Proposed Agreement between California Energy Commission and DOE- Lawrence Berkeley National Laboratory

Title: National Lab Buildings Energy Efficiency Research Projects
Amount: $4,911,721.00
Term: 42 months
Contact: Chris Scruton
Committee Meeting: 4/4/2011

Funding

FY	Program	Area	Initiative	Budget	This Project	Remaining Balance	
09	Electric	Buildings	Standards and Policy Coordinations	$2,434,200	$87,523	$0	0%
09	Natural Gas	Buildings	Energy Efficient Hot Water Generation and Distribution	$1,800,000	$1,000,000	$0	0%
09	Natural Gas	Buildings	NG fired and waste heat augmented heating/power systems and cooling solutions for commercial buildin	$450,000	$100,000	$0	0%
10	Electric	IAW	Energy Efficiency and Emerging Technologies	$5,250,000	$670,000	$0	0%
10	Electric	Buildings	Research Centers	$800,000	$400,000	$400,000	50%
10	Electric	Buildings	Strategic Demonstrations Standards and Policy Coordination	$1,865,800	$866,489	$733,511	39%
10	Electric	Buildings	Technology Innovations	$5,464,200	$1,396,719	$2,070,981	38%
10	Natural Gas	Buildings	Advanced Energy-Efficient Heating Systems and Building Envelopes	$2,020,000	$390,990	$1,629,010	81%

Recommendation

Approve this agreement with Lawrence Berkeley National Laboratory for $4,911,721.00. Staff recommends placing this item on the discussion agenda of the Commission Business Meeting.

Issue

California has enacted the Global Warming Solutions Act of 2006 (also known as AB-32). In support of this law, the California Public Utilities Commission, in coordination with the Energy Commission and the Air Resources Board, developed the California Long Term Energy Efficiency Strategic Plan. These measures call for major reductions in greenhouse gas emissions related to California buildings and industry. These reductions will require a major improvement in energy efficiency because facility occupants require a reasonable level of indoor environmental quality. Research and technological development is required to meet these goals.

Background

The PIER buildings and industrial efficiency teams invited proposals related to these policy goals from the Lawrence Berkeley National Laboratory (LBNL) in January of 2011. LBNL assisted with the process, and agreed to manage all the projects and reporting tasks as a single contract. Without this approach, a multi-project program of this nature would not be possible for the PIER buildings and industrial efficiency teams.

All interested LBNL researchers were invited to participate in a teleconference on January 14,2011, in which Energy Commission staff explained the PIER program and selection criteria. A description of funding sources, topics, required sections, and selection criteria is included in Appendix 1.

The Energy Commission received 42 short form proposals on January 31, 2011 and 15 were selected for PIER funding, based on suitability for projects to use available funding sources, market connectedness, geographic diversification, and potential for energy savings and ratepayer benefit. A complete listing of proposals received is in Appendix 2

Proposed Work

The 15 proposals recommended for funding are as follows:
Budget Category: Domestic Hot Water Distribution

Project 1: Title: Reducing Waste In Residential Hot Water Distribution Systems
PI: Jim Lutz
Rank: 3
Amount: $280,000
Project Summary:
The goal of this 24 month project is to improve performance of residential hot water distribution systems in California by collecting and evaluating information that will lead to improved standards for residential plumbing construction. The research will include a field study of actual water use in six California houses and developing estimates for the efficiency of the hot water systems based on the measured usage. The water use will be monitored using available flow meters and wireless network technology. About 570 million cubic feet of natural gas are used each day for water heating in California homes. Little is known about how people actually use hot water, but anecdotes indicate that

