CALIFORNIA

Public Interest Energy Research

Independent PIER Review Panel Report

March 2000

California Council on Science and Technology

California Public Interest Energy Research

Independent PIER Review Panel Report

March 2000

Panel Members

JOHN S. FOSTER, JR. (CHAIR)
HAROLD M. AGNEW
RICHARD E. BALZHISER
PATRICIA A. BUFFLER
LINDA R. COHEN
T. KENNETH FOWLER
FRED KITTLER
PETER M. MILLER
ESTEBAN SORIANO
JAMES L. SWEENEY
MARY L. WALSHOK
CARL J. WEINBERG

CCST PIER Committee Review Members

ROGER G. NOLL (CHAIR)
OCTAVIA DIENER
MAXINE SAVITZ
EDWARD C. STONE
C. BRUCE TARTER

California Council on Science and Technology

LEGAL NOTICE

COPYRIGHT

 Library of Congress Cataloging Number in Publications Data Main Entry Under Title:

California Independent PIER Review Panel Report, March 2000
ISBN 1-930117-13-2

The California Council on Science and Technology is a nonprofit organization established in 1988 at the request of the California State Government and sponsored by the major post secondary institutions of California, in conjunction with leading private-sector firms. CCST's mission is to improve science and technology policy and application in California by proposing programs, conducting analyses, and helping government implement policies and initiatives for a better economy and quality of life.

For questions or comments on this publication contact:

California Council on Science and Technology
1130 K Street, Suite 280
Sacramento, California 95814

by voice at (916) 492-0996

by fax at (916) 492-0999

or e-mail at ccst@ccst.ucr.edu

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

The Public Interest Energy Research (PIER) program was established in January 1998 to conduct energy research, development, and demonstration (RD&D) projects for the public interest.[1] The program was created when California's electricity industry was restructured in 1996, which both reduced public interest RD&D activity by the utility companies, and created new opportunities for public interest energy RD&D projects. The legislature authorized not less than $62.5 million annually for the program through December 2001. The California Energy Commission (CEC) receives $61.8 million annually, with the remainder administered by the California Public Utilities Commission (CPUC) for transmission and distribution projects.

An independent review panel also was established to evaluate the PIER program's public value and to make recommendations to the Legislature and to the Governor.[2] This report presents the panel's findings to date. The panel focused on indirect measures of public value since project outcomes are not yet available.

The panel found that energy-related issues are important enough, both nationally and to California's unique interests, to warrant a targeted, effective energy RD&D program. California's energy infrastructure faces serious challenges, including the need to: meet increasing demand for energy; maintain system stability and security with restructured electricity markets; improve transmission capabilities; continue increasing efficiency of energy-using technologies; and improve environmental performance of energy systems. The state has the intellectual resources and economic infrastructure to address those challenges through a well-managed, high-quality RD&D program.

The importance of energy RD&D to California's continued economic growth, environmental performance, and science and technology leadership demands that the PIER program be implemented effectively.

The California Energy Commission was assigned to implement most of the PIER program. The CEC has realized some important accomplishments over the last two years, including: establishing a Policy Advisory Council; conducting a transition solicitation that preserved key elements of the utilities' public interest RD&D activities; conducting two competitive general solicitations and one targeted programmatic solicitation; and initiating a framework for planning and managing the program into the future. As of December 1999, the CEC had awarded approximately $101.6 million under the PIER program in four competitive solicitations, interagency agreements, and sole source awards.[3] The panel reviewed the current portfolio and found that while it generally meets a criterion of public interest, it could be improved with clearer policy direction.

Despite its successes, the PIER program has suffered from a variety of problems hindering effective program execution. These include:

- The lack of a program director responsible for program planning and execution for 20 of the 24 months since the inception of the program;
- A mismatch and lack of clarity between responsibilities, authority and assets for the program area managers;
- Limited coordination among CEC elements supporting the program;
- An overly complex and time-consuming contracting process for PIER projects; and
- Unclear connections among other federal and private-sector energy RD&D activities, California's future energy-related needs, program goals, and public interest criteria.

The CEC has attempted to address some of these issues by establishing the position of PIER Program Manager, filling that position, and developing a process that more closely links future energy-related challenges to program objectives and public interest criteria.

1 Assembly Bill 1890, Deregulation of the Electrical Industry, September 23, 1996.

2 Senate Bill 90, as amended, Energy resources: renewable energy resources: funding. (enacted in 1997)

3 The $101.6 million breaks down as follows: $49 million (83 projects) in the Transition, PIER 1, and PIER 2 competitive solicitations; $6.5 million in interagency agreements and sole source awards during 1998; 1999 expenditures include sole source awards of $11.8 million to EPRI and $365,100 to GRI for membership and study participation; sole source awards of $4.5 million and $100,000 in the Strategic program area; $12 million in interagency agreements; and $17.3 million (three awards of approximately $2 million each per year for three years) in the Buildings program area.

However, the root cause of many of these problems appears to be inherent in the current nature of the CEC, and in how the CEC implements its rules and procedures. Although the CEC has historically conducted planning, policy, RD&D management, and regulatory functions, its organizational culture tends to be risk averse, with an emphasis on due process and consensus building. The relationship between staff and Commissioners can be ambiguous. CEC also has a large, complex bureaucracy which has developed a set of standard operating procedures that tend to disguise the flexibility available to CEC to manage RD&D. At a broad level, this description characterizes CEC's implementation of PIER to date.

In contrast, a successful RD&D management organization and its programs must encourage innovation and informed risk taking. Experience strongly suggests that this requires three core elements:

- A full-time executive with the authority and stature to manage the program responsively and efficiently. This individual would provide critical leadership, help create and maintain a high-quality RD&D program, provide strategic guidance, and establish good working relationships with important external organizations. The executive must have the autonomy and flexibility necessary to accomplish the mission, and be fully responsible and accountable for program outcomes.
- An organizational environment that enables effective and efficient management. This includes: streamlined management, contracting, oversight, and decision making processes with limited though important input from outside stakeholders; an appropriate balance among responsibility, authority, and resource ownership throughout organizational levels; a culture that encourages informed risk taking; and a flexible staffing processes to attract the highest quality technical and management talent.
- A high-quality knowledge base embodied in the skills and capabilities of its management and staff. This implies a focus on continued personnel development and the ability to reach beyond the organization for knowledgeable personnel.

CEC's internal constraints have shaped a PIER organization with policies and practices that need improvement if PIER is to become a superior RD&D management program. In particular, the characteristics of the CEC's dominant organizational culture conflict with the attributes of an organizational environment that facilitate a high-quality RD&D program.

The panel agrees that the PIER program has many strengths and is sponsoring some high-quality RD&D projects. However, unless it is significantly transformed, PIER may not become a truly outstanding research and development program that will benefit the citizens of California.

The panel has identified two alternative ways to enhance the future success of the PIER program:

1. Increase the autonomy and flexibility of PIER within the CEC. This includes: raising the stature of PIER; clearly defining the roles of the CEC Commissioners; providing a program director with responsibility and authority for program planning and execution; delegating greater responsibility to the PIER program area managers; and streamlining personnel and contracting policies, with management and core staff responsible solely for PIER.
2. Provide PIER with the requisite autonomy and flexibility through an external organization that will provide the kinds of flexible decision-making and personnel recruitment discussed above. Options include: assigning PIER to an existing university or the creation of a university association; assigning PIER to an organization with broad energy RD&D portfolio management experience; creating a new independent agency with responsibility for energy RD&D; or incorporating the PIER program into the newly announced California Institutes for Science and Innovation.

The panel chose not to evaluate in detail the pros and cons of various organizational arrangements, but agreed unanimously on the characteristics necessary for an outstanding program.

Therefore, the panel recommends that the PIER program be continued but be transformed into a new organizational environment, either inside or outside the CEC, that would provide the legal and organizational basis for a superior public interest energy RD&D program.

1. INTRODUCTION

1.1 CHARGE TO THE PANEL

Assembly Bill (AB) 1890 restructured the California electricity industry in 1996.[4] The legislation also authorized collection of a surcharge on retail electricity sales of not less than $62.5 million annually for four years to ensure a continuation of public interest energy research, development, and demonstration projects. The Public Interest Energy Research (PIER) program was established at CEC to implement this provision, funded at $61.8 million annually from January 1, 1998 to December 31, 2001. Senate Bill (SB) 90 further defined the PIER program in October 1997,[5] identifying key program areas and administrative and funding criteria.[6] While the originating legislation assured a funding level of not less than $62.5 million for four years, the program does not terminate automatically.[7]

Public Resources Code Section 25620.9(a) directed that an independent panel be established to conduct a comprehensive evaluation of the PIER program. The evaluation was to include a review of the public value of programs including, but not limited to, such factors as the monetary and nonmonetary benefits to public health and the environment of those programs and the benefits of those programs in providing funds for technology development that would otherwise not be adequately funded.

CEC requested the assistance of the California Council on Science and Technology (CCST) to nominate panel members and manage the review process. The panel members were selected because of their competencies in areas necessary to evaluate the PIER program and their broad experience in RD&D program management and execution.[8] The panel reviewed PIER documentation, including draft strategic plans and PIER project summaries, met with PIER personnel and two CEC Commissioners, and considered alternative RD&D organizational structures.

A preliminary report to the Governor and Legislature on the PIER program implementation is required no later than March 31, 2000 and a final report no later than March 31, 2001.

This preliminary report presents the panel's findings regarding both PIER program management and public benefits, and makes near-term and longer-term recommendations.

1.2 APPROACH

The independent review panel examined recent PIER program planning and offered suggestions for how to immediately impact program management and effectiveness. The panel also assessed the program from a longer term perspective which included potential legislative actions. The panel did not assess or make recommendations about proposals submitted to the PIER program, because that responsibility was outside of the panel's scope.

The panel held eight public meetings from February 1999 through February 2000. These meetings included briefings by PIER program managers and staff on plans, execution, and results to date. This was supplemented by interviews and analysis conducted by the RAND Corporation, under contract to CCST to provide technical support to the panel. The panel included management, staffing, and process issues as well as the core public value issues in its program review.

4 Assembly Bill 1890, Deregulation of the Electrical Industry, September 23, 1996.

5 Senate Bill 90, as amended, Energy resources: renewable energy resources: funding (enacted in 1997). The PIER program does not address issues related to transportation or nuclear energy.

6 CEC, *PIER 1998 Annual Report*, March 1999.

7 The originating legislation leaves determination of minimum funding levels after December 2001 to the discretion of the CPUC, which collects the PIER surcharge and administers $700,000 in PIER transmission and distribution projects.

8 See Appendix A, Matrix of Panel Member Competencies. Panel member selection included conflict of interest disclosure. While some panel members are under contract with CEC or other interested parties, no conflicts of interest exist with respect to PIER.

To better frame its review of the PIER program, the panel developed two sets of questions. The first set investigated the direction, consistency and implementation of PIER's program goals, and the second concerned project evaluation.

For the overall PIER portfolio, the panel's review focused on the extent to which managers knew the portfolio's general direction, the program's objectives and motivation, and how responsibilities for RD&D were divided between the state, the federal government, and industry.

For specific program areas, the panel and program area managers were requested to address:

- What is to be accomplished by the program and how is it now performing?
- If successful, what difference will it make?
- If adopted, would it be cost effective?
- How can one periodically tell how a project is proceeding?
- How does one know when it is finished?
- What is the plan to transition the technology to industry?

The second set of questions concerned project evaluation. The panel developed a set of measures that could be used to tell periodically if PIER is being as successful as possible in accomplishing its legislatively stated missions. Given that project outcomes are not yet available, the measures were divided into two sets of time-sensitive questions:

How is success judged in the near term (i.e., two years), before projects are completed and outcomes identified?

- Is a clear vision based on future state needs in place and communicated effectively?
    - Are the right management processes in place and working internally?
    - Are the right relationships with legislators, industry and other RD&D organizations in place?
    - Are there appropriate market connectivity mechanisms in place?
    - Do other organizations (e.g., Department of Energy, Electric Power Research Institute) take the program seriously and want to be involved?
    - Do the best performers want to be involved?
- How is success to be judged over the long term (i.e., ten or more years) after a significant number of projects have been completed and outcomes are available?
    - Are all conditions for success in the near term still met?
    - Have technologies been created or improved that are in commercial use or on the way to being commercialized?
    - Have these technologies and knowledge produced public benefits significantly greater than their costs?

These measures provide the framework within which the panel reviewed the PIER program. The panel focused its efforts on the near-term measures since relatively few projects have been completed to date. This meant the program's current public value had to be evaluated indirectly.

In May 1999, the panel informally presented its initial observations and suggestions to the CEC RD&D Committee. This was intended as near-term feedback to help improve program management. In January 2000, the panel provided summary information to the Governor and Legislature to inform state policy makers about PIER.[9]

9 Independent PIER Review Panel, Executive Summary – December 1999, Letter and attachment to the Governor and to the Legislature, January 4, 2000.

2. IMPORTANCE OF ENERGY RD&D IN CALIFORNIA

California has an outstanding record of leadership in energy RD&D and in the development of sound energy policies and practices. While it has the third lowest energy intensity within the U.S., it is nonetheless the second largest consumer of energy, behind Texas.[10] A rich mixture of low energy-intensity industries and a relatively mild climate have contributed to California's success to date, and high energy prices have contributed to California's energy efficiency, but the state faces an uncertain energy future.

All Californians benefit from the state's efficient use of energy. Energy efficient housing design and appliance standards reduce consumer energy bills. Low energy use per unit output in the industrial sector makes California businesses more competitive, and helps to preserve the natural environment. Energy RD&D has played a pivotal role in facilitating improvements in energy intensity; without an effective energy RD&D program, California will be unable to meet the challenges ahead.

2.1 RD&D FUNDING IN DECLINE

California has, historically, derived great benefit from energy RD&D, performed both in the state and elsewhere. For example, the Lawrence Berkeley National Laboratory (LBNL) has estimated that the net present value of technologies derived from building energy efficiency programs at LBNL is more than one hundred times greater than the amount spent on the programs.[11] California's leadership in energy RD&D also provides the state with a high-quality jobs base, an attractive business environment and greater competitiveness. California's extensive research in renewable energy, along with aggressive implementation of the Public Utility Regulatory Policy Act (PURPA) and advantageous geography, has contributed to the state having 40 percent of the world's geothermal power plants, 30 percent of the installed wind capacity, and 90 percent of the solar generation capacity;[12] these capabilities help to preserve the state's natural environment and present the opportunity for substantial export industries.

In recent years, however, funding for energy RD&D—from all sources—has declined sharply. Responding to new competitive pressures from the electric power industry's restructuring, investor owned utilities have reduced their spending on RD&D that they directly perform and also their contributions to industry consortia.[13] Private energy firms have also reduced their support,[14] as low energy prices worldwide have reduced both profits and the incentive to innovate. Department of Energy (DOE) funding has been steadily reduced—from $6.2 billion to $1.3 billion in the last 20 years[15]—for a number of reasons, including a reaction against large-scale RD&D failures in previous years, broader reductions in

---

10 U.S. Department of Energy, Energy Information Administration (EIA). 1999. *State Energy Data Report*, 1997. DOE/EIA-0214(97). U.S. Government Printing Office. Washington, D.C.

11 Lawrence Berkeley National Laboratory (LBNL). 1995. From the Lab to the Marketplace: Making America's Buildings More Energy Efficient. Spending on the programs totaled $71 million through 1993; the net present value of the derived technologies through 2015 is estimated at $7.5 billion (constant 1995 dollars).

12 California Energy Commission (CEC). 1999a. California Energy Facts. www.energy.ca.gov/html/calif_energy_facts.html. (Accessed December 18, 1999.)

13 Until the recent deregulation, the California Public Utility Commission (CPUC) required electric utilities to invest in energy research. California electricity Investor Owned Utilities (IOU) RD&D funds declined from $122 million in 1991 to $61 million in 1996, with a corresponding change in emphasis toward operating and support activities. See CEC, *Working Group Report on Public Interest Research, Development, and Demonstration Activities, Appendices*, September 6, 1996 (P500-95-010A). There is some evidence to suggest that IOU RD&D investments have continued to decline since 1996; the IOUs transferred most of the remaining 1996 RD&D funds to the CEC to meet the new PIER obligation. CPUC Decision 97-11-022, November 5, 1997. See for example Southern California Edison Annual Status Report on RD&D, filed with the CPUC March 1998, pg. 1-4.

14 Twenty-five of the nation's largest energy companies reduced their R&D expenditures from $1.9 billion to $1.1 billion (constant 1987 dollars), from 1983 to 1993; EIA. 1995. *Energy R&D: Shaping Our Nation's Future in a Competitive World*. Secretary of Energy Advisory Board.

15 Constant 1997 dollars; White House Office of Science and Technology Policy (OSTP). 1997. *Federal Energy Research and Development for the Challenges of the Twenty-First Century*. President's Committee of Advisors on Science and Technology.

federal support for research, and little expectation among legislators of an impending energy crisis. Spending by the states, while never especially large compared with federal RD&D budgets, has generally targeted issues of particular concern to those states; this support, too, is in decline.[16] Along with support for RD&D, spending has declined on demand side management and other energy efficiency programs.

In this climate, valuable RD&D - which benefits the public interest and is vital to California's continued prosperity – may not be supported adequately by market mechanisms or by the federal government, and will require state support. The organization that manages this effort must recognize the particular energy needs of California that are not adequately addressed by other research enterprises, and target its support to those areas.

2.2 CALIFORNIA ENERGY CHALLENGES

California faces numerous challenges in its energy future. The state is expected to continue its rapid population growth of the last several decades. Much of this growth – and considerable internal migration – will be in inland areas, which have hotter climates than in the currently densely populated coastal areas. New construction in these regions will increase the use of residential and commercial air conditioning. Trends towards larger residences and increased electrical appliance use statewide will also increase energy usage. The expansion of the industrial, agricultural, and commercial sectors of the economy will place a heavier load on the state's energy supply capabilities. New end-use categories – such as electric vehicles or desalination plants – may impose further burdens. Additionally, as the use of information systems becomes integral to the functioning of the economy, the quality of electric power will become increasingly important.

