California Energy Commission
June 12, 2024 Business Meeting
Backup Materials for Redoxblox, Inc.

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

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

[PROPOSED]

RESOLUTION NO: 24-0612-09b

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION: Redoxblox, Inc.

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

RESOLVED, that the CEC approves agreement EPC-23-027 with RedoxBlox, Inc. for a $8,936,778 grant. The project will install and demonstrate a 3 MWh thermochemical energy storage system on the University of California at San Diego's medical campus that will provide more than 24 hours of electrical output and emergency support to the hospital and medical campus in loss-of-power events, including delivering high temperatures for industrial customers. Staff recommends conditional approval of this item based upon funding availability as of the 2024 Budget Act; and

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

CERTIFICATION

The undersigned Secretariat to the CEC does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the CEC held on June 12, 2024.

AYE:
NAY:
ABSENT:
ABSTAIN:

Dated:

_____
Kristine Banaag
Secretariat

STATE OF CALIFORNIA
CALIFORNIA ENERGY COMMISSION

CEC-270 (Revised 9/2022)

GRANT REQUEST FORM (GRF)

A. New Agreement Number

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

New Agreement Number: EPC-23-027

B. Division Information

1. Division Name: ERDD
2. Agreement Manager: Zoe Higgerson
3. MS-:43
4. Phone Number: 916-931-5128

C. Recipient's Information

1. Recipient's Legal Name: RedoxBlox, Inc.
2. Federal ID Number: 86-1484721

D. Title of Project

Title of project: Thermochemical Energy Storage for Disadvantaged Communities

E. Term and Amount

1. Start Date: 6/12/2024
2. End Date: 6/30/2028
3. Amount: $8,936,778.00

F. Business Meeting Information

1. Are the ARFVTP agreements $75K and under delegated to Executive Director? No
2. The Proposed Business Meeting Date: 6/12/2024.
3. Consent or Discussion? -Discussion
4. Business Meeting Presenter Name: Zoe Higgerson
5. Time Needed for Business Meeting: 5 minutes.
6. The email subscription topic is: EPIC (Electric Program Investment Charge).

Agenda Item Subject and Description:

RedoxBlox, Inc.
Proposed resolution approving agreement EPC-23-027 with RedoxBlox, Inc. for a $8,936,778 grant and adopting staff's determination that this action is exempt from CEQA. The project will install and demonstrate a 3 MWh thermochemical energy storage system on the University of California at San Diego's medical campus that will provide more than 24 hours of electrical output and emergency support to the hospital and medical campus in loss-of-power events,including delivering high temperatures forindustrial customers. Staff recommends conditional approval of this item based upon funding availability as of the 2024 Budget Act. (EPIC funding) Contact: Zoe Higgerson

G. California Environmental Quality Act (CEQA) Compliance

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

   If yes, skip to question 2.

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

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

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

a) Agreement **IS** exempt?

Yes

Statutory Exemption?
No

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

PRC section number: None

CCR section number: None

Categorical Exemption?
Yes

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

CCR section number: Cal. Code Regs., tit. 14, § 15301 ; Cal. Code Regs., tit. 14, § 15303 ; Cal. Code Regs., tit. 14, § 15304; Cal. Code Regs., tit. 14, § 15306 ;

Common Sense Exemption? 14 CCR 15061 (b) (3)
No

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

The University of California, San Diego Campus, Physical and Community Planning department, issued a CEQA Notice of Exemption for the project on September 20, 2023. The exemption was based on 14 C.C.R. § 15301, Existing Facilities. The equipment would be placed on existing, vacated concrete foundations previously occupied by a 2.8 MW molten carbonate fuel cell generating plant, which was decommissioned in 2023. The site was previously permitted for major electrical infrastructure and electricity generating equipment, and the proposed thermochemical energy storage (TCES) system coupled with a turbogenerator for electricity-to-electricity storage plus heat delivery, will reuse some of that electrical infrastructure to access the University's 12 kV electrical distribution system. In addition, a 100-ton adsorption chiller associated with the former generator remains onsite fully functional and permitted, and will be repurposed for the proposed thermal energy storage system operation.

In addition, Section 15303, Small Structures applies: This project consists of installation of a small structure. The combined heat and power (CHP) system will include a 10 MWh-th (3 MWh-e) RedoxBlox thermochemical energy storage vessel paired with a microturbine for a peak electrical output of 100 kW-e and 24 hours of storage located on the University of California at San Diego (UCSD) medical campus.

The equipment will be installed on two existing 14 x 16 feet concrete pads, labeled Module A and Module B. Each pad formerly supported a 52-ton fuel cell. The plan is to install the TCES vessel and Ansaldo turbogenerator on the Module A (~35 tons) pad and the balance of plant on the Module B pad. The highest dimension of the equipment is about 20 feet off the pad. These dimensions are in line with the various examples of exempt structures under Section 15303.