as much as $1,000,000,000 annually of California water and fuel is wasted as people run water, waiting for it to get to usable temperature, which, after brief usage, then cools down in the pipes. Much of this waste is related to the hot water distribution systems designed by plumbers. Only fixture locations are indicated on layout drawings submitted for plan review. Requiring plans for piping layouts to obtain building permits will be a major process change that will require justification based on facts about field performance of these systems. Field performance data from this project will also contribute to the development of simulation tools. The project team is active in relevant committees in national organizations such as the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and the American Council for an Energy-Efficient Economy (ACEEE). The results of this study will be presented in papers at those forums, as well as contributing to development of California Title 20 and 24 efficiency standards. East Bay Metropolitan Utility District has expressed support and interest in participating in this project. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b)(2), AB-32 and the California Public Utilities Commission (CPUC)/Energy Commission Energy Efficiency Strategic Plan by leading to improved residential hot water distribution systems which can reduce both energy and water use.

Project 2: Title: Simulation Models for Improved Water Heating Systems
PI: James Lutz
Rank: 2
Amount: $470,000
Project Summary:
The goal of this 12 month project is to reduce natural gas and water used in residential domestic hot water applications by developing improved simulation models for building standards development. A significant amount of disparate research precedes this project, but the existing software tools are outdated and not inter-operable, which is increasingly a barrier to advancement. The research objectives of this project include: a) deconstructing existing hot water simulation models, b) correcting and augmenting with lab work and new information, where needed, c) re-coding software models using state-of-the-art tools and techniques, and d) making the models publicly available through open-source software libraries for research, product development, and efficiency standards development purposes. This team includes several leading developers of simulation software and also experts in hot water generation and distribution and is well-connected with other development and standards efforts. Reports will be published describing the software library and how it can be used to develop improved building energy standards for hot water generation and distribution, including Title 24, Title 20, ASHRAE 90.1 & 90.2

This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b)(2), AB-32 and the CPUC/Energy Commission energy Efficiency Strategic Plan by leading to improved residential hot water distribution systems which can reduce both energy and water use.

Project 3: Title: Improved Standards Through End-use Meter Development
PI: Rich Brown
Rank: 1
Amount: $250,000
Project Summary:

The goal of this 18 month project is to develop inexpensive end-use meters to better enable research on how water is actually used in homes, leading to better design standards for domestic hot water distribution systems. Better information about the performance of these systems is needed, but current metering technology is poorly suited to measuring water use at fixtures. This project would utilize standard strain gauge and sensor technology in the design of battery-powered meters for water and natural gas that would communicate using radio mesh networks. These meters could be used by researchers to amass data on how water is actually used and wasted in homes, and will provide feedback to end-users on their consumption. Intel, PG&E, and East Bay Metropolitan Water District have expressed support for this project. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b)(2), AB-32 and the CPUC/Energy Commission energy Efficiency Strategic Plan by leading to improved residential hot water distribution systems which can reduce both energy and water use.

Budget Category: Non-Residential Combined Cooling Heat Power

Project 4: Title: Encouraging Combined Heat and Power in California Buildings
PI: Chris Marnay
Rank: 1
Amount: $200,000
Project Summary:
The goal of this 18 month project is to maximize the cost-effectiveness of implementing California zero net-energy policy goals for commercial buildings in a technology-neutral fashion, particularly considering combined cooling, heat and power (CCHP). It will achieve this by extending the existing Distributed Energy Resources Customer Adoption Model (DER-CAM) to consider several scenarios for prototypical buildings in the California Commercial End-Use Survey (CEUS) database for the 2030 time-frame, and by enhancing the model with additional functionality about energy pricing models, active and passive thermal energy storage, CO2 and criteria air pollution emissions, and restaurant applications. Analysis of technologies such as CCHP is complex and typically only undertaken for large facilities. CCHP for sites under 5MW may be cost-effective but is seldom considered due to this complexity of analysis. Private firms typically only emphasize the benefit of technology they are selling, without analysis of alternatives. There is a need for a technology-neutral assessment of the potential value of competing technologies and approaches in smaller commercial buildings as represented in the CEUS data base, to assist owner's and designer's decision-making, and to guide the design of public policies to encourage desired outcomes. The team has had success with the DER-CAM tool in related projects. This project has support from US DOE, and also supports Governor Brown's initiative to promote the use of distributed generation. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b) (2), AB-32 and the CPUC/CEC energy Efficiency Strategic Plan by improving the energy efficiency of commercial buildings.