These increased energy demands – both base load and peak load – will further encumber an already strained generation, transmission, and distribution network. California (and the western states region) currently operates with very little electric power reserve capability during peak summertime demands, and peak demand growth exceeds the growth in generation capacity. A severe heat wave could cause widespread and sustained power outages.[17]

Many of California's fossil fuel power plants are aging and will soon be retired, and its nuclear power plants may be taken off line even before their permits expire. Many of those plants still in operation will require upgrades to meet stricter environmental standards, taking them out of service temporarily. Furthermore, the same population pressures that increase the demand for new generation capacity make more difficult the siting of those new facilities.[18]

Increasingly strict state and national environmental standards and potential international environmental treaty obligations will demand an ever cleaner and more efficient energy supply system. At the same time, restructuring in the energy industry will create uncertainty in energy prices, availability and reliability.

Expanding the state's energy supply infrastructure to meet increasing demand will be very costly if limited by existing technologies. However, targeted RD&D could reduce the economic costs and environmental impact of adding new capacity to meet the energy demands.

2.3 PUBLIC INTEREST RD&D COULD MEET CALIFORNIA'S ENERGY CHALLENGES

California has faced energy challenges in the past, and has responded with creativity. The energy crisis of the early 1970s spurred passage of the Warren-Alquist act (1974),[19] which established the CEC and instituted some of the nation's first – and still most comprehensive – energy codes. Title 24, the residential and commercial building code, is the strictest and most comprehensive such code.[20] The state's energy efficiency programs are regarded as models by other states. California leads the nation

---

16 California state support now accounts for well over half of all U.S. state R&D funding; American Council for an Energy Efficient Economy (ACEEE). 1999. Summary Table of Public Benefit Programs and Electric Utility Restructuring. www.aceee.org/briefs/mktabl.htm. (Accessed December 18, 1999.)

17 CEC, *High Temperatures and Electricity Demand: An Assessment of Supply Adequacy in California, Trends and Outlook,* July 1999.

18 *op.cit.*

19 CEC. 1998. The Warren-Alquist Act. P160-98-001.

20 CEC. 1995. *Energy Efficiency Standards for Residential and Nonresidential Buildings.* P400-95-001.

in spending on demand-side-management (DSM) programs and on estimated savings from those programs.[21] California also is endowed with tremendous intellectual and institutional resources, with several of the world's premier research universities, top government laboratories and a diverse industrial base.

Progressive legislation and a robust infrastructure have enabled energy RD&D programs to play a central role in California's ability to meet its energy needs. As the gap widens between California's energy needs and funding for energy RD&D, state support grows ever more important. While AB 1890 began the process of restructuring California's electricity industry, it also authorized not less than $250 million over a four-year period to support energy RD&D projects through PIER. The legislature affirmed that market solutions alone would not address all of California's energy challenges, and that state-funded energy RD&D targeted to critical areas is needed since other sources of funding are in decline.

Public benefits of PIER may include:

- developing new industries that address widespread energy concerns and contribute to the state's economic growth;
- lowering energy costs for consumers and businesses; and
- reducing environmental impacts.

More broadly, public interest energy research should be a key component of California's science and technology infrastructure to ensure the state's future prosperity.

21 EIA. 1997. *U.S. Electric Utility Demand-Side Management 1996*. DOE/EIA-0589(96). U.S. Government Printing Office. Washington, D.C.

3. ESSENTIALS OF SUCCESSFUL RD&D MANAGEMENT

The legislation that created PIER anticipated a state-managed energy RD&D program that would support energy-related research not adequately funded by public- or private-sector organizations. PIER was expected to support a coordinated set of projects with significant public benefits; it was not simply a funding mechanism to provide contracts and grants to interested parties. In practice, this meant that PIER would need to identify state energy challenges, formulate a program for meeting those challenges, develop a strategy for implementing the program, develop and release RFPs, evaluate proposals and select projects for funding, negotiate contracts or other funding vehicles, monitor the research activity, and assess how well projects met program goals. These are the responsibilities of an RD&D management organization; how well it carries out these responsibilities is determined by the organization's characteristics.

There is no single best path to a superior RD&D management organization. However, certain principles pertaining to leadership, organizational environment and knowledge base guide all superior RD&D management organizations, and, to some extent, all innovative organizations.[22] While no organization or program can be expected to reflect all of these principles when it launches, a superior RD&D management organization will continuously incorporate these principles into its operations.

3.1 LEADERSHIP

An RD&D management organization requires a strong leader, not simply a manager. A leader keeps others in focus, maintains morale, and creates an environment that enables the fullest exploitation of talents. A leader earns the trust of everyone in the organization, both above and below, and has full responsibility for and authority over intellectual, administrative, personnel, and financial areas. The leader facilitates relationships with other relevant organizations and creates and maintains an environment appropriate for RD&D management.

A single leader improves accountability and consistency in program direction. He or she must have the authority to develop the vision to link program objectives to challenges, and to develop a strategy for addressing those challenges. The leader also has the responsibility to present and defend the strategy and objectives to external oversight authorities. There is less tendency for oversight organizations to micromanage if there is respect for the leader and understanding and acceptance of program plans and objectives.

A leader must be able to deploy resources, dollars and people. Activities must be coordinated among various disciplines and specialties. Each project must be embedded in a portfolio that balances the need for setting the objectives, available resources, degree of risk, and time of completion.

An RD&D leader needs to control the program budget, with clear rights and authority that confer stature and respect. A leader requires the authority to use a variety of funding mechanisms, appropriate for different types of RD&D activities. He or she also must have the ability to respond rapidly to a changing environment, including the relative importance of subject areas, budget and staff changes, quality of RD&D performers, and program outputs and outcomes.

Innovative groups thrive on challenging work and stimulating colleagues. Such a group requires a superior leader, especially when the group must be formed quickly and action taken quickly. The leader's charge is especially difficult if the group is inherited from a prior program, or if the personnel have been designated by others. Successful leaders seek to reduce distractions, and are allowed to do so, while ensuring that information flow is sufficient to the organization's planning needs.

22 R&D management organizations that have struggled with some of the same issues that the CEC faces in administering PIER and that, to varying degrees, have found solutions, are the Defense Advanced Research Projects Agency (DARPA), the Electric Power Research Institute (EPRI), the Gas Research Institute (GRI), the Atomic Energy Commission (AEC) and the Advanced Technology Program (ATP) at the National Institute of Standards and Technology (NIST). An excellent discussion of the experiences at the R&D organizations is contained in Corey (1997).

Successful leaders insulate their people from bureaucratic interference and ensure their autonomy, even when this protection may conflict with the organization's norms of control over decision processes, funds, contracts, and rules changes. The successful leader benefits from an enlightened administrative oversight that values the rewards of innovation more than it values control.

3.2 ORGANIZATIONAL ENVIRONMENT

A superior RD&D management organization has well-established concepts and processes that define the organization's goals and objectives. These goals and objectives are jointly developed with upper management and stakeholders to ensure that the right problems and the potential influence of RD&D are understood. The organization must communicate with political bodies who have oversight responsibility.

A superior organization has a vital and clear objective purpose, and can link each of its activities to that purpose. It becomes the framework for purposeful RD&D management.

An RD&D management organization requires an environment that fosters innovative thinking and allows intelligent failure. A well-functioning organization must be open and fair. RD&D management organizations must reduce the fear of failure. Bold and risky, but well-conceived and managed projects that fail but yield valuable information must not be punished. Otherwise, only guaranteed successes will be funded, stifling innovation. This is a particularly difficult environment to develop in a public organization, wherein failure can be construed as mismanagement of funds. The authorities that oversee disbursement of public funds as well as citizens should prize innovation and tolerate occasional failure as an acceptable cost of the innovation process.

A successful RD&D program requires an environment that minimizes oversight organization interference in program execution. Inappropriate interference by oversight organizations with established program management procedures can reduce the efficiency and effectiveness of RD&D management. There is a distinction here between appropriate policy guidance and oversight functions, and micromanagement by external organizations.

Good RD&D management also enables stakeholders to provide feedback to program managers in order to improve overall policies, objectives, processes, and resource allocation among program areas. The feedback process should be at least partially internal to the program.

3.3 KNOWLEDGE BASE

A successful contractual RD&D management organization requires a high-quality team of managers and staff. The organization's knowledge base – its ability to provide technical assessments of proposals and provide technical oversight of projects – resides in its staff. High-quality staff are drawn to the organization by its mission, its leader, and an operating environment in which they can be assured of the responsibility, authority and resources to perform effectively.

The leader of a superior organization should engage the most talented, knowledgeable, and experienced managers who possess the diversity to address a spectrum of challenges. Superior performance requires good content knowledge, recognized by peers. High-quality information on the technologies and disciplines involved in the programs should flow quickly and directly to the work groups.

4. EVALUATION OF PIER PROGRAM IMPLEMENTATION

To date, the PIER program within CEC has achieved a number of important accomplishments, but has yet to exhibit the characteristics of a superior RD&D management organization outlined in Section 3.

The panel recognizes the difficulty in starting a large RD&D program[23] in a short time frame and commends the CEC for adequately addressing some critical aspects of that start-up and for making substantial improvements over the past year. Nevertheless, PIER program implementation to date suffers from a variety of problems relating to leadership, organization, rules and procedures, and knowledge base. The key issues and problems are discussed in more detail below. The final subsection describes the panel's evaluation of the PIER program portfolio.

As of December 1999, the CEC had awarded approximately $101.6 million in four competitive solicitations, interagency agreements, and sole source awards.[24] Much of this activity took place as part of Phase I, which included the Transition solicitation and two competitive general solicitations; the panel's findings relate predominantly to the portfolio generated by these three solicitations, and the planning and management which followed.

4.1 LEADERSHIP

4.1.1 The panel found that the CEC's long delay to appoint a leader for the PIER program has hindered program execution.

The PIER program was initiated without a full-time program manager: no one was clearly in charge with the appropriate authority and available time to fully execute the program. There was some central guidance from the RD&D Committee regarding program objectives, strategy, planning, and resource allocation, but the guidance sometimes conflicted and at other times was inappropriately detailed. Accountability was clearly compromised. Program area leaders and others involved with PIER implementation met occasionally to coordinate their efforts, but were not particularly effective without a full-time program manager to balance responsibilities, authority and resources.

A program manager was appointed at the end of August 1999, 20 months after the program began. The memorandum describing the new program manager's responsibilities and authority addressed several specific problems concerning program execution.[25] The memo acknowledges that resources allocated to PIER have not been available for PIER activities, that determining priorities between PIER and other programs within the CEC Divisions has been problematic, and that accountability of staff to PIER program managers and leaders was unclear. The memo gives increased responsibility and authority regarding these issues to the PIER program manager, and defines elements of the relationship among program managers, PIER subject area leaders, CEC Divisions, and staff. However, the roles and responsibilities of the program manager have not been well defined, and in the panel's opinion are inadequate.

4.1.2 The panel is concerned that the program manager's role is still not well defined.

First, the roles and responsibilities between the PIER program manager and the RD&D Committee remain ambiguous. Formally, the Committee provides policy guidance and oversight, while CEC staff formulates and executes the program according to that guidance. Prior to the appointment of a program manager, there was considerable micromanagement from the RD&D Committee. It is not clear if this micromanagement will cease. Additionally, the position of program manager apparently lacks the authority to develop the PIER program's vision and strategy.

Second, the program manager does not have a direct influence over staffing for the program. This includes selection of staff based on the capabilities needed for PIER, determining staffing levels and level

23 The PIER program represents approximately 23% of CEC's FY1997/1998 funding.

24 The $101.6 million breaks down as follows: $49 million (83 projects) in the Transition, PIER 1, and PIER 2 competitive solicitations; $6.5 million in interagency agreements and sole source awards during 1998; 1999 expenditures include sole source awards of $11.8 million to EPRI and $365,100 to GRI for membership and study participation; sole source awards of $4.5 million and $100,000 in the Strategic program area; $12 million in interagency agreements; and $17.3 million (three awards of approximately $2 million each per year for three years) in the Buildings program area.

25 CEC Memorandum from Kent Smith, Executive Director, "PIER Program", September 20, 1999.

of effort, enforcing staff availability and commitments, and providing input to staff performance evaluations. An attempt was made to structure PIER as a matrix organization in order to draw more fully on the expertise embodied in several CEC Divisions. While this was well intentioned, execution has been problematic. The panel observes that lack of direct resource ownership makes the PIER program just another program within the CEC hierarchical structure, one without a clear home. Thus, while the recent appointment of a program manager will benefit the program, the current split of responsibilities among the RD&D Committee, the Divisions, and the program manager does not enable the type of critical leadership required for a truly effective program.

Third, the responsibility for presenting and defending the program plan to external oversight agencies is unclear. The lack of a leader has meant that there was no individual accountable for PIER. In the panel's view, the program manager should present and defend PIER's objectives, programs and plans to the CEC, the Legislature and the Governor. Assuming that the Legislature and Governor accept the program plan as presented, the need for subsequent micromanagement is reduced. This function is currently the responsibility of the RD&D Committee Chair, or the Chair of the entire Commission. The PIER program manager's responsibilities, as currently defined, do not include this important function.

4.1.3 The panel found that only three of the six PIER program areas had full-time leaders during the initial planning phases, which hindered program planning and execution.

The temporary leaders had other responsibilities and were not able to devote as much time and effort as warranted to PIER. In some cases, the temporary program area leaders were working outside of their area of expertise. Program areas with full-time dedicated leaders performed planning functions much better. Those functions included performing the necessary market surveys and surveys of public- and private-sector RD&D activities, as well as identifying key California energy-related challenges. Goals and objectives were developed that related at least in part to the program area's vision of future California energy-related challenges. However, strategy, approaches and definitions were not consistent across all six program areas. Also, interactions with key RD&D performing organizations at the federal level and in the private sector were limited and inconsistent.[26]

As of December 1999, five of the six subject areas had permanent full-time leaders each of whom qualified for their positions.[27] Team leaders, as well as the PIER program manager, have begun to participate in the hiring of some staff to fill positions within each subject area.[28]

4.1.4 The PIER program lacks a clear vision to guide program planning and implementation.

The planning for PIER needs to be conducted with an understanding of probable energy futures for California, and in the context of other public- and private-sector energy RD&D activities. The vision should include identification of California's future energy challenges, based on analysis of changes in state energy demand and economic growth, supply preferences as reflected in state energy policy, and the needs of the energy infrastructure. The vision should also account for other public- and private-sector energy programs.

CEC documents provide a foundation for developing this vision.[29] Together, these documents establish California energy policy, track trends in energy supply and demand, identify current and future needs of the energy system (e.g., new generation capacity, enhanced transmission and distribution infrastructure),

---

26 Some important interactions with other RD&D managing or performing organizations did occur. For instance, the CEC and the DOE signed a Memorandum of Understanding on March 2, 1998 to create a partnership in energy technology planning and information transfer. A similar agreement was signed with the New York State Energy Research and Development Authority. See CEC News Release, March 2, 1998. The DOE agreement is broader than just PIER and is intended to include activities not included in PIER (i.e., transportation).

27 In November 1999, the leader of the Industry/Agriculture/Water program area left the CEC. He had been hired from outside to fill that position; at the time of this writing, a replacement had not yet been appointed. A permanent leader for the Strategic program area has recently been appointed; up until December 1999, this was the program that had a temporary leader. All current area leaders were appointed from within the CEC.

28 CEC Memorandum from Kent Smith, Executive Director, "PIER Program", September 20, 1999.

29 See, for instance, Energy Development Report, December 1992 (P500-92-010); Critical Changes: California's Energy Future, 1997 Biennial Report; CEC, Baseline Energy Outlook, August 1998 (P300-98-012); CEC, High Temperatures and Electricity Demand: An Assessment of Supply Adequacy in California, Trends and Outlook, July 1999.

and identify technology development opportunities relevant to the state's needs. This existing wealth of relevant information has not yet been adequately incorporated into PIER planning activities.

4.1.5 The PIER program's existing strategy provides limited guidance for program planning.

The original PIER program strategy was not based on a clear vision of California's future energy challenges, and so did not reflect a complete picture of what PIER should accomplish.[30] The strategy was also somewhat limited in developing the approach to achieve program objectives. For instance, there is insufficient discussion of how existing RD&D organizations can manage and perform elements of the program. This strategy also did not ensure that PIER's six subject areas are sufficiently coordinated and integrated. While no initial strategy should be expected to be comprehensive, the panel is concerned that progress toward an improved strategy has been too slow.

A draft integrated program plan for Phase II of PIER was released in June 1999 – 19 months after the program began – and states that this plan is the "first integration of the six program areas."[31] The draft integrated plan was intended to identify the key objectives and issues for each program area, and reduce duplication among the areas. It also proposed 1999/2000 funding allocations among the program areas.

The draft integrated plan begins to address the panel's concern that the program areas be coordinated, and that consistent definitions and processes be applied across the program elements. However, it does not add any new information or attempt to align subject area plans and goals. Rather, it simply put the existing individual program area draft plans (first released in January 1999) into a common format using common language.[32]

Additional PIER planning and strategy development was conducted from June through October 1999.[33] During this time, PIER subject area leaders engaged in a complex process that developed scenarios and identified future energy technology needs. While the results indicate a good effort to coordinate activities, introduce strategic planning, and align goals and resources, the plan does not go far enough in addressing the panel's concerns. Remaining issues include:

- Leadership. California's best talent was not tapped to address strategic direction and program management, and to identify technological solutions to meet future state energy-related challenges. Brainstorming sessions by the PIER team leaders[34], while important, do not necessarily lead to the best solutions. In addition, many of these discussions about PIER's strategy took place before the PIER program manager was appointed.
- PIER has not been adequately coordinated with existing energy RD&D organizations and their programs. These organizations include Electric Power Research Institute (EPRI), Gas Research Institute (GRI), Department of Energy (DOE), University of California (UC). Leveraging with other RD&D programs and/or management capabilities is important, given PIER's small budget as compared to national government and private-sector programs.
- The plan lacks quantitative goals. While the plan includes many statements regarding "improved" performance, there are relatively few cases of quantified, measurable objectives to be achieved. The plan should quantitatively identify what is possible and practical to achieve in specific technology and issue areas.

