

ENERGY RESEARCH, DEVELOPMENT, AND DEMONSTRATION GRANTS

Exhibit A SCOPE OF WORK

[PIR-13-008, The Regents of the University of California, San Diego]

I. TASK AND ACRONYM/TERM LISTS

A. Task List

Task #	CPR ¹	Task Name
1		Project Administration
2		Fuel Cell Absorption Chiller Heat Recovery System Design, Procurement and Installation
3	x	Data Collection and Analysis
4		Evaluation of Costs and Benefits for California and Utility Ratepayers
5		Technology/Knowledge Transfer Activities

B. Acronym/Term List

Acronym/Term	Meaning
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CARB	California Air Resources Board
CCHP	Combined Cooling Heating and Power
CHP	Combined Heat and Power
CPR	Critical Project Review
DER	Distributed Energy Resources
DG	Distributed Generation
ECUP	East Campus Utility Plant
GHG	Green House Gas
LCR	Local Capacity Region
LHV	Lower Heating Value
M&V	Measurement and Verification
MW	Megawatt
OTC	Once Through Cooling
SONGS	San Onofre Nuclear Generating Station
TAC	Technical Advisory Committee
Recipient	University of California – San Diego

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

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

A. Purpose of Agreement

The purpose of this Agreement is to fund instrumentation, operational data collection, and analysis of the performance of a 330 ton heat recovery absorption chiller to be integrated with a commercialized 2.8 Megawatt (MW) molten carbonate fuel cell that utilizes directed biogas fuel. The fuel cell has been operating for more than 23 months on the University of California, San Diego (UCSD) microgrid. Assessment of the increased performance will also include recommendations to improve system efficiency from the current 47% simple cycle efficiency to over 68% Combined Heat and Power (CHP) efficiency.

B. Problem/ Solution Statement

Problem

This project will address the technical challenge of whether a simple cycle source of electric generation certified by California Air Resources Board (CARB) as “Ultraclean” at 47% efficient can be modified with the addition of heat recovery to achieve CHP efficiencies exceeding 68% in order to enhance the technology’s currently undervalued economic, environmental and ratepayer benefits. Large, customer-based fuel cells, such as the directed-biogas-fed 2.8 MW fuel cell that has been operational at UCSD since January 2012, produce clean energy with a simple cycle efficiency of about 47%. However, it is unknown if the waste heat of this directed biogas fuel cell can be captured and used for district cooling (which represents a predominant customer load demand in Southern California) by installing a heat recovery absorption chilling system to raise the CHP efficiency to a globally significant 68+%. The absence of vetted, granular performance data, the undervaluation of CHP fuel cells’ economic, environmental and ratepayer benefits in current models, and the limited public outreach of this public option has constrained the preferred, distributed-CHP approach from being deployed on a larger scale. There is a well-documented imperative to achieve a high penetration of ultra-efficient, safe, reliable, resilient and CARB-compliant self-generation resources in Southern California due to the growing demand for electricity; the future elimination of Once Through Cooling (OTC) in coastal area natural gas-fired power plants; the recent closure of San Onofre Nuclear Generating Station (SONGS); and the resultant pressures on electrical and natural gas transmission systems.

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Solution

The recipient will install an absorption chiller and a densely populated and diverse set of sensors and measurement devices on the heat recovery system and associated fuel cell, collect the performance data at an unprecedented level of granularity and fidelity, and complete a comprehensive performance evaluation.

C. Goals and Objectives of the Agreement

Agreement Goals

The goals of this Agreement are to:

- The primary goal is to demonstrate and analyze a CARB-certified “Ultra Clean”, multi-MW fuel cell technology in a globally unprecedented CHP configuration that could provide near-term and significant power generation capacity to Southern California’s commercial and industrial users. The CHP configuration would also be grid-interconnected and capable of exporting surplus power to the grid due to the ultra-efficient utilization of the regionally available combination of biogas, biomethane, and (renewable) natural gas.
- A technical performance goal is to use grid-connected CHP fuel cells to fully demonstrate a significant increase in the localized utilization of regionally available biogas, biomethane, and (renewable) natural gas.

Additional goals include:

- Collection of performance data and determine overall combined fuel cell–heat recovery system efficiency.
- Identify improvements to increase fuel cell-heat recovery absorption chilling system performance and overall efficiency.