Budget Category: Natural Gas Space Heating and Building Envelope

Project 5: Title: Building Air-Tightness Through Appliance Venting Standards
PI: Craig Wray
Rank: 1
Amount: $390,990

Project Summary: The goal of this 18-month project is to improve energy efficiency of residential buildings while improving occupant health and safety by developing and disseminating ways to ensure combustion appliance venting safety while at the same time facilitating tighter building envelopes. In many residential building retrofit programs, if a gas-fired water heater or furnace is connected to the conditioned space, envelope air tightening is constrained by concerns related to vent back-drafting and spillage of combustion products into the interior space. Reducing residential infiltration by 10% would save an estimated 20-40 million therms ($30-$60 million) and 90-180 GWh ($13-$25 million) annually. The current tests to assess combustion safety are time consuming and do not reliably predict vent performance and safety. In this project, LBNL will combine measurements and simulations to produce improved test methods, guidelines, and standards for evaluating and diagnosing combustion safety issues. The results of this project would be disseminated through Title 24 and by proposing modifications to ASTM testing procedures. Combustion safety experts from PG&E have expressed support for this research. This project promotes the policy goals contained in the IEPR, Public Resources Code Section 25620.1 (b) (2), AB-32 and the CPUC/Energy Commission energy Efficiency Strategic Plan by leading to tighter residential envelopes.

Budget Category: Technical Innovation Buildings and Community

Project 6: Title: Efficient Electronics Through Measurement and Communication
PI: Alan Meier
Rank: 1
Amount: $400,000

Project Summary:
The goal of this 30 month project is to reduce energy use in appliances and plug loads by working with manufacturers to incorporate power measurement and reporting capability into power supplies used in consumer electronic devices. Plug loads represent roughly 30% of total electricity use in California homes, and about the same in commercial buildings, and are a growing fraction in both sectors. The ability to monitor energy use in specific plug loads will help to identify opportunities to reduce it. The research team will demonstrate a proof of concept with a power supply that measures and accumulates energy data, and transfers that information to a data aggregating point such as a router or smart meter. The project team at Lawrence Berkeley National Lab (LBNL) has extensive experience in energy use of electronics and have had many recommendations to Energy Star adopted, such as equipment that automatically shifts to a low power mode. LBNL has partnered with Power Integrations, a global power supply manufacturer, and ARM, a leading designer of advanced embedded microprocessors, to help develop this new market and bring further expertise to this project. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b)(2), AB-32 and the CPUC/Energy Commission energy Efficiency Strategic Plan by leading to reduced energy use from plug loads.

Project 7: Title: Innovative Air Cleaner for Improved IAQ and Energy Savings
PI: William Fisk
Rank: 2
Amount: $350,000

Project Summary:

The goal of this 24 month project is to enable energy savings by developing an air cleaner that can enable reduction of outdoor air for ventilation while at the same time improving indoor air quality. Ventilation air, typically about 15 cubic feet/minute per occupant, is a constant cooling load in commercial buildings during very hot peak times. Some of this ventilation requirement is related to toxic pollutants such as volatile organic compounds (VOC) and formaldehyde out gassing from building materials and furniture. Traditionally, 'the solution to pollution is dilution', in other words, ventilation. The proposed air cleaner will enable a reduction in ventilation rates by removing VOC using a regenerable carbon filter and by removing formaldehyde using an innovative catalytic filter, in addition to standard particulate filters. Early stage proof-of-concept was demonstrated with funding from DOE. Projected manufacturing costs appear to be reasonable, and strong commercialization interest has been expressed by UT Carrier Corp and Calgon Carbon. The research team is currently involved with PIER-funded, science-based state, national and international air quality standards development, and interacts regularly with relevant regulatory agencies such as Energy Commission, ARB, CalOSHA, and US EPA. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b) (2), AB-32 and the CPUC/Energy Commission Energy Efficiency Strategic Plan by reducing the need for outdoor air ventilation.

