STATE OF CALIFORNIA

GRANT REQUEST FORM (GRF)

CEC-270 (Revised 02/13) CALIFORNIA ENERGY COMMISSION

New Agreement EPC-14-027 (To be completed by CGL Office)

Division	Agreement Manager:	MS-	Phone
ERDD	Quenby Lum	43	916-327-1492

Recipient's Legal Name	Federal ID Number
Regents of the University of California, Los Angeles Campus	95-6006143

Title of Project
High Temperature Hybrid Compressed Air Energy Storage

Term and Amount	Start Date	End Date	Amount
	5/8/2015	3/31/2017	$ 1,621,628

Business Meeting Information			
☐ ARFVTP agreements under $75K delegated to Executive Director.			
Proposed Business Meeting Date	4/8/2015	☐ Consent	☒ Discussion
Business Meeting Presenter	Quenby Lum	Time Needed:	5 minutes
Please select one list serve. EPIC (Electric Program Investment Charge)			

Agenda Item Subject and Description

THE REGENTS OF THE UNIVERSITY OF CALIFORNIA, LOS ANGELES CAMPUS. Proposed resolution approving Agreement EPC-14-027 with the Regents of the University of California, on behalf of the Los Angeles Campus for a $1,621,628 grant to help build an energy storage system that can efficiently store grid-level energy from renewable sources and release that energy when it is needed to meet peak demand.

California Environmental Quality Act (CEQA) Compliance

1. Is Agreement considered a "Project" under CEQA?
   ☒ Yes (skip to question 2) ☐ No (complete the following (PRC 21065 and 14 CCR 15378)):
   Explain why Agreement is not considered a "Project":
   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:
   ☒ a) Agreement **IS** exempt. (Attach draft NOE)
   ☐ Statutory Exemption. List PRC and/or CCR section number:
   ☒ Categorical Exemption. List CCR section number: 14 CCR §§ 15301, 15304, 15306, 15311
   ☐ Common Sense Exemption. 14 CCR 15061 (b) (3)

   Explain reason why Agreement is exempt under the above section:

   Cal. Code Regs., tit. 14, sect. 15301 All of the components for this project will be installed at an existing site at Cal Poly, Pomona. The components will be connected via piping systems, and therefore there is no alteration to the structure other than securing the components on the ground. For this project, the connection to the power facility (the electrical grid) is already available at the site and there is no need to modify the site for this purpose. The components for the high temperature hybrid compressed air energy storage system will result in only minor alteration of the existing structures and facilities at the site. Therefore, this project is exempt pursuant to 14 C.C.R. § 15301 because it consists of minor alterations to existing structures and facilities which involve negligible or no expansion of use.

   Cal. Code Regs., tit. 14, sect. 15304 For this project site, minor re-paving of an already paved area may be needed. No other alteration to the ground will occur. No healthy, mature, scenic trees will be removed during the potential re-paving. Therefore, this project is exempt pursuant to 14 C.C.R. § 15304 because this project will result in only minor alterations to land with no removal of vegetation.

   Cal. Code Regs., tit. 14, sect. 15306 This project will involve studying the behavior of a high temperature hybrid compressed air energy storage system by collecting data during charging and discharging processes. The power output, response time and energy loss will be measured using collected data. The outcome of this research will be published in a final report. These data collection activities, which will occur at a previously developed area on the campus of Cal Poly, Pomona, will result in no major disturbance to an environmental resource. Therefore, this project is exempt pursuant to 14 C.C.R. § 15306 because it is a project to conduct basic data collection, research, experimental management, and resource evaluation which will not result in major disturbances to an environmental resource.

   Cal. Code Regs., tit. 14, sect. 15311 The components for the proposed energy storage project are portable and they will be connected via piping systems. This project will develop a temporary, portable structure in a location where all utilities are available and have capacity for use. Therefore, this project is exempt pursuant to 14 C.C.R. § 15311 because it consists of construction or placement of minor structures accessory to existing facilities.

