current natural gas supplies are produced in state, California must ensure that its infrastructure can sufficiently move and store natural gas for future years. The *2007 IEPR* also calls for a balanced expansion of storage capacity to avoid short-term interruptions and severe weather damage. Such balanced storage capacity will also further stabilize prices. In addition, the *2008 Energy Action Plan Update* recommended research to assess natural gas storage impacts and the conditions necessary for investment.

The research initiatives in this research area attempt to increase safety and reliability of natural gas services for California ratepayers (Table 7). A modernized and secure infrastructure that improves natural gas deliverability also leads to improved services and a more reliable system. The sensor control technologies research initiative specifically addresses the safety and security concerns of California’s natural gas system by improving monitoring and maintenance of the natural gas infrastructure. Developing this technology is necessary to maintain the quality of current capacity and maximize the existing infrastructure. The *2007-2011 Plan* identifies a research solution to “develop a NG system (cyber and physical) that is resilient to natural and man-made events, self-diagnosing, and self-healing.” The monitoring devices developed in this initiative directly deal with this goal.

Table 7: Research Area 4 for 2008-2009 NG Budget Plan

Research Solution	Budget
Improve the safety of natural gas production, storage, delivery, and use.	\$175,000
Analyze impact storage would have on market and the conditions required for investment in storage infrastructure.	\$500,000
Total	\$675,000

Source: California Energy Commission Staff

Similarly, the model and tool development conducted in the storage analysis project will help promote better use of natural gas storage, alleviating problems associated with supply fluctuations. Improved storage capability in California should lead to reduced costs and a better understanding of natural gas markets. Such cost reductions and stabilization should benefit ratepayers.

The PIER NG program research in this area will provide several long-term benefits by advancing an integrated reliable and secure natural gas system improving safety, delivery, and services. The cost of natural gas should also decline from improved use of storage technologies and a better understanding of natural gas markets.

Environmentally Sound Natural Gas System

Environmentally sound natural gas system research addresses several issues outlined in the *2007-2011 Plan*. For example, global climate change issues are leading to consumer and government support for regulations and incentives to reduce emissions of greenhouse gases. Urban development and pressures of growing economy and population affect sensitive habitats, air quality, and water quality. Applying existing regulations and any new environmental protection regulations will have impacts on energy infrastructure constraints, energy prices, and protection of the environment, public health, safety, and environmental justice. Additional research is imperative to help guide policy makers address these issues.

R&D for pollution control technologies must also be considered as part of the solution to maintain environmental quality standards set by California's policies. AB 32 requires California to reduce its greenhouse gas emissions to 1990 levels by 2020. This legislation includes emissions associated with California's natural gas system and will require substantial efficiency and optimization of natural gas consumption, especially those that burn natural gas for heating and various industrial processes.

This research area advances an environmentally sound natural gas system and provides several health and environmental benefits such as improving indoor and outdoor air quality, minimizing the environmental footprint of the energy infrastructure, and reducing California's emissions that contribute to climate change.

The *2007 IEPR* and the *2008 Energy Action Plan Update* place a high priority on reducing greenhouse gas emissions associated with natural gas to meet the AB 32 goals. The *2007 IEPR* states that natural gas "is and will remain the major fuel in California's supply portfolio and must be used prudently as a complementary strategy to reduce greenhouse gas emissions." Additional investment in research and development that helps California use its natural gas resources most efficiently to meet increasing demand is necessary and prudent.

The research initiatives in this area (Table 8) contribute to the knowledge base for future decision-making and environmental policy formulation relative to natural gas. The PIER air quality fuels roadmap, for example, is an effort to address the need for an improved understanding of the current and future air quality impacts from the conveyance and use of alternative and renewable fuels in California. Policy makers and regulators can incorporate this knowledge into building a reliable, sustainable, and environmentally and economically sound energy generation portfolio. Another initiative will make the particulate matter dilution tunnel

test method for stationary sources more accurate for the low emissions of particulate matter from natural gas sources and to better characterize the emissions of fine, ultrafine and nanoparticles from natural gas sources. Such research is needed to help quantify emissions levels and facilitate the implementation of emission standards and long-term reduction targets. The measurement of particulate emissions will also enable improved air quality and its corresponding health benefits for California ratepayers.

Table 8: Research Area 5 Budget for 2008-2009 NG Budget Plan

Research Solution	Budget
Develop strategies to reduce direct and indirect GHG emissions (CO2, NO, CH4) associated with natural gas in California.	\$175,000
Develop methods (emissions testing protocols) to improve regulatory processes (pipeline siting) and inform future state environmental/energy policy.	\$600,000
Create tools for assessing the impacts of global climate change on key sectors and develop robust mitigation and adaptation strategies.	\$1,350,000
Improve the understanding of and develop solutions to reduce the impacts on air quality, biological, land use, public health, and water from natural gas production, storage, and use, and contribute to a sustainable energy future.	\$100,000
Total	\$2,225,000

Source: California Energy Commission Staff

An environmentally sound natural gas system has several health and long-term environmental advantages. In particular, ratepayers should expect reduced health risks due to improved indoor and outdoor air quality, minimized footprint from energy infrastructure, decreased biological impacts on local ecosystems, and reduced contributions to climate change.

CHAPTER 3: Update on 2007-2008 NG Budget Plan Activities

This chapter provides an update on the 2007-2008 Program Plan,¹⁰ which used the same research areas and solutions from the 2007-2011 Plan to guide the R&D effort for 2007. Table 10 outlines the original and revised budgets current and pending allocations as of December 31, 2007.

Table 10: 2007-2008 NG Budget Plan Summary

Research Areas / Research Solutions	Original Budget	Revised Budget	YTD Allocation	Pending Allocation
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¹⁰ Public Interest Energy Research Program, Natural Gas. California Energy Commission. Proposed Program Plan and Funding Request for 2007-2006 which was submitted to the CPUC in August 2006.

Research Areas / Research Solutions	Original Budget	Revised Budget	YTD Allocation	Pending Allocation
Affordable, Comfortable, and Energy Smart Choices	\$3,000,000	\$3,110,382	\$1,548,281	\$1,562,101
Increase efficiency of existing building systems and industrial processes.	\$500,000	\$488,502	\$164,440	\$324,062
Reduce the first costs and operating costs of energy efficient technologies and systems for buildings and industries.	\$1,000,000	\$951,880	\$0	\$951,880
Reduce and optimize the hot water use in residential, commercial and industrial operations by developing technologies that conserve water or provide cost-effective alternate thermal energy sources.	\$1,500,000	\$1,670,000	\$1,383,841	\$286,159
Clean and Diverse Supply That Optimizes Resources	\$2,350,000	\$2,320,530	\$749,986	\$1,570,544
Assess the quality and interchangeability of liquefied natural gas to determine its environmental and performance impact.	\$800,000	\$660,214	\$0	\$660,214
Improve and reduce the cost of clean combustion technologies.	\$550,000	\$750,000	\$749,986	\$14
Reduce the cost and improve the performance of solar thermal, biogas, and geothermal technologies for natural gas replacement as well as hybrid systems.	\$1,000,000	\$910,316	\$0	\$910,316
Clean and Diverse Transportation System	\$6,000,000	\$5,953,828	\$2,498,000	\$3,455,828
Develop and demonstrate advanced fuel efficient transportation technologies and fuel switching strategies that result in a cost-effective reduction of on-road and off-road petroleum fuel use in the short and long term.	\$1,000,000	\$1,000,000	\$1,000,000	\$0
Develop and demonstrate technologies for the in-state production of renewable and non-petroleum transportation fuels.	\$5,000,000	\$4,953,828	\$1,498,000	\$3,455,828
Integrated Natural Gas System that is Reliable and Secure	\$1,950,000	\$1,168,857	\$500,000	\$668,857
Analyze impact storage would have on the market and the conditions required for investment in storage infrastructure.	\$350,000	\$0	\$0	\$0
Develop a natural gas that is resilient to natural and man-made events, self-diagnosing, and self-healing.	\$800,000	\$668,857	\$0	\$668,857
Improve means of measuring and predicting economic impacts of natural gas use.	\$800,000	\$500,000	\$500,000	\$0
Environmentally Sound Natural Gas System	\$1,900,000	\$2,153,262	\$774,753	\$1,378,509
Create tools for assessing the impacts of global climate change on key sectors (for example, ecosystems, energy, and infrastructure) and develop robust mitigation and adaptation strategies.	\$750,000	\$955,000	\$448,991	\$506,009
Develop strategies to reduce direct and indirect GHG emissions (for example, CO ₂ , NO _x , CH ₄) associated with natural gas in California.	\$500,000	\$475,762	\$75,762	\$400,000
Improve understanding of and develop solutions to reduce impact of air quality, biological, land-use, public health, and water from natural gas production, distribution, storage, and use, and contribute to a sustainable energy future.	\$250,000	\$250,000	\$250,000	\$0
Develop methods (for example, emissions testing protocols) to improve regulatory processes (for example, pipeline siting) and inform future state environmental/energy policy.	\$400,000	\$472,500	\$0	\$472,500
Small Grants	\$1,000,000	\$1,000,000	\$1,000,000	\$0
Program Administration	\$1,800,000	\$2,293,141	\$2,293,141	\$0
Total	\$18,000,000	\$18,000,000	\$9,364,161	\$8,635,839