30 California Energy Commission, *Strategic Plan for Implementing the RD&D Provisions of AB-1890*, June 1997 (P500-97-007).

31 California Energy Commission, *Public Interest Energy Research Program Plan*, July 5, 1999, draft. The plan was developed by Arthur D. Little (ADL), a CEC technical support contractor, working with the program area teams. It is intended to remain in draft form and be a "living document".

32 This limitation was part of the Phase I task order to ADL; the draft integrated plan was the deliverable.

33 The process and results are documented in a series of ADL generated reports and briefings: the July 1999 binder on scenario development; "Building an effective innovation Strategy for PIER – Phase II", briefing prepared for the PIER Independent Evaluation Panel, August 23, 1999; and *Public Interest Energy Research Program Plan*, October 1999.

34 Team leaders used input from 40 stakeholders and other expert group meetings that had been held in support of PIER over the last several years.

- The strategic plan should realistically consider the time it takes to complete energy RD&D projects and commercialize those ideas. The scenario development time frame of three to 10 years does not necessarily correspond to California's future energy challenges. Studies characterizing the current energy situation can be completed in one to two years. Some RD&D projects can be completed in two to five years. Commercialization might take another 10 to 20 years.

The panel also feels that the process used to generate the October 1999 strategic plan was overly complex and would be expensive and time consuming to repeat, and therefore, the process is not responsive to rapidly changing energy-related challenges. The plan does not identify management strategies, policies and guidance normally found in program plans. This includes the use of existing RD&D management and performing organizations, handling sole source and unsolicited proposals,[35] and the need for follow-through at each step of the commercialization process.

4.1.6 PIER Phase II execution is proceeding without an adequate program plan.

Tentative spending plans for Phase II are shown in Table 4.1. The Industry/Agriculture/Water area is emphasized; it has the least amount of on-going work in the current portfolio. The majority of funds for each program area will go toward targeted research; the notion of focusing the research effort was planned from the outset of the PIER program. Funds also are identified for interagency agreements and memberships and participation in EPRI and GRI. This funding allocation was developed concurrently with the draft integrated plan. With the time imperative to continue the implementation of the PIER program, Phase II was developed in the absence of complete strategic guidance and effective integration of the program areas. Funding allocations also are unrelated to the October 1999 strategic plan. Described below are several actions undertaken by the CEC that appear appropriate, but were not implemented within the context of an adequate plan.

Table 4.1 PIER Program Phase II Allocations (planned as of July 1999)

Program Areas	Amount ($ millions)
Buildings (End-use Energy Efficiency)	$10.0
Industry, Agriculture, Water (End-use Energy Efficiency)	$15.5
Environmental Preferred Advanced Generation	$13.5
Renewables Generation	$10.5
Environmental Research	$10.6
Strategic Research	$11.6
Source: 1999/2000 PIER Subject Area Funding Proposals, presented at Policy Advisory Council meeting, 21 June 1999	

In June 1999, the CEC gave notice that it intended to award sole source contracts to EPRI and GRI for membership and research. The GRI contract is funded at $365,100 and covers the period July-December 1999. The EPRI contract includes both an extension of existing research ($1.536 million) and funding for participation in 23 additional projects over 1999 and 2000 valued at $10.222 million. The CEC has asserted significant public benefits, up to approximately $1 billion, from the initial $1.5 million investment in EPRI.[36] The additional EPRI targets were selected in a systematic process involving the PIER program area teams. Each PIER program area is funding at least one EPRI target. While the relative magnitude of the funding allocated to these efforts requires careful justification – EPRI and GRI awards are nine percent of annual PIER appropriations – the use of these and similar organizations is an effective way to leverage PIER funds.

35 Policies on sole sourcing and unsolicited proposals have recently been developed, but are not included in the plan.

36 Thomas Tanton, Advisor to Vice Chairman Rohy, briefing to Policy Advisory Council, June 21, 1999. The panel did not attempt to verify this claim.

In July 1999, the Buildings area released an RFP for future work. This solicitation was targeted to issues identified in the draft integrated plan, and is a programmatic solicitation; CEC was looking to award several large contracts (each about $2 million per year for three years) for an integrated program of RD&D in a targeted issue area for multiple years. A program was defined as a collection of projects addressing a set of common issues or goals. One purpose of the programmatic solicitation was to reduce the CEC's management and administrative burden. Three programmatic awards of approximately $2 million per year for three years were made in December 1999. The panel supports the concept of programmatic solicitations not only to reduce administrative burdens, but also to make use of the RD&D management experience of existing organizations.

4.1.7 The CEC has not yet developed and operationalized a succinct definition of public interest criteria that is consistent across program areas.

While the CEC has developed and used several definitions of public interest in the past,[37] the panel is concerned that a definition specific to the purposes of PIER has not yet been unambiguously defined and operationalized at the working level. The panel recognizes that public interest criteria as defined and operationalized in the two general solicitations provided useful guidance in developing the current portfolio. However, the panel is of the opinion that further attempts to define and operationalize a definition of public interest should be undertaken. The results should be consistently applied across subject areas.

The panel was provided a two-page definition of public interest and found this definition to be unsatisfactory in a number of ways.[38] The panel feels that the definition does not adequately reflect PIER's environmental work, which is not necessarily "commercialized" or "market focused." PIER is not an economic development program for energy technology; it needs to be stressed that basic R&D adds useful knowledge, and that relevance to California is the principal criterion. The CEC should formally review and define the public interest for purposes of PIER.

Proposed projects must also be assessed on the basis of whether the private sector, regulated sectors, or federal, state, or local government agencies would otherwise fund the research without the support of California taxpayers. The CEC should define and then apply a set of criteria which will help to consistently evaluate PIER contract awards. This is a difficult task and the CEC should attempt to develop such a framework with external guidance and assistance.

4.2 ORGANIZATION, RULES AND PROCEDURES

A successful RD&D program must be located within an organization that has rules that enable effective and efficient management. These include: streamlined management, contracting, and oversight processes; an appropriate balance among responsibility, authority, and resource ownership throughout organizational levels; and a culture that encourages informed risk taking.

The panel found a series of problems within the CEC that does not allow for the kind of flexibility, risk-taking, and innovative solutions that characterize successful R&D programs. The panel recognizes the constraints that public organizations face in any endeavor that involves spending public money and balancing the goals of multiple stakeholders. The challenge for a public sector RD&D management program is to protect the public goals while minimizing their costs so that oversight activities do not entail such bureaucratic delays and details that the innovative requirements of an RD&D program are compromised.

The panel believes that the CEC has not yet found the proper balance for PIER. Some specific instances are discussed in more detail in the subsections that follow; their occurrences in part derive from the structure that the CEC has chosen for PIER (e.g., the commissioner committee system, the committee participation, and the overall contract approval process), which are not required by state law.

---

37 CEC's definitions of public interest can be found in documents relating to their evaluation of the IOU's RD&D program, ETAP, the 1996 CPUC Working Group report on RD&D, the 1997 Strategy for Implementing AB 1890, the PIER 1 and PIER 2 solicitations, and the recent Buildings Energy Efficiency RFP(400-99-401). Each is somewhat different, though a careful reading of these documents suggests that the various definitions are in fact related to each other and to goals established at the time the definitions were created.

38 This definition is reproduced in its entirety in Appendix C.

4.2.1 The panel found that there was inadequate staff support to get things done in a timely fashion.

There are three aspects to this problem. First, there were simply not enough personnel to carry out the various tasks associated with the PIER program in the early stages of implementation, including planning, source selection, contract preparation, and contract monitoring. Those personnel that were assigned to PIER often had other commitments that limited their availability. Second, some of the staff did not have the requisite skills and experience to effectively perform the duties they were assigned. Problems here included lack of subject area knowledge and contracting experience. Third, the contracting and legal staff were external to the program and have interests and observe practices that can differ with PIER interests.

The first and second problems are well on their way to being resolved. Most of the PIER staff positions have been filled with staff who have knowledge of the subject area. As discussed above, PIER managers do not yet have complete authority to establish priorities for staff, so some availability and commitment conflicts remain. The divergent interests of the contracting and legal staffs are inherent in CEC's structure and nature; this problem can be resolved by changing the rules under which PIER operates within CEC, and training legal and contracting staff to operate under those rules when working on the PIER program.

4.2.2 The panel found that PIER's overall management structure within CEC does not adequately balance authority and responsibility.

The current management structure was established in August 1998, several months after the PIER 2 solicitation was released and PIER 1 awards were announced.[39] This structure was intended to manage the Phase I activities and begin planning for Phase II. As discussed above, the quality of the initial program area teams varied, as did the degree of planning (technology and market assessments).

It was intended that the PIER program be structured as a matrix organization embedded in a more traditional hierarchy; it was considered a possible model for a future reorganization of the entire CEC. As executed, the PIER program's management structure is not operating as a matrix organization. A clear definition of roles and responsibilities for program and division management is lacking. In the current structure, issues are reported to the RD&D Committee and administrative issues are reported through the CEC Divisions. PIER managers do not control resources. The PIER program and the CEC Divisions have different and often conflicting interests. The result is often conflicting demands and confusion at the staff level.

The role and responsibilities of the Commissioners relative to the staff is ambiguous, causing some confusion. Commissioners performed the policy review of each proposal during the PIER 1 and PIER 2 source selection process, but they have other duties. There are a total of eleven Committees in the CEC, each with a presiding and an associate Commissioner. The RD&D Committee is responsible for developing policy guidelines and oversight for PIER. Both Commissioners are on four additional Committees. As a result, the Commissioners have a limited amount of time to allocate to any one Committee.

4.2.3 The panel found that while the overall approach taken in the first solicitations was reasonable, some elements were not well defined.

The transition phase was a fairly straightforward continuation of IOU public interest RD&D activities, but the selection criteria appeared somewhat ambiguous. Since all of those IOU activities met the CPUC's definition of public interest, criteria were needed that could rank those activities by importance in terms of meeting future state energy challenges and providing benefits to ratepayers. Operationalized criteria at that level had not been worked out.

For the PIER 1 and PIER 2 general solicitations, planning and preparation consisted of the CPUC Working Group effort in 1996, the Strategic Plan in 1997, and the deliberations of the Policy Advisory Council in 1997 and 1998. Program goals and objectives were developed through workshops with stakeholders and iteration with the Policy Advisory Council. PIER 1 and PIER 2 were intentionally designed as broadly as possible in order to capture the best ideas for state-funded energy RD&D; future solicitations were planned to be more focused.

---

39 The management structure was focused on the Phase II effort. See CEC Memorandum from Commissioner David Rohy, "Interim PIER Organizational Structure", September 18, 1998. See also internal CEC documents entitled "Responsibilities of PIER RD&D Project Managers," dated February 20, 1998, and *Commission Contract Manual*, Section 6, "Contract Management", September 1997.

However, as mentioned previously, market assessments, reviews of federal and private efforts, and state energy challenges were at least identified in some areas, but were inconsistent across the program areas. Additionally, the content of the RFPs, particularly the type of information and format required for the statement of work and associated attachments, had not been adequately vetted. Contract preparation and management was not well planned, nor had the key players (e.g., contract managers) been identified and assigned. The result was a mixed set of proposals that appears to fall randomly across the dimensions of technological maturity, public interest, objectives addressed, expected benefits, and time horizon for obtaining those benefits.

4.2.4 The panel found that the project selection and contracting processes were overly complex.

Source selection for PIER 1 and PIER 2 was well defined in the solicitations, but was fairly complex; it entailed three sets of evaluations conducted by three different groups of people. An initial screening was conducted to remove non-responsive proposals. A technical scoring team and a policy scoring team then scored each proposal according to criteria laid out in the RFP. These teams often included experts from other organizations. Scores were combined, proposals ranked, and then selected from top down based on funds allocated to the solicitation. The awards were then approved at a previously scheduled CEC Business Meeting. An internal CEC evaluation (for which CEC should be commended) also noted the complexity and inefficiency associated with some aspects of this process.[40]

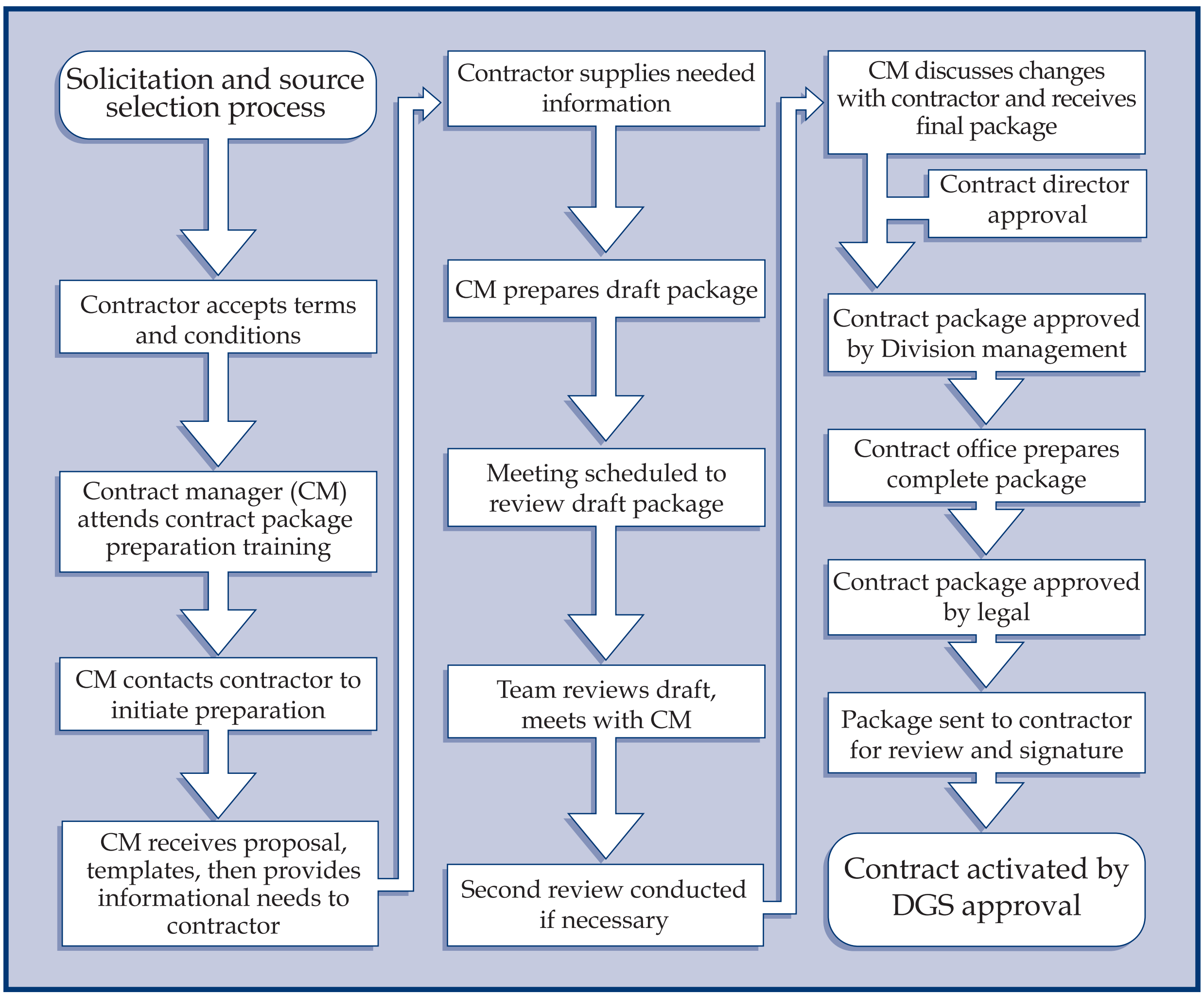

Figure 4.1. Contract preparation process flow

40 See CEC PIER Market Connectivity Team, "Feedback on the Selection Process in the PIER 1st and 2nd General Solicitations", draft briefing charts, February 1, 1999 and accompanying "Technical Handout for Slides."

The diagram in Figure 4.1 illustrates the complexity of the contract preparation process that occurs after Business Meeting approval. The process is led by a core group consisting of the appointed contract preparation director (CEC staff), the assigned contract manager, and representatives from the CEC's contracting and legal offices. This four person team is responsible for substance (content) and quality control of all documents associated with the contract. The idea of setting up the team was to enable legal and contracting functional reviews earlier in the process. There is little evidence that the volume of contracts funneling through this team presented a bottleneck (44 PIER 1 and 2 proposals went through this process). The team concept appears to have allowed earlier legal and contracting office input to be included in the contract packages without creating any substantial delays. Key activities that occur in the contract preparation process are writing the statement of work (based on the proposal), developing measurable technical and performance objectives for the projects, developing milestones, identifying products and deliverables, developing budgets (by task) for both the PIER and matching funds, and any special attachments to the contract.

Work on the contract officially begins when the Department of General Services (DGS) signs off on the contract. However, provision was made so that contractors could begin work earlier if they financed the work themselves. Invoices dating to the date of formal CEC approval at a Business Meeting could be legitimately submitted after DGS approval.

The panel recognizes that the Commissioners are concerned about the lack of flexibility in PIER contracting processes. The panel also commends CEC for asking the Legislature for some waivers and new contracting authority not normally found in state contracting.[41]

4.2.5 The panel found that the time from when a proposal was received to when a contract was signed was too long for RD&D projects, especially given the relatively small size of some of the projects and the contractors.