   ☐ b) Agreement **IS NOT** exempt. (Consult with the legal office to determine next steps.)
   Check all that apply
   ☐ Initial Study
   ☐ Negative Declaration
   ☐ Mitigated Negative Declaration
   ☐ Environmental Impact Report
   ☐ Statement of Overriding Considerations

STATE OF CALIFORNIA
GRANT REQUEST FORM (GRF)
CEC-270 (Revised 02/13) CALIFORNIA ENERGY COMMISSION

List all subcontractors (major and minor) and equipment vendors: (attach additional sheets as necessary)	
Legal Company Name:	Budget
California State Polytechnic University, Pomona	$ 100,000
	$

List all key partners: (attach additional sheets as necessary)
Legal Company Name:

Budget Information

Funding Source	Funding Year of Appropriation	Budget List No.	Amount
EPIC	13-14	301.001A	$1,621,628
			$
R&D Program Area: ESRO: ETSI		TOTAL:	$1,621,628
Explanation for "Other" selection			
Reimbursement Contract #:		Federal Agreement #:	

Recipient's Administrator/ Officer				**Recipient's Project Manager**			
Name:	Pirouz Kavehpour			Name:	Pirouz Kavehpour		
Address:	420 WESTWOOD PLZ			Address:	420 WESTWOOD PLZ		
City, State, Zip:	LOS ANGELES, CA 90095-8357			City, State, Zip:	LOS ANGELES, CA 90095-8357		
Phone:	310-825-6494 /	Fax:	- -	Phone:	310-825-6494 /	Fax:	- -
E-Mail:	pirouz@seas.ucla.edu			E-Mail:	pirouz@seas.ucla.edu		

Selection Process Used

☒ Competitive Solicitation Solicitation #: PON-13-302
☐ First Come First Served Solicitation

The following items should be attached to this GRF		
1. Exhibit A, Scope of Work		☒ Attached
2. Exhibit B, Budget Detail		☒ Attached
3. CEC 105, Questionnaire for Identifying Conflicts		☒ Attached
4. Recipient Resolution	☒ N/A	☐ Attached
5. CEQA Documentation	☐ N/A	☒ Attached

Agreement Manager	**Date**	**Office Manager**	**Date**	**Deputy Director**	**Date**

Exhibit A
Scope of Work

A. Task List

Task #	CPR[1]	Task Name
1		General Project Tasks
2		Thermodynamic Simulation of High Temperature Hybrid-Compressed Air Energy Storage Cycle with Design Parameters
3	X	High Temperature Thermal Storage Installation and Testing
4	X	Compressor and Low Pressure Tanks Installation and Testing
5	X	Turboexpander and Generator Installation
6		Installation of Low Temperature Thermal Energy Storage
7		Installation of Recuperator
8		Underground Storage Installation and Testing
9		Pilot Scale 74 kW Demo with LTES and Recuperator
10		Grid Response Simulation and Modeling
11		Evaluation of Project Benefits
12		Technology/Knowledge Transfer Activities
13		Production Readiness Plan

B. Acronym/Term List

Acronym/Term	Meaning
AA-CAES	Advanced Adiabatic Compressed Air Energy Storage
CAES	Compressed Air Energy Storage
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CPR	Critical Project Review
HTH-CAES	High Temperature Hybrid Compressed Air Energy Storage
HTES	High Temperature Thermal Energy Storage
IOU	Investor-Owned Utility
LTES	Low Temperature Thermal Energy Storage
TAC	Technical Advisory Committee

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

A. Purpose of Agreement

The purpose of this Agreement is to fund the development of a 74kW high temperature hybrid compressed air storage system.

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

Exhibit A
Scope of Work

B. Problem/ Solution Statement

Problem

Integrating renewable energy into the energy delivery system presents challenges, such as managing variable and intermittent generation from sources such as wind and solar. To address these challenges, the California Public Utilities Commission has identified energy storage procurement targets for investor-owned utilities (IOUs). The U.S. Department of Energy and California Independent System Operator have also identified a need for energy storage. However, there are significant barriers to energy storage use, including high capital costs, lack of information regarding performance, and limited operational experience.

Solution

The Recipient will develop a fully-functional, low-cost, 74 kW pilot High Temperature Hybrid Compressed Air Energy Storage (HTH-CAES) system that can efficiently store grid-level energy and release that energy when it is needed to meet peak demand, particularly for ancillary services and load following use-cases. The Recipient will also collect data, and document and report on the performance and operations of the HTH-CAES system in order to increase knowledge and understanding of how these storage systems perform and operate at the grid level.

