STATE OF CALIFORNIA

GRANTS/CONTINGENT AWARD REQUEST

CEC-270 (Revised 02/10) CALIFORNIA ENERGY COMMISSION

To: Grants and Loans Office Date: 3/21/2013

Project Manager: Jeffrey Doll Phone Number: 916-327-1713

Office: Energy Efficiency Research Office Division: Energy Research and Development MS- 51

Project Title: Innovative Low-Energy Occupant-Responsive Controls for Heating, Ventilation and Air Conditioning Systems

Type of Request: *(check one)*

☒ **New Agreement:** *(include items A-F from below)* Agreement Number: PIR-12-026

Program: PIER NG / Buildings End-Use Energy Efficiency

Solicitation Name and/or Number: PON-12-503-06 (Building Energy Efficiency Research and Technology Grant Program)

Legal Name of Recipient: Regents of the University of California/California Institute for Energy and Environment

Recipient's Full Mailing Address: Center for the Built Environment University of California, 390 Wurster Hall #1839 Berkeley, CA 94704

Recipient's Project Officer: Fred Bauman Phone Number: (510) 642-7848

Agreement Start Date: 6/30/2013 Agreement End Date: 3/31/2017

☐ **Amendment :** *(Check all that apply)* Agreement Number:

- ☐ Term Extension – New End Date:
- ☐ Work Statement Revision *(include Item A from below)*
- ☐ Budget Revision *(include Item B from below)*
- ☐ Change of Scope *(include Items A – F as applicable from below)*
- ☐ Other:

ITEMS TO ATTACH WITH REQUEST:

A. Work Statement
B. Budget
C. Recipient Resolution, if applicable. (Resolution may be requested in Special Conditions if not currently available.)
D. Special Conditions, if applicable.
E. CEQA Compliance Form
F. Other Documents as applicable
- Copy of Score Sheets
- Copy of Pre-Award Correspondence
- Copy of All Other Relevant Documents

California Environmental Quality Act (CEQA)

☒ CEC finds, based on recipient's documentation in compliance with CEQA:

- ☒ Project exempt: 14 CCR Section 15301 NOE filed:
- ☐ Environmental Document prepared: NOD filed:
- ☐ Other:

☒ CEC has made CEQA finding described in CEC-280, attached

Funding Information:

*Source #1:	NG	Amount:	$ 1,000,000.00	Statute:	12-	FY: 12-13	Budget List #: 501.001G
*Source #2:	PIER-E	Amount:	$ 629,399.00	Statute:	11-	FY: 12-13	Budget List #: 501.027J
*Source #3:		Amount:	$	Statute:		FY:	Budget List #:

If federally funded, specify federal agreement number:

*** Source Examples include ERPA, PIER-E, PIER-NG, FED, GRDA, ARFVT, OTHER.**

Business Meeting Approval: *(refer to Business Meeting Schedule)*

Proposed Business Meeting Date: 6/12/2013 ☐ Consent ☒ Discussion

Business Meeting Participant: Jeffrey Doll Time Needed: 5 minutes

Agenda Notice Statement: *(state purpose in layperson terms)*

Possible approval of a ☒ Grant / ☐ Contingent Award to…

REGENTS OF THE UNIVERSITY OF CALIFORNIA. Possible approval of Agreement PIR-12-026 with the Regents of the University of California/ California Institute for Energy and Environment for a $1,629,399 grant to demonstrate the use of plug-in low energy personal comfort systems that will allow optimized control of heating, ventilation, and air conditioning (HVAC) systems in integrated building applications. The agreement includes $192,500 in match funding. (PIER electricity and natural gas funding) Contact: Jeffrey Doll.

Project Manager	Date	Office Manager	Date	Deputy Director	Date

Exhibit A
Scope of Work

TECHNICAL TASK LIST

Task #	CPR	Task Name
1	N/A	Administration
2		Occupant-Responsive Control and Conditioning Systems
2.1		Personal Comfort Technologies
2.2		Rules for Variable Air Volume Systems
2.3		Feedback Loop and Information Technologies
2.4	X	Energy and Comfort Simulations
3		Demonstration, Deployment, and Commercialization
3.1		Demonstration #1
3.2		Demonstration #2
3.3	X	Demonstration, Deployment, and Commercialization Plan
4		Standards and Codes
5		Technology Transfer Activities
6		Production Readiness Plan

KEY NAME LIST

Task #	Key Personnel	Key Subcontractor(s)
1	Fred Bauman, Carl Blumstein, Karl Brown – UC Berkeley	
2	Edward Arens, Fred Bauman – UC Berkeley Gwelen Paliaga, Steve Taylor – Taylor Engineering	Taylor Engineering
2.1	Stefano Schiavon, Hui Zhang, Edward Arens – UC Berkeley Gwelen Paliaga	
2.2	Edward Arens, Hui Zhang, Gwelen Paliaga, Jeff Stein, Steve Taylor	
2.3	David Culler , Carl Blumstein, Karl Brown, Fred Bauman, Stefano Schiavon – UC Berkeley	
2.4	Fred Bauman, Stefano Schiavon	
3	Edward Arens, Fred Bauman, Carl Blumstein, Karl Brown, David Culler, Stefano Schiavon, Hui Zhang, Gwelen Paliaga, Jeff Stein	Taylor Engineering
3.1	Edward Arens, Fred Bauman, Carl Blumstein, Karl Brown, Stefano Schiavon, Hui Zhang, Gwelen Paliaga, Jeff Stein, Steve	
3.2		

