

EXHIBIT A SCOPE OF WORK

A. Task List

Task #	CPR ¹	Task Name
1		General Project Tasks
2		Ubiquitous, Low-Cost Sensing, Distributed Intelligence and Communications
3		Task Ambient Daylighting - Data-Driven Daylighting Control
4	X	Standard User Interface Elements
5	X	Outcome-Based Lighting Systems: Methodologies, Metrics, and Controls Testing
6		Evaluation of Project Benefits
7		Technology/Knowledge Transfer Activities

B. Acronym/Term List

Acronym/Term	Meaning
6LoWPAN	Internet Protocol version 6 over Low power Wireless Personal Area Networks
AP	Application
API	Application Programming Interface
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CPR	Critical Project Review
DALI	Digitally Addressable Lighting Interface
EISG	Energy Innovative Small Grants
FLEXLAB	LBNL's Facility for Low Energy eXperiments in Buildings
IP	Intranet Protocol

¹ Please see subtask 1.3 in Part III of the Scope of Work (General Project Tasks) for a description of Critical Project Review (CPR) Meetings.

LAP	Lighting Action Plan
LED	Light-Emitting Diode
TAC	Technical Advisory Committee
ZigBee	Low-cost, low-power, wireless mesh network specification for a suite of high-level communication protocols used to create personal area networks based on an IEEE 802.15.4 standard

I. PURPOSE OF AGREEMENT, PROBLEM/SOLUTION STATEMENT, AND GOALS AND OBJECTIVES

A. Purpose of Agreement

This purpose of this Agreement is to fund flexible, networked lighting control systems that reliably save energy. This project will develop intelligent lighting control systems that reliably save energy, provide lighting services closely tailored to the building occupants' needs, and allow seamless integration into whole-building control and automation systems. The results of this Agreement will target California's Title 24 Building Energy Efficiency Standards revisions in 2019, establishing methods by which these site-specific configuration and operation networked lighting controls systems can be effectively addressed, and more easily implemented by the marketplace to achieve code compliance.

B. Problem/ Solution Statement

Problem

California's Lighting Action Plan (LAP) 2013-2015 calls for a 60%–80% reduction in lighting energy use by 2020². In addition, the Lighting Efficiency and Toxics Reduction Act (AB 1109) requires reductions of average statewide electrical energy consumption, from 2007 levels, by 50% for indoor residential lighting, and by 25% for indoor commercial and outdoor lighting. California law and directives drive the urgency of reducing lighting energy consumption. Current control systems are expensive, difficult to use, lack multi-vendor interoperability, and as a result, are not widely accepted by consumers.

Solution

This project advances lighting control system innovation to help realize California's lighting efficiency goals. This research is driven by the convergence of four major trends in commercial buildings, and provides new opportunities for energy savings through advanced, automated and intelligent control systems:

1. **Increased control granularity:** An increasing number of building systems are now controllable with a level of discretion that has not previously been possible, for example, Light Emitting Diode (LED) systems that are fully dimmable and individually addressable.
2. **Increased sensor availability and use:** Environmental sensors such as light sensors, occupancy sensors, carbon dioxide sensors, and power meters are becoming less expensive to install in buildings.

² CPUC-2013, CA Energy Efficiency Strategic Plan, Lighting Action Plan 2013-2015. Available online at: http://www.cpuc.ca.gov/NR/rdonlyres/81B1D776-D00B-4423-ABF2-B34F814CA749/0/LAP_20131107_Distribute.pdf

3. **Pervasive communication through wireless networks:** Wireless networks are nearly ubiquitous in buildings today. Wi-Fi®, Bluetooth®, ZigBee®, and others are increasingly used for building control purposes.
4. **Low-cost computation:** Bundling digital intelligence at the sensors and lights adds virtually no incremental cost. Coupled with communications, this enables interactive, optimized, rule-based control and fault detection systems at very low cost.

This project leverages these four trends and enables the collection of more and better data (sensors), transmission of these data to loads (wireless networks), and more intelligent control of these loads (controllable loads—algorithms). The recipient plans to employ increased control capabilities through enhanced algorithms that tap local environmental conditions and user preferences data. This project will help to facilitate widespread customer acceptance through ease of use by which users can understand and manipulate controls for the desired result. This critical interoperability ensures that lighting systems are as easy to use for people as their other electronic components. This project will develop the next generation, of less centralized, lighting control systems comprised of distributed points of intelligence that exploit emerging market trends to produce the energy savings required to meet the LAP’s 60%–80% lighting energy reduction by 2020.

C. Goals and Objectives of the Agreement

Agreement Goals

The goals of this Agreement are to:

- Make use of enhanced lighting controls and sensors more ubiquitous;
- Make lighting system energy use more controllable and efficient; and
- Make lighting systems more responsive to human needs.

Ratepayer Benefits:³ This Agreement will result in ratepayers’ benefits from greater electricity reliability and lower costs by enabling building owners to better understand, interact and control the lighting system energy use.

Technological Advancement and Breakthroughs:⁴ This Agreement will lead to technological advancement and breakthroughs to overcome barriers to the achievement of the State of California’s statutory energy goals by reducing energy use by as much as 1,500 gigawatt-hours per year statewide when fully implemented.

