A. **A)New Agreement** # EPC-19-015 (to be completed by CGL office)

| B) Division | Agreement Manager: | MS- | Phone |
|---|---|---|---|
| ERDD | Dustin Davis | 51 | 916-327-2223 |

| C) Recipient's Legal Name | Federal ID Number |
|---|---|
| The Regents of the University of California on behalf of the Davis campus -Western Cooling Efficiency Center | 94-6036494 |

| D) Title of Project |
|---|
| Optimizing Heat Pump Load Flexibility for Cost, Comfort, and Carbon Emissions |

**E) Term and Amount**

| Start Date | End Date | Amount |
|---|---|---|
| 6/15/2020 | 3/31/2024 | $ 2,537,436 |

**F) Business Meeting Information**

ARFVTP agreements $75K and under delegated to Executive Director

Proposed Business Meeting Date 5/13/2020 Consent Discussion

Business Meeting Presenter Brad Williams Time Needed: 5 minutes

Please select one list serve.

**Agenda Item Subject and Description:**
REGENTS OF THE UNIVERSITY OF CALIFORNIA ON BEHALF OF THE DAVIS CAMPUS-WESTERN COOLING EFFICIENCY CENTER. Proposed resolution approving agreement EPC-19-015 with The Regents of the University of California, on behalf of the Davis campus, for a $2,537,436 grant to develop and test an advanced control system that saves energy, improves grid reliability, and reduces greenhouse gas emissions by optimizing heat pump operation based on building owner/occupant preferences, comfort and use patterns, electricity pricing, electricity grid needs, real-time greenhouse gas emission rates, and weather data, and adopting staff's determination that this action is exempt from CEQA. Pilot testing will occur in low-income residential units in Northern California.

**G) California Environmental Quality Act (CEQA) Compliance**

1. 1. Is Agreement considered a "Project" under CEQA?

   Yes (skip to question 2)

   No (complete the following (PRC 21065 and 14 CCR 15378)):

   Explain why Agreement is not considered a "Project":

1. 2. If Agreement is considered a "Project" under CEQA:
   a. a) Agreement **IS** exempt.

      Statutory Exemption. List PRC and/or CCR section number:

      Categorical Exemption. List CCR section number: Cal. Code Regs., tit 14, § 15301

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

      Explain reason why Agreement is exempt under the above section: Exemption

15301 applies to this project since the work involves minor alterations of existing public or private structures, facilities, mechanical equipment, or topographical features, and which involve negligible or no expansion of use beyond that existing. This project will only install monitoring devices and hardware and/or software that optimize the energy use of HVAC and water heating. For these reasons, the project will not have a significant environmental impact and is exempt under section 15301.

a. b) Agreement **IS NOT** exempt. (consult with the legal office to determine next steps)

Check all that apply

Initial Study

Negative Declaration

Mitigated Negative Declaration

Environmental Impact Report

Statement of Overriding Considerations

**H) List all subcontractors (major and minor) and equipment vendors:** (attach additional sheets as necessary)

| **Legal Company Name:** | **Budget** |
|---|---|
| TRC Engineers, Inc. | $ 683,796 |
| Mutual Housing | $ 20,000 |
| RCD Housing | $ 20,000 |
| TBD ZNE Housing Design | $ 50,000 |
| WattTime | $ 95,000; (match 35,000) |
| Ratnesh Sharma | $ 75,000 |
| HVAC Contractor | $ 15,000 |
| ecobee | $ 0 ; (match$42,000) |
| | $ |
| | $ |

**I) List all key partners: (attach additional sheets as necessary)**

| **Legal Company Name:** |
|---|
| |
| |
| |
| |

J. **J) Budget Information**

| Funding Source | Funding Year of Appropriation | Budget List Number | Amount |
|---|---|---|---|
| EPIC | 18-19 | 301.001F | $2,537,436 |
| | | | $ |
| | | | $ |
| | | | $ |

R&D Program Area: EERO: Buildings TOTAL: $ 2,537,436

Explanation for “Other” selection

Reimbursement Contract #: Federal Agreement #:

**J. K) Recipient’s Contact Information**

**1. 1. 1. Recipient’s Administrator/Officer**

Name: Jasen Okunnuga

Address: 215 SAGE ST STE 100

City, State, Zip: DAVIS, CA 95616-7379

Phone: 530-752-2659

E-Mail: jdokunnuga@ucdavis.edu

**1. 2. Recipient’s Project Manager**

Name: Caton Mande

Address: 215 Sage Street, Suite 100

City, State, Zip: Davis, CA 95616-7379

Phone: 530-752-1789

E-Mail: cwmande@ucdavis.edu

**J. L) Selection Process Used**

Competitive Solicitation Solicitation #: GFO-19-301

First Come First Served Solicitation Solicitation #:

