



**CALIFORNIA  
ENERGY COMMISSION**



**California Energy Commission  
March 12, 2026 Business Meeting  
Backup Materials for Association for Energy Affordability,  
Inc.**

The following backup materials for the above-referenced agenda item are available in this PDF packet as listed below:

1. Proposed Resolution
2. Grant Request Form
3. Scope of Work

**CALIFORNIA ENERGY COMMISSION**

**PROPOSED RESOLUTION: Association for Energy Affordability, Inc.**

**RESOLUTION NO: 26-0312-XX**

**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-25-047 with Association for Energy Affordability for a \$1,499,630 grant. This project will develop an electric heat pump prototype using ultra-low global warming potential refrigerants. The system will provide heating, cooling and hot water heating and will be demonstrated in multifamily residences. The system will be evaluated for advances to safety, energy performance, cost effectiveness, and market potential; and

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

**APPROVED AND ADOPTED this 12th day of March 2026, by the following vote:**

AYE:

NAY:

ABSENT:

ABSTAIN:

**CERTIFICATION**

The undersigned Secretariat to the CEC does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly approved and adopted by affirmative vote of the CEC at a meeting held on March 12, 2026.

Kim Todd  
Secretariat



## GRANT REQUEST FORM (GRF)

### A. New Agreement Number

**IMPORTANT:** New Agreement # to be completed by Contracts, Grants, and Loans Office.

**New Agreement Number:** EPC-25-047

### B. Division Information

1. Division Name: ERDD
2. Agreement Manager: Karen Perrin
3. MS: 51
4. Phone Number: 916-776-0803

### C. Recipient's Information

1. Recipient's Legal Name: Association for Energy Affordability, Inc.

### D. Title of Project

Title of project: Safety, Efficiency, and Scalability for Ultra-low GWP Multifunction Air-to-Water Heat Pump Systems

### E. Term and Amount

1. Start Date: 3/13/2026
2. End Date: 3/31/2031
3. Amount: \$1,499,630.00

### F. Business Meeting Information

1. Are the ARFVTP agreements \$75K and under delegated to Executive Director? No
2. The Proposed Business Meeting Date: 3/12/2026
3. Consent or Discussion? Discussion
4. Business Meeting Presenter Name: Harrison Reynolds
5. Time Needed for Business Meeting: 10 minutes
6. The email subscription topic is: Electric Program Investment Charge (EPIC)

#### **Project Description:**

Proposed resolution approving agreement EPC-25-047 with Association for Energy Affordability, Inc., for a \$1,499,630 grant and adopting staff's recommendation that this action is exempt from CEQA. The purpose of this project is to fund the development of an electric heat pump prototype using ultra-low global warming potential refrigerants. The system will provide heating, cooling and hot water heating and will be demonstrated in multifamily residences. The system will be evaluated for advances in safety, energy performance, cost effectiveness, and market potential.

### G. California Environmental Quality Act (CEQA) Compliance

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

Yes

If yes, skip to question 2.

If no, complete the following (PRC 21065 and 14 CCR 15378) and explain why Agreement is not considered a "Project":



Agreement will not cause direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment because:

**2. If Agreement is considered a “Project” under CEQA answer the following questions.**

a) Agreement **IS** exempt?

Yes

Statutory Exemption?

No

If yes, list PRC and/or CCR section number(s) and separate each with a comma. If no, enter “None” and go to the next question.

PRC section number: None

CCR section number: None

Categorical Exemption?

Yes

If yes, list CCR section number(s) and separate each with a comma. If no, enter “None” and go to the next question.

CCR section numbers: Cal. Code Regs., tit. 14, §§ 15301; 15306

Cal. Code Regs., tit. 14, Section 15301 provides that the operation, repair, maintenance, permitting, leasing, licensing, or minor alteration of existing structures, facilities, mechanical equipment or topographical features involving negligible or no expansion of use beyond that existing are categorically exempt from the provisions of CEQA.

This project involves laboratory work and the installation, testing, and replacement of mechanical equipment within existing multifamily buildings with no expansion of use and no physical alteration of the structures beyond routine HVAC and water heating work. The project consists of the in-laboratory development and subsequent onsite installation propane-based heat pump systems as replacements of existing systems. No new buildings will be constructed, and no increase in building units. Installation activities are limited to multifunction water heater heat pumps paired with compact thermal storage modules for up to 8 multifamily units in Hanford, California. The scope integrates all necessary valves and controls, use of existing or equivalent refrigerant lines, electrical connections, occupancy, or square footage will occur. The project does not involve grading, trenching beyond minor electrical or conduit work typical of HVAC and water heater replacement, vegetation removal, or disturbance of undisturbed land. All work will occur within previously developed residential sites, and the upgraded equipment will serve the same space-conditioning and water heating functions as the existing systems. Therefore, there will only be minor alterations of an existing structure and there will be no, or negligible expansion of use beyond the current HVAC system. For these reasons, the project will not have a significant effect on the environment and falls under the categorical exemption listed in 14 C.C.R. §15301.



Cal. Code Regs., tit. 14, §15306 provides that projects which consist of basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource are categorically exempt from CEQA. This project consists of research and data collection associated with the in-laboratory development and subsequent onsite installation of propane-based heat pump systems as replacements of existing HVAC and hot water systems. This project will cause minimal or no disturbance to the land and does not have the potential to cause serious or major disturbances to an environmental resource. This project will not have a significant effect on the environment therefore it is exempt under California Code of Regulations, title 14, section 15306.