Figure 4.2 shows the total cycle time, and its component intervals, for three solicitations. The intervals are defined as:

- RFP to Award: This is the time from release of the solicitation to the publishing of the Notice of Award that identifies the winning proposals.
- Award to CEC approval: Time from the Notice of Award to the Business Meeting at which the full Commission approves the awards.
- CEC approval to CRM: Time from Business Meeting approval to Contract Request Memo (CRM). The CRM is issued when the preparation of all materials to be incorporated into the contract is complete.[42]
- CRM to contractor signed: Time interval in which the CEC contracts office formally assembles the previously prepared material into a contract and sends it to the contractor for signature.
- Contractor signed to CEC signed: The CEC signs off on the contract after the contractor does.
- CEC signed to DGS approval: The Department of General Services must approve all contract actions.

Figure 4.2 shows that the average total cycle time increased in more recent solicitations. However, the transition phase was fundamentally different: fewer bidders (only five), fewer proposals, and some CEC familiarity with both the bidder and the projects since they were continuations of IOU RD&D activities that CEC had historically tracked. In fact, the transition phase intervals are very different from those in PIER 1 and 2. The longest interval was the time from the CRM (request for formal contract package) to contractor signature. Apparently, the delay was due to contractor objections to elements of the CEC's terms and conditions. In PIER 1 and 2, the process was streamlined by standardizing the terms and conditions, based on the type of bidder organization; most bidders accepted these without objection. The Transition

41 These waivers and new authority are contained in SB 90, which authorizes CEC to engage in sole source, single source, and competitive negotiations, and waives the requirement that new regulations be approved by the Office of Administrative Law.

42 Materials include the statement of work (including measurable technical and economic performance objectives), schedule of deliverables, budgets for PIER and matching funds, property rights and lists and confidential deliverables, lists of key personnel and subcontractors, contractor labor and overhead rates, pre-approved travel and equipment purchases, CEC contract transmittal form, California Environmental Quality Act (CEQA) determination, and a literature search (done by CEC).

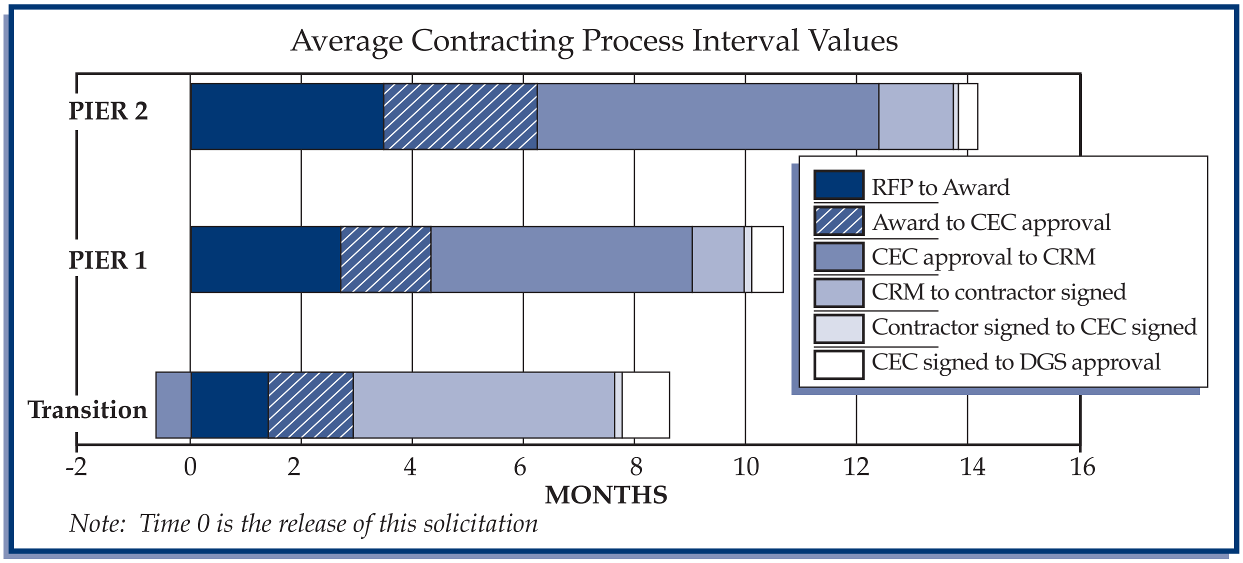

Figure 4.2 PIER program contracting process milestone intervals (data provided by CEC)

solicitation also shows a negative number for the interval in which the statement of work is prepared. This appears to be an administrative outcome – the contract package (statement of work and exhibits) was completed prior to the CEC Business Meeting approving the awards. In contrast, this is the longest interval in PIER 1 and 2.

Note that every interval increased from PIER 1 to PIER 2. There is no variation among specific proposals within each solicitation for the first two intervals, which constitute the source selection process. The time from notice of award to Business Meeting approval is purely an administrative delay based on the relative timing of previously scheduled Business Meetings. This results from the internally generated requirement that all funding expenditures greater than $10,000 be approved at a public meeting. The statement of work preparation time has the most variation, both among projects within a solicitation and across the PIER 1 and PIER 2 solicitations. Table 4.2 shows that while the average interval time for PIER 2 is longer, the standard deviation for this interval is longer in PIER 1. Comparing the total cycle times for each project in PIER 1 and PIER 2, we find that PIER 1's average is dominated by two long projects, while PIER 2 has many relatively long projects. Thus, the average cycle time is a valid measure showing an increase from PIER 1 to PIER 2.

The PIER 2 solicitation was released prior to the completion of the PIER 1 source selection, and well before any experience was gained with contract preparation and monitoring (See Appendix B). Thus, transferring lessons from the PIER 1 experience to PIER 2 was difficult and occurred only on an ad hoc basis.

Table 4.2. Statement of Work Preparation Duration

	PIER 1	**PIER 2**
Average length (months)	4.7	6.1
Standard deviation (months)	3.0	2.0
Minimum (months)	1.3	2.1
Maximum (months)	13.2	10.2
Note: data provided by CEC		

4.2.6 The panel believes that a significant portion of the process-related problems plaguing PIER are internally imposed or are inherent in CEC's structure.

A long list of factors affected the length of the PIER 1 and 2 contracting cycle. These factors included:

- Time spent negotiating terms and conditions. Although terms and conditions had been standardized, some contractors insisted on negotiating changes to particular aspects. These changes were generally not made.
- The solicitations did not include mandatory tasks for the statement of work. Neither solicitation provided a template for creating a good statement of work. The result was that many proposals did not include items fundamental to CEC's style of contracting, including measurable technical and performance objectives, clear task definitions, clear identification of products and deliverables, and reporting requirements (CEC requests a kickoff meeting, monthly status reports, quarterly status reports, and a final meeting and report).
- Work statements submitted by applicants were incomplete or poorly organized. Many proposals included work statements that did not have a good logical flow (sequence of tasks).
- Budgets (for both PIER and matching funds) were not submitted in the CEC's preferred format, which allocates portions of the budget to specific tasks.
- Lost partners. In some cases, individual members of the bidding team became unavailable before the contract was signed.
- Miscommunications between the CEC and the contractor. In some cases, guidelines provided by the contract manager, or the contractor's response, were misunderstood by the other party.
- Contract managers were brought into the PIER process late (after source selection) and often had little subject area or contracting knowledge. The selection of a contract manager for a given project occurred after Business Meeting approval and the individual often had not participated in any of the proposal evaluations. Further, selection was in large part based on staff availability rather than knowledge of the substantive area.
- Special conditions, omissions or shortcomings identified during the technical evaluation were not communicated to the contractors in a timely fashion. Resolving these items often required negotiation. The contractor often did not become aware of these conditions until during contract preparation.

Not all proposals were affected by all factors. More commonly, the cycle time for contract package preparation for each contract was dominated by one or two factors. Also, the panel recognizes that many of these factors are start-up problems that would be corrected as the CEC gains additional experience developing PIER contracts.

Additionally, the process was adversely affected by staff perceptions about contracting rules and obligation authority. For instance, CEC treated all proposals in each solicitation as competing against each other. In fact, competition could have been limited to proposals addressing each specific program area, thus improving CEC's ability to allocate funds among areas. Another example is that project approval occurred at the CEC Business Meetings. In the past, contracts were approved at the Business Meetings. A step was inserted due to concern about encumbrance issues (the time in which funds could be obligated and the authority to do so).

Also, individuals on the three different review teams (initial screening, technical scoring, and policy scoring) were not necessarily on other teams. This introduced some inefficiency in the process as new staff came up to speed.

On behalf of the panel, RAND interviewed 15 contractors representing PIER 1 and 2 to obtain their views on the contracting process. Overall, the contractors were generally pleased with PIER, though they noted dissatisfaction with the contract development and cycle time problems discussed above. In particular, they noted that state regulations compel excessive non-technical detail in proposals and the process itself fluctuated somewhat as the CEC defined it. However, many of the contractors interviewed felt that the revisions to the statement of work were helpful. After contract activation, the contractors expressed satisfaction with contract monitoring and reporting. CEC contract managers are considered well qualified and helpful.

One aspect of the contracting process that remains ambiguous is whether contractual conditions imposed under PIER are appropriate for RD&D activities. RD&D contracting is a subset of procurement contracting; however, the nature of the RD&D service or product being procured is fundamentally different from a well-defined product. Experience suggests there is perhaps too much emphasis on generating specific results and outcome accountability that cannot always be determined specifically in RD&D efforts. Contracting mechanisms should reflect the inherent risk in RD&D.[43] Lessons from organizations that have funded similar research (NIST, GRI, EPRI, DOE, DARPA) should be incorporated into the contracting and program management process.

The CEC has acknowledged the panel's critique of its PIER-related management and contracting processes, and has begun to address some of the issues raised. However, the CEC has been slow to tackle the difficult problems deriving from its organizational structure and the bureaucratic policies that result.

4.3 KNOWLEDGE BASE

Staff knowledge of energy technology, markets and trends directly affects planning processes, allocation decisions and source selection. Staff familiarity with RD&D management concepts and contracting procedures affects the efficiency of program execution. The CEC was weak in some areas, stronger in others. The resulting portfolio reflects this mix of in-house capabilities.

The panel did not evaluate this element of PIER implementation directly. Issues regarding the quality of the subject area leaders early in the program, and the apparent lack of training and experience of some contract managers were discussed previously. In general, the panel believes that the CEC has a strong knowledge base in most technical areas relevant to the PIER program. However, the panel is concerned that the knowledge base, represented either by staff with special skills and capabilities, or in the myriad of published and unpublished technical reports CEC staff generates, was not brought to bear on the PIER program in a timely manner.

4.4 PORTFOLIO ANALYSIS

4.4.1 The panel commends CEC for continuing part of the utilities' public interest energy RD&D activities.

In anticipation of electric industry restructuring, investor owned utilities (IOUs) had been steadily reducing RD&D investment in general, and public interest activities in particular, since 1994. The transition phase was intended to preserve public interest RD&D previously funded by IOUs while PIER program implementation began. The solicitation made it clear that winning projects would be funded for a single year; the initiative for obtaining follow-on funding from PIER was placed clearly on the contractors and would need to be accomplished through a future solicitation or sole source award. Competitive bids were limited to the three electric IOUs in the state and the California Institute for Energy Efficiency (CIEE). The CEC received 62 proposals, of which 39 projects valued at $17 million were awarded contracts.[44] A review of these contracts indicates no matching funds, a minimal statement of work that provides limited detail on deliverables, schedule, approach, and objectives, and very little discussion of market connectivity.

Figure 4.3 shows that the current PIER portfolio covers similar subject areas as the public interest RD&D performed by the IOUs prior to the establishment of PIER.[45] The IOUs tended to emphasize reliability and reduction of operating costs because that is in their business interest. PIER focuses more on new supply

43 A March 1996 General Accounting Office report, *DOD Research: Acquiring Research by Nontraditional Means* (GAO/NSIAD-96-11), notes that contracts are most often used when the purpose is the acquisition of goods or services for the direct benefit of the government; cooperative agreements or other transactions are assistance instruments used when the purpose is to stimulate or support research and development for more public purposes.

44 Technically, four contracts were awarded to the IOUs (PG&E, SDG&E, and SCE) and CIEE. Each contract included multiple independent projects.

45 Absolute values are different. The Pre-PIER IOU total (public interest and regulatory) RD&D program (1993-1994 base year) included 138 projects. The average total electricity IOU expenditure from 1991-1994 was $110.8 million; about half of this was considered public interest RD&D. The PIER portfolio after one year (transition and two general solicitations) includes 83 projects valued at $49 million. The transition phase alone is 39 projects valued at $17 million. IOU date from CEC RD&D *Working Group Report, Working Group Report on Public Interest Research, Development & Demonstration Activities, Appendices*, September 6, 1996 (P500-96-010A), pg. App III-6 and III-37 to III-47.

options (Advanced Generation and Renewables program areas).[46] While only a rough comparison, it does suggest that PIER picked up where the IOUs left off, with a greater emphasis on subject areas more closely aligned with the public interest; this was a primary purpose of PIER. Of course, the transition projects were continuations of the IOUs' public interest RD&D, by definition.[47] The panel believes that the initial approach of funding a transition phase to continue worthwhile RD&D activities of the IOUs with significant public benefits was appropriate and well done.

4.4.2 The panel has found that the current portfolio supports stated program objectives but needs to be significantly improved.

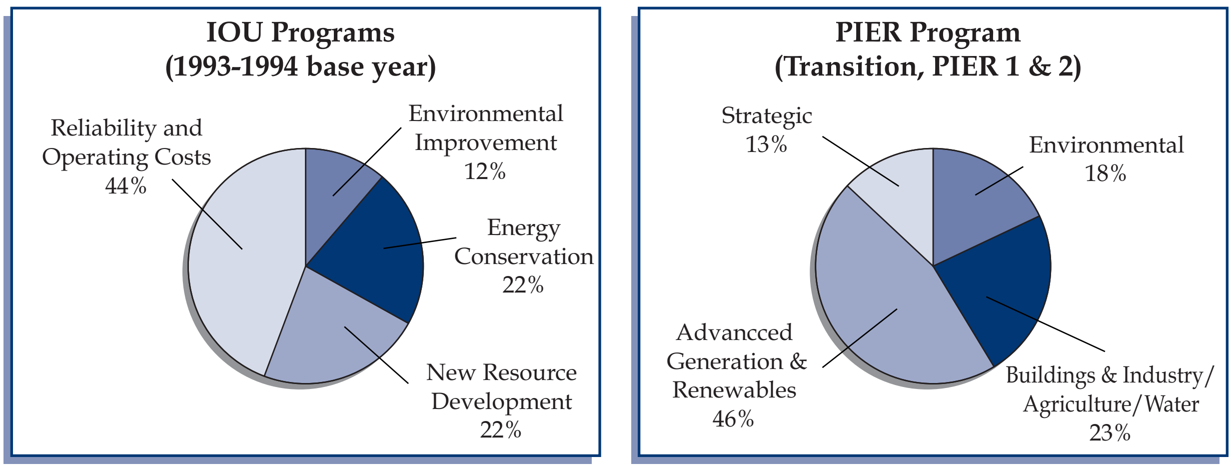

Figure 4.3 Comparison of Investor Owned Utilities and PIER program area coverage

The panel reviewed the portfolio resulting from the transition and two general solicitations and found that while it generally meets the criterion of public interest, it could be improved with clearer policy direction.

4.4.3 Planning for follow-on research has not been given adequate management attention.

In funding an RD&D activity, the expectation should be that if the initial phases are successful, then subsequent phases will be funded, either through PIER, another funding source, or by the participants themselves. As of December 1999, only the Transition projects had reached completion. Of the 39 transition projects, eight will be continued within PIER, 10 will be continued outside of PIER, one was cancelled by mutual agreement, and 20 will not be continued. However, the Transition projects were a special case, since the contractors were told that continuation would depend on their initiative.

The panel is concerned that there is no formal process for evaluating the relative success of a project and deciding whether continued funding is worthwhile. The panel acknowledges the informal mechanisms that PIER has set up to accomplish this activity, but believes that the program might benefit if the process was more formalized. Provisions for evaluating the appropriateness of follow-on funding should be considered as part of the market connectivity plans required of PIER-funded projects.

46 It should be noted that the six PIER program areas had not yet been established when the transition solicitation was released.

47 The 1997 IOU activities, or similar previous IOU RD&D activities, upon which the transition proposals were based, had already met the CPUC's criteria for incorporation into the IOU's electricity price and rate decisions.

5. ALTERNATIVE ORGANIZATIONAL STRUCTURES

The PIER program is constrained in many ways, but the root cause of not achieving full potential seems to be its organizational environment, which affects the way in which CEC's rules and procedures are implemented. Efforts to improve the program's performance that do not address the CEC's risk averse, bureaucratic culture can be at most halfway measures. An entrenched bureaucracy can enfeeble even the most compelling reforms or the most capable manager; an outstanding knowledge base will go to waste if the program staff are inhibited from taking initiative.

CEC performs policy and planning as well as regulatory and adjudicatory functions. Prior to PIER, CEC managed relatively smaller RD&D related efforts, including the Energy Technologies Advancement Program (ETAP), and transportation and geothermal RD&D programs. Until recently, CEC also evaluated utility RD&D proposals and made recommendations to the CPUC.[48] Despite this experience, CEC's behavior with respect to PIER implementation has consistently been closer to a "regulatory agency model", impeding program execution. Operating procedures with respect to contracting and public hearings—some developed for other purposes, some developed specifically for PIER—have been inappropriately applied.

There are many candidate models for a successful RD&D management organization, not all of which are necessarily appropriate to meeting California's energy needs; in the years prior to restructuring, a broad variety of organizational structures was considered.[49] In reviewing PIER's performance to date, the panel finds that two alternative models merit further consideration, each presenting different degrees of likely risk and potential reward.