Source: California Energy Commission Staff

A total of \$9,364,161 was allocated from July 1, 2007, through December 31, 2007. An additional \$8,635,839 from the 2007-2008 NG Budget Plan is projected to be allocated by June 30, 2008, to disperse the \$18 million budget.

Although most research areas experienced minor revisions to the original budget (occurring during the year primarily as a result of project proposal evaluation), the most significant budget allocation change resulted from increased program administration expenses¹¹. Administrative changes resulting from SB 1250 shifted the budget cycle from a calendar year basis to a state

¹¹ Program year 2007 funding changed from January 1, 2007 to July 1, 2007, therefore the revised program administration budget reflects an additional \$493,131 in personnel expenses for that extra six-month period.

fiscal year basis. As authorized¹² by the CPUC, the funds for the additional program administration expenses were shifted from the 2007 research budget.

PIER NG funded five projects in January 2007 for more than \$1.5 million that were related to analyzing the impact on the market of NG storage and developing a resilient storage infrastructure. These projects were funded from the *2006-2007 Budget Plan*. As a result of these recent investments, subsequent research on this issue was postponed to future budget cycles. PIER NG also leveraged any other funding sources to help fund research to measure the economic effects of natural gas use. These funds were reallocated to cover the additional administrative expenses and increase funding on higher priority research, including more energy efficiency and fewer greenhouse gas emissions.

Affordable, Comfortable, and Energy Smart Choices for Daily Life and a Strong California Economy

To date, for FY 2007-2008 PIER NG has funded four projects for \$1,548,281 that met the objectives research area (See Table 11). The energy efficiency calculator tool was developed to increase the knowledge base for future decision-making and end-use policy LNG. Both hot water projects and the natural gas fired burner projects provided benefits targeted specifically for California ratepayers by developing energy-efficient technologies for buildings and conducting research on potential opportunities for efficiency improvements. More efficient energy use means cost savings for California ratepayers and a reduction in California’s natural gas demand. Such research also helps the state meet its aggressive efficiency goals.

Table 11: Research Area 1 Projects for FY 2007-2008 Year to Date

Title	Company	Research Description	Funding
Hot Water Distribution System Research	Heschong Mahone Group	This project focuses on opportunities to save energy in multifamily hot water distribution systems. The heat loss characteristics of hot water pipes will be better characterized, advanced control options will be developed, and energy-related design guidance and code recommendations will be published.	\$929,841
Improved Natural-Gas Fired Aluminum Smelter Burner	Gas Technology Institute	GTI is installing a demonstration of a commercial-size prototype flex-flame burner in California. Thorock Metals in Compton hosted the early demonstration tests. Field demonstration is slated to be conducted over two years and will consist of parametric and life-cycle tests to optimize operating conditions, to confirm burner reliability, and to collect data on decreased emissions and energy use. The burner design is expected to lend itself to mass production.	\$10,000

¹² CPUC Decision G-3394, December, 2006

Water Heating and Hot Water Usage in California Homes	Lawrence Berkeley National Laboratory	Through a partnership with the Department of Water Resources (DWR), the research continues efforts to characterize residential hot water usage; measure how much water and energy is wasted in hot water distribution systems (HWDS) in California residences; investigate the effectiveness of current retrofit options in reducing this waste of water and energy; provide evaluations of gas storage water-heating technologies; develop recommendations for energy-related code changes to improve the efficiency of HWDS; and test efficiency of gas storage water heaters.	\$454,000
Energy Efficiency Calculator Tools	Southern California Gas Co.	To develop Web-based software and desktop tools to aid California industries to identify, analyze, and prioritize energy (i.e. natural gas and other alternate energy sources) savings opportunities. The tools are designed to help industrial end users in analysis of energy saving opportunities and savings (energy in terms of MM Btu/year, energy cost in terms of US\$ and CO2 savings) by implementing selected energy-saving projects.	\$154,440
Total			\$1,548,281

Source: California Energy Commission Staff

PIER NG expects to fund additional research projects in this area through two solicitations before the end of FY 2007-2008. The first solicitation focuses on research projects for waste heat recovery from California industrial processes. These projects consider a range of technologies, including gas-liquid heat exchangers, advanced materials, chemically reactive systems, thermo-electric systems, innovative working fluids, high temperature combustion air preheaters, low NOx burners using highly preheated air, and load preheating and moisture removal. The second solicitation focuses on near-term building efficiency technologies, tools, and/or market research necessary to meet California's aggressive natural gas efficiency goals, reduce the first costs and operating costs of energy efficiency technologies, and support future changes to the state's appliance and building energy efficiency standards.

Clean and Diverse Natural Gas Supply That Optimizes California's Resources

The projects in Table 12 address the objectives to develop a clean and diverse natural gas supply optimizing California's resources. The Stirling engine project reduces the emissions associated from fossil-fueled Stirling engines to comply with California standards. The Stirling engine technology also encourages alternative fuel sources since this technology can run on various heat sources, including heat converted from renewable resources. Alternative fuels reduces California's dependence on natural gas. Similarly, the combined heat and power (CHP) project develops technology that encourages more efficient natural gas use for heating and electricity and helps reduce greenhouse gas emissions.

Table 12: Research Area 2 Budget for FY 2007-2008 Year to Date

Title	Company	Research Description	Funding
Integrated CHP Using Ultra-Low-NOx Supplemental Firing	Gas Technology Institute	GTI is developing an ultra-low-NOx CHP system that packages a state-of-the-art gas turbine and boiler with an innovative natural gas-fired supplemental burner. GTI will conduct a field trial and demonstration of the ultra low-NOx burner technology with a 70 kW microturbine. The burner is believed to have the capability of being scaled up to be used with a multi-megawatt gas turbine, which would increase the CHP market potential.	\$500,450

A 100 kW Dual Shell Stirling Engine Integrated with a Catalyzed Flow Burner Designed to Meet the ARB 2007 Emission Standards	ADI Thermal Power Corporation	ADI Thermal Power will group four of its 25 kW Stirling engines into a 100 kW, four-cylinder engine package, integrate a new steam reformer module to convert some of the otherwise wasted exhaust thermal energy to chemical energy of a fuel, modify the burner system to meet California Air Resources Board (CARB) 2007 emission requirements, and add an overall control system to maintain emissions performance and meet facility electrical and thermal needs.	\$249,536
Total			\$749,986

Source: California Energy Commission Staff

Before the end of June 2008, PIER NG expects to fund additional research projects in this area to assess natural gas supply impacts from LNG and develop technologies that use renewable resources instead of natural gas. PIER NG will request proposals to analyze the impact on water resources from LNG receiving terminals. PIER NG also plans to extend the scope of an existing project with Gas Technology Institute to expand testing that evaluates the air quality and safety impacts of using specification gases (for example, field testing industrial and commercial burners). PIER NG is considering two research projects that would replace natural gas with renewable resources. The first will demonstrate an advanced gasification process converting waste wood into usable syngas for process heating. The second will demonstrate a biogas treatment system combining media adsorption and a microwave treatment that can remove siloxanes and hydrogen sulfide (H₂S) from biogas. This system would allow post combustion technologies on engines, turbines, and boilers to meet existing 2007 ARB emission standards and regenerate and reuse spent substances at a cost less than existing disposal and replacement methods.