Agreement Objectives

The objectives of this Agreement are to:

- Develop and promote low-cost sensing, distributed intelligence and communications
- Create an effective task ambient daylighting system, integrating sensors with data-driven daylighting control using Open Application Programming Interface (API)
- Develop standard user interface elements for lighting control systems accepted by key industry stakeholders

³ California Public Resources Code, Section 25711.5(a) requires projects funded by the Electric Program Investment Charge (EPIC) to result in ratepayer benefits. The California Public Utilities Commission, which established the EPIC in 2011, defines ratepayer benefits as greater reliability, lower costs, and increased safety (See CPUC “Phase 2” Decision 12-05-037 at page 19, May 24, 2012, http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/167664.PDF).

⁴ California Public Resources Code, Section 25711.5(a) also requires EPIC-funded projects to lead to technological advancement and breakthroughs to overcome barriers that prevent the achievement of the state’s statutory and energy goals.

- Develop industry-accepted outcome-based lighting system methodologies, metrics and controls testing
- Target California's Title 24 Building Energy Efficiency Standards revisions for 2019 to incorporate next generation lighting control systems
- Work with standards organizations to add capabilities to their protocols;
- Identify technological solutions to realize energy savings from next generation lighting control systems.

II. TASK 1 GENERAL PROJECT TASKS

PRODUCTS

Subtask 1.1 Products

The goal of this subtask is to establish the requirements for submitting project products (e.g., reports, summaries, plans, and presentation materials). Unless otherwise specified by the Commission Agreement Manager (CAM), the Recipient must deliver products as required below by the dates listed in the **Project Schedule (Part V)**. Products that require a draft version are indicated by marking “**(draft and final)**” after the product name in the “Products” section of the task/subtask. If “(draft and final)” does not appear after the product name, only a final version of the product is required. With respect to due dates within this Scope of Work, “**days**” means working days.

The Recipient shall:

For products that require a draft version

- Submit all draft products to the CAM for review and comment in accordance with the Project Schedule (Part V). The CAM will provide written comments to the Recipient on the draft product within 15 days of receipt, unless otherwise specified in the task/subtask for which the product is required.
- Submit the final product to the CAM once Agreement has been reached on the draft. The CAM will provide written approval of the final product within 15 days of receipt, unless otherwise specified in the task/subtask for which the product is required.
- If the CAM determines that the final product does not sufficiently incorporate his/her comments, submit the revised product to the CAM within 10 days of notice by the CAM, unless the CAM specifies a longer time period.

For products that require a final version only

- Submit the product to the CAM for approval.
- If the CAM determines that the product requires revision, submit the revised product to the CAM within 10 days of notice by the CAM, unless the CAM specifies a longer time period.

For all products

- Submit all data and documents required as products in accordance with the following Instructions for Submitting Electronic Files and Developing Software:

- **Electronic File Format**

Submit all data and documents required as products under this Agreement in an electronic file format that is fully editable and compatible with the Energy Commission's software and Microsoft (MS)-operating computing platforms, or with any other format approved by the CAM. Deliver an electronic copy of the full text of any Agreement data and documents in a format specified by the CAM, such as memory stick or CD-ROM.

The following describes the accepted formats for electronic data and documents provided to the Energy Commission as products under this Agreement, and establishes the software versions that will be required to review and approve all software products:

- Data sets will be in MS Access or MS Excel file format (version 2007 or later), or any other format approved by the CAM.
- Text documents will be in MS Word file format, version 2007 or later.
- Documents intended for public distribution will be in PDF file format. The Recipient must also provide the native Microsoft file format.
- Project management documents will be in Microsoft Project file format, version 2007 or later.

- **Software Application Development**

Use the following standard Application Architecture components in compatible versions for any software application development required by this Agreement (e.g., databases, models, modeling tools), unless the CAM approves other software applications such as open source programs:

- 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 CAM. The CAM will consult with the Energy Commission's Information Technology Services Branch to determine whether the exceptions are allowable.

MEETINGS

Subtask 1.2 Kick-off Meeting

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

The Recipient shall:

- Attend a “Kick-off” meeting with the CAM, the Commission Agreement Officer (CAO), and any other Energy Commission staff relevant to the Agreement. The Recipient will bring its Project Manager and any other individuals designated by the CAM to this meeting. The administrative and technical aspects of the Agreement will be discussed at the meeting. Prior to the meeting, the CAM will provide an agenda to all potential meeting participants. The meeting may take place in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

The administrative portion of the meeting will include discussion of the following:

- Terms and conditions of the Agreement;
- Administrative products (subtask 1.1);
- CPR meetings (subtask 1.3);
- Match fund documentation (subtask 1.7);
- Permit documentation (subtask 1.8);
- Subcontracts (subtask 1.9); and
- Any other relevant topics.

The technical portion of the meeting will include discussion of the following:

- The CAM's expectations for accomplishing tasks described in the Scope of Work;
 - An updated Project Schedule;
 - Technical products (subtask 1.1);
 - Progress reports and invoices (subtask 1.5);
 - Final Report (subtask 1.6);
 - Technical Advisory Committee meetings (subtasks 1.10 and 1.11); and
 - Any other relevant topics.
- Provide an *Updated Project Schedule*, *List of Match Funds*, and *List of Permits*, as needed to reflect any changes in the documents.

The CAM shall:

- Designate the date and location of the meeting.
- Send the Recipient a *Kick-off Meeting Agenda*.

