

GRANT REQUEST FORM (GRF)

CEC-270 (Revised 02/13)

CALIFORNIA ENERGY COMMISSION



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

Budget Information			
Funding Source	Funding Year of Appropriation	Budget List No.	Amount
EPIC	13-14	301.001A	\$2,530,952
			\$
			\$
			\$
			\$
			\$
R&D Program Area:	ESRO: ETSI	TOTAL:	\$2,530,952
Explanation for "Other" selection			
Reimbursement Contract #:		Federal Agreement #:	

Recipient's Administrator/ Officer				Recipient's Project Manager			
Name:	Keith Steel			Name:	Mani Thothadri		
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Selection Process Used	
<input checked="" type="checkbox"/> Competitive Solicitation	Solicitation #: PON-13-302
<input type="checkbox"/> First Come First Served Solicitation	

The following items should be attached to this GRF	
1. Exhibit A, Scope of Work	<input type="checkbox"/> Attached
2. Exhibit B, Budget Detail	<input type="checkbox"/> Attached
3. CEC 105, Questionnaire for Identifying Conflicts	<input type="checkbox"/> Attached
4. Recipient Resolution	<input type="checkbox"/> N/A <input type="checkbox"/> Attached
5. CEQA Documentation	<input type="checkbox"/> N/A <input type="checkbox"/> 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		Site Preparation & Material Procurement for Solar Array and ORC
3		Thermal Energy Storage (TES) Development – Phase Change Material (Pcm) Material Selection
4	X	Solar Development Deployment And Installation
5		System Commissioning
6		TES Development: Encapsulated PCM And Model Development
7		Testing Data Collection and Analysis
8		TES Pilot - Deploy, Install & Test
9		Demonstration Testing and System Optimization
10		Development Of Go To Market Tools
11		Evaluation of Project Benefits
12		TES Development - PCM Storage Testing, Data Collection, And Analysis
13		Technology/Knowledge Transfer Activities
14		Production Readiness Plan

B. Acronym/Term List

Acronym/Term	Meaning
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
COMSOL	Company Name
CPR	Critical Project Review
CPV	Concentrating Photovoltaic Array
FEM	Finite Element Method
LCOE	Levelized Cost Of Electricity
ORC	Organic Rankine Cycle Machine
PCM	Phase Change Materials
POCO	Poco Graphite Company Product
PV	Photovoltaic Solar Panel
TAC	Technical Advisory TES: Thermal Energy Storage Committee

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

A. Purpose of Agreement

The purpose of this Agreement is to fund pilot testing and demonstration of a solar hybrid system with advanced storage and low temperature turbine to produce on-demand solar electricity.

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.

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B. Problem/ Solution Statement

Problem

Currently solar photovoltaic (PV) systems are only available as a complementary power generation option and are only able to deliver power in a cost effective manner during daylight hours. This presents a challenge in matching the generated electricity to a user's demand. While much advancement in efficiency has been gained in solar development; the harvested PV energy is intermittent and not primarily designated into the base load scheduling order. Current solar thermal solutions for power generation have been proven for utility scale steam cycle generation and can generate beyond available daylight with thermal storage solutions but do not present a cost effective solution for utility scale generation or a practical solution for distributed generation due the requirement of large-scale deployments, on-site trained personnel, as well as safety considerations inherent in any steam plant.

Solution:

The proposed solution integrates unique, proven high efficiency technologies to adequately address these challenges and will provide a scalable solution that will be readily deployable to an array of communities in California. The solution has not been deployed to date because of the unavailability of the right technology to address these challenges efficiently. The proposed technologies to be integrated include an actively cooled (with water) Parabolic Concentrated PV from the recipient along with thermal storage to store the waste heat for on demand deployment of waste heat to power in a skid mounted Organic Rankine Cycle (ORC) system manufactured by Electratherm. Advanced thermal storage was developed by Jet Propulsion Laboratories.

C. Goals and Objectives of the Agreement

Agreement Goals

The goal of this Agreement is to pilot test a modular, scalable solution to harness renewable solar energy to generate electricity in utility-scale and distributed power generation and demand response applications. The system will effectively match power generation to demand and generate electricity beyond the solar day.