5.1 ENHANCE PIER WITHIN CEC

The panel has identified a number of inadequacies in the current CEC management of PIER. None of the remedies requires changing the basic structure of CEC. The panel finds that CEC has not taken full advantage of the flexibility already accorded it. Taken together, these changes entail raising the program's status (and that of the staff) within CEC, and streamlining the procedures that PIER and its contractors must follow.

As noted elsewhere in this report, many of the impediments that PIER faces stem from its situation in an agency with a risk adverse culture and complex relationships between staff and Commissioners. The strict contracting procedures and degree of accountability necessary for sound regulatory policy are excessive for an RD&D management organization, and may deter some high-quality research performers from seeking support.[50] The Legislature may wish to consider granting PIER relief from specific CEC contracting rules, in favor of procedures more typically in place at other, successful RD&D funding agencies. This would encourage a more innovative perspective.

The panel also finds that PIER's subordinate administrative position within CEC is not commensurate with its budgetary weight and with the program's potential impact on California's future. By elevating PIER to a CEC division, creating the position of Director, and vesting greater responsibility in the program managers, the program would be less subject to its current constraints. This change in status would be

48 CEC *Energy Development Report*; CEC Staff Report, *Analysis Regarding the Consistency of California Investor Owned Utilities' 1993 Research and Development and Demonstration Programs with State Energy Policy*, September 1993, in CPUC *Commission Advisory and Compliance Division Biennial Report on Energy Utility Research, Development, and Demonstration Programs*, October 21, 1993. The utilities are no longer required to submit their RD&D program plans to the CPUC, so CEC no longer provides an evaluation.

49 For an exposition of alternative research organizations considered by the state, see *Energy development: Research, development and demonstration and electric industry restructuring*, R&D Committee, California Energy Commission, 1995; and *Working group report on public interest research, development and demonstration activities*, P50-96-010, RD&D Working Group, California Energy Commission, 1996.

50 As noted in Section 4, contracting procedures were the greatest source of dissatisfaction among both contractors and contract managers.

more than merely symbolic; with the Director granted full authority over project selection and management of staff resources (but still guided by CEC objectives and policies), the Commission would be able to attract outstanding candidates for the position.[51]

As it stands, these functions are performed by two Commissioners who have several different responsibilities. The CEC Commissioners' responsibilities should be to establish overall objectives and policies, review management effectiveness, and create a climate for PIER to develop into a high-quality RD&D management organization. Responsibility for outreach to the state Legislature, Governor's office, Department of Energy, other RD&D organizations, and the private sector should be delegated to the Director of the PIER program.

5.2 PIER IN AN ORGANIZATION EXTERNAL TO CEC

There are positive arguments to be made for greater administrative and managerial independence for organizations that sponsor R&D. The panel suggests considering two variants of an independent PIER within the State government, and several that put PIER outside the State government.

The first variant within state government is a stand-alone R&D sponsoring organization fully independent of the CEC, akin to federal agencies such as the National Science Foundation or National Institutes of Health.[52] This option would provide for close state oversight of PIER performance; CEC would still bear responsibility for setting state energy policy, guiding the research organization in its broad objectives.

This variant is quite similar to the independent, single-purpose, contract manager option as proposed in the 1996 Working Group Report. The research organization would be guided by a board appointed by the Governor or CPUC, which would develop an annual focus area plan; the organization would have sole responsibility for soliciting and awarding proposals, negotiating contracts, and day-to-day operational and financial planning.

The second variant of an independent agency within state government more closely corresponds to the principles in Section 3, and may be implemented in the newly announced California Institutes for Science and Innovation. In order to attract the highest quality technical personnel, staff in the variant of an independent agency could be experienced R&D management professionals on several-year assignments to the agency.

PIER also may be managed by an organization external to the State government. Such an organization could be not-for-profit or for profit, and it could be created anew or placed within an existing institution. Candidate nonprofit institutions include the University of California or one of its campuses, a private research university, or a newly created university association; or a research institution such as EPRI (which frequently acts as a grant administrator for federal agencies), SRI or GRI. A private, for-profit energy consulting firm might provide a more risk seeking culture; such an organization would not necessarily have conflicts of interest or otherwise be ill-suited to manage PIER.

The external organization model was actively considered in the CEC's draft 1995 *Energy Development Report*, framed as a state-chartered corporation.[53] This nonprofit organization would manage all (non-transportation) public goods RD&D, with the authority for state energy policy residing elsewhere. While the report emphasized cofunding and public-private partnerships, such an organization could just as readily issue RFPs and be funded by a ratepayer assessment. This corporation would be run by a board of directors, assisted by advisory bodies comprising representatives from industry and environmental and consumer groups; the public benefit energy R&D organizations in several states are so structured.

51 Similar positions in other organizations include the Director of Research in the U.S. Department of Energy, who reports to the Secretary; and the Vice President for Research at IBM, who reports to the President.

52 Of course, NSF does not conduct any scientific research in-house, while NIH staff performs the majority of its funded work; this distinction does not bear on their benefiting from independence.

53 California Energy Commission, *Research Development and Demonstration and Electricity Industry Restructuring, Draft Energy Development*, Vol. 1 Part 11, June 1995.

5.3 DESIRED ORGANIZATIONAL CHARACTERISTICS

Creating an entirely new research organization presents the opportunity to craft a set of procedures that embody the principles of successful R&D management, but at considerable costs in time and money. An ab initio organization development does not make use of an existing base of expertise, experience and connections, which can be invaluable in attracting the most talented staff and contractors. An established organization, by contrast, can use its reputation to draw topnotch technical people for indefinite tenures (and provide for greater career advancement than may be likely in a state agency), backed by capable permanent administrative staff.

As is the case with all of the options, there are pitfalls in creating new R&D institutions. In designing a major R&D effort, we can learn and profit from the mistakes and failures of others. The following are examples of desirable organizational characteristics:

- **Deliberate Build-up.** Successful R&D management organizations are difficult to create because; (1) they require exceptionally talented people who have many career opportunities; and (2) the exact nature of the work to be done is impossible to describe in detail before the work is begun. Therefore, there is considerable uncertainty concerning the best way to proceed. If the people at an institution do not measure up to its demands in talent, or are mismatched with the mission, the organization will fail. Hence, one must develop a well-articulated mission and plan before ramping up the implementing organizations to scale, and ensure that the leaders of the program are free of short-term goals in achieving full staffing.
- **Long-term Perspective**. Industry is good at projects that are aimed at improving technology or introducing new products within a year or two. The most effective role for government is rarely to accelerate the development of commercial products in the short run. Government is most effective in building the technology base of industry. In many industries, advancements in the technology base can not be effectively protected through intellectual property laws, so industry is not likely to recover the cost of this kind of work if it is performed inside a company. The state can make a substantial contribution by developing new knowledge in applied science and engineering that expands the technology base of industry and thereby leads to follow-on developmental innovations within firms.
- **Balance External Inputs**. Balancing political accountability and technical significance is very difficult in R&D programs. Technical expertise is necessary to assess the merits of a project and the capabilities of researchers; however, complete delegation of these responsibilities is inconsistent with principles of democratic accountability. Thus, the program should selectively elicit and incorporate peer review and thematic recommendations from industrial, academic and public interest advisory boards.
- **Streamline Implementation**. Government R&D programs fail if they treat R&D activity as a standard procurement contract. Because R&D is inherently uncertain, for the management of R&D programs to be effective, researchers should be given considerable flexibility in the day-to-day management of the work and the allocation of expenditures. Government officials sometimes worry about flexibility because it creates the opportunity for inefficiency. However, solving this problem through controls and extensive monitoring of activities undermines the effectiveness of the work. A desirable model for encouraging useful, high-quality R&D is to use past success as a factor in making future awards. Because of the long time horizon of research, the necessity for obtaining support over a number of years creates a powerful incentive to spend funds wisely.

6. SUMMARY AND RECOMMENDATIONS

The importance of energy RD&D to California's continued economic growth, environmental performance, and science and technology leadership demands that the PIER program be implemented effectively. California's energy system faces serious challenges, including the need to: meet increasing demand for energy; maintain system stability and security with restructured electricity markets; improve transmission capabilities; continue increasing efficiency of energy-using technologies; and improve environmental performance of energy systems. The state has the intellectual resources and economic infrastructure to address those challenges through a well-managed RD&D program.

The panel found that many of the factors affecting the efficiency and effectiveness of the PIER program's planning, contracting and management processes are internal to CEC. At a fundamental level, these factors are inherent in the current structure of the agency and its standard operating procedures. CEC's internal constraints have shaped a PIER organization through policies and practices that need improvement if PIER is to satisfy the expectations in its establishment. In particular, the characteristics of the CEC's organizational culture and bureaucracy conflict with the characteristics of an organizational environment that facilitates a superior RD&D program.

The panel agrees that the PIER program has many strengths and is sponsoring some high-quality RD&D projects. However, unless it is significantly transformed, PIER may not become a truly outstanding research and development program that will benefit the citizens of California.

The panel has identified two alternative ways to enhance the future success of the PIER program:

1. Increase the autonomy and flexibility of PIER within the CEC. This includes: raising the stature of PIER; clearly defining the roles of the CEC Commissioners; providing a program director with responsibility and authority for program planning and execution; delegating greater responsibility to the PIER program area managers; and streamlining personnel and contracting policies, with management and core staff responsible solely for PIER.
2. Provide PIER with the requisite autonomy and flexibility through an external organization that will provide the kinds of flexible decision-making and personnel recruitment discussed above. Options include: assigning PIER to an existing university or the creation of a university association; assigning PIER to an organization with broad energy RD&D portfolio management experience; creating a new independent agency with responsibility for energy RD&D; or incorporating the PIER program into the newly planned California Institutes for Science and Innovation.

The panel chose not to evaluate in detail the pros and cons of various organizational arrangements, but agreed unanimously on the characteristics necessary for an outstanding program.

Therefore, the panel recommends that the PIER program be continued but be transformed into a new organizational environment, either inside or outside the CEC, that would provide the legal and organizational basis for a superior public interest energy RD&D program.

APPENDIX A: BIOGRAPHIES

INDEPENDENT PIER REVIEW PANEL MEMBERS

SHORT BIOGRAPHIES

Dr. Harold M. Agnew is the retired President, General Atomics and Past Director of Los Alamos Scientific Laboratory. He was Science Advisor to the Supreme Allied Commander in Europe 1961-64 and a New Mexico State Senator from 1955-61. Dr. Agnew's honors and awards include: recipient of the Ernest Orlando Lawrence award, 1966; and the Enrico Fermi award, 1978. He is an elected member of the National Academy of Science, the National Academy of Engineering and Fellow of the American Association for the Advancement of Sciences.

Dr. Richard E. Balzhiser retired as President and Chief Executive Officer of the Electric Power Research Institute (EPRI) in Palo Alto, California in August 1996. He remains active in a President Emeritus role at EPRI in addition to serving on several industry boards and technical advisory committees. Dr. Balzhiser currently serves a variety of boards and committees including the Energy Subcommittee of the President's Council of Advisors on Science and Technology, the Mobil Technical Advisory Committee, the Pacific Northwest Laboratory Advisory Committee, the Technical Advisory Board of the Massachusetts Institute of Technology Energy Laboratory, the Board of Directors for the Aerospace Corporation, the Board of Directors for Reliant Energy, and the Board of Directors of Nexant, LLC.

Dr. Patricia A. Buffler is Dean Emerita and Professor of Epidemiology and Public Health at the School of Public Health, University of California, Berkeley. Dr. Buffler's research interests include epidemiology of cancer, specifically childhood leukemia and effects of environmental exposures and genetic susceptibility. She serves on the Board of Directors, U.S.-Japan Radiation Effects Research Foundation, Hiroshima, Japan; the World Health Organization, Expert Advisory Panel on Occupational Health; the Board of Scientific Counselors for the National Center for Infectious Diseases; the U. S. Public Health Service Centers for Disease Control and Prevention, Task Force on Community Preventive Services; and the National Institutes of Health, National Advisory Council on Environmental Health Sciences. She is a fellow for the American Association for the Advancement of Science and the American College of Epidemiology and a member of the Institute of Medicine/National Academy of Sciences.

Dr. Linda R. Cohen is Professor and Chair for the Department of Economics at the University of California, Irvine. Her fields of study are political economy, government regulation, government policy for science and technology, and positive political theory and law. Dr. Cohen has advised numerous federal departments and agencies on science policies, including the Departments of Energy and Commerce, the Office of Technology Assessment and the Congressional Research Service and has served on several committees for the National Research Council. She has testified before state agencies and commissions, including the California Energy Commission and the California Constitutional Reform Commission.

Dr. John S. Foster Jr. is a retired Vice President of Science and Technology at TRW Inc., and a member and former chairman of the Defense Science Board. Dr. Foster is currently Chairman of the Board of Directors of Pilkington Aerospace, Chairman of Technology Strategies and Alliances, and a consultant to TRW, Sikorsky, Jaymark, Arete Associates and Defense Group Inc. His field of specialization is Industrial Manufacturing and Operating Systems Engineering and he is recognized for his work in the design and development of nuclear weapons and in the technological leadership in defense research and engineering. Dr. Foster was the director of the Lawrence Livermore National Laboratory from 1961 to 1965. Dr. Foster left the Laboratory to become the DOD's Director of Defense Research and Engineering (1965 - 1973).

Dr. T. Kenneth Fowler is Professor Emeritus in the Department of Nuclear Engineering, University of California, Berkeley. Dr. Fowler was chair of the Department from 1988 to 1994 and helped establish the multi-disciplinary Center for Nuclear and Toxic Waste Management at UC Berkeley. His honors and awards include elected membership in the National Academy of Sciences; Fusion Power Associates Distinguished Career Award, 1995; and The Berkeley Citation, 1995. Dr. Fowler's areas of interest include fusion energy and energy research funding and the appropriate role of government in anticipating problems of energy-associated pollution and energy-associated competition for resources in its research funding policies.

Fred W. Kittler is co-founder and co-president of Velocity Capital Management, an investment firm based in Palo Alto that provides equity funding for public and private technology and communications companies. Mr. Kittler was a research analyst and portfolio manager for J. Morgan Investment Management where he managed their portfolios of small technology and health science company stocks. He serves on the Visiting Committee On Advanced Technology for the National Institute for Standards and Technology.

Peter M. Miller is a scientist with the Natural Resources Defense Council, Inc., a nonprofit national environmental organization. He is part of NRDC's energy project, which promotes the increased development of energy efficiency and other environmentally sound and cost-effective energy resources. His work involves research, analysis, and advocacy at the state, national, and international levels. He has participated in utility advisory committees in California, Hawaii, and the Pacific Northwest, in numerous proceedings before the California Energy Commission, the California Public Utilities Commission and the Northwest Power Planning Council, and in rulemakings before the U.S. Department of Energy. He was appointed to the California Board for Energy Efficiency in April 1997.

Dr. Esteban Soriano established his own market research and program assessment company (The Resource Group), specializing in educational and economic assessments. He currently serves as Vice President for University Advancement at California State Polytechnic University, Pomona. He is an expert in communication strategies, economic impact studies and assessments, methodology and research design, and has extensive experience relating to electric and water utilities.

Dr. James L. Sweeney is Professor of Management Science and Engineering, Stanford University. Dr. Sweeney has 25 plus years of experience working in energy and environmental economic issues, having worked at the federal level in the Federal Energy Administration in the 1970s, to a long history of research and analysis in energy economics and technology issues. Dr. Sweeney has had inputs into a number of National Energy Plans, has been a member of numerous National Research Council committees, and was one of the founding members of the International Association for Energy Economics.

Dr. Mary L. Walshok is Associate Vice Chancellor - Extended Studies and Public Programs and Adjunct Professor in the Department of Sociology at the University of California, San Diego. She is the recipient of many awards and honors, among them a Kellogg Foundation national fellowship. Dr. Walshok serves on the board of the California Council for the Humanities and is a member of numerous community boards and professional associations including the San Diego Community Foundation, Girard Foundation, Eureka Communities, Foundation for Enterprise Development and ACCION.

Carl J. Weinberg is currently a private consultant after retiring from Pacific Gas and Electric Company where he worked for almost 20 years including eight years as Manager of Research and Development. Mr. Weinberg has been a contributor to the development and implementation of corporate, industry, and national energy policies and strategies through research program management. He has extensive understanding of energy technologies, including commercial and potential renewable and conservation technologies, and has demonstrated effectiveness at accelerating technology readiness and proving technology benefits.

MATRIX OF PANEL MEMBERS' COMPETENCIES

Panel members were chosen based on an assessment of the required capabilities needed on the panel. Table A.1 shows the match between needed capabilities and panel member competencies.

Table A.1 Matrix of Panel Member Competencies

	Academic	Industry	Public Interest
Technology – issues in R&D for energy and other technologies	*Cohen* *Sweeney*	*Balzhiser* *Foster*	
Economics/Markets – market impacts of technologies, economics of energy		*Kittler*	
General energy and energy alternatives	*Fowler*	*Agnew*	*Weinberg*
Public Health and Environmental Impacts	*Buffler*		*Miller*
Non-energy	*Walshok* *Soriano*		

CCST PIER COMMITTEE REVIEW MEMBERS

SHORT BIOGRAPHIES

Octavia Diener is President and Owner of Densmore Engines in Fresno and Sacramento and is President and Owner of Tavie Farms, Inc. Ms. Diener was appointed to former Governor Wilson's State Transportation Commission, and is a member of the Fresno Business Council. She is an immediate Past President of the Fresno Economic Development Corporation, and a board member of the Futures Institute at CSU, Fresno. Ms. Diener was appointed by U.S. Agriculture Secretary Lying to the National Advisory Committee on Futures and Options, and has been active in the Central California Epilepsy Foundation, the Muscular Dystrophy Association, and the Foundation Board for Agriculture at CSU, Fresno.

