

**PROGRAM PLAN AND
FUNDING REQUEST
FOR 2005
Natural Gas
Public Interest
Research Program**

Commission Report

OCTOBER 29, 2004
500-04--085CM



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ACKNOWLEDGEMENTS

Energy Commission staff acknowledge the excellent assistance provided to this report's production by the University of California's California Institute for Energy and the Environment (CIEE). Specifically, the assistance provided by Steve Schiller, Carl Blumstein, and Bob Knight proved enormously valuable to the timeliness and quality of this Program Plan.

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EXECUTIVE SUMMARY

The California Public Utilities Commission (CPUC), in Decision 04-08-010, has designated the California Energy Commission as Administrator of the Natural Gas Public Interest Research and Development Program. This report complies with the requirements of CPUC Decision 04-08-010 and defines the first year (2005) plan and budget for research and development (R&D) activities that address maximizing the effectiveness and efficiency of California's gas resources as well as mitigating the environmental effects of gas consumption. It establishes a set of Program "Research Areas" that constitute a \$12 million R&D effort for 2005 that meet the requirements for public purpose research and development. As noted in the State's 2003 Energy Action Plan, California's economic prosperity and quality of life are increasingly reliant upon dependable, high quality, and reasonably priced energy. Furthermore, as the CPUC stated in Decision 04-08-010, gas is a vital resource in the economic future of California. This plan provides for a R&D Program that supports this important energy resource.

Public purpose gas R&D activities are directed towards developing science or technology, the benefits of which accrue to California citizens and which are not adequately addressed by competitive or regulated entities. The California Energy Commission has gathered public input from its own energy and environmental R&D experts, interested parties, research groups, the CPUC's Energy Division and the State's utilities to define this public purpose Gas R&D Program. With the CPUC's approval, this Program will begin on January 1, 2005.

The Energy Commission, as the Gas R&D Program administrator, is seeking approval for a 2005 Program year budget. This includes multi-year funding for years 2004 and 2005 program administration costs, as well as year 2005 research activities. Table ES1 on page 3 summarizes recommended and prioritized Program Research Areas with an associated budget request for 2005.

With respect to the utility transition research projects, it is the Energy Commission's understanding that SEMBRA has submitted a request to the CPUC for approximately \$725,000 to complete its public purpose gas R&D activities. This Energy Commission funding request does not include a separate budget item for these SEMBRA R&D projects. The CPUC may select none, some, or all of these projects for continuation in 2005 and, as required, utilize a portion of the requested \$12 million to fund them during 2005. The Energy Commission's preferred scenario is for the CPUC to delegate authority for funding or not funding some or all of these projects directly to the Energy Commission. The Energy Commission could then, as Program Administrator, decide which portion, if any, of the \$12 million budget should be allocated to these utility transition projects. Alternatively, the CPUC may utilize input from the Energy Commission in making the utility transition project funding decision at some future date after approving this Research Program Plan. |

In addition to managing the public purpose research activities that fit within the defined Program Research Areas, the Energy Commission will also initiate a comprehensive planning process in 2005 to define a multi-year R&D program focused on delivering benefits to California's citizens. To that end, the Energy Commission will hold public workshops and use its extensive R&D experience to develop the multi-year research strategy and then submit a 2006 program plan and funding request, based on the strategy, by August 31, 2005.

The Energy Commission will administer the gas R&D program as part of its Public Interest Energy Research (PIER) Program. This established research program has existing infrastructure for the management of public interest energy orientated R&D activities.

This report is organized into the following Sections:

- Section 1 provides an overview of California gas usage as well as the regulatory background associated with this R&D Program
- Section 2 describes the process used to develop this report
- Section 3 describes the recommended 2005 Research Areas and funding levels
- Section 4 provides an overview of the administrative plan for the gas R&D program
- The Appendices list (included) and provide (under separate cover) the Abstracts received by the Energy Commission in response to its request to the public for gas R&D recommendations

Table ES1. Research Program and Funding Request Summary¹

Ranked Program Research Area – with ranked Project Research Areas	Description of Program Area	Budget Allocation Per Program Research Area
<p>1. Gas Efficiency –</p> <ul style="list-style-type: none"> ▪ Gas water heating technology ▪ Gas space heating technology ▪ Commercial food service technology ▪ Industrial combustion efficiency ▪ Industrial waste heat recovery ▪ Gas appliance technology ▪ Gas space cooling technology 	<p>This area focuses on improving the efficiency of gas consuming equipment in the residential, commercial and industrial sectors</p>	\$5.0 million
<p>2. Renewables</p> <ul style="list-style-type: none"> ▪ Water heating alternatives ▪ Process heating alternatives ▪ Renewable natural gas fuel replacements 	<p>This area focuses on developing and commercializing alternative fuel sources, particularly solar energy and biofuels.</p>	\$2.0 million
<p>3. Environmental</p> <ul style="list-style-type: none"> ▪ Air quality impacts and mitigation strategies for combustion of alternative gas supplies (e.g. off-spec and LNG) ▪ Climate change adaptation and mitigation--issues and implications for the natural gas system 	<p>This research will improve analytical capability for assessing potential criteria air pollutant (indoor and regional) and greenhouse gas impacts and mitigation strategies for traditional and non-traditional NG blends.</p>	\$2.25 million
<p>4. Strategic Analyses</p> <ul style="list-style-type: none"> ▪ Tool and model development to aid in targeting appropriate infrastructure improvements ▪ Economic research to address State gas energy policy issues ▪ Security related to catastrophic events 	<p>This research address topics such as value of increased gas storage; impact on gas prices and reliability of various fuel specifications, including off-spec and LNG; market analysis, identifying real time slack capacity needed in pipelines and mitigating impact of catastrophic events (e.g., earthquakes and terrorism).</p>	\$1.25 million
Administration	<p>Covers the period from 9/1/04 – 12/31/05; includes planning, project selection, contracting, project management and reporting.</p>	\$1.5 million
Utility Transition Project(s)		To be determined and included as portion of above budget items
Total		\$12.0 million

¹ If the CPUC decides to fund one or more of the SEMPRA transition R&D projects, the budget can be taken from the appropriate Program Research Area budget items, above.

SECTION 1: INTRODUCTION

Natural Gas Consumption and Gas R&D Activities

California Natural Gas Consumption²

California uses approximately 2 trillion cubic feet of natural gas per year. Currently, pipelines from sources outside the State supply 85 percent of natural gas consumed in California. Historically the primary use of this fuel was for space heating in homes and businesses and process related loads in industry. Currently, about one-third of the gas is used in power plants, one-third in core accounts (primarily residential and commercial consumption), and one-third industrial non-core (mostly used in the petro-chemical and food processing industries). However, electricity generation's dependence on relatively clean-burning natural gas now means that California's annual natural gas use by power plants is expected to increase at rate higher than that of other sectors.

California's total demand for natural gas is also increasing. According to the Energy Commission's forecast for natural gas demand from 2003 to 2013, natural gas demand in California will increase as follows:

- Core demand (including residential, commercial, and smaller industrial customers) will increase from 0.66 to 0.73 trillion cubic feet (Tcf), a rate of 0.9 percent per year
- Non-core demand (large industrial customers) will increase from 0.74 to 0.77 Tcf, an annual growth rate of only 0.4 percent
- Electric generation demand will increase from 0.8 to 0.93 Tcf, or 1.5 percent per year.

The Energy Commission's forecast says total natural gas demand will increase at an average of 1.0 percent per year in California from 2003 to 2013. However, this represents less than half of the annual rate by which total U.S. natural gas demand is projected to grow during the same period. It is important to realize that this

² The information in this subsection is from the California Energy Commission's Integrated Energy Policy Report Subsidiary Volume: Electricity And Natural Gas Assessment Report, December, 2003, 100-03-014F

forecast includes the effects of natural gas energy efficiency programs, and assumes that the current levels of funding for energy efficiency programs will continue through 2011, as authorized by the California Legislature. In effect, the need for California to expand its gas system infrastructure and supplies has been delayed due to the level of conservation and efficiency activities in the state.

Gas R&D Activities

Natural gas R&D in California has historically been conducted by the State's natural gas utilities. This research can be divided into two categories: regulated and public purpose. Regulated gas R&D has been the primary focus of the utilities' efforts.

The CPUC Decision 04-08-010 to increase public purpose gas R&D is important because the trend in government and private-sector investment in energy and gas-related R&D, according to the Gas Technology Institute (GTI)³, has been downward over the past decade. Declines have been seen in federal government energy R&D funding as well as in private-industry and not-for-profit R&D funding. Not including the Research Program described in this report, national funding for R&D by gas utilities and pipeline companies in 2005 is expected to total less than \$30 million – a drop of 90% over the past decade, again, according to GTI⁴. In the mid-1990s, the budget for the Gas Research Institute (GRI) managed cooperative R&D program reached approximately \$200 million.⁵ In 2004, the GRI budget fell to \$60 million and the GRI-managed R&D program is slated to end in December 2004⁶. Thus, the California Gas R&D program will be an important source of gas R&D for the entire country.

The California Gas R&D Program will fit within the Energy Commission's existing Public Interest Energy Research (PIER) program. The PIER Program supports energy R&D projects that will help improve the quality of life in California by bringing environmentally safe, affordable and reliable energy services and products to the marketplace. PIER funding efforts are focused on the following R&D program areas:

- Buildings End-Use Energy Efficiency
- Energy Innovations Small Grant Program
- Energy-Related Environmental Research
- Energy Systems Integration
- Environmentally-Preferred Advanced Generation
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy Technologies

³ Gas Technology Institute 2005-2009 R&D Plan & 2005 R&D Program, May 2004

⁴ *ibid*

⁵ *ibid*

⁶ *ibid*

The PIER Program annually awards more than \$62 million to the most promising public interest energy research by partnering with R&D organizations including individuals, businesses, utilities, and public or private research institutions. PIER brings new energy services and products to the marketplace and creates statewide environmental and economic benefits. This objective of commercializing R&D program results will continue within the Gas R&D Program.