This project does not involve impacts on any particularly sensitive environment; does not involve any cumulative impacts of successive projects of the same type in the same place that might be considered significant; does not involve unusual circumstances that might have a significant effect on the environment; will not result in damage to scenic resources within a highway officially designated as a state scenic highway; the project site is not included on any list compiled pursuant to Government Code section 65962.5; and the project will not cause a substantial adverse change in the significance of a historical resource. Therefore, none of the exceptions to categorical exemptions listed in CEQA Guidelines section 15300.2 apply to this project, and this project will not have a significant effect on the environment.

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

No

If yes, explain reason why Agreement is exempt under the above section. If no, enter "Not applicable" and go to the next section.

b) Agreement **IS NOT** exempt.

**IMPORTANT:** consult with the legal office to determine next steps.

No

If yes, answer yes or no to all that applies. If no, list all as "no" and "None" as "yes".

Additional Documents	Applies
Initial Study	No
Negative Declaration	No
Mitigated Negative Declaration	No
Environmental Impact Report	No
Statement of Overriding Considerations	No
None	Yes

**H. Is this project considered "Infrastructure"?**



No

**I. Subcontractors**

List all Subcontractors listed in the Budget (s) (major and minor). Insert additional rows if needed. If no subcontractors to report, enter “No subcontractors to report” and “0” to funds. **Delete** any unused rows from the table.

Subcontractor Legal Company Name	CEC Funds	Match Funds
Emanant Systems LLC	\$ 339,075	\$0
Rocky Mountain Institute	\$ 195,188	\$0

**J. Vendors and Sellers for Equipment and Materials/Miscellaneous**

List all Vendors and Sellers listed in Budget(s) for Equipment and Materials/Miscellaneous. Insert additional rows if needed. If no vendors or sellers to report, enter “No vendors or sellers to report” and “0” to funds. **Delete** any unused rows from the table.

Vendor/Seller Legal Company Name	CEC Funds	Match Funds
Intertek Testing Services, NA, Inc.	\$276,750	\$0
Contractor TBD	\$80,000	\$0
Aris Hydronics Inc	\$0	\$150,000
Gridworks Energy Consulting LLC	\$0	\$150,000
Thermaduct,LLC	\$0	\$150,000

**K. Key Partners**

List all key partner(s). Insert additional rows if needed. If no key partners to report, enter “No key partners to report.” **Delete** any unused rows from the table.

Key Partner Legal Company Name
No key partners to report

**L. Budget Information**

Include all budget information. Insert additional rows if needed. If no budget information to report, enter “N/A” for “Not Applicable” and “0” to Amount. **Delete** any unused rows from the table.

Funding Source	Funding Year of Appropriation	Budget List Number	Amount
EPIC	25-26	301.001M	\$ 1,499,630

**TOTAL Amount: \$ 1,499,630**

R&D Program Area: ICMB: Buildings



Explanation for "Other" selection Not applicable

Reimbursement Contract #: Not applicable

Federal Agreement #: Not applicable

**M. Recipient's Contact Information**

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

Name: Meghan Duff

Address: 5900 Hollis Street, Suite R2,

City, State, Zip: Emeryville, CA 94608

Phone: (510) 431-1795

E-Mail: mduff@aeacleanenergy.org

**2. Recipient's Project Manager**

Name: Andrew Brooks

Address: 5900 Hollis St Ste R2

City, State, Zip: Emeryville, CA 94608-2098

Phone: 510-431-1791

E-Mail: abrooks@aea.us.org

**N. Selection Process Used**

There are three types of selection process. List the one used for this GRF.

Selection Process	Additional Information
Competitive Solicitation #	GFO-24-305
First Come First Served Solicitation #	Not applicable
Other	Not applicable

**O. Attached Items**

1. List all items that should be attached to this GRF by entering "Yes" or "No".

Item Number	Item Name	Attached
1	Exhibit A, Scope of Work/Schedule	Yes
2	Exhibit B, Budget Detail	Yes
3	CEC 105, Questionnaire for Identifying Conflicts	Yes



<b>Item Number</b>	<b>Item Name</b>	<b>Attached</b>
4	Recipient Resolution	No
5	Awardee CEQA Documentation	Yes

**Approved By**

Individuals who approve this form must enter their full name and approval date in the MS Word version.

**Agreement Manager:** Karen Perrin

**Approval Date:** 01/26/2026

**Branch Manager:** Anthony Ng

**Approval Date:** 01/29/2026

**Director:** Jonah Steinbuck (Delegated to Branch Manager, Anthony Ng)

**Approval Date:** 01/29/2026

**Exhibit A**  
**Scope of Work**  
**Association for Energy Affordability**

**I. TASK AND ACRONYM/TERM LIST**

**A. Task List**

<b>Task #</b>	<b>CPR<sup>1</sup></b>	<b>Task Name</b>
1		General Project Tasks
2	X	Applied Research & Design
3	X	Laboratory Testing
4		Measurement and Verification
5		Commercialization Strategy
6		Evaluation of Project Benefits
7		Technology Transfer Activities

**B. Acronym/Term List**

<b>Acronym/Term</b>	<b>Meaning</b>
AB	Assembly Bill
AHJ	Authority Having Jurisdiction
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
AWHP	Air to Water Heat Pump
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CEC	California Energy Commission
CPR	Critical Project Review
CPUC	California Public Utilities Commission
DOE	Department of Energy (US)
FCU	Fan Coil Unit
GWP	Global Warming Potential
GHG	Greenhouse Gas
I/O	Input/Output
MEP	Mechanical, Electrical, and Plumbing
OEM	Original Equipment Manufacturer
SB	Senate Bill
TAC	Technical Advisory Committee
TRL	Technology Readiness Level
US	United States

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

**A. Purpose of Agreement**

The purpose of this Agreement is to fund research and development of an all-electric, integrated mechanical heat pump system that will deliver hot water and space conditioning in a modular unit. The prototype will be laboratory tested, and field evaluated using ultra-low global warming potential (GWP) refrigerants to advance safety, while maintaining cost effectiveness, energy

## **Exhibit A Scope of Work Association for Energy Affordability**

performance, minimizing safety concerns, meeting customer needs and advancing market potential.