Dr. Roger G. Noll is the Morris M. Doyle Professor of Public Policy, Department of Economics, Stanford University. Dr. Noll's primary area of teaching and research is public policies towards business. He is the author or co-author of 11 books and over 250 articles in areas such as telecommunications policy, federally supported research and development, environmental policy, and the management of universities. Before coming to Stanford, Dr. Noll was Institute Professor of Social Science at Caltech, Senior Fellow at the Brookings Institution, and Senior Economist at the President's Council of Economic Advisors. Dr. Noll has served on many government boards and commissions, including the Secretary of Energy Advisory Board, the Advisory Board of the National Science Foundation, the Advisory Board of the National Aeronautics and Space Administration, the Commission on Behavioral and Social Sciences and Education of the National Research Council, and the President's Council for a National Agenda for the 1980's. Dr. Noll was the founding President and Chairman of the Board of the Telecommunications Policy Research Foundation.

Dr. Maxine L. Savitz is the General Manager, Technology Partnerships, Honeywell. Dr. Savitz has over 30 years experience managing research, development and implementation programs for the public and private sectors. Dr. Savitz joined Honeywell, previously AlliedSignal, in 1985. From 1987 until June 1999 she was the General Manager of AlliedSignal Ceramics Components, which is the only U.S. owned silicon nitride structural ceramic manufacturer for gas turbine application. In this capacity she oversaw the development and manufacturing of innovative materials for the aerospace, transportation, and industrial sectors. She is currently General Manager for Technology/Partnerships. Prior to joining Honeywell Dr. Savitz was employed at the U.S. Department of Energy and its predecessor agencies. From 1979 to 1983, she served in the capacity of Deputy Assistant Secretary for Conservation at DOE. She is a member of the Secretary of Energy's Advisory Board and the National Science Board. She is a member of the National Academy of Engineering and formerly served on the NMAB. She received her B.A. from Bryn Mawr College and Ph.D. in Chemistry from the Massachusetts Institute of Technology, and held a postdoctoral fellowship at University of California, Berkeley.

Dr. Edward C. Stone has served as the Director of the Jet Propulsion Laboratory since January 1991. Dr. Stone is Vice President and David Morrisroe Professor of Physics at the California Institute of Technology. He has been a principal investigator on several NASA spacecraft missions, and served as the project scientist for the Voyager Mission. He coordinated the efforts of 11 teams of scientists in their studies of Jupiter, Saturn, Uranus and Neptune. Dr. Stone received the National Medal of Science and the American Philosophical Society Magellanic Award. He was a Sloan Foundation fellow and has received the NASA Exceptional Scientific Achievement Medal, the NASA Distinguished Service Medal, the American Aeronautics and Astronautics Dryden Medal and Space Science Award, the NASA Distinguished Public Service Medal and the NASA Outstanding Leadership Medal. Dr. Stone is a member of the National Academy of Sciences, the W.M. Keck Foundation's Board of Directors, the American Philosophical Society, and the International Academy of Astronautics. He is a Fellow of the American Physical Society, the American Geophysical Union, the American Institute of Aeronautics and Astronautics and the American Astronautical Society. He is also a member of the American Astronomical Society, the International Astronomical Union, and an honorary member of the Astronomical Society of the Pacific.

Dr. Bruce Tarter is the eighth director of the Lawrence Livermore National Laboratory. His career began in 1967 as a member of the Theoretical Physics Division. He has served in various technical leadership assignments at the Laboratory in weapons physics, geosciences research, and space programs including strategic defense projects. Dr. Tarter has served on numerous research and institutional management committees within and outside the Laboratory. He has been a lecturer and graduate student advisor at the Department of Applied Sciences of the University of California, Davis/Livermore, and is an Adjunct Professor, Department of Applied Science, University of California, Davis. Memberships include the American Physical Society, the American Astronomical Society, the International Astronomical Union, and the American Association for the Advancement of Science. He received the Roosevelts Gold Medal Award for Science and is a Fellow of the American Physical Society.

APPENDIX B: PIER PORTFOLIO DESCRIPTION

TRANSITION AND GENERAL SOLICITATIONS

This appendix describes the current PIER program portfolio (Transition, PIER 1, and PIER 2).[54] Also included is a brief description of the Energy Innovations Small Grants program which is a part of PIER.

In anticipation of electric industry restructuring, investor owned utilities (IOUs) had been steadily reducing RD&D investment in general, and public interest activities in particular, since 1994. The transition phase was intended to preserve public interest RD&D previously funded by IOUs while PIER program implementation began. Competitive bids were limited to the three electric IOUs in the state and the California Institute for Energy Efficiency (CIEE). The CEC received 62 proposals, of which 39 projects valued at $17 million were awarded contracts.[55]

The two initial general solicitations provided an adequate beginning to a broader PIER program. CEC received 180 proposals in response to the PIER 1 general solicitation in February 1998. The proposals covered three program areas: Renewable Generation, Environmentally Preferred Advanced Generation, and Energy-related Environmental Research. In June 1998, 20 of these projects were approved, valued at $18.3 million in PIER funding. In April 1998, the CEC released the PIER 2 general solicitation covering the remaining program areas of End-use Energy Efficiency, Industry/Agriculture/Water, and Strategic Research. The CEC received 169 proposals, and in October 1998, approved 24 of these for contracts, valued at $13.8 million. Approximately $48 million in matching funds were proposed.

Table B.1 provides some descriptive statistics for the PIER portfolio by solicitation. Of particular note is the very large range in size of projects within each phase, and that the transition phase did not include any matching funds.

Table B.1 PIER Portfolio Descriptive Statistics by Solicitation

Solicitation	RFP Release date	Total value ($ 1,000)	Minimum ($ 1,000)	Maximum ($ 1,000)	Number of projects	Total match funds ($ 1,000)
Transition	October 10, 1997	17,024	40	2,000	39	0
PIER 1	February 13, 1998	18,344	150	2,889	20	42,288
PIER 2	April 10, 1998	13,609	75	1,148	24	63,140

Note: Data reflect noticed awards for PIER Phase I activity. Data from PIER 1998 Annual Report

The substance of each PIER contract varies significantly in terms of cost drivers. For instance, the percent of total cost accounted for by overhead costs varies from zero to over 60 percent.[56] Similarly, matching funds, a key source selection and funding determination variable, can be deceiving. First, the total value of matching funds associated with a PIER solicitation is driven by a few very large projects. Second, the components of the matching funds can vary significantly. For instance, in one of the larger projects, $13.9

54 The panel acknowledges the recent awards to GRI and EPRI, as well as the three programmatic awards under the Buildings subject area. However, the panel's analysis of the PIER portfolio focused on those projects awarded under the Transition and two General Solicitations; these 83 projects comprise the portfolio that the panel reviewed in detail.

55 Technically, four contracts were awarded to the IOUs (PG&E, SDG&E, and SCE) and CIEE. Each contract included multiple independent projects.

56 There is no relationship between total contract value and percent overhead costs embedded in the contract.

million in matching funds is proposed against $2.9 million in PIER funding; $13.5 million of the matching funds is the value of equipment contributed by the study participants.[57] Since that equipment will remain after the conclusion of the effort, such in-kind contributions are fundamentally different from contributions of funds or direct labor. PIER management processes do not evaluate either of these variables at this level.

Additionally, the appropriateness of matching funds included in PIER 1 and 2 proposals is not always clear. Some projects that appear to be very close to commercialization provided few matching funds, when the expectation should be that more mature technologies closer to commercial application would attract relatively higher levels of contractor funds.[58]

Table B.2 presents similar descriptive data by program area. In this case, the Industry/Agriculture/Water area stands out as having the fewest projects, with the smallest range, and the least matching funds. This is the area with the least CEC in-house expertise. With that exception, the data reflect a reasonable balance among subject areas.

Table B.2 PIER Portfolio Descriptive Statistics by Program Area

Program Area	Total value ($ 1,000)	Minimum ($ 1,000)	Maximum ($ 1,000)	Number of projects	Total match funds ($ 1,000)
Buildings (End-use Energy Efficiency)	9,984	90	756	24	23,322
Industry, Agriculture, Water (End-use Energy Efficiency)	1,460	250	450	4	144
Environmental Preferred Advanced Generation	11,066	300	2,000	14	7,624
Renewable Generation	11,358	90	1,381	16	16,749
Environmental Research	8,884	40	2,889	12	19,736
Strategic Research	6,226	75	1,057	13	2,025

Note: Data reflect noticed awards for PIER Phase I. Data from PIER 1998 Annual Report

Table B.3 is a matrix containing selected information for each project in the Transition, PIER 1, and PIER 2 solicitations. The descriptive information includes contractor, PIER and matching funds, project description, PIER phase, and contracting status. The information included in Table B.3 is derived from the brief project summaries contained in the *1998 PIER Program Annual Report,* project proposal and contracts, proposal technical evaluations, and other program documentation.

57 Data from contract 500-97-044, Exhibit C-2.

58 Matching funds are considered appropriate when the RD&D participants are intended to benefit in some way (e.g., profits from sales). See also General Accounting Office, *DOD Research: Acquiring Research by Nontraditional Means*, March 1996 (GAO/NSIAD-96-11).

Table B.3 PIER Projects

Contract #	Company Name	Project Title	Project Amount	Match Funds	Program Area	Project Description	Solicitation	Contracted
500-97-010-01	Pacific Gas & Electric	Evaluate Small Air Conditioning Units	$500,000	$-	End-Use	Evaluate advanced, small commercial roof top package cooling system technologies for operation in California's hot/dry climate.	T	Y
500-97-010-02	Pacific Gas & Electric	Improve C/E of Building Commissioning	$300,000	$-	End-Use	Investigate and demonstrate methods to reduce the cost of building commissioning and diagnosis.	T	Y
500-97-010-03	Pacific Gas & Electric	Improve C/E of Building Control Systems	$250,000	$-	End-Use	Investigate solutions to the data acquisition and monitoring challenges faced when using energy management systems for advanced control, performance monitoring, diagnostics, and commissioning.	T	Y
500-97-010-04	Pacific Gas & Electric	Regional Ambient Aerosol Study (RAAS)	$399,000	$-	Environmental	Improve the scientific understanding of the PM10/PM2.5 problem in Northern California with an emphasis on quantification of emissions, the chemistry and physics involved in transport, the formation and removal of PM10/PM2.5, and characterization of the meteorological conditions conducive to high PM10/PM2.5 concentrations.	T	Y
500-97-010-05	Pacific Gas & Electric	Bird Strike Monitor	$100,000	$-	Environmental	Continue development of an affordable, reliable and proven device to detect bird collisions with transmission and distribution wires.	T	Y
500-97-010-06	Pacific Gas & Electric	Avian Powerline Interaction Committee	$40,000	$-	Environmental	Support PG&E's lead role in the Avian Powerline Interaction Committee (APLIC) and the presentation of a short course on preventing bird collisions and electrocutions.	T	Y
500-97-010-07	Pacific Gas & Electric	Food Service Technology Center	$350,000	$-	End-Use	Integrate a two-part effort to investigate ways to 1) reduce the release of cooking-related particles from the exhaust systems of commercial kitchens and 2) minimize the amount of building energy associated with operation of such systems.	T	Y
500-97-010-08	Pacific Gas & Electric	Wildlife Interactions with Utility Facilities	$130,000	$-	Environmental	Conduct research to evaluate the durability of specialized □ add-on insulation products and perch deterrent products installed in the field to reduce wildlife electrocutions and resulting outages. In addition, research will be conducted to evaluate the usefulness of the GIS model that incorporates the PG&E electrical distribution network and predictable wildlife resources to reduce the risk for wildlife electrocutions/collisions and outages on selected circuits.	T	Y
500-97-010-09	Pacific Gas & Electric	Electric System Seismic Safety and Reliability	$1,000,000	$-	Strategic	Develop methods and technologies that can be applied to reduce the earthquake vulnerability and improve the seismic reliability and safety of electric transmission and distribution systems.	T	Y
500-97-011-01	San Diego Gas & Electric	Trenchless Burial Equipment	$130,000	$-	Environmental	Support the demonstration of three systems interrelated to underground distribution applications for the purpose of improving systems reliability and lower costs to ratepayers.	T	Y

Table B.3 (Continued) PIER Projects

Contract #	Company Name	Project Title	Project Amount	Match Funds	Program Area	Project Description	Solicitation	Contracted
500-97-011-02	San Diego Gas & Electric	Fuel Cell Development and Demo	$300,000	$-	Advanced Generation	Assist in the advancement of molten-carbonate fuel cell technology by testing a 75kW fuel cell stack.	T	Y
500-97-011-03	San Diego Gas & Electric	PV Chargeport Demonstration	$90,000	$-	Renewables	Demonstrate how a PV covered parking system can provide grid support and electric vehicle charging.	T	Y
500-97-011-04	San Diego Gas & Electric	Distributed Resources Demonstration	$450,000	$-	Advanced Generation	Demonstrate how fossil-fuel based distributed generation systems can be seamlessly integrated into an existing electric distribution system.	T	Y
500-97-011-05	San Diego Gas & Electric	Dynamic Circuit Thermal Line Rating	$110,000	$-	Strategic	Develop improved estimates of conventional fixed normal and emergency transmission line thermal ratings and demonstrate the feasibility of real-time transmission line ratings using dynamic thermal line ratings.	T	Y
500-97-011-06	San Diego Gas & Electric	Systems Stability and Reliability	$100,000	$-	Strategic	Investigate the feasibility of implementing Flexible AC Transmission (FACTS) devices on Extra High Voltage (EHV) transmission lines for the purpose of increasing power transfer capability and import capability.	T	Y
500-97-012-01	Edison Technology Solutions	Water & Wastewater Electrotechnologies	$410,000	$-	Environmental	Provide design criteria for membrane reclamation plants □ including optimum membrane design flux and strategies for the recovery of backwash water.	T	Y
500-97-012-02	Edison Technology Solutions	Low Dross Aluminum Meter	$450,000	$-	Ind/Ag/Water	Demonstrate the economic, environmental and waste reduction benefits of the low-dross aluminum smelter technology in an effort to lower the capital cost.	T	Y
500-97-012-03	Edison Technology Solutions	Integrated Agricultural Technology	$320,000	$-	Ind/Ag/Water	Demonstrate a number of energy-efficient and environmentally friendly electrotechnologies that will help enhance the competitiveness of the agricultural sector, improve productivity, mitigate toxic chemicals, reduce energy consumption and water usage.	T	Y
500-97-012-04	Edison Technology Solutions	UV Printing on Plastics	$250,000	$-	Ind/Ag/Water	Develop and pilot test UV printing on plastic bags and demonstrate a commercial six-color UV printing system in an effort to reduce emissions of VOC from graphics arts operations.	T	Y
500-97-012-05	Edison Technology Solutions	Habitat & Species Protection	$525,000	$-	Environmental	Evaluate raptor use and mortality associated with power lines, identify where it occurs and develop recommendations to minimize such impacts during the siting and operation and maintenance of utility power lines. In addition, multiple species habitat conservation research and habitat evaluation will be performed to develop protocols for characterization and monitoring of critical California habitat types to avoid or minimize impacts.	T	Y
500-97-012-06	Edison Technology Solutions	Desert and Mountain Air Transport (DMAT)	$825,000	$-	Environmental	Develop and apply new methods for characterizing and quantifying the regional transport and chemistry of visibility-impairing emissions leading to improvements in regional visibility in California.	T	Y

Table B.3 (Continued) PIER Projects

Contract #	Company Name	Project Title	Project Amount	Match Funds	Program Area	Project Description	Solicitation	Contracted
500-97-012-07	Edison Technology Solutions	Solid Oxide Fuel Cell/Micro Turbine Generation Hybrid	$2,000,000	$-	Advanced Generation	Demonstrate the proof-of-concept testing of the integration of a solid-oxide fuel cell and micro turbine into a hybrid generation system that could offer significant efficiency and environmental advantages.	T	Y
500-97-012-08	Edison Technology Solutions	Micro Turbine Generator (Distributed Generation)	$500,000	$-	Advanced Generation	Develop and test small gas turbine (30-60kW) generation technology based on extrapolating an automotive design into a land-based generation unit.	T	Y
500-97-012-09	Edison Technology Solutions	Solar Dish/Stirling	$430,000	$-	Renewables	Purchase, install and test a 25kW solar dish/Stirling generation system for a full year in a California climate.	T	N
500-97-012-10	Edison Technology Solutions	Solar Two	$1,200,000	$-	Renewables	Continue the operation, maintenance, testing and evaluation of the 10 MW Solar Two Central Receiver Project. The project is designed to yield system and subsystem performance and design improvement information to validate the operational, maintenance and technical characteristics of molten nitrate salt receiver and storage technologies and reduce the economic and technical risks.	T	Y
500-97-012-11	Edison Technology Solutions	Photovoltaics	$1,000,000	$-	Renewables	Operate and monitor several PV systems to evaluate their year-round performance and efficiency	T	Y
500-97-012-12	Edison Technology Solutions	Phasor Measurement Units	$150,000	$-	Strategic	Provide real-time monitoring and potential of future control of the Western Systems Coordinating Council (WSCC) electric power grid using Phasor Measurement Units (PMU), which are low-cost sensors that measure voltage, current phase angles and magnitudes. The project will develop a system to pool data from all major WSCC members and make it available to all participating members. The system will allow various energy control centers and systems to monitor the entire WSCC system.	T	Y
500-97-012-13	Edison Technology Solutions	USAT MOD-2	$1,000,000	$-	Strategic	Continue satellite communication development toward high-data rate supervisory monitoring, control and energy event-driven applications.	T	Y
500-97-012-14	Edison Technology Solutions	Energy Source Stabilizer (ESS)	$250,000	$-	Strategic	Develop an Energy Source Stabilizer (ESS) that functions through a generating machine governor or other electronic-controlled power device (i.e., battery energy storage systems, superconducting magnetic energy storage systems or high-voltage DC lines).	T	Y
500-97-012-15	Edison Technology Solutions	Substation Reliability	$215,000	$-	Strategic	Increase system efficiency, reliability and capacity and to reduce operation and maintenance costs of substations.	T	Y
500-97-013-01	California Institute for Energy Efficiency	CIEE Collaborative Program Planning and Management	$600,000	$-	Environmental	Provide administrative support to the PIER buildings area.	T	Y
500-97-013-02	California Institute for Energy Efficiency	Residential Thermal Distribution Systems	$400,000	$-	End-Use	Develop new knowledge of residential air distribution systems and prototype technologies to assist the process of updating duct leakage test methods, to develop a test method for evaluating the longevity of duct sealants and to quantify the relationship between distribution effectiveness and HVAC equipment sizing.	T	Y