**M) The following items should be attached to this GRF**

| | | |
|---|---|---|
| 1. | | 1. Exhibit A, Scope of Work Attached |
| 2. | | 2. Exhibit B, Budget Detail Attached |
| 3. for Identifying Conflicts | | 3. CEC 105, Questionnaire Attached |
| 4. N/A | 4. Attached | Recipient Resolution |
| 5. N/A | 5. Attached | CEQA Documentation |

_____ _____

**Agreement Manager** **Date**

_____ _____

**Office Manager** **Date**

_____ _____

**Deputy Director** **Date**

# EXHIBIT A
# Scope of Work
# UC Davis

## I. TASK ACRONYM/TERM LISTS

### A. Task List

| Task # | CPR[1] | Task Name |
|---|---|---|
| 1 | | General Project Tasks |
| 2 | | Market Characterization |
| 3 | X | Develop Advanced Water Heating Controls |
| 4 | | Develop Advanced Space Conditioning Controls |
| 5 | X | Test and Demonstrate Advanced Water Heating Controls |
| 6 | | Further Research in Advanced Space Conditioning Controls |
| 7 | | Market Barriers and Commercialization Assessment |
| 8 | | Evaluation of Project Benefits |
| 9 | | Technology/Knowledge Transfer Activities |
| 10 | | Production Readiness Plan |

### B. Acronym/Term List

| Acronym/Term | Meaning |
|---|---|
| ASCC | Advanced Space Conditioning Controls |
| AWHC | Advanced Water Heating Controls |
| CAM | Commission Agreement Manager |
| CAO | Commission Agreement Officer |
| CPR | Critical Project Review |
| IPMVP | International Performance Measurement and Verification Protocol |
| MPC | Model Predictive Control |
| PGE | Pacific Gas and Electric |
| SCE | Southern California Edison |
| SDGE | San Diego Gas and Electric |
| TAC | Technical Advisory Committee |

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

### A. Purpose of Agreement

The purpose of this Agreement is to fund the development and testing of an advanced heat pump control system to increase load flexibility based on building owner/occupant preferences, residential electricity tariffs, real-time electricity price signals, demand response signals, and the electrical grid's real-time greenhouse gas emission rates.

[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.

## B. Problem/ Solution Statement

**Problem**

Heat pumps for space conditioning and water heating are currently controlled using rule-based logic to maintain a programmed water temperature or indoor air temperature setpoint. While this approach is proven and robust for maintaining a user-defined setpoint, this type of control does not provide any flexibility as to when the heat pump operates. For example, whenever the water or air setpoint is not satisfied, the rule-based control will run the heat pump until the setpoint is satisfied, regardless of the cost of electricity or the electrical grid GHG emissions rate. As California continues to decarbonize the electrical grid and more customers electrify, load flexibility among heat pumps is becoming critical for maximizing the use of carbon-free electricity sources when they are available, stabilizing the electricity grid, and minimizing the cost of operation to end-users.

**Solution**

The recipient will develop and test an open-source framework for heat pump load flexibility controls that will be employed for both Advanced Water Heating Controls (AWHC) and Advanced Space Conditioning Controls (ASCC), with the goal of providing a common platform that can be leveraged to manage residential electricity use across multiple types of equipment and devices. Tackling both space conditioning and water heating controls from a common framework is impactful and efficient, as most of the data needed for a heat pump load flexibility controller (e.g., electricity pricing, grid DR signals, grid emissions, weather) are not specific to the heat pump end-use type. By applying one framework applicable to both water heating and space conditioning equipment, the project will demonstrate the scalability and futureproofing of heat pump load control systems that are compatible with future investments in synergistic technologies.

## C. Goals and Objectives of the Agreement

**Agreement Goals**

The goal of this Agreement is to develop and test an open-source advanced heat pump load control system that will increase load flexibility and accomplish the following:

- Reduce the financial, grid, and emissions impacts of heat pump water heaters, with goal of achieving average household performance metrics specified in Table 5 of the recipient's proposal to GFO-19-301.

