STATE OF CALIFORNIA
GRANT REQUEST FORM (GRF)
CEC-270 (Revised 12/2019) CALIFORNIA ENERGY COMMISSION

A) New Agreement # PIR-21-004 (to be completed by CGL office)

B) Division	Agreement Manager:	MS-	Phone
ERDD	Baldomero Lasam	43	916-776-0784

C) Recipient's Legal Name	Federal ID Number
The Regents of the University of California on behalf of the Los Angeles Campus	95-6006143

D) Title of Project
Direct Solar Conversion of Biogas to Hydrogen and Solid Carbon: A Novel, Zero-Carbon Process

E) Term and Amount

Start Date	End Date	Amount
5/23/2022	3/31/2026	$ 749,999

F) Business Meeting Information

☐ ARFVTP agreements $75K and under delegated to Executive Director

Proposed Business Meeting Date 5/11/2022 ☐ Consent ☒ Discussion

Business Meeting Presenter Baldomero Lasam Time Needed: 5 minutes

Please select one list serve. NaturalGas (NG Research Program

Agenda Item Subject and Description:
The Regents of the University of California on behalf of the Los Angeles Campus.
Proposed resolution approving Agreement PIR-21-004 with UCLA for a $749,999 grant to advance a novel technology that uses solar energy to convert low carbon hydrogen gas into clean hydrogen, and adopting staff's determination that this action is exempt from CEQA.

G) California Environmental Quality Act (CEQA) Compliance

1. Is Agreement considered a "Project" under CEQA?
   ☒ Yes (skip to question 2)
   ☐ No (complete the following (PRC 21065 and 14 CCR 15378)):

   Explain why Agreement is not considered a "Project":

2. If Agreement is considered a "Project" under CEQA:
   a) ☒ Agreement **IS** exempt.
   ☐ Statutory Exemption. List PRC and/or CCR section number:
   ☒ Categorical Exemption. List CCR section number: Cal. Code Regs., tit. 14, § 15303 ; Cal. Code Regs., tit. 14, § 15306
   ☐ Common Sense Exemption. 14 CCR 15061 (b) (3)

   Explain reason why Agreement is exempt under the above section: 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. Under this grant, first, the technology will be

developed and tested at existing laboratory facilities at UCLA in Los Angeles, California. (California Nanosystems Institute, 570 Westwood Plaza building 114, Los Angeles.) Second, the technology will be moved to an existing wind farm for testing at a larger scale, using solar thermal power. There are no sensitive environmental resources at the demonstration site. For these reasons, the proposed work will not have any significant effect on the environment and is exempt under Cal. Code Regs., tit 14, Section 15306,

Section 15303, "New Construction or Conversion of Small Structures", covers construction and location of limited numbers of new, small facilities or structures; and installation of small new equipment and facilities in small structures. The demonstration phase of the project includes preparing and deploying a pilot technology demonstration consisting of at least two skid-mounts or shipping containers holding the technology, a trailer, a parabolic solar collector, a tank truck for renewable biogas, a tank or tanks for hydrogen gas, and appurtenances, with a total area of 5.000 square feet or so, on up to an acre of land. These components will sit on disturbed land at a wind turbine farm within the existing property boundary. After testing, the components will be removed. Hydrogen gas storage safety protocols will be followed. Based on these characteristics, the project is exempt under Section 15303.

b) Agreement **IS NOT** exempt. (consult with the legal office to determine next steps)

Check all that apply

- ☐ Initial Study
- ☐ Negative Declaration
- ☐ Mitigated Negative Declaration
- ☐ Environmental Impact Report
- ☐ Statement of Overriding Considerations

H) List all subcontractors (major and minor) and equipment vendors: (attach additional sheets as necessary)

Legal Company Name:	**Budget**
DNV GL USA, INC.	$ 5,000
Homeboy Industries	$ 5,086
	$
	$
	$
	$
	$
	$
	$
	$

I) List all key partners: (attach additional sheets as necessary)

Legal Company Name:
Southern California Gas Company
Wintec Energy, LTD
THE ADEPT GROUP, INC.