Clean and Diverse Transportation System

The projects in Table 13 address technology development requirements identified in the *State Alternative Fuels Plan* and focus on fuel diversity, vehicle efficiency, and reducing fossil carbon in fuels. Landfill gas represents about 11 percent of California's entire biomass energy resource potential. Its availability also typically coincides with fleets that are readily adaptable to using this fuel. Demonstrating small scale purification and liquefaction landfill gas projects will accelerate this fuel use for transportation. A finding of the research roadmap for natural gas vehicles identifies the lack of heavy-duty natural gas engine sizes and capacity. The NG Program funded research projects in this area to link stationary and vehicular natural gas engine markets to provide incentives for greater production of natural gas engines.

Table 13: Research Area 3 Budget for FY 2007-2008 Year to Date

Title	Company	Research Description	Funding
Purification and Liquefaction of Biomethane Landfill Gas for Transportation Fuel	Gas Technology Institute	GTI will develop and demonstrate a system to convert landfill gas into liquefied natural gas (LNG) to be used as motor fuel for heavy duty vehicles. Gas clean-up research is to be led by Linde-BOC, the largest supplier of cryogenic gas products in the world. Commercialization and deployment efforts will be performed through Waste Management Incorporated (WMI), the largest landfill owner/operator and a large consumer of LNG in refuse trucks in the United States. The project will be sited at WMI's Altamont Landfill in Livermore, and LNG generated will fuel WMI's fleet of heavy duty vehicles.	\$998,000

Advanced Reciprocating Engine Technology for Power Generation	Request for Proposal	Joint project with PIER's Environmentally Preferred Advanced Generation subject area to identify and develop key technology in lean burn, stoichiometric exhaust gas recirculation, or other air-fuel mixtures for natural gas engines for use in stationary power generation applications or transportation applications. Stoichiometric EGR technology allows the use of a three-way catalyst to meet increasingly more the stringent emission requirements. Three-way catalysts require stoichiometric exhaust gas composition that is typically found in light duty vehicles. Advanced technologies that provide benefits to heavy-duty vehicles used in both on- and off-road transportation would be supported by PIER Transportation.	\$1,000,000
Biomethane Cleanup in California Dairy Farms	Request for Proposal	Joint project with the PIER Renewable subject area to quantify, through a combination of field and laboratory studies, the technical and environmental performance of California's dairy biogas power systems including manure and effluent handling, anaerobic digestion, and biogas-to-electricity generation processes. The project's goals are to be achieved by monitoring, sampling, and analyzing material flows, documenting energy consumption and generation. The project will undertake detailed element, mass, and energy balances on the operating systems in use across multiple farms in California.	\$500,000
Total			\$2,498,000

Source: California Energy Commission Staff

Before the end of June 2008, PIER NG expects to fund additional research projects in the area of Clean and Diverse Transportation System. These projects will center on developing in-state capabilities to produce renewable and non-petroleum transportation fuels.

Integrated Natural Gas System That Is Reliable and Secure

The University of California–Berkeley Energy Institute-funded project focused on developing tools and analysis to improve efficiency of natural gas markets. This energy market study project was awarded \$500,000 to addresses a major research area objective to improve the efficiency of natural gas markets by analyzing the reliability / adequacy of NG supply, market design, and demand response programs.

Table 14: Research Area 4 Budget for FY 2007-2008 Year to Date

Title	Company	Research Description	Funding
Center for the Study of Energy Markets	Center for the Study of Energy Markets - UC Berkeley Energy Institute	Conduct research in five general market areas: (1) reliability/adequacy of supply, (2) retail policies/demand response, (3) market design, (4) interactions of environmental regulation and energy markets, and (5) competition and pricing of refined fuel products. In addition to economic research and preparation of technical papers, the CSEM program also sponsors research and policy conferences, and other elements of a tech transfer function, to facilitate the communication of its research findings and opinions to policy makers in the government agencies and industry.	\$500,000
Total			\$500,000

Source: California Energy Commission Staff

By June 30, 2008, PIER NG expects to fund additional research projects in this area. This research will focus on developing a natural gas infrastructure that is resilient to natural and man-made events. With a limited budget and research topics running the gamut from pipeline operations, seismic safety, market volatility to price impacts of varying natural gas specifications, PIER NG will tap the existing expertise in each of these areas at the lowest direct cost to the program. PIER NG will join the Gas Storage Technology Consortium (GSTC) and participate in its research funding program as a simple and cost-effective way to leverage funds and research. The GSTC helps develop, demonstrate, and commercialize technologies to improve the integrity, flexibility, deliverability, and cost-effectiveness of the nation's underground natural gas/hydrocarbon storage facilities. The consortium's membership includes natural gas storage operators, local distribution companies, pipeline companies, natural gas industry research organizations, and academic institutions. GSTC is funding research on natural gas storage technology and an on-line inspection of pressure vessels and piping program.

Environmentally Sound Natural Gas System

The 2007-2008 NG Budget Plan funds two projects that meet the goal of this research area, to provide an environmentally sound natural gas system in California. The air pollution study will improve the capability to measure air pollution, which will help California to quantify its emissions and long-term progress of reduction efforts. Similarly, the low NOx burner project will reduce emissions of criteria pollutants that contribute to poor air quality and the associated health impacts, and help meet California environmental regulations.

Table 15: Research Area 5 Budget for FY 2007-2008 Year to Date

Title	Company	Research Description	Funding
California AUAV Air Pollution Profiling Study	Scripps Institution of Oceanography - UC San Diego	Use lightweight autonomous unmanned aerial vehicles (AUAVs) to routinely profile the atmospheric concentration of black carbon, aerosol, carbon monoxide, ozone, and solar radiation over a period of one year. Data from the vertical profiles of pollution up to 12,000 feet above sea level combined with estimated back trajectories would help to sort out the original sources of pollution and BC in particular. The researchers will use the collected data to estimate the climatic effect of BC in California. The researchers will also collect rain and snow in four locations in the Sierra Nevada to measure the amount of carbon deposited with or on top of the snow. Other measurements will be taken to estimate the effect that BC has on snow reflectivity and, therefore, on the tendency of snow to melt.	\$698,991

Ultra Low NOx Burners	Gas Research Institute	The purpose of this project is to develop and demonstrate a 5-ppmv ultra-low-NOx burner for industrial water tube boilers that is based on GTI's patented Forced Internal Recirculation technology. GTI has teamed up with Coen Company of Burlingame to develop this burner and demonstrate it at a site in Pasadena (California Institute of Technology).	\$75,762
Total			\$774,753

Source: California Energy Commission Staff

Before the end of June 2008, PIER NG expects to fund additional research projects in this area related to greenhouse gas emissions measurement, greenhouse gas emissions reduction, and gas fuel interchangeability. PIER NG will provide additional funding to the pilot project California Greenhouse Gas Emission Measurement Project (CALGEM). This subsequent research will conduct specific measurements and modeling activities that address the goal of accurately verifying reductions in greenhouse gas emissions over time and quantify the relative contributions from different source sectors. PIER NG intends to fund projects focused on research for waste heat recovery from industrial processes in California that will lead to reduced greenhouse gas emissions for industrial end users. PIER NG will also fund a project to develop gas fuel interchangeability criteria (GFIC) that will help industrial and commercial combustion system operators, manufacturers and regulatory agencies to predict fuel variation impacts before provisioning for these different fuels. The program will focus on combustor efficiency, durability, and emissions and how they are affected by fuels that may not meet present-day fuel specifications.

CHAPTER 4:

Small Grants Program

The Energy Commission proposes an additional \$1 million for the grant program (including administration) to complement ongoing core research for natural gas. This successful program in electricity research—Energy Innovations Small Grant Program (EISG)—has a primary objective to provide opportunities for funding feasibility studies and since 2006 has included emerging and promising natural gas technologies. The EISG is administered by San Diego State University Research Foundation.

These grants are specifically designed for assessing “proof of concept,” and successful projects are considered for substantive research funding in future years. The program is a valuable tool for engaging the larger research community, capturing new ideas, and thus ensuring the highest value research is identified and supported by the natural gas program.