Exhibit A
Scope of Work

Task #	Key Personnel	Key Subcontractor(s)
	Taylor	
3.3	Carl Blumstein, Karl Brown, Fred Bauman, Edward Arens, Hui Zhang, David Culler	
4	Edward Arens, Fred Bauman, Stefano Schiavon, Hui Zhang, Gwelen Paliaga, Jeff Stein	
5	Carl Blumstein, Karl Brown, Fred Bauman, Edward Arens, Hui Zhang, David Culler	

GLOSSARY
Terms and acronyms used throughout this scope of work are defined as follows:

Term/ Acronym	Definition
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
BMS	Building Management System
CBE	Center for the Built Environment, UC Berkeley
Energy Commission	California Energy Commission
CPM	Commission Project Manager
CPR	Critical Project Review
DDC	Direct Digital Controls
EM	Energy Management
HVAC	Heating, Ventilating, and Air Conditioning
IOU	Investor-Owned Utilities
PCS	Personal Comfort System
USGBC	US Green Buildings Council
VAV	Variable Air Volume

Problem Statement:
State goals for building energy efficiency improvements require a change in the relationship between energy use and occupant comfort through an integrated approach involving new designs, technologies, operation, control, commissioning, and monitoring. However, the pace of innovation and the integration of ideas is not adequate to support the significant energy improvements demanded of the building industry. The rate at which codes and standards are changing is too slow and inhibits the widespread market impact of new developments.

There is a need for a new control paradigm based on expanded roles of occupants, operators, and automation in control. This paradigm applies equally to existing

buildings and to new designs. It includes innovative personal comfort technologies, control improvements, and web-based information technology that have the potential to dramatically improve traditional levels of energy efficiency, increase occupant satisfaction and thermal comfort, and increase the flexibility and useful life of conditioning systems.

The new paradigm requires: (1) new operational approaches and a reexamination of how comfort performance is quantified in standards and design tools; a higher level of sensing and feedback to produce the efficiency gains they are capable of; (3) integration into occupant-based heating, ventilating, and air conditioning (HVAC) control systems; and (4) training of building professionals.

Goals of the Agreement:
The goal of this Agreement is to develop, evaluate, integrate, demonstrate, and plan for the scaled deployment of three innovative strategies that will dramatically improve both energy efficiency and occupant comfort in buildings. The strategies are:

- Low-energy personal comfort systems (PCSs) that provide direct local heating and cooling to building occupants and test methods for assessing the efficiency of PCSs;
- Innovative control improvements to variable air volume (VAV) reheat systems, including lower minimum diffuser airflow rates, occupant-responsive temperature reset strategies, and rogue-zone control; and
- Information technology in the form of open-source software for implementing actuation control logic across a full range of legacy or new direct digital control (DDC) systems in retrofit, DDC upgrade, or new construction scenarios.

The strategies will correct frequently-occurring control problems and optimize operation through the use of occupant-responsive comfort devices and innovative information technologies.

Objectives of the Agreement:
The objectives of this Agreement are to:

- Demonstrate and bring to the market new low-energy, localized PCSs, and develop methods for certifying their efficiency.
- Develop and demonstrate innovative improvements to VAV control systems
- Use open-source information technology software for implementing actuation control logic across a full range of DDC systems.
- Create a Demonstration, Deployment, and Commercialization Plan for the innovative strategies, with occupant-based HVAC controls.
- Demonstrate integrated applications of the innovations with occupant-based HVAC controls.
- Implement the results in codes and standards such as Titles 20 and 24 of the California Code of Regulations, and Standards 55 and 90.1 of the American

Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE) Standards.
- Perform technology transfer activities to encourage adoption of the standards in common practice.

TASK 1 ADMINISTRATION

Instructions for Submitting Electronic Files and Developing Software

Electronic File Format
The Recipient will deliver an electronic copy (CD ROM or memory stick or as otherwise specified by the Commission Project Manager (CPM) of the full text of any Agreement products in a compatible version of Microsoft Word (.doc).
The following describes the accepted formats of electronic data and documents provided to the Energy Commission as products and establishes the computer platforms, operating systems, and software versions that will be required to review and approve all software deliverables.

- Data sets will be in Microsoft (MS) Access or MS Excel file format.
- PC-based text documents will be in MS Word file format.
- Documents intended for public distribution will be in PDF file format, with the native file format provided as well.
- Project management documents will be in MS Project file format.