Recipient Products:

- Updated Project Schedule (*if applicable*)
- Updated List of Match Funds (*if applicable*)
- Updated List of Permits (*if applicable*)

CAM Product:

- Kick-off Meeting Agenda

Subtask 1.3 Critical Project Review (CPR) Meetings

The goal of this subtask is to determine if the project should continue to receive Energy Commission funding, and if so whether any modifications must be made to the tasks, products, schedule, or budget. CPR meetings provide the opportunity for frank discussions between the Energy Commission and the Recipient. As determined by the CAM, discussions may include project status, challenges, successes, advisory group findings and recommendations, final report preparation, and progress on technical transfer and production readiness activities (if applicable). Participants will include the CAM and the Recipient, and may include the CAO and any other individuals selected by the CAM to provide support to the Energy Commission.

CPR meetings generally take place at key, predetermined points in the Agreement, as determined by the CAM and as shown in the Task List on page 1 of this Exhibit. However, the CAM may schedule additional CPR meetings as necessary. The budget will be reallocated to cover the additional costs borne by the Recipient, but the overall Agreement amount will not increase. CPR 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 CAM.

The Recipient shall:

- Prepare a *CPR Report* for each CPR meeting that: (1) discusses the progress of the Agreement toward achieving its goals and objectives; and (2) includes recommendations and conclusions regarding continued work on the project.
- Submit the CPR Report along with any other *Task Products* that correspond to the technical task for which the CPR meeting is required (i.e., if a CPR meeting is required for Task 2, submit the Task 2 products along with the CPR Report).
- Attend the CPR meeting.
- Present the CPR Report and any other required information at each CPR meeting.

The CAM shall:

- Determine the location, date, and time of each CPR meeting with the Recipient's input.
- Send the Recipient a *CPR Agenda* and a *List of Expected CPR Participants* in advance of the CPR meeting. If applicable, the agenda will include a discussion of match funding and permits.
- Conduct and make a record of each CPR meeting. Provide the Recipient with a *Schedule for Providing a Progress Determination* on continuation of the project.
- Determine whether to continue the project, and if so whether modifications are needed to the tasks, schedule, products, or budget for the remainder of the Agreement. If the CAM 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 *Progress Determination* on continuation of the project, in accordance with the schedule. The Progress Determination may include a requirement that the Recipient revise one or more products.

Recipient Products:

- CPR Report(s)
- Task Products (draft and/or final as specified in the task)

CAM Products:

- CPR Agenda
- List of Expected CPR Participants
- Schedule for Providing a Progress Determination
- Progress Determination

Subtask 1.4 Final Meeting

The goal of this subtask is to complete the closeout of this Agreement.

The Recipient shall:

- Meet with Energy Commission staff to present project findings, conclusions, and recommendations. The final meeting must be completed during the closeout of this Agreement. This meeting will be attended by the Recipient and CAM, at a minimum. The meeting may occur in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be divided into two separate meetings at the CAM's discretion.

- The technical portion of the meeting will involve the presentation of findings, conclusions, and recommended next steps (if any) for the Agreement. The CAM will determine the appropriate meeting participants.
- The administrative portion of the meeting will involve a discussion with the CAM and the CAO of the following Agreement closeout items:
 - Disposition of any state-owned equipment.
 - Need to file a Uniform Commercial Code Financing Statement (Form UCC-1) regarding the Energy Commission's interest in patented technology.
 - The Energy Commission's request for specific "generated" data (not already provided in Agreement products).
 - Need to document the Recipient's disclosure of "subject inventions" developed under the Agreement.
 - "Surviving" Agreement provisions such as repayment provisions and confidential products.
 - Final invoicing and release of retention.
- Prepare a *Final Meeting Agreement Summary* that documents any Agreement made between the Recipient and Commission staff during the meeting.
- Prepare a *Schedule for Completing Agreement Closeout Activities*.
- Provide *All Draft and Final Written Products* on a CD-ROM or USB memory stick, organized by the tasks in the Agreement.

Products:

- Final Meeting Agreement Summary (*if applicable*)
- Schedule for Completing Agreement Closeout Activities
- All Draft and Final Written Products

REPORTS AND INVOICES

Subtask 1.5 Progress Reports and Invoices

The goals of this subtask are to: (1) periodically verify that satisfactory and continued progress is made toward achieving the project objectives of this Agreement; and (2) ensure that invoices contain all required information and are submitted in the appropriate format.

The Recipient shall:

- Submit a monthly *Progress Report* to the CAM. Each progress report must:
 - Summarize all Agreement activities conducted by the Recipient for the preceding month, including an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. See the Progress Report Format Attachment for the recommended specifications.
 - Provide a synopsis of the project progress, including accomplishments, problems, milestones, products, schedule, fiscal status, and any evidence of progress such as photographs.
- Submit a monthly or quarterly *Invoice* that follows the instructions in the “Payment of Funds” section of the terms and conditions. In addition, each invoice must document and verify:
 - Energy Commission funds received by California-based entities;
 - Energy Commission funds spent in California (*if applicable*); and
 - Match fund expenditures.

Products:

- Progress Reports
- Invoices

Subtask 1.6 Final Report

The goal of this subtask is to prepare a comprehensive Final Report that describes the original purpose, approach, results, and conclusions of the work performed under this Agreement. The CAM will review and approve the Final Report, which will be due at least **two months** before the Agreement end date. When creating the Final Report Outline and the Final Report, the Recipient must use a Style Manual provided by the CAM.

Subtask 1.6.1 Final Report Outline

The Recipient shall:

- Prepare a *Final Report Outline* in accordance with the *Style Manual* provided by the CAM.
- Submit a draft of the outline to the CAM for review and comment.
- Once Agreement has been reached on the draft, submit the final outline to the CAM. The CAM will provide written approval of the final outline within 10 days of receipt.