Funding

The maximum funding available is \$95,000 per hardware project and \$50,000 per modeling project. Although there are no requirements for matching funds or repayment, cost sharing between the grant applicant and PIER is encouraged and is considered in the selection process.

Eligibility

Participation in the EISG program is open to these groups, with these specific limitations:

1. **Individuals:** To apply as an individual, the individual must act independently. If employed or affiliated with an organization, applicant must have authority from the organization he or she represents to pursue project development exclusively as an individual, with no rights reserved to the organization. The individual, not the organization, will retain all intellectual property rights accrued from the grant project.
2. **All Businesses:** There is no restriction on the size of the business.
3. **Non-Profit Organizations:** Possess IRS tax exemption status. Non-profit organizations that are already under contract to the Energy Commission to perform PIER-related work are prohibited from applying to the EISG Program.
4. **Academic Institutions:** Public or private postsecondary institutions only.

The Energy Commission reserves the right to limit participation in a particular solicitation to one or more applicant groups and/or to limit the subject areas in order to meet overall program objectives. If a solicitation is restricted by applicant type or subject area, it will be clearly identified in the solicitation notice published on the EISG Natural Gas Solicitation Web page.

Summary and Results of the 2006-2007 EISG Solicitation

The first EISG Natural Gas Solicitation (#06-01 G) resulted in 30 proposals accepted by the July 31, 2006, deadline. The initial screening resulted in 19 eligible proposals and were scored by two to five technical reviewers with recognized expertise in the subject area. The reviewers approved 15 proposals that advanced to the Program and Technical Review Board (PTRB).

The PTRB is a group of 10 to 14 individuals with recognized energy expertise with representatives from the Energy Commission, California State University, the University of California, private industry, and investor-owned utility companies. The PTRB is responsible for final scoring and preparing a ranking of the grant applications funding for consideration in a public meeting by the Energy Commission.

The PTRB recommended eight projects for funding. One applicant declined funding due to receipt of private funding. The Energy Commission approved funding for seven projects, totaling \$619,913. See Appendix A for a list of approved projects.

Summary and Results of the FY 2007-2008 EISG Solicitation

The recent EISG Natural Gas Solicitation (#07-01 G) had 17 proposals accepted by the November 30, 2007, deadline. The initial screening resulted in seven eligible proposals and will be reviewed by the Program and Technical Review Board before final selection.

Planned FY 2008-2009 EISG Solicitation

In 2008-2009 *NG Budget Plan*, the ESIG is expected to carry out another solicitation for grant awards for natural gas projects. Table 9 describes the major activities and preliminary deadlines for this solicitation.

Table 9: EISG 2008-2009 Solicitation Preliminary Deadlines

Solicitation Published:	August 15, 2008
Pre-proposal Abstracts Accepted (Optional):	Through October 31, 2008
Grant Applications Received:	Through November 30, 2008
CPUC Funding Approval:	TBD
Energy Commission Approval of Awards:	Approx. 20 weeks from cut-off date
Notification of Awards:	Within five business days
Begin Executing Agreements:	April 2009

Source: California Energy Commission Staff

CHAPTER 5:

Program Administration

Administration expenses for the FY 2008-2009 are budgeted at \$3.1 million, an increase of \$1.3 million compared with the FY 2007-2008 budget. These funds are used for personnel expenses and technical assistance.

The Energy Commission is requesting CPUC's approval to spend up to 15 percent for program support (Energy Commission support and technical assistance) from the annual FY 2008-2009 allocation of \$21 million. In the first three years, the Energy Commission operated the PIER NG program with a 10 percent program support budget. SB 76 expanded the Natural Gas Research program scope with the addition of a transportation research element. Given this expansion, and the benefit of three years of experience administering the program, the Energy Commission requests spending up to 15 percent for program support.

The FY 2005-2006 Budget Act authorized five permanent positions for the program. The FY 2006-2007 Budget Act authorized an additional five permanent positions. The FY 2007-2008 Budget Act authorized an additional four positions, for a total of 14 positions. This *2008-2009 NG Budget Plan* includes three new permanent technical positions to identify, develop, and manage a growing portfolio of natural gas research projects.

Beginning with FY 2007-2008, the PIER NG program funding is appropriated through the Budget Act. To reflect this change, the Energy Commission will increase or decrease the amount appropriated in the Budget Act by the general sections statewide control sections for such items as employers' retirement contributions (SEC. 3.60) or other support items issued by Governor's executive orders (for example, general salary increases, and so forth). The Energy Commission would propose to fund these costs from interest earned from the Natural Gas Sub-Account, Public Interest Research, Development and Demonstration Fund (Fund 3109). This sub-account was established by Senate Bill 1250 (Perata, Chapter 512, Statutes of 2006). These incremental costs are consistent with state support cost for all state agencies. The Energy Commission is not requesting the CPUC to transfer any additional funds above the annual amount authorized by the Budget Act.

The Energy Commission requested additional personnel funds for the *2008-2009 NG Budget Plan* to accommodate four new permanent positions to help implement the PIER NG program. These positions are required to provide the technical expertise necessary to accommodate the escalating project workload in the natural gas program and respond to new legislative mandates. These positions are three engineers who will identify and evaluate opportunities for research, develop and manage natural gas research projects, and help bring successful natural gas technologies to market.

The Energy Commission also requested additional technical assistance funds for the *2008-2009 NG Budget Plan*. The program has an ongoing need for specialized staff not adequately provided for under civil service classifications given the fast pace of change and high degree of technical expertise required in public interest energy research. The specialists retained for this purpose provide valuable assistance in activities ranging from engineering feasibility studies, to

life cycle environmental assessments, to component/material failure analysis. These technical assistance resources fill an important gap and are key to the success of the program.

APPENDICIES

APPENDIX A:

Approved EISG Proposals (Cycle 06-01G)

Table 16: Approved Grant Proposals for Funding (EISG Cycle 06-01G)

Proposal Number	Organization	Descriptive Project Title	Dollar Amount
06-01-11G	Altex Technologies Corporation	High Efficiency Heat and Power Systems for CCHP Applications	\$94,915
06-01-12G	Functional Coating Technology	Highly Efficient Production of Electricity and Syngas Using a Natural-Gas Fuel Cell	\$94,998
06-01-06G	Meruit	Testbed Design for Gas Turbine Exhaust Pressure Recovery	\$50,000
06-01-05G	Energy Concepts Company	Solar Thermal Heat Pump/Chiller	\$95,000
06-01-30G	Oregon State University	Enabling the Thermochemical Production of Hydrogen from Water: Investigation of the Bunsen Reaction in a Low Vapor Pressure Solvent	\$95,000
06-01-29G	University of Southern California	A Pore Flow Reactor for Landfill Gas Clean-Up	\$95,000
06-01-20G	Colorado State University	Feasibility Assessment of Operating Gas Engines on Alternative Gas Fuels	\$95,000
06-01-17G	UC Berkeley	Renewable Generation of a Natural Gas Analogue	\$95,000
Total			\$714,913

Source: California Energy Commission Staff

APPENDIX B:

Summary of PIER NG Research Projects

Table 17: PIERNG Research Projects Funded FY 2005 (1/1/2005 through 12/31/2005)