Project 8:
Title: Improved Audio-Video Efficiency Through Inter-Device Control
PI: Bruce Nordman
Rank: 3
Amount: $375,000

Project Summary:
The goal of this 30 month project is to develop and promote manufacturer adoption of a technology and communication standard for how audio/video devices can manage their power states. In California, electronics comprise nearly 20% of residential electricity use, with much of this being audio/video devices. Many of these devices are consuming power even when not in active use, such as a television receiving output from a DVD player that has been on 'pause' for an hour. The research team will address this problem by working with manufacturers to develop interoperability and communication mechanisms among audio-visual devices that limit the amount of time unneeded devices are powered up. The team will outline a standard for interoperability, with research that justifies and explains the standard content, and that also outlines how related existing standards should be modified. The project team at Lawrence Berkeley National Lab (LBNL) has extensive experience in communication technologies, electronics research, and standards development. LBNL is already working with the Energy Star program on standards development in this area, and various electronics industry associations, including the IEEE Consumer Electronic Society and the Consumer Electronics Association, have been receptive to the concept of interoperable standards development for energy efficiency. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b) (2), AB-32 and the CPUC/Energy Commission Energy Efficiency Strategic Plan by reducing standby power losses in consumer electronics.

Budget Category: Standards and Policy Development

Project 9:
Title: Performance Data for Improving Title 24 Compliance Systems
PI: Philip Haves

Rank: 1
Amount: $300,000

Project Summary: The goal of this 12-month project is to assist the Energy Commission standards office in its intention to move from building performance simulation based on DOE-2 and towards a generic process for certifying simulation programs for Title 24 compliance. To do so, LBNL proposes to develop, test, and verify a set of EnergyPlus reference models for systems specified by the Energy Commission. These systems are expected to include conventional mixed air systems, underfloor air distribution systems, radiant heating and cooling systems, chilled beams, natural and displacement ventilation, complex facades and window systems, phase-change materials, and others, together with corresponding sets of architectural and mechanical drawings for use in creating input files for candidate simulation programs. This work will build on system templates being developed for an EnergyPlus Graphical User Interface project for PIER and DOE. Work will be coordinated with the Nonresidential Building Standards group at the Energy Commission, and with architectural and engineering firms that contributed to EnergyPlus template development, including Arup, Capital Engineering, Guttmann and Blaevoet, HOK, SOM, and Taylor Engineering. The standards office at the energy commission expressed strong support for this project. This project promotes the policy goals of AB 32 and the CPUC/Energy Commission energy Efficiency Strategic Plan by leading to better simulation tools for California standards compliance.

Project 10: Title: Enabling Tools for Design of Energy-Efficient Building Systems
PI: Michael Wetter
Rank: 2
Amount: $395,731 (plus $325,000 DOE cost share)
Project Summary: The goal of this 18-month project is to accelerate the development, design, and rate of adoption of very-low-energy building systems. These systems require control strategies that cannot be easily simulated or tested with today's building-oriented simulation software. The simulation group at LNBL had early success with a tool called Modelica, which was previously applied to industrial, aeronautical and automotive simulation processes. This project would build an open-source library of Modelica applications for control strategy design, novel use of ambient thermal sources and sinks, heat recovery, and other techniques that can't be modeled with standard building simulation tools, but are potentially effective in California's climate. Modelica also has the capability to compile object code which can be downloaded into building control hardware. This enables comparison of actual building operational characteristics with simulation results, allowing refinement of simulation models using measured performance, and giving assurance that operational strategies in actual buildings correspond with simulated strategies. This will provide a way for control designers and architectural engineers to rapidly and more accurately simulate concepts before trial in actual buildings. The software will enable measurement and verification tool developers and providers to add physics-based models of products, subsystems, and whole-building systems to augment statistical methods currently used. A number of leading engineering firms expressed interest and support for the project, cost share of $325,000 is available from US DOE, and the project builds on and leverages multi-million dollar investments by the European Union. This project promotes the policy goals of AB 32 and the CPUC/Energy Commission energy Efficiency Strategic Plan by promoting innovative, lower energy space conditioning systems in California buildings.