Recipient Products:

- Final Report Outline (draft and final)

CAM Product:

- Style Manual

Subtask 1.6.2 Final Report**The Recipient shall:**

- Prepare a *Final Report* for this Agreement in accordance with the approved Final Report Outline and the Style Manual provided by the CAM.
- Submit a draft of the report to the CAM for review and comment. Once Agreement on the draft report has been reached, the CAM will forward the electronic version of the final report for Energy Commission internal approval. Once the CAM receives approval, he/she will provide written approval to the Recipient.
- Submit one bound copy of the Final Report to the CAM.

Products:

- Final Report (draft and final)

MATCH FUNDS, PERMITS, AND SUBCONTRACTS**Subtask 1.7 Match Funds**

The goal of this subtask is to ensure that the Recipient obtains any match funds planned for this Agreement and applies them to the Agreement during the Agreement term.

While the costs to obtain and document match funds are not reimbursable under this Agreement, the Recipient may spend match funds for this task. The Recipient may only spend match funds during the Agreement term, either concurrently or prior to the use of Energy Commission funds. Match funds must be identified in writing, and the Recipient must obtain any associated commitments before incurring any costs for which the Recipient will request reimbursement.

The Recipient shall:

- Prepare a *Match Funds Status Letter* that documents the match funds committed to this Agreement. 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 this 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 cash match funds, their source(s) (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied.
 - The amount of each in-kind contribution, a description of the contribution type (e.g., property, services), the documented market or book value, the 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 must identify its owner and provide a contact name, address, telephone number, and the

address where the property is located.

- A copy of a letter of commitment from an authorized representative of each source of match funding that the funds or contributions have been secured.
- At the Kick-off meeting, discuss match funds and the impact on the project if they are significantly reduced or not obtained as committed. 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 *Supplemental Match Funds Notification Letter* to the CAM of receipt of additional match funds.
- Provide a *Match Funds Reduction Notification Letter* to the CAM if existing match funds are reduced during the course of the Agreement. Reduction of match funds may trigger a CPR meeting.

Products:

- Match Funds Status Letter
- Supplemental Match Funds Notification Letter (*if applicable*)
- Match Funds Reduction Notification Letter (*if applicable*)

Subtask 1.8 Permits

The goal of this subtask 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, with the exception of costs incurred by University of California recipients. Permits must be identified and obtained before the Recipient may incur any costs related to the use of the permit(s) for which the Recipient will request reimbursement.

The Recipient shall:

- Prepare a *Permit Status Letter* that documents the permits required to conduct this Agreement. If no permits are required at the start of this Agreement, then state this in the letter. If permits will be required during the course of the Agreement, provide in the letter:
 - A list of the permits that identifies: (1) the type of permit; and (2) the name, address, and telephone number of the permitting jurisdictions or lead agencies.
 - The schedule the Recipient will follow in applying for and obtaining the permits.

The list of permits and the schedule for obtaining them will be discussed at the Kick-off meeting (subtask 1.2), and a timetable for submitting the updated list, schedule, and copies of the permits will be developed. The impact on the project 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 progress reports and will be a topic at CPR meetings.

- If during the course of the Agreement additional permits become necessary, then provide the CAM with an *Updated List of Permits* (including the appropriate information on each permit) and an *Updated Schedule for Acquiring Permits*.
- Send the CAM a *Copy of Each Approved Permit*.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the CAM within 5 days. Either of these events may trigger a CPR meeting.

Products:

- Permit Status Letter
- Updated List of Permits (*if applicable*)

- Updated Schedule for Acquiring Permits (*if applicable*)
- Copy of each Approved Permit (*if applicable*)

Subtask 1.9 Subcontracts

The goals of this subtask are to: (1) procure subcontracts required to carry out the tasks under this Agreement; and (2) ensure that the subcontracts are consistent with the terms and conditions of this Agreement.

The Recipient shall:

- Manage and coordinate subcontractor activities in accordance with the requirements of this Agreement.
- Incorporate this Agreement by reference into each subcontract.
- Include any required Energy Commission flow-down provisions in each subcontract, in addition to a statement that the terms of this Agreement will prevail if they conflict with the subcontract terms.
- If required by the CAM, submit a draft of each *Subcontract* required to conduct the work under this Agreement.
- Submit a final copy of the executed subcontract.
- Notify and receive written approval from the CAM prior to adding any new subcontractors (see the discussion of subcontractor additions in the terms and conditions).

Products:

- Subcontracts (*draft if required by the CAM*)

TECHNICAL ADVISORY COMMITTEE

Subtask 1.10 Technical Advisory Committee (TAC)

The goal of this subtask is to create an advisory committee for this Agreement. The TAC should be composed of diverse professionals. The composition will vary depending on interest, availability, and need. TAC members will serve at the CAM's discretion. The purpose of the TAC is to:

- Provide guidance in project direction. The guidance may include scope and methodologies, timing, and coordination with other projects. The guidance may be based on:
 - Technical area expertise;
 - Knowledge of market applications; or
 - Linkages between the Agreement work and other past, present, or future projects (both public and private sectors) that TAC members are aware of in a particular area.
- Review products and provide recommendations for needed product adjustments, refinements, or enhancements.
- Evaluate the tangible benefits of the project to the state of California, and provide recommendations as needed to enhance the benefits.
- Provide recommendations regarding information dissemination, market pathways, or commercialization strategies relevant to the project products.