Agreement Objectives

The objectives of this Agreement are to:

- Raise the current simple cycle efficiency of an operating 2.8 MW directed biogas fuel cell from 47% to 68% Lower Heating Value (LHV) by demonstrating the globally unprecedented integration of a 330 ton absorption chiller.
- Determine if a heat recovery absorption chiller efficiency target of 21% can be maintained as fuel cell exhaust heat temperature drops below 700 deg. F and mass flow rates drop below 32,000 lb/hr as the fuel cell stack degrades.

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III. TASK 1 PROJECT ADMINISTRATION

PRODUCTS

Subtask 1.1 Products

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

The Recipient shall:

For products that require a draft version

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

For products that require a final version only

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

For all products

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

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

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

- Data sets will be in MS Access or MS Excel file format (version 2007 or later), or any other format approved by the CAM.
 - Text documents will be in MS Word file format, version 2007 or later.
 - Documents intended for public distribution will be in PDF file format. The Recipient must also provide the native Microsoft file format.
 - Project management documents will be in Microsoft Project file format, version 2007 or later.
- **Software Application Development**
Use the following standard Application Architecture components in compatible versions for any software application development required by this Agreement (e.g., databases, models, modeling tools), unless the CAM approves other software applications such as open source programs:
 - Microsoft ASP.NET framework (version 3.5 and up). Recommend 4.0.
 - Microsoft Internet Information Services (IIS), (version 6 and up) Recommend 7.5.
 - Visual Studio.NET (version 2008 and up). Recommend 2010.
 - C# Programming Language with Presentation (UI), Business Object and Data Layers.
 - SQL (Structured Query Language).
 - Microsoft SQL Server 2008, Stored Procedures. Recommend 2008 R2.
 - Microsoft SQL Reporting Services. Recommend 2008 R2.
 - XML (external interfaces).

Any exceptions to the Electronic File Format requirements above must be approved in writing by the CAM. The CAM will consult with the Energy Commission's Information Technology Services Branch to determine whether the exceptions are allowable.

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MEETINGS

Subtask 1.2 Kick-off Meeting

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

The Recipient shall:

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

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

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

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

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

The CAM shall:

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

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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.

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- 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.

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- 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 research objectives of this Agreement; and (2) ensure that invoices contain all required information and are submitted in the appropriate format.

The Recipient shall:

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

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- Energy Commission funds spent in California (*if applicable*); and
- Match fund expenditures.

Products:

- Progress Reports
- Invoices

Subtask 1.6 Final Report

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

Subtask 1.6.1 Final Report Outline

The Recipient shall:

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

Recipient Products:

- Final Report Outline (draft and final)

CAM Product:

- Style Manual

Subtask 1.6.2 Final Report

The Recipient shall:

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

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Products:

- Final Report (draft and final)

MATCH FUNDS, PERMITS, AND SUBCONTRACTS

Subtask 1.7 Match Funds

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

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

The Recipient shall:

- Prepare a *Match Funds Status Letter* that documents the match funds committed to this Agreement. If no match funds were part of the proposal that led to the Energy Commission awarding this Agreement and none have been identified at the time this Agreement starts, then state this in the letter.

If match funds were a part of the proposal that led to the Energy Commission awarding this Agreement, then provide in the letter:

- A list of the match funds that identifies:
 - The amount of cash match funds, their source(s) (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied.
 - The amount of each in-kind contribution, a description of the contribution type (e.g., property, services), the documented market or book value, the source (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or real property, the Recipient must identify its owner and provide a contact name, address, telephone number, and the address where the property is located.
- A copy of a letter of commitment from an authorized representative of each source of match funding that the funds or contributions have been secured.
- At the Kick-off meeting, discuss match funds and the impact on the project if they are significantly reduced or not obtained as committed. If applicable, match funds

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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 reimbursable under this Agreement. 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*.