J) Budget Information

Funding Source	Funding Year of Appropriation	Budget List Number	Amount
NG Subaccount, PIERDD	20-21	501.001O	$749,999
			$
			$
			$
			$
			$

R&D Program Area: EGRO: Renewables TOTAL: $ 749,999

Explanation for "Other" selection

Reimbursement Contract #: Federal Agreement #:

K) Recipient's Contact Information

1. Recipient's Administrator/Officer

Name: Bruce Dunn

Address: 420 Westwood Plz

City, State, Zip: Los Angeles, CA 90095-8357

Phone: 310-825-1519

E-Mail: bdunn@ucla.edu

2. Recipient's Project Manager

Name: Timothy Fisher

Address: 420 Westwood Plz

City, State, Zip: Los Angeles, CA 90095-8357

Phone: 310-206-8113

E-Mail: tsfisher@ucla.edu

L) Selection Process Used

☒ Competitive Solicitation Solicitation #: GFO-21-502

☐ First Come First Served Solicitation Solicitation #:

☐ Non-Competitive Bid Follow-on Funding (SB 115)

M) The following items should be attached to this GRF

1.	Exhibit A, Scope of Work		☐ Attached
2.	Exhibit B, Budget Detail		☐ Attached
3.	CEC 105, Questionnaire for Identifying Conflicts		☐ Attached
4.	Recipient Resolution	☐ N/A	☐ Attached
5.	CEQA Documentation	☐ N/A	☐ Attached

Agreement Manager **Date**

Office Manager **Date**

Deputy Director **Date**

EXHIBIT A
Scope of Work

I. TASK ACRONYM/TERM LISTS

A. Task List

Task #	CPR[1]	Task Name
1		General Project Tasks
2	X	Demonstrate Biogas Conversion in Laboratory Simulated Solar Reactor
3	X	Design, Build, and Characterize Scaled Photo-Thermal Reactor
4		Field Demonstration: Solar-Thermal H2 and Graphite Co-Production from Biogas
5		Evaluation of Project Benefits
6		Technology/Knowledge Transfer Activities

B. Acronym/Term List

Acronym/Term	Meaning
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CEC	California Energy Commission
CH4	Methane
CO2	Carbon Dioxide
CPR	Critical Project Review
H2	Hydrogen
IR	Infrared
kg	Kilogram
SMR	Steam Methane Reforming
TAC	Technical Advisory Committee

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

A. Purpose of Agreement

The purpose of this Agreement is to fund the development and demonstration of a novel hydrogen production pathway that converts 100 percent renewable biogas into hydrogen and high-value graphitic carbon. Relying on concentrated solar energy as a heat source, the project will generate low-carbon hydrogen and produce graphitic electrode material as a value added product.

B. Problem/ Solution Statement

Problem

Hydrogen is overwhelmingly produced through steam methane reforming (SMR; 95 percent of current hydrogen production), a process that converts methane to hydrogen while yielding significant carbon dioxide (CO_2) emissions. While electrolysis of water using renewable electricity is currently the leading technology for producing low-carbon hydrogen and is commercially

[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.

available, this process cannot cost-effectively convert biogas or other sources of biogenic fuel into hydrogen.

Solution
This project will scale up an alternative process to electrolysis in which concentrated radiation from simulated solar source, a device that produces light similar to natural sun rays, converts 100 percent renewable biogas to hydrogen gas and graphitic carbon.

The project's approach differs from SMR, water splitting, and prior solar-thermal hydrogen production in that it processes a useful, carbon-containing fuel without a separate catalyst, and ends with a low-carbon fuel as well as a valuable solid graphitic product.