Software Application Development
If this Scope of Work includes any software application development, including but not limited to databases, websites, models, or modeling tools, the Recipient will use the following standard Application Architecture components in compatible versions:

- Microsoft ASP.NET framework (version 3.5 and up) Recommend 4.0.
- Microsoft Internet Information Services (IIS), (version 6 and up) Recommend 7.5.
- Visual Studio.NET (version 2008 and up) Recommend 2010.
- C# Programming Language with Presentation (UI), Business Object and Data Layers.
- SQL (Structured Query Language).
- Microsoft SQL Server 2008, Stored Procedures Recommend 2008 R2.
- Microsoft SQL Reporting Services Recommend 2008 R2.
- XML (external interfaces).

Any exceptions to the Electronic File Format requirements above must be approved in writing by the Energy Commission's Information Technology Services Branch.

Exhibit A
Scope of Work

Task 1.1 Attend Kick-off Meeting

The goal of this task is to establish the lines of communication and procedures for implementing this Agreement.

The Recipient shall:

- Attend a "Kick-Off" meeting with the Commission Project Manager (CPM), the Grants Officer, and a representative of the Accounting Office. The Recipient shall bring its Project Manager, Agreement Administrator, Accounting Officer, and others designated by the CPM to this meeting. The administrative and technical aspects of this Agreement will be discussed at the meeting. Prior to the kick-off meeting, the CPM will provide an agenda to all potential meeting participants.

  The administrative portion of the meeting shall include, but not be limited to, the following:
  - Discussion of the terms and conditions of the Agreement
  - Discussion of Critical Project Review (Task 1.2)
  - Match fund documentation (Task 1.6) *No work may be performed until this documentation is in place.*
  - Permit documentation (Task 1.7)
  - Discussion of subcontracts needed to carry out project (Task 1.8)

  The technical portion of the meeting shall include, but not be limited to, the following:
  - The CPM's expectations for accomplishing tasks described in the Scope of Work
  - An updated Schedule of Products
  - Discussion of Progress Reports (Task 1.4)
  - Discussion of Technical Products (Product Guidelines located in Section 5 of the Terms and Conditions)
  - Discussion of the Final Report (Task 1.5)

  The CPM shall designate the date and location of this meeting.

- Submit an updated Schedule of Products, List of Match Funds, and List of Permits to the CPM.

Recipient Products:

- Updated Schedule of Products
- Updated List of Match Funds
- Updated List of Permits

Commission Project Manager Product:

- Kick-Off Meeting Agenda

Task 1.2 Critical Project Review (CPR) Meetings

The goal of this task is to determine if the project should continue to receive Energy Commission funding to complete this Agreement and to identify any needed modifications to the tasks, products, schedule, or budget.

CPRs provide the opportunity for frank discussions between the CPM and the Recipient. The CPM may schedule CPRs as necessary, and CPR costs will be borne by the Recipient.

Participants include the CPM and the Recipient, and may include the Commission Grants Officer, the Energy Research and Development Division technical lead, other Energy Commission staff and Management, and any other individuals selected by the CPM to provide support to the Energy Commission.

The Commission Project Manager shall:

- Determine the location, date, and time of each CPR meeting with the Recipient. These meetings generally take place at the Energy Commission, but they may take place at another location or may be conducted via electronic conferencing (e.g., WebEx), as determined by the Commission Project Manager.
- Send the Recipient the agenda and a list of expected participants in advance of each CPR. If applicable, the agenda shall include a discussion of both match funding and permits.
- Conduct and make a record of each CPR meeting. One of the outcomes of this meeting will be a schedule for providing the written determination described below.
- Determine whether to continue the project, and if so whether modifications are needed to the tasks, schedule, products, and/or budget for the remainder of the Agreement. If the CPM concludes that satisfactory progress is not being made, this conclusion will be referred to the Deputy Director of the Energy Research and Development Division.
- Provide the Recipient with a written determination in accordance with the schedule. The written response may include a requirement for the Recipient to revise one or more products that were included in the CPR.

The Recipient shall:

- Prepare a CPR Report for each CPR that discusses the progress of the Agreement toward achieving its goals and objectives. This report shall include recommendations and conclusions regarding continued work on the project. This report shall be submitted along with any other products

- Present the required information at each CPR meeting and participate in a discussion about the Agreement.

Commission Project Manager Products:

- Agenda and a list of expected participants
- Schedule for written determination
- Written determination

Recipient Product:

- CPR Report(s)

Task 1.3 Final Meeting

The goal of this task is to close out this Agreement.

The Recipient shall:

- Meet with Energy Commission staff to present the project findings, conclusions, and recommendations. The final meeting must be completed during the closeout of this Agreement.

  This meeting will be attended by, at a minimum, the Recipient, the Commission Grants Office Officer, and the CPM. The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be divided into two separate meetings at the discretion of the CPM.
  The technical portion of the meeting shall involve the presentation of an assessment of the degree to which project and task goals and objectives were achieved, in addition to findings, conclusions, recommended next steps (if any) for the Agreement, and recommendations for improvements. The CPM will determine the appropriate meeting participants.