Title	Company	Research Description	Funding
Design & Development of a Very High Efficiency / Low-Emissions Natural Gas-Fired Boiler	Gas Technology Institute	GTI proposes to install a demonstration 10 to 15 million Btu/h Super Boiler in California. Field demonstration will consist of parametric and life-cycle tests of up to 12 months. At the conclusion of the demonstration period, the host site will have the option to purchase the Super Boiler for future use.	\$239,969
Improved Natural-Gas Fired Aluminum Smelter Burner	Gas Technology Institute	GTI proposes to install a demonstration of a commercial size prototype flex-flame burner in California. Thorock Metals in Compton hosted the early demonstration tests. Field demonstration is slated to be conducted over two years and will consist of parametric and life-cycle tests to optimize operating conditions, to confirm burner reliability, and to collect data on decreased emissions and energy use.	\$359,990
Reduce Natural Gas Use for Industrial Process Heat using High-Temperature Parabolic Trough Solar Collectors	American Energy Assets	Industrial Solar Technology Corporation (IST) will install a parabolic trough solar system to deliver process heat to the Frito-Lay plant located in Modesto. The proposed solar heating system totals 54,500 sq. ft. of net collector aperture area. It is estimated that the system will deliver 14 billion Btu/year of thermal energy, which will displace about 19 billion Btu/year of natural gas currently used to heat water and generate steam.	\$700,000
Hot Water Data Analysis and Field Test	Lawrence Berkeley National Lab	NA	\$50,400
2005 Plan CA Natural Gas Price Shock Survey	Toulan School of Urban Studies and Planning, Portland State University	Developing improved knowledge of consumer response to the large natural gas price increases expected during the winter of 2005-2006. The data collected at this time can later be analyzed to better inform longer-term consumer-focused policies, programs and utility rates. The research shall: (1) develop a research design, (2) construct a survey instrument, (3) develop a representative random sample of California residential households, (4) use telephone interviews to administer the survey, (5) and combine survey data with information from utility bills and weather observations.	\$324,800
San Jose State University Foundation Environmental Business Cluster	San Jose State University Foundation	NA	\$77,986
San Jose State University Foundation Environmental Business Cluster (EBC)	San Jose State University Foundation	NA	\$28,334
Biogas-Powered 100kW Microturbine with Ultra-low Emissions for CHP Applications	Lawrence Berkeley National Lab	Lawrence Berkeley National Lab, Elliot Engineering and Professional Engineering Solutions will develop and demonstrate a recuperated microturbine with a low swirl ultra-low emission combustor designed for operation on biogas and capable of meeting the California Air Resources Board (ARB) proposed 2013 Waste Gas Emission Standards. The proposed CHP unit will replace natural gas by using digester gas produced at the East Bay Municipal Utility Districts waste water treatment facility in Oakland. The waste heat from the microturbine will be used at this facility.	\$500,000
Production and Conditioning of High Sulfur Biogas for Fuel Cell Combined Heat and Power Generation	Gas Technology Institute	Gas Technology Institute will demonstrate high-sulfur biogas cleaning and conditioning to stringent fuel cell gas quality levels to displace natural gas fueling of two direct fuel cell power plants for combined heat and power generation. This project will demonstrate onsite processing and anaerobic digester for converting onion peel waste products to biogas at Gills Onions, the largest fresh onion processor in the world (110,000 tons/year 10% of Californias onion production), in Oxnard.	\$394,198
Next Generation Instantaneous Water Heater	Gas Technology Institute	The contractor will provide a review of available information on current instantaneous water heaters and conduct stakeholder interviews to identify technical and market barriers affecting the adoption of the technology in California. Current instantaneous water heater technology will be evaluated for its market and energy savings potential. The contractor will recommend next-generation water heater technology for the California market.	\$200,738

Energy Efficient Natural Gas Chillers, Water Heating and Food Service Equipment	Pacific Gas and Electric Company	The proposed research will create a roadmap for advancing technology in the gas-fired commercial water heating systems and gas fired commercial food service areas within the food service industry. The research will also provide the basis for developing and advancing the focus on natural gas cooling as well as proving opportunities for future research in this area.	\$667,000
Design & Development of Low-Cost High-Temperature Solar Collectors for Mass Production.	UC Merced	This PIER contract will demonstrate cost-effective high-temperature solar collectors for the production of heat for industrial processes and absorption chillers for refrigeration. The design is expected to meet the criteria of having an installed cost of no more than \$15/square foot of reflector area in 2005 dollars. These results will be in line with the criteria identified by the CPUC (D.04-08-010) for public interest gas R&D projects: "Focus on energy efficiency, renewable technologies, conservation and environmental issues."	\$577,563
Super Boiler	Gas Research Institute	This project will develop a first-generation Super Boiler and demonstrate it at an industrial site in Southern California. The Super Boiler technology developed by GTI and Cleaver-Brooks uses a combination of advanced staged combustion with interstage cooling and advanced membrane technology that recovers flue gas moisture and its latent heat. Lab tests with a 75-horsepower boiler have shown the technology capable of fuel-to-steam efficiency exceeding 94% together with NOx emissions below 5 ppmv. The boiler is also more compact than conventional models and reduces water consumption by up to 5%, making it attractive to potential end users. In the current phase of the project, a 300-horsepower Super Boiler will be designed, built, installed, and demonstrated at a manufacturing facility in Southern California.	\$397,563
Pipeline Integrity Management for Ground Movement Hazards	Pipeline Research Council International	This project will develop an improved, comprehensive set of guidelines and recommended practices that can be implemented within the industry for evaluating pipelines in areas subjected to large-scale ground movements. The project consists of five major activities: (1) defining geohazards; (2) improving methods to model pipeline-soil interaction; (3) improving models of pipeline response to geohazards; (4) developing improved methods to reduce pipeline risk posed by geohazards; and (5) compiling a guidance document available to the pipeline industry, public agencies, and engineering consultants as a free download from the PRCI website. PRCI will support regular updates to the guidance document. The project will last 30 months. The U.S. Dept. of Transportation and other parties will provide \$815,033 in match funding.	\$140,000
Ultra Low Nox Burners	Gas Research Institute	This project will develop and demonstrate a 5-ppmv ultra-low-NOx burner for industrial water tube boilers that is based on GTI's patented Forced Internal Recirculation technology. GTI has teamed up with Coen Company of Burlingame to develop this burner and demonstrate it at a site in Pasadena (California Institute of Technology). The FIR burner is capable of reaching this level of NOx emissions with reduced flue gas recirculation and lower excess air than other types of ultra-low-NOx burners. In this project, the burner has been developed and a 62-million-Btu/h prototype will be demonstrated on a water tube boiler at the Pasadena site.	\$43,638
Fuel Cell Demo	Logan Energy, Inc.	This project will maintain two (2) PEM fuel cells that are to be installed in San Diego, one as a component of a "sustainable communities" project and the second at a city of San Diego office complex. This work will help to bring the benefits of distributed generation technologies, particularly fuel cells, to the California consumer. The contractor is to install the unit, start-up and commission the fuel cell, furnish as-built plans, and provide one-year maintenance, service, and customer support.	\$50,000
Natural Gas Variability in California: Environmental Impacts and Device Performance	Gas Technology Institute	This project will test, evaluate, and model classes of industrial, commercial, and residential burners and their combustion control systems to determine performance and emissions effects of liquefied natural gas (LNG) and other substitute gases relative to traditional natural gas. This interchangeability data will provide a means to operate a flexible, safe, and diversified natural gas system for California customers.	\$3,000,000
Climate Change and Sea Level Rise: Implications for the California Coast	University of Florida	This project will: (1) collect geological and geomorphological data to better understand shoreline change during recent times; (2) collect information regarding the transport of sediments from river systems to coastal regions (mostly through a critical review of the existing literature); (3) enhance the coastal evolution model developed in collaboration with the Kavli Institute and Scripps Institution of Oceanography and the University of Florida; (4) use the new model to identify "hotspots" of potential erosion or accretion along the California coast; and (5) use different sea level rise scenarios to estimate potential shoreline changes in important California coastal areas.	\$599,625
Super Efficient Gas Water Heating Appliance Initiative	Valley Energy Efficiency Corporation	This effort will fund the first phase of the Super Efficient Gas Water Heater Appliance Initiative (SEGWHAI) to develop the foundation for this multi-year initiative. This work will include the technical and market analyses necessary to determine the best ways to help achieve a 30% efficiency improvement in gas water heaters. At the end of this first year, this initiative should be at the beginning of the prototype development stage.	\$395,303