Regulatory Background

Assembly Bill 1002 (stats. 2000, Ch. 932)⁷ granted the California Public Utilities Commission (CPUC) authority and discretion to determine appropriate natural gas funding levels for low-income, energy efficiency and public interest R&D activities. AB 1002 is consistent and in harmony with Public Utilities Code Sections 890(a) and 890(d) that direct the CPUC to establish a natural gas surcharge for certain specified public policy programs and annually determine the amounts “required” to administer and fund these programs. The CPUC issued Order Instituting Rulemaking (R.) 02-10-001 on October 3, 2002, to determine broad policy issues and adopt a long-term framework to implement AB 1002. On April 22, 2003, the Assigned Commissioner issued an Assigned Commissioner’s Ruling (ACR) determining the category, need for hearing, scope and schedule of the proceeding. The ACR divided R.02-10-001 into two phases. The First Phase addressed issues concerning policy and implementation of AB 1002 through a workshop. Phase Two addressed R&D issues, including defining public interest R&D, project identification and evaluation, and establishing funding levels.

In Decision 04-08-010 dated August 19, 2004 and mailed August 23, 2004 the CPUC addressed both Phase One and Phase Two issues. Since this report responds to certain Phase Two issues, the definition of the 2005 R&D Program and the related Phase Two adopted policies from Decision 04-08-010 are summarized below.

Definition of Public Interest Gas R&D

The adopted definition of public interest R&D is:

Public interest gas R&D activities are directed towards 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.⁸

In addition, the CPUC expects approved R&D projects to meet the following criteria:

⁷ AB 1002 is codified in Public Utilities Code Sections 890 *et seq.*

⁸ This definition is based on the Working Group Report on Public Interest R&D Activities, September 6, 1996, submitted in R.94-04-031, pp. ES-2 and 2-7

1. Focus on energy efficiency, renewable technologies, conservation and environmental issues
2. Support State energy policy
3. Offer a reasonable probability of providing benefits to the general public
4. Consider opportunities for collaboration and co-funding opportunities with other entities.

Administration of Public Interest Gas R&D

The Administrator of public interest R&D has the responsibility to offer public interest projects for approval, and provide oversight so that projects are performed in a timely manner, within a budget, and at a reasonable cost. The CPUC selected the Energy Commission as Administrator for the gas R&D program because the Energy Commission currently manages the PIER program, and central to its mission is the development of public energy policy. In addition, Energy Commission is subject to the Bagley-Keene Open Meeting Act and the Public Records Act requirements that help ensure public accountability.

The Energy Commission, as Administrator will manage daily activities and R&D projects, including planning, project procurement, project accounting and program evaluation. The CPUC will review and approve the annual plans for R&D projects to be funded. The CPUC also decided not to establish any additional committees, boards or other entities to oversee the Administrator at this time.

Budget for Public Interest Gas R&D

The CPUC adopted a first year Gas R&D Program cap of \$12 million beginning January 1, 2005. The CPUC also adopted the principle of zero-based budgeting for the R&D Program and further provided that this initial cap can be increased by up to \$3 million annually pending identification and approval of additional R&D projects, to a maximum cap of \$24 million after four years. After this period, the CPUC will assess the reasonableness of the funding level, and the overall R&D program.

The budget includes all necessary R&D administrative costs. In addition, the CPUC allowed the Energy Commission to access up to \$1 million in the Fund during 2004 if necessary to begin its administration of the R&D program. The start-up funds are included in the R&D spending cap for program year 2005.

The CPUC also ordered the utilities to report any unspent R&D funds to its Energy Division as of December 31, 2004, and any unspent R&D funds will be used for future R&D programs.

First Year and Annual Submittals and Approval Process

The CPUC's Decision addressed several submittals to the CPUC for finalizing the 2005 Program. This included directing the utilities to provide updated R&D plans to the CPUC within 60 days of the effective date of the decision (approximately October 22nd). These updated plans are to detail how the utilities will end any current public interest R&D projects they are conducting, or transfer these projects to the Administrator by December 31, 2004.

The Decision also provided for a process and mechanisms for the new Administrator's first year's (2005) and future years' annual project submittals and budget requests. The 2005 program submittal is the focus of this report. The CPUC also encouraged parties to submit project and program ideas throughout the planning cycle of each year's R&D Program, as follows;

- Potential projects should be provided to the Administrator and CPUC Energy Division by September 30, 2004 for the 2005 R&D program – see Section 2 and the Appendix of this report for information on the project abstracts that were submitted
- For future years, suggested projects should be provided to the Administrator and the Energy Division by July 31 of the year preceding the year for adopting the next annual gas R&D program
- By August 31 of each year, the Administrator is to provide a prioritized list of projects that meet the CPUC's adopted project criteria to the Energy Division, prior to the January 1 R&D program effective date. However, for R&D program year 2005, the list should be provided by October 31, 2004.
- On March 31st of each year the Administrator will provide the Energy Division with a prior year Annual Report on R&D Activities and Spending.

SECTION 2: DEVELOPMENT OF 2005 NATURAL GAS R&D PLAN

The fundamental elements of this Research Program Plan are the recommendations for which Gas R&D Program Research Areas should be funded for 2005, what priority should be associated with each Program Area, and funding levels for each Program Area. In this section the process used for developing these recommendations and the actual recommendations are discussed.

Plan Development Process

Decision 04-08-010 was approved by the CPUC on August 19, 2004. This resulted in a relatively short time to accomplish two important goals of the Decision. First, obtain, by September 30, the public's recommendations for projects to consider funding as part of the 2005 plan. Second, complete the 2005 program plan by October 31. In collaboration with the CPUC, the Energy Commission used the following process to meet these goals:

1. Strategic Coordination with CPUC Energy Division Staff

The Energy Commission and CPUC staff formed a collaborative effort to define methods, products and timeframes in order to satisfy the requirements of the Decision. With input from CPUC staff and CEC Commissioners, Energy Commission staff used a programmatic approach that established a prioritized list of research subject areas with budget allocations for each area. Furthermore, each research subject area was comprised of two or more project areas, also prioritized but with no specific budget allocation. Finally, any research subject area rejected for the 2005 plan was listed along with an explanation for the rejection.

2. Evaluate and Rank Public Project Input for Consideration in the Plan

The CPUC and CEC staff agreed that input for consideration would consist of Project Concept Abstracts submitted via the Internet. The Request for Abstracts announcement was posted at the CEC and the CPUC and directed submitters to a URL where the application form could be accessed. The Request for Abstracts informed the public that the abstracts would be used to calibrate and validate the 2005 research plan and budget. The solicitation and ranking of abstracts do not constitute any intention or obligation to fund projects. *There will be a separate process for selecting actual projects for funding after the R&D Program is approved.*

Staff agreed to use Web postings and e-mail to existing CPUC and CEC lists of interested parties to advertise the Request for Abstracts. The sub-section below details the process used to gather and evaluated project concept abstracts.

3. Coordinate Input from Energy Commission and State Sources

The CEC staff gathered input from the following areas of the Energy Commission and State government:

- Recommendations and guidance from the Governor's office
- Public Utilities Code Section 740.1 which provides a guide for determining the selection of R&D projects
- Energy Commission's Energy Efficiency and Demand Analysis Division
- Energy Commission's Natural Gas Office
- Energy Commission's Research and Development Committee, Commissioner Arthur Rosenfeld Presiding, Commissioner John Geesman, Member
- Each of the other Energy Commissioners
- Research staff of the Energy Commission's Public Interest Energy Research Program
- Energy Commission's Transportation Energy Division

4. Coordinate Stakeholder Input

CEC staff held meetings with the organizations listed below. In each meeting, the representatives of each organization were presented with critical points from the CPUC Decision, the approach being used to plan development, and the timeline for completing the Program Plan due on October 31. The representatives were invited to comment on the development approach and proposed organization and content of the Program Plan.

Participating organizations included:

- Electric Power Research Institute
- Gas Technology Institute
- SEMPRA Energy
- Pacific Gas and Electric Company
- Lawrence Berkeley National Laboratory

5. Establish Research Focus Areas and Budget for 2005

Results from the previous steps were used to develop, prioritize and provide budgets for each of the research subject areas are presented below.

Request for Project Abstracts

Decision 04-08-010 invited the gas utilities and public to submit "...potential gas R&D projects to the Administrator and the (CPUC) for consideration and inclusion in annual R&D programs." Furthermore, in recognition of the scant time available for development of the 2005 plan, the CPUC moved the deadline for these projects submissions from July 31, 2004 to September 30, 2004. CPUC and Energy Commission staff realized the limited time (two weeks) was too short to ask for projects proposals developed sufficiently to make funding decisions. In addition, Energy Commission and CPUC staff agreed to develop the 2005 plan programmatically, rather than pre-determining a list of specific projects for funding. Therefore, staff decided to request brief abstracts of project concepts. The Request for Concept Abstracts was posted at the CPUC and CEC on September 16, 2004. The Request for Project Concept Abstracts resulted in 172 submissions being submitted that described research efforts with a total budget of nearly \$250 million, as summarized in Table 2.1.

The Abstracts were evaluated by senior Energy Commission research staff and used to validate and calibrate the recommendations of Energy Commission's Commissioners and research staff.

The abstract evaluation process proceeded as follows:

1. Screening

Energy Commission research staff used the following screening criterion on all abstracts submitted: Does the Project Abstract describe a public purpose natural gas R&D activity? If so, the abstract proceeded to the second step. If not, the abstract would not be further evaluated. Public Purpose was defined per the CPUC's Decision 04-08-010.

2. Sorting

Abstracts were analyzed for content and assigned to one of the following research subject areas:

- End-use residential, commercial, industrial or agricultural energy efficiency
- Renewable energy
- Environmental Effects
- Strategic Analysis

Table 2.1 summarizes the abstracts submitted.