Project 11: Title: Gaining Title 24 Credit for Efficient Evaporative Cooling
PI: Philip Haves

Rank: 3
Amount: $250,000
Project Summary: The goal of this 30 month project is to facilitate adoption of advanced evaporative cooling technologies in California by developing an improved indirect evaporative cooling model for Title 24 compliance. Hybrid indirect evaporative cooling systems have significantly better energy performance than traditional HVAC systems in the dry California climate, but are difficult to justify in new construction because they don't receive realistic credit for energy savings with Title 24 compliance software. Since hybrid systems are new to the market, they are also more expensive than conventional systems, and without accurate modeling to predict performance gains, it is harder to justify the added first-cost. In this project, simulation experts from LBNL would leverage knowledge of advanced evaporative cooling from the UC Davis Western Cooling Efficiency Center and elsewhere to develop plug-ins to EnergyPlus Title 24 compliance software. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b)(2), AB 32 and the CPUC/Energy Commission Energy Efficiency Strategic Plan by facilitating the adoption of advanced evaporative cooling technologies as an alternative to standard compressor driven air conditioning in dry California climates.

Primary Budget Category: Urban Heat Island Mitigation

Project 12: Title: Urban Heat Island Mitigation Phase 2
PI: Ronnen Levinson
Rank: 1
Amount: $400,000

Project Summary:
The goal of this 24 month project is to increase the adoption of cool roofs, cool pavements, and shade trees as 'cool community' measures through the expansion and dissemination of research about their benefits, including energy savings, and CO2 emission reductions. This will be done by creating codes, assisting with city implementation programs, and outreach and education efforts to other agencies such as CalTrans. Cool community measures have the potential to save ratepayers in California an estimated $500 million/year by reducing ambient urban peak summer temperatures, along with significant air quality benefits, if implemented across California. The research team has previous experience in developing California Title 24 standards for low-slope cool roofs for nonresidential buildings (2005) and residential buildings (2008). The project team at LBNLhas extensive experience with deployment and research on cool roof and cool pavement technologies and has developed key relationships with cities, industry, and other government agencies. This project was previously approved in the 2010-2011 PIER buildings budget plan by the RD&D Committee. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b)(2), AB 32 and the CPUC/Energy Commission Energy Efficiency Strategic Plan by promoting cool communities that can reduce energy used for air conditioning.

Primary Budget Category: IAW Energy Efficiency and Emerging Technologies

Project 13: Title: Data Center Energy Efficiency Demonstration Projects
PI: Bill Tschudi
Rank: 1
Amount: $300,000 Proposed Cost Share: $50,000

Project Summary: The goal of this 24 month project is to work with Silicon Valley Leadership Group (SVLG) member companies to develop demonstration projects. At a given company, the specific demonstration(s) selected will fit into the company's strategy for energy efficiency improvement. Demonstrations may highlight current industry best practices that have yet to be adopted, new or emerging technology solutions, operational changes, commissioning, etc., and can address software, IT equipment, or infrastructure issues. LBNL will also organize the Data Center Energy Efficiency Summit and present results from the demonstration. LBNL will participate in planning meetings to discuss the status of member projects and strategy to recruit more projects. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b) (2), AB-32 and the CPUC/Energy Commission Energy Efficiency Strategic Plan by reducing energy use in data centers