C. Goals and Objectives of the Agreement

Agreement Goals

The goals of this Agreement are to:

- Construct a low capital cost, durable, and efficient pilot scale HTH-CAES system to address use-cases such as ancillary services and load following; and
- Demonstrate the cost saving advantages of combining low and high temperature energy storage (LTES & HTES) units to improve the efficiency of the HTH-CAES system.

Ratepayer Benefits:[2] This Agreement will demonstrate the ratepayer benefits of greater electricity reliability, lower costs, and increased safety. The HTH-CAES system will allow power plants to store energy that is generated during off-peak hours, and then allow them to deploy that energy during peak usage hours, thereby increasing reliability of the IOU grid. Furthermore, unlike fossil fuel powered storage systems, the HTH-CAES system will not employ combustibles and has considerably less complexity than Advanced Adiabatic Compressed Air Energy Storage (AA-CAES) systems for improved safety. Finally, the project uses a low-cost HTES design which allows a single storage system to be scaled dynamically to accommodate any changing grid demand at a small incremental cost. This eliminates the need for additional auxiliary storage systems that are necessary with other technologies, thereby lowering the overall investment capital cost.

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

Technological Advancement and Breakthroughs:[3] This Agreement will lead to technological advancement and breakthroughs to overcome barriers to the achievement of the State of California's statutory energy goals by utilizing a novel HTH-CAES design which is a compromise between existing CAES and AA-CAES designs. HTH-CAES allows for the addition of grid energy directly to the thermal storage unit through thermoelectric heaters to achieve temperatures much higher than traditional CAES and AA-CAES, paving the way for a new class of energy storage systems. This advancement in compressed air technology will allow HTH-CAES systems to perform as well as a much larger AA-CAES system while costing approximately the same as a small conventional CAES system.

II. TASK 1 GENERAL PROJECT TASKS

PRODUCTS

Subtask 1.1 Products
The goal of this subtask is to establish the requirements for submitting project products (e.g., reports, summaries, plans, and presentation materials). Unless otherwise specified by the Commission Agreement Manager (CAM), the Recipient must deliver products as required below by the dates listed in the **Project Schedule (Part V).** Products that require a draft version are indicated by marking **"(draft and final)"** after the product name in the "Products" section of the task/subtask. If "(draft and final)" does not appear after the product name, only a final version of the product is required. With respect to due dates within this Scope of Work, **"days"** means working days.

The Recipient shall:

For products that require a draft version

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

For products that require a final version only

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

For all products

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

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

Exhibit A
Scope of Work

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

  The following describes the accepted formats for electronic data and documents provided to the Energy Commission as products under this Agreement, and establishes the software versions that will be required to review and approve all software products:
  - Data sets will be in MS Access or MS Excel file format (version 2007 or later), or any other format approved by the CAM.
  - Text documents will be in MS Word file format, version 2007 or later.
  - Documents intended for public distribution will be in PDF file format. The Recipient must also provide the native Microsoft file format.
  - Project management documents will be in Microsoft Project file format, version 2007 or later.

- ***Software Application Development***
  Use the following standard Application Architecture components in compatible versions for any software application development required by this Agreement (e.g., databases, models, modeling tools), unless the CAM approves other software applications such as open source programs:
  - Microsoft ASP.NET framework (version 3.5 and up). Recommend 4.0.
  - Microsoft Internet Information Services (IIS), (version 6 and up) Recommend 7.5.
  - Visual Studio.NET (version 2008 and up). Recommend 2010.
  - C# Programming Language with Presentation (UI), Business Object and Data Layers.
  - SQL (Structured Query Language).
  - Microsoft SQL Server 2008, Stored Procedures. Recommend 2008 R2.
  - Microsoft SQL Reporting Services. Recommend 2008 R2.
  - XML (external interfaces).

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

Exhibit A
Scope of Work

MEETINGS

Subtask 1.2 Kick-off Meeting
The goal of this subtask is to establish the lines of communication and procedures for implementing this Agreement.
The Recipient shall:

- Attend a "Kick-off" meeting with the CAM, the Commission Agreement Officer (CAO), and any other Energy Commission staff relevant to the Agreement. The Recipient will bring its Project Manager and any other individuals designated by the CAM to this meeting. The administrative and technical aspects of the Agreement will be discussed at the meeting.

