

CALIFORNIA
ENERGY
COMMISSION

**PUBLIC INTEREST ENERGY RESEARCH
PROGRAM**

**2007 – 2011 NATURAL GAS RESEARCH
INVESTMENT PLAN**

COMMISSION REPORT

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Arnold Schwarzenegger, *Governor*

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ABSTRACT

This strategic plan for natural gas research has been developed as a complement to the Public Interest Energy Research (PIER) electricity five-year plan. The planning process for developing this five-year plan is characterized as closely tied to policy. The entire five-year plan has been structured around current State energy policy, as well as anticipating future policy issues. This five-year plan is integrated with the electricity five-year plan and program management plan that are simultaneously being developed. The team charged with the development of the plan consists of 26 key PIER staff, divided into three task forces (Electricity, Natural Gas, and Program Management). Additional perspective from key stakeholders, both within and outside the Energy Commission, was obtained through hundreds of interviews and multiple workshops. This document is a culmination of those interviews and meetings and reflects the thoughts and opinions of dozens of individuals from multiple stakeholder groups.

KEYWORDS

Public Interest Energy Research, PIER, PIERNG, Public Interest Energy Research Development and Demonstration, Natural Gas Research Investment Plan

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EXECUTIVE SUMMARY

Energy Issues Important to Californians

As directed by current State energy policy described in the *Energy Policy Report*, the *Energy Action Plan* and other State policy initiatives, and incorporating emerging issues from major trends and drivers, the Public Interest Energy Research (PIER) Natural Gas program has identified five key energy issues important to California. For each issue, the PIER Natural Gas program defined strategic objectives to accomplish during the next five years.

1. Affordable, comfortable, and energy-smart choices for daily life and a strong California economy.
 - 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 (NG).
2. Clean and diverse NG supply that optimizes California's resources.
 - a. Facilitate and encourage importation of liquefied natural gas (LNG).
 - b. Increase the volume and sources of in-state NG supplies.
 - c. Develop technologies to produce NG from alternative sources.
 - d. Develop renewable energy technologies to replace use of NG.
 - e. Develop knowledge base for future decision-making and informed supply policy relative to NG.
3. Clean and diverse transportation system in California.
 - 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 NG system that is reliable and secure.
 - a. Develop NG storage technologies.
 - b. Improve safety and security of production, storage, delivery, and use.
 - c. Develop tools and analysis to improve efficiency of NG markets.
 - d. Reduce peaks for improved asset utilization.
 - e. Understand and address impacts of LNG on NG infrastructure and related interchangeability issues.
 - f. Develop knowledge base for future decision-making and informed delivery, integration, and infrastructure policy relative to NG.

5. Environmentally sound NG system in California.
 - a. Understand the nature/significance of climate change and its relationship to NG 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 NG 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 NG.

Benefits and Challenges Ahead for PIERNG

The California Energy Commission (Energy Commission) has managed the PIER program for the State of California since 1999; however, 2005 was the first year for the PIER Natural Gas (PIERNG) program. To date, more than \$10 million worth of NG projects have been approved by the Energy Commission and launched by the PIERNG program. The PIERNG program with the California Public Utilities Commission (CPUC) will continue to build on this initial investment and collaborate to create a valuable portfolio of Research Development and Demonstration (RD&D) project investments that will help California meet its energy challenges in the years ahead.

California has a unique demographic and geographic profile, as well as unique vulnerabilities to natural and man-made disasters that require California-focused energy solutions. In addition, California government leaders need unbiased, accurate, and timely information to facilitate effective energy policy making.

The PIERNG program and its portfolio of RD&D investments will bring great benefits to Californians. Expected benefits of the PIERNG program include lower energy costs, achieved through the more efficient use of energy and the improved utilization and performance of the delivery system. They also include a clean and environmentally friendly energy system, based on renewable and alternative energy sources, that is cost-competitive with traditional NG resources. Other potential benefits are increased reliability of energy service, reduced health risk from poor indoor and outdoor air quality, reduced environmental and social footprint from energy infrastructure, reduced biological impacts, and reduced impacts from climate change.

PIER NATURAL GAS PROGRAM OVERVIEW

PIER Natural Gas History

AB 1002 (Wright), Chapter 932, Statutes of 2000, granted the California Public Utilities Commission (CPUC) the authority and discretion to determine the appropriate funding levels for NG low-income, energy efficiency, and public interest research, development and demonstration (RD&D) activities. On August 19, 2004, the CPUC adopted Decision 04-08-010 that established the level of funding for NG public interest RD&D, identified the California Energy Commission (Energy Commission) as the administrator of the PIERNG program, and established the administrator's responsibilities.

Recent legislation has added new responsibilities to the Energy Commission as administrator of the PIERNG program. SB 76 (Budget Committee), Chapter 81, Statutes of 2005, added Section 901 to the Public Utilities Code requiring the Energy Commission and the California Air Resources Board (CARB) to jointly develop a strategic research plan. The Energy Commission is expected to allocate one half of the PIERNG funds in any given program year consistent with that plan. SB 76 allows that up to one-third of the program funds may be used for transportation related public interest energy research and development provided the research provides NG ratepayer benefits.

Development of the Natural Gas Five-Year Plan

Unlike the PIER electricity program, which is mandated by legislation to develop a five-year strategic plan, there is no direct policy mandating the development of a NG five-year plan. This plan has been voluntarily created for three principle reasons. First, there are significant synergies between NG and electricity research that can be best captured by a joint-planning effort. Second, the CPUC requires an annual program plan for NG research activities. The five-year plan will provide the strategic direction for those subsequent annual plans. And third, SB 76 requires planning with the CARB to coordinate energy and environmental research priorities. The investment plan represents co-planning by the CARB and the Energy Commission at the strategic level and represents the forum for achieving consensus between CARB and the Energy Commission on natural gas strategic research issues and their respective priorities.¹

The natural gas strategic research plan is the reference document for Air Resources Board and Energy Commission co-planning. The Energy Commission may collaborate further on project areas where our interests overlap.

The planning process for developing this five-year plan is characterized as closely tied to policy, integrated and inclusive. The entire five-year plan has been structured around current State energy policy, as well as anticipating future policy issues. This five-year plan is integrated with the electricity five-year plan and program management plan that are simultaneously being developed. The team charged with the development of the

plan consists of 26 key PIER staff, divided in 3 task forces (Electricity, NG, and Program Management). Additional perspective from key stakeholders, both within and outside the Energy Commission, was obtained through hundreds of interviews and multiple workshops. This document is a culmination of those interviews and meetings and reflects the thoughts and opinions of dozens of individuals from multiple stakeholder groups.

As the PIERNG program moves forward with the implementation of the NG five-year plan, each program area will develop detailed roadmaps to translate the strategic objectives and research solutions into solicitations and proposed research projects. The program will go through an annual budgeting process and select a portfolio of short-, medium- and long-term investments in research projects and related outcomes. The program will revisit the portfolio every year as it goes through its budgeting cycle.

PIER Mission and Vision

The PIER program, including both electricity and NG research, has developed improved mission and vision statements. The program developed the improved statements to respond to the program's legislative mandates, as well as inspire staff, guide planning efforts, describe the desired end-state of the program, and communicate to stakeholders the purpose and objectives for the program. Figure 1 describes the new PIER mission and vision statements, as well as the desired energy context and organizational values.

Figure 1: California Energy Context, Mission Statement, Vision Statement, and Values

California Energy Context

California provides clean, affordable, reliable, and resilient sources of energy where consumers have choices that meet their needs, businesses prosper, and the State's beauty and environmental integrity are preserved.

PIER Mission Statement

The PIER program provides advanced energy innovations in hardware, software, systems, exploratory concepts, supporting knowledge, and balanced portfolio of near-mid-long term energy options for a sustainable energy future in California.

PIER Vision Statement

Sustainable energy choices for utilities, State and local government, and large and small consumers in California.

PIER Values

Legislative Mandate

- Improves the quality of life of Californians by protecting public health and providing environmentally sound, safe, reliable, and affordable energy services and products.
- Undertakes public interest energy RD&D projects that are not adequately provided for by competitive and regulated energy markets.
- Advances energy science and technology of value to Californians.

Processes

- Responds to energy problems important to Californians.
- Informs and responds to State policy.
- Provides environmental stewardship and natural resource conservation.
- Anticipates energy issues that California will face.
- Provides leadership to develop affordable, innovative, and useful solutions.
- Maintains integrity, objectivity, and trust as California's gateway for new energy technologies.
- Strives towards excellence in solutions, management, and administrative processes.
- Attracts, retains, and motivates the most talented staff.
- Balances a portfolio of incremental, breakthrough, and radical innovations.

Stakeholder Collaboration

- Works with stakeholders to plan research and transfer technology.
- Maximizes resources through valuable partnerships.
- Funds the best and brightest researchers.

Role of Policy, Technology, and Public Interest Research

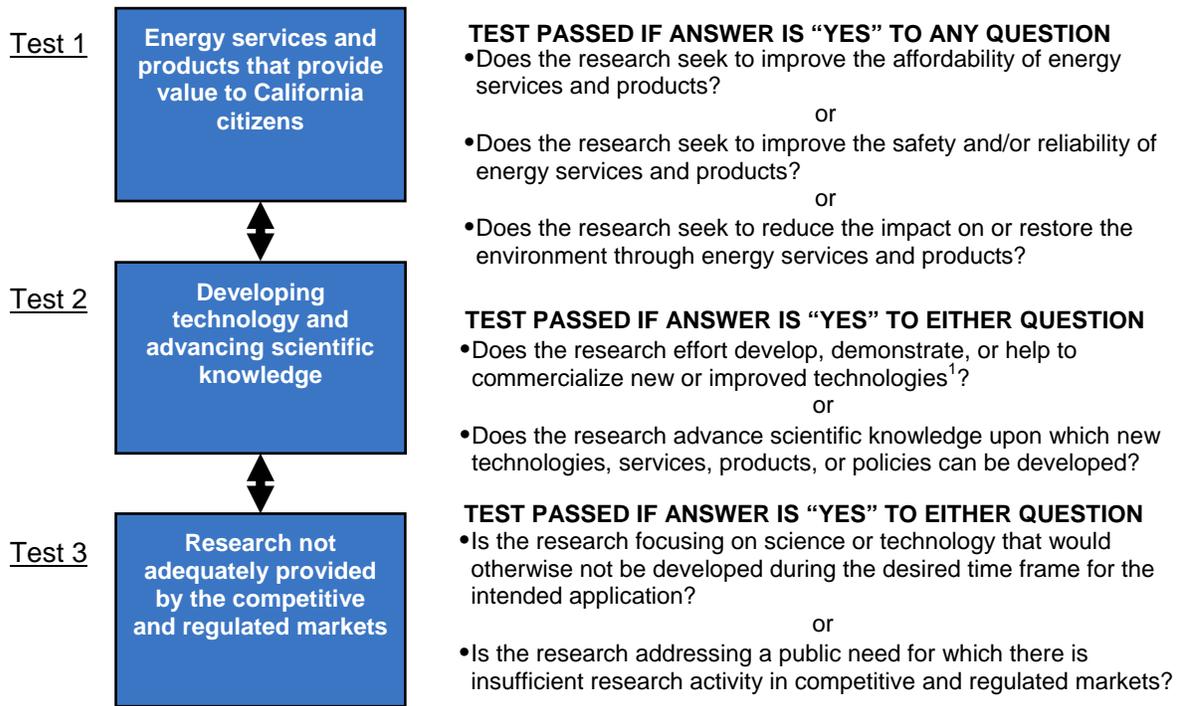
The PIERNG program will play a key role in technology development and informing energy policy. PIERNG will perform public interest research that enables the development and market adoption of new energy technologies that respond to current energy policy and provide significant benefits to Californians. PIERNG will perform research that provides valuable input to policy makers regarding science and technology, resulting in enhanced and timely policy development, including research required to develop regulations, tariffs, and incentives. In addition, PIERNG will perform research on emerging energy issues that will lead to the development of future State energy policy.

As the PIERNG program supports State energy policy and technology development, the program is legislatively mandated to perform only public interest energy research. To meet this mandate, the PIER program developed a set of screening criteria for both electricity and NG research (See Figure 2) that can be used in selecting a wide range of potential projects across the different program areas.

The public interest criteria (See Figure 2) consist of three tests that a project needs to pass to be eligible for PIERNG funding. This screen is the first step in the project selection process. If a proposed project meets the public interest screening criteria, it will then be evaluated against additional project selection criteria (such as alignment of the project with PIERNG's strategic objectives, value to ratepayers, contribution to research roadmap, as well as others) used by PIERNG to select the best projects to fund.

The CPUC supported the same definitions for public interest NG projects as the Energy Commission utilized in electricity funds (See Figure 3).

Figure 2: Public Interest Screening Criteria



¹Technology includes hardware, software, systems, exploratory concepts, and supporting knowledge.

Figure 3: CPUC Decision 04-08-010

We agree with UC and CEC (Energy Commission) that the definition contained in the 1996 Working Group Report on Public Interest RD&D activities is appropriate to define gas public interest R&D. This definition is relatively simple, although applying the definition to particular projects may be more difficult. Thus, our adopted definition is:

Public interest gas R&D activities are directed toward developing science or technology, 1) the benefits of which [sic] accrue to California citizens and 2) are not adequately addressed by competitive or regulated entities.

The PIER program will continue to improve and refine public interest research screening criteria in 2006. As California investor-owned utilities (IOUs) seek to reestablish regulated research programs, it will be important to clarify the definition of regulated, competitive, and public interest energy research. PIER will work with the CPUC, IOUs, State regulators, private industry, and other stakeholders to clarify the definition and relationship among these classifications of energy research.

SB 76 (See Figure 4) adds new language that must be factored into the selection of transportation projects. Figure A1-4, in the addendum, describes the public interest screen that will be applied to transportation research.

Figure 4: Senate Bill 76

**Senate Bill 76 amends Section 740.8 of the Public Utilities Code to read:
As used in Section 740.3, “interests” of ratepayers, short- or long-term, mean direct benefits that are specific to ratepayers in the form of safer, more reliable, or less costly gas or electrical service, consistent with Section 451, and activities that benefit ratepayers and that promote energy efficiency, reduction of health and environmental impacts from air pollution, and greenhouse gas emissions related to electricity and natural gas production and use, and increased use of alternative fuels.**

SEC. 6. Section 901 is added to the Public Utilities Code, to read:

(a) Funds allocated pursuant to this article for public interest energy research and development shall be administered by the Energy Resources Conservation and Development Commission consistent with orders and decisions adopted by the commission.

(b) One half of funds allocated pursuant to this article for natural gas public interest energy research and development shall be expended pursuant to a strategic research plan jointly developed by the state Air Resources Board and the Energy Resources Conservation and Development Commission to ensure coordination of the state’s energy and environmental research priorities. The plan shall be submitted for review and approval to the commission.

(c) Up to one-third of the funds allocated pursuant to this article may be used for transportation related public interest energy research and development provided the research provides natural gas ratepayer benefits and those benefits are identified in the plan.

(d) Funds allocated in subdivisions (b) and (c) shall not be used for the California Hydrogen Blueprint Plan.

(e) This section shall remain in effect until January 1, 2009, and as of that date is repealed unless a later enacted statute extends or repeals that date.

ENERGY ISSUES IMPORTANT TO CALIFORNIA

Policy Shaping California's Energy Future

Chapter 7.1 of the Warren-Alquist Act states that "it is in the best interests of the people of California that the quality of life of its citizens be improved by providing environmentally sound, safe, reliable, and affordable energy services and products." State legislators and policy makers are continuously looking to improve energy services and products to achieve these objectives. They set the direction for California through a series of laws and policy initiatives that cover a wide range of energy issues. The PIERNG program provides the research to support these efforts. In addition to supporting California issues, PIERNG also informs federal energy and environmental policy.

The *Energy Policy Report* is the recognized publication required by law to recommend energy policy. It is developed every two years, with an update in-between, by the Energy Commission in collaboration with such organizations as the CPUC, California Environmental Protection Agency (CalEPA), and California Independent System Operator (CA ISO). It defines the energy issues that the state will need to address over the coming years. It also identifies areas of policy, regulatory, and technology research that the PIERNG program will need to address. The *Energy Policy Report* development process includes extensive participation for key industry stakeholders (for example, 56 public workshops were held during the development of the 2005 *Energy Policy Report*). The 2005 *Energy Policy Report*, published November 2005, addressed the following issues:

- Electricity needs and procurement policies.
- Demand-side resources, distributed generation, and other electricity supplies.
- Transmission challenges.
- Renewable resources for electricity generation.
- The challenges and possibilities of NG.
- Integrating water and energy strategies.
- Transportation fuels.
- Global climate change.
- California-Mexico border region energy issues.