# EXHIBIT A
# Scope of Work
# UC Davis

Table 5 from GFO-19-301: Performance metrics of AWHC for average household (3-bedroom single-family home or 2-bedroom unit in a multi-family housing building)

| **Performance Metric** | **Baseline Performance:** Rule-Based Control | **Target Performance:** AHWC: Model Predictive Control | **Evaluation Method** | **Metric Significance** |
|---|---|---|---|---|
| Seasonal End-use Load Flexibility, Summer (kW, kWh) | 0 kW, 0 kWh | 0-5 kW, 10-20 kWh | Simulations, Laboratory Testing, M&V | Reduce end-user utility costs, support utility and grid operator load flexibility goals for improved grid operations |
| Seasonal End-use Load Flexibility, Fall (kW, kWh) | 0 kW, 0 kWh | 0-5 kW, 5–15 kWh | Simulations, Laboratory Testing, M&V | Reduce end-user utility costs, support utility and grid operator load flexibility goals for improved grid operations |
| Seasonal End-use Load Flexibility, Winter (kW, kWh) | 0 kW, 0 kWh | 0-5 kW, 5–15 kWh | Simulations, Laboratory Testing, M&V | Reduce end-user utility costs, support utility and grid operator load flexibility goals for improved grid operations |
| Seasonal End-use Load Flexibility, Spring (kW, kWh) | 0 kW, 0 kWh | 0-5 kW, 10–20 kWh | Simulations, Laboratory Testing, M&V | Reduce end-user utility costs, support utility and grid operator load flexibility goals for improved grid operations |
| Annual End-use Load Flexibility, (kW, kWh) | 0 kW, 0 kWh | 0-5 kW, 30–70 kWh | Simulations, Laboratory Testing, M&V | Reduce end-user utility costs, support utility and grid operator load flexibility goals for improved grid operations |
| Renewable Energy Overgeneration Mitigated | 0 kWh | 30–70 kWh | Simulations, Laboratory Testing, M&V | Support California's goals for renewable energy use targets |
| Reduced Peak Energy Costs | $0 | $0 | N/A | N/A |
| T&D Capacity Upgrades Deferral/Avoidance | TBD | TBD | TBD | TBD |
| Peak Demand Reduction (kW) | 0 kW | 0 kW | N/A | N/A |

# EXHIBIT A
# Scope of Work
# UC Davis

| **Performance Metric** | **Baseline Performance:** Rule-Based Control | **Target Performance:** AHWC: Model Predictive Control | **Evaluation Method** | **Metric Significance** |
|---|---|---|---|---|
| Heat Pump Operational Cost Reduction and Energy Savings | $0 | $10–$15 (10-15% Savings) | Simulations, Laboratory Testing, M&V | Reduce end-user utility costs, reduce burden of operational costs associated with electric water heating |

- Reduce the financial, grid, and emissions impacts of heat pump space conditioning, with the goal of achieving average household performance metrics specified in Table 6 of the recipient's proposal to GFO-19-301.

# EXHIBIT A
# Scope of Work
# UC Davis

Table 6 from GFO-19-301: Performance metrics for ASCC for average household (3-bedroom single-family home or 2-bedroom unit in a multi-family housing building)

| **Performance Metric** | **Baseline Performance:** Rule-Based Control | **Target Performance:** ASCC: Model Predictive Control | **Evaluation Method** | **Metric Significance** |
|---|---|---|---|---|
| Seasonal End-use Load Flexibility, Summer (kW, kWh) | 0 kW, 0 kWh | 0-4 kW, 5–50 kWh | Simulations, M&V | Reduce end-user utility costs, support utility and grid operator load flexibility goals for improved grid operations |
| Seasonal End-use Load Flexibility, Fall (kW, kWh) | 0 kW, 0 kWh | 0-4 kW, 5–50 kWh | Simulations, M&V | Reduce end-user utility costs, support utility and grid operator load flexibility goals for improved grid operations |
| Seasonal End-use Load Flexibility, Winter (kW, kWh) | 0 kW, 0 kWh | 0-4 kW, 30–150 kWh | Simulations, M&V | Reduce end-user utility costs, support utility and grid operator load flexibility goals for improved grid operations |
| Seasonal End-use Load Flexibility, Spring (kW, kWh) | 0 kW, 0 kWh | 0-4 kW, 5–60 kWh | Simulations, M&V | Reduce end-user utility costs, support utility and grid operator load flexibility goals for improved grid operations |
| Annual End-use Load Flexibility, (kW, kWh) | 0 kW, 0 kWh | 0-4 kW, 225–1550 kWh | Simulations, M&V | Reduce end-user utility costs, support utility and grid operator load flexibility goals for improved grid operations |
| Renewable Energy Overgeneration Mitigated | 0 kWh | 225–1550 kWh | Simulations, M&V | Support California's goals for renewable energy use targets |
| Reduced Peak Energy Costs | $0 | $0 | N/A | N/A |
| T&D Capacity Upgrades Deferral/Avoidance | TBD | TBD | TBD | TBD |
| Peak Demand Reduction (kW) | 0 kW | 0 kW | N/A | N/A |