Table 2.1 Project Concept Abstracts Received from Utilities and Public

Research Subject Area	Number Received	Funding Requested
Efficiency: Residential, Commercial, Industrial and Agricultural	58	\$97 million
Renewable Energy	16	\$30 million
Environmental Effects	61	\$87 million
Strategic Analysis	24	\$17 million
Abstracts Screened	13	\$18 million
Totals:	172	\$249 million

3. Abstract Review and Rating

Project Abstracts considered public interest were then ranked within each Program Research Area. The abstracts are ranked as high, medium or low using the following set of criteria:

- Potential Benefits
- Connection to State Energy Policy and gas issues identified in California Energy Action Plan
- Potential for success, reasonable probability of providing benefits to the general public
- Whether adequately addressed by competitive or regulated entities
- Consideration of opportunities for collaboration and co-funding opportunities with other entities

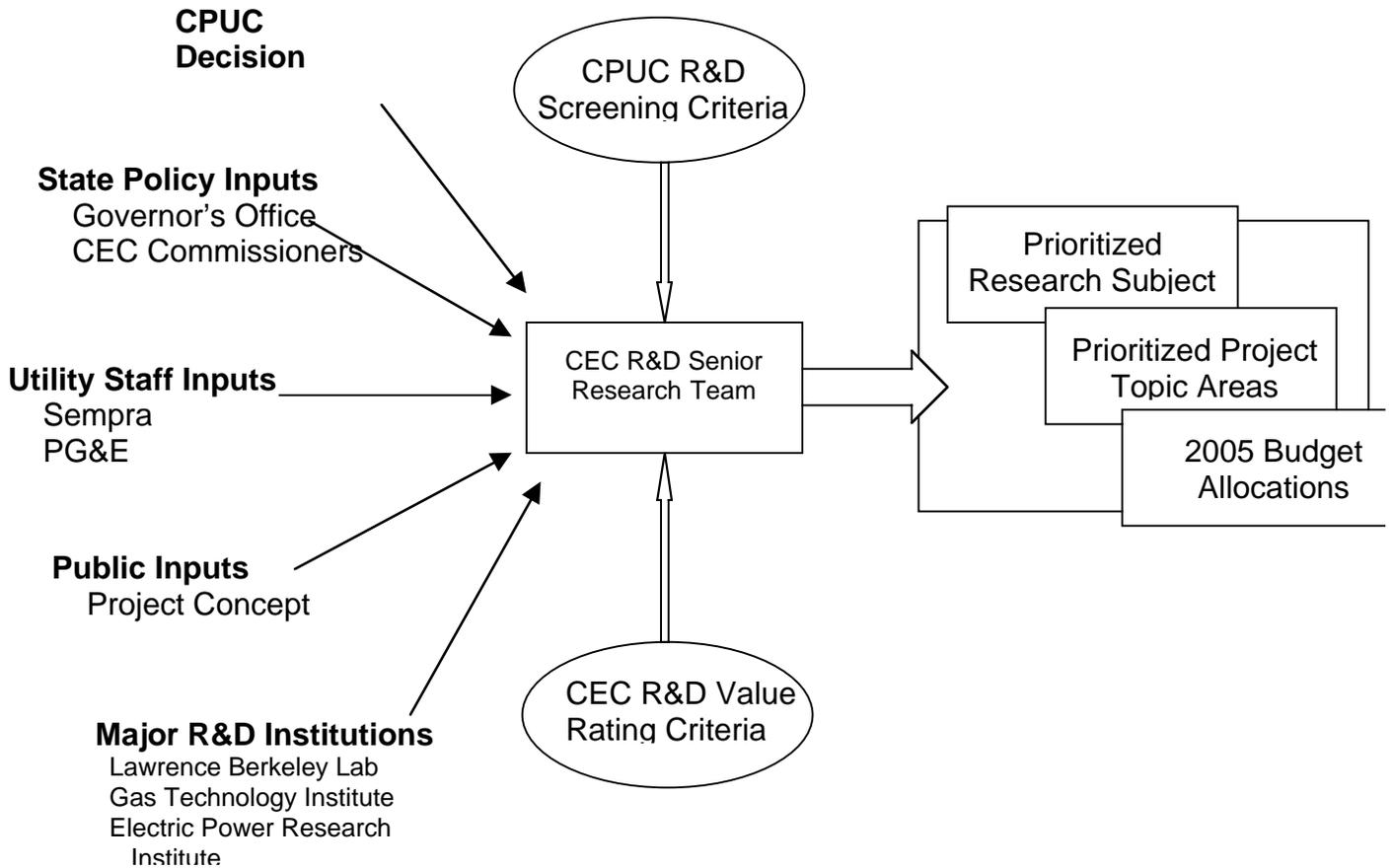
For example, an abstract that described a project with clear public purpose (as defined in Decision 04-08-010), addressed natural gas issues identified in State policy, had strong, apparent likelihood for success and indicated credible opportunities for collaboration and shared-funding would be assigned a High (H) rating. Conversely, an abstract that failed to address the criteria in aggregate would be assigned a Low (L) rating.

The Appendix provides a listing of all Abstracts received and their rankings including all abstracts screened out and the reasons for screening them out.

Selection of Program Research Areas

Figure 2.1 summarizes the input used by Energy Commission staff to develop the Research Areas, budget and Project Areas.

Figure 2.1 Inputs to the 2005 Natural Gas Public Interest Research Program



A fundamental guiding principle for the selection and funding of research activities is CPUC Decision 04-08-010 Finding of Fact Number 32:

Reasonable criteria for R&D project selection include a focus on energy efficiency, renewable technologies, conservation and environmental issues, support of State energy policy, a reasonable probability of providing benefits to the general public, and opportunities for collaboration and co-funding with other entities.

With the input received and using the clear direction of the above Finding, the Energy Commission selected the following Research Areas:

- Efficiency
- Renewables
- Environmental
- Strategic Analyses (in support of State Energy Policy)

Important elements of the selection and prioritization process were the abstracts received the public. For example:

- About a dozen abstracts were received, and ranked high or medium, that indicated the potential associated with gas water heating efficiency improvements and approaches for research that covered topics such as technology improvements, distribution and control enhancements, and systematic research into hot water demand patterns. This was a key reason why energy efficiency, and in particular, water heating efficiency, was ranked so high as a research area.
- Similar to the input received on gas water heating efficiency, about eight abstracts were received that covered combustion efficiency, and these were also ranked medium or high – and thus this was another reason for high priority (and funding) for efficiency R&D.
- Also about a dozen abstracts were received that addressed alternative fuel issues (e.g. bio-fuels) however, these abstracts were ranked medium or low and thus while “Renewable natural gas fuel replacements” was included as a Project Research Area, it was given a lower priority.
- In some cases the abstracts pointed to a number of excellent research opportunities. However, in defining and prioritizing the specific research areas, the Energy Commission staff used its own experience and expertise to adjust the definitions and priorities. This was the case, for example, with the Strategic Analyses Program Research Area. Quite a few abstracts defined the Project Research Areas of tools and models, economic research, and security research, however the Energy Commission staff used their own input and that of the Governor’s office to set the priorities of each Project Research Area.

Once the Program Research Areas were defined it was important to confirm that these research topics match State policy. In addition to the referenced CPUC Decision, California has a number of policy documents that help define the policy objectives of the Gas R&D Program. These include the California 2003 Energy Action Plan (EAP)⁹, the Integrated Energy Policy Report (IEPR)¹⁰, and recent CPUC Decisions¹¹. The 2003 EAP is particularly relevant to the R&D Program.

⁹ Adopted by Energy Commission, CPUC, and California Power Authority in May and April of 2003.

The following table summarizes the Program Research Areas selected for the gas R&D program and their policy basis as defined in this policy documents.

**Table 2.2: Policy Bases for Program Research Areas
Supporting Documents EAP, IEPR, and CPUC Decisions**

Program Research Area	Summary of Rationale	Energy Action Plan Reference
Efficiency	<ul style="list-style-type: none"> ▪ Loading order ▪ Lowest cost, most impact ▪ Key to meeting CPUC EE goals ▪ All sectors (R, C and I) are involved 	<p>The goal of the EAP is to “Ensure that adequate, reliable, and reasonably-priced electrical power and natural gas supplies, including prudent reserves, are achieved and provided through policies, strategies, and actions that are cost-effective and environmentally sound for California’s consumers and taxpayers.”</p> <p>The State’s energy agencies intend to achieve this through six specific measures, one of which is to ensure a reliable supply of reasonably priced natural gas.</p> <p>“... the agencies commit to ... Make continuing progress in meeting the state’s environmental goals and standards, including minimizing the energy sector’s impact on climate change.”</p> <p>The Plan also specifies that “to protect the public’s health and safety and ensure our quality of life, the agencies support the most cost-effective and environmentally sound strategies, including consideration of global climate change.”</p>
Renewables	<ul style="list-style-type: none"> ▪ Diversity of supply ▪ Loading order ▪ Needed effort because of lack of existing R&D 	
Strategic Analysis	<ul style="list-style-type: none"> ▪ Required for public policy development and development of future R&D initiatives 	
Environmental	<ul style="list-style-type: none"> ▪ State commitment to clean environment ▪ Importance of air quality to health and economic viability 	

¹⁰ California Energy Commission’s Integrated Energy Policy Report, December, 2003, 100-03-014F and the 2004 update, October 2004, 100-04-006CTF

¹¹ Decision 04-09-060

Using these policy guidance documents and an understanding of California's current gas markets the gas R&D efforts will have the objective of developing and bringing to market processes, technologies and systems that:

- Increase the efficiency of its utilization
- Reduce environmental effects associated with gas usage
- Expand the supply of natural gas in California, and
- Increase the efficiency of gas distribution and storage

These activities will have a net impact of helping ensure a reliable supply of reasonably priced natural gas that meets California's demand for such supplies.

Thus, with the guidance of the CPUC Decision, the abstract input, input from other interested parties and Energy Commission experience and expertise, the four Research Areas were confirmed as appropriate. These Research Areas are described in Section 3. Below is a discussion of their importance as R&D topics in California.

Efficiency and Renewable Sources

As indicated in Section 1, crucial to slowing California's increasing demand for natural gas is the more efficient use of gas and the development of alternative fuel sources, particularly renewable sources such as biogas and solar energy. While market forces are a major factor in demand and efficiency/conservation efforts, the technology engine for efficiency and alternative fuels is R&D. In order to take advantage of continuing opportunities associated with reductions in gas demands per unit of economic activity, The Energy Commission will focus much of the gas R&D effort on efficiency and renewables. In addition to the development of energy efficient and renewable technologies, research will also address system interactions through combined applications in low energy buildings, commonly referred to as zero-energy residential and commercial buildings.