The *Energy Action Plan* is a policy implementation plan that also provides guidance on State energy policy. Jointly developed by the Energy Commission and the CPUC, with input from the CalEPA, CA ISO, and the Business, Transportation, and Housing Agency, the *Energy Action Plan* is meant to provide direction on the implementation of energy policy. This plan also identifies areas where public interest energy research is required. The *Energy Action Plan II*, adopted September 2005, identified the following key actions for energy RD&D:

- Energy efficiency technologies transformation to tools and standards.

- Demand response technologies, including communication and control, planning tools, end-use technologies, and validation methodologies.
- New technologies for renewables and greenhouse gas mitigation, including efficiency, renewable generation, and energy storage.
- NG RD&D to address biogas and syngas, storage reservoir management, safety and efficiency, and high-quality NG.
- Efficiency improvements of petroleum-fueled vehicles; availability and use of non-petroleum fuels.
- Clean coal technology RD&D and CO2 sequestration.
- Cost-effective dry cooling technologies and minimization of once-through cooling practices.
- Transmission technology development to maximize efficient use of the bulk electricity grid.
- Participation of the Biomass Collaborative with the Interagency Working Group's efforts on an integrated and comprehensive State policy on biomass that encompasses electricity, NG, and transportation fuel substitution potential.
- Climate change – Consequence evaluation of climate change and adaptation and mitigation strategies for California.

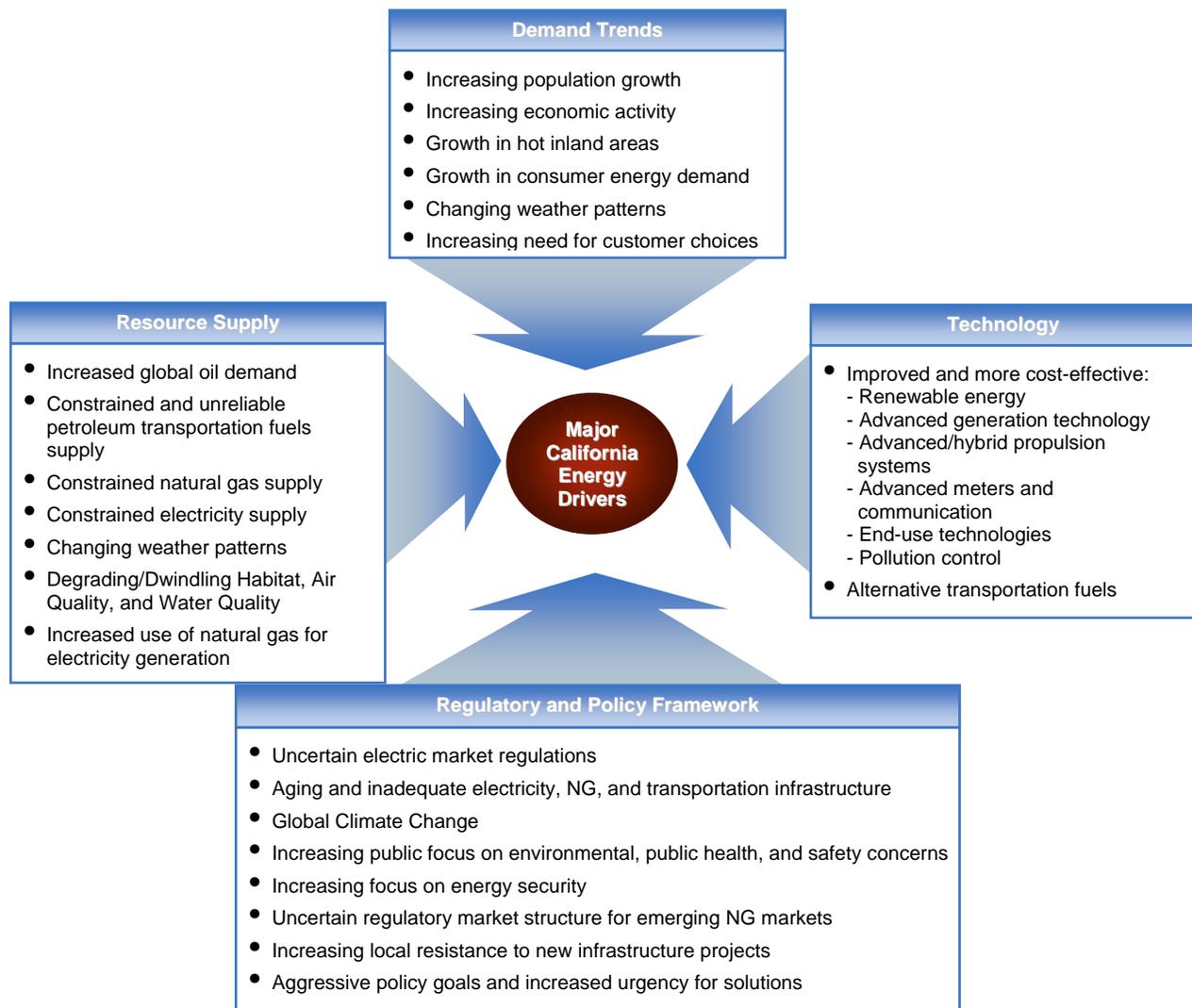
In addition to these reports, the PIERNG program supports additional State energy policy initiatives from the Governor and regulatory agencies (for example, Energy Commission Siting and Standards Divisions, CPUC, and CARB).

Throughout this document, specific policy statements from the *Energy Policy Report*, *Energy Action Plan*, and other energy policy initiatives that are guiding PIER research will be identified. A summary of the energy policy supported by PIER research can be found in Appendices A – E.

Trends and Drivers

In addition to following direction from State energy policy, the PIERNG program will continuously look at trends and drivers shaping the energy sector and the related emerging policy and technology issues that will lead to environmentally sound, safe, reliable, and affordable energy services and products. While developing this five-year plan, PIERNG identified 26 energy trends and drivers. Figure 5 lists the trends and drivers grouped into four categories: Demand Trends, Resource Supply, Technology, and Regulatory and Policy Framework.

Figure 5: California Energy Trends and Drivers



Demand Trends

There are significant trends impacting the demand for energy in California. Specifically, the population and economic development in hot/cold inland areas requires new energy infrastructure, increases home energy consumption and peak demand spikes, and increases driving distances and use of transportation fuel. In addition, the growth of the entire western region population increases demand for electricity, NG and transportation fuels and will put pressure on the infrastructure unless the growth can be mitigated by decreased per-capita consumption.

Resource Supply

The availability and stability of the electricity and natural supplies, including in-state generation, importation from other western states (for example, coal, renewables,

hydroelectric power from Northwest) and Baja California, Mexico, and the importation of LNG will impact prices and increase price volatility. In addition, changing weather patterns will likely reduce the available snow pack to be used for hydroelectricity.

Regulatory and Policy Framework

Uncertainty exists in the direction of regulatory control and the effects in the competitive markets. This includes but is not limited to tariff structures and the fact that current approaches to calculate life cycle costs do not consider fuel costs. Furthermore, the application for existing regulations and consumer and government support for new regulations to protect the environment (for example, Renewable Portfolio Standards, efficiency standards, local air quality emission regulations) will have implications to infrastructure constraints, energy prices, and protection of the environment, public health, safety, and environmental justice.

Technology

Technology breakthroughs in performance and cost, along with the wide adoption of advanced technologies for generation, meters, communication, and transportation, will provide additional energy supply options, increased environmental benefits, and reduced life cycle costs.

Key Energy Issues

As directed by current State energy policy, and incorporating emerging issues from these trends and drivers, the PIERNG program has identified five key energy issues important to California. These issues are:

- Affordable, comfortable, and energy-smart choices for daily life and a strong California economy.
- Clean and diverse NG supply that optimizes California's resources.
- Clean and diverse transportation system in California.
- Integrated NG system that is reliable and secure.
- Environmentally sound NG system in California.

The following sections will identify key policy directives, as well as define PIERNG strategic objectives and PIERNG research solutions for each of the five key energy issues over the 2007 to 2011 period. Through this document there are sidebars with examples of research projects that address the key energy issues and their benefits.

AFFORDABLE, COMFORTABLE, AND ENERGY-SMART CHOICES FOR DAILY LIFE AND A STRONG CALIFORNIA ECONOMY

Current State Policy

The Governor's directive, *Energy Action Plan/Energy Policy Report* Loading Order, and CPUC demand reduction goals provide key policy guidance to research toward achieving affordable, comfortable, and energy-smart choices for daily life and a strong California economy. Specifically, the CPUC has established the state goal of a cumulative reduction of 290 million therms in NG demand from IOU 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).

The *Energy Policy Report* defined NG efficiency as the top priority for PIERNG. It called for the implementation of a loading order to encourage the most efficient, clean, and cost-effective energy options to meet demand. The *Energy Policy Report* also defined the need for Combined Heating and Power (CHP) to play a larger role in improving NG efficiency. Furthermore, the *Energy Policy Report* defined the need to reduce use and increase efficiency of NG in the water sector. The *Energy Action Plan* and the Governor have identified the need to develop new technologies to improve the efficiency of NG supplies. A list of relevant policies can be found in Appendix A.

Trends and Drivers

Demand trends are a key concern for PIERNG in this area as it anticipates future needs. Increasing population growth will lead to increased demand for NG unless it can be reduced by further efficiency gains. A significant portion of the State's population growth is occurring in hot/cold inland areas, increasing energy consumption and peak demand spikes. Furthermore, there is increasing pressure from consumers to select their energy services from a set of energy products and services. Other trends that could have a significant impact in this area include changing weather patterns,

Super Efficient Gas Water Heater Appliance Initiative

Problem

More than 10 million California homes heat water with natural gas. Conventional residential gas water heaters use a simple but antiquated design that wastes energy. As a result, water heating accounts for over 40 percent of all natural gas used in California homes.

PIER Solution

The Super Efficient Gas Water Heater Appliance Initiative (SEGWHA) is a multi-year program that will generate the necessary market pull and foster partnerships to develop cost-effective replacement water heaters with energy savings of approximately 30 percent compared to new conventional units, with a 50 percent reduction in nitrogen oxide (NOx) emissions.

Preliminary work on this effort will include the technical and market analyses necessary to determine the best ways to achieve a significant efficiency improvement in gas water heaters. This first phase will assess manufacturer interest and capabilities, document probable pathways for gas water heater technology improvements, and assess the potential for energy and environmental benefits. A big part of this effort includes building partnerships with gas utilities, manufacturers, gas trade associations, national energy efficiency organizations, as well as US DOE and Environmental Protection Agency.

Expected Benefits

A 30 percent improvement in efficiency will save 47.6 million therms/year California and 2.8 million Tons of CO₂/year. A 50 percent reduction in NOx emissions will save 0.48 million Pounds NOx/year.

the constrained supply of NG, and the wide adoption by energy consumers of real-time energy management and dynamic control systems.

PIERNG Strategic Objectives

To support the State in accomplishing these policies and goals, as well as anticipate future needs, the PIERNG program has defined three strategic objectives that will provide California with affordable, comfortable, and energy-smart choices for daily life and a strong California economy:

- 1. Reduce cost and improve performance of efficiency systems for buildings and industrial processes.** This objective is directly tied to helping the State meet the aggressive efficiency goals, as well as supporting the implementation of efficiency as the first option in the loading order.
- 2. Develop energy-efficient technologies for unique California conditions and industries.** This objective will also help the State meet the aggressive efficiency goals and the implementation of efficiency as the first option in the loading order. Moreover, it will help address issues related to population and economic growth in hot/cold inland areas.
- 3. Develop knowledge base for future decision-making and informed end-use policy for NG.** This objective will address the trends, technology gaps, and emerging energy issues to provide policy makers with the knowledge required to develop effective future policy in this area.

PIERNG Research Solutions

To achieve these strategic objectives, the PIERNG program identified nine research solutions. The solutions were prioritized into primary, secondary, and tertiary areas of RD&D based on relevance to State policy, critical technical gaps, and the potential impact of emerging trends and drivers.

Primary Areas of RD&D

- Reduce first costs and operational costs of energy-efficient technologies and systems for buildings and industries.
- Increase efficiency of existing building systems and industrial processes (for example, develop replacement / retrofit products, improve operational strategies, identify intervention tactics).
- Develop energy-efficient end-use technologies and strategies for unique California conditions and industries (for example, climate, construction practices, state standards, and industrial processes).

Secondary Areas of RD&D

- Develop sustainable technologies, designs, and systems for buildings and industrial applications (for example, sustainable building construction practices, use of industrial waste as an energy resource).

- Develop integrated gas/electric solutions, including combined cooling, heat and power systems for commercial, institutional, and industrial applications where heat is the desired product.
- Optimize the use of thermal energy in industrial processes, including waste heat recovery and clean combustion.
- 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.

Tertiary Areas of RD&D

- Develop benchmarking tools and standard practices and specifications for energy efficiency.
- Develop commissioning, benchmarking, diagnostic tools, standard practices, and specifications for efficiency.
- Improve understanding of consumer behavior and market issues.
- Improve control strategies to capture synergies between water and space heating.

Benefits to Californians

As the PIERNG program works to enable affordable, comfortable, and energy-smart life choices for daily life and a strong economy, Californians will gain important benefits. The most important benefit is lower energy costs that will be 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; and improved environmental quality.

CLEAN AND DIVERSE NATURAL GAS SUPPLY THAT OPTIMIZES CALIFORNIA’S RESOURCES

Current State Policy

The *Energy Action Plan/Energy Policy Report* Loading Order and the Governor’s Ten Point Plan for increasing the diversity of NG supply portfolio and support of LNG provide key policy guidance on NG supply-related issues. RD&D on these issues will enable the State to achieve a clean and diverse NG supply that optimizes California’s resources.

The *Energy Policy Report* defined the need to support import of LNG, addressing facility safety, environmental, and quality issues.² The Governor’s response to the IEPR encouraged the construction of LNG facilities and infrastructure to help ensure adequate supply and price stability. The *Energy Policy Report* and *Energy Action Plan* promote the increase of NG production from alternative sources and RD&D to support policies affecting biogas and syngas supply. The *Energy Policy Report* also defined the need to manage gas quality and gathering issues related to the expansion of in-state production. Furthermore, the *Energy Action Plan* defined the need for RD&D to improve long-term reservoir management. A list of relevant policies can be found in Appendix B.

Trends and Drivers

Resource availability, demand trends, and regulatory framework are key drivers in this area. The availability and stability of NG supply will impact prices and price volatility. There is increased use of NG for electricity generation as well as increased consumer demand for NG. Moreover, there is uncertainty around how to regulate new NG markets and quality that will affect the development of the market and the infrastructure.

PIERNG Strategic Objectives

To support the State in accomplishing these policies, and to anticipate future needs, the PIERNG program has defined five strategic objectives that will provide California with a clean and diverse NG supply that optimizes the state’s resources:

- 1. Facilitate and encourage importation of LNG.** This objective responds to the request by the *Energy Policy Report* and the Governor to facilitate and encourage the importation of LNG. It will help address trends related to

Industrial Solar Use

Problem

Increases in natural gas prices and stringent emission requirements require use of less polluting alternatives. Yet the lack of confidence in emerging solar technologies and their ability to integrate industrial systems has limited deployment of the technology.

PIER Solution

In collaboration with an industrial energy user in the food processing industry, PIERNG has funded a demonstration of a 55,000 sq ft solar collector system that will reduce natural gas use by 30 percent. A consortium of utilities, Air Quality Management Districts, and other agencies would monitor the performance and use the data to accept the technology as a Best Available Control Technology in California.

Expected Benefits

Reduce the dependence on natural gas and reduce emission by using the abundant solar resource in California.

increased demand and resource availability. It will also help develop regulations related to NG markets and infrastructure.

2. **Increase the volume and sources of in-state NG supplies.** This objective responds to the *Energy Policy Report* and *Energy Action Plan* issues related to in-state NG supplies. It will also help address trends related to increased demand and resource availability.
3. **Develop technologies to produce NG from alternative sources.** This objective responds to the *Energy Policy Report*, *Energy Action Plan*, and the Governor's issues related to alternative sources. It will also help address trends related to increased demand and resource availability.
4. **Develop renewable energy technologies to replace use of NG.** This objective responds to the Governor's request to expand the generation of gas from landfills, biomass, and other renewable sources. It will also help address trends related to increased demand and resource availability.
5. **Develop knowledge base for future decision-making and informed supply policy relative to NG.** This objective will address the trends, technology gaps, and emerging energy issues to provide policy makers with the knowledge required to develop effective future policy in this area.