### **B. Problem/ Solution Statement**

#### **Problem**

Buildings account for approximately 25% of greenhouse gas (GHG) emissions in California, with heating, cooling, and domestic hot water responsible for more than half of residential energy consumption. Although several ultra-low GWP refrigerants are emerging as potential climate-forward alternatives, each poses unique technical and regulatory challenges. Among these, R290 (propane) stands out for its high energy efficiency, favorable thermodynamic properties, and similar behavior to today's common refrigerants. The primary barrier to R290 adoption is its high flammability, which warrants serious technical, policy, and market attention.

Therefore, developing a scalable, low-cost, energy efficient mechanical solution with ultra-low GWP refrigerants for multifamily retrofits is needed—one that addresses both operational energy and refrigerant-related climate impacts, while paving a safe and viable path to deployment of ultra-low GWP refrigerants.

#### **Solution**

The Recipient will develop and validate modular, centralized, multifunction air-to-water heat pump systems (AWHPs, while advancing critical subsystem components that enable the safe adoption of R290 (propane) and improve overall efficiency. The solution focuses on accelerating the safe and scalable adoption of R290 in U.S. markets, through technical innovation, lab testing, field validation, and strategic policy and market transformation work. AWHPs offer a safer application path for R290 by isolating refrigerant in factory-sealed outdoor units with low charge volumes. The system includes a modest amount of thermal storage to improve efficiency during low-load conditions and to provide domestic hot water, and it provides a "thermal storage ready" platform capable of future retrofit integration with high volume stratified thermal storage, phase-change storage, or other solutions as needed.

The solution employs a combination of measures:

- Safety for R290 Refrigerant - This includes freeze prevention during power outages, effective leak detection, and robust mitigation methods.
- Efficiency and Energy Cost Reduction - These include the integration of moderate thermal storage, advanced control of staged, variable-speed modular heat pumps, and forecast-based outdoor temperature reset for ideal heat pump efficiency. Furthermore, incorporate demand response and demand flexibility strategies.
- Streamlined Design and Installation - Major features include a centralized modular system that significantly reduces the number of heat pumps required, simplifies electrical infrastructure, and minimizes extensive piping, penetration, and interior electrical upgrades.

### **C. Goals and Objectives of the Agreement**

#### **Agreement Goals**

The goals of this Agreement are to:

**Exhibit A**  
**Scope of Work**  
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- Design and install a modular, ultra-low-GWP multi-function air-to-water heat-pump system that enables cost-effective electrification.
- Accelerate a safe transition to ultra-low GWP refrigerants by proving the performance of innovative new leak-prevention, leak-detection, and-mitigation strategies.
- Improve heat-pump system efficiency and reduce annual energy cost for heating and cooling by an expected 10-20% compared to incumbent heat pump systems.
- Achieve energy consumption, reliability, and operation that are comparable to, or better than, individual space heat pumps.
- Reduce equipment and installation costs by utilizing improvements to the packaged modular systems.
- Increase the Technology Readiness Level of the AWHPs system from current 3-4 to TRL 6-7.
- Accelerate commercialization by automating the system design to de-risk entry for stakeholders.
- Conduct a comparison study of existing multi-functional heat pumps with the proposed technology.
- Openly share project outcomes and best practices with the help of a network of outreach partners and guide strategic policy evolution.

**Ratepayer Benefits**<sup>7</sup>

This Agreement is intended to result in the ratepayer benefits of lower costs, increased safety, and greater electricity reliability. It is expected to cut heating and cooling energy use by an estimated 20-30 percent compared to conventional heat pump systems. This translates directly into lower utility bills for customers, while also deferring costly grid upgrades, and enabling more efficient use of grid resources, which reduces electricity prices for ratepayers. In addition, reducing the expected installed cost of electrification, frees owner capital for other critical building upgrades.

The replacement of gas-combustion appliances with systems using low GWP refrigerants removes sources of carbon-monoxide poisoning, gas leaks, and fire hazards, and reduces indoor NOx emissions. These innovations support the State of California's statutory energy goals, and efficiency and greenhouse gas emission reduction directives.

**Technological Advancement and Breakthroughs**<sup>8</sup>

This Agreement is intended to lead to technological advancement and breakthroughs to overcome barriers to the achievement of the State of California's statutory energy and climate goals by advancing technologies for an AWHP system that uses ultra-low GWP refrigerant. By overcoming the operational energy and refrigerant-related climate impacts, such as performance, affordability, energy cost and safety, this project is intended to pave a safe and viable path to foster technological innovation and improve environmental impacts for communities across California.