The turbine and generator do not rely on burning fossil gas. Rather, hot compressed air from the TCES will be delivered to the expander section of the gas turbine to generate electricity. Instead of using the combustion of a fossil fuel to provide the heat, RedoxBlox's system uses the zero-carbon oxidation reaction of its energy storage material. Thus, it appears there is no discretionary air pollution emissions permit needed.

Section 15304, Minor Alterations to Land applies: Within the established site, this project includes minor trenching and backfilling where the surface is restored, which do not involve removal of healthy, mature, scenic trees. There will be trenching for piping and other connections.

Cal. Code Regs., tit. 14, Section 15306 provides that projects which consist of basic data collection, research, experimental management, and resource evaluation activities, and which do not result in a serious or major disturbance to an environmental resource are categorically exempt from the provisions of the California Environmental Quality Act. This project involves demonstration and testing of the RedoxBlox TCES and related equipment.

For these reasons, the proposed project will have no significant effect on the environment and is categorically exempt under sections 15301, 15303, 15304, and 15306.

The project will not impact an environmental resource of hazardous or critical concern where designated, precisely mapped, and officially adopted pursuant to law by federal, state, or local agencies; does not involve any cumulative impacts of successive projects of the same type in the same place that might be considered significant; does not involve unusual circumstances that might have a significant effect on the environment; will not result in damage to scenic resources within a highway officially designated as a state scenic highway; the project site is not included on any list compiled pursuant to Government Code section 65962.5; and the project will not cause a substantial adverse change in the significance of a historical resource. Therefore, none of the exceptions to categorical exemptions listed in CEQA Guidelines section 15300.2 apply to this project, and this project will not have a significant effect on the environment.

b) Agreement **IS NOT** exempt.

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

No

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

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

H. Subcontractors

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

Subcontractor Legal Company Name	CEC Funds	Match Funds
CZero, Inc. aka The Real Czero, Inc.	$ 5,006,076	**$**0
Electric Power Research Institute, Inc.	$ 300,000	**$**0
The Regents of the University of California, on behalf of the San Diego Campus	$ 2,995,413	**$**0
Guy Nielson Company Industrial Division, Inc.	$24,737	**$0**
California Environmental Justice Alliance	$95,000	**$0**
TBD Site Design and Engineering	$250,000	**$0**
TBD Construction Contractor for full site build out	$1,310,000	**$62,500**

I. Vendors and Sellers for Equipment and Materials/Miscellaneous

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

Vendor/Seller Legal Company Name	CEC Funds	Match Funds
No vendors to report	**$**	**$**

J. Key Partners

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

Key Partner Legal Company Name
No key partners to report

K. Budget Information

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

Funding Source	Funding Year of Appropriation	Budget List Number	Amount
EPIC	22-23	301.001J	$ 8,936,778

TOTAL Amount: $ 8,936,778

R&D Program Area: ESTB: ETSI

Explanation for "Other" selection Not applicable

Reimbursement Contract #: Not applicable

Federal Agreement #: Not applicable

L. Recipient's Contact Information

1. Recipient's Administrator/Officer

Name: Tim Grove

Address: 5066 Santa Fe St

City, State, Zip: San Diego, CA 92109-1608

Phone: 250-216-7119

E-Mail: timothy.grove@redoxblox.com

3. Recipient's Project Manager

Name: Tim Grove

Address: 5066 Santa Fe St

City, State, Zip: San Diego, CA 92109-1608

Phone: 250-216-7119

E-Mail: timothy.grove@redoxblox.com

M. Selection Process Used

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

Selection Process	Additional Information
Competitive Solicitation #	GFO-22-307
First Come First Served Solicitation #	Not applicable
Other	Not applicable

N. Attached Items

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

Item Number	Item Name	Attached
1	Exhibit A, Scope of Work/Schedule	Yes
2	Exhibit B, Budget Detail	Yes
3	CEC 105, Questionnaire for Identifying Conflicts	Yes
4	Recipient Resolution	No
5	Awardee CEQA Documentation	No

Approved By

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

Agreement Manager: Zoe Higgerson

Approval Date: 3/8/2024

Branch Manager: Reynaldo Gonzalez

Approval Date: 3/19/2024

Director: Reynaldo Gonzalez for Jonah Steinbuck

Approval Date: 3/19/2024

Exhibit A
Scope of Work
RedoxBlox, Inc.

I. TASK ACRONYM/TERM LISTS

A. Task List

Task #	CPR[1]	Task Name
1		General Project Tasks
2		Detailed Design
3		Safety, Security, and Risk Mitigation Assessment
4	X	Operational Strategy
5		Storage Material Production and Validation
6		Site Preparation
7	X	System Fabrication and Shipping
8		On-Site Construction and Commissioning
9		System Testing and Analysis
10		Life Cycle, Technoeconomic Analysis and Benefits Analysis
11		Community Based Organization Activities
12		Evaluation of Project Benefits
13		Technology/Knowledge Transfer Activities

B. Acronym/Term List

Acronym/Term	Meaning
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CEC	California Energy Commission
CPR	Critical Project Review
TAC	Technical Advisory Committee
TCES	Thermochemical Energy Storage
UCSD	University of California – San Diego

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

A. Purpose of Agreement

The purpose of this Agreement is to fund the demonstration of the Recipient's novel TCES system in an electrical storage application by coupling it with an externally fired microturbine. While the Recipient's TCES low-cost, high-energy density solution has been demonstrated at smaller scales, this project will be the first commercial demonstration of TCES coupled with a turbine to reproduce electricity. In addition, the waste heat will be used to power an absorption chiller, allowing a near 100% heat utilization.