PIERNG Research Solutions

To achieve these strategic objectives, the PIERNG program identified research solutions. The solutions were prioritized into primary and secondary areas of RD&D based on relevance to State policy, critical technical gaps, and the potential impact of emerging trends and drivers.

Primary Areas of RD&D

- Assess the quality and interchangeability of LNG to determine its environmental and performance impact.
- Reduce the cost and improve the performance of technologies to produce NG (or biogas) from landfills, wastewater treatment, synthetic gas (syngas), and biomass.
- 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).
- Improve and reduce the cost of clean combustion technologies.

Rocket Technology to Combust Natural Gas

Problem

If carbon dioxide (CO₂) emissions are constrained or taxed because of global warming concerns, the cost of electricity from fossil-fired generation plants will increase because the CO₂ must be removed from a large volume of stack exhaust.

PIER Solution

Use rocket technology to combust natural gas with oxygen obtained from an air separation plant. Generate electricity in a steam turbine, condense out the water, and sequester the CO₂ or use the CO₂ for enhanced oil recovery.

Expected Benefits

With carbon sequestration, this is a nearly zero-emission power plant. The technology could be cost competitive with even the best natural gas-fired combined cycle power plant, if carbon emissions are limited.

- Improve and reduce the cost of NG thermal gasification convergence methods and reformer technologies.

Secondary Areas of RD&D

- Facilitate the development of standards for gas quality (for example, LNG, non-conventional and interstate) and gathering issues.
- Support the development of co-production technologies (for example, substitute NG and electricity).

Benefits to Californians

As the PIERNG program works to enable a clean and diverse NG supply that optimizes California's resources, Californians will gain important benefits. The most important benefit is that Californians will have a clean and environmentally friendly energy system, based on renewable energy sources, that is cost-competitive with traditional oil- and gas-fueled generation technologies. Other benefits include reduced dependence on out-of-state/international resources and reduced volatility of energy prices. For example, the PIERNG has recently funded a demonstration project at a major food processing company in California's Central Valley to reduce the use of NG by medium temperature solar collectors. Besides reducing NG use by 30 percent, the industry helps reduce the emission in a location that is in non-compliance with the EPA NOx requirements.

CLEAN AND DIVERSE TRANSPORTATION SYSTEM

Current State Policy

Transportation issues have been historically outside the mandated direction of the PIER program. However, recent legislation, SB 76, states that “Funds deposited in the Public Interest Research, Development, and Demonstration Fund may be expended for projects that serve the energy needs of both stationary and transportation purposes if the research provides a NG ratepayer benefit.”

The Energy Commission and the CalEPA, in separate proceedings, have evaluated the State’s most critical transportation energy issues and engaged stakeholders and other agencies to develop policy and action recommendations to address these issues. The Energy Commission and Cal EPA have developed policy and action recommendations for the Governor aimed at achieving a clean and diverse transportation system that meets increasing fuel demand through efficiency improvements and alternative fuels:

- Double the combined CAFE standard for new passenger cars and light-trucks by 2020 (2003 *Energy Policy Report*).
- Increase the percent of on-road non-petroleum fuel use to 20 percent by 2020 and 30 percent by 2030 (2003 *Energy Policy Report*).
- Reduce greenhouse gas emissions to 2000 level by 2010, to 1990 level by 2020, and to 80 percent below 1990 level by 2050 (Governor Executive Order S-3-05 included in Appendix G).
- Advance technology that provides petroleum reduction, greenhouse gas, and air quality benefits and supports the long-term transition to a transportation system based on alternative fuels such as hydrogen.
- Expand California’s goods movement industry and infrastructure in a manner that will increase mobility and relieve congestion, and improve air quality and protect public health (Governor’s Goods Movement policy statement).
- Reduce air pollution by up to 50 percent (Governor’s Environmental Action Plan).

PIER is guided by the *Energy Policy Report* recommendations and public processes that engage the research community to develop its transportation research strategies. A list of relevant policies can be found in Appendix C.

Trends and Drivers

Transportation accounts for half of all energy used in the State and is responsible for nearly half of all greenhouse gas emissions. Transportation also is the largest source of air pollution, emitting nearly 70 percent of smog-forming pollutants. Demand for gasoline and diesel has grown nearly 50 percent in the past 20 years and is continuing, even in the face of record prices. Population growth, consumer preference for less efficient vehicles, increasing traffic congestion and driving distances, lack of alternative

fuels and adequate mass transit options are contributing to this demand for fuel. Since California is almost entirely dependent on oil for transportation uses 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.

PIER Strategic Objectives

To support the state in accomplishing these policies and goals, as well as anticipate future needs, the PIER program has defined four strategic objectives that will provide California with a clean and diverse transportation:

- 1. *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.*** By pursuing petroleum reduction opportunities within California that also maximize economic, environmental and public health objectives, the State can galvanize broader public and private resources, create price competition within the transportation market, and accelerate the pursuit of reducing our dependence petroleum.
- 2. *Develop and demonstrate technologies to improve efficiency within the transportation system.*** Increasing vehicle fuel economy is the most cost-effective means to reduce gasoline use, greenhouse gas emissions, and vehicle pollution. Since CAFE standards are the purview of the federal government, the State must look to other strategies to enhance the efficient use of gasoline and diesel fuels. These include development of vehicle efficiency technologies that can be adopted by the industry, demonstrating innovative mass-transit applications, and commercializing systems that conserve gasoline and diesel fuel.
- 3. *Develop and demonstrate alternative fuels, vehicles and fueling infrastructure.*** Another important strategy the State can directly affect is diversification of the fuel supply. In this regard, priority should be given to fuel blends (for example, non-petroleum fuels blended with gasoline and diesel) that can be used in existing engine systems and fueling infrastructure. Renewable fuel blends should be of particular importance given the potential to produce these fuels from in-State resources and provide economic value to California. However, given the significant long-term potential to reduce petroleum use, greenhouse gas emissions and vehicle pollution, the State should support all reasonable non-petroleum fuel and technology options.
- 4. *Develop the knowledge base and advanced analytical tools for future decision-making and informed transportation policy.*** This strategy fills a critical gap in energy policy by more clearly defining the relationships between

transportation energy supply and demand and the effects on consumer behavior, market behavior and land-use planning.

PIER Research Solutions

To achieve these Strategic Objectives, the PIER program used the IEPR recommendations to identify research solutions for transportation. The solutions represent areas of RD&D based on relevance to state policy, critical analytical and technical gaps, and the potential impact of emerging trends and drivers.

In 2006, the PIER transportation program will start a series of planning meetings with CARB staff, other key stakeholders, and state transportation agencies to assist in prioritizing and refining the research solutions. In parallel, PIER also expects to select and fund several near-term transportation research projects that provide clear benefits to California electricity ratepayers as required by SB76 and address urgent State transportation policy mandates. These mandates include needs to reduce California's petroleum dependency, reduce California's contributions to greenhouse gasses and reduce air quality impacts from the transportation sector. Decisions on priorities will also be dictated by the amount of public research funds allocated to transportation. The Energy Commission intends to use a broad interpretation of electricity ratepayer benefits as they apply to transportation research projects. For example, transportation projects that improve efficiency or reduce air emissions or reduce greenhouse gasses or increase alternative fuels use would be considered for funding. However, project proponents will be expected to identify benefits to electricity ratepayers. The addendum provides further detail on the project selection methodology.

Advanced Energy Pathways

Problem

The future of the electricity and natural gas sectors is strongly linked to the energy pathways that the State may choose for the different sectors of the economy. The potential energy pathways for the transportation sector in particular such as plug-in hybrids and the use of hydrogen as a transportation fuel could severely affect the natural gas and electricity systems by increasing or decreasing the prices and availability for these two energy carriers.

PIER Solution

The purpose of this on-going research is to conduct an integrated analysis that compares the costs and benefits of alternative transportation fuel pathways from the perspective of electricity and natural gas sectors, greenhouse gas emissions, tailpipe emissions, gasoline consumption, cost-effectiveness, technical challenges, infrastructure issues, safety issues, and policy implications.

Expected Benefits

The findings from this project are expected to provide policy makers with as comprehensive a view as possible of the various pathways and their costs and benefits.

Transportation Research Solutions

- 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.
- Develop and demonstrate alternative transportation fuels that can augment available transportation fuel supplies with non-petroleum sourced fuels, can

optimize their efficiency, environmental and public health benefits, and commercial viability over the mid and long term.

- 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.
- Develop and demonstrate options for alternative fuel distribution, infrastructure development and deployment and accelerate storage and distribution technology development for non-petroleum alternative fuels.
- Develop and demonstrate mitigation strategies that address the environmental and economic impacts of non-petroleum alternative fuel production, distribution and utilization, and accelerate the deployment and refinement of highly efficient transportation technologies.
- Develop and demonstrate advanced planning tools, processes and regulatory models that integrate fuel choices and demand considerations and innovative mass-transit strategies in local land-use and transportation planning.
- Develop technologies and tools to further understand consumer behavior and preferences and how these are affected by fuel choices and market conditions.

Benefits to Californians

To meet the State's growing population and economic demands, ensuring a reliable, clean, affordable transportation system is vital. The Energy Commission has started an integrated analysis of the costs and benefits of alternative transportation fuel pathways and implications of these pathways on electricity and NG sectors, greenhouse gas emissions, tailpipe emissions, gasoline consumption, cost-effectiveness, technical challenges, infrastructure issues, safety issues, and policy implications. 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. In the years ahead, as the PIER program works to enable a clean and diverse transportation system, Californians will gain important benefits that include reduced impact from global climate change, reduced health 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

Current State Policy

Increasing the safety and security of the NG infrastructure, improving NG markets, and increasing the use of NG storage in support of the *Energy Policy Report*, *Energy Action Plan*, and Governor's Ten Point Plan (see Appendix F) provide key policy guidance to research toward achieving an integrated NG system that is reliable and secure.

The *Energy Policy Report* and the Governor defined the need for storage to help provide adequate supply and protect prices. The *Energy Policy Report* defined the need for increased capacity of pipeline infrastructure. The *Energy Action Plan* defined the need to improve NG markets and RD&D to support safety issues. A list of relevant policies can be found in Appendix D.

Trends and Drivers

The regulatory framework and technology advances have significant impact in this area as they anticipate future policy needs. The poor state of current infrastructure, lack of collaboration, and regulatory constraints to develop 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.

PIERNG Strategic Objectives

To support the State in accomplishing these policies and goals, as well as anticipate future needs, the PIERNG program has defined six strategic objectives that will provide California with a safe, secure, and reliable NG system:

1. **Develop NG storage technologies.** This objective will help meet NG storage needs defined by the *Energy Policy Report* and the Governor. It will also help improve the aging and inadequate infrastructure.

Knowledge of Consumer Response

Problem

Consumer response to energy problems can be crucial in moderating demand and stabilizing supply resources. Rapidly rising natural gas prices this coming winter will almost certainly reduce overall demand. But this "elasticity" of consumption is not well understood, either in terms of how it occurs in the population or when. From research on the 2000-2001 electricity supply crisis in California, we learned that the conservation response was widespread. The natural gas price shocks of the winter of 2005-2006 might produce similar, widespread responses. Our knowledge in this area is very limited and, as a result, so are the policy tools available to support consumer choice and energy/economic system resilience.

PIER Solution

Develop improved knowledge of consumer response to the large natural gas price increases expected during the winter of 2005-2006 by surveying residential customers as the price impacts are arriving.

Expected Benefits

The data collected from this survey will be analyzed, using a variety of approaches, to better inform longer-term consumer-focused policies, programs and utility rate tariffs.

2. **Improve safety and security of NG production, storage, delivery, and use.** This objective will address *Energy Action Plan* safety issues as well as the increasing focus on energy security and protection against natural and terrorist threats to energy infrastructure.
3. **Develop innovative tools, methods, and models to improve efficiency of NG markets.** This objective will help address the *Energy Action Plan* requirement to improve NG markets.
4. **Reduce peaks for improved asset utilization.** This objective will improve the throughput of the aging and inadequate energy infrastructure.
5. **Understand and address impacts of LNG on NG infrastructure and related interchangeability issues.** This objective will help meet NG supply policies related to promoting and facilitating importation of LNG as well as improve the aging and inadequate energy infrastructure.
6. **Develop knowledge base for future decision-making and informed delivery, integration, and infrastructure policy relative to NG.** This objective will address the trends, technology gaps, and emerging energy issues to provide policy makers with the knowledge required to develop effective future policy in this area.

PIERNG Research Solutions

To achieve these strategic objectives, the PIERNG program identified research solutions. The solutions were prioritized into primary, secondary, and tertiary areas of RD&D based on relevance to State policy, critical technical gaps, and the potential impact of emerging trends and drivers.

Primary Areas of RD&D

- Analyze impact storage would have on the market and the conditions required for investment in storage infrastructure.
- Investigate an efficient interface of electricity and NG infrastructure.
- Support improvement of technologies and tariffs for demand response (for example, communication, control and integration, automation strategies).
- Develop a NG system (cyber and physical) that is resilient to natural and man-made events, self-diagnosing, and self-healing.

Secondary Areas of RD&D

- Support efforts by others to analyze interchangeability impacts on various sectors, such as gas distribution, end-use, system reliability, and transportation.
- Improve the understanding of NG markets.
- Improve means of measuring and predicting economic impacts of NG use.
- Improve the safety of NG production, storage, delivery, and use.
- Improve the NG infrastructure between Mexico and California to accommodate LNG.
- Develop tools and models to assess the risks associated with predominantly NG-fueled electric generation.

- Develop tools and models to understand impact policy actions have on infrastructure investment decisions.

Benefits to Californians

As the PIERNG program works to enable an integrated NG system that is reliable and secure, Californians will gain important benefits. The most important benefit is the increased safety and reliability of NG service. This increased reliability will be the result of a modernized and secure infrastructure where NG deliverability is improved. Another important benefit will be the reduced cost of NG that will result from improved use of storage technologies and a better understanding of NG markets.

ENVIRONMENTALLY SOUND NATURAL GAS SYSTEM

Regional Climate Change Modeling

Problem

Long-term planning requires a qualitative understanding of how climate may change in California. There is also an urgent need to try to estimate the likelihood of the different climate scenarios projected for California.

PIER Solution

PIER is in the process of developing probability climate projections for California with the level of temporal and geographical resolution needed to estimate impacts at the sub-regional or local levels. PIER researchers are also developing the tools needed to generate probabilistic climate projections based on the outputs of multiple global climate models and the enhanced numerical and statistical regional climate models.

Expected Benefits

Long-term planning in California such as the *Energy Policy Report* and the 2010 *State Water Plan* will use the probabilistic climate projections being developed by PIER. In addition, PIER researchers will estimate potential impacts and identify coping or adaptation strategies using these projections. PIER will report these findings in the biennial reports on climate change science required by the Governor's Executive Order of June 2005.

Current State Policy

The *Energy Policy Report* and *Energy Action Plan* goals, Governor's Executive Order and Ten Point Plan, and pertinent laws and regulations provide key policy guidance to achieve an environmentally sound NG future. Specifically, the key goal the state has defined is:

- By 2010, 2020, and 2050, reduce greenhouse gas emissions to 2000 levels, 1990 level, and 80 percent below 1990 levels, respectively (Governor Executive Order S-3-05).

In addition to this goal, the Governor's policy defines the need to assess global climate change impacts to water supply, public health, agriculture, coastline, and forestry. The *Energy Policy Report*, *Energy Action Plan*, and Governor also define the need to develop climate change mitigation and adaptation technologies.

The federal and California Endangered Species Acts protect plants and animal resources from adverse effects due to development projects. The Migratory Bird Treaty Act prohibits the taking, killing or possessing of migratory birds, which applies to birds colliding with or being electrocuted by energy structures. California and

federal Clean Air Acts limit the amount of pollutants (for example, ozone, respirable particulate matter PM₁₀, fine particulate matter PM_{2.5}) in ambient air. The Clean Water Act protects water resources. A list of relevant policies can be found in Appendix E.