Improved Greenhouse Gasses Inventory Methods for California Landfills	Landfills +, Inc.	This project is generating the information and developing the model that will be used to improve California's inventory of methane emissions from landfills. The improved inventory methods will enable other agencies to encourage and track methane reductions. The Climate Action Team has identified controlling emissions from landfills as a near-term option for the California Integrated Waste Management Board to help meet the state's greenhouse gas emission targets. Improved inventory methods will also address the needs of the California Air Resources Board in relation to AB 32. The Integrated Waste Management Board and local regulatory agencies are key partners in this research.	\$399,929
Develop Recommendations to Improve Hot Water Equipment and System Efficiencies in California Homes	Lawrence Berkeley National Lab	This project will include several research tasks with the purpose of increasing the energy and water efficiency of residential water heaters and hot water distribution systems (HWDS). The first tasks focus on providing HWDS data, analyses, and recommendations to the 2008 Title 24 Residential Building Energy Efficiency Standards proceeding. The second set of tasks consists of three pilot phase or feasibility studies that will be used to plan future RD&D projects to assess residential hot water usage patterns and to improve the efficiency of water heating technologies and distribution systems.	\$1,396,000
Commercial Gas Fryer for Food Service	Gas Technology Institute	This project will design, develop and test a commercially viable gas fryer that reduces energy costs, improves performance, and reduces oil consumption. The contractor will develop specifications and fryer designs concepts; fabricate, assemble, and bench test the fryer; and then conduct computational fluid dynamics tests to analyze both heat transfer and combustion. A prototype fryer will be built and tested according to ANSI and ASTM standards. The contractor will also develop a market transformation plan to introduce the gas fryer product to the California market.	\$357,802
Power Generation Integrated Steam System	CMC-Engineering	This purpose of this project is to develop, demonstrate and introduce a novel, complete, packaged combined heat and power (CHP) system matched to existing thermal loads to provide a low-cost, clean, and efficient system for distributed generation (DG). The CHP system consists of a gas turbine for electricity generation and a boiler (steam generator) with a low NOx burner. The heat in the gas turbine exhaust contributes to incremental steam generation above that contributed by the boiler burner.	\$57,725
Total			\$10,958,563

Source: California Energy Commission Staff

Table 18: PIER NG Research Projects Funded FY 2006-2007 (1/1/2006 through 6/30/2007)

Title	Company	Research Description	Funding
Improved Natural-Gas Fired Aluminum Smelter Burner	Gas Technology Institute	GTI proposes to install a demonstration of a commercial size prototype flex-flame burner in California. Thorock Metals in Compton hosted the early demonstration tests. Field demonstration is slated to be conducted over two years and will consist of parametric and life-cycle tests to optimize operating conditions, to confirm burner reliability, and to collect data on decreased emissions and energy use. The burner design is expected to lend itself to mass production.	\$14,573
Gas Storage Technology Consortium Membership for three Calendar Years (2006-2008)	Gas Storage Technology Consortium	Join the Gas Storage Technology Consortium (GSTC) as full members for a cost of \$2,500 for three calendar years (2006, 2007, and 2008). The GSTC was established in June 2004 with a five-year contract from the U.S. Department of Energy National Energy Technology Laboratory. Since then the GSTC has co-funded 12 projects totaling \$1.69M. Currently there are 44 members in 18 states plus 1 in D.C. and 1 in Canada. The mission of the GSTC is to assist in the development, demonstration, and commercialization of technologies to improve the integrity, flexibility, deliverability, and cost-effectiveness of the nation's underground natural gas/hydrocarbon storage facilities.	\$2,500
Characterization and Mitigation Strategies of Fugitive Methane Emissions from the Natural Gas System	ICF Resources, LLC	The objectives are to: (1) Collect and review data from individual Air Quality Districts (AQDs) and reporting facilities and confirm the nature and accuracy of emissions estimates; (2) Analyze and aggregate emissions estimates from individual facilities to the California AQDs to estimate baseline methane emissions for sources with significant emissions reduction potential at the state level; (3) Determine best available methane emissions abatement technologies; (4) Determine the cost effectiveness of technologies in abating methane emissions from the oil and gas industry using ICF's report on mitigation options for non-CO2 gases as a starting point; and (5) Based on results, recommend cost-effective mitigation options to reduce emissions from the NG sector and contribute to the state's efforts to achieve the goals set forth in AB 32.	\$160,000
San Jose State University Foundation Environmental Business Cluster (EBC)	San Jose State University Foundation	NA	\$45,418
Field Demonstration of Emerging Energy Efficient Industrial Technologies	The Regents of the University of California, Office of the President - CIEE	NA	\$127,500
Validation of a New Technology for Real-Time Measurement of the Isotopic Composition of Methane in Ambient Air	Gas Technology Institute	Researchers will field test and verify a new instrument (the GyroTM) able to measure the isotopic composition and atmospheric concentration of both methane and CO2 in real time. This instrument's use could vastly improve inverse methods measurements, with the potential to significantly improve California's methane and CO2 greenhouse gas inventories.	\$250,000
Observation of Methane and other Non-Carbon Dioxide Greenhouse Gas Emissions from California	Lawrence Berkeley National Lab	Researchers will measure atmospheric concentrations of CH4 and other non-CO2 greenhouse gases and study the use of the data collected to verify the accuracy of estimated GHG emissions from in-state sources and determine if ambient measurements could be used to track in-state emissions. This will be the first time that researchers will investigate the feasibility of using ambient GHG measurements to track emissions at the regional or state level.	\$660,000
Next Generation Instantaneous Water Heater	Gas Technology Institute	The contractor will provide a review of available information on current instantaneous water heaters and conduct stakeholder interviews to identify technical and market barriers affecting the adoption of the technology in California. Current instantaneous water heater technology will be evaluated for its market potential and energy savings potential. The contractor will recommend next-generation instantaneous water heater technology that can be successful in the California market.	\$160,469
Determining the Volatility of Ultrafine PM Emissions from Compressed Natural Gas Vehicles Control Technologies	California Air Resources Board	The objective of this research is to determine the volatility of UF PM emissions from compressed natural gas (CNG) vehicles equipped with various types of emission control technologies representing near-term technology. In this project, researchers will collect samples of the UF PM for chemical speciation. This data will inform researchers as to the volatility of UF PM and will allow a better understanding of its formation, possible health effects, and control strategies. Once both the relative toxicity and volatility of UF PM emissions are known, emission control technology that will best protect human health can be identified for CNG vehicles. This, in turn, will reduce the deployment barriers and help expand the availability of vehicles capable of using alternative fuels.	\$350,000