The TAC may be composed of qualified professionals spanning the following types of disciplines:

- Researchers knowledgeable about the project subject matter;
- Members of trades that will apply the results of the project (e.g., designers, engineers, architects, contractors, and trade representatives);
- Public interest market transformation implementers;
- Product developers relevant to the project;
- U.S. Department of Energy research managers, or experts from other federal or state agencies relevant to the project;
- Public interest environmental groups;
- Utility representatives;
- Air district staff; and
- Members of relevant technical society committees.

The Recipient shall:

- Prepare a *List of Potential TAC Members* that includes the names, companies, physical and electronic addresses, and phone numbers of potential members. The list will be discussed at the Kick-off meeting, and a schedule for recruiting members and holding the first TAC meeting will be developed.
- Recruit TAC members. Ensure that each individual understands member obligations and the TAC meeting schedule developed in subtask 1.11.
- Prepare a *List of TAC Members* once all TAC members have committed to serving on the TAC.
- Submit *Documentation of TAC Member Commitment* (such as Letters of Acceptance) from each TAC member.

Products:

- List of Potential TAC Members
- List of TAC Members
- Documentation of TAC Member Commitment

Subtask 1.11 TAC Meetings

The goal of this subtask is for the TAC to provide strategic guidance for the project by participating in regular meetings, which may be held via teleconference.

The Recipient shall:

- Discuss the TAC meeting schedule with the CAM at the Kick-off meeting. Determine the number and location of meetings (in-person and via teleconference) in consultation with the CAM.
- Prepare a *TAC Meeting Schedule* that will be presented to the TAC members during recruiting. Revise the schedule after the first TAC meeting to incorporate meeting comments.
- Prepare a *TAC Meeting Agenda* and *TAC Meeting Back-up Materials* for each TAC meeting.
- Organize and lead TAC meetings in accordance with the TAC Meeting Schedule. Changes to the schedule must be pre-approved in writing by the CAM.

- Prepare *TAC Meeting Summaries* that include any recommended resolutions of major TAC issues.

Products:

- TAC Meeting Schedule (draft and final)
- TAC Meeting Agendas (draft and final)
- TAC Meeting Back-up Materials
- TAC Meeting Summaries

III. TECHNICAL TASKS

TASK 2 UBIQUITOUS, LOW-COST SENSING, DISTRIBUTED INTELLIGENCE AND COMMUNICATIONS

The goal of this task is to enable an advanced, day-light aware, fault detecting, lighting ecosystem that utilizes low-cost sensors and open communication interfaces to maximize energy savings and ease multi-vendor interoperability. The work is broken into four sub-tasks.

Subtask 2.1 Low-cost, Self-powered Sensors

The goal of this subtask is to develop low-cost, self-powered, sensors for light level, shade position, occupancy and glare.

The Recipient shall:

- Develop and provide a *Sensor Specification Memo* based on a review of use cases and information from industry stakeholders.
- Develop use cases for lighting sensing and control, and define sensor types and performance criteria for successful system implementation.
- Develop a self-powered sensor platform based on the *Sensor Specification Memo* criteria. Platform will enable operation of sensors identified in the *Sensor Specification Memo* without battery replacement or main power.
- Develop key sensors utilizing commercially available components to meet the specifications outlined in the *Sensor Specification Memo*.
- Fabricate prototype sensor units and measure their performance in laboratory conditions.
- Develop and provide *Prototype Sensor Design Documentation* which includes all details of the sensor design including cost estimates, component selections, wiring diagrams, and measured performance.

Products:

- Sensor Specification Memo
- Prototype Sensor Design Documentation

Subtask 2.2 Open, IP-based Lighting System API

The goal of this subtask is to is an open, (Internet Protocol (IP) based application (AP)) for lighting systems that is compatible with the dominant IP wireless systems (WiFi and Low power Wireless Personal Area Networks [6LoWPAN]).

The Recipient shall:

- Develop and provide a *Wireless API Industry Users Group Formation Memo* which details the members and planned accomplishments of a group of stakeholders lead by ARM and the recipient. This group will define the features required in the software stack for open, low-cost wireless lighting control.
 - Prepare a list of potential API Industry Users Group Members that includes the names, companies, physical and electronic addresses, and phone numbers of potential members. The list will be discussed at the Kick-off meeting, and a schedule for recruiting members and holding the first API Industry Users Group meeting will be developed.
 - Recruit API Industry Users Group members. Ensure that each individual understands member obligations and the meeting schedule.
 - Submit *Documentation of API Industry Users Group Member Commitment* (such as Letters of Acceptance) from each API Industry Users Group member.
 - Develop and provide *API Industry Users Group Meeting Schedule* that specifies date time and location of all desired meetings for the term of the Agreement.
- Develop software elements required for wireless lighting sensing and control. The software shall consist of open source implementations of low-power, low-cost IP communication Internet Protocol version 6 over Low power Wireless Personal Area Networks (6LoWPAN) as agreed upon by API Industry Users Group stakeholders as well as application level APIs for data exchange. This API contains an abstraction that allows vendor or hardware specific implementations to be addressed using a common schema and taxonomy. This work is a higher level API than the DALI API work in Subtask 2.3.
- Release an open-source software stack for low-cost wireless communication that is built on open standards and broad industry support.
- Develop and provide a *Prototype Wireless API Implementation Memo* which details the open source software released as well as documentation on accessing and utilizing the APIs for lighting control.