Trends and Drivers

Regulatory trends will have the largest impact in this research area. Global climate change issues will lead to consumer and government support for regulations and incentives to reduce emissions of greenhouse gases. Urban development and pressures of growing economy and population are significantly impacting sensitive habitat, air quality, and water quality. The application of existing regulations and

consumer and government support for new regulations to protect the environment will have implications to energy infrastructure constraints, energy prices, and protection of the environment, public health, safety, and environmental justice. Moreover, pollution control technologies like emerging electro technology could provide performance and cost improvements to restore environmental quality.

PIERNG Strategic Objectives

To support the State in accomplishing these policies and goals, as well as anticipate future needs, the PIERNG program has defined four strategic objectives that will provide California with an environmentally sound NG system:

- 1. Understand the nature/significance of climate change and its relationship to NG and develop strategies for greenhouse gas reduction and impacts mitigation/adaptation.** This objective will help achieve the greenhouse gas reduction goal. It will address *Energy Policy Report, Energy Action Plan*, and the Governor's policies to assess climate change impacts and develop mitigation and adaptation technologies. It will also address the increasing consumer support to reduce emissions of greenhouse gases.
- 2. Improve the understanding of, and develop solutions for, reducing biological, land-use, air-quality, and water-related impacts of NG production, storage, delivery, and use and contribute to a sustainable energy future.** This objective will help meet current environmental regulation as defined in various policy documents, including the Endangered Species Acts, the Migratory Bird Treaty Act, the California and federal Clean Air Acts, and the Clean Water Act. It will help develop new regulations to protect the environment. It will also help develop emerging pollution control technologies.
- 3. Develop emission control technologies for gas combustion.** This objective will help meet current environmental regulation as defined in the California and federal Clean Air Acts. It will help develop new air quality regulations to protect the environment and public health. It will also help develop emerging pollution control technologies.
- 4. Develop knowledge base for future decision-making and informed environmental policy relative to NG.** This objective will address the trends, technology gaps, and emerging energy

Natural Gas Variability

Problem

Standards for natural gas in California are currently under review in preparation for new LNG supplies. The interchangeability of current devices to operate on varying fuel formulations is a concern, and information is needed to assess environmental impacts, energy efficiency, safety, and performance of using LNG.

PIER Solution

- Measurement of safety, performance, and direct exhaust emissions for current and emerging technologies operated with varied fuels.
- Chamber-based experiments to quantify exposure relevant to pollutant emission rates.
- In-the-field quantification of emissions from as-installed appliances.
- Application and development of modeling tools to investigate effect of fuel variability on safety, performance, and emissions

Expected Benefits

Determine actions needed to reduce negative impacts of nontraditional blends of NG. It will also improve the understanding of indoor air quality impacts of combustion of NG and LNG, related health risks, and their mitigation strategies.

issues to provide policy makers with the knowledge required to develop effective future policy in this area.

PIERNG Research Solutions

To achieve these strategic objectives, the PIERNG program identified research solutions. The solutions were prioritized into primary, secondary, and tertiary areas of RD&D based on relevance to State policy, critical technical gaps, and the potential impact of emerging trends and drivers.

Climate Change Science

Problem

There are significant uncertainties on how climate may change in California and how it would affect State resources and its economy. There are also substantial uncertainties on the best strategies designed to reduce net greenhouse gas emissions in the State and how to best cope or adapt to a changing climate.

PIER Solution

PIER has developed a long-term plan on climate change and is implementing this plan with the creation of the California Climate Change Center. The Center, the first State-sponsored research group in the nation, is developing the data, methods, and tools needed to inform the formulation of climate change policy in the State. The Center is also leading the production of the climate impacts and adaptation reports required by the Governor's Executive Order of June 2005.

Benefits

PIER is informing climate policy formulation in the State. Different programs or reports such as the statewide greenhouse gas inventory, the 2005 *Energy Policy Report*, and the Climate Action Team report are directly or indirectly using research products and findings produced by the Center.

Primary Areas of RD&D

- Develop strategies to reduce direct and indirect greenhouse gas emissions (for example, CO₂, NO, CH₄) associated with NG in California.
- 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.
- Improve the understanding of and develop solutions to reduce impacts on air quality, biological, land-use, public health, and water from NG production, distribution, storage, and use, and contribute to a sustainable energy future.
- Develop methodologies (for example, emissions testing protocols) to improve regulatory processes (for example, pipeline siting) and inform future State environmental/energy policy.

Secondary Areas of RD&D

- Improve the understanding of State-specific environmental and economic tradeoffs resulting from emerging gas resources and technology (for example, efficiency, advanced burners, LNG).
- Develop methodologies for designing and establishing sustainable communities.
- Develop methods for assessing environmental and economic implications of fuel choices and interdependence (conventional and alternative) in electricity and NG.
- Develop tools and techniques for assessing and improving indoor environmental quality.

Tertiary Areas of RD&D

- Support technological performance and cost improvement research for gas combustion emissions control.
- Develop life-cycle analytical techniques for assessing site-specific environmental impacts from NG facilities.
- Develop methods for assessing the environmental and economic trade-offs of conventional and alternative energy infrastructure.
- Support national research initiatives (for example, gas interchangeability) designed to protect and restore critical environmental resources.

Benefits to Californians

As the PIERNG program works to enable an environmentally sound NG system, there are a series of resulting health and environmental benefits. These benefits include: reduced health risk from poor indoor and outdoor air quality, reduced footprint from energy infrastructure, reduced biological impacts, and reduced impact from climate change.

CROSS-CUTTING ELEMENTS

The five energy issues described in the previous section are not the only management perspective that the PIERNG program will use to identify research solutions. Based on input from stakeholders and internal analysis of the five program areas, the PIERNG program has identified several cross-cutting elements that are common throughout more than one of the five key energy issues. In the future, the PIERNG program will continue to identify and evaluate potential research solutions concerning the five key energy issues, as well as the current overlapping themes and other cross-cutting themes that are identified.

These cross-cutting areas include but are not limited to:

- ***Integration of electricity, NG, and transportation science and technology issues.*** These areas are inherently interrelated, and the trade-offs in proposed solutions and proposed research projects will be assessed. For example, the program will explore the combined peak of electricity and NG consumption.
- ***Carbon Management.*** Increasingly environmental management, fuel selection, and energy use management involve the effective management of carbon in the fuel and in the resulting by-products of energy generation. This cross-cutting element will provide an integrated systems perspective for assessing trade-offs and interrelationships.
- ***Customer choice and behavior.*** It has become apparent that consumer behavior and choice are not fixed or rigid and that they are important (and not always well understood) variables in the overall energy equation.
- ***Competitiveness of California.*** All energy research needs to be assessed with regard to its impact on California's economic competitiveness.
- ***Sustainable Communities.*** A sustainable community is defined as a community that meets the needs of its citizens without sacrificing the ability of future generations to meet their own needs. The goal of energy sustainability is the harnessing of resources that: (1) are not substantially depleted by continued use; (2) do not emit substantial pollutants or other hazards to the environment; and (3) do not involve the perpetuation of substantial health hazards or social injustices. There are many interrelated issues associated with the development of sustainable communities that need to be explored and defined and RD&D solutions implemented to optimize the solutions. Among them, California needs to provide a constant flow of clean and affordable energy solutions to support its low income citizens and ratepayers.

- ***Safety and security of energy supply system.*** Recent terrorist attacks and natural disasters have raised the safety and security concerns related to the energy supply system.
- ***Efficiency, stability, and reliability of energy supply system.*** There are many interrelationships, linkages, and trade-offs among these energy system elements.

The use of cross-cutting themes will provide the PIERNG program with a more robust framework to identify appropriate research options and best meet California's energy needs.

IMPLEMENTING RESEARCH SOLUTIONS THROUGH STAKEHOLDER PARTNERSHIPS

Informing Energy Policy

There are two main vehicles for the implementation of the PIERNG research results: energy policy and market adoption. Generally, energy policy will provide guidance for PIERNG research. However, in some cases, the PIERNG research will inform policy makers as they develop energy policy. For example, the PIERNG staff will work closely with the Energy Commissioners and provide technical input, based on the PIERNG research results and technical expertise, in the development of future energy policy documents such as the *Energy Action Plan* and *Energy Policy Report*.

In addition to these major policy reports, the PIERNG research will support the development of regulations, incentives, and tariffs. The PIERNG program will work closely with the Energy Commission Efficiency and Renewables Division, Facilities Siting Division, Fuels and Transportation Division, CPUC, and CARB. It is expected that the PIERNG program will also collaborate extensively with other regulatory agencies: Air Pollution Control Districts, Department of Water Resources, Department of Fish and Game, and Department of Forestry.

Delivering Technology Research to the Marketplace

As with informing policy, the PIERNG program will actively engage stakeholders in the definition, development, and market adoption of technology research to ensure the implementation of research results. While still focusing on public interest research not adequately provided by competitive and regulated markets, the eventual market adoption of PIERNG technology development is required for the PIERNG technology research to capture the expected benefits to Californians. The best approach to ensure market adoption is to enable the PIERNG-sponsored technology developers (for example, technology RD&D organizations funded by PIERNG) to work closely with energy services and product manufacturers, distributors, the CPUC, IOUs, energy services providers, and consumers.

Emerging Technologies Coordinating Council

ETCC
The Emerging Technologies Coordinating Council (ETCC) is a group of representatives from the Energy Commission, Pacific Gas & Electric, Southern California Edison, Southern California Gas, and San Diego Gas & Electric charged with administering California utility ratepayer-funded programs for energy related research and energy-efficient emerging technologies.

Mission
The Emerging Technologies Coordinating Council coordinates among its members to facilitate the application of energy-efficient emerging technologies that will transform the market and benefit California ratepayers.

The collaboration with these technology stakeholders will be done at various levels. PIERNG programs are expected to have advisory committees formed by members from various stakeholder groups that will provide guidance regarding the research roadmaps as well as help evaluate projects and

identify opportunities to increase the adoption of the research results. The PIERNG program will also form and sponsor industry councils and/or working groups that are focused on a particular issue (for example, Energy Efficiency Emerging Technologies Coordinating Council, Interconnection Rule 21 Working Group).

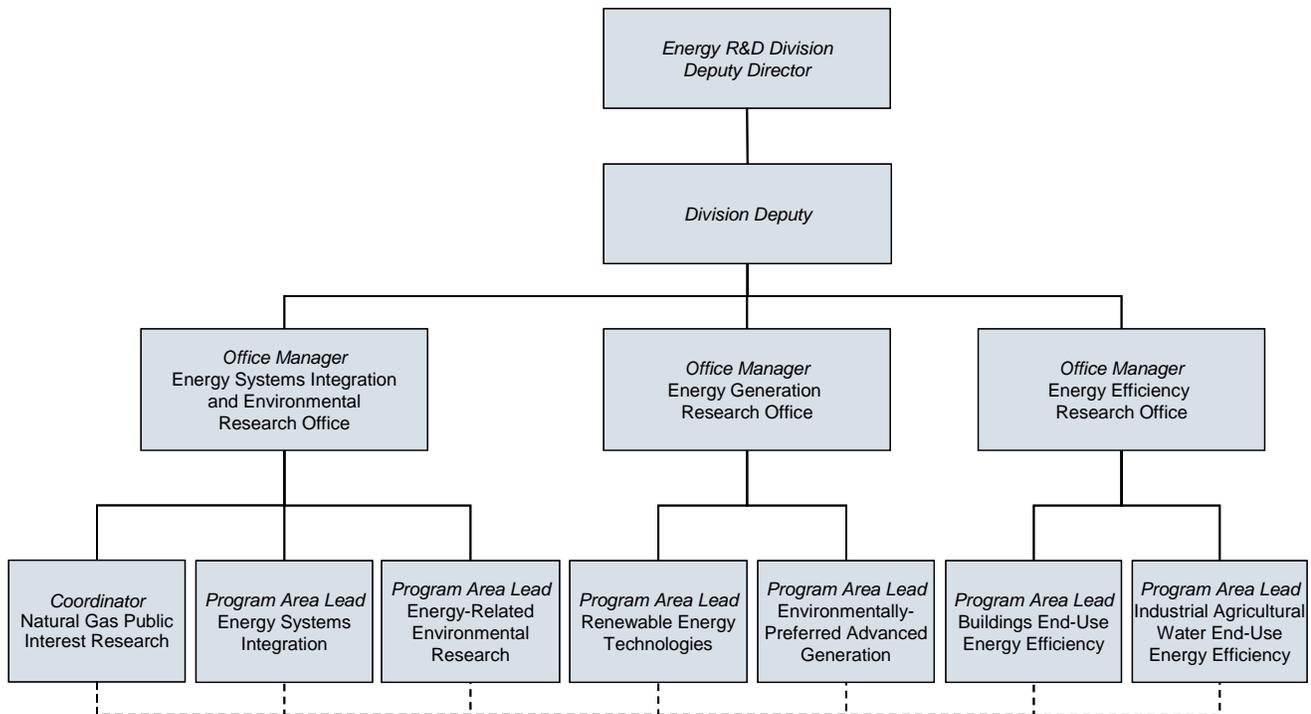
MANAGING THE PIERNG PROGRAM

Organizational Structure

The \$15M PIERNG program is administered by the same PIER staff that manages \$62.5 million per year of electricity research funding. As a result, the PIERNG program was incorporated into the existing organizational structure of the PIER program.

The Public Interest Energy Research program leadership is composed of a director, a deputy director, three office managers, and six program area leads. Also, a PIERNG coordinator facilitates the efforts of the other six program area leads for PIERNG research activities (Figure 6) with CPUC and CARB. The organizational structure and mechanisms to manage transportation research have not been determined at this point. This structure, implemented in 2005, is the result of the PIER program's efforts to continuously improve the management of the program as well as respond to recommendations the Independent Review Panel made in its March 2004 report. This new structure provides a strong framework for internal collaboration through regular inter-office coordination meetings at the senior levels where opportunities can be more readily identified and seized upon.

Figure 6: Public Interest Energy Research Organizational Structure



Key Operating Processes

The PIERNG program is leveraging the program management capabilities that are in place for electricity research. Since its inception, the PIER program has been working on five key operating processes. The PIER program has taken advantage of the legislatively mandated five-year planning effort to assess its experiences and performance, and develop a plan to continuously improve key operating processes. A task force composed of staff across the PIER program and the Energy Commission support functions including Contracts, Legal, Human Resources, and Audit was formed to assess current operating processes and provide improvement recommendations. As part of the program management assessment, objectives in PIER’s key operating process were captured and shared with internal and external stakeholders (Figure 7).

Figure 7: Objectives in Key Operating Processes

Key Operating Process	PIER Objectives
Stakeholder Coordination and Outreach	<ul style="list-style-type: none"> PIER will have a consistent external communications strategy for key stakeholder groups, including policymakers, energy industry, and consumers. PIER will have a strong working relationship with other divisions at the Energy Commission.
Contracting	<ul style="list-style-type: none"> PIER and support functions will work toward common goals in an efficient and effective manner.
Human Resources	<ul style="list-style-type: none"> PIER will be staffed with highly motivated and capable research project managers who collaborate across program areas. PIER will access a diverse range of experts for extended periods to support its research and program management objectives.
Research Planning	<ul style="list-style-type: none"> Research will reflect current concerns and find solutions to future needs. Coordinated research planning will take place across PIER program areas and fit into an overall PIER-wide research plan with little additional work. Resource allocation will be coordinated into the overall PIER budget.
Research Implementation	<ul style="list-style-type: none"> PIER will continuously increase the amount of public interest benefits achieved through funded projects. Research across all program areas will be consistent and logical, easily explained and defensible.

Staff and Resources

Because PIERNG is a new program, it currently uses six person years (PY) of permanent staff resource to manage the program workload. As the program matures and additional projects are funded, we expect the staffing to increase accordingly.

Inter-Agency Coordination

SB 76 requires the Energy Commission and the CARB to plan one-half of each year's funds allocated for NG public interest research and development. The joint plan must address two requirements; first, to coordinate the state's energy and environmental research priorities and, second, to articulate the nature of benefits that must accrue to NG ratepayers as a result of funded transportation energy research.

The Energy Commission will engage the CARB and other energy and transportation research stakeholders to develop the joint plan. The joint plan and subsequent updates will be amended to the NG strategic plan after approval by the two agencies.

Partnerships

As with the PIER program, partnerships will play an important role for the PIERNG program. The PIERNG program will scan public and private organizations for research activities in PIERNG's areas of interest to build on the expertise and innovations from other research organizations.³ The PIERNG program expects to work closely with the CPUC and CARB on planning and partner with such institutions as the University of California Office of the President, the California State University, the U.S. Department of Energy, utilities, and the national laboratories (for example, National Renewable Energy Laboratory, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory) to leverage resources and help fund research projects. Moreover, the PIER program is currently planning the development of an advisory committee, with participation of individuals representing key stakeholder groups that will work with the program on various planning activities.