Developing a Multi-State natural Gas Infrastructure Simulation Model to Analyze the Value of Natural Gas Storage in California	Energy & Environmental Analysis, Inc.	The proposed research will consist of two major components: (1) Two conceptual papers that describe the role of natural gas storage in the California and broader North American energy markets and juxtapose how gas storage is valued by individual market participants versus how it might be valued from the perspective of public benefits and public policies and (2) 30 analytic case study reports based on a fully specified computer model of natural gas storage operations that provides detailed economic evaluation of current and potential future storage infrastructure in California and surrounding western states. The two papers will be completed in the first year of this project along with the first 10 case studies. The last 20 case studies will be provided in the second year.	\$732,733
Water Heating and Hot Water Usage in California Homes	Lawrence Berkeley National Lab	The proposed research will continue efforts to characterize residential hot water usage through a partnership with the Department of Water Resources (DWR). This project will measure how much water and energy is wasted in hot water distribution systems (HWDS) in California residences and investigate the effectiveness of current retrofit options in reducing this waste of water and energy. This research will also continue supporting the market introduction of efficient gas storage water heaters by providing evaluations of promising technology innovations. This project will conduct efficiency tests on three promising, alternative storage-type gas water heaters. The proposed research also includes the continuation of efforts to collect the necessary data, conduct analysis and develop recommendations for energy-related code changes to improve the efficiency of HWDS.	\$525,000
High Efficiency Gas-Fired Drum Dryer for Food Applications	Gas Technology Institute	This PIER contract will demonstrate a cost-effective gas-fired drum dryer that combines high energy efficiency (75-85%) with lower Nitrous Oxide emissions (<50 parts per million). Testing will be performed at a California host site.	\$950,458
Reverse Annulus Single Ended Radiant Tube (RASERT)	Gas Technology Institute	This PIER contract will demonstrate a cost-effective gas-fired reverse annulus single-ended radiant tube (RASERT) that combines high energy efficiency (68%) with lower Nitrous Oxide emissions (50% reduction). This demonstration is intended to validate the technology performance, quantify efficiency improvements, and engage industry partners and utilities in advancing the technology via subsequent commercialization actions. Testing will be performed at a California host site. These results will be in line with the criteria identified by the CPUC (D.04-08-010) for public interest gas R&D projects: "Focus on energy efficiency, renewable technologies, conservation and environmental issues".	\$284,969
Effect of Natural Gas Fuel Composition on Vehicle Performance and Emissions	UC Riverside	This project will evaluate the performance of natural gas vehicles using various natural gas blends (based on expected LNG imports to California) and the air pollutant emissions impacts of using those gases. The project will include developing the test protocols, identifying and obtaining vehicles/engines to test, selecting natural gas blends to test, obtaining and blending gases, testing and data analyses. Testing will address issues such as the impact of the different LNG blends on power, knock potential, fuel economy/CO2 and emissions of pollutants.	\$400,000
Natural Gas Variability in California: Environmental Impacts and Device Performance	Gas Technology Institute	This project will test, evaluate, and model classes of industrial, commercial, and residential burners and their combustion control systems to determine performance and emissions effects of liquefied natural gas (LNG) and other substitute gases relative to traditional natural gas. This interchangeability information will provide a means to operate a flexible, safe natural gas system using the widest gas supply options for California customers.	\$736,690
Field Demonstration of 0.2 Grams Per Brake Horsepower-Hour NOx Natural Gas-Fired Engine	California Air Resources Board	This research will accelerate the commercialization of the Cummins Westport ISI natural gas engine that meets the 2010 NOx and PM standards. The engine will use spark ignition, exhaust gas recirculation technology with three-way catalyst technology for improved efficiency and lower costs. With power ratings from 250 to 320 horsepower, the engine will meet the requirements of many bus and truck applications. A successful demonstration will promote the advancement of technology to control NOx emissions, reduce engine fuel consumption, and add another technology available to meet the 2010 standards for new engines and for retrofit applications.	\$225,000
Using the California Fleet, Conduct Physicochemical and Toxicological Assessment of Particulate Matter Emissions	California Air Resources Board	This research will determine the relative toxicity of volatile and non-volatile PM fractions from heavy and light-duty vehicles operating with, and without, control technologies. Testing will be conducted in vehicle emissions laboratories using the unique USC particle concentrator technology for collection of sufficient emission samples for subsequent toxicological analysis. The USC particle concentrator is a PM collector that can capture coarse, fine, and ultra-fine fractions of PM. Testing and verifying potential impacts is necessary for expanding the availability and promoting the use of alternative fuel vehicles and engines.	\$225,000

Developing a Low-Cost, Daily Simulation Model of the California Natural Gas Transportation and Storage Network	UC Davis	This research will develop an analytical tool that will help inform policy, infrastructure, and daily operational decisions in the California natural gas network. The tool is a model of the pipeline and storage natural gas network in California, detailed enough to represent daily transportation and storage operations. Engineering, economic, and institutional information will be combined so that the model solves for a flow and inventory profile under a set of conditions that are as close as possible to the ones faced by actual participants in the natural gas market. The model will solve for the most efficient natural gas allocation for California while testing for the introduction of LNG, infrastructure expansions, modifications to regulatory constraints, and changes in seasonal demand.	\$55,948
Heavy-Duty Emissions and Fuel Consumption Improvement	California Air Resources Board	This research will evaluate the combination of vehicle platforms and technologies that would result in the greatest real-world emissions and fuel consumption improvements, particularly in the case of biofuel efficiency. This will be done by testing engines provided by OEMs that are in development and fueling them with ultra-low sulfur diesel, B20 and one or more other biodiesel blends. The testing will include a 13 mode transient cycle analysis, as well as cold and hot start testing.	\$150,000
Using Gasoline, Diesel, and Compressed Natural Gas (CNG) Vehicles, Characterize the Significance of Lube Oil in PM Formation	California Air Resources Board	This research will: a) Determine, to what extent, lube oil affects PM emissions while under various operating conditions, including varied duty cycle and temperature changes; b) Determine what lubricant properties influence PM formation; c) Determine if a lubricant be formulated to reduce PM emissions. Understanding the formation characteristics of PM emissions from natural gas vehicles will help in the development of PM mitigation technologies. This, in turn, will reduce deployment barriers and help to expand the availability of vehicles capable of using alternative fuels.	\$100,000
Expansion of proprietary models to conduct research on infrastructure and market demand scenarios	Black & Veatch Corporation / Lukens Energy Group	This project involves analyzing the California and western North America natural gas markets to understand whether natural gas underground storage will play a significant role in meeting natural gas demand needs for the forecasted growth in the California natural gas market. The analysis will consider competing assets to underground natural gas storage, review out-of-state alternatives, and review potential impediments to the increase of natural gas underground storage in California. The final deliverable will be a report that develops conclusions and analysis.	\$266,277
Solar Combined Heat and Power System	EDTEK	This project is the next phase of a previous PIER funded project, which was performed between 1999 and 2002. EDTEK has developed a low-cost, co-generating solar concentrator system that efficiently produces hot water and electricity. The solar combined heat and power system will be field demonstrated to confirm the long-term operational viability. Under this proposed project, the contractor will be teamed with the California State University San Diego to address the field-testing issues by installing a 48 kw thermal/15 kw electrical system (15 two-axis tracking parabolic four-dish cogeneration systems) on the university campus and monitoring operation for a one-year period.	\$500,000
Developing a research assessment of regulatory barriers to the expansion of natural gas storage facilities in California	MRW & Associates	This project specifically addresses barriers to increased natural gas storage in California with an emphasis on the market power threshold test by conducting a comprehensive analysis of barriers to expanded independent gas storage infrastructure in California. This analysis will draw upon existing academic literature on market power and market power threshold tests in the energy industry. The overall purpose of this research is to provide an assessment of whether market power threshold tests or other entry barriers are inhibiting independent gas storage infrastructure development in California and to evaluate possible changes to these tests that would allow for increased infrastructure development.	\$109,077
Field demonstration of natural gas savings using recycled glass for brick manufacturing	Fireclay Tile Inc.	This project will be a field demonstration to leverage the research study funded by California Department of Conservation's Recycling Division. The report demonstrates that bricks can be made using conventional forming strategies, but containing 50 percent coarse (12 mesh and finer) recycled glass as a substitute for ceramic grog, with energy savings of up to 40 percent.	\$122,500
Hot Water Distribution System Research	Heschong Mahone Group	This project will focus on opportunities to save energy in multifamily hot water distribution systems. The heat loss characteristics of hot water pipes will be better characterized, advanced control options will be developed, and energy-related design guidance and code recommendations will be published.	\$500,000

Engine CHP Emission Control Technology	DE Solutions, Inc.	This project will test and adapt automotive emissions control components for use on stationary natural gas engines in CHP applications. The automotive systems use air/fuel ratio controllers, a robust three-way catalyst, oxygen sensors, an oxidation catalyst, control software, diagnostics, and alarms. The new system will be applicable to rich burn and cooled exhaust gas recirculation engines less than 1,000 kW in size. Two CHP system manufactures, Tecogen and BluePoint Energy, will implement the new system on their engines so that the systems will exceed ARB 2007 requirements and SCAQMD's Rulemaking requiring continuous monitoring and control. Advances from the project are expected to begin being implemented in Tecogen and BluePoint Energy products as early as the end of 2008.	\$749,013
Commercial Gas Fryer for Food Service	Gas Technology Institute	This project will design, develop and test a commercially viable gas fryer that reduces energy costs, improves performance, and reduces oil consumption. The contractor will develop specifications and fryer designs concepts; fabricate, assemble, and bench test the fryer; and then conduct computational fluid dynamics tests to analyze both heat transfer and combustion. A prototype fryer will be built and tested according to ANSI and ASTM standards. The contractor will also develop a California market transformation plan outlining activities that Pitco, the key partner, can use to introduce the new gas fryer product.	\$286,025
Power Generation Integrated in Burners for Packaged Industrial/Commercial Boilers	CMC-Engineering	This project will develop, demonstrate, and introduce a packaged CHP system that integrates an unrecuperated 80 kW microturbine with a ultra-low NOx burner for packaged boilers. All of the waste exhaust heat of the microturbine is recovered within the boiler inlet air, thereby eliminating the need for waste heat recovery in a recuperator, a heat exchanger that is an expensive component of a conventional microturbine generator.	\$168,718
Estimation of Long-Term Energy-Efficiency Potentials for California Buildings and Industry	Lawrence Berkeley National Lab	Under this project the researchers are developing long-term energy efficiency supply curves (i.e., graphic displays of costs and availability of resources) under different socioeconomic scenarios. They are using the results of the investor-owned utilities' study as a starting point and will extend this study to 2050.	\$550,000
Integrated CHP Using Ultra-Low-NOx Supplemental Firing	Gas Technology Institute	GTI will develop and demonstrate an ultra-low-NOx CHP system that packages a state-of-the-art gas turbine and boiler with an innovative natural gas-fired supplemental burner. GTI will conduct a field trial and demonstration of the ultra low-NOx burner technology with a 70 kW microturbine. The burner is believed to have the capability of being scaled up to be used with a multi-megawatt gas turbine, which would increase the CHP market potential.	\$987
Production and Conditioning of High Sulfur Biogas for Fuel Cell Combined Heat and Power Generation	Gas Technology Institute	Gas Technology Institute will demonstrate high-sulfur biogas cleaning and conditioning to stringent fuel cell gas quality levels to displace natural gas fueling of two direct fuel cell power plants for combined heat and power generation. This project will demonstrate onsite processing and anaerobic digester for converting onion peel waste products to biogas at Gills Onions, the largest fresh onion processor in the world (110,000 tons/year 10% of Californias onion production), in Oxnard.	\$105,723
Total			\$9,514,578