Products:

- Wireless API Industry Users Group Formation Memo
- Documentation of API Industry Users Group Member Commitment
- API Industry Users Group Meeting Schedule
- Prototype Wireless API Implementation Memo

Subtask 2.3 Open API for DALI

The goal of this subtask is to develop an open API for the digitally addressable lighting interface (DALI), the dominant digital interface for controlling all electric light sources, including new LED drivers and legacy fluorescent ballasts.

The Recipient shall:

- Create and provide an *Industry Advisory Stakeholder Group (DALI User Group) Formation Memo*. The objective of this memo set up stakeholder group to consist of stakeholders such as IES Computer Protocol Committee, Lighting Control Association, interested manufacturers and California Lighting Technology Center. The group will advise the development team on program direction, etc. DALI User Group formation includes but is not limited to:
 - Prepare and provide a *List of Potential DALI Users Group Members* that includes the names, companies, physical and electronic addresses, and phone numbers of potential members. (The list will be discussed at the Kick-off meeting, and a

- schedule for recruiting members and holding the first DALI User Group meeting will be developed).
- Recruit DALI Users Group Members. Ensure that each individual understands member obligations and the meeting schedule.
 - Prepare and Provide *Schedule of DALI User Group Meetings* that specifies date time and place of DALI User group meetings during the term of the Agreement.
 - Submit *Documentation of DALI User Group Member Commitment* (such as Letters of Acceptance) from each member.
 - Prepare and provide *List of Confirmed DALI Users Group Members*. Ensure that each individual understands member obligations and the meeting schedule.
 - Develop and provide a report on an *Open API for "Standard" DALI Report* to include but not be limited to developing an Open API that provides prospective lighting application developers with a documented interface to all DALI functions obeying "Standard" DALI. A portion of the program development work may be sub-contracted (TBD).
 - Develop and provide an *Open API for DALI 2.0 Report*, and expand API to include sensor interfaces, to include but not be limited to expanded API report including DALI 2.0 functionality, which includes interfaces to all applicable sensors including, but not limited to:
 - Fixture-integrated light and occupancy sensors,
 - Area-based light and occupancy sensors, and
 - Glare sensors.
 - In addition the API would treat other significant functionality in DALI 2.0 including multi-master operation and collision avoidance, etc. The API sensor interface functionality will be tested in LBL's Facility for Low Energy experiments in Buildings (FLEXLAB).
 - Develop and provide *Plan for Open API Maintenance* to include but not limited to frequency and type of maintenance and expected performance enhancement.
 - Transition API maintenance to appropriate standards group to include but not be limited to transition the continued Open API development and maintenance to the IES Computer Protocol committee, the Lighting Controls Association or other organization (to be identified).

Products:

- Industry Stakeholder Advisory Group (DALI User Group) Formation Memo
- List of Potential DALI User Group Members
- Schedule of DALI User Group meetings
- Documentation of DALI User Group Commitment
- List of Confirmed DALI User Group Members
- Open API for "Standard" DALI Report
- Open API for DALI 2.0 Report
- Plan for API Maintenance

Subtask 2.4 Prototype System Evaluation

The goal of this subtask is to combine these elements with analytical tools that enable control algorithms, fault detection and energy-efficiency metric calculation implementation.

The Recipient shall:

- Combine elements from Subtask 2.1, 2.2 and 2.3 with analytical tools that enable control algorithms, fault detection and energy-efficiency metric calculation implementation.

- Integrate the system components into a prototype system which includes self-powered sensors, DALI ballasts, and wireless infrastructure to showcase overall system capabilities and interaction of the open APIs.
- Prepare and provide an *Evaluation of Integrated Prototype Components with Open APIs Memo* that includes but is not limited to specification and evaluation of integrated Open API components.
- Prepare a *Draft and final Report on Ubiquitous, Low-Cost Sensing, Distributed Intelligence and Communications* that includes but is not limited to: specification and evaluation of control algorithms, self-powered sensors, DALI ballasts and wireless infrastructure necessary for the interaction of integrated Open API components.

Products:

- Evaluation of Integrated Prototype Components with Open APIs Memo
- Report on Ubiquitous, Low-Cost Sensing, Distributed Intelligence and Communications (draft and final)

TASK 3 TASK AMBIENT DAYLIGHTING - DATA-DRIVEN DAYLIGHTING CONTROL

This task's goals are: (1) to refine and build pre-production task ambient daylighting systems; and (2) to field test pre-production task ambient daylighting systems. Building upon California Energy Commission Energy Innovative Small Grants (EISG)-funded work, the recipient will develop a prototype system of intelligent task lights and luminaires to implement this concept. This task will refine this system and reduce its cost by integrating low-cost sensors and communications from Task 2 above, and improve the user interface to adhere to the principles developed in Task 4.

The Recipient shall:

- Test and characterize the performance of initial prototype task ambient daylight prototypes (developed through previous Energy Commission EISG-funded work) in the FLEXLAB facility.
- Refine existing task ambient daylighting specification in response to FLEXLAB test results and in order to decrease system cost, improve system performance, and improve system reliability. This task is expected to include:
 - The selection of a wireless communication protocol between task lamp illuminance sensor and ceiling luminaire controller that is robust yet cost-effective.
 - The development of control systems based on inexpensive microcontrollers designed to replace the relatively expensive reprogrammable controllers in the current prototypes.
 - The refinement of communications and control systems for overhead lighting systems to leverage emerging protocols and technologies as well as technologies identified in Task 2.
- Prepare and provide a *Task Ambient Daylighting Specification Report* that includes but is not limited to the following:
 - A description of the technical specifications of the Task Ambient Daylighting system, including the system sensors, microcontrollers, wireless communications systems, and control algorithms.
- Develop, test, and refine Task Ambient Daylighting systems. This task will culminate in the production of at least 20 prototype systems appropriate for field testing in occupied office applications.