C. Goals and Objectives of the Agreement

Agreement Goals
The goals of this Agreement are to:

- Advance the readiness of experimental solar radiation-based biogas to high-purity low-carbon hydrogen production technology.
- Optimize the system design and operation to achieve higher low carbon hydrogen and graphitic carbon yield.
- Optimize system operation, diagnostics, and hardware to increase cost competitiveness and meet hydrogen cost targets.
- Scale up the current laboratory system to demonstrate biogas to hydrogen production at field scale.
- Generate environmental and economic data needed to support greater adoption and commercialization of emerging low carbon hydrogen production technology.

Ratepayer Benefits: This Agreement will result in the following ratepayer benefits: 1) Greater electricity reliability by developing a new technology capable of producing: low-carbon hydrogen that can be stored and subsequently used to power backup or resiliency power generation systems. The technology could potentially be deployed at scales ranging from small scale fuel cell or microgrid backup systems to industrial or utility scale hydrogen storage systems used for resiliency. 2) Lower costs for renewable hydrogen production by developing a new, low-carbon, low cost hydrogen production technology capable of converting biogas to hydrogen while further offsetting production costs through co-product sales. Hydrogen generated by the system can be subsequently used for a variety of end uses including transportation, high-temperature heating for industrial processes, and electricity generation in fuel cells or otherwise to support high-efficiency and reduced cost electricity production based on stored renewable energy.

Technological Advancement and Breakthroughs: This Agreement will advance a novel technology that uses concentrated solar energy that convert 100 percent renewable biogas into low-carbon hydrogen and a high-value form of solid carbon.

Agreement Objectives
The objectives of this Agreement are to:

- Advance the development status of the technology from TRL 3 to at least TRL 5.
- Achieve hydrogen costs targets of $2.5 per kilogram (kg) of hydrogen projected at commercial/industrial scale.

- Produce an average rate of 1 kg hydrogen per day over a series of at least 10 testing cycles.
- Achieve maximum hydrogen purity for end-use operations.
- Optimize system operation for maximizing graphitic carbon capture to facilitate achieving cost target.
- Demonstrate the project in a natural gas Investor Owned Utility service territory (Southern California Gas Company).

EXHIBIT A
Scope of Work

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

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

Products:

- 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

EXHIBIT A
Scope of Work

IV. TECHNICAL TASKS

TASK 2: PROCESS DEVELOPMENT OF BIOGAS CONVERSION IN LABORATORY SIMULATED SOLAR REACTOR

The goal of this task is to successfully demonstrate laboratory scale biogas to hydrogen and graphitic carbon conversion using a simulated solar reactor.

The Recipient shall:

- Improve diagnostics for increased efficacy and hydrogen yield. This activity will include but is not limited to:
  - A description of how the additional laser sources and software upgrades for absorption diagnostics to include oxygen-containing species impact the project's objectives;
  - A description of how to calibrate diagnostics for relevant species;
  - A description of diagnostics for inlet biogas; and
  - Demonstration of an increased efficacy from upgrading the system's diagnostic.
- Establish baseline yields/production for biogas at previously used conditions for methane (CH_4).This activity will include but is not limited to:
  - Conduct decomposition experiments using a laboratory biogas with metered inputs of hydrocarbon and CO_2 inlet reactants; and
  - Design and execute decomposition experiments over relevant ranges of flow, pressure, and power with measured yields of solid carbon and product gases.
- Identify and prove chemical precursors that increase specific surface area of graphitic carbon deposits. This activity will include but is not limited to:
  - Synthesize chemical precursors and apply to starting substrates;
  - Conduct decomposition experiments with different precursors and concentrations; and
  - Measure specific surface areas of resulting solid graphitic products, identifying maximal conditions.
- Optimize thermochemical conditions of the system to maximize production and yield. This activity will include but is not limited to:
  - Design comprehensive testing campaign using Bayesian experimental design for parameters including reactant flow rates, operating pressure, optical power, and chemical precursors;
  - Execute designed experiments;
  - Develop surrogate model based on experimental results to maximize throughput and yield; and
  - Conduct refined experiments to validate optimal conditions from surrogate model.
- Prepare a *Process Development Report* that includes but is not limited to:
  - Process flow diagram ;
  - Final piping and instrumentation diagram;
  - Testing matrix; and
  - Refined process conditions, which includes input and output parameters.
- Prepare *CPR Report #1*.