Although today's mainstream heat pump technologies have enjoyed decent adoption in new single-family homes and higher-income single-family retrofits, heat pump adoption in other sectors lags significantly behind the pace needed to reach California's 2030 targets. This agreement advances solutions that are tailored specifically to overcome many of the technical and economic hurdles that hinder electrification in multifamily buildings. By expanding the total addressable heat-pump market, the agreement can help close the current heat pump adoption

**Exhibit A**  
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gap and put California on pace to meet its 2030 emissions reductions, energy-savings, and renewable-integration targets.

**Agreement Objectives**

The objectives of this Agreement are to:

- Design, fabricate and test at least two subsystem design concepts for AWHPs using R290 focused on efficiency, refrigerant leak prevention, detection, and mitigation. This includes validation of their effectiveness in supporting safe application of R290 in alignment with evolving U.S. codes and standards. Collaborate with at least two heat pump manufacturers to integrate and validate the laboratory-tested subcomponents and system design strategies to achieve measurable progress toward a commercial launch.
- Validate the full-scale prototype performance including the installation, commissioning, and measurement of a full-scale prototype centralized modular multiplex multifunction AWHP system at a multifamily site.
- Perform a comparative analysis of refrigerants and system design options to include differences in first cost, energy operating cost, and annual greenhouse gas emissions between multifunction heat pumps utilizing ultra-low-GWP refrigerants, multifunction heat pumps using current standard low-GWP refrigerants, incorporating best available data about energy performance, refrigerant leakage, and other system-level performance factors. Develop and disseminate a series of targeted commercialization and policy briefs that:
  - Explore, assess, and compare at least two viable business models- quantifying total-cost-of-ownership, and assessing the potential for expanded product offerings, increased market participation, and higher adoption rates in the multifamily sector compared to incumbent technologies and business models.
  - Document market barriers and offers actionable strategies for addressing identified policy, regulatory, and economic obstacles to adoption of R290 AWHP systems.

**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)**. All products submitted which will be viewed by the public, must comply with the accessibility requirements of Section 508 of the federal Rehabilitation Act of 1973, as amended (29 U.S.C. Sec. 794d), and regulations implementing that act as set forth in Part 1194 of Title 36 of the Federal Code of Regulations. All technical tasks should include product(s). 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:**

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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 California Energy Commission's (CEC) 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.

The following describes the accepted formats for electronic data and documents provided to the CEC 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.
- 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 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).

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Any exceptions to the Electronic File Format requirements above must be approved in writing by the CAM. The CAM will consult with the CEC'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, and other CEC staff relevant to the Agreement. The Recipient's Project Manager and any other individuals deemed necessary by the CAM, or the Project Manager shall participate in 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 for all potential meeting participants. The meeting may take place in person or by electronic conferencing (e.g., Teams, Zoom), with approval of the CAM.

The Kick-off meeting will include discussion of the following:

- The CAM's expectations for accomplishing tasks described in the Scope of Work;
  - An updated Project Schedule;
  - Terms and conditions of the Agreement;
  - Invoicing and auditing procedures;
  - Travel;
  - Equipment purchases;
  - Administrative and Technical products (subtask 1.1);
  - CPR meetings (subtask 1.3);
  - Monthly Calls (subtask 1.5)
  - Quarterly Progress reports (subtask 1.6)
  - Final Report (subtask 1.7)
  - Match funds (subtask 1.8);
  - Permit documentation (subtask 1.9);
  - Subawards (subtask 1.10);
  - Technical Advisory Committee meetings (subtasks 1.11 and 1.12);
  - Agreement changes;
  - Performance Evaluations; and
  - Any other relevant topics.
- Provide *Kick-off Meeting Presentation* to include but not limited to:
    - Project overview (i.e. project description, goals and objectives, technical tasks, expected benefits, etc.)
    - Project schedule that identifies milestones
    - List of potential risk factors and hurdles, and mitigation strategy
  - Provide an *Updated Project Schedule, Match Funds Status Letter, and Permit Status Letter*, as needed to reflect any changes in the documents.

**The CAM shall:**

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

**Recipient Products:**

- Kick-off Meeting Presentation
- Updated Project Schedule (*if applicable*)
- Match Funds Status Letter (subtask 1.7) (*if applicable*)
- Permit Status Letter (subtask 1.8) (*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 CEC 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 CEC 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 CEC.

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 may 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 CEC, 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 and submit 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.
- 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* with a list of expected CPR participants in advance of the CPR meeting. If applicable, the agenda may 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. A determination of unsatisfactory progress This may result in project delays, including a

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potential Stop Work Order, while the CEC determines whether the project should continue.

- 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)

**CAM Products:**

- CPR Agenda(s)
- 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 CEC 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 of the following Agreement closeout items:
    - Disposition of any procured equipment.
    - The CEC'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 copies of *All Final Products* organized by the tasks in the Agreement.

**Products:**

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

**MONTHLY CALLS, REPORTS AND INVOICES**

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**Subtask 1.5 Monthly Calls**

The goal of this task is to have calls at least monthly between the CAM and Recipient to verify that satisfactory and continued progress is made towards achieving the objectives of this Agreement on time and within budget.

The objectives of this task are to verbally summarize activities performed during the reporting period, to identify activities planned for the next reporting period, to identify issues that may affect performance and expenditures, to verify match funds are being proportionally spent concurrently or in advance of CEC funds or are being spent in accordance with an approved Match Funding Spending Plan, to form the basis for determining whether invoices are consistent with work performed, and to answer any other questions from the CAM. Monthly calls might not be held on those months when a quarterly progress report is submitted or the CAM determines that a monthly call is unnecessary.