Table B.3 (Continued) PIER Projects

Contract #	Company Name	Project Title	Project Amount	Match Funds	Program Area	Project Description	Solicitation	Contracted
500-97-013-03	California Institute for Energy Efficiency	Alternatives to Compressor Cooling	$350,000	$-	End-Use	Develop and evaluate house designs capable of providing comfort in California transition climates without the use of conventional compressor-based cooling.	T	Y
500-97-013-04	California Institute for Energy Efficiency	Commercial Thermal Distribution Systems	$400,000	$-	End-Use	Provide new technology and applications knowledge that will allow the construction and energy services industries to reduce energy waste in commercial thermal distributions systems.	T	Y
500-97-013-05	California Institute for Energy Efficiency	Diagnostics for Building Commissioning Operations	$350,000	$-	End-Use	Demonstrate an advanced operator information system for whole-building commissioning and operations.	T	Y
500-97-013-06	California Institute for Energy Efficiency	Development of High Efficiency Lighting Torchieres	$90,000	$-	End-Use	Develop and test the next generation of advanced, high lumen output fluorescent lamps for use in torchieres in commercial applications.	T	Y
500-97-013-07	California Institute for Energy Efficiency	Laboratory Type Facilities	$375,000	$-	Strategic	Provide new technology and applications knowledge that will reduce the energy intensity and improve the performance of laboratory-type facilities.	T	Y
500-97-013-08	California Institute for Energy Efficiency	Building Design Advisor	$350,000	$-	End-Use	Improve the functionality of sophisticated energy analysis tools for use in the schematic phase of commercial building design.	T	Y
500-97-013-09	California Institute for Energy Efficiency	Formation of NOx in Industrial Gas Burners & Gas	$335,000	$-	Advanced Generation	Develop technologies to attain and maintain energy-efficiency operation of natural gas industrial burners and stationary gas turbines with ultra-low emissions of NOx	T	Y
500-97-031	Alzeta Corp	Low NOx Gas Turbine Combustors for Distributed Power Generation	$878,788	$675,000	Advanced Generation	Test a low NOx combustor in gas turbines and turbine test cells.	1	Y
500-97-032	The Wind Turbine Co.	Next Generation Wind Turbine Development Project	$950,000	$6,935,733	Renewables	Develop and test a 350 kW wind turbine.	1	Y
500-97-033	Catalytica Combustion Systems, Inc.	Durability of Catalytic Combustion Systems	$1,316,303	$3,290,846	Advanced Generation	Develop and demonstrate a catalytic combustion system.	1	Y
500-97-034	Electromagnetic Instruments	Development of Extended Logging Tool for Geothermal Exploration and Field Development	$1,380,709	$1,407,953	Renewables	Develop and test an extended logging tool for geothermal exploration and field development.	1	Y
500-97-035	Bergquam Energy Systems	Design & Optimization of a Solar Fired 2E Absorption Chiller	$150,000	$150,000	Renewables	Design and optimize a solar fired 2E absorption chiller.	1	Y
500-97-036	Regents of the UC-Santa Cruz	Golden Eagles in a Perilous Landscape: Tracking the Effects of Mitigation for Energy Based Mortality	$675,121	$-	Environmental	Study the effects of wind-energy mitigation measures on golden-eagle mortality.	1	Y
500-97-037	Powerwheel Associates	Powerwheel Demonstration	$200,000	$200,000	Renewables	Develop and demonstrate a 75 kW low-head hydroelectric technology.	1	Y
500-97-038	Environmental Research Corporation	A Novel Steam Reforming Reactor for Fuel Cell Distributed Power Generation	$349,852	$303,458	Advanced Generation	Develop and evaluate catalysts and absorbents for a steam reforming process within fuel cell systems.	1	Y

Table B.3 (Continued) PIER Projects

Contract #	Company Name	Project Title	Project Amount	Match Funds	Program Area	Project Description	Solicitation	Contracted
500-97-039	M-C Power Corporation	75-kW MCFC Power Plant Verification Test Project	$1,000,000	$1,956,841	Advanced Generation	Design and test a 75 kW molten-carbonate fuel cell power generation system.	1	Y
500-97-040	Gas Research Institute	Natural Gas Cofiring in Biomass Fueled Boilers	$655,702	$731,784	Renewables	Develop and test a low-NOx burner for cofiring applications in biomass fueled boilers.	1	Y
500-97-041	Gas Research Institute	Energy Efficient, Low Emission, Cost Effective microPilot Ignited Natural Gas Engine Driven Genset for Deregulated, Distributed Power Generation Markets	$982,528	$250,000	Advanced Generation	Develop and demonstrate a micropilot-ignited natural gas engine.	1	Y
500-97-042	AeroVironment, Inc.	Ultra-High Efficiency Packaged Microcogeneration System	$1,035,420	$425,319	Advanced Generation	Develop and demonstrate an ultra-high-efficiency packaged micro-cogeneration system.	1	N
500-97-043	Electric Power Research Institute	Assessment of the Costs and Impacts of Global Climate Change--California Implications & Potential Costs.	$2,159,800	$28,400,000	Environmental	Assess the potential costs and implications to California of global climate change.	1	Y
500-97-044	Edison Technology Solutions	Electrotechnology Application for Potable Water Production & Protection of the Environment.	$2,889,678	$13,936,267	Environmental	Develop and test various electrotechnologies for potable water production and environmental protection.	1	Y
500-97-045	Westinghouse Electric Company	Megawatt-Class Pressurized Solid Oxide Fuel Cell/Gas Turbine Power System Demonstration	$550,000	$550,000	Advanced Generation	Design a megawatt-class pressurized solid oxide fuel cell/gas turbine power system.	1	N
500-97-046	Powerlight Corp.	Powertherm Product Development	$542,362	$1,052,361	Renewables	Develop and test a commercial PV/thermal solar collector system.	1	Y
500-97-047	Utility Power Group, Inc.	Residential Electric Power Security	$426,343	994,799	Renewables	Develop and test a residential rooftop PV system.	1	Y
500-97-048	EDTEK	Hybrid Solar-Fossil Thermophotovoltaics	$867,945	$1,917,107	Renewables	Demonstrate a hybrid solar-fossil thermophotovoltaic cogeneration technology.	1	Y
500-97-049	Powerlight Corp.	Powerguard California Manufacturing	$958,991	$1,994,421	Renewables	Develop manufacturing methods for a roof tile PV product.	1	Y
500-97-050	Sacramento Municipal Utility District	PVUSA Power Conditioning Unit Test Center	$374,847	$140,080	Renewables	Develop a power conditioning/converting unit test center at PVUSA.	1	Y
500-98-020	Lawrence Berkeley National Lab	Energy Efficient Downlights for California Kitchens	$648,603	$320,028	End-Use	Develop and demonstrate low-cost energy efficient downlights for residential kitchens.	2	N
500-98-021	Windlite Corporation	Increased Energy Efficiency of Refrigerators and Air Conditioners Through Use of Advanced Power Electronics	$411,614	$114,714	End-Use	Develop and demonstrate innovative power electronics to improve the efficiency of residential refrigerators by allowing for the operation of 3-phase motors in single-phase applications.	2	Y

Table B.3 (Continued) PIER Projects

Contract #	Company Name	Project Title	Project Amount	Match Funds	Program Area	Project Description	Solici-tation	Contracted
500-98-022	Davis Energy Group	Development of an Advanced Indirect Heat Exchange Module	$248,719	$84,618	End-Use	Develop and test a heat exchanger for an advanced indirect evaporative cooler.	2	Y
500-98-023	RLW Analytics, Inc./ GeoPraxis, Inc.	Conceptual Design Energy Analysis Tool (CDEAT) R&D	$452,655	$194,900	End-Use	Develop an energy analysis module for inclusion in existing 3-D conceptual building design software used for commercial buildings.	2	Y
500-98-024	Davis Energy Group	Alternatives to Compressor Cooling: Phase V	$713,246	$150,437	End-Use	Develop and evaluate alternatives to compressor cooling for residential buildings.	2	Y
500-98-025	Eley Associates	A Tool for the Comprehensive Analysis of Low-Rise Residential Buildings	$216,190	$200,000	End-Use	Develop a Windows-based design and analysis tool that will assist homeowners and design professionals in evaluating the energy use of residential buildings, taking into account the new complexities of the restructured electricity markets.	2	Y
500-98-026	Lawrence Berkeley National Lab	HVAC Distribution System in Commercial Buildings	$537,000	$413,000	End-Use	Refine or develop diagnostic tools for the measurement of the performance of commercial thermal distribution systems and to develop and evaluate duct improvement technologies for these systems.	2	N
500-98-027	Eley Associates	Building Specification Guidelines for Energy Efficiency	$233,280	$-	End-Use	Develop a reference set of energy efficiency specification for inclusion in construction documents for commercial buildings.	2	Y
500-98-028	Arthur D. Little, Inc.	Design Refinement and Demonstration of a Market-Optimized, Residential Heat-Pump Water Heater	$756,095	$109,235	End-Use	Design, test and demonstrate a market-optimized residential heat-pump water heater.	2	Y
500-98-029	Gas Research Institute	Removing the Key Technical Barrier to the Widespread Use of Advanced Absorption Cooling	$690,178	$235,000	End-Use	Develop and test new corrosive resistant materials for absorption coolers.	2	Y
500-98-030	WaterTech Partners	Recycling Chiller-Bath Rinse Water in Poultry Processing	$440,400	$144,000	Ind/Ag/Water	Demonstrate the feasibility of using ozone water treatment technology to recycle chiller bath rinse water in poultry processing operations.	2	Y
500-98-031	Pacific Gas & Electric	Improving Energy Efficiency of Commercial Kitchen Exhaust Systems	$276,165	$225,000	End-Use	Improve the energy efficiency of commercial kitchen ventilation systems by performing flow-visualization research and publishing design guidelines for the food service industry.	2	Y
500-98-032	Lawrence Berkeley National Lab	Next Generation Power Management User Interface for Office Equipment	$449,841	$-	End-Use	Assess and develop power management interface standards for office equipment.	2	N
500-98-033	Lawrence Berkeley National Lab	Instrumented Home Energy Rating and Commissioning	$710,000	$137,000	End-Use	Develop diagnostic and audit tools, and metrics for evaluating energy-related performance and commissioning guidelines for new and existing houses.	2	Y
500-98-034	Engineering Data Management	Development of a Real-Time Monitoring/ Dynamic Rating System for Overhead Lines	$499,402	$510,019	Strategic	Develop and demonstrate a system for real-time monitoring of conductor clearances/sags in power lines.	2	Y

Table B.3 (Continued) PIER Projects

Contract #	Company Name	Project Title	Project Amount	Match Funds	Program Area	Project Description	Solicitation	Contracted
500-98-035	W. Brandt Goldsworthy & Associates	Development of a Composite Reinforced Aluminum Conductor	$75,000	$65,000	Strategic	Develop a composite reinforced aluminum conductor for use in electricity transmission systems.	2	Y
500-98-036	Trinity Flywheel Power	2 kWhr Flywheel Energy Storage System	$1,057,406	$1,062,494	Strategic	Demonstrate a 2kWhr flywheel energy storage system for distributed generation and load shifting that is directly scaleable to 10 kWhr.	2	Y
500-98-037	Energy & Environmental Research	Utilization of Waste Renewable Fuels in Boiler with Minimization of Pollutant Emissions	$981,952	$610,238	Renewables	Research and develop a hybrid combustion/gasification technology that utilizes low-grade biomass and waste fuels to reduce pollutant emissions in existing biomass boilers.	2	Y
500-98-038	Energy Compression Research Corp.	Light-Activated Surge Protection Thyristor for Distribution System Reliability	$494,239	$93,292	Strategic	Design and build a prototype light-activated surge protection thyristor with a high-current capacity that will increase distribution system reliability by preventing surge-initiated cascading electrical failures.	2	Y
500-98-039	Southern California Edison	Investigation of Secondary Loop Supermarket Refrigeration Systems	$300,000	$150,000	End-Use	Design and test an energy efficient secondary loop refrigeration system for supermarkets.	2	Y
500-98-040	Alternative Energy Systems Consulting, Inc	Intelligent Software Agents for Control & Scheduling of Distributed Generation	$554,010	$59,543	Advanced Generation	Develop and demonstrate software for the scheduling and control of distributed energy resources in a competitive market.	2	Y
500-98-041	Solar Turbines Incorporated	Catalytic Combustor-Fired Industrial Gas Turbine for Distributed Power & Cogeneration Applications	$814,543	$773,391	Advanced Generation	Develop an ultra-low NOx catalytic combustion system for industrial gas turbines in distributed power and cogeneration applications.	2	Y
500-98-042	Material Integrity Solutions, Inc.	Sagging Line Mitigator (SLiM)	$900,000	$304,833	Strategic	Develop and test a sagging line mitigator to automatically counteract the sagging of high voltage transmission lines due to high ambient temperature and current flow.	2	Y
500-98-043	Collins Pine Company	Collins Pine Co. BCI Cogeneration Project	$1,149,961	$382,274	Renewables	Develop and demonstrate how co-locating a biomass-to-ethanol (and other co-products) manufacturing facility with a biomass electric generator can improve the economic viability of biomass power plants.	2	Y
		contracted projects totals	$45,328,024	$69,942,638				

ENERGY INNOVATIONS SMALL GRANT PROGRAM

The Energy Innovations Small Grant (EISG) Program awards up to $75,000 each to small businesses, small nonprofits, individuals and academic institutions proposing projects relevant to any of the six PIER program areas. The program is intended to fund projects that establish the feasibility of research and development concepts related to the PIER program. The grant program resides within the Strategic Program Area, but is administered by the California State University Institute (CSUI) through an inter-agency agreement with the Energy Commission.[59] It is funded at $2.5 million annually with $2 million available for grants, and has released three solicitations since March, 1999, resulting in 216 proposals received. As of December 1999, 18 projects valued at $1.35 million have been approved.

The primary goal of the program is to determine the feasibility of research and development concepts that fall within the PIER implementation plan. All grant projects will produce a "feasibility analysis report" which, among other things, will tell whether or not the goals of the project were attained and the potential for further development of the concept. Successful projects could proceed to subsequent development stages such as additional PIER funding, patent applications, or commercial development.

One of the grant program's objectives is to offer a simplified and efficient application and project management process so that the "transaction costs" to the applicants are minimized. Policy decisions made in the program's development stages assured this outcome, and include:

- Exemption from royalty provisions
- Exemption from Disabled Veteran Enterprise participation rules
- Exemption from match fund requirements
- Limiting scope of work to concept feasibility analysis
- Limiting project duration to 18 months or less
- Limiting the maximum award amount to $75,000
- Delegating solicitations, application scoring and project management to an administrator

Therefore, the project execution process for the EISG program is significantly shorter than the normal PIER contracts process. Two grant agreements have been fashioned to accommodate the differences between the California universities and other eligible grant recipients - a general agreement and one tailored to meet the specific requirements of the CSU and UC projects.

Grant proposals must advance through roughly four months of screening and reviews in order to be approved for funding. The initial screening is performed by EISG program staff and ensures that the proposals meet the basic requirements set forth in the solicitation. After passing through the initial screening, projects undergo reviews by three or four technical peer reviewers.

[59] CSUI has executed agreements with the San Diego State University Foundation and the Regents of the University of California to assist in the day-to-day administration of the program. The staff at the San Diego State University Foundation works closely with the CEC program manager.

APPENDIX C: CEC DEFINITION OF PUBLIC INTEREST

The following is the definition of public interest provided to the panel in August 1999 upon request:[60]

PUBLIC INTEREST RESEARCH & DEVELOPMENT

Definition:

"Public Interest Energy Research is that which, through a range of RD&D activities, provide benefit to broad classes of California ratepayers in the areas of:

- *Strategic*
- *Renewable*
- *Environmentally Preferred Advanced Generation*
- *End-Use Energy Efficiency*
- *Environmental Enhancements*

And, that is not otherwise adequately undertaken by competitive and regulated markets."

Range of activities: Basic research, applied research, design, development, demonstration. No commercialization activities are permitted with these funds. However, manufacturing readiness activities are encouraged as part of the R&D. Examples of commercialization activities that are not eligible for PIER funding are tooling, marketing, advertising, training, distribution of goods, and actual full scale production.

Applicability and Beneficiaries: The Public Interest Energy R&D (PIER) must have broad applicability benefiting the greatest number of California ratepayers possible or those that represent the greatest use of electricity. All classes of ratepayers must benefit from at least one of the many activities of the PIER program.

Areas of R&D: All PIER work must be contained within the subject areas defined by SB 90. Project work should not include that which is being adequately performed by private and regulated entities. Also, R&D that is merely directed toward compliance with existing LORS is not allowed unless a major economic benefit or other significant collateral benefits ensue from the use of the new technology.

Eligibility: All legal entities and individuals that possess the proper qualifications are eligible to participate in the R&D.

Focus of R&D: R&D should be focused on the elements of public good specified in the strategic plan or appended documents. All R&D should be directed toward resolving energy issues affecting Californians. PIER benefits must be directed toward Californians. Each project should have a "market focus" to ensure that a path exists to take the benefits from the research stage to the ultimate user.

Goals of Public Interest Energy R&D: Public Interest R&D should advance energy science or technology in a manner that benefits citizens of California. Usually this means advancing concepts or ideas to the stage where they can be utilized in a product, service or regulation. Project plans should include tasks that would make the developed science or technology ready for utilization.