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

B. Problem/ Solution Statement

Problem

Industrial / utility energy storage systems must be low cost, scalable, safe, compact, and be able to rapidly charge and discharge. However, current solutions are limited in *at least* one of these categories. Thermal technologies are typically low cost and safe, but have low energy density, are not compact, cannot rapidly charge or discharge, and scaling becomes challenging with heating large systems – in particular resistive heaters are fragile and risk of breakage increases with size. Electrochemical technologies can be compact, but often are costly, and scale linearly which results in significant footprint at large scales.

Solution

The Recipient's TCES system provides a solution to all the listed requirements. The storage material is produced from abundant, low-cost materials and consists of a simple balance of plant to harness the thermochemical energy. The thermochemical energy density is comparable to Li-ion, keeping the system compact. Due to the volumetric nature of the storage vessel, the system can be scaled to industrial and utility scales while keeping the footprint relatively small. The storage material is also non-toxic, fully recyclable, and environmentally benign.

This project will be an important step in advancing the technology. The Recipient has operated smaller scale units that have proven the efficacy of the storage media, but this project will be the first operated in a real-world environment coupled with a turbomachine for recuperating electrical energy. Successful deployment at this scale enables the technology to be scaled to sizes that have a significant improvement in economics.

C. Goals and Objectives of the Agreement

Agreement Goals

The goals of this Agreement are to:

- Design and build a 10 MWh TCES system coupled to a 100 kW turbogenerator and deliver 200 kW of waste heat to an absorption chiller.
- Demonstrate 24+ hours of storage at max turbogenerator output.
- Validate fast charging capabilities of the storage material.
- Assess integration performance of thermal system and microturbine through heat loss, reliability, and turbine performance relative to proven performance with natural gas.
- Enable students the opportunity to participate in a project related to energy storage through internships, research projects, and potential employment opportunities.
- Demonstrate the reliability attributes of this system to provide emergency support to the hospital and medical campus in loss-of-power scenarios.
- Demonstrate the benefit of the technology applied to other low-income and disadvantaged communities.

Ratepayer Benefits:[2] This Agreement will result in the ratepayer benefits of greater electricity reliability, lower costs, and increased safety by enabling an important scaling step of a technology that has the potential to store energy at a low cost and achieve widespread deployment. This project represents a significant step in the development of the Recipient's energy storage technology as it pertains to support of the electrical grid. Energy storage is well documented as a critical portion of decarbonization and is a requirement for future grid stability as more variable renewable generation is installed.
The cost of the Recipient TCES is significantly lower than Li-ion, and at scale is projected to present a LCOS of <$0.03 / kWh. To reach the size required to achieve this goal, the technology must be demonstrated at smaller scales – starting with the project proposed here. An additional benefit of TCES over Li-ion is improved safety, and a simple, reliable system design that does not use exotic rare-earth materials.

Technological Advancement and Breakthroughs:[3] This Agreement will lead to technological advancement and breakthroughs to overcome barriers to achieving the State of California's statutory energy goals by demonstrating the first real-world implementation of high-temperature thermochemical energy storage coupled with a turbogenerator. The Recipient has demonstrated the storage media in laboratory and small pilot settings, but this would be the first integration with a turbine. This step is important to prove that the technology is a viable electrical storage system. Upon completion of this project, larger systems will be deployed, working towards utility scale storage systems.

In addition to the integration breakthrough, this project will also advance the scale of the storage vessel by deploying the largest to date worldwide. The Recipient is simultaneously working on development of heat storage systems as well that deliver high temperatures to industrial customers, without converting back to electricity. These systems will have similar energy storage capacity, but the design is different due to the pressure requirements of the turbo block. There are some shared characteristics, but the added challenge of pressuring the storage vessel is significant and is an important advancement achieved by this project.

Agreement Objectives
The objectives of this Agreement are to:

- Demonstrate energy storage density >1800 MJ/m^3 at the proposed scale.
- Maintain high temperature operation for 1000 hours over a year.
- Achieve 250 hours of electrical discharge over the year of operation.
- Demonstrate 95% electricity-to-heat storage efficiency.
- Achieve at least 25% turbine efficiency.
- Reach absorption chiller COP of 0.68.
- Deploy full electrical power output within 240 seconds.
- Demonstrate fast charging capabilities by heating TCES bed at 100 kW/m^3 or higher.