  Prior to the meeting, the CAM will provide an agenda to all potential meeting participants. The meeting may take place in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

  The administrative portion of the meeting will include discussion of the following:
  - Terms and conditions of the Agreement;
  - Administrative products (subtask 1.1);
  - CPR meetings (subtask 1.3);
  - Match fund documentation (subtask 1.7);
  - Permit documentation (subtask 1.8);
  - Subcontracts (subtask 1.9); and
  - Any other relevant topics.

  The technical portion of the meeting will include discussion of the following:
  - The CAM's expectations for accomplishing tasks described in the Scope of Work;
  - An updated Project Schedule;
  - Technical products (subtask 1.1);
  - Progress reports and invoices (subtask 1.5);
  - Final Report (subtask 1.6);
  - Technical Advisory Committee meetings (subtasks 1.10 and 1.11); and
  - Any other relevant topics.

- Provide an *Updated Project Schedule, List of Match Funds,* and *List of Permits*, as needed to reflect any changes in the documents.

The CAM shall:

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

Recipient Products:

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

CAM Product:

- Kick-off Meeting Agenda

Exhibit A
Scope of Work

Subtask 1.3 Critical Project Review (CPR) Meetings
The goal of this subtask is to determine if the project should continue to receive Energy Commission funding, and if so whether any modifications must be made to the tasks, products, schedule, or budget. CPR meetings provide the opportunity for frank discussions between the Energy Commission and the Recipient. As determined by the CAM, discussions may include project status, challenges, successes, advisory group findings and recommendations, final report preparation, and progress on technical transfer and production readiness activities (if applicable). Participants will include the CAM and the Recipient, and may include the CAO and any other individuals selected by the CAM to provide support to the Energy Commission.

CPR meetings generally take place at key, predetermined points in the Agreement, as determined by the CAM and as shown in the Task List on page 1 of this Exhibit. However, the CAM may schedule additional CPR meetings as necessary. The budget will be reallocated to cover the additional costs borne by the Recipient, but the overall Agreement amount will not increase. CPR meetings generally take place at the Energy Commission, but they may take place at another location, or may be conducted via electronic conferencing (e.g., WebEx) as determined by the CAM.

The Recipient shall:

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

The CAM shall:

- Determine the location, date, and time of each CPR meeting with the Recipient's input.
- Send the Recipient a *CPR Agenda* and a *List of Expected CPR Participants* in advance of the CPR meeting. If applicable, the agenda will include a discussion of match funding and permits.
- Conduct and make a record of each CPR meeting. Provide the Recipient with a *Schedule for Providing a Progress Determination* on continuation of the project.
- Determine whether to continue the project, and if so whether modifications are needed to the tasks, schedule, products, or budget for the remainder of the Agreement. If the CAM concludes that satisfactory progress is not being made, this conclusion will be referred to the Deputy Director of the Energy Research and Development Division.
- Provide the Recipient with a *Progress Determination* on continuation of the project, in accordance with the schedule. The Progress Determination may include a requirement that the Recipient revise one or more products.

Recipient Products:

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

Exhibit A
Scope of Work

CAM Products:

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

Subtask 1.4 Final Meeting

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

The Recipient shall:

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

  The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be divided into two separate meetings at the CAM's discretion.
  - The technical portion of the meeting will involve the presentation of findings, conclusions, and recommended next steps (if any) for the Agreement. The CAM will determine the appropriate meeting participants.
  - The administrative portion of the meeting will involve a discussion with the CAM and the CAO of the following Agreement closeout items:
    - Disposition of any state-owned equipment.
    - Need to file a Uniform Commercial Code Financing Statement (Form UCC-1) regarding the Energy Commission's interest in patented technology.
    - The Energy Commission's request for specific "generated" data (not already provided in Agreement products).
    - Need to document the Recipient's disclosure of "subject inventions" developed under the Agreement.
    - "Surviving" Agreement provisions such as repayment provisions and confidential products.
    - Final invoicing and release of retention.

- Prepare a *Final Meeting Agreement Summary* that documents any agreement made between the Recipient and Commission staff during the meeting.
- Prepare a *Schedule for Completing Agreement Closeout Activities*.
- Provide *All Draft and Final Written Products* on a CD-ROM or USB memory stick, organized by the tasks in the Agreement.