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- 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 research direction. The guidance may include research scope and methodologies, timing, and coordination with other research. The guidance may be based on:
 - Technical area expertise;

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- Knowledge of market applications; or
- Linkages between the agreement work and other past, present, or future research (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 project research 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 research 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

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Subtask 1.11 TAC Meetings

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

The Recipient shall:

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

Products:

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

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IV. TECHNICAL TASKS

*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. **Subtask 1.1 (Products)** describes the procedure for submitting products to the CAM.*

TASK 2 FUEL CELL ABSORPTION CHILLER HEAT RECOVERY SYSTEM DESIGN, PROCUREMENT AND INSTALLATION

The goal of this task is to demonstrate a modification of an existing directed biogas fed 2.8 MW fuel cell by installing an absorption chiller for district cooling applications. This modification is expected to exceed the US Environmental Protection Agency Energy Star Efficiency standard of 66% overall efficiency LHV.

The Recipient shall:

- Modify the January 2012 installed 2.8 MW directed biogas fuel cell located at the East Campus Utility Plant (ECUP) so that excess heat will be captured and converted into chilled water using a 330 ton absorption chiller. Waste heat from the fuel cell process will be recovered using a 2-stage, lithium bromide and water absorption chiller.
- Determine the ability to exceed an improvement to 66+% efficiency LHV from the current simple cycle 47% efficiency on the fuel cell.
- Obtain all permits and approvals for installation of heat recovery absorption chiller.
- Finalize design plans for heat recovery absorption chiller.
- Receive delivery of heat recovery absorption chiller.
- Complete installation of heat recovery absorption chiller.
- Begin operations of fuel cell and heat recovery absorption chiller
- Document system installation and operations, including recommendations for future installations of biogas fuel cell CHP systems for *Final System Installation and Operations Report*.

Products:

- Final System and Installation and Operations Report

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TASK 3 DATA COLLECTION AND ANALYSIS

The goal of this task is to install sensors and measurement devices in order to collect data on the performance of the heat recovery absorption chiller and ensure thorough cleansing, mining, analysis and visualization of this data. The Recipient shall ensure that key conclusions and recommendations from the data analysis are included in the Tasks' reports.

TASK 3.1 Installation of Sensors and Interface with UCSD's Existing Data Acquisition

The goal of this task is to install sensors and measurement devices throughout the 2.8 MW fuel cell and 330 ton heat recovery absorption chiller, and interface data collection with UCSD's data acquisition system.

The Recipient shall:

- Install sensors for measuring performance parameters for the fuel cell and absorption chiller for CCHP.
- Interface sensors with UCSD's Ethernet data collection system.
- Interface with the OSI PI historian and data collection system.
- Interface data processing and control interfaces with the Power Analytics microgrid controller.
- Prepare a Sensor Installation Plan for CHP/CCHP of directed biogas fuel cells to include but not to be limited to descriptions of how many and what type of sensors and measurement devices will be installed.
- Prepare a Data Processing and Flow Diagram for CHP/CCHP of directed biogas fuel cells to include but not to be limited to showing how the fluids and heat flow through the system, and the locations of major components, sensors, and measurement devices.
- Participate in CPR as described in Task 1.3.

Products:

- Sensor Installation Plan
- Final Data Processing and Flow Diagram
- CPR Report

TASK 3.2 Data Collection and Analysis

The goal of this task is to collect, cleanse, mine, analyze and visualize data to determine the effectiveness of biogas for fuel cell use and heat recovery for absorption chilling. Data will be collected from diverse sources, including but not limited to field instrumentation and programmable logic controllers on board the equipment. A common data base will be constructed in which these data will reside for continued analysis and trending.

ENERGY RESEARCH, DEVELOPMENT, AND DEMONSTRATION GRANTS

Exhibit A SCOPE OF WORK

[PIR-13-008, The Regents of the University of California, San Diego]

The Recipient shall:

- Define thermal characteristics of the fuel cell heat recovery absorption chilling system hourly performance analysis of the ECUP with the fuel cell system, with and without an absorption chiller.
- Determine ECUP cooling annual, seasonal, monthly, weekly, daily, hourly and 5 minute loads.
- Collect data including, but not limited to, the following:
 - Status and position of valves
 - Position and status of heat recovery diverter
 - Chilled water temperature and pressure
 - Condenser input and output temperature
 - Bypass position and status
 - Fuel cell exhaust gas backpressure
 - Fuel cell exhaust gas outlet temperature
 - Fuel cell exhaust gas inlet temperature
 - Electrical parameters on the fuel cell DC-AC inverter
 - Fuel cell AC revenue meter
 - Cooling loads, 5 min intervals
 - Instantaneous chilled water production (tons)
 - Integrated chilled water production (ton-hours)
 - Alarm logs
- Collect, cleanse, mine, analyze and visualize performance data for the fuel cell and absorption chiller for CCHP.
- Prepare a Draft Data Collection and Analysis Plan for CHP/CCHP of directed biogas fuel cells to include but not to be limited to the results and conclusions from data collection detailed in Task 3.2.
- Prepare a Final Data Collection and Analysis Results for CHP/CCHP of directed biogas fuel cells

Products:

- Draft Data Collection and Analysis Plan
- Final Data Collection and Analysis Results

TASK 4 EVALUATION OF COSTS AND BENEFITS FOR CALIFORNIA AND UTILITY RATEPAYERS

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

ENERGY RESEARCH, DEVELOPMENT, AND DEMONSTRATION GRANTS

Exhibit A SCOPE OF WORK

[PIR-13-008, The Regents of the University of California, San Diego]

- Respond to CAM questions regarding responses to the questionnaires.
- Calculate the following potential benefits to California ratepayers and discuss in a Cost-Benefit Report:
 - Annual electricity and thermal savings (kilowatt-hours and therms)
 - Peak load reduction and shifting,
 - Energy cost reductions,
 - Greenhouse gas emission reductions,
 - Air emission reductions (e.g., oxides of nitrogen),
 - Water use and/or cost reductions.

[Questionnaires] [Cost-Benefit Report]:

- State the timeframe and assumptions used in the Cost-Benefit Report
- Identify impacted market segments in California,
- Discuss any qualitative or intangible benefits to California investor-owned utility (IOUS) electricity ratepayers, including timeframe and assumptions,
- Explain how the proposed project will lead to technological advancement to achieving the state's statutory energy goals.

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
- Cost-benefit Report

TASK 5 TECHNOLOGY AND 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 research. Use the format provided by the CAM.
- Prepare a *Final Project Fact Sheet* at the project's conclusion that discusses research results. Use the format provided by the CAM.
- Conduct technology transfer activities in accordance with the Technology and Knowledge Transfer Plan. These activities will be reported in the Progress Reports.
- Conduct discussions with military, IOUs, the California Independent System Operator, and industrial stakeholders.

ENERGY RESEARCH, DEVELOPMENT, AND DEMONSTRATION GRANTS

Exhibit A

SCOPE OF WORK

[PIR-13-008, The Regents of the University of California, San Diego]

- Conduct site visits to potential commercial or industrial installation that can use the technology.
- Meet with California Center for Sustainable Energy to discuss the Department of Energy's CHP Technical Assistance Program and possible outreach as part of Technology Transfer.

Products:

- Initial Fact Sheet (draft and final)
- Final Project Fact Sheet (draft and final)

V. PROJECT SCHEDULE

Please see the attached Excel spreadsheet.

RESOLUTION NO:

STATE OF CALIFORNIA

**STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION**

RESOLUTION - RE: UNIVERSITY OF CALIFORNIA, SAN DIEGO

RESOLVED, that the State Energy Resources Conservation and Development Commission (Energy Commission) adopts the staff CEQA findings contained in the CEC 94 Contract Request Form or CEC 270 Grant Request Form (as applicable).

RESOLVED, that the Energy Commission approves Agreement PIR-13-008 with **The Regents of the University of California, San Diego** for a \$390,553 grant to install an absorption chiller onto an existing fuel cell system and to collect and analyze its performance data to demonstrate the viability of a directed biogas combined cooling, heat and power fuel cell system on the UC San Diego campus.

FURTHER BE IT RESOLVED, that the Executive Director shall execute the same on behalf of the Energy Commission.

CERTIFICATION

The undersigned Secretariat to the Commission does hereby certify that the foregoing is a full, true, and correct copy of a Resolution duly and regularly adopted at a meeting of the California Energy Commission held on June 18, 2014.

AYE: [List of Commissioners]

NAY: [List of Commissioners]

ABSENT: [List of Commissioners]

ABSTAIN: [List of Commissioners]

Harriet Kallemeyn,
Secretariat