**The CAM shall:**

- Schedule monthly calls.
- Provide questions to the Recipient prior to the monthly call.
- Provide call summary notes to Recipient of items discussed during call.

**The Recipient shall:**

- Review the questions provided by CAM prior to the monthly call.
- Provide verbal answers to the CAM during the call.

**Product:**

- Email to CAM concurring with call summary notes.

**Subtask 1.6 Quarterly 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 *Quarterly 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 reporting period, 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. Progress reports are due to the CAM the 10th day of each January, April, July, and October. The Quarterly Progress Report template can be found on the ECAMS Resources webpage available at: <https://www.energy.ca.gov/media/4691>
- Submit a monthly or quarterly *Invoice* on the invoice template(s) provided by the CAM.

**Recipient Products:**

- Quarterly Progress Reports
- Invoices

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**CAM Product:**

- Invoice template

**Subtask 1.7 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. When creating the Final Report Outline and the Final Report, the Recipient must use the CEC Style Manual provided by the CAM.

**Subtask 1.7.1 Final Report Outline**

**The Recipient shall:**

- Prepare a *Final Report Outline* in accordance with the *Energy Commission Style Manual* provided by the CAM.

**Recipient Products:**

- Final Report Outline (draft and final)

**CAM Products:**

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

**Subtask 1.7.2 Final Report**

**The Recipient shall:**

- Prepare a *Final Report* for this Agreement in accordance with the approved Final Report Outline, Energy Commission 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)
- Submit a draft of the Executive Summary to the TAC for review and comment.

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- Develop and submit a *Summary of TAC Comments on Draft Final Report* received on the Executive Summary. For each comment received, the Recipient will identify in the summary the following:
  - Comments the Recipient proposes to incorporate.
  - Comments the Recipient does propose to incorporate and an explanation for why.
- 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.
- Incorporate all CAM comments into the *Final Report*. If the Recipient disagrees with any comment, provide a *Written Responses to Comments* explaining why the comments were not incorporated into the final product.
- Submit the revised *Final Report* electronically with any Written Responses to Comments within 10 days of receipt of CAM's Written Comments on the Draft Final Report, unless the CAM specifies a longer time period or approves a request for additional time.

**Products:**

- Summary of TAC Comments on Draft Final Report
- Draft Final Report
- Written Responses to Comments (*if applicable*)
- Final Report

**CAM Product:**

- Written Comments on the Draft Final Report

**MATCH FUNDS, PERMITS, AND SUBAWARDS**

**Subtask 1.8 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. 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 application that led to the CEC 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 application that led to the CEC 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

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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 1.9 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:**

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- Permit Status Letter
- Updated List of Permits (*if applicable*)
- Updated Schedule for Acquiring Permits (*if applicable*)
- Copy of Each Approved Permit (*if applicable*)

**Subtask 1.10 Obtain and Execute Subawards and Agreements with Site Hosts**

The goal of this task is to ensure quality products and to execute subrecipients and site host agreements, as applicable, required to carry out the tasks under this Agreement consistent with the Agreement Terms and Conditions and the Recipient's own procurement and contracting policies and procedures.

**The Recipient shall:**

- Execute and manage subawards and coordinate subrecipients activities in accordance with the requirements of this Agreement.
- Execute and manage site host agreements, and ensure the right to use the project site throughout the term of the Agreement, as applicable. A site host agreement is not required if the Recipient is the site host.
- Notify the CEC in writing immediately, but no later than five calendar days, if there is a reasonable likelihood the project site cannot be acquired or can no longer be used for the project.
- Incorporate this Agreement by reference into each subaward.
- Include any required Energy Commission flow-down provisions in each subaward, in addition to a statement that the terms of this Agreement will prevail if they conflict with the subaward terms.
- Submit a *Subaward and Site Letter* to the CAM describing the subawards and any site host agreement needed or stating that no subawards or site host agreements are required.
- If requested by the CAM, submit a draft of each *Subaward* and any *Site Host Agreement* required to conduct the work under this Agreement.
- If requested by the CAM, submit a final copy of each executed *Subaward* and any *Site Host Agreement*.
- Notify and receive written approval from the CAM prior to adding any new subrecipient (see the terms regarding subrecipient additions in the terms and conditions).

**Products:**

- Subaward and Site Letter
- Draft Subawards (*if requested by the CAM*)
- Draft Site Host Agreement (*if requested by the CAM*)
- Final Subawards (*if requested by the CAM*)
- Final Site Host Agreement (*if requested by the CAM*)

**TECHNICAL ADVISORY COMMITTEE**

**Subtask 1.11 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:

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- 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.
- 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, to the extent the TAC members feel is appropriate, 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 ensure a long-term perspective on decision-making and progress toward the project's strategic goals.

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 1.12.

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- 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 1.12 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* for each TAC Meeting 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 ensure a long-term perspective on decision-making and progress toward the project's strategic goals.
- Review and provide comments to proposed project performance metrics.
- Review and provide comments to proposed project Draft Technology Transfer Plan.

**Products:**

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

**Exhibit A**  
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**Subtask 1.13 Project Performance Metrics**

The goal of this subtask is to finalize key performance targets for the project based on feedback from the TAC and report on final results in achieving those targets. The performance targets should be a combination of scientific, engineering, techno-economic, and/or programmatic metrics that provide the most significant indicator of the research or technology's potential success.