| **Performance Metric** | **Baseline Performance:** Rule-Based Control | **Target Performance:** ASCC: Model Predictive Control | **Evaluation Method** | **Metric Significance** |
|---|---|---|---|---|
| Heat Pump Operational Cost Reduction and Energy Savings | $0 | $10–$65 (5–30% Savings) | Simulations, M&V | Reduce end-user utility costs, reduce burden of operational costs associated with electric space conditioning |

- Describe the barriers to and opportunities for deployment of load flexibility controls.
- Advance technology readiness level of AHWC and ASCC to at least 7.
- Publish the AHWC and ASCC methods, control logic, and supporting documentation through an open-source license and disseminate these and project outcomes to heat pump equipment manufacturers and the public through outreach activities (e.g. conferences, webinars, newsletter, website, publications).

Ratepayer Benefits:[2] This Agreement will result in the ratepayer benefits of greater electricity reliability and lower cost by developing an open-source turn-key model predictive control (MPC) system that can automatically shift, shed, shape, and/or shimmy residential heat pump electrical loads away from time periods when the electrical grid is under high stress and the cost of electricity is high. This will result in lower costs for residential customers, reduce demand on the electrical grid, and a reduction in greenhouse gas emissions.

Technological Advancement and Breakthroughs:[3] 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 developing an open-source turn-key MPC system that will optimize (shift, shed, shape, and/or shimmy) heat pump operation based on building owner/occupant preferences, comfort and use patterns, electricity pricing, electricity grid needs, real-time GHG emission rates, and weather data. The developed MPC system will be easy to use and will eliminate the need for installers or end-users to have subject matter expertise in MPCs or heat pump systems.

**Agreement Objectives**

The objectives of this Agreement are to develop, and test an advanced control system that optimizes heat pump operation based on:

- Building owner/occupant preferences, comfort, and use patterns;
- Electricity pricing, including time-of-use schedules and/or hourly or sub-hourly price signals;

[2] 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).

[3] 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.

- Electricity grid needs, which may be reflected in ways other than price signals (e.g. demand response (DR) signals)
- Electricity grid real-time greenhouse gas (GHG) emission rates; and
- Weather data (current and forecasted), where applicable.

## III. 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, including the Final Report Outline and Final Report

- 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.
- Consider incorporating all CAM comments into the final product. If the Recipient disagrees with any comment, provide a written response explaining why the comment was not incorporated into the final product.
- Submit the revised product and responses to comments within 10 days of notice by the CAM, unless the CAM specifies a longer time period, or approves a request for additional time.

For products that require a final version only

- Submit the product to the CAM for acceptance. The CAM may request minor revisions or explanations prior to acceptance.

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.

o **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:
  - o Terms and conditions of the Agreement;
  - o Administrative products (subtask 1.1);
  - o CPR meetings (subtask 1.3);
  - o 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 towards 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 progress made on all Agreement activities as specified in the scope of work for the preceding month, including accomplishments, problems, milestones, products, schedule, fiscal status, and 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.
- Submit a monthly or quarterly *Invoice* that follows the instructions in the "Payment of Funds" section of the terms and conditions, including a financial report on Match Fund and in-state 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 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 the 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. *(See Task 1.1 for requirements for draft and final products.)*

**Recipient Products:**

- Final Report Outline (draft and final)

**CAM Product:**

- Style Manual
- Comments on Draft Final Report Outline
- Acceptance of Final Report Outline

**Subtask 1.6.2 Final Report**

**The Recipient shall:**

- Prepare a *Final Report* for this Agreement in accordance with the approved Final Report Outline, Style Manual, and Final Report Template provided by the CAM with the following considerations:
  - Ensure that the report includes the following items, in the following order:
    - Cover page (**required**)
    - Credits page on the reverse side of cover with legal disclaimer (**required**)
    - Acknowledgements page (optional)
    - Preface (**required**)
    - Abstract, keywords, and citation page (**required**)
    - Table of Contents (**required**, followed by List of Figures and List of Tables, if needed)
    - Executive summary (**required**)
    - Body of the report (**required**)
    - References (if applicable)
    - Glossary/Acronyms (If more than 10 acronyms or abbreviations are used, it is required.)
    - Bibliography (if applicable)
    - Appendices (if applicable) (Create a separate volume if very large.)
    - Attachments (if applicable)