- Ratepayer Benefits:² This Agreement will result in the ratepayer benefit[s] of: greater electricity reliability, lower costs, or increased safety by
 - exploiting more of the sun's energy, translating to a leveled cost of electricity (LCOE) of 5-8¢/kWhr at the distributed (behind the meter) level. This is substantially lower than average price of 10-14.1¢/kWhr paid by California commercial customers today.
 - ability to exploit storage to level consumption and reduce demand charges.
 - Provides the option to store the thermal-derived component of the energy at a very attractive cost and convert it to electricity on demand. (The cost is ~\$50/kWh in terms of electricity output, and there is no need for power electronics to manage the storage.)

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).

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- Creates on-demand power (by combining storage with an ORC) equivalent to dispatchable central generation but without congesting the grid.
- Balances deployment of PV automatically and naturally with deployment of energy storage, mitigating the impact of high PV penetration on grid stability and tempering the need to expand transmission and distribution capacity.
- Creates potential opportunities to perform additional services for the California grid, such as frequency regulation and demand response management.
- Matches peak electricity generation and displacement to peak summer demand for air conditioning, further ameliorating grid management issues.

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 advancing understanding of advanced phase change memory based storage for hybrid PV-thermal integration. This is truly a one of a kind innovative project that has the potential to transform the solar and storage industries to meet California's goals.

Agreement Objectives

The objectives of this Agreement are to

- pilot test an innovative solution that converts as much incident sunlight directly into electricity as is possible with a low-cost single-axis concentrating photovoltaic (CPV) array, incorporating standard c-Si PV cells.
- Capture, in the form of heat, the remaining energy that the PV cells cannot utilize, and which other CPV approaches struggle to dissipate
- Store the heat as hot water at low cost utilizing advanced phase change memory based storage
- Convert the heat on demand into dispatchable electricity with an ORC turbine.

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.

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.

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The Recipient shall:

For products that require a draft version

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

For products that require a final version only

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

For all products

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

- **Electronic File Format**

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

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

- Data sets will be in MS Access or MS Excel file format (version 2007 or later), or any other format approved by the CAM.
 - Text documents will be in MS Word file format, version 2007 or later.
 - Documents intended for public distribution will be in PDF file format. The Recipient must also provide the native Microsoft file format.
 - Project management documents will be in Microsoft Project file format, version 2007 or later.
- **Software Application Development**
Use the following standard Application Architecture components in compatible versions for any software application development required by this Agreement (e.g., databases, models, modeling tools), unless the CAM approves other software applications such as open source programs:

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- Microsoft ASP.NET framework (version 3.5 and up). Recommend 4.0.
- Microsoft Internet Information Services (IIS), (version 6 and up) Recommend 7.5.
- Visual Studio.NET (version 2008 and up). Recommend 2010.
- C# Programming Language with Presentation (UI), Business Object and Data Layers.
- SQL (Structured Query Language).
- Microsoft SQL Server 2008, Stored Procedures. Recommend 2008 R2.
- Microsoft SQL Reporting Services. Recommend 2008 R2.
- XML (external interfaces).

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

MEETINGS

Subtask 1.2 Kick-off Meeting

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

The Recipient shall:

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

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

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

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

- The CAM's expectations for accomplishing tasks described in the Scope of Work;
- An updated Project Schedule;
- Technical products (subtask 1.1);
- Progress reports and invoices (subtask 1.5);
- Final Report (subtask 1.6);

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- Technical Advisory Committee meetings (subtasks 1.10 and 1.11); and
- Any other relevant topics.

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

The CAM shall:

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

Recipient Products:

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

CAM Product:

- Kick-off Meeting Agenda

Subtask 1.3 Critical Project Review (CPR) Meetings

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

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

The Recipient shall:

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

The CAM shall:

- Determine the location, date, and time of each CPR meeting with the Recipient's input.

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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.
 - 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

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confidential products.

- Final invoicing and release of retention.

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

Products:

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

REPORTS AND INVOICES

Subtask 1.5 Progress Reports and Invoices

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

The Recipient shall:

- Submit a monthly *Progress Report* to the CAM. Each progress report must:
 - Summarize 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

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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.