[2] California Public Resources Code, Section 25711.5(a) requires projects funded by the Electric Program Investment Charge (EPIC) to result in ratepayer benefits. The California Public Utilities Commission, which established the EPIC in 2011, defines ratepayer benefits as greater reliability, lower costs, and increased safety (See CPUC "Phase 2" Decision 12-05-037 at page 19, May 24, 2012, http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/167664.PDF).
[3] California Public Resources Code, Section 25711.5(a) also requires EPIC-funded projects to lead to technological advancement and breakthroughs to overcome barriers that prevent the achievement of the state's statutory and energy goals.

- Validate recyclability of energy storage material, retaining 95% of reactive material.
- Calculate LCOS of <$0.05/kWh through full technoeconomic analysis.

III. TASK 1 GENERAL PROJECT TASKS

PRODUCTS

Subtask 1.1 Products
The goal of this subtask is to establish the requirements for submitting project products (e.g., reports, summaries, plans, and presentation materials). Unless otherwise specified by the Commission Agreement Manager (CAM), the Recipient must deliver products as required below by the dates listed in the **Project Schedule (Part V).** All products submitted which will be viewed by the public, must comply with the accessibility requirements of Section 508 of the federal Rehabilitation Act of 1973, as amended (29 U.S.C. Sec. 794d), and regulations implementing that act as set forth in Part 1194 of Title 36 of the Federal Code of Regulations**.** All technical tasks should include product(s). Products that require a draft version are indicated by marking **"(draft and final)"** after the product name in the "Products" section of the task/subtask. If "(draft and final)" does not appear after the product name, only a final version of the product is required. With respect to due dates within this Scope of Work, **"days"** means working days.

The Recipient shall:

For products that require a draft version, including the Final Report Outline and Final Report

- Submit all draft products to the CAM for review and comment in accordance with the Project Schedule (Part V). The CAM will provide written comments to the Recipient on the draft product within 15 days of receipt, unless otherwise specified in the task/subtask for which the product is required.
- Consider incorporating all CAM comments into the final product. If the Recipient disagrees with any comment, provide a written response explaining why the comment was not incorporated into the final product.
- Submit the revised product and responses to comments within 10 days of notice by the CAM, unless the CAM specifies a longer time period, or approves a request for additional time.

For products that require a final version only

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

For all products

- Submit all data and documents required as products in accordance with the following:

Instructions for Submitting Electronic Files and Developing Software:

  - **Electronic File Format**

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

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

- Data sets will be in MS Access or MS Excel file format (version 2007 or later), or any other format approved by the CAM.
- Text documents will be in MS Word file format, version 2007 or later.
- Project management documents will be in Microsoft Project file format, version 2007 or later.

- **Software Application Development**
  Use the following standard Application Architecture components in compatible versions for any software application 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 CEC's Information Technology Services Branch to determine whether the exceptions are allowable.

MEETINGS

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

The Recipient shall:

- Attend a "Kick-off" meeting with the CAM, the Commission Agreement Officer (CAO), and any other CEC 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;
- Invoicing and auditing procedures;
- 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 (subtask 1.5);
- Final Report (subtask 1.6);
- Technical Advisory Committee meetings (subtasks 1.10 and 1.11); and
- Any other relevant topics.

- Provide *Kick-off Meeting Presentation* to include but not limited to:
  - Project overview (i.e. project description, goals and objectives, technical tasks, expected benefits, etc.)
  - Project schedule that identifies milestones
  - List of potential risk factors and hurdles, and mitigation strategy

- Provide an *Updated Project Schedule, Match Funds Status Letter,* and *Permit Status Letter*, as needed to reflect any changes in the documents.

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

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

CAM Product:
- Kick-off Meeting Agenda

Subtask 1.3 Critical Project Review (CPR) Meetings
The goal of this subtask is to determine if the project should continue to receive CEC funding, and if so whether any modifications must be made to the tasks, products, schedule, or budget. CPR meetings provide the opportunity for frank discussions between the CEC and the

Recipient. As determined by the CAM, discussions may include project status, challenges, successes, advisory group findings and recommendations, final report preparation, and progress on technical transfer and production readiness activities (if applicable). Participants will include the CAM and the Recipient and may include the CAO and any other individuals selected by the CAM to provide support to the CEC.

CPR meetings generally take place at key, predetermined points in the Agreement, as determined by the CAM and as shown in the Task List on page 1 of this Exhibit. However, the CAM may schedule additional CPR meetings as necessary. The budget 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 CEC, but they may take place at another location, or may be conducted via electronic conferencing (e.g., WebEx) as determined by the CAM.

The Recipient shall:

- Prepare and submit a *CPR Report* for each CPR meeting that: (1) discusses the progress of the Agreement toward achieving its goals and objectives; and (2) includes recommendations and conclusions regarding continued work on the project.
- Attend the CPR meeting.
- Present the CPR Report and any other required information at each CPR meeting.