  The administrative portion of the meeting shall involve a discussion with the CPM and the Grants Officer about the following Agreement closeout items:
  - Disposition of any equipment purchased with Energy Commission funds
  - Energy Commission's request for specific "generated" data (not already provided in Agreement products)
  - Need to document Recipient's disclosure of "subject inventions" developed under the Agreement
  - "Surviving" Agreement provisions

  - Final invoicing and release of retention
- Prepare written documentation of any agreements made between the Recipient and Commission staff during the meeting.
- Prepare a schedule for completing the closeout activities for this Agreement.

Products:

- Written documentation of meeting agreements
- Schedule for completing closeout activities

Task 1.4 Monthly Progress Reports

The goal of this task is to periodically verify that satisfactory and continued progress is made towards achieving the research objectives of this Agreement on time and within budget.

The objectives of this task are to summarize activities performed during the reporting period, to identify activities planned for the next reporting period, to identify issues that may affect performance and expenditures, and to form the basis for determining whether invoices are consistent with work performed.

The Recipient shall:

- Prepare a Monthly Progress Report that summarizes all Agreement activities conducted by the Recipient for the reporting period, including an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. Each progress report is due to the CPM within 10 days of the end of the reporting period. The recommended specifications for each progress report are contained in the Terms and Conditions of this Agreement.
- In each Monthly Progress Report and invoice, document and verify:
  - Energy Commission funds received by California-Based Entities (CBEs);
  - Energy Commission funds spent in California; and
  - Match fund expenditures

  Also provide a synopsis of project progress.

Product:

- Monthly Progress Reports

Task 1.5 Final Report

The goal of the Final Report is to assess the project's success in achieving its goals and objectives, advancing science and technology, and providing energy-related and other benefits to California.

The objectives of the Final Report are to clearly and completely describe the project's purpose, approach, activities performed, results, and advancements in science and technology; to present a public assessment of the success of the project as measured by the degree to which goals and objectives were achieved; to make insightful observations based on results obtained; to draw conclusions; and to make recommendations for further projects and improvements.

The Final Report shall be a public document. If the Recipient has obtained confidential status from the Energy Commission and will also prepare a confidential version of the Final Report, the Recipient shall perform the following activities for both the public and confidential versions of the Final Report.

The Recipient shall:

- Prepare an Outline of the Final Report.
- Prepare a Final Report following the approved outline and the latest version of the Final Report guidelines which will be provided by the CPM. The CPM shall provide written comments on the Draft Final Report within 15 working days of receipt. The Final Report must be completed at least 90 days before the end of the Agreement Term.
- Submit one bound copy of the Final Report with the final invoice.

Products:

- Draft Outline of the Final Report
- Final Outline of the Final Report
- Draft Final Report
- Final Report

Task 1.6 Identify and Obtain Match Funds

The goal of this task is to ensure that the match funds planned for this Agreement are obtained and applied to this Agreement during the term of this Agreement.

The costs to obtain and document match fund commitments are not reimbursable through this Agreement. Although the Energy Commission budget for this task will be zero dollars, the Recipient may utilize match funds for this task. Match funds shall be spent concurrently or in advance of Energy Commission funds for each task during the term of this Agreement. Match funds must be identified in writing and the associated

commitments obtained before the Recipient can incur any costs for which the Recipient for which the Recipient will request reimbursement.

The Recipient shall:

- Prepare a letter documenting the match funding committed to this Agreement and submit it to the CPM at least 2 working days prior to the kick-off meeting. If no match funds were part of the proposal that led to the Energy Commission awarding this Agreement and none have been identified at the time this Agreement starts, then state such in the letter. If match funds were a part of the proposal that led to the Energy Commission awarding this Agreement, then provide in the letter a list of the match funds that identifies the:
  - Amount of each cash match fund, its source (including a contact name, address and telephone number), and the task(s) to which the match funds will be applied.
  - Amount of each in-kind contribution, a description, documented market or book value, its source (including a contact name, address and telephone number), and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or real property, the Recipient shall identify its owner and provide a contact name, address, telephone number, and the address where the property is located.
- Provide a copy of the letter of commitment from an authorized representative of each source of cash match funding or in-kind contributions that these funds or contributions have been secured. For match funds provided by a grant a copy of the executed grant shall be submitted in place of a letter of commitment.
- Discuss match funds and the implications to the Agreement if they are reduced or not obtained as committed, at the kick-off meeting. If applicable, match funds will be included as a line item in the progress reports and will be a topic at CPR meetings.
- Provide a letter including the appropriate information to the CPM if during the course of the Agreement additional match funds are received.
- Provide a letter to the CPM within 10 days if during the course of the Agreement existing match funds are reduced. Reduction in match funds must be approved through a formal amendment to the Agreement and may trigger an additional CPR.

Products:

- A letter regarding match funds or stating that no match funds are provided
- Copy(ies) of each match fund commitment letter(s) (if applicable)
- Letter(s) for new match funds (if applicable)
- Letter that match funds were reduced (if applicable)

Task 1.7 Identify and Obtain Required Permits

The goal of this task is to obtain all permits required for work completed under this Agreement in advance of the date they are needed to keep the Agreement schedule on track.