Project 14: Title: Energy Savings Through Data Center Waste Heat Reuse
PI: Bill Tschudi
Rank: 2
Amount: $120,000 Proposed Cost Share: In-kind est. ~$250,000

Project Summary: This 12 month project will focus on high performance computing data centers since these centers are eight to ten times more energy intensive than enterprise data centers and produce greater amounts of waste heat.
The project has three goals:
1) Develop a comprehensive status report on the design approaches and devices being explored and applied for reusing waste heat expelled from data center servers inside.
2) Evaluate the function and energy-saving performance of an innovative waste heat reuse system currently being installed in a new data center at LBNL.
3) Provide a technology case study on the innovative waste-heat reuse system at LBNL for hydronic heating, including lessons-learned and energy savings achieved.

This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b) (2), AB 32 and the CPUC/Energy Commission Energy Efficiency Strategic Plan by reducing energy use in data centers

Project 15: Title: Energy Efficiency in Small Server Rooms
PI: Bill Tschudi
Rank: 3
Amount: $250,000 Proposed Cost Share: $50,000

Project Summary:
The goal of this 18 month project is to improve overall energy efficiency over current practice for IT resources and support systems when deployed in small server closets and rooms. The project will investigate utilization, along with various power and cooling configurations currently in use,l in a sampling of such spaces and characterize the energy use in four unique situations. Through an in-depth look at several actual server room configurations, recommendations for efficiency improvement will be developed, including broader recommendations that could eliminate the "server closet" altogether through such technologies as cloud computing, server virtualization, server consolidation in data centers,

and other solutions. The objective is to reduce the energy use of servers and associated power and cooling infrastructure in commercial buildings by 50%. Realizing this potential will require further research to apply the recommendations in more types of buildings, publication of guidelines for IT and energy managers, and dissemination of the guidelines through utility programs and vendor services. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b) (2), AB 32 and the CPUC/Energy Commission Energy Efficiency Strategic Plan by reducing energy use in data centers

Justification and Goals

The projects within this proposed contract address the following:

- Public Resources Code Section 25620.1. (a-c):
  This project is part of a "full range of research, development, and demonstration activities that . . . are not adequately provided for by competitive and regulated markets," and "will develop, and help bring to market increased energy efficiency in buildings, appliances, lighting, and other applications beyond applicable standards, and that benefit electric utility customers," and "will advance energy science or technologies of value to California citizens..."

- Public Resources Code Section 25401:
  This section requires the Energy Commission to "carry out studies, technical assessments, research projects, and data collection directed to reducing wasteful, inefficient, unnecessary, or uneconomical uses of energy." This research will lead to such reduction through the opportunities identified for building and appliance standards.

- These projects are also consistent with the Integrated Energy Policy Report, AB 32 and the CPUC's Energy Efficiency Strategic Plan, which specifically identifies the need for lighting research to meet the state's policy goals for energy efficiency.

- The projects also address the following specific elements of the 2009 natural gas research plan, which was presented to, and accepted by, the CPUC:

1. Domestic hot water distribution. (Projects 1, 2 and 3)
2. Non-residential combined cooling, heating and power systems. (Project 4)
3. Natural gas space heating and building envelope. (Projects 5)

This will be accomplished by:

- Improving indoor air quality (IAQ) through improved air cleaning technology to substantially reduce the energy required for building ventilation
- Developing an improved EnergyPlus indirect evaporative cooling model that would provide sufficient flexibility to allow modeling of various advanced hybrid evaporative systems.
- Developing tools needed to provide broader end-use metering information for natural gas and water in homes, for use in end-use studies, energy efficiency standards, and other efforts to control and reduce energy consumption.