The CAM shall:

- Determine the location, date, and time of each CPR meeting with the Recipient's input.
- Send the Recipient a *CPR Agenda* with a list of expected CPR participants in advance of the CPR meeting. If applicable, the agenda 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)

CAM Products:

- CPR Agenda(s)
- Progress Determination

Subtask 1.4 Final Meeting

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

The Recipient shall:

- Meet with CEC staff to present project findings, conclusions, and recommendations. The

final meeting must be completed during the closeout of this Agreement. This meeting will be attended by the Recipient and CAM, at a minimum. The meeting may occur in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be divided into two separate meetings at the CAM's discretion.

- The technical portion of the meeting will involve the presentation of findings, conclusions, and recommended next steps (if any) for the Agreement. The CAM will determine the appropriate meeting participants.
- The administrative portion of the meeting will involve a discussion with the CAM and the CAO of the following Agreement closeout items:
  - Disposition of any procured equipment.
  - The CEC's request for specific "generated" data (not already provided in Agreement products).
  - Need to document the Recipient's disclosure of "subject inventions" developed under the Agreement.
  - "Surviving" Agreement provisions such as repayment provisions and confidential products.
  - Final invoicing and release of retention.

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

Products:

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

REPORTS AND INVOICES

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

The Recipient shall:

- Submit a monthly *Progress Report* to the CAM. Each progress report must:
  - Summarize progress made on all Agreement activities as specified in the scope of work for the preceding month, including accomplishments, problems, milestones, products, schedule, fiscal status, and an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. See the Progress Report Format Attachment for the recommended specifications.
- Submit a monthly or quarterly *Invoice* that follows the instructions in the "Payment of Funds" section of the terms and conditions, including a financial report on Match Funds and in-state expenditures.

Products:

- Progress Reports
- Invoices

Subtask 1.6 Final Report
The goal of this subtask is to prepare a comprehensive Final Report that describes the original purpose, approach, results, and conclusions of the work performed under this Agreement. When creating the Final Report Outline and the Final Report, the Recipient must use the CEC 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 *Energy Commission Style Manual* provided by the CAM.

Recipient Products:
- Final Report Outline (draft and final)

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

Subtask 1.6.2 Final Report

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

- Develop and submit a *Summary of TAC Comments on Draft Final Report* received on the Executive Summary. For each comment received, the recipient will identify in the summary the following:
  - Comments the recipient proposes to incorporate.
  - Comments the recipient does propose to incorporate and an explanation for why.
- Submit a draft of the report to the CAM for review and comment. The CAM will provide written comments to the Recipient on the draft product within 15 days of receipt.
- Incorporate all CAM comments into the *Final Report*. If the Recipient disagrees with any comment, provide a *Written Responses to Comments* explaining why the comments were not incorporated into the final product.

- Submit the revised *Final Report* electronically with any Written Responses to Comments within 10 days of receipt of CAM's Written Comments on the Draft Final Report, unless the CAM specifies a longer time period or approves a request for additional time.

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

CAM Product:
Written Comments on the Draft Final Report

MATCH FUNDS, PERMITS, AND 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 CEC 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 CEC awarding this Agreement and none have been identified at the time this Agreement starts, then state this in the letter.

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

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

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

Subtask 1.8 Permits
The goal of this subtask is to obtain all permits required for work completed under this Agreement in advance of the date they are needed to keep the Agreement schedule on track. Permit costs and the expenses associated with obtaining permits are not reimbursable under this Agreement, with the exception of costs incurred by University of California recipients. Permits must be identified and obtained before the Recipient may incur any costs related to the use of the permit(s) for which the Recipient will request reimbursement.

The Recipient shall:
- Prepare a *Permit Status Letter* that documents the permits required to conduct this Agreement. If <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 each 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.
- Help set the project team's goals and contribute to the development and evaluation of its statement of proposed objectives as the project evolves.
- Provide a credible and objective sounding board on the wide range of technical and financial barriers and opportunities.
- Help identify key areas where the project has a competitive advantage, value proposition, or strength upon which to build.
- Advocate, to the extent the TAC members feel is appropriate, on behalf of the project in its effort to build partnerships, governmental support, and relationships with a national spectrum of influential leaders.
- Ask probing questions that insure a long-term perspective on decision-making and progress toward the project's strategic goals.

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

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

The Recipient shall:

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

Products:

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

Subtask 1.11 TAC Meetings
The goal of this subtask is for the TAC to provide strategic guidance for the project by participating in regular meetings, which may be held via teleconference.

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

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

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

Subtask 1.12 Project Performance Metrics
The goal of this subtask is to finalize key performance targets for the project based on feedback from the TAC and report on final results in achieving those targets. The performance targets should be a combination of scientific, engineering, techno-economic, and/or programmatic metrics that provide the most significant indicator of the research or technology's potential success.

The Recipient shall:

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

Products:

- TAC Performance Metrics Summary
- Project Performance Metrics Results

IV. TECHNICAL TASKS

*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 Detailed Design

The goal of this task is to complete the detailed design of the TCES system. This effort will include design relating to the storage vessel, physical turbine integration, and the electrical connections for charging and discharging. The output will be final engineering drawings that can be used for construction.