CONCLUSION

Benefits of PIERNG

The PIERNG program is expected to be extremely important and valuable to California. The state cannot rely on federal government public interest energy research, nor can it rely solely on research developed by industry or utilities. California has a unique demographic and geographic profile, as well as unique vulnerabilities to natural and man-made disasters, that require California-focused energy solutions. In addition, policy makers in California need unbiased, accurate, and timely information to drive effective energy policy making. Moreover, technology and scientific research investment decisions that have a clear public benefit need to be made with minimum bias.

California continues to lead other states in the development of energy policy and technology. Only New York and recently Texas have programs comparable to PIERNG. PIERNG brings great benefits to Californians, including:

- Lower energy costs, achieved through the more efficient use of energy and the improved utilization and performance of the delivery system.
- A clean and environmentally friendly energy system, based on renewable energy sources, that is cost-competitive with traditional oil- and gas-fueled generation technologies.
- Reduced dependence on out-of-state/international resources and reduced volatility of energy prices.
- Increased reliability of energy service. This increased reliability will be the result of a modernized and secure delivery system.
- Reduced volatility of transportation fuel prices and reduced dependence on foreign oil.
- Reduced health risk from poor indoor and outdoor air quality, reduced footprint from energy infrastructure, increased availability of water resources, reduced biological impacts, and reduced impact from climate change.

Challenges Ahead for PIERNG

As the PIERNG program works during the next five years to achieve its strategic objectives and deliver expected benefits to Californians, it will need to manage and overcome significant challenges along the way. While there is much uncertainty about future challenges, some issues that PIERNG will need to actively monitor are:

- **Increasing Complexity.** The recent energy crisis has highlighted the complexity of the energy system in California. Moreover, there are increasing levels of energy policy being developed in the State that PIERNG needs to support.
- **Changing Priorities.** State policy attempts to balance the often conflicting interests of Californians (for example, environmental protection with low cost

energy). Forces outside the state (for example, economic recession) can often shift the interests and result in changes to policies and research priorities.

- **Competition for Funding.** Investment in utility-funded NG technologies have significantly reduced over the last 20 years. California IOUs are interested in receiving funding from the CPUC to reestablish regulated research programs. PIER will work with the IOUs to support their requests. However, the outcome is still uncertain.
- **Global/Out-of-State Energy Prices.** As California works toward a more independent energy future, this objective will take many years to accomplish. Before long, California will be subject to the volatility of international and out-of-state energy resource prices, including oil, NG, and LNG. The economic attractiveness of alternative solutions developed by PIERNG is often based on comparisons to these volatile resources.

APPENDICES

Appendix A: Policy Relevant to Energy RD&D - Affordable, Comfortable, and Energy-Smart Choices For Daily Life

- Warren Alquist Act, Chapter 7.1 - Undertake public interest energy RD&D not adequately provided for by competitive and regulated energy markets that improve the quality of life of Californians by providing environmentally sound, safe, reliable, and affordable energy services and products.

Efficiency

- *Energy Policy Report* – NG efficiency is the top priority of the Energy Commission’s NG RD&D program.
- *Energy Policy Report* – Combined heat and power (especially large scale) should play a larger role in improving NG efficiency.
- *Energy Policy Report* – Reduce use and increase efficiency of NG in water sector.
- *Energy Action Plan* – RD&D to support efficiency.
- Governor – Invest in emerging technologies that improve the efficiency and effectiveness of NG supplies and infrastructure.

Demand Response

- *Energy Policy Report* – Evaluate potential responses to extreme conditions to avoid costly NG curtailments.
- *Energy Policy Report* – Expand analytic capability to determine potential peak demand.

Cal / Baja Border Region

- *Energy Policy Report* - Implement a “loading order” to encourage development of the most efficient, clean, and cost-effective energy options to meet demand.

Goals

- CPUC – Cumulative reduction of 453 million therms (~2 percent) in NG demand from IOU customers by 2013.

Table with Initial Joint Staff Natural Gas Saving Goals, CPUC D04-09-060

Time Period	PG&E	SCG	SDG&E	Total
3 Years (2005 - 2007)	23.5 Mth	33.2 Mth	2.9 Mth	59.7 Mth
5 Year (2005 - 2009)	43.7 Mth	61.6 Mth	5.5 Mth	110.7 Mth
10 Years (2005 - 2014)	114.5 Mth	161.6 Mth	14.3 Mth	290.4 Mth

Note: These figures are a combination of NG savings projected from current funding levels plus the expected savings from an increase in program funding. The cumulative annual savings estimates in the last column are the result average funding increases of 15 percent in 2006 and then 10 percent per year from 2007 – 2014. These results in an annual funding level in 2014 that is roughly 3 times or 147 percent increase relative to 2002 expenditures.

Baseline for Electricity Saving Goals, California Energy Commission, California Energy Demand 2006-2016, Staff Energy Forecast, September 2005, CEC-400-2005-034-SF-ED2

Energy Consumption (MM Therms)	SDG&E	SCG	PG&E	Total
2004	545	8,042	4,849	13,436

Appendix B: Policy Relevant to Energy RD&D - Clean and Diverse Energy Supply that Optimizes California's Resources

- Warren Alquist Act, Chapter 7.1 - Undertake public interest energy RD&D not adequately provided for by competitive and regulated energy markets that improve the quality of life of Californians by providing environmentally sound, safe, reliable, and affordable energy services and products.

Supply Diversity

- *Energy Policy Report* – Increase diversity of NG supply portfolio.
- *Energy Policy Report* – Support import of liquefied NG (LNG), addressing facilities, safety, environmental, and quality issues.
- *Energy Policy Report* – Increase NG production from alternative sources.
- *Energy Action Plan* – RD&D to support supply policies affecting biogas and syngas.
- *Energy Action Plan* – RD&D to improve long-term reservoir management.
- Governor – Encourage construction of LNG facilities and infrastructure.
- Governor – Encourage expansion of projects to generate gas from landfills, biomass, and other renewable sources.
- Governor – Increase production and NG import capability to ensure adequate supply and stable prices.

Quality/Gathering

- *Energy Policy Report* – Manage gas quality and gathering issues related to expansion of in-state production.

Cal / Baja Border Region

- *Energy Policy Report* - Develop programs to reduce demand.

Appendix C: Policy Relevant to Energy RD&D - Clean and Diverse Transportation System

- Warren Alquist Act, Chapter 7.1 - Undertake public interest energy RD&D not adequately provided for by competitive and regulated energy markets that improve the quality of life of Californians by providing environmentally sound, safe, reliable, and affordable energy services and products.
- SB 76 – Allows for transportation research that provides direct benefits by making NG service safer, more reliable, or less costly, and provides benefit to ratepayers by promoting energy efficiency, reduction of health and environmental impacts from air pollution, reduction of greenhouse gas emissions, and increased use of alternative fuels.
- SB 76 – Coordination between Energy Commission and CARB on transportation energy and environmental research priorities.
- AB 2076 – Reduce emissions and the dependency on petroleum.
- AB 1493 - By January 2005, adopt regulations to achieve the maximum feasible reduction of vehicle greenhouse gas emissions and provide automakers with maximum flexibility in developing cost-effective compliance methods.
- CARB - Alternative plan to comply with AB 1493 greenhouse gas emission regulations that allows for use of alternative-fueled vehicles including compressed NG, liquid petroleum gas, ethanol, electric vehicles, and hydrogen-fueled vehicles.
- *Energy Policy Report* – Develop partnerships with auto manufacturers to demonstrate viability and promotion of plug-in hybrid electric vehicles.
- *Energy Policy Report* – California must pursue a diverse portfolio of fuels and advanced transportation technologies that address both current supply and demand problems and build a sustainable foundation for the eventual move to a hydrogen transportation fuel economy.
- *Energy Policy Report* – Using renewable diesel fuels, gas-to-liquid fuels, battery-electric and hybrid-electric vehicles, and hydrogen-fueled vehicles, California could significantly reduce petroleum demand, criteria pollutants, toxic air contaminants, and greenhouse gas emissions. These fuels and technologies presently suffer from higher cost and/or limited availability and need to be more effectively integrated into energy and air quality policies.
- Governor 03/04 *Energy Policy Report* Response – Significant reduction of gasoline and diesel use and increase the use of alternative fuels.
- Governor Executive Order S-3-05 – Greenhouse gas emission reduction targets.

Goals

- Energy Commission/CARB: Reduce gasoline and diesel fuel demand to 15 percent below 2003 demand by 2020.
- Energy Commission/CARB: Increase percent of non-petroleum fuel usage to 20 percent by 2020 and 30 percent by 2030.

- Governor: By 2010, 2020, and 2050, reduce greenhouse gas emissions to 2000 levels, 1990 level, and 80 percent below 1990 levels, respectively.

Appendix D: Policy Relevant to Energy RD&D - Integrated Natural Gas System that is Reliable and Secure

- Warren Alquist Act, Chapter 7.1 - Undertake public interest energy RD&D not adequately provided for by competitive and regulated energy markets that improve the quality of life of Californians by providing environmentally sound, safe, reliable, and affordable energy services and products.

Storage

- *Energy Policy Report* – Storage to balance demand from intermediate and peaking power plants.
- *Energy Policy Report/Governor* – Storage to provide adequate supply and protect prices.

Capacity

- *Energy Policy Report* – Adequate capacity of pipeline infrastructure.

Cal / Baja Border Region

- *Energy Policy Report* - Ensure that planning, permitting, construction, and operation of NG infrastructure is coordinated.

Markets

- *Energy Action Plan* - Improve NG markets.

Safety

- *Energy Action Plan* – RD&D to support safety issues.

Appendix E: Policy Relevant to Energy RD&D - Environmentally Sound Energy System

- Warren Alquist Act, Chapter 7.1 - Undertake public interest energy RD&D not adequately provided for by competitive and regulated energy markets that improve the quality of life of Californians by providing environmentally sound, safe, reliable, and affordable energy services and products.

Reduce Greenhouse Gas Emissions

- Governor – Greenhouse gas emission reduction targets.
- *Energy Policy Report* – Use CHP as a means to provide air quality and greenhouse gas reduction emissions benefits.

Assess Impacts Global Climate Change

- Governor – Assess Global Climate Change impacts to water supply, public health, agriculture, coastline and forestry.

GCC Mitigation/Adaptation

- Governor – Mitigation and adaptation efforts will be necessary to prepare for global warming.
- *Energy Action Plan* – RD&D on greenhouse gas mitigation technologies.
- *Energy Policy Report* - Include climate change strategies in-state planning.

Cal / Baja Border Region

- *Energy Policy Report* - Implement a cross-border emissions credit trading and offsets program.

Environmental Stewardship

- *Energy Policy Report* - Use sustainable building designs.
- Governor – Invest in emerging technologies that improve the environmental impact of energy supplies and infrastructure.
- California Environmental Quality Act – Requires evaluation of direct, indirect and cumulative impacts of developments.

Air Quality

- California ambient air quality standards – Table of Standards in Section 70200 of Title of the California Code of Regulations
 - Ozone (O₃)
 - 1 hour – 0.09 ppm
 - 8 hour – 0.070 ppm
 - Respirable Particulate Matter (PM₁₀)

- 24 hour – 50 micrograms/m³
- Annual Arithmetic Mean – 20 micrograms/m³
- Fine Particulate Matter (PM_{2.5})
 - Annual Arithmetic Mean – 12 micrograms/m³
- National Ambient Air Quality Standards
 - Ozone (O₃)
 - 8 hour – 0.08 ppm
 - Respirable Particulate Matter (PM₁₀)
 - 24 hour – 150 micrograms/m³
 - Annual Arithmetic Mean – 50 micrograms/m³
 - Fine Particulate Matter (PM_{2.5})
 - 24 hour – 65 micrograms/m³
 - Annual Arithmetic Mean – 15 micrograms/m³

Biological and Land Use

- Federal Endangered Species Act – Protection of endangered and threatened animal and plant species and their habitats.
- Invasive Species Executive Order (February 1999) – Requires prevention, response and control, monitoring, and restoration programs to reduce invasions by non-native species. Applies to terrestrial and aquatic habitats.
- California Fish and Game Code – Requires State permits for any activities that might cause mortality of native wildlife (not just rare species). Also protects all nesting birds.
- California Endangered Species Act – Prohibits taking of plant and animal species designated by the State as threatened or endangered or candidate species petitioned for listing.

Water Resources

- Clean Water Act – Prohibits impacts to wetlands and ‘water of the U.S.’ without a permit.
- California Ocean Protection Act of 2004 – Establishes the Ocean Protection Council.
- California Ocean Protection Trust Fund – Encourages protection, conservation, and maintenance of healthy coastal waters and ocean ecosystems.
- Ocean Protection Plan – Has several goals and action items that include increasing the abundance and diversity of California's oceans, bays, estuaries, and coastal wetlands and make water in these bodies cleaner. Eliminate adverse impacts of offshore oil and gas development.
- California Ocean Protection Council – Ocean and Coastal Information, Research, and Outreach Strategy – Its action plan identifies that information and research is needed to protect and restore ocean and coastal organisms, ecosystems, and habitats, including study the stressors on marine life of current and potential ocean uses.

Goals

- By 2010, 2020, and 2050, reduce greenhouse gas emissions to 2000 levels, 1990 level, and 80 percent below 1990 levels, respectively.
- Other environmental policy goals.

Appendix F: Governor's Ten Point Plan

The Governor's electricity plan is designed to ensure an adequate, stable supply of electricity at reasonable prices. The plan encourages the use of emerging technologies to preserve and protect California's environment and promote economic growth.

1. Resource Adequacy

- Minimum 15 percent reserve margins for all suppliers of electricity, by 2006

2. Competitive Procurement

- Open, transparent procurement process ensures best value to ratepayers in terms of price, risk, reliability and environmental impact
- Cost recovery for utilities encourages long-term contracts

3. Transmission

- Legislation to establish transmission corridors
- Encourage investment to reduce congestion, increase grid reliability

4. Rate Relief

- Encourage CPUC to implement equitable rate designs for allocating system costs
- Reduce rates for all customers from Federal Energy Regulatory Commission (FERC) refunds and Department of Water Resource (DWR) contract renegotiations

5. Natural Gas

- Increase in-state gas storage, production and NG import capability to ensure adequate supply and stable prices

6. Renewable Energy

- Accelerate renewable mix of 20 percent by 2010
- Million Solar Roofs Initiative
- Western Governor's Association Clean and Diversified Energy Resolution: 30,000 MW by 2015

7. Energy Efficiency

- Increase State's energy efficiency 20 percent by 2010
- Energy efficiency prioritized in the Energy Action Plan's loading order
- Green Buildings Executive Order – State will lead by example
- WGA Clean Energy Resolution: 20 percent gain by 2020
- Zero energy homes, building codes, appliance standards

8. Dynamic Pricing/Advanced Metering

- Encourage technology, rate designs and consumer behavior to reduce power usage during peak hours
- Deploy advanced interval meters to all customers

9. Core/Non-core

- Allow large customers to choose their electricity supplier

10. Research & Development

- Invest in emerging technologies that improve the efficiency, effectiveness and environmental impact of energy supplies and infrastructure

Appendix G: Executive Order S-3-05 by the Governor of the State of California

WHEREAS, California is particularly vulnerable to the impacts of climate change; and

WHEREAS, increased temperatures threaten to greatly reduce the Sierra snowpack, one of the State's primary sources of water; and

WHEREAS, increased temperatures also threaten to further exacerbate California's air quality problems and adversely impact human health by increasing heat stress and related deaths, the incidence of infectious disease, and the risk of asthma, respiratory and other health problems; and

WHEREAS, rising sea levels threaten California's 1,100 miles of valuable coastal real estate and natural habitats; and

WHEREAS, the combined effects of an increase in temperatures and diminished water supply and quality threaten to alter micro-climates within the State, affect the abundance and distribution of pests and pathogens, and result in variations in crop quality and yield; and

WHEREAS, mitigation efforts will be necessary to reduce greenhouse gas emissions and adaptation efforts will be necessary to prepare Californians for the consequences of global warming; and

WHEREAS, California has taken a leadership role in reducing greenhouse gas emissions by: implementing the California Air Resources Board motor vehicle greenhouse gas emission reduction regulations; implementing the Renewable Portfolio Standard that the Governor accelerated; and implementing the most effective building and appliance efficiency standards in the world; and

WHEREAS, California-based companies and companies with significant activities in California have taken leadership roles by reducing greenhouse gas (GHG) emissions, including carbon dioxide, methane, nitrous oxide and hydrofluorocarbons, related to their operations and developing products that will reduce GHG emissions; and

WHEREAS, companies that have reduced GHG emissions by 25 percent to 70 percent have lowered operating costs and increased profits by billions of dollars; and

WHEREAS, technologies that reduce greenhouse gas emissions are increasingly in demand in the worldwide marketplace, and California companies investing in these technologies are well-positioned to profit from this demand, thereby boosting California's economy, creating more jobs and providing increased tax revenue; and

WHEREAS, many of the technologies that reduce greenhouse gas emissions also generate operating cost savings to consumers who spend a portion of the savings

across a variety of sectors of the economy; this increased spending creates jobs and an overall benefit to the statewide economy.