- Enabling the accreditation of simulation programs for use in Title 24, through providing a subset of reference innovative building energy systems.
- Advancing the full suite of heat island mitigation measuresâ€”cool roofs, cool pavements, and shade treesâ€”through expansion and dissemination of research about their benefits, including energy savings, CO2 emission reduction and global cooling
- Improving the design of simulation models for water heaters and hot water distribution systems (WH & HWDS) so they are capable of future expansion to accommodate new technologies.
- Improving the efficiency of hot water distribution systems in California
- Stimulating economic and environmentally sound natural gas-fired CHP and CCHP adoption in California's medium-sized commercial building sector
- Increasing the ability to monitor energy use in buildings and identify opportunities to reduce energy usage by incorporating standard power measurement and reporting capability into power supplies
- Accelerating the invention, development, design, and rate of adoption of very-low-energy building systems by developing a system-level design and operation analysis tool to be used by design firms to effectively evaluate new HVAC system configurations.
- Saving substantial electricity by creating a technology standard for how inter-connected audio/video devices manage their own power state and incorporate this into future products and into communication standards.
- Improving energy efficiency while maintaining occupant health and safety by reducing the combustion appliance barrier to increased air tightening.
- Improving overall energy efficiency over current practice for IT resources and their support systems when deployed in small server closets and rooms.
- Accelerating the adoption of energy-saving measures in data centers.
- Reducing energy loss in data centers by utilizing waste heat in an innovative facility hydronic heating system.

#	Title	Description	Potential Benefit	PIER Amount	Match	Supporters
1	Field Performance of Residential Hot Water Distribution	Improve performance of residential hot water distribution systems by collecting and evaluating information on actual water use that can lead to improved standards for residential plumbing construction. Field monitoring of actual water use to determine efficiency of hot water systems. Potential to reduce natural gas and water use (including embedded energy).	• 570 million cf of gas used for hot water heating • Up to $1B/yr of water and fuel wasted	$280,000		• CEC Efficiency Standards • East Bay Metropolitan Utility District
2	Simulation Models for Water Heaters and Hot Water Distribution Systems	Develop improved simulation models for building standards development. Research objectives are to deconstruct and correct existing models using new information and modern software practice, and make them publicly available.	Reduce natural gas and water used for residential domestic hot water	$470,000		• CEC Efficiency Standards
3	End-Use Gas and Water Meter Development	Develop inexpensive end use meters to enable research on how water is used in homes-leading to better design standards for domestic hot water distribution systems. The meter could provide feedback to end users on their consumption.	Reduce natural gas and water used for residential domestic hot water	$250,000		• Intel • PG&E • East Bay Metropolitan Water District
4	Decision Tools for Combined Cooling, Heating and Power in	Extend the existing Distributed Energy Resources Customer Adoption Model(DER-CAM) to consider several scenarios for	Provide decision-making tool s for small	$200,000		• US DOE • CPUC • Natural Gas Utilities

#	Title	Description	Potential Benefit	PIER Amount	Match	Supporters
	Small Buildings	prototypical buildings in the California Commercial End Use Survey (CEUS) database for the 2030 time frame and enhance the model with additional functionality such as energy pricing, active and passive thermal energy storage, CO2 and criteria air pollution emissions and other applications.	commercial building owners regarding CHP options			
5	Solving Combustion Appliance Hazards From Residential Air Tightness	Improve energy efficiency of residential building by developing ways to ensure combustion appliance venting safety while facilitating tighter building envelopes. LBNL will combine measurements and simulations to produce improved test methods, guidelines and standards for evaluating and diagnosing combustion safety issues	10% reduction in residential infiltration results in annual savings of 20-40 million therms and 90-180 GWh.	$390,990		• CEC Efficiency Standards • PG&E
6	Adding Measurement and Communications to Power Supplies	Reduce energy use in appliances and plugs loads and work with manufacturers to incorporate power measurement and reporting capability into power supplies in consumer electronics. Demonstrate a proof of concept power supply that measures and accumulates energy data, and transfers information to a data aggregating point (e.g., smart meter)	Reduce plug load energy use--plug loads consume 30% of total electricity in CA homes	$400,000		• Power Integration • ARM