The Recipient shall:

- The Recipient will be responsible for the design, manufacturing, and testing of the storage media. The Recipient has also invented electrodes to charge the bed, and will be responsible for these components including developing project specific electrode configurations. The Recipient will also conduct an initial design of the vessel, insulation, integration, controls, and balance of plant.
- The Recipient will engage an engineering firm to complete the detailed design of the vessel and turbine integration, including the vessel shell, piping, balance of plant, and controls. The Recipient and has already received a quote for this effort.
- Design appropriate turbine integration systems, including any filter requirements.
- Select power electronics for charging.
    - Include additional transformer depending on voltage requirements.
- The result of the above work will be the delivery of a *Detailed Engineering Design* that will be used for construction of the system. This Detailed Engineering Design will include, but is not limited to:
    - Material and energy balances
    - Process flow diagrams
    - Piping and instrumentation diagrams
    - Control strategy
    - Equipment list
    - Equipment datasheets
    - Single-line diagrams
- Complete a *FMEA / HAZOP Review*.

Products:

- Detailed Engineering Design
- FMEA / HAZOP Review

TASK 3 Safety, Security, and Risk Mitigation Assessment

The goals of this task are to:

- Review the safety requirements of operating at UCSD and ensure that the system is up to standard.
- Assess the cybersecurity and site security risks to the project and develop methods and procedures to minimize these aspects.
- Perform a full risk assessment and develop a risk mitigation strategy.

The Recipient shall:

- Engage with UCSD during the design phase to incorporate any additional safety measures specific to the selected site.
- Develop a *Cybersecurity Plan* that will include risks and outcomes, as well as mitigation strategies and procedures to minimize these risks.
- Consider any and all factors that could impact the project and reduce the chances of a successful deployment. Each factor should be assigned a risk value and ranked. For any significant risks mitigation strategies must be put in place to reduce the risk score to an acceptable level. These efforts will be documented in a *Project Risk Assessment* document.

Products:

- Cybersecurity Plan
- Project Risk Assessment (draft and final)

TASK 4 Operational Strategy

The goal of this task is to develop the controls and operating strategy for running the energy storage system. This includes charging and electrical discharge response and timing.

The Recipient shall:

- Develop an *Operating Plan* to determine the optimum mode of operation to support the UCSD grid. Goals of this operating plan will be to maximize the benefit to the facilities on campus. The Operating Plan will include, but is not limited to:
    - Charge and discharge inputs from UCSD grid to optimize stability of the grid
    - Grid constraints for charge and discharge during testing campaign
    - Approval and communications plans for changes to system operating schedule
- Prepare a *CPR Report #1* in accordance with subtask 1.3 (CPR Meetings).
- Participate in a CPR meeting.

Products:

- Operating Plan
- CPR Report #1

TASK 5 Storage Material Production and Validation

The goal of this task is to procure raw materials, synthesize the thermochemical energy storage material, and validate the quality.

The Recipient shall:

- Procure sufficient quantities of raw materials to supply the TCES system.
    - All received materials will be tested to ensure they meet specifications as per The Recipient's quality control standards.
- Synthesize the storage media from raw materials.
    - Raw material will be upgraded to the appropriate quality for producing the final product.
    - All materials will be ground, mixed, formed, and calcined according to standard operating procedures.

- Completed batches of storage material will be validated according to The Recipient's quality assurance program.
- Generate *Storage Material Validation Report* for 30 tons of material which will include but is not limited to:
    - Record of production and tracking numbers for shipment of material
    - Test results on samples for storage material dimensions, density, and reactivity
    - Sign-off from Senior Scientist that material meets The Recipient standards for use in system

Products:

- Storage Material Validation Report

TASK 6 Site Preparation

The goal of this task is to prepare the site at UCSD for installation of the TCES system. Preparation will be needed to host the storage vessel and microturbine, as well as electrical interconnections and connections to the absorption chiller.

The Recipient shall:

- Follow-up with SDG&E on any outstanding requirements for interconnection approval. The site host UCSD has an existing generation agreement that is being modified for this project.
- Prepare the area to install the storage vessel and microturbine. This entails clearing any existing equipment or material, and modifying the area as needed to accommodate the TCES system.
- Confirm the site has enough structural integrity to support the unit.
- Prepare the electrical switchgear by isolating any equipment to be tied-in to.
    - Arrangements with SDG&E may be required to execute on this portion.
- Setup the absorption chiller currently sitting idle to connect to the turbine exhaust.
- Complete *Site Preparation Report* which will include but is not limited to:
    - Checklist of all interconnections – charging power, discharged power, heat recovery, auxiliary power, controls – that must be prepared prior to system installation.
    - Confirmation the system siting area is cleared and prepared for installation.
    - Sign off from UCSD facilities department that the site has been prepared and is ready to receive delivery of components for installation.

Products:

- Site Preparation Final Report

TASK 7 System Fabrication and Shipping

The goals of this task are to fabricate the storage vessel and associated piping and instrumentation for the system. Once completed, the system must be shipping to site in preparation for installation.