- Ensure that the document is written in the third person.
- Ensure that the Executive Summary is understandable to the lay public.
  - Briefly summarize the completed work. Succinctly describe the project results and whether or not the project goals were accomplished.
  - Identify which specific ratepayers can benefit from the project results and how they can achieve the benefits.
  - If it's necessary to use a technical term in the Executive Summary, provide a brief definition or explanation when the technical term is first used.
- Follow the Style Guide format requirements for headings, figures/tables, citations, and acronyms/abbreviations.
- Ensure that the document omits subjective comments and opinions. However, recommendations in the conclusion of the report are allowed.
- Include a brief description of the project results in the Abstract.

- Submit a draft of the report to the CAM for review and comment. The CAM will provide written comments to the Recipient on the draft product within 15 days of receipt
- Consider incorporating all CAM comments into the Final Report. If the Recipient disagrees with any comment, provide a written response explaining why the comment was not incorporated into the final product
- Submit the revised Final Report and responses to comments within 10 days of notice by the CAM, unless the CAM specifies a longer time period or approves a request for additional time.
- Submit one bound copy of the *Final Report* to the CAM along with *Written Responses to Comments on the Draft Final Report*.

**Products**:

- Final Report (draft and final)
- Written Responses to Comments on the Draft Final Report

**CAM Product:**

- Written Comments on the Draft Final Report

## *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.
    - If different from the solicitation application, provide 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.

**The TAC shall:**

- Help set the project team's goals and contribute to the development and evaluation of its statement of proposed objectives as the project evolves.
- Provide a credible and objective sounding board on the wide range of technical and financial barriers and opportunities.
- Help identify key areas where the project has a competitive advantage, value proposition, or strength upon which to build.
- Advocate on behalf of the project in its effort to build partnerships, governmental support and relationships with a national spectrum of influential leaders.
- Ask probing questions that insure a long-term perspective on decision-making and progress toward the project’s strategic goals.

**Products:**

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

## IV. TECHNICAL TASKS

### TASK 2: MARKET CHARACTERIZATION

The goal of this task is to estimate the potential for market penetration and costs (including labor and materials) of load flexibility controls for heat pumps.

**The Recipient shall:**

- Collect data on current and projected future rate structures (e.g. time of use rates) for market rate and low-income residential customers in IOU territories.
- Describe utility and grid operator goals and objectives for residential heat pump load flexibility controls, including magnitude of adoption required to achieve load shifting targets, and utility strategies to promote load shifting to residential customers (e.g. time of use rates, real-time price signals, demand response).
- Estimate current and forecasted market penetration of heat pumps (both water heating and space conditioning) in new construction and retrofit residential housing.
- Characterize typical installation locations, including whether the heat source is indoor or outdoor air.
- Characterize ability to deploy load flexibility controls (current capabilities and feasibility and cost of retrofitting improved controls) among water heating and space conditioning heat pumps from a variety of manufacturers.
- Prepare *Market Characterization of Heat Pump Load Flexibility Controls for Residential Applications in California Report*, which will include but not be limited to:
    - Description of current and projected utility rate structures for market rate and low-income residential customers
    - Grid operator goals and objectives for residential heat pump load flexibility controls
    - Current and forecasted market penetration of heat pumps,
    - Characterize typical installation locations and;
    - Characterize manufacturer capability to deploy heat pump load flexibility controls.

**Products:**

- Market Characterization of Heat Pump Load Flexibility Controls for Residential Applications in California Report (draft and final)

### TASK 3: DEVELOP ADVANCED WATER HEATING CONTROLS

The goal of this task is to form a framework for heat pump load flexibility controls for the residential building sector and apply the framework to develop advanced water heating controls for single-tank heat pump water heater systems that provides hot water to individual housing units.

**The Recipient shall:**

- Form a framework for heat pump load flexibility controls that is immediately applicable to single-tank heat pump water heaters while considering futureproofing for additional applications.