Products:

- Process Development Report (Draft/Final)
- CPR Report #1

TASK 3: DESIGN, BUILD AND CHARACTERIZE SCALED PHOTO-THERMAL REACTOR
The goal of this task is to complete needed engineering design then procure needed equipment and build a field scale demonstration photo-thermal reactor that is integrated with an existing concentrated solar receiver.

The Recipient shall:

- Develop a thermochemical system model for the scaled-up photothermal reactor. This activity includes but is not limited to:
  - Develop optical model of field concentrator based on ray tracing software (e.g., Zemax OpticsStudio, SolTrace);
  - Develop thermochemical system model of scaled up system and related software (e.g., Python, CoolProp, Cantera), to include thermochemistry, thermodynamics, and heat transfer processes; and
  - Integrate optics and thermochemical models to predict field reactor performance based on optimized Task 2 conditions and variations thereof.
- Establish and test the existing solar concentrator and confirm that it is capable of producing heating and temperatures needed for the proposed system (i.e., target > 900°C). This activity includes but is not limited to:
  - Install solar concentrator at field demonstration site;
  - Measure peak temperature on porous web substrate in receiver;
  - Adjust optical and receiver components to map temperature response; and
  - Provide mitigation plan as needed to achieve the target temperature.
- Design and build a full, field-scaled photo-thermal reactor, to be transported to the field demonstration site. This activity includes but is not limited to:
  - Design custom receiver/reactor to include provisions for coolant, inlet gases, product gases, and porous web substrate roll-to-roll handing;
  - Test custom receiver/reactor with lab solar simulator to validate functions; and
  - Install custom receiver/reactor in field solar concentrator.
- Design and test the on-line control software, with infrared (IR) diagnostics, needed to operate and provide measurements on the system for field use. This activity includes but is not limited to:
  - Acquire and integrate data acquisition and control hardware with IR diagnostics, flow control, and thermal metrology;
  - Write control software using LabView for all hardware functions, including safety interlocks;
  - Evaluate custom control software and hardware with lab solar simulator to validate functions; and
  - Install custom control software and hardware in field solar concentrator.
- Prepare a *Scaled Photo-thermal Reactor Design and Data Report* that includes but is not limited to:
  - System model;
  - Temperature test results;
  - Receiver reactor integration; and
  - On-line control software summary.
- Prepare *CPR Report #2*.

Products:

- Process Scaled Photo-thermal Reactor Design and Data Report (Draft/Final)
- CPR Report #2

TASK 4: FIELD DEMONSTRATION: SOLAR-THERMAL H2 AND GRAPHITE CO-PRODUCTION FROM BIOGAS

The goal of this task is complete a field demonstration of the proposed solar thermal to hydrogen and graphite co-production system, using biogas as a feedstock, and to collect and verify applicable measurement and verification / validation data.

The Recipient shall:

- Establish baseline yield and production based on lab-optimized conditions, for the field demonstration. This activity includes but is not limited to:
  - Operate fully integrated concentrator-receiver-reactor system with control software; and
  - Measure solid carbon and hydrogen yields based on lab optimized conditions (Task 2) and compare to model predictions (Task 3).
- Evaluate roll-to-roll graphitic carbon capture versus batch processing for the capture of graphitic carbon liberated from the incoming biogas. This activity includes but is not limited to:
  - Measure carbon capture in fixed web condition; and
  - Measure carbon capture in roll-to-roll web operation at various web speeds to determine maximum production and yield.
- Test ability to vary/optimize thermochemical conditions based on variable biogas composition, using online diagnostics and controls. This activity includes but is not limited to:
  - Design field testing campaign using Bayesian experimental design for parameters including biogas flow rates, operating pressure, solar concentrations, chemical precursors, and web speed;
  - Execute designed experiments; and
  - Develop surrogate model based on experimental results to maximize throughput and yield.
- Demonstrate production of high-concentration hydrogen at a rate of at least 1 kg per day, plus co-product graphitic carbon. This activity includes but is not limited to:
  - Produce an average rate of 1 kg hydrogen per day over a series of at least 10 testing cycles (or fewer as approved in writing by the CAM); and
  - Verify and quantify the production of graphitic carbon as a co-product from the incoming biogas.
- Complete all measurement and verification, including third party / external verification and validation, including all critical measurements and outputs. This activity includes but is not limited to:
  - Measure graphitic quality and specific surface area of graphitic carbon product from day-long process; and
  - Validate product gas composition using third party test vendor.
- Prepare a *Field Demonstration Report* that includes but is not limited to:
  - Baseline yields;
  - Evaluation of roll to roll carbon capture;
  - Optimization of thermo-chemical conditions;
  - Validation of hydrogen production rates;
  - Validation of hydrogen costs;
  - Results and analysis of the testing;
  - Comparison of the results against the project objectives; and