The Recipient shall:

- Fabricate the storage vessel. Components of this include:
    - Pressure vessel that will contain all insulation and storage material.

    - Insulation layers
- Synthesize electrodes.
- Fabricate the piping for handling air flow into and out of the storage vessel, and into the microturbine.
- Prepare the balance of plant for the system including the following:
    - Control valves
    - Instrumentation
        - Thermocouples
        - Flow meters
        - Pressure transducers
    - Air blower for system charging
    - Power electronics
- Verify pressure vessel holds pressure, and all controls and instruments are functional as part of a factory acceptance test. Submit the results as a *Factory Acceptance Test Approval*
- Ship all components to the installation site.
- Prepare a *CPR Report #2* in accordance with subtask 1.3 (CPR Meetings).
- Participate in a CPR meeting.

Products:
- Factory Acceptance Test Approval
- CPR Report #2

TASK 8 On-Site Construction and Commissioning
The goals of this task are to construct the system on site and carry out testing of the system before connecting to the grid. The vessel will be shipped completed, but it will need to be filled with storage material, and all the associated piping connect.

The Recipient shall:
- Receive all components of the system on site and complete and inventory check:
    - Vessel
    - Storage material
    - Piping system
    - Microturbine
    - Control system
- Construct the system by placing major equipment on site. The largest component will the be the storage vessel. The microturbine will also be sited, along with a control room.
- Fill the storage vessel with the Recipient storage material.
- Connect all components of the system (piping to storage vessel, to microturbine).
- Test all systems once in place:
    - Confirm vessel holds pressure.
    - Valves respond to control inputs.
    - Instruments read appropriately.
    - Charging is effective.
    - Microturbine is operational.
- Approve system for operation on *Operational Approval Form*. Approval for operation will include, but is not limited to:

- Completed checklist of all subsystems tested and shown to be operational.
- Controls and instrumentation are confirmed to be acting as expected.
- Operating personnel have been trained on the system including emergency shutdown procedures.
- Signoff from campus facilities and safety personnel that the system is approved to operate.

Products:

- Operational Approval Form

TASK 9 System Testing and Analysis

The goal of this task is to systematically test the extremes of performance through a strict test regime and review the performance of the system. In particular, the system performance will be compared against the targeted project performance metrics established at the outset.

The Recipient shall:

- Develop a *Detailed Measurement and Verification Plan* which will include details of baseline energy consumption and on-site emissions. It will also outline the measurement techniques and methods to be employed to assess project performance.
- Develop a *Thermochemical Energy Storage System Assessment Plan* which consists of a series of operational modes to evaluate the performance of the system. Key performance metrics are listed in the “Project Performance Metrics” attachment provided as part of the proposal.
- Execute the testing regime once the system is operational. Tests will be conducted in a systematic manner, with data and observations collect for later analysis.
- Process the raw data. This data will need to be checked for accuracy, and any erroneous data removed.
- Calculate the field performance metrics based on the processed data, and compare them to stated targets.
- Write and present a *Thermochemical Energy Storage Performance Analysis,* which will include but is not limited to:
    - Summary of the testing data, including an indicative cycle with temperatures, electricity flow, pressures, and other measured quantities
    - Calculated energy density
    - Calculated round-trip efficiency
    - Electrical ramp rates achieved
    - Maximum charging rate
    - Any other relevant performance metrics calculated through the testing campaign

Products:

- Detailed Measurement and Verification Plan
- Thermochemical Energy Storage System Assessment Plan
- Thermochemical Energy Storage Performance Analysis

TASK 10 Life Cycle, Technoeconomic, and Benefits Analysis
The goals of this task are to perform a LCA, TEA, and benefits analysis for the project and system.

The Recipient shall:

- Generate a *Life Cycle Analysis* to quantify the embodied carbon or other criteria in the energy storage system and estimate the payback time required to achieve net emissions savings. Tools such as National Energy Technology Laboratory's CO2U LCA Guidance Toolkit or openLCA will be used to develop a framework for the LCA work. System inputs will be estimated including a high-level breakdown of primary system components and the corresponding carbon emissions, including raw materials extraction, processing, and manufacturing. Energy inputs based on the strategy developed in the low-carbon energy procurement work will be included. End of life considerations including decommissioning and recycling will be estimated.
- Perform a *Technoeconomic Analysis* for the project. A review of the renewable energy availability in candidate region (real-time solar or wind generation) will be performed to identify a desirable mix of resources that can provide zero-carbon electricity daily. The project team will develop an 8760-hour annual dispatch model with energy storage showing intermittent charging with zero-carbon energy and discharging on demand. Local solar and wind production data will be modeled with the National Renewable Energy Laboratory's System Advisor Model tool or similar. An optimal mix of solar, wind, and storage will be developed that achieves at least 90% zero-carbon charging on an hourly basis at minimum cost.
- A *Cost-Benefits Analysis* will be conducted with the energy storage system at the project location and use cases for the site host. Capital and operating costs for the full commercial scale system will be estimated. The benefits will be quantified, including energy arbitrage, ancillary services, reduced fuel costs, carbon emissions reduction credits, and other value streams as applicable. The project team will use the EPRI DER-VETTM modeling tool to optimize the dispatch of the energy storage system and maximize revenues. The costs and benefits will be used to estimate the value proposition for the energy storage system when deployed at commercial scale.