With increasing gas consumption by the state's consumers and a continued reliance on out of state sources for a majority of the gas supplies a compelling mechanism for achieving reliable and reasonable prices gas is to reduce the demand for gas through efficiency and conservation. In order to help implement efficiency and conservation an active R&D program is needed to develop and commercialize new systems, methods and technologies. Research on efficiency and renewable natural gas alternatives will be closely coordinated with Energy Commission and CPUC renewable and efficiency incentive programs to capture synergies between the efforts, and provide increased benefits to California citizens.

The CPUC also recognizes the importance of efficiency in its September 23rd, 2004 Decision 04-09-060, which adopts aggressive energy saving targets for California's largest utilities. The CPUC's natural gas saving goals will triple the annual gas savings by the end of the decade. Thus, again, the need is identified for new and commercialized efficiency technologies and systems that the new R&D program will support.

Natural gas end use efficiency improvement and renewable gas alternatives are strongly in the public interest because of the public's need for control of energy expenditures in the face of projected gas price increases. These research efforts also serve to reduce overall gas demand, responding to concerns over future gas availability at times of peak need. End-use efficiency and renewable alternative also contribute to reductions in greenhouse gas emissions, with far-reaching public benefit implications for the risks of disruptive climate changes in California.

Environmental Effects of Natural Gas Use

Another important element of the CPUC's Decision 04-09-060 is that the combined electricity and natural gas savings will reduce carbon dioxide emissions by more than 9 million tons per year by 2013, equivalent to taking 1.8 million passenger vehicles (40% of Bay Area vehicles) off the road. This brings up the important issue of environmental impacts of energy use.

Natural gas extraction, transport, distribution, and use contribute to the environmental problems facing California. Natural gas is a relatively clean fuel compared to other fossil fuels, but the massive amount of this fuel consumed in California contributes to our air quality problems and is responsible for a large share of the total greenhouse gas (GHG) emissions from in-state sources.

Much of California is already out of compliance with federal and state standards for ozone and fine particles. Thirty-four of California's 58 counties failed one or more of three clean air tests graded in the American Lung Association State of the Air: 2004 report. Natural gas consumption in California contributes approximately 10 percent to the total NOx burden from man-made sources in the state.¹²

Indoor pollution from combustion of natural gas is also an area of concern. With citizens spending an average of 87% of their time indoors, state and federal comparative risk studies consistently ranked indoor air pollution among the top four environmental problems. Indoor pollution is estimated to cost California a minimum of \$2-5 billion per year.¹³ There is a need to better understand and mitigate the emissions from natural gas combustion sources and the resulting impact on indoor air quality, particularly as building envelopes become tighter to conserve energy.

¹² Staff communication with Vijay Bhargava, Air Resources Board on October 1, 2004.

¹³ Briefing Paper, Indoor Air Quality in California, Air Resources Board, March 2002

There is considerable uncertainty about what the optimal climate change adaptation and mitigation strategies are for California. Hydrogen is increasingly under consideration as an important strategy for reducing greenhouse gas emissions. As a prime feedstock, natural gas supplies could be affected if hydrogen (H₂) becomes a dominant energy carrier. Currently, natural gas consumption in the state represents more than one third of the carbon dioxide emissions from the combustion of fossil fuels with a trend towards rapidly increasing emissions. Climate change has the potential to significantly affect every sector of California's economy and its natural resources.

In the increasingly complex interactions between the state economy and environmental drivers however, foundational research is needed to provide a knowledge base for informing state policy. The environmental issues addressed in the environmental portfolio of projects begin to develop this knowledge base. During the first year, projects will relate directly to emissions and air quality in California and to climate change. Policy makers and regulators will most likely use the information developed in these projects to develop future actions needed to protect California's residents.

For example, research suggests that less water will be available during the spring and summer seasons because less precipitation in the future may fall as snow to form a natural water reservoir in California for the warm season. Also, the impact of climate change on natural ecosystems may prove devastating to an ecosystem already impacted by increased urbanization.

Strategic Analyses

The State Energy Action Plan states as a goal the "adequate, reliable, and reasonably-priced electrical power and natural gas supplies, including prudent reserves, are achieved and provided through policies, strategies, and actions that are cost-effective and environmentally sound for California's consumers and taxpayers". In order for California to have such an infrastructure it needs the tools and models to analyze the infrastructure as well as specific, targeted analyses of specific aspects of the infrastructure, such as integrity during times of catastrophic events. The strategic analyses and the tool and model development tackle infrastructure and policy issues not addressed by competitive or regulated entities. The development of these tools, and the related analyses, is in the public interest since it will lead a more robust and reliable natural gas infrastructure in California.

SECTION 3: NATURAL GAS RESEARCH PROGRAM AREAS AND BUDGETS

This section describes the research activity categories that the Energy Commission recommends for funding in 2005 with ranked priorities and funding levels. These recommendations were prepared according to the process defined in Section 2. The research areas described in this Section were selected based on their ability to support state energy policy, their reasonable probability of providing benefits to the general public, and consideration of both gaps in gas R&D activities and collaboration/co-funding opportunities with other existing R&D activities.

The following definitions are used in this Section:

- *Gas R&D Program* – This is the Public Purpose Gas R&D program to be administered by the Energy Commission
- *Program Research Areas* – These are the high-level portfolios of research activities that fit within one of the broad research areas defined by the CPUC or Energy Commission. The Energy Commission has defined priorities and funding levels for each of these Program Research Areas.
- *Project Research Areas* – Within each Program Research Area that are two or more sub-categories of research topics, which are called Project Research Areas. The Energy Commission has defined priorities for each of these Project Research Areas.

The first sub-section below provides a summary of all the recommended Program Research Areas. The following four sub-sections describe each of the Program Research Areas. The last two sub-sections briefly describes the utility transition programs and the rejected Program Research Areas¹⁴.

Summary of Recommended Program Research Areas

Program and Project Research Areas

The following table summarizes the Program and Project Research Areas recommended for funding during in 2005.

¹⁴ As required per Order 04-08-010

Table 3.1: Summary of Program and Project Research Areas with Budget Estimates

Ranked Program Research Area – with ranked Project Research Areas	Description of Program Area	Budget Allocation Per Program Research Area
1. Gas Efficiency – <ul style="list-style-type: none"> ▪ Gas water heating technology ▪ Gas space heating technology ▪ Commercial food service technology ▪ Industrial combustion efficiency ▪ Industrial waste heat recovery ▪ Gas appliance technology ▪ Gas space cooling technology 	This area focuses on improving the efficiency of gas consuming equipment in the residential, commercial and industrial sectors	\$5.0 million
2. Renewables <ul style="list-style-type: none"> ▪ Water heating alternatives ▪ Process heating alternatives ▪ Renewable natural gas fuel replacements 	This area focuses on developing and commercializing alternative fuel sources, particularly solar energy and biofuels.	\$2.0 million
3. Environmental <ul style="list-style-type: none"> ▪ Air quality impacts and mitigation strategies for combustion of alternative gas supplies (e.g. off-spec and LNG) ▪ Climate change adaptation and mitigation- - issues and implications for the natural gas system 	This area focuses on assessing potential criteria air pollutant (indoor and regional) and greenhouse gas impacts and mitigation strategies for traditional and non-traditional NG blends.	\$2.25 million
4. Strategic Analyses <ul style="list-style-type: none"> ▪ Tool and model development to aid in targeting appropriate infrastructure improvements ▪ Economic research to address State gas energy policy issues ▪ Security related to catastrophic events 	This research address topics such as value of increased gas storage; impact on gas prices and reliability of various fuel specifications, including off-spec and LNG; market analysis, identifying real time slack capacity needed in pipelines and mitigating impact of catastrophic events (e.g., earthquakes and terrorism).	\$1.25 million
Administration	Covers the period from 9/1/04 – 12/31/05; includes planning, project selection, contracting, project management and reporting.	\$1.5 million
Utility Transition Project(s)		To be determined and included as portion of above budget items
Total		\$12.0 million

Funding Principles

The CPUC's Decision requires a zero-based budget, i.e., all expenditures must be justified each year. Therefore, this funding request is based on analyses of a variety of research areas against the basic criteria outlined in the CPUC's Decision and supplemented by input from Energy Commission professional research staff. These criteria are:

- Potential Benefits
- Connection to State Energy Policy and gas issues identified in California Energy Action Plan
- Potential for success, reasonable probability of providing benefits to the general public
- Not addressed by competitive or regulated entities
- Consideration of opportunities for collaboration and co-funding opportunities with other entities

In addition, the Energy Commission also established some additional criteria for 2005 Program year funding and prioritization decisions. These are:

- Activities should emphasize gas technology and system research and not technologies and systems that have application for electricity generation, since the Energy Commission's PIER electricity program funds research for the purpose.
- The research should have application potential for other Energy Commission and CPUC programs, such as the Energy Commission's energy efficiency programs and natural gas IEPR activities and the CPUC's Public Goods Charge (PGC) energy efficiency programs.

Within each Program Research Area are prioritized Project Research Areas. The funding allocated for each Program Area will be allocated to the Project Research Areas listed in priority order. Because of budgeting priorities, funding will be allocated to each Program Area and thus research will be conducted in each Program Area; however, because of this funding allocation approach, there may not be sufficient funding in each Program Area to fund all of the Project Research Areas.

Public Interest Focus of Recommended Research

When designing research and development activities it is important to define the research problem being addressed and expected research objectives and benefits. These items are discussed within the descriptions of each Program Research Area in Sections 3.2 through 3.5. In addition, for public interest R&D it is important to consider the policy bases for the proposed research activities, as discussed in Section 2.

The Research Areas selected are consistent with the CPUC's policy direction that research be focused on energy efficiency, renewable energy, conservation, and environmental issues. In addition, each of the selected Research Areas addressed has the following public interest focus in that proposed research must:

- Advance science or technology not adequately addressed by competitive and regulated markets
- Address a solution to a significant energy or environmental problem
- Address a California market need
- Provide a clear potential benefit to California citizens

The significance of gas R&D is clear in terms of the magnitudes of energy savings possible and the dangers to the State's economy and environment inherent in lack of action. Needs within the California market, and the potential benefits for the market, are also clear as one reviews the State's recent history of increasing gas prices, shortages, and increasing population growth-related demands and emissions.