Products:

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

Exhibit A
Scope of Work

REPORTS AND INVOICES

Subtask 1.5 Progress Reports and Invoices
The goals of this subtask are to: (1) periodically verify that satisfactory and continued progress is made towards achieving the project objectives of this Agreement; and (2) ensure that invoices contain all required information and are submitted in the appropriate format.

The Recipient shall:

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

Products:

- Progress Reports
- Invoices

Subtask 1.6 Final Report
The goal of this subtask is to prepare a comprehensive Final Report that describes the original purpose, approach, results, and conclusions of the work performed under this Agreement. The CAM will review and approve the Final Report, which will be due at least **two months** before the Agreement end date. When creating the Final Report Outline and the Final Report, the Recipient must use a Style Manual provided by the CAM.

Subtask 1.6.1 Final Report Outline

The Recipient shall:

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

Recipient Products:

- Final Report Outline (draft and final)

CAM Products:
- Style Manual
- Comments on Draft Final Report Outline
- Approval of Final Report Outline

Subtask 1.6.2 Final Report

The Recipient shall:
- Prepare a *Final Report* for this Agreement in accordance with the approved Final Report Outline 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.

Products:
- Final Report (draft and final)

CAM Products:
- Comments on Draft Final Report

MATCH FUNDS, PERMITS, AND SUBCONTRACTS

Subtask 1.7 Match Funds
The goal of this subtask is to ensure that the Recipient obtains any match funds planned for this Agreement and applies them to the Agreement during the Agreement term.

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

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

  If match funds were a part of the proposal that led to the Energy Commission awarding this Agreement, then provide in the letter:
  - A list of the match funds that identifies:
    - The amount of cash match funds, their source(s) (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied.
    - The amount of each in-kind contribution, a description of the contribution type (e.g., property, services), the documented market or book value, the source

(including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or real property, the Recipient must identify its owner and provide a contact name, address, telephone number, and the address where the property is located.

- A copy of a letter of commitment from an authorized representative of each source of match funding that the funds or contributions have been secured.

- At the Kick-off meeting, discuss match funds and the impact on the project if they are significantly reduced or not obtained as committed. If applicable, match funds will be included as a line item in the progress reports and will be a topic at CPR meetings.
- Provide a *Supplemental Match Funds Notification Letter* to the CAM of receipt of additional match funds.
- Provide a *Match Funds Reduction Notification Letter* to the CAM if existing match funds are reduced during the course of the Agreement. Reduction of match funds may trigger a CPR meeting.

Products:

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

Subtask 1.8 Permits

The goal of this subtask is to obtain all permits required for work completed under this Agreement in advance of the date they are needed to keep the Agreement schedule on track. Permit costs and the expenses associated with obtaining permits are not reimbursable under this Agreement, with the exception of costs incurred by University of California recipients. Permits must be identified and obtained before the Recipient may incur any costs related to the use of the permit(s) for which the Recipient will request reimbursement.

The Recipient shall:

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

  The list of permits and the schedule for obtaining them will be discussed at the Kick-off meeting (subtask 1.2), and a timetable for submitting the updated list, schedule, and copies of the permits will be developed. The impact on the project if the permits are not obtained in a timely fashion or are denied will also be discussed. If applicable, permits will be included as a line item in progress reports and will be a topic at CPR meetings.
- If during the course of the Agreement additional permits become necessary, then provide the CAM with an *Updated List of Permits* (including the appropriate information on each permit) and an *Updated Schedule for Acquiring Permits*.
- Send the CAM a *Copy of Each Approved Permit*.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the CAM within 5 days. Either of these events may trigger a CPR meeting.

Products:

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

Subtask 1.9 Subcontracts

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

The Recipient shall:

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

Products:

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

TECHNICAL ADVISORY COMMITTEE

Subtask 1.10 Technical Advisory Committee (TAC)

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

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

Exhibit A
Scope of Work

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

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

The Recipient shall:

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

Products:

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

Subtask 1.11 TAC Meetings

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

The Recipient shall:

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

Products:

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

III. TECHNICAL TASKS

*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: THERMODYNAMIC SIMULATION OF HIGH TEMPERATURE HYBRID-COMPRESSED AIR ENERGY STORAGE CYCLE WITH DESIGN PARAMETERS

The goals of this task are to: (1) simulate the thermodynamics behavior of the high temperature hybrid compressed air energy storage system during charge and discharge processes; and (2) optimize the high temperature hybrid compressed air energy storage system for the highest over-all efficiency.