NOW, THEREFORE, I, ARNOLD SCHWARZENEGGER, Governor of the State of California, by virtue of the power invested in me by the Constitution and statutes of the State of California, do hereby order effective immediately:

1. That the following greenhouse gas emission reduction targets are hereby established for California: by 2010, reduce GHG emissions to 2000 levels; by 2020, reduce GHG emissions to 1990 levels; by 2050, reduce GHG emissions to 80 percent below 1990 levels; and
2. That the Secretary of the California Environmental Protection Agency ("Secretary") shall coordinate oversight of the efforts made to meet the targets with: the Secretary of the Business, Transportation and Housing Agency, Secretary of the Department of Food and Agriculture, Secretary of the Resources Agency, Chairperson of the Air Resources Board, Chairperson of the Energy Commission, and the President of the Public Utilities Commission; and
3. That the Secretary shall report to the Governor and the State Legislature by January 2006 and biannually thereafter on progress made toward meeting the greenhouse gas emission targets established herein; and
4. That the Secretary shall also report to the Governor and the State Legislature by January 2006 and biannually thereafter on the impacts to California of global warming, including impacts to water supply, public health, agriculture, the coastline, and forestry, and shall prepare and report on mitigation and adaptation plans to combat these impacts; and
5. That as soon as hereafter possible, this Order shall be filed with the Office of the Secretary of State and that widespread publicity and notice be given to this Order.

Appendix H: Trends and Drivers Description

	Driver	Definition
Demand Trends	Increasing Population Growth	Growth of western region population increases demand for electricity, natural gas, and transportation fuels, and will put pressure on the infrastructure unless growth can be mitigated by decreased per capita consumption.
	Increasing Economic Activity	Economic growth increases overall energy consumption; shifts from industrial to information economy and changing standards of living will change consumption patterns and increase energy demand unless mitigated by decreased per capita consumption.
	Growth in Hot Inland Areas	Population and economic development in hot/cold inland areas requires new energy infrastructure, increases home energy consumption, increases peak demand spikes, and increases driving distances, traffic congestion, and use of transportation fuel.
	Growth in Consumer Energy Demand	Growth in per capita use of energy consumption devices including an increased use of electronic devices and consumer comfort expectations (multiple AC units).
	Changing Weather Patterns	Changing temperatures will lead to increased demand for natural gas and electricity.
	Increasing Need for Consumer Choices	Increasing pressure from consumers to select their energy services from a set of energy products and services options (DG, DR, EE, Premium Power).

	Driver	Definition
Resource Availability	Increased Global Oil Demand	Increased global competition for oil from China and India will impact the prices and increase price volatility of gasoline, diesel, LNG and propane.
	Constrained and Unreliable Petroleum Transportation Fuels Supply	In-state production capacity and export to western states of gasoline, diesel, and propane, distribution infrastructure will impact prices and increase price volatility.
	Constrained Natural Gas Supply	Availability and stability of natural gas supply, including in-state production and storage, import of natural gas from other states and Baja, import of LNG, reliance on NG for electricity generation in the Western Region will impact prices and increase price volatility.
	Constrained Electricity Supply	Availability and stability of electricity supply, including in-state generation and import from other western states (coal, renewables, hydro power from Northwest) and Baja will impact prices and increase price volatility.
	Changing Weather Patterns	Changing weather patterns likely to impact water resources (reduce the available snow pack to be used for hydroelectricity).
	Degrading/Dwindling Habitat, Air Quality and Water Quality	Urban development and pressures of growing economy and population are significantly impacting sensitive habitat, air quality and water quality.
	Increased Use of Natural Gas for Electricity Generation	Urban development and pressures of growing economy and population are significantly impacting sensitive habitat, air quality and water quality.

	Driver	Definition
Regulatory Framework	Uncertain Electric Market Regulations	There is uncertainty in the direction of regulatory control and the effects in electric prices and the competitive markets. This includes but is not limited to tariff structures and the fact that current approaches to calculate life cycle costs do not consider fuel costs.
	Aging and Inadequate Electricity Infrastructure Constraints	The poor state of current infrastructure, lack of collaboration, and constraints to develop new infrastructure for electricity (generation, T&D) results in reduced capacity and higher energy prices. Contributing factors include current permitting process challenges (environmental siting rules), costs, and benefits.
	Aging and Inadequate Natural Gas Infrastructure Constraints	The poor state of current infrastructure, lack of collaboration, and constraints to develop new infrastructure for natural gas (pipelines, storage, LNG terminals), results in reduced capacity and higher energy prices, with impacts on the environment, cost, and benefits.
	Aging and Inadequate Transportation Infrastructure Constraints	The poor state of current infrastructure, lack of collaboration, and constraints to develop new infrastructure for transportation (drilling, refining) results in reduced capacity and higher energy prices, with impacts on the environment, cost, and benefits.
	Global Climate Change	There is an impact to the state from climate change, as well as consumer and government support for regulations and incentives to reduce emissions of greenhouse gases. The state's organizations will also have to adapt to the new conditions (operations).
	Increasing Public Focus on Environmental, Public Health, and Safety Concerns	The application for existing regulations and consumer and government support for new regulations to protect the environment (RPS, efficiency standards, local air quality emission regulations) will have implications to infrastructure constraints, energy prices, and protection of the environment, public health, safety and environmental justice.
	Increasing Focus on Energy Security	Concern and protection against natural and terrorist threats to energy infrastructure and supply will result in more and better security and response measures be developed and implemented to improve the state's economic resiliency and energy security.
	Uncertain Regulatory Market Structure for Emerging NG Markets	There is uncertainty around how to regulate new natural gas markets and NG quality that will affect development of the market and the infrastructure.
	Increasing Local Resistance to New Infrastructure Projects	There is increasing resistance from communities to building new energy infrastructure projects in their areas (not in my back yard – NIMBY). This trend is contributing to the infrastructure constraints.
	Aggressive Policy Goals and Increased Urgency for Solutions	With high costs of energy, the poor state of the energy infrastructure, local resistance to new projects and increased public focus on environmental concerns, the state energy policy makers have established a series of aggressive and urgent policy goals.

	Driver	Definition
Technology	Improved and More Cost-Effective Renewable Energy	Increased availability and wide adoption of technologies to generate electricity from renewable resources (solar, wind, biomass, geothermal, hydroelectric) will provide additional supply options, and the related environmental benefits and life cycle cost implications.
	Improved and More Cost-Effective Advanced Generation Technology	Technology breakthrough in performance and cost, and wide adoption of advanced generation technology for transportation and stationary applications (distributed, modular) will provide additional supply options, and the related environmental benefits and life cycle cost implications.
	Improved and More Cost-Effective Advanced and Hybrid Propulsion Systems	Wide adoption of advanced and hybrid propulsion systems (gasoline/electric, diesel/electric, plug-in hybrids, fuel cells) for transportation applications (including mass transit and the transportation of goods) will provide additional supply options, and the related efficiency benefits and life cycle cost implications.
	Increased Availability of Alternative Fuels for Transportation	Technology breakthrough in performance and cost, and wide adoption of alternative fuels for transportation applications (ethanol, GTL, FT diesel, hydrogen), will provide additional supply options, the environmental and efficiency benefits, and life cycle cost implications.
	Improved and Cost-Effective Advanced Meters, Information Technology, Communications	Technology breakthrough in performance and cost and wide adoption of advanced functionality meters (time of use, power line communications), broadband communications, and IT will provide increased throughput from infrastructure.
	Improved and Cost-Effective End-Use Technologies	Wide adoption of real-time energy management and dynamic control systems with advanced capabilities (efficiency, demand response, dynamic rates), will provide efficiency benefits.
	Pollution Control	Emerging electro technology could provide performance and cost improvements to restore environmental quality.

Appendix I: Acronym List

AB	Assembly Bill
CARB	California Air Resources Board
BIPV	Building Integrated Photo Voltaic
CCHP	Combined Cooling, Heating and Power
CIEE	California Institute for Energy and Environment
CIWMB	California Integrated Waste Management Board
CHP	Combined Heat and Power
CPUC	California Public Utilities Commission
DG	Distributed Generation
DOE	United States Department of Energy
EPA	Environmental Protection Agency
ETCC	Emerging Technology Coordinating Council
GCC	Global Climate Change
HVAC	Heating, Ventilation, Air-Conditioning
ICLS	Integrated Classroom Lighting System
IJE	Inter-Jurisdictional Exchange
IOU	Investor Owned Utilities
ISO	Independent Service Operator
LBNL	Lawrence Berkeley National Laboratory
LLNL	Lawrence Livermore National Laboratory
LNG	Liquefied NG
NG	Natural Gas
MW	Megawatt
NREL	National Renewable Energy Laboratory
PIER	Public Interest Energy Research
PUC	Public Utilities Commission
PY	Person Years
RD&D	Research Development and Demonstration
RPS	Renewable Portfolio Standard
SB	Senate Bill
SMUD	Sacramento Municipal Utility District
T&D	Transmission and Distribution
UCOP	University of California Office of the President
WTC	Wind Turbine Company
ZENH	Zero Energy New Home

Appendix J: Strategic Objectives and Research Solutions Summary Tables

Affordable, Comfortable and Energy-Smart Choices for Daily Life and a Strong Economy	
PIER Strategic Objectives	<ol style="list-style-type: none"> 1.Reduce cost and improve performance of efficiency systems for buildings and industrial processes. 2.Develop energy efficient technologies for unique California conditions and industries. 3.Develop knowledge base for future decision-making and informed end-use policy relative to natural gas.
Primary Solutions	<ul style="list-style-type: none"> •Reduce first costs and operational costs of energy efficient technologies and systems for buildings and industries. •Increase efficiency of existing building systems and industrial processes (develop replacement / retrofit products, improve operational strategies, identify intervention tactics). •Develop energy efficient end use technologies and strategies for unique California conditions and industries (climate, construction practices, state standards, industrial processes).
Secondary Solutions	<ul style="list-style-type: none"> •Develop sustainable technologies, designs and systems for buildings and industrial applications (sustainable building construction practices, use of industrial waste as an energy resource). •Develop integrated gas/electric solutions, including combined cooling, heat, and power systems for commercial, institutional and industrial applications where heat is the desired product. •Optimize the use of thermal energy in industrial processes, including waste heat recovery and clean combustion. •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.
Tertiary Solutions	<ul style="list-style-type: none"> •Develop benchmarking tools and standard practices and specifications for energy efficiency. •Develop commissioning, benchmarking, diagnostic tools, standard practices, and specifications for efficiency. •Improve understanding of consumer behavior and market issues. •Improve control strategies to capture synergies between water and space heating.

Clean and Diverse Natural Gas Supply that Optimizes California's Resources	
PIER Strategic Objectives	<ol style="list-style-type: none"> 1.Facilitate and encourage importation of LNG. 2.Increase the volume and sources of in-state natural gas supplies. 3.Develop technologies to produce natural gas from alternative sources. 4.Develop renewable energy technologies to replace use of natural gas. 5.Develop knowledge base for future decision-making and informed supply policy relative to natural gas.
Primary Solutions	<ul style="list-style-type: none"> •Assess the quality and interchangeability of LNG to determine its environmental and performance impact. •Reduce the cost and improve the performance of technologies to produce natural gas (or biogas) from landfills, wastewater treatment, syngas, and biomass. •Reduce the cost and improve the performance of solar thermal, biogas, and geothermal technologies for natural gas replacement (space heating and industrial applications) as well as hybrid systems (solar/gas hybrids). •Improve and reduce the cost of clean combustion technologies. •Improve and reduce the cost of natural gas thermal gasification convergence methods and reformer technologies.
Secondary Solutions	<ul style="list-style-type: none"> •Facilitate the development of standards for gas quality (LNG, non-conventional and interstate) and gathering issues. •Support the development of co-production technologies (substitute natural gas and electricity).

Clean and Diverse Transportation System

PIER Strategic Objectives	<ol style="list-style-type: none"> 1. 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. 2. Develop and demonstrate technologies to improve efficiency within the transportation system. 3. Develop and demonstrate alternative fuels, vehicles, and fueling infrastructure. 4. Develop the knowledge base and advanced analytical tools for future decision-making and informed transportation policy.
Solutions	<ul style="list-style-type: none"> • 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. • Develop and demonstrate alternative transportation fuels that can augment available transportation fuel supplies with non-petroleum sourced fuels, can optimize their efficiency, environmental and public health benefits, and commercial viability over the mid and long term. • 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. • Develop and demonstrate options for alternative fuel distribution, infrastructure development and deployment and accelerate storage and distribution technology development for non-petroleum alternative fuels. • Develop and demonstrate mitigation strategies that address the environmental and economic impacts of non-petroleum alternative fuel production, distribution and utilization, and accelerate the deployment and refinement of highly efficient transportation technologies. • Develop and demonstrate advanced planning tools, processes and regulatory models that integrate fuel choices and demand considerations and innovative mass-transit strategies in local land-use and transportation planning. • Develop technologies and tools to further understand consumer behavior and preferences and how these are affected by fuel choices and market conditions.

Integrated Natural Gas System that is Reliable and Secure

PIER Strategic Objectives	<ol style="list-style-type: none"> 1. Develop natural gas storage technologies. 2. Improve safety and security of natural gas production, storage, delivery, and use. 3. Develop innovative tools, methods and models to improve efficiency of natural gas markets. 4. Reduce peaks for improved asset utilization. 5. Understand and address impacts of LNG on natural gas infrastructure and related interchangeability issues. 6. Develop knowledge base for future decision-making and informed delivery, integration, and infrastructure policy relative to natural gas.
Primary Solutions	<ul style="list-style-type: none"> • Analyze impact storage would have on market and the conditions required for investment in storage infrastructure. • Investigate an efficient interface of electricity and natural gas infrastructure. • Support improvement of technologies and tariffs for demand response (communication, control and integration, automation strategies). • Develop a natural gas system (cyber and physical) that is resilient to natural and man-made events, self-diagnosing, and self-healing.
Secondary Solutions	<ul style="list-style-type: none"> • Support efforts by others to analyze interchangeability impacts on various sectors, such as gas distribution, end use, system reliability, and transportation. • Improve the understanding of natural gas markets. • Improve means of measuring and predicting economic impacts of natural gas use. • Improve the safety of natural gas production, storage, delivery, and use. • Improve the natural gas infrastructure between Mexico and California to accommodate LNG. • Develop tools and models to assess the risks associated with predominantly natural gas-fueled electric generation. • Develop tools and models to understand impact policy actions have on infrastructure investment decisions

Environmentally Sound Natural Gas System

PIER Strategic Objectives	<ol style="list-style-type: none"> 1. Understand the nature/significance of climate change, its relationship to natural gas and develop strategies for GHG reduction and impacts mitigation/adaptation. 2. Improve the understanding of, and 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. 3. Develop emission control technologies for gas combustion. 4. Develop knowledge base for future decision-making and informed environmental policy relative to natural gas.
Primary Solutions	<ul style="list-style-type: none"> • Develop strategies to reduce direct and indirect GHG emissions (CO₂, NO, CH₄) associated with natural gas in California. • Create tools for assessing the impacts of Global Climate Change on key sectors (ecosystems, energy, and infrastructure) and develop robust mitigation and adaptation strategies. • Improve the understanding of and develop solutions to reduce air quality, biological, land-use, public health, and water impacts of natural gas production, distribution, storage, and use, and contribute to a sustainable energy future. • Develop methodologies (emissions testing protocols) to improve regulatory processes (pipeline siting) and inform future state environmental/energy policy.
Secondary Solutions	<ul style="list-style-type: none"> • Improve the understanding of state-specific environmental and economic tradeoffs resulting from emerging gas resources and technology (efficiency, advanced burners, LNG). • Develop methodologies for designing and establishing sustainable communities. • Develop methods for assessing environmental and economic implications of fuel choices and interdependence (conventional and alternative) in electricity and natural gas. • Develop tools and techniques for assessing and improving indoor environmental quality.
Tertiary Solutions	<ul style="list-style-type: none"> • Support technological performance and cost improvement research for gas combustion emissions control. • Develop life-cycle analytical techniques for assessing site-specific environmental impacts from natural gas facilities. • Develop methods for assessing the environmental and economic trade-offs of conventional and alternative energy infrastructure. • Support national research initiatives (gas interchangeability) designed to protect and restore critical environmental resources.