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

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reimbursement.

The Recipient shall:

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

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

- A list of the match funds that identifies:
 - The amount of cash match funds, their source(s) (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied.
 - The amount of each in-kind contribution, a description of the contribution type (e.g., property, services), the documented market or book value, the source (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or real property, the Recipient must identify its owner and provide a contact name, address, telephone number, and the address where the property is located.
- A copy of a letter of commitment from an authorized representative of each source of match funding that the funds or contributions have been secured.
- At the Kick-off meeting, discuss match funds and the impact on the project if they are significantly reduced or not obtained as committed. If applicable, match funds will be included as a line item in the progress reports and will be a topic at CPR meetings.
- Provide a *Supplemental Match Funds Notification Letter* to the CAM of receipt of additional match funds.
- Provide a *Match Funds Reduction Notification Letter* to the CAM if existing match funds are reduced during the course of the Agreement. Reduction of match funds may trigger a CPR meeting.

Products:

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

Subtask 1.8 Permits

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

The Recipient shall:

- Prepare a *Permit Status Letter* that documents the permits required to conduct this Agreement. If no permits are required at the start of this Agreement, then state this in the letter. If permits will be required during the course of the Agreement, provide in the letter:

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- 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)

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

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

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

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

The Recipient shall:

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

Products:

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

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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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III. TECHNICAL TASKS

TASK 2: SITE READINESS & MATERIAL PROCUREMENT FOR SOLAR ARRAY AND ORC

The goal of this task is to establish site readiness for installation and detailed design of the integrated plant. From the design, the material will be procured. The goal is to establish the site readiness, plant design, select critical interface components, and simulate the operation and performance of the selected component.

The Recipient shall:

- Perform detailed analysis of the proposed site for the installation of the solar array for shading in various seasons, structural analysis for foundations, wind speed specification design analysis, including all the preparatory work for permitting by various authorities and construction.
- Create the design for the plant to be installed onsite in the production facility.
- Complete material procurement activities
- Prepare and Provide a *Summary Plant Design Completion Report* to include, but not be limited to, all procured materials.

Products:

- Summary Plant Design Completion Report

TASK 3: THERMAL ENERGY STORAGE (TES) DEVELOPMENT – PHASE CHANGE MATERIAL (PCM) MATERIAL SELECTION

The goal of this task is develop an advanced thermal energy storage device with phase change materials (PCMs) which will store heat during the day and provide constant temperature fluid at the outlet when there is no sun. There are several subtasks outlined over the duration of the project, below.

PCM MATERIAL SELECTION

Phase change materials make ideal TES candidates because of the mode of storing and extracting heat during phase allows for high volumetric heat densities and also provides heat at a constant temperature during the freezing/thawing cycles. Typical candidates found in the literature are paraffin blends or salt hydrates encapsulated in various containers. More attractive candidates for our application would be sugar alcohols such as D-mannitol or Erythritol. The candidate selection would be based on the melting point, heat of fusion, density, and thermal conductivity.

The Recipient shall:

- Conduct detailed literature search to include all potential candidates such as paraffin waxes, sugar alcohols, hydrated salts
- Develop metrics for down-selection of candidates based on thermal performance, stability and cost
- Make final selection and characterize the properties such as thermal conductivity and heat of fusion.
- Prepare a *Summary Report of PCM Material Selection* that will include, but not be limited to, research finding of suitable materials

Products:

- Summary Report of PCM material selection

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TASK 4: SOLAR DEVELOPMENT DEPLOYMENT AND INSTALLATION

The goal of this task is to perform all construction and site preparation activities. Once the site is prepared, the installation and connection of the major systems will occur.

The Recipient shall:

- Conduct timely mobilization of labor and material to the plant site
- Perform all construction
- Integrate major system components
- Participate in CPR meeting as per task 1.3
- Prepare and provide an *Installation Report*, which will include, but not be limited to, the completed Designed System and Components

Products:

- CPR Report
- As Built Installation Report

TASK 5: SYSTEM COMMISSIONING

The goal of this task is to establish plant operation. This phase will integrate the concentrating photovoltaic thermal, thermal storage, and ORC systems and establish system level controls for demand response.