**The Recipient shall:**

- Complete and submit the project performance metrics section of the *Initial Project Benefits Questionnaire*, developed in the Evaluation of Project Benefits task, to the CAM.
- Present the draft project performance metrics at the first TAC meeting to solicit input and comments from the TAC members.
- Develop and submit a *TAC Performance Metrics Summary* that summarizes comments received from the TAC members on the proposed project performance metrics. The *TAC Performance Metrics Summary* will identify:
  - TAC comments the Recipient proposes to incorporate into the *Initial Project Benefits Questionnaire*, developed in the Evaluation of Project Benefits task.
  - TAC comments the Recipient does not propose to incorporate with and explanation why.
- Develop and submit a *Project Performance Metrics Results* document describing the extent to which the Recipient met each of the performance metrics in the *Final Project Benefits Questionnaire*, developed in the Evaluation of Project Benefits task.
- Discuss the *Project Performance Metrics Results* at the Final Meeting.

**Products:**

- TAC Performance Metrics Summary
- Project Performance Metrics Results

**IV. TECHNICAL TASKS**

**TASK 2: APPLIED RESEARCH & DESIGN**

The goals of this task are to conduct research to advance both subcomponent and whole system design strategies, begin to prepare for subsystem testing based on research advancement, and to develop engineering design documents to advance a modular multiplex multifunction AWHP system using R290 refrigerant.

**The Recipient shall:**

- Develop the conceptual and technical designs for the multiplex AWHP system using R-290 architecture with controls that will enable energy resiliency and grid flexibility to minimize electric load during net peak.
- Complete the conceptual design of multiple subsystems and their whole-system integration including:
  - Low-voltage ductless fan coil units (FCUs) with air filters with wireless controls that provide heating, cooling, and hot water to thermal storage nodes distributed across an array of apartments.

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- Refrigerant leak prevention, detection, and mitigation strategies
- Alternate indirect thermal storage tank designs
- Collaborate with manufacturer partners to determine the viability of the design of the prefabricated modular insulation and soffit chase infrastructure to streamline retrofit installation of plumbing systems.
- Develop an identifying schematic level detail and functional constraints to define the design target for the subsystems.
- Prepare a *Component and Controls Specification Plan* summarizing the schematic level detail and functional constraints to define the design target for the subsystems.
- Develop the design for lab test rigs, and the lab testing objectives, including measurement points, control function, test procedures, and quantitative metrics.
- Develop the *Draft Full-scale Prototype Design Plans*, to include a definition of the control functions for the summary of the mechanical, electrical, plumbing, and control schematics, proposed materials, installation layout, and control input/output (I/O) mapping integration. The plan will be prepared and submitted ahead of the installation work, and the Design Report will represent “as built” documentation, to be submitted in Task 4. The design documentation shall include: A complete list of the intended Installer Parameters to guide commissioning the prototype system.
- Collaborate with manufacturers to prepare modular subsystem packages suitable for factory assembly, informed by applied R&D and preliminary lab testing results.
- Develop a baseline system design for the host building (if an appropriate baseline system is not already in place) to facilitate comparison against the proposed prototype, and document key design and performance differences.
- Support iterative improvements to the systems and controls during subsystem laboratory testing and full-scale prototype evaluation and update design documentation accordingly.
- Develop a whole-system, open-source tool that can be used to assist designers and contractors in sizing and selecting appropriate system configurations based on building characteristics and design inputs. Prepare and submit a *Design Support Tool* document that describes an overview of the tool.
- Participate in the Critical Project Review and prepare *CPR Report #1* as required by Subtask 1.3.
- Develop and submit a *Test Rig Design Plan* that summarizes the proposed control schematics, materials, and technical annotations, to guide fabrication of the laboratory test rigs.

**Products:**

- Component and Controls Specification Plan
- Draft Full-scale Prototype Design Plans
- Design Support Tool
- CPR Report #1
- Test Rig Design Plan

**TASK 3: LABORATORY TESTING**

## **Exhibit A Scope of Work Association for Energy Affordability**

The goals of this task are to conduct subcomponent testing to validate safety and performance, and integration-readiness of critical subsystem components to confirm they meet the technical requirements necessary for a full-scale prototype integration and field deployment. This task supports advancement from TRL 3–4 to TRL 6–7 for multiple core technologies associated with R290-based AWHP systems.

### **The Recipient shall:**

- Prepare a *Draft Laboratory Testing Plan* that defines test objectives, quantitative performance targets, safety requirements, measurement approaches, and instrumentation requirements. The plan shall reflect functional priorities identified and developed in Task 2 including priorities identified in the *Component and Controls Specification Plan* and technical procedures and performance targets detailed in the *Test Rig Design Plan*.
- Define the available testing timeframe and prioritize test conditions for each subsystem.
- Prepare a *Final Laboratory Testing Plan* that incorporates the testing conditions.
- Fabricate or procure test rig assemblies to evaluate subsystems possibly including:
  - Refrigerant leak prevention, detection, and mitigation components
  - Freeze protection mechanisms and failure scenarios
  - Thermal and hydraulic performance of multiple indirect thermal storage tank configurations
  - Low-voltage fan coil units with quality air filtration and associated embedded control logic for zone-level performance
- Conduct laboratory testing to resolve research questions, validate safety functionality, and measure energy and thermal performance.
- Document test setups, procedures, and outcomes in a *Draft Laboratory Testing Report*, with attention to subsystem-specific findings, anomalies, and implications for full-system design.
- Develop the *Final Laboratory Testing Report* incorporating reviewer feedback and lessons learned.
- Update Task 2 deliverable to *Updated Draft Full-scale Prototype Design Plans* to include relevant insights from laboratory testing.
- Support strategic policy-related work under Task 5 by sharing relevant findings from refrigerant-safety testing to inform future R290 codes and standards development.
- Support manufacturers through “design preview consulting” to align new R290 system product development efforts with relevant test data, codes, standards, and certification pathways.
- Participate in the Critical Project Review and prepare *CPR Report #2* as required by Subtask 1.3.