ADDENDA

Addendum 1: Determination of Benefit of Transportation Research to Electricity and Natural Gas Ratepayers

Purpose

This addendum describes the approach that the Energy Commission will follow to identify ratepayer benefits resulting from public interest transportation research, as required by SB 76.

This addendum is organized into the following sections:

- I. Background
- II. The Energy Commission's interpretation of SB76
- III. Using energy system linkages to understand how transportation research impacts ratepayers
- IV. Using California transportation energy policy to help prioritize research investments
- V. The Energy Commission's proposed methodology for identifying transportation research benefits
- VI. Conclusion

I. Background

Senate Bill 76 (SB 76, Figure A1-1), the legislation that led to the formation of the PIER Transportation Research Area, provides guidance to the Energy Commission on determining the areas of transportation research that are appropriate for public interest funding. This law requires that public interest research done for transportation also provide benefits to California's NG and electricity ratepayers. SB 76 further lays out broad areas of ratepayer benefits to be realized by transportation research, summarized as:

1. Direct benefits specific to making gas or electrical service:

- Safer, more reliable

OR

- Less costly

AND

2. Activities that benefit ratepayers and that promote ALL of the following:

- Energy efficiency
- Reduction of health and environmental impacts from air pollution
- Reduction of greenhouse gas emissions related to NG and electricity production and use
- Increased use of alternative fuels.

Figure A1-1: Excerpts from SB 76

SENATE BILL 76

Section 384 of the Public Utilities Code is amended to read:

b) Funds deposited in the Public Interest Research, Development, and Demonstration Fund may be expended for projects that serve the energy needs of both stationary and transportation purposes if the research provides an electricity ratepayer benefit.

Section 740.8 of the Public Utilities Code is amended to read:

740.8. As used in Section 740.3, "interests" of ratepayers, short- or long-term, mean direct benefits that are specific to ratepayers in the form of safer, more reliable, or less costly gas or electrical service, consistent with Section 451, and activities that benefit ratepayers and that promote energy efficiency, reduction of health and environmental impacts from air pollution, and greenhouse gas emissions related to electricity and NG production and use, and increased use of alternative fuels.

Section 901 is added to the Public Utilities Code, to read:

(c) Up to one-third of the funds allocated pursuant to this article may be used for transportation related public interest energy research and development provided the research provides NG ratepayer benefits and those benefits are identified in the plan.

Prior to SB 76, the Energy Commission was already legislatively mandated to perform only public interest energy research. The Warren-Alquist Act (Figure A1-2) provided general guidance as to what should be considered public interest energy research.

Figure A1-2: Excerpts from Warren-Alquist Act Governing PIER

WARREN-ALQUIST ACT

CHAPTER 7.1. PUBLIC INTEREST ENERGY RESEARCH, DEMONSTRATION, AND DEVELOPMENT PROGRAM

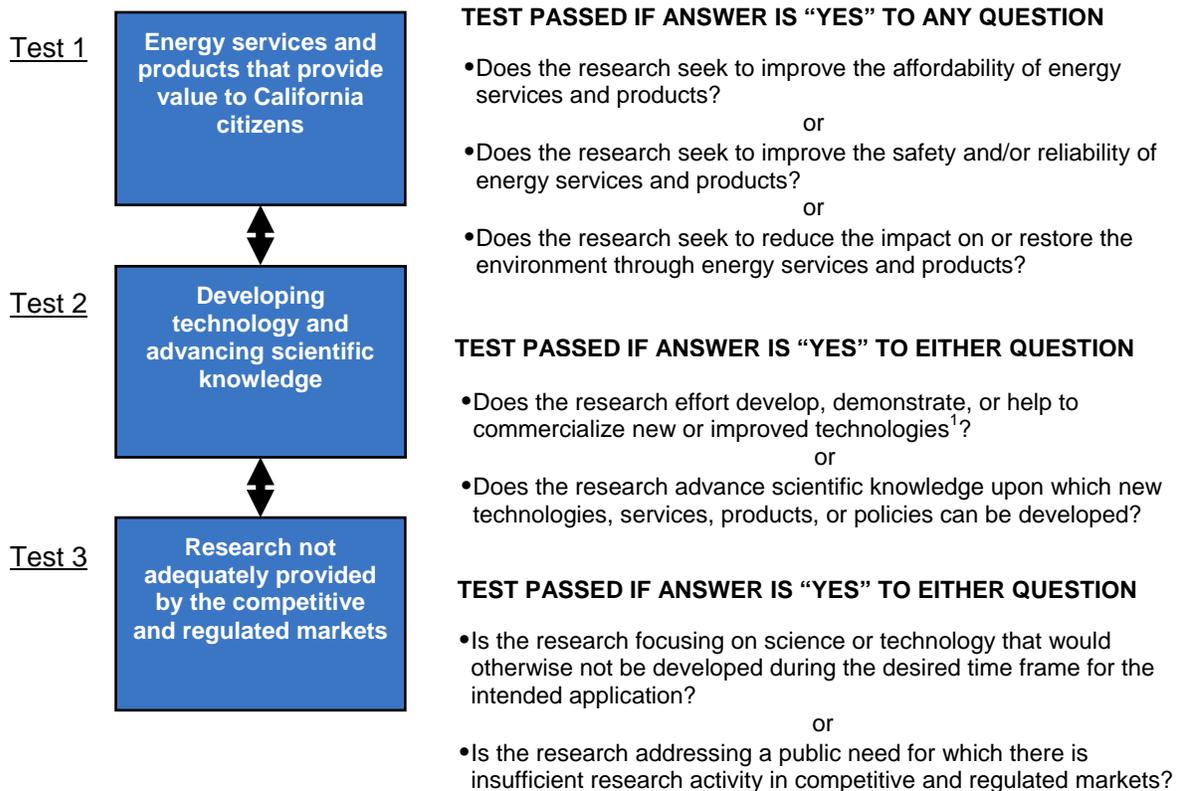
25620. Findings and declarations; environmentally sound, safe, reliable, and affordable energy services and products

The Legislature hereby finds and declares all of the following:

- (a) It is in the best interests of the people of this state that the quality of life of its citizens be improved by providing environmentally sound, safe, reliable, and affordable energy services and products.
- (b) To improve the quality of life of this state's citizens, it is proper and appropriate for the state to undertake public interest energy research, development, and demonstration projects that are not adequately provided for by competitive and regulated energy markets.
- (c) Public interest energy research, demonstration, and development projects should advance energy science or technologies of value to California citizens and should be consistent with the policies of Section 399.7 of the Public Utilities Code.

Prior to SB 76, the PIER program developed a more specific set of criteria based upon the law in Box 2 that could be used to select projects. These criteria were used to create a screen (Figure A1-3), consistent with the PIER legislation in Box 2, to determine if a project meets the public interest mandate. In this screen, each proposed project needs to pass three tests to meet the public interest criteria and be eligible for PIER funding. If a proposed project meets the public interest screening criteria, it is then evaluated against additional project selection and prioritization criteria.

Figure A1-3: Non-transportation Public Interest Screen, Prior to SB 76



¹Technology includes hardware, software, systems, exploratory concepts, and supporting knowledge.

This addendum modifies the screening criteria based upon the Energy Commission’s interpretations of SB 76 in order to both satisfy overall public interest mandates and assure that PIER transportation research will also provide benefits to California’s NG and electricity ratepayers.

II. Energy Commission’s Interpretation of SB 76

1. SB 76 provides broad guidance but the Energy Commission needs to develop a clear investment decision making process and methodology.

SB 76 does not provide sufficient public interest transportation research investment guidance needed to ensure providing benefits to California’s ratepayers. Therefore, the broad guidance in SB 76 will be used to create a more specific, transparent methodology for making these types of investment decisions, similar to what the Energy Commission did pursuant to the Warren-Alquist Act.

2. SB 76 expands the PIER program’s mission, however this expanded scope is limited to transportation energy research

The PIER program now has an expanded mission that now includes transportation issues. However, research that is not directly related to transportation energy is not within this expanded scope. For example, a project that would examine the health effects of particulate matter from non-transportation related sources would not be included.

3. SB 76 expands the ratepayer benefit activities where PIER can invest.

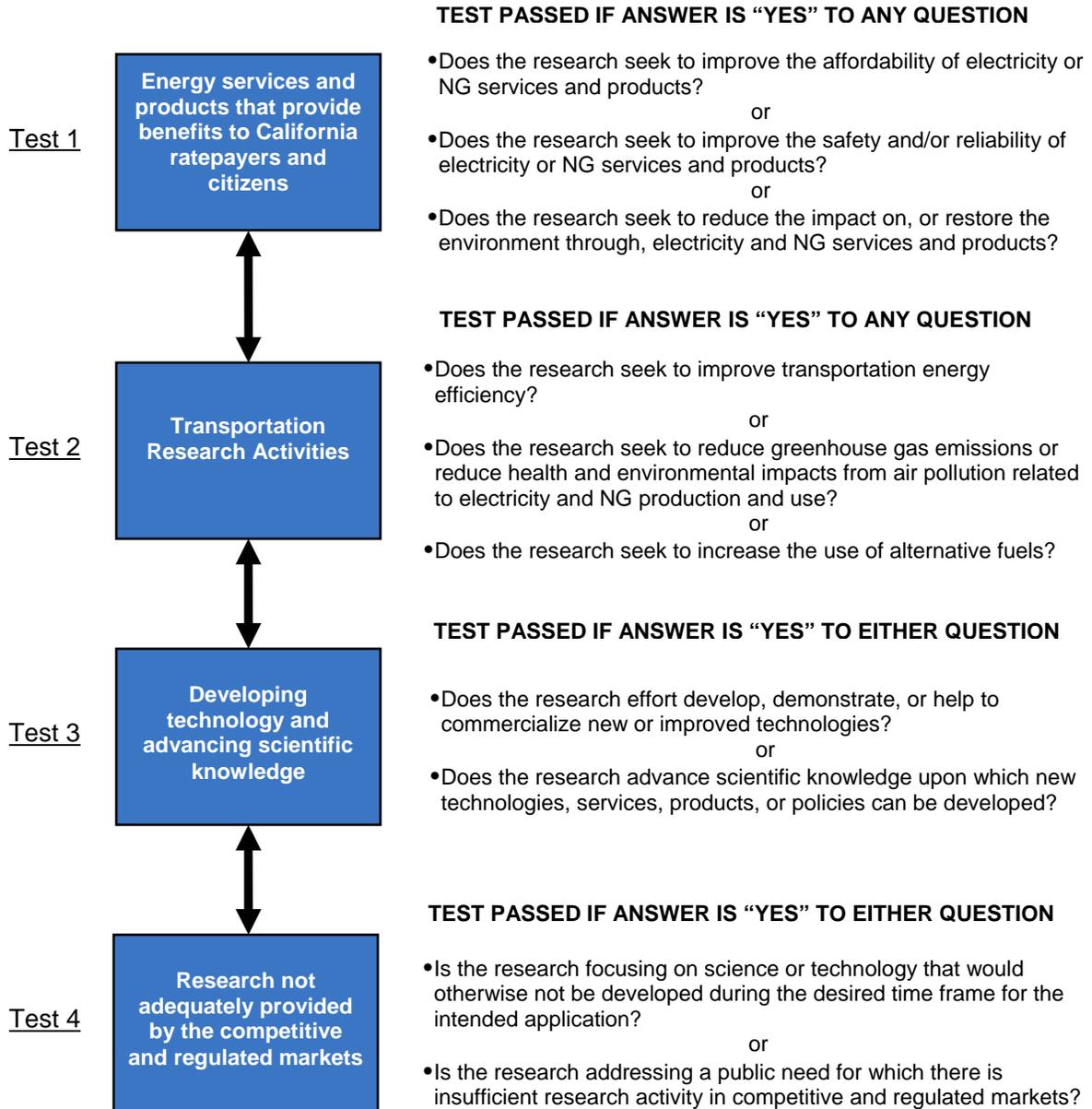
SB 76 identifies the following activities that benefit ratepayers:

- Energy efficiency
- Reduction of health and environmental impacts from air pollution
- Reduction of greenhouse gas emissions related to NG and electricity production and use
- Increased use of alternative fuels.

Some of these activities are explicitly or implicitly called out in the Warren-Alquist Act and the Public Interest Screening Process (Figure A1-3). The PIER program currently engages in activities related to energy efficiency research activities. This research is implicitly included under “research that seeks to improve the affordability of energy services and products” in Figure A1-3. The PIER program also currently engages in research activities related to the reduction of health and environmental impacts from air pollution. This research activity is explicitly called out under “research that seeks to reduce the impact on or restore the environment through energy services and products.” While greenhouse gas emissions research is also implied under this screen as well, SB 76 reinforces State environmental policy by explicitly calling attention to greenhouse gas emissions reductions as distinct from reductions of other air pollutants. Also, increased use of alternative fuels is not specifically called out in the Warren-Alquist Act, nor in the Public Interest Screening Process, and is another research objective that SB 76 adds to the PIER program.

The Energy Commission proposes to modify its Public Interest Screening Process (Figure A1-4) to explicitly include “reduction of greenhouse gas emissions related to NG and electricity production and use” and “increased use of alternative fuels” in Test 1. This Screening Process will then be applied to all proposed research initiatives and projects.

Figure A1-4: Public Interest Screen for Transportation Research



4. The law could be interpreted to mean that all activities identified in SB 76 must be collectively addressed by each research project. The Energy Commission believes the intent was to apply these requirements to the research portfolio as a whole.

SB 76 States, "SEC. 5. Section 740.8 of the Public Utilities Code is amended to read: 740.8. As used in Section 740.3, "interests" of ratepayers, short- or long-term, mean direct benefits that are specific to ratepayers in the form of safer, more reliable, or less costly gas or electrical service, consistent with Section 451, and activities that benefit ratepayers and that promote energy efficiency, reduction of health and environmental impacts from air pollution, **and** greenhouse gas emissions related to NG and electricity production and use, **and** increased use of alternative fuels."

It is not likely that one project could address all the benefits and activities identified in SB 76. Therefore, it is necessary for the Energy Commission to apply the guidance in SB 76 to its entire transportation research project portfolio. The Energy Commission likely will have many projects in its research portfolio that are addressing one or more of the benefits and activities identified in SB 76. For example, it might have a project that is eliminating barriers to using alternative fuels, a project that is studying how improved transportation energy efficiency is going to impact greenhouse gas emissions and another project that is addressing the air emissions impact of plug-in hybrid electric vehicles. This is how the Energy Commission currently manages its research portfolio under the Warren-Alquist Act and the Energy Commission proposes to use this same approach.

5. SB 76 does not change the Energy Commission's obligations to follow existing public interest criteria

SB 76 does not change the Energy Commission's obligations to invest in public interest research, as required in the Warren-Alquist Act. Therefore, investments in transportation research must be consistent with other public interest criteria, specifically Tests 3 and 4 in Figure A1-4. For example, research that is already adequately provided by competitive or regulated markets would be not included. Therefore, a project that would improve the efficiency of conventionally fueled automobiles should be adequately covered by the automotive industry and would not be funded by PIER.

6. SB 76 does not in itself provide enough guidance for prioritizing among possible research investments, so the Energy Commission will need to make investment trade-offs using additional criteria.