The Recipient shall:

- Develop a theoretical mathematical thermodynamic model for the charging process and for determining the metrics for fabrication
- Simulate the charging process using Recipient's in-house software and find optimal efficiency of charge model
- Develop a thermodynamic model for discharging process
- Simulate the discharging process and find efficiency of discharge model
- Calculate the overall efficiency of the system
- Optimize the distribution of energy between compressed air and thermal energy storage
- Prepare and provide an *Optimized Thermal Model Report,* to include but not be limited to:
    - The results and analysis of the thermodynamic simulations of the charging and discharge models.
    - The overall efficiency of the system.
    - The results of the optimization process.
    - The metrics required for fabrication.

Products:

- Optimized Thermal Model Report (draft and final)

TASK 3: HIGH -TEMPERATURE THERMAL ENERGY STORAGE INSTALLATION AND TESTING

The goal of this task is to fabricate, install and test the high temperature thermal storage unit.

The Recipient shall:

- Fabricate the HTES unit
- Calibrate the heating capacity of the HTES unit
- Install thermal insulation for HTES unit

- Prepare a *Stored Thermal Load Test Plan*
- Test stored thermal load
- Prepare and provide a *Thermal Storage Performance Report* to include, but not be limited to the results and analysis of the thermal storage testing
- Prepare a CPR Report in accordance with subtask 1.3 (CPR Meetings)
- Participate in a CPR meeting in accordance with subtask 1.3

Products:
- Stored Thermal Load Test Plan
- Thermal Storage Performance Report (draft and final)
- CPR Report

TASK 4: INSTALL AND TEST COMPRESSOR AND LOW-PRESSURE TANKS
The goals of this task are to (1) install compressors; (2) install low-pressure tanks and connections; and (3) test compression performance for the HTH-CAES system.

The Recipient shall:
- Install air compressors for the HTH-CAES system
- Install low pressure tanks for the HTH-CAES system
- Install tubing connections for the HTH-CAES system
- Create a *Test Plan* for *Charging Tanks* and test the charging process by pressurizing the tanks
- Prepare an *Efficiency Estimate* of the system from the test results
- Prepare a *Scaled Tank Testing Report* to include but not be limited to:
    - Results and analysis of the scaled tank tests.
    - Projected charging performance of the full scale system.
- Prepare a *CPR Report* in accordance with subtask 1.3 (CPR Meetings)
- Participate in a CPR meeting in accordance with subtask 1.3

Products:
- Test Plan for Charging Tanks
- Efficiency Estimate
- Scaled Tank Testing Report
- CPR Report

TASK 5: INSTALL TURBOEXPANDERS AND GENERATORS
The goals of this task are to (1) install turboexpanders; and (2) attach the generators to each turboexpander for the HTH-CAES system.

The Recipient shall:
- Install turboexpanders
- Attach generators to turboexpanders
- Create a *Turboexpander/Generator Test Plan,* to include but not be limited to:
    - A procedure for operating the Turboexpander and generator and evaluating their performance.
- Test turboexpander and generator output

- Prepare a *Turboexpander/Generator Report* which will include but not be limited to:
    - A discussion of the results and analysis from the turboexpander and generator testing.
- Prepare a CPR Report in accordance with subtask 1.3 (CPR Meetings)
- Participate in a CPR meeting

Products:

- Turboexpander/Generator Test Plan
- Turboexpander/Generator Report (draft and final)
- CPR Report

TASK 6: INSTALLATION OF LOW TEMPERATURE THERMAL ENERGY STORAGE

The goal of this task is to install the low temperature thermal energy storage for the HTH-CAES system.

The Recipient shall:

- Manufacture LTES system
- Prepare a *Heat Capacity Test Plan* to include but not be limited to:
    - A procedure to charge the LTES and evaluate its heat capacity.
- Test heat capacity of the LTES
- Connect the LTES to the HTH-CAES system
- Prepare an *LTES Report* to include but not be limited to:
    - A discussion of the results and analysis of the LTES heat capacity tests.

Products:

- Heat Capacity Test Plan
- LTES Report (draft and final)

TASK 7: INSTALLATION OF RECUPERATOR

The goal of this task is to install a recuperator to retrieve the remaining heat in the air after leaving turboexpanders, and bring that heat back to the HTH-CAES system.