Permit costs and the expenses associated with obtaining permits are not reimbursable under this Agreement. Although the Energy Commission budget for this task will be zero dollars, the Recipient shall budget match funds for any expected expenditures associated with obtaining permits. Permits must be identified in writing and obtained before the Recipient can make any expenditure for which a permit is required.

The Recipient shall:

- Prepare a letter documenting the permits required to conduct this Agreement and submit it to the CPM at least 2 working days prior to the kick-off meeting. If there are no permits required at the start of this Agreement, then state such in the letter. If it is known at the beginning of the Agreement that permits will be required during the course of the Agreement, provide in the letter:
  - A list of the permits that identifies the:
    - Type of permit
    - Name, address and telephone number of the permitting jurisdictions or lead agencies
  - The schedule the Recipient will follow in applying for and obtaining these permits
- Discuss the list of permits and the schedule for obtaining them at the kick-off meeting and develop a timetable for submitting the updated list, schedule, and copies of the permits. The implications to the Agreement if the permits are not obtained in a timely fashion or are denied will also be discussed. If applicable, permits will be included as a line item in the Progress Reports and will be a topic at CPR meetings.
- If during the course of the Agreement additional permits become necessary, provide an updated list of permits (including the appropriate information on each permit) and an updated schedule to the CPM.
- As permits are obtained, send a copy of each approved permit to the CPM.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the CPM within 5 working days. Either of these events may trigger an additional CPR.

Products:

- Letter documenting the permits or stating that no permits are required
- Updated list of permits as they change during the term of the Agreement (if applicable)

- Updated schedule for acquiring permits as changes occur during the term of the Agreement (if applicable)
- A copy of each approved permit (if applicable)

Task 1.8 Obtain and Execute Subcontracts

The goal of this task is to ensure quality products and to procure subcontracts required to carry out the tasks under this Agreement consistent with the terms and conditions of this Agreement and the Recipient's own procurement policies and procedures. This task will also provide the Energy Commission an opportunity to review the subcontracts to ensure that the tasks are consistent with this Agreement, and that the budgeted expenditures are reasonable and consistent with applicable cost principles.

The Recipient shall:

- Manage and coordinate subcontractor activities.
- Submit a draft of each subcontract required to conduct the work under this Agreement to the Commission Agreement Manager for review.
- Submit a final copy of the executed subcontract.
- If the Recipient decides to add new subcontractors, it shall notify the Commission Agreement Manager.

Products:

- Draft subcontracts
- Final subcontracts

TECHNICAL TASKS

*Products not requiring a draft version are indicated by marking **"(no draft)"** after the product name.*

TASK 2 OCCUPANT-RESPONSIVE CONTROL AND CONDITIONING SYSTEMS

The goal of this task is to develop innovative approaches to optimize the control of HVAC systems for energy efficiency in conjunction with the use of: (1) low-energy PCSs that provide direct local heating and cooling for building occupants; (2) occupant-responsive temperature resets based on adaptive comfort and clothing models; (3) technology for occupant satisfaction polling; (4) technology allowing partial direct occupant control of HVAC and lighting systems including smart phone applications; and (5) other fast-emerging new information technology.

Exhibit A
Scope of Work

Task 2.1 Personal Comfort Technologies

The goal of this task is to design, test, and fabricate a new prototype PCS chair, develop performance specifications and test methods for energy/comfort efficiency of PCS devices, and study the applicability of the adaptive comfort model to PCS devices.

The Recipient shall:

- Prepare Fabrication and Performance Specifications for a PCS Chair, Foot Warmer, and Fan.
- Fabricate 75 PCS chairs for demonstration field studies.
- Prepare a PCS Chair Energy and Comfort Assessment Report that includes but is not limited to:
    - A description of the design of a new version of the PCS chair, including cost of manufacture and key components such as battery, fans, heating elements, and controls.
    - Quantification of the heating/cooling performance, occupant comfort in the PCS chair under exposure to warm and cold temperatures, and occupants' use of personal controls using the thermal manikin and human subject testing in the Controlled Environment Chamber of the Recipient's Center for the Built Environment (CBE).
- Prepare a Report on Efficiency Test Method for PCS Devices that includes but is not limited to:
    - A summary of the literature and development of a heating effect and a portable heater efficiency index, and a cooling effect and a cooling fan efficiency index.
    - A determination (based on laboratory tests) of the most important parameters that affect the portable heater efficiency index and the cooling fan efficiency index.
    - A description of test procedures and a recommendation on minimum performance values for the portable heater efficiency index and the cooling fan efficiency index.

Products:

- Fabrication and Performance Specifications for PCS Chair, Foot Warmer, and Fan (no draft)
- PCS Chair Energy and Comfort Assessment Report
- Report on Efficiency Method of Test for PCS Devices

Task 2.2 Rules for Variable Air Volume Systems

The goal of this task is to develop, test, and specify new sequences and strategies for optimizing control of building HVAC systems for energy efficiency in conjunction with the use of occupant-based comfort and information technology innovations. In combination

with results from Tasks 2.1 and 2.3, this task will also result in integrated plans for conducting developmental field testing and subsequent demonstration field studies.