#	Title	Description	Potential Benefit	PIER Amount	Match	Supporters
7	Air Cleaner for Removing Toxic Chemicals	Develop an air cleaner which can reduce outdoor air for ventilation while improving indoor air quality. Research could enable a reduction in ventilation rates by removing VOC and formaldehyde using innovate filters.	Reduce the amount of outside air that needs to be heated or cooled	$350,000		• UT Carrier Corp • Calgon Carbon
8	Audio/video Inter-Device Power Control	Develop and promote manufacturer adoption of a technology and communication standard audio/video devices that can manage their power states. Work with manufacturers to develop interoperability and communication mechanisms among audio visual devices which limit the time unneeded devices are powered up. Outline standard for interoperability with research that justifies and explains the standard content and outlines how existing standards should be modified.	Reduce electronic energy use--electronics comprise 20% of residential electricity use.	$375,000		Consumer electronics Manufacturers EPA EnergyStar
9	Reference Data Sets for Validating Energy Simulation Programs	Develop, test and verify a set of EnergyPlus reference models that will enable the use of a generic process for certifying simulation programs to Title 24 compliance rather than using building performance simulation based on DOE-2. Research will building on templates being developed in	Simplify building performance simulation programs for Title 24 compliance	$300,000		• CEC Efficiency Standards • Architectural and engineering firms

#	Title	Description	Potential Benefit	PIER Amount	Match	Supporters
		previous PIER and DOE contracts.				
10	Simulation Software for Design and Operation of Very Efficient Buildings	Accelerate the development, design and rate of adoption of very low energy building systems by building an open source library for Modelica, a simulation software program. The program will include applications for control strategy, design, novel use of ambient thermal sources and sinks, heat recovery and other techniques.	Facilitate the evaluation of low energy building systems by architects and engineers using effective building simulation tools.	$395,731	$325,000 (DOE)	• Engineering firms • US DOE
11	Evaporative Cooling Models for Title 24 Compliance	Facilitate adoption of advanced evaporative cooling technologies by developing an improved indirect evaporative cooling model for T-24 compliance.. The researchers will develop plug-ins to Energy Plus T-24 compliance software to predict performance gains.	Increased use of evaporative cooling technologies in hot dry climates—reducing air conditioning use.			• CEC Efficiency Standards
12	Urban Heat Island Mitigation (Phase 2)	Increase the adoption of cool roofs, cool pavements, and shade trees as cool community measures through dissemination of research about benefits, such as energy savings and CO2 reductions. Assist with city implementation programs and outreach and education efforts.	Cool community measures can save ratepayers up to $500 million/yr	$400,000		Local Government s implementing SB375 CalTrans
13	Data Center	Develop demonstrations with the	Reduce	$300,000	$50,000	• SVLG

#	Title	Description	Potential Benefit	PIER Amount	Match	Supporters
	Energy Efficiency Demonstration Project	Silicon Valley Leader Group (SVLG) to highlight current industry best practices, new or emerging technology solutions, operational changes, commission and can address software, IT equipment or infrastructure issues. Organize Data Center Energy Efficiency Summit and present findings from research projects.	energy use in data centers			• Data Center Commissioning Agents • Data Center Owners
14	Data Center Waste Heat Reuse	Evaluate and assess performance of energy saving options for waste heat reuse in high performance computing data centers. Develop status report, and provide case study on the innovative waste heat reuse system at LBNL for hydronic heating.	Reduce energy use in data centers	$120,000	$250,000	Facilities with data centers and heating needs
15	Energy Efficiency in Small Server Rooms	Improve the energy efficiency of IT resources and support systems in small server closets and rooms. Investigate utilization, power and cooling configurations and characterize energy use.	Reduce energy use of servers in commercial buildings by 50%.	$250,000	$50,000	Facilities with small server rooms
	Total			$4,911,721	$675,000	