  - Include all process and performance data required in the test data collection plan.
- Prepare an independent *Measurement and Verification Report* that includes but is not limited to:
  - Gas product composition

Products:

- Field Demonstration Report (Draft and Final)
- Measurement and Verification Report (Final)

TASK 5 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 July 15th 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.
- Perform a *Technoeconomic and Life-cycle Analysis* of the lab-scale to field-scale system that will include:
  - Cost analysis of Hydrogen production and scale-up
  - Hydrogen purity assessment
  - Preliminary Technoeconomic and Lifecycle Assessment of the reactor system including solar concentrator

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

- Technoeconomic and Life-cycle Analysis Report (Draft/Final)

TASK 6 TECHNOLOGY/KNOWLEDGE TRANSFER ACTIVITIES

The goal of this task is to conduct activities that will accelerate the commercial adoption of the technology being supported under this agreement. Eligible activities include, but are not limited to, the following:

- Scale-up analysis including manufacturing analysis, independent design verification, and process improvement efforts.
- Technology verification testing, or application to a test bed program located in California.
- Legal services or licensing to secure necessary intellectual property to further develop the technology
- Market research, business plan development, and cost-performance modeling.
- Entry into an incubator or accelerator program located in California

The Recipient Shall:

- Develop and submit a *Technology Transfer Plan* that identifies the proposed activities the recipient will conduct to accelerate the successful commercial adoption of the technology.
- Present the *Draft Technology Transfer Plan* to the TAC for feedback and comments.
- Develop and submit a *Summary of TAC Comments* that summarizes comments received from the TAC members on the *Draft Technology Transfer Plan*. This document will identify:
    - TAC comments the recipient proposes to incorporate into the *Final Technology Transfer Plan*.
    - TAC comments the recipient does not propose to incorporate with and explanation why.
- Submit the *Final Technology Transfer Plan* to the CAM for approval.
- Implement activities identified in *Final Technology Transfer Plan.*
- Develop and submit a *Technology Transfer Summary Report* that includes high level summaries of the activities, results, and lessons learned of tasks performed relating to implementing the *Final Technology Transfer Plan*. This report should not include any proprietary information.
- When directed by the CAM, develop presentation materials for an CEC- sponsored conference/workshop(s) on the project.
- Provide at least (6) six *High Quality Digital Photographs* (minimum resolution of 1300x500 pixels in landscape ratio) of pre and post technology installation at the project sites or related project photographs.

Products:

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

V. PROJECT SCHEDULE

Please see the attached Excel spreadsheet.

RESOLUTION NO: 22-0511-17a

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION: THE REGENTS OF THE UNIVERSITY OF CALIFORNIA ON BEHALF OF THE LOS ANGELES CAMPUS

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 PIR-21-004 with The Regents fo the University of California on behalf of the Los Angeles campus for a $749,999 grant to advance a novel technology that uses solar energy to convert low carbon hydrogen gas into clean hydrogen; 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 May 11, 2022.
AYE:
NAY:
ABSENT:
ABSTAIN:

_____
Liza Lopez
Secretariat