The Recipient shall:

- Install recuperator at the exit of turboexpanders.
- Create a *Recuperator Test Plan*
- Test the recuperator.
- Prepare a *Recuperator Performance Report* to include but not be limited to
    - A discussion of the results and analysis of the recuperator performance tests.

Products:

- Recuperator Test Plan
- Recuperator Performance Report

TASK 8: INSTALL AND TEST UNDERGROUND AIR STORAGE TANK
The goal of this task is to install an underground air storage tank.

The Recipient shall:

- Finalize the location of the storage tank
- Construct the underground pressure tank
- Create an Underground Tank Test Plan
- Connect the tank to the compressors
- Conduct pressurization test of underground tank
- Prepare and provide a *Underground Storage Tank Report*, which will include but not be limited to:
    - A description of the underground storage layout and location.
    - A discussion of the construction methods
    - The results and analysis of the pressurization test.

Products:

- Underground Tank Test Plan
- Underground Storage Tank Report

TASK 9: PILOT SCALE 74 KW DEMO WITH LTES AND RECUPERATOR
The goal of this task is to store electrical energy in the form of thermal energy and compressed air, and retrieve it for up to 6 hours.

The Recipient shall:

- Prepare a *Full Scale System Test Plan,* to include, but not be limited to:
    - A procedure for compressing air for the underground storage system.
    - A procedure for running the LTES.
    - A procedure for charging the HTES.
    - A procedure for running the entire system and producing electricity.
- Conduct a Full Scale System Test, which includes
    - Compressing the underground storage system.
    - Storing heat from compressed air in LTES.
    - Charging HTES using electric heaters.
    - Discharging air through LTES, HTES, turboexpanders, and recuperator.
    - Producing electricity at the output of generators.
- Prepare *Full Scale HTH-CAES Performance Report* which will include, but not be limited to:
    - A description of startup, charging and discharging procedures.
    - A discussion of power input to compressors, HTES; and power output from generators.
    - A discussion of overall system efficiency.

Products:

- Full Scale System Test Plan
- Full Scale HTH-CAES Performance Report (draft and final)

Exhibit A
Scope of Work

TASK 10: GRID RESPONSE SIMULATION AND MODELING
The goals of this task are to simulate, in two phases, grid response for (1) ancillary system; and (2) load following.

The Recipient shall:

- Create software interface to simulate grid behavior.
- Assemble hardware interface.
- Connect hardware to system for Phase 1 simulation.
- Create *Phase 1 Scaled System Test Plan* to include, but not limited to, the performance characteristics of the scaled system that uses above ground steel tanks.
- Test the response and system behavior of the Phase 1 scaled system.
- Prepare *Phase 1 Scaled System Performance Report* which will include but not be limited to:
    - A discussion of the performance characteristics of the scaled system that uses above ground steel tanks instead of the full underground storage system that Phase 2 will employ.
- Connect hardware to system for Phase 2 simulation.
- Create *Phase 2 Full Pilot Scale System Test Plan* to include, but not limited to, the performance characteristics of the full scale system that utilizes the full underground storage system.
- Test the response and system behavior of the Phase 2 full pilot scale system.
- Prepare *Phase 2 Full Pilot Scale Performance Report* which will include but not be limited to:
    - A discussion of the performance characteristics of the full scale system that utilizes the full underground storage system instead of the above ground steel tanks that the Phase 1 scaled system employed.

Products:

- Phase 1 Scaled System Test Plan
- Phase 1 Scaled System Performance Report
- Phase 2 Full Pilot Scale System Test Plan
- Phase 2 Full Pilot Scale Performance Report

TASK 11: EVALUATION OF PROJECT BENEFITS
The goal of this task is to report the benefits resulting from this project.

The Recipient shall:

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

    - <u>For Product Development Projects and Project Demonstrations:</u>
        - Published documents, including date, title, and periodical name.