Program Area 1 - Natural Gas End-Use Efficiency

This Program Research Area has been given the highest priority ranking because of the aggressive energy efficiency goals established by the CPUC, energy efficiency's position in the "loading order" as defined in the California Energy Action Plan, the importance of efficiency in reducing the growth rate of natural gas consumption in California, and the large number of high potential energy efficiency R&D activities that have been identified in this planning process. With this high priority, the Energy Commission is recommending a 2005 program year budget of \$5 million. Funded projects are expected to have one to three year durations.

Efficiency Research Problem

California's core customers, primarily the small industrial, commercial and residential gas customers, consumed approximately 0.66 Tcf of gas in 2003 at an estimated cost to consumers of about \$4 Billion (at \$6/MMBtu). Equipment age, lack of technology innovation, and inefficient buildings and usage practices are principal barriers to improvement. Technology and market assessments indicate that substantial increases in efficiency and reductions in energy consumption are possible through development of technologies and building practices that are not currently cost-effective and/or effectively commercialized.

California's non-core customers, primarily large industrial customers, consume about 0.75 Tcf of gas per year at a cost to consumers of another \$4.5 billion (again at \$6/MMBtu). This usage constitutes nearly 41% of all non-electricity generation gas use in California. If "in-house" electricity generation is added, then the industrial sector consumes 33% of the total natural gas use in California. Efficient utilization of gas by this sector is often constrained by stringent environmental compliance requirements, lack of new technology and institutional barriers. Substantial increases in efficiency, reductions in energy consumption, and emissions improvements are possible through development and deployment of advanced technologies and operating techniques.

Efficiency Objectives and Benefits

This end use efficiency program includes R&D activities that: (a) reduce the energy input requirements per unit of output or service of residential and commercial devices or systems and/or (b) reduce overall energy consumption by reducing demand for energy consuming goods and/or services in California residential, commercial and/or industrial facilities.

The benefits associated within this Area are achieving increases in end-use efficiency and the resulting improved air quality, decreased use of fossil fuels, reduced expenditures on energy by consumers, and increased statewide and regional economic benefits through less reliance on imported gas supplies.

Specifically, these benefits would include:

- Lower energy consumption, and thus lower energy bills for consumers, through improved combustion, heat transfer, controls, and/or waste heat recovery
- Reduced emission without the attendant energy efficiency penalty
- Improved reliability of gas supply and delivery systems through reduced demand

- Increased ability to use alternative fuels to natural gas use (for commercial and industrial consumers)

To achieve these benefits, this program will be closely coordinated with ratepayer-funded energy efficiency programs and with the State's building standards and appliance efficiency standards programs

Efficiency Project Research Areas

The potential project areas are listed in the order of priority according to the criteria that were established for this purpose and described in Section 2.

Gas Water Heating Technology

Water heating accounts for one of the highest gas energy uses in the residential sector and is potentially the area with the greatest opportunity for efficiency improvement. This research project area will address the development of reliable and efficient thermal water heating technologies as well as improved water heating distribution designs for both single and multi-family applications. This area was given this high priority because of the amount of gas consumed for this end-use and the potential for substantial savings impacts.

Gas Space Heating Technology

Including both the residential and commercial sectors, gas space heating accounts for the highest gas energy use in the State. This research project area will address high efficiency furnace and boiler development, improved heat recovery systems, and more efficient distribution systems such as ducts in conditioned space. This area was given its high priority because substantial improvements may be possible in commercial-scale gas boilers and furnaces, which constitute a large share of commercial and multi-family building heating sources.

Commercial Food Service

Gas use is extremely high in the food service industry due to inefficient equipment and practices. This research project area will address improved efficiencies for commercial kitchen equipment used for cooking. This area was given its high priority because there are many undeveloped opportunities for high-efficiency gas cooking appliances, existing programs that the Energy Commission can collaborate with, and potential for indoor air quality improvements as well as reduced gas consumption.

Industrial Combustion Efficiency Improvements

This area covers a wide range of potential activities associated with improving the efficiency of gas combustion. A focus of this work will be research on gas burners and evaluating the integration of multi-fuel technologies. This area was given its

priority because combustion efficiency can be severely compromised with increasingly stringent environmental regulations.

Industrial Waste Heat Recovery in Industrial Processes

Large industrial gas-fired thermal sources could permit effective use of waste heat to replace conventional natural gas use. There are many opportunities to add or improve waste heat recovery in industrial processes, although they are constrained by the variety of such processes, the long life of existing equipment, and variations in retrofit and production economics among users. However, there are multiple opportunities for economic recovery of waste heat through new technologies. Potential projects could include heat exchangers improvements and the development of sensors and controls. This area was given a high priority because almost 40-60% of process heat is wasted to the atmosphere.

Residential and Commercial Gas Appliances

This research area will address opportunities for efficiency improvements in residential cooking equipment and residential and commercial clothes dryers. Current gas clothes drying, both in household and larger scales, is a major gas use involving standard mass market products, and its efficiency could be significantly improved with advances in areas such as heat recovery, fabric exposure, and alternative moisture removal technologies. This area was given its priority because substantial improvements may be possible in residential and commercial-scale gas appliances and the potential for market introduction is significant given the supply chain and statewide incentive programs.

Gas Space Cooling Technology

Gas cooling currently represents a very small fraction of gas energy use in California and current high costs and technology barriers discourage broader implementation. However, the peak shaving opportunity afforded by gas cooling warrants some continuing research in improved efficiency and reliability of equipment, reduced first costs, and resolution of market barriers to technology adoption. Gas cooling was included and given its priority because innovations in gas-powered cooling could provide a new cost-effective strategic approach to electricity peak demand reduction.

Program Area 2 - Renewable Natural Gas Alternatives

This Program Research Areas has been given the second highest priority ranking because of its position as second in the "loading order" as defined in the California Energy Action Plan and the importance of renewables with respect to reducing California's dependency on natural gas imports. With this high priority, the Energy Commission is recommending a 2005 program year budget of \$2 million. As more R&D is conducted funding and priority adjustments will be considered for future years. Funded projects are expected to have one to three year durations.

Renewables Research Problem

California's wealth of renewable resources are spread geographically throughout the state. In a number of situations, renewable resources could be used in lieu of natural gas. For example, solar energy can be harnessed to provide hot water for residential, commercial and industrial purposes. Similarly, "biogas" resources generated from landfills, wastewater treatment facilities, dairy operations and food processing plants can be cleaned and substituted for natural gas. Moreover, substituting "biogas" resources for natural gas also helps address environmental issues posed by disposal of the biomass residues that act as sources of the biogas. However, increases in conversion efficiency, lower costs and improved environmental performance are needed to make these renewable natural gas alternatives viable in California's energy markets.

Renewables Objectives and Benefits

The renewables program area includes R&D activities that reduce overall gas consumption by developing alternative energy sources for California residential, commercial and/or industrial sectors. The benefits associated with this Research Area are decreases in the consumption of gas and the resulting improved air quality (including potential reduction in the environmental impacts associated with current disposal practices for California's biomass residues), potential reduced expenditures on energy by consumers, and increased statewide and regional economic benefits through less reliance on imported gas supplies. To achieve these benefits, this program will be closely coordinated with the Energy Commission's and other entities renewable energy incentive and education programs.

Renewables Project Research Areas

The potential project areas are listed in order of priority according to the criteria established for this purpose and described in Section 2.

Water Heating Alternatives

This area addresses cost-effective alternatives to gas fueled water heating in residential and commercial applications. The primary focus will be on low cost, higher efficiency solar water heating for residential and commercial use; combined renewable electric (e.g., photovoltaics) and solar water heating technologies and thermophotovoltaic water heating technologies. This area was given the highest ranking because of the potential for substantial, and quick-to-market, technology improvements in an end-use with high gas usage.

Process Heating Alternatives for Industry

This area addresses finding cost-effective alternatives to gas fueled water heating, steam generation and drying in industrial applications. The primary focus will be on renewable fuels for commercial and industrial process heating and combined concentrating solar power electric/thermal technologies to meet combined heat and

power needs. This area was given its priority because of the potential for introducing alternative gas resources within the industrial market sector.

Renewable Natural Gas Replacement Alternatives

This area addresses finding cost-effective, renewable alternatives to conventional natural gas resources. The primary focus will be on improved biogas technologies for meeting on-site agricultural natural gas use, enhanced methods for cleaning biogas to develop cost-competitive natural gas substitutes, and improved biomass to biogas and thermal gasification conversion methods to increase renewable natural gas alternatives. This area deserves its priority because of the potential for expanding the use of alternative gas supplies within California's gas distribution and utilization infrastructures.

Program Area 3 - Environmental Implications of Natural Gas Use

This Program Research Areas has been given the third highest priority ranking because while it does not directly affect energy usage, as efficiency and renewables, this area has been identified as important for informing State energy policy. With this priority the Energy Commission is recommending a 2005 program year budget of \$2.25 million. This budget is appropriate because of the relative priority placed on environmental values by state policy, the possible impacts of climate change, and significance of the changing natural gas market on air quality. These issues have profound health and welfare implications and research is critical for identifying alternative policy options. Funded projects are expected to have one to five year durations.

Environmental Research Problem

Natural gas extraction, transmission, distribution, and consumption contribute to the environmental problems facing California. It is used widely for both process heat and electricity generation in the agricultural, residential, commercial, and industrial sectors of the State economy.

Natural gas is a relatively clean fuel compared to other fossil fuels, but the massive amount of this fuel consumed in California contributes to its air quality problems and is responsible for a large share of the total greenhouse gas (GHG) emissions from in-state sources. Natural gas consumption in the state represents more than one-third of the carbon dioxide emissions from the combustion of fossil fuels with a trend towards rapidly increasing emissions.

Indoor pollution from combustion of natural gas is also an area of concern. State and federal comparative risk studies consistently ranked indoor air pollution among the top four environmental problems. There is a need to better understand the emissions from natural gas combustion sources in homes and the resulting impact on indoor air quality, particularly as building envelopes become tighter to conserve energy.