---

60 The two-page document has been re-typed into this report exactly as provided.

Project Management: All projects should be managed in an efficient manner with specified goals and milestones. Projects that fail to meet agreed upon milestones are subject to review, rescheduling and/or termination.

Time Frame of R&D: PIER projects should be selected to achieve a balance of results in the near, medium and far terms.

Proposal Criteria: Specific criteria will be adopted for each procurement. However, any award from the PIER program must provide one or more of the PIER program Public Interest Criteria.
In addition each project must demonstrate the likelihood, timing and economic or social value of the concept and the path to full societal utilization upon successful completion of the R&D. This concept has been named "market connection" in this program.

RECORD OF PANEL'S COMMENTS

The panel found this definition to be unsatisfactory in a number of ways, including:

- The phrase "no commercialization activities are permitted…" is ambiguous and unnecessarily limits the range of activities PIER can engage in. For instance, "manufacturing readiness activities" implies production tooling, which is a commercialization activity.
- The criterion of "must have broad applicability benefiting the greatest number…" seems unnecessarily expansive at the risk of missing narrow high-leverage opportunities. Further, the notion of "ratepayers" needs to be better defined in this context. It would also be helpful to define the broad categories of benefits intended in PIER-sponsored RD&D.
- The concept of "adequately performed by private and regulated entities" is a core criterion for PIER and should be more fully defined. Other government sponsored RD&D, particularly at the federal level, should also be considered as part of the concept of "adequately funded."
- The eligibility requirement, while technically correct, is unnecessary and does not contribute to an understanding of public interest.
- Concerning R&D focus, while a "market focus" is clearly appropriate for some pure activities, it may not be appropriate for environmental research or for basic or exploratory research efforts with potential revolutionary long-term implications.
- The "goals of public interest energy R&D" statement is at the heart of PIER and should be moved to a dominant position.
- The statement on project management does not contribute to an understanding of public interest and should be deleted.
- The notion of short, medium, and long terms is ambiguous but provides appropriate flexibility. The value is in the expected returns of the research that would occur over these time periods. The word "balance" could be removed, without adversely affecting the concept and to provide for increased flexibility at the discretion of PIER decision-makers.
- The proposal criteria, as stated, are redundant and unhelpful, and should be deleted. In order to operationalize the definition of public interest, specific criteria should flow from the elements of public interest described in the definition. The document could help this by specifying critical specific criteria.
- PIER needs to ensure that its funding leads to significant improvement in cost, efficiency or environmental performance. Such improvement needs to be quantified and made explicit in both program objectives and public interest criteria.

APPENDIX D: ABBREVIATIONS AND ACRONYMS

Symbol	Definition
ACEE	American Council for an Energy Efficient Economy
ADL	Arthur D. Little, Inc
ATP	Advanced Technology Program
CARB	California Air Resources Board
CCST	California Council on Science and Technology
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CIEE	California Institute for Energy Efficiency
CPUC	California Public Utilities Commission
CRM	Contract Request Memorandum
CSU	California State University
CSUI	California State University Institute
DARPA	Defense Advanced Research Projects Agency
DGS	Department of General Services
DOD	Department of Defense
DOE	Department of Energy
DSM	Demand-side-management
EIA	Energy Information Administration
EISG	Energy Innovations Small Grant
EPRI	Electric Power Research Institute
ETAP	Energy Technologies Advancement Program
GRI	Gas Research Institute
IOU	Investor Owned Utilities
NERC	North American Electric Reliability Council
NIST	National Institute of Standards and Technology
PG&E	Pacific Gas & Electric
PIER	Public Interest Energy Research
RD&D	Research, Development, & Demonstration
RFP	Request For Proposals
SCE	Southern California Edison
SDG&E	San Diego Gas & Electric
UC	University of California
WSCC	Western Systems Coordinating Council

BIBLIOGRAPHY

"Competitive Negotiation Briefing" presented to PIER Independent Review Panel, Public Interest Energy Research (PIER) Workshop, February 1998.

"Energy Deregulation: Status of Natural Gas Customer Choice Programs," *Report to Congressional Requesters GAO/RCED-99-30*, December 1998.

"Governor's Advanced Technology Initiative," California Council on Science and Technology, September 1999.

"Pentagon Agency Thrives on In-Your-Face Science," *Science*, Vol. 285, September 3, 1999, pp. 1476-79.

CEC Market Connectivity Team, "Recommendations to Improve the PIER Solicitation Selection Process" Briefing, April 12, 1999.

"Report to the President on Federal Energy Research and Development for the Challenges of the Twenty-First Century," Presidents Committee of Advisors on Science and Technology Panel on Energy Research and Development, November 1997.

California Energy Commission, "Responsibilities of PIER RD&D Project Managers," February 20, 1998.

"Review Panel Report," *California Institute for Energy Efficiency Triennial Review April 12-13*, May 10, 1999.

"Statement of Vice Chair David Rohy, Ph.D., To The Committee on Science U.S. House of Representatives," *The Resources Agency*, March 31, 1998.

Abel, Amy and Larry Parker, "Electricity: The Road Toward Restructuring," *Congressional Research Service Issue Brief IB10006*, 9/15/99.

Anderson, Carrie, "Energy Use in the Supply, Use, and Disposal of Water in California," *California Energy Commission*, January 25, 1999.

Applied Decision Analysis, Inc., "Public Interest Energy Research (PIER) Program Goals and Objectives, Results from the Facilitated Decision Making Process," Prepared for California Energy Commission, ADA-98-2178, February 6, 1998.

Arthur D. Little, Inc., *Pier Innovation Strategy Phase 2,* Presentation to the CEC, Reference CCoSFO1775, July 30, 1999.

Bakken, Wendell, Ricardo Amon, Tom Tanton, Prab Sethi, John Sugar, "Plan for Research in Industry/Agriculture/Water." *Pier Process Energy Team Draft.* January 22, 1999.

Batham, Mike, Avtar Bining, Kelly Birkinshaw, David Hatfield, Arthur J. Soinski, "Draft Plan for Research in Environmentally Preferred Advanced Generation Technologies," *The Pier EPAG Team*, January 25, 1999.

Blumstein, C. and S. Wiel, "Public-interest research and development in the electric and gas utility industries, *Utilities Policy 7* (1998) pp. 191-199.

California Energy Commission Staff and Arthur D. Little, Inc. *Building an Effective Innovation Strategy for PIER*, Meeting with the Policy Advisory Council, California Energy Commission, October 27, 1999.

California Energy Commission, “1996 Energy Technology Status Report,” P500-96-006, December 1997.

California Energy Commission, “1998 Baseline Energy Outlook.” Report P300-98-012.

California Energy Commission, “Building an Effective Innovation Strategy for PIER,” Meeting with the Independent Evaluation Panel, October 12, 1999.

California Energy Commission, “Building an Effective Innovation Strategy for PIER – Phase II,” Meeting with the Independent Evaluation Panel, August 23, 1999.

California Energy Commission, “California Energy Commission Public Interest Energy Research (PIER) Program First General Solicitation,” RFP 500-97-503, February 11, 1998.

California Energy Commission, “California Energy Commission Responses to the Legislative Analyst’s Questions Regarding Energy Technology Development Programs,” Material for California Energy Commission Energy Technology Development Hearing, Memorandum, March 18, 1999.

California Energy Commission, “California Energy Commission’s Quarterly Report Concerning the Public Interest Energy Research Program,” April 8, 1998.

California Energy Commission, “California Energy Commission’s Quarterly Report Concerning the Public Interest Energy Research Program,” July 15, 1998.

California Energy Commission, “California Energy Commission’s Quarterly Report Concerning the Public Interest Energy Research Program,” October 30, 1998.

California Energy Commission, “California Energy Commission’s Quarterly Report Concerning the Public Interest Energy Research Program,” January 22, 1999.

California Energy Commission, “California Energy Commission’s Quarterly Report Concerning the Public Interest Energy Research Program,” April 27, 1999.

California Energy Commission, “California Energy Commission’s Quarterly Report Concerning the Public Interest Energy Research Program,” July 26, 1999.

California Energy Commission, “Contract Management, Commission Contract Manual, September 1997.

California Energy Commission, “Draft Charter for the Independent Public Interest Energy Research (PIER) Review Panel,” As of March 17, 1999.

California Energy Commission, “Energy Innovations Small Grant Program,” March 1999 Solicitation Notice.

California Energy Commission, “Funded PIER Projects by Program Areas,” February 1, 1999.

California Energy Commission, “List of Proposed Awards by Program Area,” Public Interest Energy Research (PIER).

California Energy Commission, “Manual for the Evaluation of Research, Development and Demonstration Programs and Projects,” Consultant Report P-500-97-010, October 1997.

California Energy Commission, “Operational Guide for PIER Stage 2 Implementation,” January 13, 1999.

California Energy Commission, “PIER Policy Advisory Council Meeting Summary for June 21, 1999.”

California Energy Commission, "PIER Policy Advisory Council Meeting Summary for January 28, 1999."

California Energy Commission, "PIER Policy Advisory Council Meeting Summary for June 9, 1998."

California Energy Commission, "PIER Policy Advisory Council Memorandum," June 1998.

California Energy Commission, "Program Issue Areas – Suggestions from PAC Members."

California Energy Commission, "Public Interest Energy Research Program Plan," June 15, 1998.

California Energy Commission, "Public Interest Energy Research Program Plan," Draft, October 20, 1999.

California Energy Commission, "Research Development and Demonstration and Electricity Industry Restructuring," *Draft Energy Development*, Vol. 1 Part 11, June 1995.

California Energy Commission, "Stage Two Pier Program Areas," October 1998.

California Energy Commission, "Strategic Plan for Implementing the RD&D Provisions of AB-1890, State of California Energy Resources Conservation and Development Commission, June 1997.

California Energy Commission, *Critical Changes: California's Energy Future*, 1997.

California Energy Commission, *Energy Development*, P500-92-010, December 1992.

California Energy Commission, Energy Resources Conservation and Development Commission, "The Research, Development and Demonstration Committee's Preliminary Recommendations Regarding RD&D Transition Funding," November 5, 1997.

California Energy Commission, Resources Agency of California, "Material for California Energy Commission Energy Technology Development Hearing," March 18, 1999.

California Public Utilities Commission, Commission Advisory and Compliance Division, *Biennial Report on Energy Utility Research, Development and Demonstration Programs*, R.87-10-013, October 1993.

California Energy Commission, RD&D Working Group, *Working Group Report on Public Interest Research, Development and Demonstration Activities*, Appendices, P500-96-010A, September 6, 1996.

Corey, E. Raymond, *Technology Fountainheads*, Harvard Business School Press, Boston, MA, 1997.

Donahue, George L., Richard H. Buenneke, Jr., Wayne G. Walker, "Why Not a Civil DARPA?" RAND Issue Paper, Vol. 1, Number 1, November 1992.

Duke, Richard and Daniel M. Kammen, "The Economics of Energy Market Transformation Programs," *The Energy Journal*, Vol. 20, No 4, pp.15-64.

Edmunds, Tom, Jeffrey Stewart and Jill Watz, "Base Case and Perturbation Scenarios." *Lawrence Livermore National Laboratory*, September 9, 1999.

Goldstone, Sy, " Mental Models for Thinking About Market Connection," Prepared for PIER Strategy Team Meeting, June 1, 1999.

Goldstone, Sy, "Mental Models for Thinking About Market Connection Portfolios - Continued," Memo, June 9, 1999.

Goldstone, Sy, Donald Schwartz, Woods, James, *Revised Preliminary PIER-MC Program Theory With Implications for a Stage 2 Planning and Screening Common Format,* August 20, 1998.

Goldstone, Sy, *Drawing on the Draft PIER Program Area Research Plans to Expand the Definition of Market Connectivity," January 8, 1999.*

Goldstone, Sy, *Feedback on the Selection Process in the PIER 1st and 2nd General Solicitations,* Briefing and Feedback and Handout, February 1, 1999.

Heinz, Jane, *EPRI – CEC Membership Briefing*, California Energy Commission, April 28, 1999.

Jenkins, Nancy, Valerie Hall, William Pennington, Ann Peterson, Mazier Shirakh, Michael Sloss, "Draft Plan for Research in Residential and Commercial Buildings End Use Efficiency," *Draft Pier Buildings Plan*, January 21, 1999.

Jordan, Gretchen B., and John C. Mortensen, "Measuring the Performance of Research and Technology Programs: A Balanced Scorecard Approach," *Journal of Technology Transfer,* Vol. 22 (2): pp. 13-20.

Klein, Yehuda L., Ron Edelstein, *Public Goods RD&D: Criteria and Metrics*, Report GRI-98/0264, Gas Research Institute, December 1998.

Loiter, Jeffrey M., and Vicki Norberg-Bohm, "Technology policy and renewable energy: public roles in the development of new energy technologies," *Energy Policy 27 (1999) 85-97.*

Margolis, Robert M. and Daniel M. Kammen, "Underinvestment: The Energy Technology and R&D Policy Challenge," *Science,* Vol. 285, July 30, 1999, pp. 690-692.

Menke, Michael M., "Essentials of R&D Strategic Excellence," *Research Technology Management,* pp. 45-47, September-October 1997.

Parker, Larry and John Blodgett, "Electricity Restructuring: The Implications for Air Quality," *Congressional Research Service Issue Brief 98-615*, September 15, 1999.

Parker, Larry B., "Electric Utility Restructuring: Overview of Basic Policy Questions, "*Congressional Research Service Issue Brief*, 97-154, June 28, 1999.

Perlack, Robert D. and Robert B. Shelton, "Government's Role in Energy Technology R&D: A Proposed Model for Strategic Guidance," *Oak Ridge National Laboratory,"* ORNL/TM-13218, April 1996.

Pacific Gas & Electric Company, *Annual RD&D Status Report for the California Public Utilities Commission*, March 31, 1997.

Public Interest Energy Research (PIER) Program, "Background Information," *PIER Program Facts,* February 1, 1999.

Pye, Mariam , Steven Nadel, *Energy Technology Innovation at the State Level: Review of State Energy Research, Development, and Demonstration (RD&D) Programs*, American Council for an Energy-Efficient Economy, July 1997.

R&D Working Group, "Working Group Report on Public Interest RD&D Activities," September 6, 1996.

Rezendes, Victor S., "Electric Utility Restructuring: Implications for Electricity R&D," *Testimony Before the Subcommittee on Energy and Environment, Committee on Science, House of Representatives, GAO/T-RCED-98-144.*

Rohy, David A., R&D in the Restructured Electricity Industry, *Briefing*, November 2, 1998.

San Diego Gas & Electric Company, *1996 Annual Report on Research, Development and Demonstration Projects*, R.87-10-013, March 20, 1996.

Schacht, Wendy H., "R&D Partnerships and Intellectual Property: Implications for U.S. Policy," *Congressional Research Service Report for Congress, 98-862*, September 15, 1999.

Simmons, George, Pramod Kulkarni, Valentino Tiangco, Arthur Soinski, Arnold Ward, Alexander Jenkins, "Renewable Energy," *Draft Research Development and Demonstration (RD&D) Plan*, Version RENPLAN9.DOC, January 25, 1999.

Sirilli, Giorgio, "Old and new paradigms in the measurement of R&D," *Science and Public Policy*, Vol. 25, No. 5, pp. 305-311, October 1998.

Sissine, Fred, "Energy Efficiency: Budget, Climate change, and Electricity Restructuring Issues," *Congressional Research Service Issue Brief IB10020*, September 15, 1999.

Sissine, Fred, "Renewable Energy: Tax Credit, Budget, and Electricity Restructuring Issues," *Congressional Research Service Issue Brief IB10041*, September 15, 1999.

Southern California Edison, *1995 Annual Status Report on Research, Development and Demonstration Projects*, Prepared for the Public Utilities Commission of the State of California, March 31, 1995.

Tanton, Tom, Linda Davis, Pramod Kulkarni, Judy Grau, Al Alvarado, Phil Misemer, Don Kondoleon, Ean O'Neill, "Strategic Energy Related Science and Technology," *Draft Plan for PIER Research*, January 25, 1999.

The California Council on Science and Technology, "California Report on the Environment for Science and Technology," November 1999.

The Resources Agency of California, "Interim PIER Organizational Structure," Memorandum, September 18, 1998.

The Resources Agency of California, "PIER Program" Memorandum, September 20, 1999.

Vonortas, Nicholas S., and Henry R. Hertzfeld, "Research and Development Project Selection in the Public Sector." *Journal of Policy Analysis and Management,* Vol. 17, No. 4, 1998, pp. 639-657.

York, Rick, Guido Franco, Chris Tooker, David Maul, Bob Eller, "Draft Plan for Research in Environment," PIER Environmental Team, December 11, 1998.

PIER REPORT TEAM CREDITS

CCST PIER Committee Review Members:

Roger G. Noll, Chair
Octavia Diener
C. Bruce Tarter
Maxine L. Savitz
Edward C. Stone

CCST Executive Director:

Susan Hackwood

Project Coordinator:

Charles F. Brown, Jr.

Technical Writing Team:

Jeffrey A. Drezner, RAND
Jonathan Kulick, RAND
With assistance from Susan Postema

RAND Technical Support and Research Team:

Mark A. Bernstein, Senior Policy Analyst
Jeffrey A. Drezner, Policy Analyst
Jonathan Kulick, Research Analyst
Sergej Mahnovski, Research Analyst
David Ortiz, Associate Researcher
Aimee Bower, Research Assistant

Sacramento Coordinator:

Annzell Loufas
Christina Rios, Administrative Support

CCST Staff:

Donna King, Accounting Support
Sue Harris, Computer Support

Cover Credit and Graphic Formatting:

Erik A. Mattila, Graphic Artist

Printer:

Crystal Printing, Sacramento, CA

This report has been printed on Utopia One Dull recycled paper.

'CC ST.

(916) 492-0996 (phone)
(916) 492-0999 (fax)

e-mail
ccst@ccst.ucr.edu

internet
http://www.ccst.ucr.edu