The Recipient shall:

- Collect data on actual variable air volume (VAV) box installations that will lead to new design guidance and code requirements for determining and lowering the controllable minimum flow rate for zone controls.
- Review prior laboratory research by Taylor/Dickerhoff, ASHRAE RP-1353, RP-1515, and others to develop a list of parameters of interest. These parameters will determine the controllable minimum flow rates.
- Identify candidate buildings and zones that cover a range of the parameters of interest, including whether the zone has PCSs.
- Test various hypotheses and comfort models to find optimal zone temperature set points that do not over-condition. Zone temperatures will be reset based on a season occupant clothing model, adaptive thermal comfort model, occupant polling, or a combination of these approaches.
- Develop a new and improved supply air temperature set point. In order to calculate reheat energy, reset the sequence by considering other parameters such as peak efficiency and part load efficiency profiles of system fans, chillers, boilers, and current zone loads.
- Develop and test solutions to rogue zones through improved controls and use of personal control systems, including identification of the optimum number of zones to ignore or suppress, automated diagnostics and reporting of rogue zones, and use of PCSs to reduce rogue zones in demonstrations studies.
- Prepare a Developmental Field Study Plan that describes Stage 1 testing. This stage will include guidance for testing of an integrated approach with occupant-based comfort and information technology innovations to ultra-low VAV zone minima, occupant-responsive zone temperature set point reset, VAV supply air temperature set point reset, rogue zone control approaches, and demand-controlled ventilation.
- Prepare a Developmental Field Study Report that includes a Demonstration Field Study Plan. The report will describe the results and lessons learned from the testing of integrated control, PCS, and information technology solutions.

  The Demonstration Field Study Plan will include: criteria for selecting buildings and control zones for demonstration studies; required measurements, BMS trend data, and additional simple Measurement and Actuation Profile (sMAP) enabled data collection; testing protocols for intervention studies allowing comparison of alternative control and technology solutions; and requirements for occupant response data collection via survey or Smartphone apps.

Products:

- Developmental Field Study Plan
- Developmental Field Study Report

Task 2.3 Feedback Loop and Information Technologies

The goal of this task is to demonstrate information technology infrastructure that is capable of integrating the otherwise disparate facets of advanced energy efficient buildings (i.e., occupant-based control, on-demand HVAC, PCS, and novel building physical capabilities) into a cohesive, optimized, overarching system. The system will permit analysis of data by operators and integration into control strategies, and will also permit feedback to occupants.

The Recipient shall:

- Develop adapters for the sMAP platform for the two project demonstration buildings to systematically collect real time measurements of VAV operations, as well as the underlying air handler unit, chiller, condenser, and economizer. Provide optimized access to large numbers of historical time-series for modeling, analysis, and feedback to operators.
- Develop instruments to collect occupant feedback on indoor environmental quality (IEQ) in field study buildings.
- Develop sMAP interfaces to PCS units and enable studies of the usage of wider operating temperature deadbands and temperature or pressure resets in the presence of personalized control.
- Develop occupant and operator-centered control interfaces for Smartphones to integrate personalized comfort directives into control algorithms through sMAP.
- Demonstrate advanced control algorithms operating on top of sMAP and presenting integrated operations modes that are not directly supported by the underlying building management system (BMS) or energy management system (EMS), such as economizer-aware VAV minimums and occupancy-based on-demand conditioning.
- Analyze occupant response data to understand the relationship between control strategies and occupant experience.
- Prepare a sMAP Interface Report that includes a sMAP platform for the two project demonstration buildings, interfaces to PCS units, smartphone interfaces, and advanced control algorithm operation on top of sMAP.
- Prepare an Occupant Survey Report that includes the results of occupant IEQ responses in field studies of buildings, and results of analysis to understand the relationship between control strategies and occupant comfort.

Products:

- Control Algorithm and sMAP Interface Report

- Occupant Survey Report

Task 2.4 Energy and Comfort Simulations

The goal of this task is to conduct simulations using EnergyPlus to determine the effectiveness, energy savings, and comfort potential of the various combinations of strategies proposed in this project.

The Recipient shall:

- Ascertain modeling modifications needed for each energy conserving strategy, including PCS control based on indoor parameters, the two most frequently used thermal comfort models, and dynamic reset models.
- Create an appropriate whole building model (based on U.S. Department of Energy reference models).
- Implement a clothing insulation model in EnergyPlus.
- Conduct a scoping study of advanced comfort modeling and assessment methods to develop recommendations for methods and metrics needed to accurately calculate and assess comfort conditions for the combined strategies to be studied.
- Conduct energy comparison parametric studies for the various combined strategies and technologies proposed in this project.
- Prepare Energy Plus Modeling Specifications for new technologies (e.g., PCS), HVAC control strategies, comfort metrics, and clothing insulation.
- Prepare new feature proposals for the EnergyPlus Star Team, a committee of experienced simulations experts from organizations such as the National Renewable Energy Laboratory, Lawrence Berkeley National Laboratory, Florida Solar Energy Center, and Construction & Engineering Research Laboratory that oversee the EnergyPlus development process and the documentation of added features.
- Prepare a Comfort Performance Simulation Report that discusses the results of the work completed in this task.
- Prepare a Saving Benefits Report that discusses electricity savings that result from the work completed in this task.
- Participate in a CPR Meeting and Prepare a CPR Report as specified in Task 1.2.