- Develop and provide a *Task Ambient Daylighting Field Test Plan*, which describes a field study of 20 or more Task Ambient Daylighting systems. Field test will evaluate at least the following:
 - System performance: How well does the system meet performance metrics (e.g. actual desktop illuminance vs target task plane illuminance vs baseline systems)?
 - Energy performance: How much energy did the system save vs baseline systems?
 - User response: What was the user response to the system?
- Prepare and provide a Task Ambient Daylighting Field Test Report which includes field test results on system performance, energy performance and user response.

Products:

- Task Ambient Daylighting Specification Report
- Task Ambient Daylighting Field Test Plan
- Task Ambient Daylighting Field Test Report

TASK 4 STANDARD USER INTERFACE ELEMENTS

This goal of this task is to develop content for a standard for lighting control user interface elements, and seek to put that content into formal standards and products.

The Recipient shall:

- Survey new lighting control products for their user interfaces to identify elements currently in use.
- Prepare and provide a *User Interface Product Survey Report* that summarizes findings from the survey, including, but not limited to:
 - Terms, symbols, colors, and metaphors found on product hardware, on displays screens, or in documentation.
 - Observed patterns, such as consistency and inconsistency in products from the same or different manufacturers
 - Concepts that lack clear labeling in the user interface.
- Prepare and provide a *Priority User Interface Elements Memo* that identifies those elements most suited to early standardization.
- Determine a standard solution for these elements.
- Prepare and provide an *Initial Standard Content Proposal Report* that includes, but is not limited to:
 - A succinct description of the proposed content, suitable for incorporation into a technology standard;
 - A detailed explanation of why the content was selected.
- Obtain reviews of the recommended elements from manufacturers and other lighting control industry stakeholders.
- Prepare and provide a *Standards Organization Selection Memo* that identifies the standards organization that proposed to host the user interface standard and explains how the organization was selected.
- Prepare and provide a *Revised Standard Content Proposal Report* that updates the standard content as warranted to take into account stakeholder feedback, and puts it into the format of the selected standards organization.
- Meet with standards organization to seek adoption of the content.
- Work with manufacturers to use the proposed standard in the design of future products.

- Prepare and provide a *Final Standard User Interface Elements Report* that summarizes project results.
- Participate in CPR Meeting per task 1.3 and prepare a *CPR Report*.

Products:

- User Interface Product Survey Report
- Priority User Interface Elements Memo
- Initial Standard Content Proposal Report
- Standards Organization Selection Memo
- Revised Standard Content Proposal Report
- Final Standard User Interface Elements Report
- CPR Report

TASK 5 OUTCOME-BASED LIGHTING SYSTEMS: METHODOLOGIES, METRICS, AND CONTROLS TESTING

This task's goal is to develop a new method for evaluating and specifying lighting systems' performance, to ensure that flexible, networked lighting technologies achieve their full potential. This task will propose a set of evaluative metrics that can be applied at finer resolutions, review current technologies for their ability to offer this information, develop a software specification for data collection, and conduct select evaluations of the effectiveness of these metrics in applied lighting systems.

The Recipient shall:

- Develop and provide a *List and Descriptions of Proposed Lighting System Performance Evaluative Metrics*. Propose a set of metrics applicable to whole building and lighting system level retrofit applications that can be used to determine the installed systems performance.
- Evaluate several commercially-available, networked lighting control systems to describe the types of data they produce in standard operation, and the interfaces for accessing these data.
- Develop a software specification that transforms event data implicitly collected by intelligent, networked lighting controllers into a stream of lighting energy use (kWh) data and other metrics that continually tracks the real-time, lighting system energy consumption at sufficiently fine temporal and spatial resolution.
- Prepare and provide a *Lighting Monitoring Software Specification Report* describing the functional characteristics of this software monitoring system.
- Develop the Lighting Monitoring Proof-of-Concept Software that implements the software specification.
- Prepare and provide a *Lighting Monitoring Proof-of-Concept Software Report* describing the implementation specifications of the software.
- Develop a test method for verifying lighting monitoring software performance accuracy.
- Prepare and provide a *Lighting Test Method Report*, describing the recommended test methods and lighting monitoring tests.
- Prepare and provide a *Software Validation Test Plan* that describes the testing to be done at LBNL's FLEXLAB facility to validate lighting monitoring system accuracy. Three lighting control systems will be selected for validation testing.
- Conduct the validation testing in FLEXLAB.
- Prepare and provide a *Validation Testing and Protocol Report* that summarizes the validation testing results conducted in FLEXLAB, including a comprehensive framework for determining performance metrics for these lighting systems, along with a proposed testing protocol.

- Develop and provide a *Report on Metrics Recommendations for Outcome-based Code Development and Compliance*, that includes but is not limited to a description of the recommended metrics for outcome based code development and compliance.
- Participate in CPR Meeting per task 1.3 and prepare a *CPR Report*.

Products:

- List and Descriptions of Proposed Lighting System Performance Evaluative Metrics
- Lighting Monitoring Software Specification Report
- Lighting Monitoring Proof-of-Concept Software Report
- Lighting Test Method Report
- Software Validation Test Plan
- Validation Testing and Protocol Report
- Report on Metrics Recommendations for Outcome-based Code Development and Compliance.
- CPR Report

TASK 6 EVALUATION OF PROJECT BENEFITS

The goal of this task is to report the benefits resulting from this project.