### **Products:**

- Laboratory Testing Plan (Draft and Final)
- Laboratory Testing Report (Draft and Final)
- Updated Draft Full-scale Prototype Design Plans
- CPR Report #2

### **TASK 4: MEASUREMENT AND VERIFICATION (M&V)**

**Exhibit A**  
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The goals of this task are to prepare the full-scale prototype for the installation, commissioning, and conduct 12 months (or less with CAM approval) testing and data collection in multifamily buildings.

**The Recipient shall:**

- Develop an *M&V Plan* which details the specific approach to verification of the system's performance.
- Procure and assemble all required subsystems.
- Secure installation contractors, confirm design requirements, provide necessary training, and coordinate with permitting authorities to obtain all required installation approvals.
- Prepare and program supervisory control sequences.
- Prepare a *Pre-Functional Performance Testing Plan* that includes steps for proper installation, initial operation strategies and a pre-start checklist for functional performance testing in multifamily buildings.
- Conduct functional performance testing to validate safe operation, control logic, and user responsiveness.
- Verify performance alignment with specifications from the Component and Controls Specification Plan.
- Deploy a monitoring system to collect detailed data on thermal performance, electrical demand, heating, cooling, and domestic hot water use, indoor and outdoor environmental conditions, refrigerant leak detection, and equipment run-time.
- Operate and monitor the system over a 12-month period, (or less with CAM approval)
- Evaluate and refine control strategies and installer parameters during the monitoring period, in coordination with manufacturer partners and building operators.
- Conduct M&V tasks, including results evaluation of performance. Produce a *M&V Report* that includes an analysis of energy usage, summary of all costs, estimate of GHG emissions; and performance reporting against the metrics defined in the *Measurement and Verification Plan*. It shall summarize monitored data, distill key performance results, document lessons learned, and describe implications for future design refinement, scaling, and commercialization
- Prepare a *Draft Prototype Performance Report* that provides a comprehensive evaluation of the demonstration. The report shall include: an analysis of energy usage, summary of all costs, estimate of GHG emissions; and performance reporting against the metrics defined in *the M&V Plan*. It shall summarize monitored data, distill key performance results, document lessons learned, and describe implications for future design refinement, scaling, and commercialization. The *Final Prototype Performance Report* shall also include an assessment of the installation process and permitting experience; observations on the demeanor and reliability of the equipment; a log of system failures, troubleshooting steps, and repair actions; evaluation of general system functionality and integration.
- Develop a *Final Full-scale Prototype Design Plan* based on prior lab testing (Task 3) and design refinement (Task 2), including a summary of MEP, bill of materials, control sequences, and commissioning requirements that Incorporates revisions.

**Products:**

- M&V Plan

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- Pre-Functional Performance Testing Plan
- M&V Report
- Prototype Performance Report (draft and final)
- Final Full-scale Prototype Design Plan

**TASK 5: COMMERCIALIZATION STRATEGY**

The goals of this task are to collaborate with and support manufacturer partners and other stakeholders to cooperatively: evaluate market, business model, and policy barriers to widespread deployment of the R290 heat pump system.

**The Recipient shall:**

- Continue collaboration with manufacturer partners to identify viable commercialization pathways; and to provide actionable guidance to accelerate safe and affordable adoption of R290 heat pumps.
- Develop and conduct structured interviews with a range of stakeholders—which may include manufacturers, distributors, contractors, property owners, and designers—to understand perceptions, hesitations, and practical concerns related to the proposed system architecture. Summarize findings through a *Structured Interview Summary*.
- Produce a *Comparative Study of Alternate Heat Pump System Architectures with Conventional, Low and Ultra-Low GWP Refrigerants* summarizing manufacturer's data, literature, and the latest available research findings to quantify differences in first cost, operating cost, lifecycle GHG emissions, and applicability in alternate multifamily applications. The comparison shall address the following alternatives:
  - Current leading technology
  - Proposed technology, and low voltage ductless terminal heating
  - Competing multifunction technology
- Investigate how the innovative multiplex system challenges conventional ownership models and utility billing practices, especially regarding submetering.
- Collaborate in relevant industry technical committee and standards development processes, in support of technology transfer, such as related to: AHRI Standard 1700 Performance Rating of Unitary Air-to-Water Heat Pump Equipment, ANSI/ASHRAE Standard 206-2024, Method of Testing for Rating of Multipurpose Heat Pumps for Residential Space Conditioning and Water Heating, ASHRAE Standard 15 Safety Standard for Refrigeration Systems and 34 Designation and Safety Classification of Refrigerants, ASHRAE TC 8.11 Unitary and Room Air Conditioners and Heat Pumps, ASHRAE TC 6.1 Hydronic and Steam Equipment and Systems, or others as determined to be strategic by the research team.
- Develop content for a series of at least 3 webinars, technology briefs, and/or case studies to highlight the technology innovations and research findings. This content will be incorporated into technology transfer products developed in Task 7 and will potentially include:
  - Guidelines for safe practices related to R290 AWHPs
  - Application of freeze protection technologies for AWHPs
  - Advances in modularity for multifunction AWHP systems
  - Design strategies for multifunction AWHP systems in multifamily
  - Low voltage ductless hydronic heating and cooling terminal units
  - Efficiency improvements for heat pump indirect water heating