The Recipient shall:

- Integrate and commission system
- Develop and deploy system level control system.
- Prepare and provide a *Commissioning Report* to include but not be limited to starting, initial operations and commissioning of the Solar Arrays

Products:

- Commissioning Report

TASK 6: TES Development: Encapsulated PCM and Model Development

Task 6.1: TES Development – Encapsulated PCM Development

Although PCMs are attractive for use in solar applications, their actual application has been limited due to some inherent challenges such as their low thermal conductivities. As a comparison, the thermal conductivity of copper is 385 W/m*K while PCMs range from 0.2 to 0.5 W/mK for most of the considered candidates. In order to make the PCMs an effective TES candidate, their conductivities have to be enhanced. There are several different techniques discussed in the technical description of the product by Jet Propulsion Laboratory and we will focus primarily on encapsulation of PCMs with conductivity enhancers.

The Recipient shall:

- Develop cost models for the different encapsulation techniques
- Narrow encapsulation techniques from a choice of a) tube banks with aluminum fins, b) POCO graphite, c) metal shavings with carbon fillers
- Optimize dimensions and loading of PCM materials into encapsulants

Exhibit A

Scope of Work

- Integrate encapsulated PCMs into assemblies possibly in a shell-and-tube assembly
- Prepare and provide a *PCM Encapsulation Summary Report* which will include, but not be limited to, material selection findings and PCM integration findings

Products:

- PCM Encapsulation Summary Report

Task 6.2: TES Development - Thermo-fluid modeling

Component-level as well as system-level models will be developed based on rigorous thermodynamics to enable system optimization and cost model development.

The Recipient shall:

- Develop component-level model of the PCM with multiphysics-capable Finite Element Method (FEM) software like COMSOL to characterize charge/discharge states and the associated moving melt zones. This will help in system-level models
- Develop system-level model of the entire system including the TES assemblies and the test rig.
- Prepare and provide a *Summary Report of Thermo-Fluid Modeling*, which will include, but not be limited to, results from PCM characterization and system performance for sizing

Products:

- Summary Report of Thermo-Fluid Modeling

TASK 7: Testing, Data Collection and Analysis

The goal of this task is to evaluate performance of the plant's main systems. The data will serve to further expand value that the integrated system will offer.

The Recipient shall:

- Collect solar PV and thermal performance data utilizing Cogenra's remote monitoring systems, correlate with actual weather data from various sources, temperature, flow rates, pressures and operating conditions of the storage and the ORC unit.
- Collect performance data for the dry cooling tower of the ORC turbine
- Collect overall system level power performance data
- Use the data for creation of performance models for plant optimization and future plant designs
- Prepare and provide *Performance Data Report*, which will include, but not be limited to, PV and thermal performance, ORC turbine performance and overall system performance
- Prepare and provide *Summary Report of Prediction Model*, which will include, but not be limited to, performance of the system versus prediction model

Products:

- Performance Data Report
- Summary Report of Prediction Model

Exhibit A

Scope of Work

TASK 8: TES Pilot - Deploy, Install & Test

The goal of this task is build a flow test-rig for characterizing the performance of the TES under diurnal cycles simulated with lab heaters and chillers. The TES assembly will be integrated into the test-rig which will be instrumented to measure flow rates, pressures, temperatures, and power.

The Recipient shall:

- Size the test-rig heaters, chillers, pumps. and other relevant test rig components
- Manufacture test-rig
- Integrate the TES assembly into the test-rig in readiness for testing
- Integrate control system and data acquisition hardware
- Perform safety review and pre-test peer review
- Perform check-out of the test-rig
- Prepare and provide a *Test Rig Operating Manual*

Products:

- Test Rig Operating Manual

TASK 9 Demonstration Testing and System Optimization

The goal of this task is to optimize plant performance to best match the load profile. This will serve to prove the viability of the system as a rapidly deployable solution that can meet varied needs in California and beyond.