The Recipient shall:

- Complete three Project Benefits Questionnaires that correspond to three main intervals in the Agreement: (1) *Kick-off Meeting Benefits Questionnaire*; (2) *Mid-term Benefits Questionnaire*; and (3) *Final Meeting Benefits Questionnaire*.
- Provide all key assumptions used to estimate projected benefits, including targeted market sector (e.g., population and geographic location), projected market penetration, baseline and projected energy use and cost, operating conditions, and emission reduction calculations. Examples of information that may be requested in the questionnaires include:

For Product Development Projects and Project Demonstrations:

- Published documents, including date, title, and periodical name.
- Estimated or actual energy and cost savings, and estimated statewide energy savings once market potential has been realized. Identify all assumptions used in the estimates.
- Greenhouse gas and criteria emissions reductions.
- Other non-energy benefits such as reliability, public safety, lower operational cost, environmental improvement, indoor environmental quality, and societal benefits.
- Data on potential job creation, market potential, economic development, and increased state revenue as a result of the project.
- A discussion of project product downloads from websites, and publications in technical journals.
- A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.

Additional Information for Product Development Projects:

- Outcome of product development efforts, such copyrights and license Agreements.
- Units sold or projected to be sold in California and outside of California.

- Total annual sales or projected annual sales (in dollars) of products developed under the Agreement.
- Investment dollars/follow-on private funding as a result of Energy Commission funding.
- Patent numbers and applications, along with dates and brief descriptions.
- Additional Information for Product Demonstrations:
- Outcome of demonstrations and status of technology.
- Number of similar installations.
- Jobs created/retained as a result of the Agreement.

For Information/Tools and Other Research Studies:

- Outcome of project.
- Published documents, including date, title, and periodical name.
- A discussion of policy development. State if the project has been cited in government policy publications or technical journals, or has been used to inform regulatory bodies.
- The number of website downloads.
- An estimate of how the project information has affected energy use and cost, or have resulted in other non-energy benefits.
- An estimate of energy and non-energy benefits.
- Data on potential job creation, market potential, economic development, and increased state revenue as a result of project.
- A discussion of project product downloads from websites, and publications in technical journals.
- A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.
- Respond to CAM questions regarding responses to the questionnaires.
- The Energy Commission may send the Recipient similar questionnaires after the Agreement term ends. Responses to these questionnaires will be voluntary.

Products:

- Kick-off Meeting Benefits Questionnaire
- Mid-term Benefits Questionnaire
- Final Meeting Benefits Questionnaire

TASK 7 TECHNOLOGY/KNOWLEDGE TRANSFER ACTIVITIES

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

The Recipient shall:

- Prepare an *Initial Fact Sheet* at start of the project that describes the project. Use the format provided by the CAM.
- Prepare a *Final Project Fact Sheet* at the project's conclusion that discusses results. Use the format provided by the CAM.
- Prepare a *Technology/Knowledge Transfer Plan* that includes:
 - An explanation of how the knowledge gained from the project will be made available to the public, including the targeted market sector and potential outreach to end users, utilities, regulatory agencies, and others.

- A description of the intended use(s) for and users of the project results.
- Published documents, including date, title, and periodical name.
- Copies of documents, fact sheets, journal articles, press releases, and other documents prepared for public dissemination. These documents must include the Legal Notice required in the terms and conditions. Indicate where and when the documents were disseminated.
- A discussion of policy development. State if project has been or will be cited in government policy publications, or used to inform regulatory bodies.
- The number of website downloads or public requests for project results.
- Additional areas as determined by the CAM.
- Conduct technology transfer activities in accordance with the Technology/Knowledge Transfer Plan. These activities will be reported in the Progress Reports.
- When directed by the CAM, develop *Presentation Materials* for an Energy Commission-sponsored conference/workshop on the results of the project.
- Prepare a *Technology/Knowledge Transfer Report* on technology transfer activities conducted during the project.

Products:

- Initial Fact Sheet (draft and final)
- Final Project Fact Sheet (draft and final)
- Presentation Materials (draft and final)
- Technology/Knowledge Transfer Plan (draft and final)
- Technology/Knowledge Transfer Report (draft and final)

IV. PROJECT SCHEDULE

Please see the attached Excel spreadsheet.

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION - RE: LAWRENCE BERKELEY NATIONAL LABORATORY

RESOLVED, that the State Energy Resources Conservation and Development Commission (Energy Commission) adopts the staff CEQA findings contained in the Agreement Request Form; and

RESOLVED, that the Energy Commission approves Agreement EPC-14-017 with the Department of Energy's Lawrence Berkeley National Laboratory for a \$1,875,000 grant to develop energy efficient lighting control systems that provide lighting services closely tailored to the needs of building occupants, and allow integration into whole-building control and automation systems; and

FURTHER BE IT RESOLVED, that the Executive Director or his/her designee shall execute the same on behalf of the Energy Commission.

CERTIFICATION

The undersigned Secretariat to the Commission does hereby certify that the foregoing is a full, true, and correct copy of a Resolution duly and regularly adopted at a meeting of the California Energy Commission held on February 25, 2015.

AYE: [List of Commissioners]

NAY: [List of Commissioners]

ABSENT: [List of Commissioners]

ABSTAIN: [List of Commissioners]

Harriet Kallemeyn,
Secretariat