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- Emerging business strategies to expand AWHP adoption
- Modular insulating soffit/chase for hydronic systems
- Emerging pathways for demand flexibility for heat pumps with thermal storage
- Policy barriers and enablers to multifunction AWHP systems in multifamily
- Develop a public-facing *Application and Best Practices Guideline for R290 AWHPs* for engineers, contractors, and code officials, drawing upon lessons from Task 3 and broader literature. This document shall describe validated leak mitigation strategies, system-level isolation techniques, code-compliant design methods, and key insights to support fire marshal and AHJ acceptance.
- Contribute technical input and validated component guidance to updates to the Component and Controls Specification Plan (Task 2 product), reflecting strategic considerations related to commercialization and policy alignment.
- Develop a series of focused *Commercialization and Policy Briefs* to support market transformation. This series shall include:
  - At least one brief analysis of viable business models (e.g., vertically integrated delivery models vs. traditional OEM-distributor-contractor frameworks), evaluating cost advantages, delivery logistics, and scalability.
  - At least one brief providing actionable recommendations that address key policy, regulatory, and economic barriers to adoption, including issues surrounding permitting, safety codes, submetering challenges, and alignment with CPUC Electric Rule 18.
  - Additional briefs, at the discretion of the research team, to address distinct challenges, such as to advance business and policy frameworks related to transactive energy management, or to provide strategic guidance on how Title 24 code enhancements could help to bridge the gaps between AHRI, ASHRAE, DOE, and EPA performance standards in regard to recognizing the unique efficiency advantages offered by multifunction heat pump systems.

**Products:**

- Structured Interview Summary
- Comparative Study of Heat Pump System Architectures with Conventional, Low and Ultra-Low GWP Refrigerants
- Application and Best Practices Guideline for R290 AWHPs
- Commercialization and Policy Briefs

**TASK 6: EVALUATION OF PROJECT BENEFITS**

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

**The Recipient shall:**

- Complete *the Initial Project Benefits Questionnaire*. The Initial Project Benefits Questionnaire shall be initially completed by the Recipient with 'Kick-off' selected for the 'Relevant data collection period' and submitted to the CAM for review and approval.
- Complete the *Annual Survey* by January 31st of each year. The Annual Survey includes but is not limited to the following information:
  - Technology commercialization progress
  - New media and publications
  - Company growth

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- Follow-on funding and awards received
- Complete the *Final Project Benefits Questionnaire*. The Final Project Benefits Questionnaire shall be completed by the Recipient with 'Final' selected for the 'Relevant data collection period' and submitted to the CAM for review and approval.
- Respond to CAM questions regarding the questionnaire drafts.
- Complete and update the project profile on the CEC's public online project and recipient directory on the [Energize Innovation website \(www.energizeinnovation.fund\)](http://www.energizeinnovation.fund), and provide *Documentation of Project Profile on EnergizeInnovation.fund*, including the profile link.
- If the Prime Recipient is an Innovation Partner on the project, complete and update the organizational profile on the CEC's public online project and recipient directory on the [Energize Innovation website \(www.energizeinnovation.fund\)](http://www.energizeinnovation.fund), and provide *Documentation of Organization Profile on EnergizeInnovation.fund*, including the profile link.

**Products:**

- Initial Project Benefits Questionnaire
- Annual Survey(s)
- Final Project Benefits Questionnaire
- Documentation of Project Profile on EnergizeInnovation.fund
- Documentation of Organization Profile on EnergizeInnovation.fund

**TASK 7: TECHNOLOGY TRANSFER ACTIVITIES**

The goal of this task is to ensure the technological learning that resulted from the project is captured and disseminated to the range of stakeholders that will be responsible for future deployments of this technology or similar technologies.

**The Recipient Shall:**

- Develop and submit a draft and final *Technology Transfer Plan* that identifies the proposed plans for industry engagement activities and describes how the recipient will conduct to accelerate the successful commercial adoption of the technology.
- Present the draft *Technology Transfer Plan* to TAC for feedback and comments.
- Develop and submit a *Summary of TAC Comments* that summarizes comments received from the TAC members on the Draft Technology Transfer Plan. This document will identify:
  - TAC comments the Recipient proposes to incorporate into the final *Technology Transfer Plan*.
  - TAC comments the Recipient does not propose to incorporate with and explanation why.
- Implement activities identified in final *Technology Transfer Plan*.
- Develop and submit a draft and final *Technology Transfer Summary Report* that includes high level summaries of the activities, results, and lessons learned of tasks performed relating to implementing the Final Technology Transfer Plan. This report should not include any proprietary information.
- When directed by the CAM, develop presentation materials for a CEC- sponsored conference/workshop(s) on the project.

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- When directed by the CAM, participate in the annual EPIC symposium(s) sponsored by the CEC.
- 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.

**Products:**

- Technology Transfer Plan (draft and final)
- Summary of TAC Comments
- Technology Transfer Summary Report (draft and final)
- High Quality Digital Photographs

**V. PROJECT SCHEDULE**

Please see the attached Excel spreadsheet – Attachment 05: Project Schedule.