The Recipient shall:

- Modify system performance profile to best utilize the renewable resources to meet the distributed energy resource facility's demands.
- Utilize the following to determine and optimize the mode of storage and the operational profile of the Organic Rankine Cycle:
 - Weather forecasts to predict expected solar output
 - Historical meter measurements and/or community usage profile predictions
 - Utilize electric rates and tariff structures to determine the value of electric energy and power from ORC
- Gather results of system to advance the rate of adoption this type of renewable energy storage solution can provide.
- Prepare and provide an *Optimization Report*, which will include, but not be limited to, obtained optimized data values reached while testing the plant's performance.

Products:

- Optimization Report

TASK 10: Development Of Go To Market Tools

The goal of this task is to develop the tools that will be used in the commercialization of the integrated renewable system. The output of Task 10 will be calculation and promotional tools to support the rapid commercialization of this solution to communities in California and beyond.

Exhibit A

Scope of Work

The Recipient shall:

- Create tools to rapidly analyze available solar resources, incorporate weather forecasts, customer usage profile, and other relevant variables to determine optimal ORC operational profile for various customer types
- Develop a marketing strategy to target communities that may receive the highest economic benefit from the system while meeting the state balanced portfolio goals.
- Prepare and provide a *Report on Use Case vs Sizing, Technology, Location*, which will include, but not be limited to, optimal ORC operation modes in a variety of settings.
- Prepare and provide a *Report on Commercialization*, which will include, but not be limited to, customer segments and market potential.

Products:

- Report on Use Case vs Sizing, Technology, Location
- Report on Commercialization

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:
 - For Product Development Projects and Project Demonstrations:
 - Published documents, including date, title, and periodical name.
 - Estimated or actual energy and cost savings, and estimated statewide energy savings once market potential has been realized. Identify all assumptions used in the estimates.
 - Greenhouse gas and criteria emissions reductions.
 - Other non-energy benefits such as reliability, public safety, lower operational cost, environmental improvement, indoor environmental quality, and societal benefits.
 - Data on potential job creation, market potential, economic development, and increased state revenue as a result of the project.

Exhibit A

Scope of Work

- A discussion of project product downloads from websites, and publications in technical journals.
- A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.
- Additional Information for Product Development Projects:
 - Outcome of product development efforts, such copyrights and license agreements.
 - Units sold or projected to be sold in California and outside of California.
 - Total annual sales or projected annual sales (in dollars) of products developed under the Agreement.
 - Investment dollars/follow-on private funding as a result of Energy Commission funding.
 - Patent numbers and applications, along with dates and brief descriptions.
- Additional Information for Product Demonstrations:
 - Outcome of demonstrations and status of technology.
 - Number of similar installations.
 - Jobs created/retained as a result of the Agreement.
- For Information/Tools and Other Research Studies:
 - Outcome of project.
 - Published documents, including date, title, and periodical name.
 - A discussion of policy development. State if the project has been cited in government policy publications or technical journals, or has been used to inform regulatory bodies.
 - The number of website downloads.
 - An estimate of how the project information has affected energy use and cost, or have resulted in other non-energy benefits.
 - An estimate of energy and non-energy benefits.
 - Data on potential job creation, market potential, economic development, and increased state revenue as a result of project.
 - A discussion of project product downloads from websites, and publications in technical journals.
 - A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.
- Respond to CAM questions regarding responses to the questionnaires.

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

Products:

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

Exhibit A

Scope of Work

Task 12: TES Development - PCM Storage Testing, Data Collection, And Analysis

The goal of this task is to collect data for the PCM-based TES which will form the basis for subsequent scaling for larger deployment.

The Recipient shall:

- Collect TES performance data with controlled heating and cooling cycles to establish maximum heat storage and extraction rates
- Use the data for creation of performance models for plant optimization and future plant designs
- Prepare and provide a *Performance Data Report* which will include but not be limited to PCM- based TES performance

Products:

- PCM-based TES Performance Data Report

TASK 13: 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.

Exhibit A

Scope of Work

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 14: 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.

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION - RE: COGENRA SOLAR, INC.

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-14-020 from PON-13-302 with **Cogenra Solar, Inc.** for a **\$2,530,952** grant to pilot test and demonstrate a solar hybrid system with advanced storage and low temperature turbine to produce on-demand solar electricity; 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