- Estimated or actual energy and cost savings, and estimated statewide energy savings once market potential has been realized. Identify all assumptions used in the estimates.
- Greenhouse gas and criteria emissions reductions.
- Other non-energy benefits such as reliability, public safety, lower operational cost, environmental improvement, indoor environmental quality, and societal benefits.
- Data on potential job creation, market potential, economic development, and increased state revenue as a result of the project.
- A discussion of project product downloads from websites, and publications in technical journals.
- A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.
- Additional Information for Product Development Projects:
    - Outcome of product development efforts, such copyrights and license agreements.
    - Units sold or projected to be sold in California and outside of California.
    - Total annual sales or projected annual sales (in dollars) of products developed under the Agreement.
    - Investment dollars/follow-on private funding as a result of Energy Commission funding.
    - Patent numbers and applications, along with dates and brief descriptions.
- Additional Information for Product Demonstrations:
    - Outcome of demonstrations and status of technology.
    - Number of similar installations.
    - Jobs created/retained as a result of the Agreement.

o For Information/Tools and Other Research Studies:

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

- Respond to CAM questions regarding responses to the questionnaires.

The Energy Commission may send the Recipient similar questionnaires after the Agreement term ends. Responses to these questionnaires will be voluntary.

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

TASK 12: TECHNOLOGY/KNOWLEDGE TRANSFER ACTIVITIES
The goal of this task is to develop a plan to make the knowledge gained, experimental results, and lessons learned available to the public and key decision makers.

The Recipient shall:
- Prepare an *Initial Fact Sheet* at start of the project that describes the project. Use the format provided by the CAM.
- Prepare a *Final Project Fact Sheet* at the project's conclusion that discusses results. Use the format provided by the CAM.
- Prepare a *Technology/Knowledge Transfer Plan* that includes:
  - An explanation of how the knowledge gained from the project will be made available to the public, including the targeted market sector and potential outreach to end users, utilities, regulatory agencies, and others.
  - A description of the intended use(s) for and users of the project results.
  - Published documents, including date, title, and periodical name.
  - Copies of documents, fact sheets, journal articles, press releases, and other documents prepared for public dissemination. These documents must include the Legal Notice required in the terms and conditions. Indicate where and when the documents were disseminated.
  - A discussion of policy development. State if project has been or will be cited in government policy publications, or used to inform regulatory bodies.
  - The number of website downloads or public requests for project results.
  - Additional areas as determined by the CAM.
- Conduct technology transfer activities in accordance with the Technology/Knowledge Transfer Plan. These activities will be reported in the Progress Reports.
- When directed by the CAM, develop *Presentation Materials* for an Energy Commission-sponsored conference/workshop on the results of the project.
- Prepare a *Technology/Knowledge Transfer Report* on technology transfer activities conducted during the project.

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

TASK 13: PRODUCTION READINESS PLAN
The goal of this task is to determine the steps that will lead to the manufacturing of technologies developed in this project or to the commercialization of the project's results.

The Recipient shall:

- Prepare a *Production Readiness Plan*. The degree of detail in the plan should be proportional to the complexity of producing or commercializing the proposed product, and to its state of development. As appropriate, the plan will discuss the following:
  - Critical production processes, equipment, facilities, personnel resources, and support systems needed to produce a commercially viable product.
  - Internal manufacturing facilities, supplier technologies, capacity constraints imposed by the design under consideration, design-critical elements, and the use of hazardous or non-recyclable materials. The product manufacturing effort may include "proof of production processes."
  - The estimated cost of production.
  - The expected investment threshold needed to launch the commercial product.
  - An implementation plan to ramp up to full production.
  - The outcome of product development efforts, such as copyrights and license agreements.
  - Patent numbers and applications, along with dates and brief descriptions.
  - Other areas as determined by the CAM.

Products:

- Production Readiness Plan (draft and final)

IV. PROJECT SCHEDULE

Please see the attached Excel spreadsheet.

RESOLUTION NO: 15-0408

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION - RE: UNIVERSITY OF CALIFORNIA, LOS ANGELES

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

RESOLVED, that the Energy Commission approves Agreement EPC-14-027 from PON-13-302 with the **Regents of the University of California, on behalf of the Los Angeles Campus** for a **$1,621,628** grant to build an energy storage system that can efficiently store grid-level energy from renewable sources and release that energy when it is needed to meet peak demand; and

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

CERTIFICATION

The undersigned Secretariat to the Commission does hereby certify that the foregoing is a full, true, and correct copy of a Resolution duly and regularly adopted at a meeting of the California Energy Commission held on April 8, 2015.

AYE: [List of Commissioners]
NAY: [List of Commissioners]
ABSENT: [List of Commissioners]
ABSTAIN: [List of Commissioners]

Harriet Kallemeyn,
Secretariat