Products:

- Life Cycle Analysis
- Technoeconomic Analysis
- Cost-Benefits Analysis

TASK 11 Community Based Organization Activities
The goal of this task is to study and validate, through community engagement programs, the potential benefits of the the Recipient's technology in areas currently impacted by natural gas power plants in California, with an emphasis on (1) due diligence of real-world benefits, (2) location-specific, targeted implementation to maximize benefits, and (3) accelerating the delivery of benefits to those communities.

The Recipient shall:

- Work with a broad range of California Environmental Justice organizations, led by the California Environmental Justice Alliance, to engage at-risk communities most severely

impacted by the ongoing utilization of California's 138 natural gas power plants located in the top 25th percentile of impacted census tracts as scored by CalEnviroScreen 4.

- Based on the outcomes of Tasks 9 and 10, quantify the potential criteria air pollutant reductions, GHG reductions, and other environmental and social benefits, such as localized workforce and economic development, attributable to scale-up of the proposed The Recipient technology deployment. These findings will be summarized in *Quantified Environmental and Social Benefits Scale-up Report.*
- Develop a peer-reviewed and published document titled *Empowering Local Communities by Displacing Fossil Gas at California Powerplants*, which will include but is not limited to:
    - A review of potential impact of The Recipient systems deployed at existing California gas plants in terms of performance, cost, and operability. Findings from the current project will be used to inform assumptions about the performance at full-scale gas plants, and the impact on the California grid in terms of energy storage potential.
- Distribute and promote findings and lessons learned through community engagement activities, studies, and follow-up activities.

Products:

- Quantified Environmental and Social Benefits Scale-Up Report
- Empowering Local Communities by Displacing Fossil Gas at California Powerplants (draft and final)

TASK 12: Evaluation of Project Benefits

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

The Recipient shall:

- Complete *the Initial Project Benefits Questionnaire*. The Initial Project Benefits Questionnaire shall be initially completed by the Recipient with 'Kick-off' selected for the 'Relevant data collection period' and submitted to the CAM for review and approval.
- Complete the *Annual Survey* by January 31st of each year. The Annual Survey includes but is not limited to the following information:
    - Technology commercialization progress
    - New media and publications
    - Company growth
    - Follow-on funding and awards received
- Complete the *Final Project Benefits Questionnaire*. The Final Project Benefits Questionnaire shall be completed by the Recipient with 'Final' selected for the 'Relevant data collection period' and submitted to the CAM for review and approval.
- Respond to CAM questions regarding the questionnaire drafts.
- Complete and update the project profile on the CEC's public online project and recipient directory on the Energize Innovation website (www.energizeinnovation.fund), and provide *Documentation of Project Profile on EnergizeInnovation.fund*, including the profile link.
- If the Prime Recipient is an Innovation Partner on the project, complete and update the organizational profile on the CEC's public online project and recipient directory on the Energize Innovation website (www.energizeinnovation.fund), and provide

Documentation of Organization Profile on EnergizeInnovation.fund, including the profile link.

Products:

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

TASK 13 Technology/Knowledge Transfer Activities

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

The Recipient Shall:

- Develop and submit a *Project Case Study Plan* that outlines how the Recipient will document the planning, construction, commissioning, and operation of the technology or system being demonstrated. The Project Case Study Plan should include:
    - An outline of the objectives, goals, and activities of the case study.
    - The organization that will be conducting the case study and the plan for conducting it.
    - A list of professions and practitioners involved in the technology's deployment.
    - Specific activities the recipient will take to ensure the learning that results from the project is disseminated to those professions and practitioners.
    - Presentations/webinars/training events to disseminate the results of the case study.
- Present the draft *Project Case Study Plan* to the TAC for review and comment.
- Develop and submit a *Summary of TAC Comments* that summarizes comments received from the TAC members on the draft *Project Case Study Plan*. This document will identify:
    - TAC comments the recipient proposes to incorporate into the final *Project Case Study Plan*.
    - TAC comments the recipient does not propose to incorporate with and explanation why.
- Submit the final *Project Case Study Plan* to the CAM for approval.
- Execute the final Project Case Study Plan and develop and submit a Project Case Study.
- When directed by the CAM, develop presentation materials for a CEC sponsored conference/workshop(s) on the project.
- When directed by the CAM, participate in annual EPIC symposium(s) sponsored by the California CEC.

- Provide at least (6) six High Quality Digital Photographs (minimum resolution of 1300x500 pixels in landscape ratio) of pre and post technology installation at the project sites or related project photographs.

Products:

- Project Case Study Plan (draft and final)
- Summary of TAC Comments
- Project Case Study (draft and final)
- High Quality Digital Photographs

IV. PROJECT SCHEDULE

Please see the attached Excel spreadsheet.