Environmental Objectives and Benefits

This environmental Research Area includes R&D activities that: (a) evaluate air quality and climate change impacts of use of natural gas and non-traditional natural gas in stationary applications, (b) identify measures to reduce negative impacts from use of those fuels, and (c) investigate the approach that the state should take to mitigate greenhouse gas emissions and to adapt to a changing climate.

This portfolio of projects will address potential future air quality impacts of the use of natural gas and non-traditional blends of natural gas and provide guidance on what actions are needed to reduce or eliminate negative impacts. It will also greatly improve the understanding of the potential indoor air quality impacts of combustion of natural gas in residences and will aid in increasing awareness of potential health risks and identifying appropriate measures to reduce those risks.

Information developed will be available to policy makers and regulators for use in developing future actions necessary to address potential negative impacts from the increased use of these gases. For example, this information will be available to the Energy Commission's building standards and building efficiency staff when developing building standards and building efficiency measures, other research institutions (e.g. Public Interest Energy Research Program) developing cutting-edge natural gas technology, and to the California Air Resources Board and air quality management districts as they develop control measures to improve air quality.

As California embarks on an ambitious path towards hydrogen as an energy carrier for stationary and transportation applications, there is a need to understand the impacts of the shift to new energy pathways to reduce the overall environmental and economic impacts. This portfolio will develop the tools and will provide the analysis that policy makers can use to decide on robust energy pathways that are environmentally sound and more broadly, optimal measures for assessing greenhouse emissions reductions goals for California..

Environmental Project Research Areas

The potential environmental project areas are listed in the order of priority according to the criteria established for this purpose and described in Section 2.

Air quality impacts of the combustion of different qualities of gas supplies

This area identifies the potential effect on power plant and other combustion sources emissions from use of non-traditional supplies of natural gas. The primary focus will be on characterizing the impacts (regional and indoor) and identifying appropriate measures to mitigate negative impacts from use of those non-traditional supplies of natural gas, e.g. off-spec and LNG, used in residential combustion sources.

Increased demand for gas and falling supplies in the United States is increasing the need to use non-traditional supplies of gas to meet future needs. This area was given the highest priority ranking because air quality impacts of this increased use of non-traditional supplies are not well understood and are of considerable concern to California because of the existing poor air quality in the state.

Climate Change Adaptations and Mitigation-- Issues and Implications for the Natural Gas System

This area addresses reducing the climate change effects of alternative and process heat gas consumption in California. Because it focuses on process heat and specifically excludes traditional sources of natural gas used for electricity generation, this research agenda complements ongoing research on climate change in the Public Interest Energy Research Program. The primary issues intended to be addressed are:

- Data/Monitoring (e.g. tools and techniques used to measure process non-CO₂ greenhouse gas emissions)
- Modeling: (economic, energy system, and impact models require improvements in order to handle the long time-horizon analyses required to address climate change), and
- Mitigation (experiments to validate analyses on the potential for reducing carbon emissions from gas, and alternative gas fuel combustion).

Program Area 4 – Strategic Analyses

In order to ensure the State's policy objective of having a secure, reliable and reasonably priced gas resource, and more research is required to understand important gas related infrastructure issues and options facing California. Thus, development of research tools and models, economic research, and strategic analyses of gas issues is ranked as the fourth priority for R&D in 2005. For California, these issues address questions and options associated with supply, transportation, storage, consumption and security. While a significant amount of

research has been devoted to electricity use, transmission/distribution and supply in California, little effort has been focused on economic tools and analyses of gas issues.

The Energy Commission is recommending a 2005 program year budget of \$1.25 million. This funding level is recommended to augment the three priority issues outlined in the CPUC Decision. The funding level is lower than the other three Program Areas because of its lower priority ranking and the relatively low cost of research expected to be conducted in this Area. Funded projects are expected to have one to two year durations.

Strategic Analyses Research Problem

California's gas markets are a complex web of regulated and non-regulated activities associated with the exploration and development of in-state gas resources, the importation of gas from outside of the state, the distribution of the gas, storage of gas, and the use of the gas by a wide range of both core and non-core customers. The improvement of the state's natural gas infrastructure requires an understanding of the technical issues and economic and environmental impacts of various options. This understanding requires the development of analysis tools and models as well as the actual analyses to inform policy makers on opportunities for targeted infrastructure improvements. One of the infrastructure issues of particular importance is reliability of the gas system in the event of a catastrophic disaster, both man-made (e.g. terrorism) and natural (e.g. earthquakes). Thus, this area may also include research associated with improving continuation of supply and distribution beyond current norms.

Strategic Analyses Objectives and Benefits

Strategic R&D topics will focus on optimizing technology investments with clear public benefits as defined in the Decision. Strategic research results are also expected to inform policy decisions. To understand and select the best infrastructure and resources for California tools and models will be developed and analyses conducted on a wide range of subjects. This work will provide information for policy decisions and optimal allocation of future technology development funds.

The proposed benefits of this work will occur in part through more timely, better informed, and effective policy decisions by State officials as well as gas service providers. This area's research will permit improved pipeline security from both earthquake and intentional damage, more economical and stable gas prices through improved cost structures and gas storage strategies, and improved understanding of market structure and regulatory actions' effect on gas prices and gas availability. Other strategic R&D benefits may be relatively specific, such as optimization of slack pipeline capacity to improve infrastructure efficiency and storage volume for peak demands, supplier price spikes, or supply interruptions.

Strategic Analyses Project Research Areas

In the Strategic Analyses Research Area, projects will be developed to meet the highest-priority needs for State policy development and decision making. These strategic studies may include collaborative research with private gas industry enterprises as well as federal and other public authorities. The results of such studies will inform policymakers and energy providers as well as technology innovators. The potential project areas are listed in a prioritized fashion according to the criteria that were established for this purpose and described in Section 2.

Tool and Model Development to Aid in Targeting Appropriate Infrastructure Improvements

This area will develop technical and economic models and tools. The primary focus will be on such products such as dynamic, real-time, tools to optimize the real time slack capacity needed in pipelines, beyond rule of thumb; tools for analyzing public benefits and costs of increased gas storage; and models and tools to improve the economic efficiency of buying/selling/storing gas and the analysis of different regulatory frameworks. This area is given the highest priority because of the need for developing such products.

Economic Research to Address State Gas Energy Policy Issues

This area involves conducting actual economic analyses of California's gas markets. The primary focus will be on valuing increased gas storage; effects of continued growth of gas-fired electricity generation capacity in California on energy price stability and environmental quality; market response and economic effects of alternative cost and incentive structures for gas, and quantifying California ratepayer cost impacts from introduction of new gas supplies. This area is given the second highest priority because of the need for the analyses as identified by State gas energy experts.

Security Related to Catastrophic Events

This area will address ways to mitigate risks to the State from catastrophic damage to the state's gas infrastructure. Activities may include: developing techniques and estimates of impacts of catastrophic natural and intentional events, seismic hazards and risk/cost analyses for California gas infrastructure, developing security strategies and implications for gas infrastructure, and gas-electricity interdependence analyses that include and effects of alternative policies on energy supply reliability in disruptive events.

Utility Transition Public Purpose Projects

One utility, SEMPRA, has indicated that they have submitted a plan to the CPUC detailing how they will end current public interest gas R&D projects or transfer these projects to the Energy Commission by December 31, 2004. The reported plan is a request for the CPUC to approve continued funding in 2005 for four projects at a cost of \$725,000. The Energy Commission has not received SEMPRA's recommendations as of the date of filing this Research Program Plan, and thus does not have specific comments on the transition projects in question.

This Research Plan does not include a separate budget item for the SEMPRA R&D projects. The money for these transition projects could be part of the \$12 million overall Program budget. For example, if it is decided to fund two of the SEMPRA transition projects at a cost of \$400,000, and the projects are efficiency related, then the \$400,000 would be taken from the \$5 million efficiency R&D line item.

There appear to be three options for the CPUC with respect to a decision about the transition projects:

1. The CPUC could delegate authority for funding or not funding these projects directly to the Energy Commission. The Energy Commission could then, as Administrator, decide which projects to fund and thus which portion, if any, of the \$12 million budget should be allocated to these utility transition projects. This is the Energy Commission's preferred option.
2. The CPUC could select none, some, or all of these projects for continuation in 2005 and, as required, utilize a portion of the requested \$12 million to fund them during 2005.
3. The CPUC could utilize input from the Energy Commission in making the utility transition project funding decision at some future date after approving the Research Program Plan.

Rejected Program Research Areas

The Energy Commission received a number of suggestions for public purpose gas R&D activities. Two areas that were rejected as either not being public purpose or inconsistent with the CPUC Order were:

- Reliability and safety of the natural gas transportation and distribution system
Maintaining a reliable and safe natural gas transportation and distribution system has traditionally been the responsibility of natural gas utilities. Research in support of these functions is therefore regulated research. The CPUC has continued to approve requests for recovery in natural gas rates of

costs associated with regulated research that addresses the reliability and safety of the natural gas transportation and distribution system.

- Highway transportation related natural gas research This topic area is explicitly removed from the scope of this program in the CPUC Decision.

In addition, some of the individual abstracts, submitted by the public, were screened out for the 2005 Program year. These are listed in the Appendix with brief explanations of the reasons for screening them.

SECTION 4: R&D ADMINISTRATION

The budget for R&D administration is for a 16-month period from September 1, 2004 to December 31, 2005 and includes the costs associated with the preparation of this 2005 Research Program Plan. Program administration includes planning, public outreach, project selection, contracting, project management, reporting and technology transfer.

Management and Planning for the Gas R&D Program

Management Structure

The Energy Commission will administer the Gas R&D Program within its Energy Research and Development Division. The Gas R&D Program will be closely coordinated with the Public Interest Energy Research (PIER) electricity Program. The Energy Commission's R&D Committee will provide oversight of the Program. Annually, Program performance will be reviewed by the CPUC, which also has annual Program budget and research portfolio approval authority.