Products:

- Energy and Comfort Performance Simulation Report
- EnergyPlus Modeling Specifications (no draft)
- Electricity Saving Benefits Report
- CPR Report (no draft)

TASK 3 DEMONSTRATION, DEPLOYMENT AND COMMERCIALIZATION

The goal of this task is to support the transfer of new technological innovations resulting from this project through a combination of comprehensive demonstration field studies and a Demonstration, Deployment, and Commercialization Plan for migrating project developments and findings into mainstream HVAC control products and energy efficiency deployment programs.

Task 3.1 Demonstration #1

The goal of this task is to conduct a demonstration field study involving the integration of project innovations in an existing building with a conventional VAV overhead air distribution system.

The Recipient shall:

- Select demonstration site #1 based on recommendations and guidance from the Demonstration, Deployment and Commercialization Plan (Task 3.3).
- Implement the Demonstration Plan (Task 2) to investigate the combination of PCSs and other control innovations and information technologies in an existing building with a conventional VAV overhead air distribution system.
- Develop an explicit procedure for the estimation of yearly energy savings based on a limited database, and develop guidelines for the applicability of the procedure.
- Prepare a Demonstration #1 Report that discusses the results of the work completed in this task.

Products:

- Demonstration #1 Report

Task 3.2 Demonstration #2

The goal of this task is to conduct a demonstration involving the integration of project innovations into a new building with advanced low-energy space conditioning systems.

The Recipient shall:

- Select Demonstration site #2 by leveraging support that the CBE has received from the Energy Commission (Energy Commission Contract #500-08-044-01) to integrate development of occupant-based HVAC controls into two field studies of buildings that use radiant systems. The field studies are scheduled to take place between 2013 and 2014.
- Investigate the applicability of adaptive comfort with PCSs.
- Implement the Demonstration Plan (Task 2) to investigate the combination of PCSs and other control innovations and information technologies in a building with radiant slabs (TABS).
- Prepare a Demonstration #2 Report that discusses the results of the work completed in this task.

Products:

- Demonstration #2 Report

Task 3.3 Demonstration, Deployment, and Commercialization Plan

The goal of this task is to prepare a Demonstration, Deployment and Commercialization Plan for migrating project innovations into mainstream HVAC control products and energy efficiency deployment programs.

The Recipient shall:

- Prepare an Interim Report for Electricity Saving Benefits: Demonstration, Deployment, and Commercialization Plan that discusses electricity savings that result from the work completed in this task.
- Prepare a Demonstration, Deployment, and Commercialization Plan that discusses the following:
  - A discussion of the analysis for demonstrations in the Recipient's campus buildings, other California higher education campus buildings, and private office space in coordination with CBE partners;
  - Deployment through the UC Berkeley Operational Excellence Energy Management Initiative;
  - Integration with the monitoring-based commissioning element of the UC/California State University/Investor-Owned Utility Energy Efficiency Partnership beginning with the 2015 program cycle;

- Identification of organizations appropriate to integrate technology innovations and make third-party program proposals to investor-owned utilities for programs based on occupant-based HVAC controls innovations; and
- Recruiting of venture-capital firms to fund the commercialization of occupant-based HVAC control innovations; and
- The creation of potential business models for commercialization of occupant-based HVAC control technologies.

- Participate in a CPR meeting and prepare a CPR Report as specified in Task 1.2.

Products:

- Interim Report for Electricity Saving Benefits: Demonstration, Deployment, and Commercialization Plan
- Demonstration, Deployment, and Commercialization Plan
- CPR Report (no draft)

TASK 4 STANDARDS AND CODES

The goal of this task is to propose needed changes to building codes and standards, including: Titles 20 and 24 of the California Code of Regulations, and ASHRAE Standards 55 (Thermal Environmental Conditions for Human Occupancy), 90.1 (Energy Standard for Buildings Except Low-Rise Residential Buildings), and 189.1 (Standard for the Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings).

The Recipient shall:

- Develop a detailed justification narrative for proposed Title 24 changes, including case study data from the field research described in this Scope of Work.
- Coordinate Title 24 change activities with the Codes and Standards Enhancement (CASE) Initiatives performed by the Energy Commission/IOU-funded California Utilities Statewide Codes and Standards Team.
- Assist the CASE team in developing the lifecycle cost analysis reports required to support CASE initiatives. This includes collecting incremental first cost data and maintenance cost data, and performing energy simulations. Sources of cost data include: mechanical and controls contractors, equipment manufacturers and vendors, manufacturers associations (e.g., the Air-Conditioning, Heating, and Refrigeration Institute) and Taylor Engineering design and retro-commissioning projects.