Source: California Energy Commission Staff

Table 19: PIER NG Research Projects Funded Year-to-Date FY 2007-2008 (7/1/2007 through 6/30/2008)

Title	Company	Research Description	Funding
A 100 kW Dual Shell Stirling Engine with a Catalyzed Flow Burner That Meets ARB 2007 Standards	ADI Thermal Power Corporation	ADI Thermal Power will group four of its 25 kW Stirling engines into a 100 kW, four-cylinder engine package, integrate a new steam reformer module to convert some of the otherwise wasted exhaust thermal energy to chemical energy of a fuel, modify the burner system to meet California Air Resources Board (ARB) 2007 emission requirements, and add an overall control system to maintain emissions performance and meet facility electrical and thermal needs.	\$249,536
Improved Natural-Gas Fired Aluminum Smelter Burner	Gas Technology Institute	GTI proposes to install a demonstration of a commercial size prototype flex-flame burner in California. Thorock Metals in Compton hosted the early demonstration tests. Field demonstration is slated to be conducted over two years and will consist of parametric and life-cycle tests to optimize operating conditions, to confirm burner reliability, and to collect data on decreased emissions and energy use. The burner design is expected to lend itself to mass production.	\$10,000
California AUAV Air Pollution Profiling Study	Scripps Institution of Oceanography - UC San Diego	Use lightweight autonomous unmanned aerial vehicles to routinely profile the atmospheric concentration of black carbon, aerosol, carbon monoxide, ozone, and solar radiation over a period of one year. Data from the vertical profiles of pollution up to 12,000 feet above sea level combined with estimated back trajectories would help to sort out the original sources of pollution and BC in particular. The researchers will use the collected data to estimate the climatic effect of BC in California. The researchers will also collect rain and snow in four locations in the Sierra Nevada to measure the amount of carbon deposited with or on top of the snow. Other measurements will be taken to estimate the effect that BC has on snow reflectivity and, therefore, on the tendency of snow to melt.	\$698,991
Integrated CHP Using Ultra-Low-NOx Supplemental Firing	Gas Technology Institute	GTI will develop and demonstrate an ultra-low-NOx CHP system that packages a state-of-the-art gas turbine and boiler with an innovative natural gas-fired supplemental burner. GTI will conduct a field trial and demonstration of the ultra low-NOx burner technology with a 70 kW microturbine. The burner is believed to have the capability of being scaled up to be used with a multi-megawatt gas turbine, which would increase the CHP market potential.	\$500,450
Center for the Study of Energy Markets	Center for the Study of Energy Markets - UC Berkeley Energy Institute	Conduct research in five general market areas: (1) reliability/adequacy of supply, (2) retail policies/demand response, (3) market design, (4) interactions of environmental regulation and energy markets, and (5) competition and pricing of refined fuel products. In addition to economic research and preparation of technical papers, the CSEM program also sponsors research and policy conferences, and other elements of a tech transfer function, to facilitate the communication of its research findings and opinions to policy makers in the government agencies and industry.	\$500,000
Water Heating and Hot Water Usage in California Homes	Lawrence Berkeley National Lab	Continue efforts to characterize residential hot water usage through a partnership with the Department of Water Resources (DWR). This project will measure how much water and energy is wasted in hot water distribution systems (HWDS) in California homes and investigate the effectiveness of current retrofit options in reducing this waste. This research will continue supporting the market introduction of efficient gas storage water heaters by providing evaluations of promising technology innovations. This project will conduct efficiency tests on three promising, alternative storage-type gas water heaters. The proposed research also includes the continuation of efforts to collect the necessary data, conduct analysis and develop recommendations for energy-related code changes to improve the efficiency of HWDS.	\$454,000
Ultra Low Nox Burners	Gas Research Institute	This project will develop and demonstrate a 5-ppmv ultra-low-NOx burner for industrial water tube boilers that is based on GTI's patented Forced Internal Recirculation technology. GTI has teamed up with Coen Company of Burlingame to develop this burner and demonstrate it at a site in Pasadena (California Institute of Technology). The FIR burner is capable of reaching this level of NOx emissions with reduced flue gas recirculation and lower excess air than other types of ultra-low-NOx burners. A 62-million-Btu/h prototype will be demonstrated on a water tube boiler.	\$75,762
Hot Water Distribution System Research	Heschong Mahone Group	This project will focus on opportunities to save energy in multifamily hot water distribution systems. The heat loss characteristics of hot water pipes will be better characterized, advanced control options will be developed, and energy-related design guidance and code recommendations will be published.	\$929,841
Energy Efficiency Calculator Tools	Southern California Gas Company	To develop Web-based software and desktop tools to aid California industries to identify, analyze, and prioritize energy (i.e. natural gas and other alternate energy sources) savings opportunities. The tools are designed to help industrial end-users in analysis of energy saving opportunities and savings (energy in terms of MM Btu/year, energy cost in terms of US\$ and CO2 savings) by implementing selected energy saving projects.	\$154,440

Purification and Liquefaction of Biomethane Landfill Gas for Transportation Fuel	Gas Technology Institute	GTI will develop and demonstrate a system to convert landfill gas into liquefied natural gas (LNG) to be used as motor fuel for heavy duty vehicles. Gas clean-up research is to be led by Linde-BOC, the largest supplier of cryogenic gas products in the world. Commercialization and deployment efforts will be performed through Waste Management Incorporated (WMI), the largest landfill owner/operator and a large consumer of LNG in refuse trucks in the US. The project will be sited at WMI's Altamont Landfill in Livermore, and LNG generated will fuel WMI's fleet of heavy-duty vehicles.	\$998,000
Advanced Reciprocating Engine Technology for Power Generation	Request for Proposal	Joint project with PIER's Environmentally Preferred Advanced Generation subject area to identify and develop key technology in lean burn, stoichiometric exhaust gas recirculation, or other air-fuel mixtures for natural gas engines for use in stationary power generation applications or transportation applications. Stoichiometric EGR technology allows the use of a three-way catalyst to meet increasingly more the stringent emission requirements. Three-way catalysts require stoichiometric exhaust gas composition that is typically found in light-duty vehicles. Advanced technologies that provide benefits to heavy-duty vehicles used in both on- and off-road transportation would be supported by PIER Transportation.	\$1,000,000
Biomethane Cleanup in California Dairy Farms	Request for Proposal	Joint project with the PIER Renewable subject area to quantify, through a combination of field and laboratory studies, the technical and environmental performance of California's dairy biogas power systems including manure and effluent handling, anaerobic digestion, and biogas-to-electricity generation processes. The project's goals are to be achieved by monitoring, sampling, and analyzing material flows, documenting energy consumption and generation. The project will undertake detailed element, mass, and energy balances on the operating systems in use across multiple farms in California.	\$500,000
Total			\$6,071,020

Source: California Energy Commission Staff