The Energy Commission's Research and Development Division Director will have overall responsibility for the Gas R&D Program. Because the Energy Commission has been managing electricity research under the PIER Program, the infrastructure for managing the Gas R&D Program is already in place. Energy Commission program leads within each R&D Program Area will oversee the different Gas R&D Program Areas and manage specific research projects. The California Institute for Energy and Environment (CIEE), at the University of California, will provide support to the Energy Commission in the management of the Gas R&D program.

Management Activities

The PIER management team will:

- Engage in outreach activities including providing coordination and collaboration with other organizations involved in natural gas research and identifying co-funding opportunities.
- Provide for credible, independent expert review of proposals, and ongoing monitoring and managing of projects to ensure that the funded research is useful and effectively transferred to the ultimate users through market mechanisms
- Provide coordination and collaboration across natural gas research projects.

- Provide ongoing monitoring of projects to ensure funded research is useful and effectively transferred to the ultimate users, and that ratepayer benefits are described for the general public.
- Monitor and manage each research award and provide fiscal and administrative oversight for each project.
- Provide reporting on progress and results of the R&D activities to the Energy Commission, the CPUC and the public.

Program Planning

The Energy Commission's Research and Development Division management team, with support from CIEE, will implement an annual planning process that will result in annual Gas R&D Program research plans. These will be submitted to the CPUC by August 31st of each year for approval of the following year's research efforts.

In addition, during the first half of 2005, the Energy Commission will develop a long-term strategic plan for the Gas Research Program. This plan will define research and development goals and define Program and Project Research Areas for the next several years. The process for developing the plan will include outreach to a wide range of state and national experts and interested parties through various techniques including one or more public workshops. This multiple-year strategic plan, with annual updates, is critical for keeping current on related R&D programs and activities elsewhere; for seeking collaborative efforts where warranted, and ensuring that the R&D activities are consistent with California' public purpose needs.

R&D Procurement Strategies

The Energy Commission will use a variety of procurement strategies for making research project awards. It is expected that the Energy Commission will seek out existing activities to enhance as well as initiate new activities. Consistent with the direction in Decision 04-08-010, opportunities for co-funding will be actively pursued.

For this first program year the Energy Commission may use several direct award mechanisms to ensure that research activities are initiated relatively early in the calendar year and that all of the funds are allocated during 2005. However, it should be noted that funds awarded and encumbered in 2005 (2005 Program year funds) may be used to fund multi-year R&D projects. For multi-year projects actual expenditure of the funds will occur over a period of several years.

Market Connection Activities

An important aspect of all public interest research is that its results are utilized in the market place by implementing agencies and private parties. Therefore, an important element of the Gas R&D Program is that part of the selection process for research activities will include consideration of the potential for commercial fruition, market adoption, industry collaboration, and co-funding. An important avenue for this commercialization of R&D will be the CPUC's Public Goods Charge energy efficiency programs and thus the Energy Commission will work with the selected Administrator of these programs on utilizing R&D results.

In addition, if any commercial benefits result from the Gas R&D Program these benefits would accrue to the ratepayers who are funding the program through the gas surcharge. Accordingly, the Energy Commission will inform the CPUC's Energy Division if and when any commercial benefits result from the gas R&D projects funded through the gas surcharge. This information will be included in the Energy Commission's annual report to the CPUC.

APPENDIX A: GAS R&D PROJECT ABSTRACTS SUMMARY

This appendix contains two tables. The first indicates abstracts that were allocated to the four Program research Areas and ranked high, medium or low. The second table lists the abstracts screened out for 2005 and the reasons for screening.

Table A-1: Gas R&D Abstract List by Category

<i>Category</i>	<i>ID#</i>	<i>Rating</i>	<i>Project Title</i>
1-Efficiency	28	H	Gas Engine-Driven Combination Heat Pump and Standby Generator
1-Efficiency	29	H	Commercial Gas Fryer for Food Service
1-Efficiency	30	H	Survey Existing Hot Water Distribution Systems and Perceived Performance
1-Efficiency	33	H	Determination of Residential Hot Water Consumption and Waste
1-Efficiency	36	H	Next Generation Instantaneous Water Heater R&D
1-Efficiency	45	H	New Concepts in High Efficiency Natural Gas Fired Space Heating
1-Efficiency	67	H	Near-Condensing Gas Storage Water Heaters: Issues of Policy and Practice
1-Efficiency	99	H	Reduce Residential Gas Water Heater Standby Losses
1-Efficiency	168	H	Characterizing the Energy Efficiency Potential of Gas-fired Commercial Food Service
1-Efficiency	170	H	Energy Efficiency Potential of Gas-Fired Commercial Water Heating Equipment and Systems
1-Efficiency	17	M	Low Income Gas Customer Technology R & D
1-Efficiency	25	M	Restaurant Heat Recovery
1-Efficiency	35	M	Low-Cost Commercial Boilers And Water Heaters
1-Efficiency	42	M	Super Boiler for Combined Steam and Hot Water in Hospitals, Institutional and Commercial Buildings
1-Efficiency	50	M	ORNL Hot Water Distribution Model Validation And Enhancement
1-Efficiency	96	M	Hot Water Distribution System Improvements
1-Efficiency	111	M	AquaSmart: High Performance Domestic Hot Water Systems
1-Efficiency	146	M	Commissioning and Diagnostics Methods and Tools for Gas-fired Equipment
1-Efficiency	147	M	Improved integration of HVAC heating and cooling in California commercial buildings
1-Efficiency	148	M	Optimizing Energy Use and Minimizing Energy Savings Uncertainties: Cost-Effective Quality Assurance
1-Efficiency	169	M	Development of a High Efficiency Commercial Gas-Fired Broiler
1-Efficiency	171	M	Energy Efficiency Potential of Gas-Fired Rooftop HVAC Units and Makeup Air Heating
1-Efficiency	8	L	Gas energy conservation, laundries
1-Efficiency	18	L	Residential Gas Cooling
1-Efficiency	26	L	Light commercial CHP

Category	ID#	Rating	Project Title
1-Efficiency	32	L	Stirling Engine-Based Cooling/Heat Pump Equipment
1-Efficiency	61	L	Residential-Small Commercial Superboiler Developments
1-Efficiency	65	L	Thermal Distribution Systems
1-Efficiency	81	L	Whole House Distribution Systems R&D
1-Efficiency	83	L	Infiltration Reduction in Existing Homes
1-Efficiency	6	H	Increasing Distributed Generation Efficiency Using Waste Heat Sources
1-Efficiency	7	H	Dual Function Absorption Cycle
1-Efficiency	43	H	Power Generation from Waste Heat
1-Efficiency	47	H	High Efficiency, Low-NOx Immersion Fluid Heaters
1-Efficiency	48	H	Development and Field Trial of Advanced Indirect Heating System
1-Efficiency	53	H	Development of an Advanced Aluminum Melting Furnace
1-Efficiency	58	H	Combustion Technology Improvements
1-Efficiency	59	H	Thermal Efficiency Improvement of Radiant Sections in Fired Heaters and Process Boilers
1-Efficiency	60	H	Synergistic Efficiency and Environmental Enhancements for Industrial Heating Systems
1-Efficiency	68	H	Efficiency Optimization of Gas-Fired Heating Systems Using Feedback From Real-Time Sensors
1-Efficiency	91	H	Heat Activated Industrial Drying Heat Pump
1-Efficiency	172	H	Energy Efficient Ultra Low NOx Industrial Burner
1-Efficiency	44	M	Low-Cost Gas Meter for Individual Industrial Equipment
1-Efficiency	57	M	High Efficiency Industrial Ovens
1-Efficiency	138	M	Efficiency Improvement in Gas-Fired Boilers, Furnaces, and Heaters by an Improved Combustion Control
1-Efficiency	2	L	Hybrid Systems For Opportunities In Natural Gas Savings In Industry
1-Efficiency	3	L	Maximizing Efficiency Of Current Rankine Cycle Utility Plants
1-Efficiency	5	L	Electric Power Production Based On Pulsed Detonation Of Natural Gas
1-Efficiency	14	L	Natural Gas Pressure Drop at Businesses to Generate Electricity
1-Efficiency	22	L	Recycling Energy Program
1-Efficiency	23	L	Pressure Into Power (PIP)
1-Efficiency	24	L	GTI Packaged Water Desalination Unit
1-Efficiency	38	L	Novel Microturbine for Distributed Electricity and/or Combined Heat and Cooling

Category	ID#	Rating	Project Title
1-Efficiency	51	L	Impingement Heating of Metals
1-Efficiency	52	L	Advanced Reciprocating Internal Combustion Engine Systems - continued R&D
1-Efficiency	54	L	Distributed Generation Process Integration
1-Efficiency	85	L	Repowering of California Utility Boiler Plants Study
1-Efficiency	140	L	A Natural Gas - Sourced Omni-Utility for Southern California
2 - Renew	136	H	Solar Thermal Technology
2 - Renew	9	M	Small Scale Plant For Producing Clean Renewable Methane
2 - Renew	10	M	Centralized Plant To Produce Biogas From Multiple Waste Streams
2 - Renew	11	M	Small ultra low NOx biogas engine
2 - Renew	41	M	Development and Demonstration of Technologies to Improve Energy and Emissions Performance in Biomass
2 - Renew	49	M	Bio-Gas Fuel Standards for Distributed Generation
2 - Renew	63	M	Efficient Landfill Gas Utilization for Electricity Generation
2 - Renew	93	M	The Road to True Zero Energy Homes in California
2 - Renew	107	M	Biomass Gasification for Production of Industrial Fuels
2 - Renew	34	L	Technology Development For Small Landfill Gas Energy Recovery Projects
2 - Renew	37	L	Transportable Biomass Gasification Plants
2 - Renew	55	L	Thermal Solar Generation
2 - Renew	82	L	Solar Upgrading of Natural Gas and Renewable Methane-Containing Gases for Distributed Generation
2 - Renew	90	L	Solar Thermal Collaboration
2 - Renew	101	L	Biomass Gasification for Production of Liquid Fuels
2 - Renew	112	L	Zero-Emission Biomass Gasification Power Project
3 - Env	19	H	Low NOx Gas Water Heater
3 - Env	20	H	LNG Interchangeability for Commercial and Industrial Users
3 - Env	70	H	Assessment of the Impact of LNG Imports on California Natural Gas Composition and on System Operation
3 - Env	74	H	Infiltration and Ventilation Interactions with Gas Appliance Venting
3 - Env	98	H	Estimating Exposure on Localized Spatial Scales from Pollutants Emitted during Distributed Generation
3 - Env	105	H	LNG Terminal Design and Safety
3 - Env	108	H	Emission Impacts of High-Btu LNG on Industrial Burners