- Prepare *Framework for Heat Pump Load Flexibility Controls Memo* to include a description of the framework and its applicability to a range of heat pump system types for single and multifamily applications.
- Characterize residential water heating use patterns, evaluate dependencies and variability within a household and between households.
- Research and characterize single-tank heat pump hot water heater efficiency over a range of water temperature set points and heat source air temperatures.
- Prepare *Background Research on Residential Water Heating Memo* to include characteristics of water heating use patterns and single-tank heat pump hot water heater efficiency over a range of water temperature set points and heat source air temperatures.
- Develop Advanced Water Heating Controls (AWHC):
    - Construct a mathematical model of a single-tank heat pump hot water heater with the following input parameters: tank size, maximum set point temperature, heat pump efficiency, heat source location.
    - Develop AWHC method to determine water temperature set points as a function of time in order to meet the performance requirements, defined as:
        - Ensure availability of hot water to satisfy occupant comfort
        - Minimize electricity costs for water heater operation
        - Minimize greenhouse gas emissions for water heater operation
    - Conduct parametric simulations to compare the performance of the AWHC to a simple rule-based control for combinations of household characteristics and single-tank heat pump hot water heater characteristics.
    - Prepare *Advanced Water Heating Control Method Memo* to include a description of the mathematical model, control method, and results of the parametric simulations.
- Coordinate with water heating manufacturing partners in AWHC implementation.
- Implement and laboratory test the AWHC deployed on a single-tank heat pump hot water heater with controller.
- Prepare *Laboratory Test Results #1 Memo* to include findings from the laboratory testing of the AWHC with the heat pump hot water heater.
- Conduct simulations of scalability and futureproofing of the control framework and ability to accommodate additional controllable equipment such as smart appliances, home automation, storage, and distributed generation.
- Prepare *Advanced Water Heating Control Development Report* that includes a summary of background research on residential water heating, the advanced water heating control method, laboratory test results, and the control framework scalability and futureproofing results.
- Prepare *CPR Report #1* and participate in CPR meeting in accordance with subtask 1.3.

**Products:**

- Framework for Heat Pump Load Flexibility Controls Memo
- Background Research on Residential Water Heating Memo
- Advanced Water Heating Control Method Memo
- Laboratory Test Results #1 Memo
- Advanced Water Heating Control Development Report (draft and final)
- CPR Report #1

**TASK 4: DEVELOP ADVANCED SPACE CONDITIONING CONTROLS**
The goal of this task is to adapt the heat pump load flexibility control framework to develop advanced space conditioning controls for residential space conditioning systems.

**The Recipient shall:**

- Research and characterize space conditioning use patterns and evaluate dependencies and variability within a household and between households.
    - Characterize residential space conditioning systems (i.e. one system per residential unit) over a range of indoor and outdoor environmental conditions.
    - Prepare *Background Research on Residential Space Conditioning Memo* to include characteristics of space conditioning use patterns and space conditioning system efficiency.
- Develop advanced space conditioning controls (ASCC)
    - Construct a general mathematical model of a residential space conditioning system and associated residential unit with the following input parameters: acceptable minimum and maximum cooling and heating set points, heat pump efficiency, availability of nighttime ventilation cooling device, and geographical location.
    - Develop ASCC method to determine space conditioning set point as a function of time in order to meet the performance requirements, defined as:
        - Ensure appropriate room temperature to satisfy occupant comfort
        - Minimize electricity costs for space conditioning system operation
        - Minimize greenhouse gas emissions for space conditioning system operation
    - Conduct a parametric simulation to compare the performance of the ASCC to a simple rule-based control for combinations of household characteristics and residential space conditioning system characteristics
    - Prepare *Advanced Space Conditioning Control Method* Memo to include, a description of the mathematical model, the control method, and the results of the parametric simulation.
- Implement and test ASCC in laboratory environment
    - Coordinate with space conditioning controls manufacturing partner in ASCC implementation.
    - Implement and laboratory test the ASCC deployed on a benchtop thermostat to verify that the controller operates as designed in response to specific combinations of inputs
    - Prepare *Laboratory Test Results #2* Memo to include the findings from the laboratory testing of the ASCC.
- Prepare *Advanced Space Conditioning Control Developmen*t *Report* to include at minimum, a summary of background research on residential space conditioning, the advanced space conditioning control method, and laboratory test results.

**Products:**

- Background Research on Residential Space Conditioning Memo
- Advanced Space Conditioning Control Method Memo
- Laboratory Test Results #2 Memo
- Advanced Space Conditioning Control Development Report (draft and final)

**TASK 5: TEST ADVANCED WATER HEATING CONTROLS**

The goal of this task is to test advanced water heating controls in a total of 25-30 housing units selected from two pilot test sites located in different CA climate zones. Both test sites will be low-income multifamily buildings.