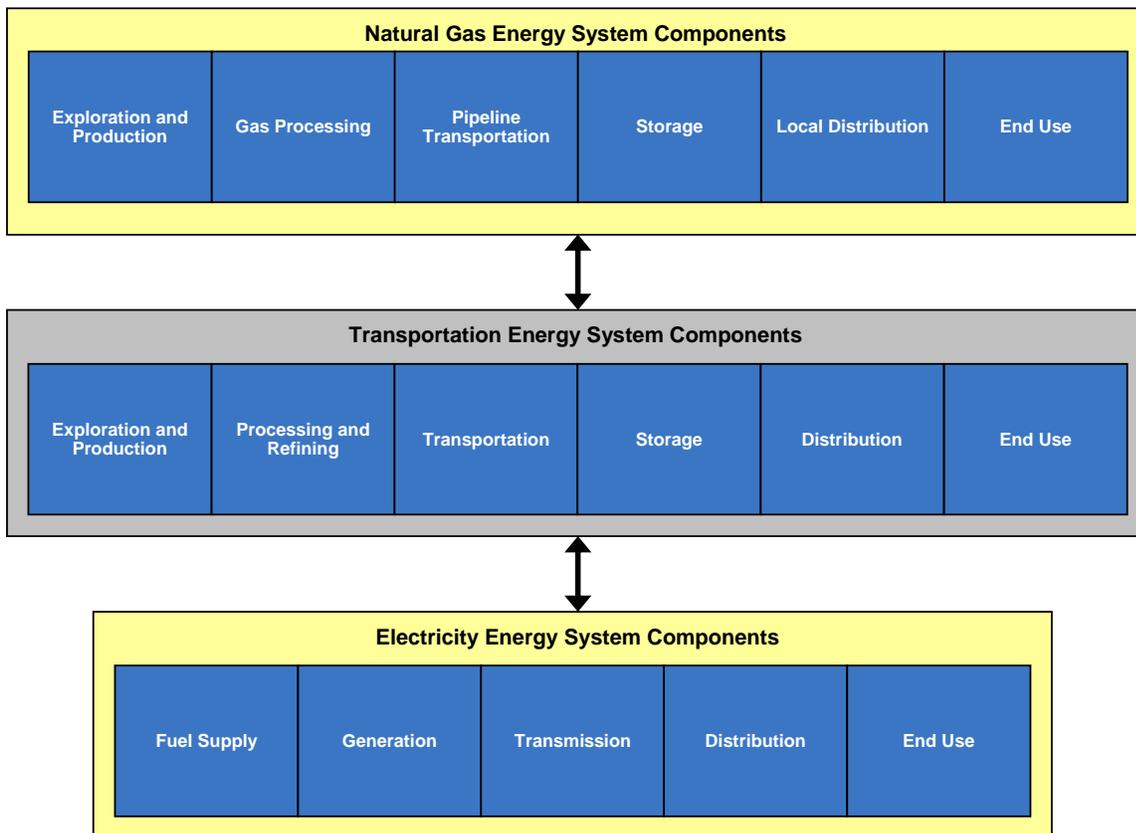
Research funds are limited; so even research that fits within the public interest criteria may not be funded. This addendum outlines what can and what can not be funded by PIER. Further road-mapping and research plan development will be completed to prioritize what should be funded, given limited funding and higher priority public needs. Criteria beyond those provided by SB 76 will be used to make project investment trade-

off decisions. These criteria will be derived from sources such as State energy policy, cost/benefit analyses and Governor’s Executive Orders.

III. Using energy system linkages to understand how transportation research impacts ratepayers

Some interactions between transportation and electric or NG systems are direct. Examples include electric plug-in vehicles or NG vehicles where the transportation energy source is drawn directly from the NG and electricity infrastructure and systems. However, other interactions are less direct, but may be important. An example is competing transportation and non-transportation uses for fuels such as biomass. A framework to better evaluate if and how specific transportation research initiatives will impact NG and electricity ratepayers will be useful to differentiate between strong, moderate, or weak linkages to the NG and electricity ratepayers (Figure A1-5).

Figure A1-5: Simplified Energy Systems Schematic



Public interest transportation research is expected to have linkages with the NG or electricity energy systems and the transportation energy system. For example, transitioning from petroleum based to non-petroleum based transportation fuels such as

electricity and biofuels will increase linkages to the electricity and NG systems over time. Proposed public interest transportation research must describe the expected ratepayer benefits. To accomplish this, proposed research need to describe credible and easily understandable impacts on the electricity and/or NG systems. Through these links, the proposed research efforts demonstrate their connection to the NG and electricity ratepayers.

IV. Using California transportation energy policy to help prioritize research and development investments

As stated earlier, SB 76 does not explicitly provide guidance for prioritizing transportation research. The Energy Commission proposes to use the energy policy guidance that has been developed through the 2005 Integrated Energy Policy Report and the second Energy Action Plan (EAP II) to prioritize transportation research. Additional guidance will come from related energy policy documents such as the State Plan from AB 1007 and the Climate Action Team's 2006 Report to the Governor.

The 2005 IEPR establishes transportation energy policy goals of:

- Reducing petroleum consumption
- Diversifying California's fuel supply
- Increasing the use of electric drive transportation technologies, including: plug-in hybrid vehicles; truck idling reduction with electrification; marine port electrification; airport ground support equipment; electric standby for truck and container refrigeration units; and electric non-road vehicles such as forklifts and other industrial equipment
- Increasing the use of natural gas transportation technologies
- Increasing vehicle efficiency and
- Reducing fuel demand through integrated transportation and land use planning.

The EAP II establishes seven joint CPUC/CEC transportation energy policy goals:

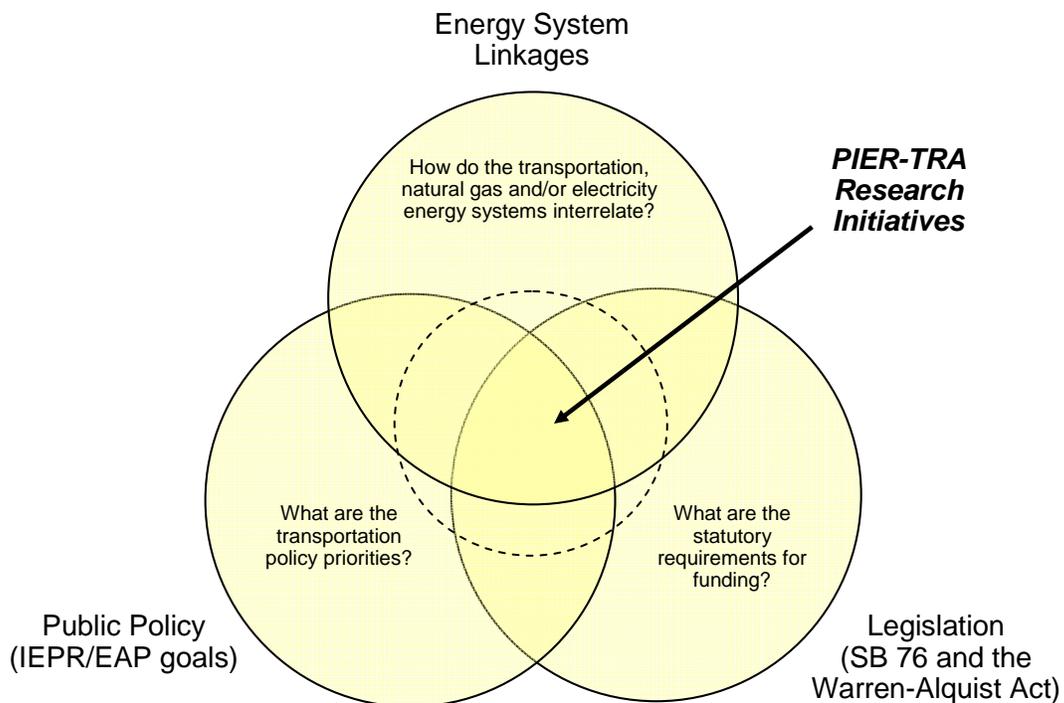
1. Prepare by March 31, 2006 a long term transportation fuels plan to increase the use of alternative fuels, increase vehicle efficiency, increase the use of mass transit, reduce dependence on petroleum fuels, and improve land use planning.
2. Increase coordination of petroleum infrastructure permitting among State, local, and regional agencies, including developing guiding principles for approval of new petroleum facilities.
3. Continue to work with other States and stakeholders to convince the federal government to double the Corporate Average Fuel Economy (CAFE) standards.
4. Work in conjunction with Cal EPA to implement the California Hydrogen Highway Blueprint.

5. Increase the use of high-efficiency, fuel flexible vehicles, and dedicated non-petroleum-fueled vehicles in the State's fleet of passenger cars and light-duty trucks. Increase the use of non-petroleum fuels in the State's fleet of medium and heavy-duty on-road and off-road vehicles.
6. Complete testing to evaluate tire rolling resistance and fuel economy potential, establish standards, and implement a voluntary reporting program. Consider a rulemaking for mandatory reporting in the event voluntary compliance is inadequate.
7. The CPUC, in conjunction with the CEC, Cal EPA, and local air districts, will continue to evaluate and implement policies to promote the development of equipment and infrastructure needed to facilitate the use of electric power and NG to fuel low-emission vehicles as required by Public Utilities Code sections 740.3, 740.8, and 451.

V. The Energy Commission's proposed methodology for identifying transportation research benefits

Similar to its actions pursuant to the Warren-Alquist Act, the Energy Commission must use the broad guidance in SB 76 to create a more specific, transparent methodology for making investments in transportation energy research that benefits NG and electricity ratepayers. The proposed framework for this methodology must ensure that the research investments comply with SB 76, account for energy system linkages, and address priority transportation energy policy (Figure A1-6).

Figure A1-6: Proposed Conceptual Framework

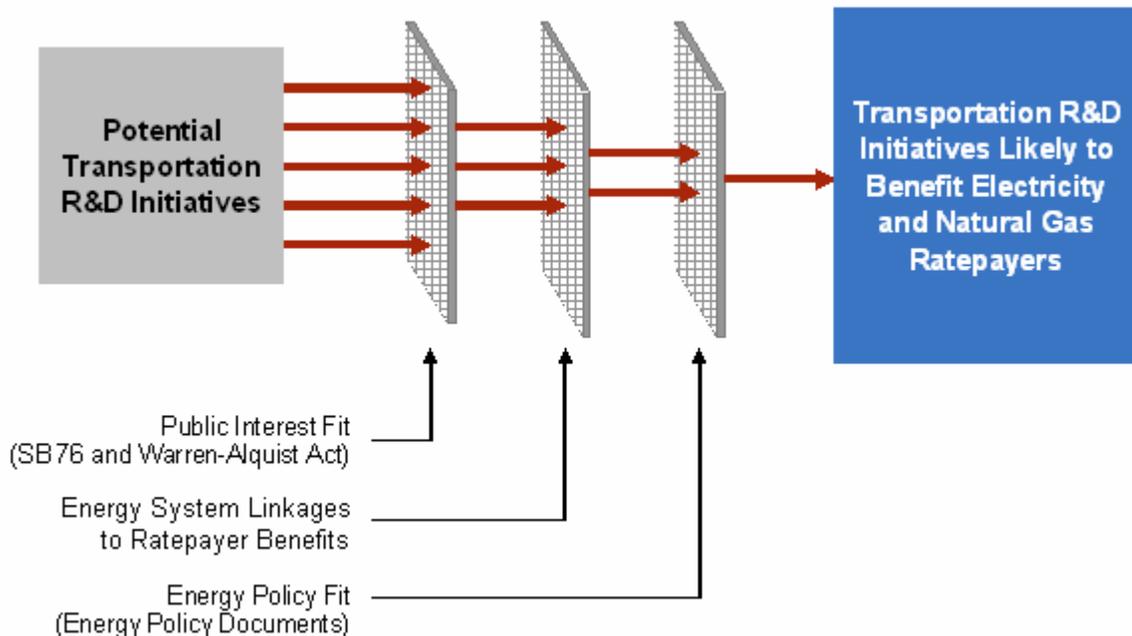


The relative weight of the Linkage, Statutory and Policy consideration elements (i.e., circles in above figure) will vary depending on the research initiative in question, therefore the overlap area containing PIER-TRA research initiatives will vary.

The Energy Commission will use this methodology to identify ratepayer benefits of PIER transportation research initiatives. This methodology (Figure A1-7) will:

1. Incorporate the requirements of statutes governing public interest energy research, including SB 76.
2. Use energy system linkages to evaluate how transportation research impacts electric and NG ratepayers.
3. Use California transportation policy in combination with statutes and system linkages to identify strong, moderate, or weak ratepayer benefit potential of research initiatives.

Figure A1-7: Proposed Methodology



See Appendix I for examples of the methodology's application to potential research.

As the Transportation Research Area grows, the program will implement a process to ensure it is investing in a balanced portfolio of research. The criteria for balancing will include risk, timing to payoff, project size, and project value. The portfolio may also be balanced around the four activities identified in SB 76 and the research priorities as identified in the IEPR/EAP process.

VI. Conclusion

As the transportation energy system moves away from its reliance on petroleum and more towards alternative fuel resources and infrastructure, NG and electricity ratepayers will be more directly affected by changes in the transportation energy system. Impacts could be negative or positive. By supporting research that mitigates negative impacts or unlocks the positive aspects, the PIER program will be making investments that are in the interest of NG and electricity ratepayers. The PIER program will work with stakeholders to find these research opportunities. Limiting the research agenda to these types of research opportunities *and* by screening any research initiatives with the Modified Public Interest Screening Tool; the PIER program will ensure that it is making investments that are in compliance with SB 76. Prioritizing these research initiatives using the public policy goals identified in the IEPR/EAP II process ensures that limited funds will be used to address the most important transportation energy issues.

Addendum 2: Illustrative Examples of Projects Reviewed Using Methodology Outlined

The following examples are provided to show how the methodology could be applied. It is not meant to imply that these are the high priority projects. It is possible that the results may change after more research plan development. They are illustrative only.

PROJECT A - Field demonstration of a novel NG engine in heavy duty road vehicles (e.g., garbage trucks, street sweepers, transit bus, truck) able to meet 2010 emission standards.

Public Interest: Passes Screen

Test 1 Passed – The research seeks to reduce greenhouse gas emissions related to NG use.

Test 2 Passed – The research effort seeks to demonstrate new or improved technologies.

Test 3 Passed – Given that it addresses 2010 emission standards in 2007, this product may not otherwise be developed during the desired timeframe for the intended application.

Energy Systems Linkage: Strong Linkage

The successful introduction of this NG engine technology would have a clear impact on the end-use demand for NG and its local distribution pattern given the limited availability of Compressed NG at vehicle fueling stations.

Policy Linkage: Strong Linkage

IEPR – If successful, this research will result in reducing petroleum consumption and increasing the use of NG transportation technologies.

EAP II – This research may increase the use of non-petroleum fuels in the State's fleet of heavy-duty on-road vehicles.

PROJECT B - Impact on engine performance and emissions using Liquefied NG (LNG) as a replacement fuel for current sources of Compressed NG (CNG).

Public Interest: Passes Screen

Test 1 Passed – The research seeks to increase the use of alternative fuels.

Test 2 Passed – The research advances scientific knowledge upon which new services and policies can be developed.

Test 3 Passed – Given the scale of the issue, the research is addressing a public need for which there is insufficient research activity in competitive and regulated markets.

Energy Systems Linkage: Strong Linkage

Research has a direct impact on NG consumption patterns by drawing on alternative fuel sources, relieving pressure on the traditional NG infrastructure used for CNG powered vehicles.

Policy Linkage: Strong Linkage

IEPR – If successful, this research will result in reducing petroleum consumption, accelerated the diversification of California’s fuel supply, and increase the use of NG transportation technologies.

EAP II – This research may reduce the use of petroleum fuels in the State’s vehicles.

PROJECT C - Research to determine effectiveness of Selective Catalytic Reduction (SCR) in conjunction with a catalyst coated silicon-carbide particulate filter in diesel ferry engines.

Public Interest: Passes Screen

Test 1 Passed – The research seeks to reduce the air quality impact of existing products.

Test 2 Passed – The research seeks to develop improved technologies.

Test 3 Passed – The research is addressing a public need for which there is insufficient research activity in competitive and regulated markets.

Energy Systems Linkage: Weak Linkage

This research has no linkage to the NG energy system as the technology is focused on diesel, a traditional petroleum-based fuel.

Policy Linkage: Weak Linkage

IEPR – This research does not support transportation energy policy as described in the IEPR.

EAP II – This research does not support any of the joint CPUC/CEC transportation energy policy goals.

¹ CARB communicated its general concurrence with the strategic objectives and related research solutions in the plan during the August 30, 2006 Energy Commission business meeting.

² 2005 Integrated Energy Policy Report, Publication # CEC-100-2005-007-CMF, Page 132

³ For example, Gas Technology Institute (GTI), DOE, IOUs