Category	ID#	Rating	Project Title
3 - Env	116	H	Development of Guidelines for the Distribution of Imported Liquefied Natural Gas (LNG) Compositions
3 - Env	129	H	Accommodating Liquefied Natural Gas (LNG)
3 - Env	130	H	Accommodating Varying Gas Chemistries from Non-Traditional Gas Supplies
3 - Env	133	H	Natural Gas Impurities – Impact on Appliances and Equipment
3 - Env	134	H	Pipeline Right-of-Way (ROW) Environmental Management
3 - Env	31	M	Combustion Sensor Development
3 - Env	46	M	Gas-Fired Recuperative Oxidizer for VOC Destruction
3 - Env	62	M	Ultra-Clean Residential and Commercial Space Heaters
3 - Env	71	M	Development of Improved Low-Emission Burners for Natural Gas-Fired Water Heaters and Furnaces
3 - Env	72	M	Low Emission Fuel-Flexible Burner for Natural Gas and Fuel Gas from Renewable Resources
3 - Env	78	M	Active Control Of Combustion Systems To Account For Fuel Variability
3 - Env	84	M	Development Of Metrics And Quantification Methods For Geographically And Temporally Varying Air Quality
3 - Env	94	M	Fuel Cell Demonstrations for California Applications
3 - Env	97	M	The Air Quality Impact of Distributed Generation on a Regional Scale
3 - Env	100	M	High Efficiency, Low NOx Stationary Natural-Gas Engines based on HCCI
3 - Env	104	M	Reducing Natural Gas Use And Simultaneously Improving Indoor Air Quality
3 - Env	109	M	Low Cost, Reliable Low NOx Burner Design For Water Heaters
3 - Env	117	M	Low Cost, Reliable Low NOx Burner Design For Water Heaters
3 - Env	127	M	Development of Simulation Models for Gas-fired Components and Combined Heating, Cooling, and Power Generation
3 - Env	135	M	Impact of Gas Composition on Reciprocating Engine Performance and Emissions
3 - Env	1	L	Conversion to Genuine Alternative Energy System
3 - Env	4	L	Modeling and Control of Distributed Energy Systems
3 - Env	27	L	Organic Rankine Cycle System Development
3 - Env	39	L	Non-Catalytic Self-Powered Hydrogen Production Unit
3 - Env	40	L	Integrated Plasma Fuel Cell (IPFC) Process Test Stand

Category	ID#	Rating	Project Title
3 - Env	64	L	Multimixture Natural Gas Clean-Up Technology for Effective Generation of Electricity
3 - Env	66	L	Aerosol Sealing of Gas Pipelines
3 - Env	69	L	Natural Gas Pretreatment for Development of Ultra-Low Emission Gas Turbines
3 - Env	73	L	Natural Gas Fired Laser For Power Generation
3 - Env	75	L	Development Of Low Emission Dual Fuel Combustor For Microturbine Generators
3 - Env	76	L	Correlation Of Flashback Tendencies With Fuel Composition
3 - Env	77	L	Evaluation Of Gas Turbine Combustor Operational Characteristics When Co-Firing With Biomass Derived
3 - Env	80	L	Recuperative Reforming of Natural Gas for Fuel Savings and Emissions Reductions at Existing Reciprocating Compressor Sites
3 - Env	95	L	Clean High Efficiency Hydrogen Power
3 - Env	102	L	High Temperature Fuel Cell Electricity and Hydrogen Co-Production
3 - Env	103	L	Ignition Enhancement of Natural Gas by in-situ Produced C2 Additives for HCCI Applications
3 - Env	106	L	Demonstration of Solid Oxide Fuel Cell Operation on Natural Gas
3 - Env	110	L	Ultra-Clean and Efficient Commercial and Small Industrial Boilers
3 - Env	113	L	Demonstration of Low-Cost Continuous Emission Monitoring of RICE Generators
3 - Env	115	L	Impact of Gas Composition on Reciprocating Engine Performance and Emissions
3 - Env	132	L	Effective Fuel Process Control for High Efficiency Natural Gas Fuel Cells
3 - Env	141	L	NOx Reduction and Efficiency Enhancement by Exhaust Gas Chemical Recuperation
3 - Env	142	L	Natural Gas HCCI Combustion For Cogeneration Applications
3 - Env	143	L	Improved NOx Reduction From Small Engines
3 - Env	144	L	Emissions Control Systems For CHP Generation
3 - Env	145	L	Gasification Based Power as a Hedge Against High Natural Gas Prices
3 - Env	150	L	Optimize Gas Engine Emission Reduction Strategies
3 - Env	158	L	Sterling Engine Testing Program
3 - Env	161	L	Deploying CHP with CEMS device in the SCAQMD Basin
3 - Env	162	L	Molten Carbonate Fuel Cell Demonstration
3 - Env	163	L	Solid Oxide Fuel Cell Demonstration

Category	ID#	Rating	Project Title
3 - Env	164	L	Particle Production from Natural Gas Combustion
3 - Env	165	L	Transport Properties for Modeling Natural Gas Combustion
3 - Env	166	L	Increasing the Efficiency of Microturbines by Enhanced Ceramics
4a--Strat	87	H	Quantifying The Impact Of Renewable Energy And Energy Efficiency Investments On Natural Gas Prices
4a--Strat	56	M	Man-Made Compressed Natural Gas Storage for Power Plants
4a--Strat	79	M	Gas-Electric Interdependency Analysis and Evaluation
4a--Strat	114	M	Seismic Hazard Analysis and Risk Reduction for the California Natural Gas Distribution System
4a--Strat	126	M	Incorporating Natural Gas Price Dynamics into Forecasting and Planning Models
4a--Strat	167	M	Alternative Gas Supplies
4a--Strat	15	L	Modeling the Formation and Distribution of Oceanic Methane Hydrates
4a--Strat	21	L	Clean Energy Technologies - Combined Utility Distribution Infrastructure Analyzer
4a--Strat	92	L	Adding retail gas tariffs to a web-based residential energy analysis tool
4a--Strat	118	L	Maximum Safe Loads On Buried Pipelines
4a--Strat	119	L	Prevention and Assessment of Critical Pipeline Strains in Hazard Regions
4a--Strat	120	L	Prevention of Third-Party Damage
4a--Strat	128	L	Gas Transmission Measurement Equipment Operating Range Expansion
4a--Strat	131	L	Reduction of Lost and Unaccounted-For Gas Volumes
4a--Strat	149	L	Intrinsically Safe Gas Sensor
4a--Strat	151	L	Rapid Post Earthquake Damage Information Collection
4a--Strat	152	L	Natural Gas Seismic Safety and Reliability - Geotechnical
4a--Strat	153	L	Natural Gas Safety and Reliability - Pipeline Mitigation
4a--Strat	154	L	Natural Gas Safety and Reliability - Integrity Management
4a--Strat	155	L	Detection of Gas Leaks and Pipe Blockages Using Embedded Wireless Network Sensor Systems
4a--Strat	156	L	Reduction of Third Party Incidents Through Prevention of Mechanical Damage
4a--Strat	157	L	Monitoring of Internal Corrosion Using Fluidized Sensors
4a--Strat	159	L	Inhibiting Dynamic Combustion Instability in Gas-Fired Industrial Application
4a--Strat	160	L	Direct Assessment of Older Pipeline Systems

Table A-2: Abstracts Rejected and Rationales

ID#	Project Title	Rationale for Rejection
12	A Novel Process Technology for Conversion of Natural Gas to Fuels	Conversion of NG to fuels for vehicles, excluded by CPUC Decision
13	Advanced Natural Gas Engines & Fuel Systems	Natural gas truck engine development; excluded by CPUC Decision
16	Natural Gas Reformer Hydrogen Refueler	NG reformer development is focused on fuel cell vehicle refueling; transportation is excluded by CPUC Decision
86	Feasibility of Integrated LNG Peak Shaving/Vehicle Fueling Networks	Focus is on LNG vehicle refueling stations serving as distributed peak shaving storage; transportation excluded by CPUC Decision
88	Natural Gas Efficiency	Unresponsive; statement against natural gas R&D
89	Photovoltaic / Thermal Collectors (PV/T) R&D	This is a photovoltaic power generation project, unrelated to gas; excluded by definition
121	Identify and Prioritize Locations Susceptible to Internal Corrosion	Develops tools/methods for finding internal pipeline corrosion; operational topic properly funded by private market for purchase and use with regulated NG rates
122	Improve CP System Effectiveness and External Corrosion Prevention, Mitigation and Monitoring	Research into pipeline corrosion damage caused by cathodic protection shielding; operational topic properly funded by private market for purchase and use with regulated NG rates
123	Managing Stress Corrosion Cracking (SCC)	Develops tool for finding/sizing pipeline stress corrosion cracks; operational topic properly funded by private market for purchase and use with regulated NG rates
124	Solid-State Sensors for Natural Gas Applications	This project is focused on hydrogen generation from NG for fuel cell vehicle use; transportation topic excluded by CPUC Decision
125	Condition Assessment Tools for Non-Piggable Pipelines	Tool for NG non-piggable pipeline inspection; operational topic properly funded by private market for purchase and use with regulated NG rates
137	Natural Gas Fluidized Catalytic Nanoparticle Reactor/ Thermoelectric System For Low Environmental Impact	Development of novel electric power generation technology; excluded from NG R&D program by definition but could be in electricity R&D program
139	Reduction of Market Barriers for Combined Heat Power by Improved Interconnect Power Quality	CHP system using inverter technology for power generation; excluded from NG R&D program by definition but could be in electricity R&D program

APPENDIX B: GAS R&D PROJECT ABSTRACT SUBMITTALS

All of the 172 abstracts that were submitted are attached under separate cover (data CD) and can also be found at the Energy Commission's website:

www.energy.ca.gov/naturalgas_research/documents/