**The Recipient shall:**

- Pilot site communications and planning
    - Work with different housing management to select a total of 25-30 units for participation in the study.
    - Prepare paperwork to ensure protection of human subjects (i.e. tenants) participating in research.
    - Manage communications, scheduling and training with housing management, maintenance staff, contractors and tenants.
    - Inspect water heating equipment in selected units to ensure it is configured correctly and operating properly.
    - Prepare the *Pilot Site Test Plan Memo,* which includes a description of units selected at each site, criteria for selection, baseline water heating equipment, and a baseline monitoring and verification (M&V) plan for the water heating system.
- Conduct baseline monitoring:
    - Identify, procure, and install baseline metering equipment in each unit (water heater electricity consumption), water flow rate from tank, water temperatures (mixing valve hot inlet, cold inlet, and mixed outlet), and heat source air temperature.
    - Prepare the *Documentation of Installation of Monitoring Equipment Memo,* which includes a description of the monitoring equipment installed at each pilot site.
    - Monitor data quality and rectify any issues that occur.
    - Prepare the *Analysis of Baseline Performance Memo,* which includes, a summary of baseline data collected, summary of data quality review, and preliminary baseline M&V results.
- Deploy AWHC
    - Conduct AHWC monitoring post installation for at least 9 months.
    - Remove monitoring equipment at the end of the monitoring period.
    - Prepare a *Preliminary Results of AWHC Performance Memo* that includes a summary of AWHC data collected, summary of data quality review, the post M&V plan, and preliminary AHWC M&V post installation results.
- Tenant, maintenance staff, and building owner satisfaction
    - Collect information from tenants, maintenance staff, and building owners on usability and satisfaction with equipment, controls, and user interface before and after AHWC retrofit.
    - Prepare a *Tenant, Maintenance Staff, and Building Owner Satisfaction Memo* #1 to document usability and satisfaction with water heating equipment before and after the AHWC retrofit.
- Prepare *Test of Advanced Water Heating Controls Report* which includes analysis of baseline controls and AWHC performance and summary of tenant, maintenance staff, and building owner satisfaction before and after the retrofit and discuss whether the goals and objectives in the agreement and listed in the recipient's proposal in response to GFO-19-301 (Table 4b) were met.

- Prepare *CPR Report #2* and participate in CPR meeting in accordance with subtask 1.3.

**Products:**

- Pilot Site Test Plan Memo
- Documentation of Installation of Monitoring Equipment Memo
- Analysis of Baseline Performance Memo
- Preliminary Results of AWHC Performance Memo
- Tenant, Maintenance Staff, and Building Owner Satisfaction Memo #1
- Test of Advanced Water Heating Controls Report (draft and final)
- CPR Report #2

**TASK 6: FURTHER RESEARCH IN ADVANCED SPACE CONDITIONING CONTROLS**

The goal of this task is to test advanced space conditioning controls in at least two housing units selected from one of the pilot test sites used for Task 5.

- Pilot site communications and planning
    - The Recipient will select at least two housing units (from those enrolled in Task 5 field test) for testing and validation of the ASCC developed in Task 4.
    - Inspect space conditioning equipment in selected units to ensure it is configured correctly and operating properly.
    - Prepare a *Pilot Site Test Plan Memo,* which includes a description of units selected for baseline monitoring plan and for the space conditioning system.
- Conduct baseline monitoring
    - Identify, procure, and install baseline metering equipment in each unit (space conditioning system electricity consumption, return, supply, and outdoor air conditions, and supply airflow).
    - Prepare *Documentation of Installation of Monitoring Equipment Memo,* which includes a description of the monitoring equipment installed at each pilot site.
    - Monitor data quality and rectify any issues that occur.
    - Prepare *Analysis of Baseline Performance Memo,* which includes a summary of baseline data collected, summary of data quality review, the baseline M&V plan, and preliminary baseline M&V results.
- Deploy ASCC
    - Conduct a benchtop laboratory test with ASCC to check the communication interface between ASCC and residential space conditioning system used at the pilot site.
    - In coordination with space conditioning controls manufacturing partner, deploy the ASCC developed in Task 4 to the selected units. If possible, install nighttime ventilation devices in these units and integrate with controller.
    - Conduct ASCC monitoring to gather data (at least 9 months) in an operational environment to compare the results to those obtained from the parametric simulation in Task 4.
    - Remove monitoring equipment at the end of the monitoring period.