- Attend Energy Commission workshops, hearings, stakeholder meetings, and conference calls to communicate and support the code change proposals.
- Prepare an Interim Report for Electricity Saving Benefits: Codes and Standards that discusses the electricity savings electricity savings of completed activities.
- Prepare a Title 24 Code Change Report that describes proposed changes in Title 24 language and discusses: reheat limitations, zone thermostatic controls, supply air temperature reset, minimum efficiency values for cooling fans and portable heater, demand controlled ventilation, energy modeling guidelines for PCS devices, and cost-effectiveness of proposed code changes.
- Prepare a Title 20 Code Change Report that: (1) describes proposed changes in Title 20 language; (2) discusses the analysis and results of new methods of testing for PCS devices; (3) reviews test methods for ceiling fans; and (4) determines the cost-effectiveness of proposed code changes.
- Attend Standards Project Committee meetings at semi-annual ASHRAE Conferences to communicate and support the standards change proposals.
- Prepare an ASHRAE Standard 55 Change Report that discusses the proposed changes to ASHRAE Standard 55, including: (1) new text on advanced comfort metrics; (2) comfort assessment methods for PCS devices; and (3) requirements for HVAC zones to turn down (reduce cooling air volume) to the minimum expected load.
- Prepare an ASHRAE Standards 90.1 and 189.1 Change Report that analyzes the effects of proposed changes to ASHRAE Standards 90.1 and 189.1. Most changes proposed for ASHRAE Standard 90.1 will likely follow those proposed for Title 24. Similarly, most changes proposed for ASHRAE Standard 189.1 will likely follow those proposed for Title 24 and ASHRAE Standards 55 and 90.1, as appropriate.

Products:

- Interim Report for Electricity Saving Benefits: Codes and Standards
- Title 24 Code Change Report
- Title 20 Code Change Report
- ASHRAE Standard 55 Change Report
- ASHRAE Standards 90.1 and 189.1 Change Report

TASK 5 TECHNOLOGY TRANSFER ACTIVITIES

The goal of this task is to develop a plan to make the knowledge gained, experimental results, and lessons learned available to key decision-makers. Tasks 3.3 and 4 are key

elements in the technology transfer plan.

The Recipient shall:

- Encourage the accelerated adoption of proposed Building Energy Efficiency Codes and Standards as common practice by educating and working with building design and maintenance professionals and other stakeholders.
- Undertake the following technology transfer activities by engaging with:
  - The University of California Berkeley Operational Excellence Energy Management Initiative;
  - The University of California/California State University/Investor-Owned Utility Energy Efficiency Partnership; and
  - Pacific Gas & Electric Company
- Prepare a Technology Transfer Plan that explains how the knowledge gained in this project will be made available to the public. The level of detail expected is least for research-related projects and highest for demonstration projects. Key elements from this plant will be included in the Final Report.
- Conduct technology transfer activities in accordance with the Technology Transfer Plan. These activities will be reported in the Monthly Progress Reports.
- Indicate the intended use(s) for and users of the project results.

Products:

- Technology Transfer Plan

STATE OF CALIFORNIA

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) COMPLIANCE

CEC-280 (Revised 02/10) CALIFORNIA ENERGY COMMISSION

Award Number: PIR-12-026 Date: March / 27 / 2013

Note: The Energy Commission Project Managers Manual includes detailed instructions on how to complete this section, with examples of grants that are "Projects" and are not "Projects". When the Project Manager is completing this section, if questions arise as to the appropriate answers to the questions below, please consult with the Energy Commission attorney assigned to review grants or loans for your division.

1. Is grant/loan considered a "Project" under CEQA? ☒ Yes *(skip to question #2)* ☐ No *(continue with question #1)*

   Please complete the following: *[Public Resources Code (PRC) 21065 and 14 California Code of Regulations (CCR) 15378]:*

   Explain why the grant/loan is ***not*** considered a "Project"? The grant/loan will not cause a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment because grant/loan involves:

2. If grant/loan is considered a "Project" under CEQA: *(choose either **IS** or **IS NOT**)*

   ☐ Grant/loan **IS** exempt:

   ☐ Statutory Exemption: *(List PRC and/or CCR section numbers)*

   ☒ Categorical Exemption: *(List CCR section number)* 14 CCR section 15301

   ☐ Common Sense Exemption. *(14 CCR 15061(b)(3))*

   Explain reason why the grant/loan is exempt under the above section:

   This project involves the modification of existing climate control systems in demonstration building sites, and laboratory testing of proposed comfort system technologies for expanded field testing and demonstration.

Please attach draft Notice of Exemption (NOE). Consult with the Energy Commission attorney assigned to your division for instructions on how to complete the NOE.

☐ Grant/loan **IS NOT** exempt. The Project Manager needs to consult with the Energy Commission attorney assigned to your division and the Siting Office regarding a possible initial study.