- Tenant, maintenance staff, and building owner satisfaction
    - Collect information from tenants, maintenance staff, and building owners on usability and satisfaction with equipment, controls, and user interface before and after ASCC retrofit.
    - Prepare a *Tenant, Maintenance Staff, and Building Owner Satisfaction Memo #2* to document usability and satisfaction with the space conditioning equipment before and after the ASCC retrofit.
- Prepare *Test of Advanced Space Conditioning Controls Report* which includes analysis of baseline controls and ASCC performance and summary of tenant, maintenance staff, and building owner satisfaction before and after the retrofit and discuss whether the goals and objectives in the agreement were met.

**Products:**

- Pilot Site Test Plan Memo
- Documentation of Installation of Monitoring Equipment Memo
- Analysis of Baseline Performance Memo
- Preliminary Results of ASCC Performance Memo
- Tenant, Maintenance Staff, and Building Owner Satisfaction Memo #2
- Test of Advanced Space Conditioning Controls Report (draft and final)

**TASK 7: MARKET BARRIERS AND COMMERCIALIZATION ASSESSMENT**

The goal of this task is to describe the current landscape and outline a pathway for commercialization of heat pump load flexibility controls.

**The Recipient shall:**

- Estimate market potential for adoption of heat pump load flexibility controls in California based on market characterization, domestic hot water and space conditioning usage patterns, testing of AWHC, and ASCC.
- Conduct interviews with manufacturers and installers to understand drivers and barriers to sell, install, and purchase AWHC and ASCC, from the supplier perspectives and that of their customers; and identify opportunities to address market barriers.
- Summarize input from participating tenants, maintenance staff, and building owners to inform further refinement of the AWHC and ASCC, including the user interface.
- Publish the AWHC and ASCC method, control logic, and supporting documentation through an open-source license.
- Prepare the *Market Barriers and Commercialization Assessment of Heat Pump Load Flexibility Controls Report*, to include but not be limited to, an estimate of the potential impact of heat pump load flexibility controls, a description of market barriers and opportunities to address them, descriptions of the control method and logic used by AWHC and ASCC, recommendations for further refinement of AWHC and ASCC, and description of the open-source license.

**Products:**

- Market Barriers and Commercialization Assessment of Heat Pump Load Flexibility Controls Report (draft and final)

**TASK 8: 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:

  - o <u>For Product Development Projects and Project Demonstrations:</u>
    - 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.
    - <u>Additional Information for Product Development Projects</u>:
      - 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.
    - <u>Additional Information for Product Demonstrations</u>:
      - Outcome of demonstrations and status of technology.
      - Number of similar installations.
      - Jobs created/retained as a result of the Agreement.

  - o <u>For Information/Tools and Other Research Studies:</u>
    - 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 9: 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(s) on the project.
- When directed by the CAM, participate in annual EPIC symposium(s) sponsored by the California Energy Commission.
- Provide at least (6) six *High Quality Digital Photographs* (minimum resolution of 1300x500 pixels in landscape ratio) of pre and post technology installation at the project sites or related project photographs.
- 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)
- High Quality Digital Photographs
- Technology/Knowledge Transfer Plan (draft and final)
- Technology/Knowledge Transfer Report (draft and final)

## V. Project Schedule

Please see the attached Excel spreadsheet: **Exhibit A Att 1. Project Schedule**

**RESOLUTION NO: 20-0513-7d**

**STATE OF CALIFORNIA**

**STATE ENERGY RESOURCES**
**CONSERVATION AND DEVELOPMENT COMMISSION**

RESOLUTION - RE: THE REGENTS OF THE UNIVERSITY OF CALIFORNIA ON BEHALF OF THE DAVIS CAMPUS-WESTERN COOLING EFFICIENCY CENTER

**RESOLVED,** that the State Energy Resources Conservation and Development Commission (CEC) adopts the staff CEQA findings contained in the Agreement or Amendment Request Form (as applicable); and

**RESOLVED,** that the CEC approves Agreement EPC-19-015 with The Regents of the University of California, on behalf of the Davis campus, for a $2,537,436 grant to develop and test an advanced control system that saves energy, improves grid reliability, and reduces greenhouse gas emissions by optimizing heat pump operation based on building owner/occupant preferences, comfort and use patterns, electricity pricing, electricity grid needs, real-time greenhouse gas emission rates, and weather data, and adopting staff's determination that this action is exempt from CEQA. Pilot testing will occur in low-income residential units in Northern California; and

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

## ***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 CEC held on May 13, 2020.

AYE:
NAY:
ABSENT:
ABSTAIN:

_____
Cody Goldthrite
Secretariat