California Energy Commission
July 26, 2023 Business Meeting
Backup Materials for Agenda Item No 08b:
Energy and Environmental Economics, 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

RESOLUTION NO: 23-0726-08b

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION: Energy and Environmental Economics, 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-23-009 with Energy and Environmental Economics, Inc. for a $798,805 grant to assess the role of hydrogen production and conversion technologies to enable decarbonization of end-use electric sector applications. This study includes scoping geologic formations in California that could enable low-cost hydrogen storage, developing datasets for projected costs and performance of hydrogen technologies from production to end-use, and developing computational tools to determine the optimal configuration of hydrogen production, storage, transport, and end-use equipment to serve California's decarbonizing electric sector; 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 July 26, 2023.

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: EPC-23-009

B. Division Information

1. Division Name: ERDD
2. Agreement Manager: Elyse Kedzie
3. MS-51
4. Phone Number: 916-805-7435

C. Recipient's Information

1. Recipient's Legal Name: Energy and Environmental Economics, Inc.
2. Federal ID Number: 94-3218646

D. Title of Project

Title of project: Techno-economic Assessment of Hydrogen as a Decarbonization Measure for California's Electric System

E. Term and Amount

1. Start Date: 8/15/2023
2. End Date: 12/15/2025
3. Amount: $798,805.00

F. Business Meeting Information

1. Are the ARFVTP agreements $75K and under delegated to Executive Director? No
2. The Proposed Business Meeting Date: 7/26/2023.
3. Consent or Discussion? Discussion
4. Business Meeting Presenter Name: Jeffrey Sunquist
5. Time Needed for Business Meeting: 5 minutes.
6. The email subscription topic is: EPIC (Electric Program Investment Charge).

Agenda Item Subject and Description:

ENERGY AND ENVIRONMENTAL ECONOMICS, INC. Proposed resolution approving agreement EPC-23-009 with Energy and Environmental Economics, Inc. for a $798,805 grant to assess the role of hydrogen production and conversion technologies to enable decarbonization of end-use electric sector applications, and adopting staff's determination that this action is exempt from CEQA. This study includes scoping potential geologic formations in California that could enable low-cost hydrogen storage, developing datasets for projected costs and performance of hydrogen technologies from production to end-use, and developing computational tools to determine the optimal configuration of hydrogen production, storage, transport, and end-use equipment to serve California's decarbonizing electric sector. (EPIC funding) Contact: Jeffrey Sunquist

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?
No

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: None

Common Sense Exemption? 14 CCR 15061 (b) (3)
Yes

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

This project involves only computer modeling and paper studies of hydrogen-based technologies. No physical construction will occur as part of this project. Therefore, it falls under the common sense exemption. The activity is covered by the general rule that CEQA applies only to projects which have the potential for causing a significant effect on the environment. Where it can be seen with certainty that there is no possibility that the activity in question may have a significant effect on the environment, the activity is not subject to CEQA.

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
Alliance for Sustainable Energy, LLC (National Renewable Energy Laboratory)	$ 99,999	$0
MRS Environmental, Inc.	$ 74,200	$0
TBD Engineering	$ 99,998	$0
Bloom Energy Corporation	$ 0	$4,000
Sacramento Municipal Utility District	$ 0	$8,400
Mainspring Energy, Inc.	$ 0	$10,000
Calpine Corporation	$ 0	$15,000
C-FER Technologies, Inc.	$ 0	$65,000

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	21-22	301.001I	$ 798,805

TOTAL Amount: $ 798,805

R&D Program Area: ESRB: 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: Jessie Knapstein

Address: 44 Montgomery St Ste 1500

City, State, Zip: San Francisco, CA 94104-4715

Phone: 415-391-5100

E-Mail: Jessie.knapstein@ethree.com

3. Recipient's Project Manager

Name: Jessie Knapstein

Address: 44 Montgomery St Ste 1500

City, State, Zip: San Francisco, CA 94104-4715

Phone: 415-391-5100

E-Mail: Jessie.knapstein@ethree.com

M. Selection Process Used

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

Selection Process	Additional Information
Competitive Solicitation #	GFO-22-304
First Come First Served Solicitation #	Not applicable
Other	Not applicable

N. Attached Items

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	Yes
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: Elyse Kedzie

Approval Date: 06/1/2023

Branch Manager: Rey Gonzalez

Approval Date: 06/2/2023

Director: Delegated to Branch Manager

Approval Date: 6/2/2023

Exhibit A
Scope of Work
Energy and Environmental Economics, Inc.

I. TASK ACRONYM/TERM LISTS

A. Task List

Task #	CPR[1]	Task Name
1		General Project Tasks
2		Hydrogen Policy and Program Review
3		Technoeconomic Analysis of Hydrogen Infrastructure
4	X	Assess Technoeconomic Potential for Underground Hydrogen Storage
5		Develop Hydrogen Production, Infrastructure and End-Use Scenarios
6		Develop Fuels Optimization Model
7		Hydrogen Infrastructure Scenario Analysis
8	X	Environmental Impacts Assessment and Mitigation Strategies
9		California Hydrogen Policy Recommendations
10		Evaluation of Project Benefits
11		Technology/Knowledge Transfer Activities

B. Acronym/Term List

Acronym/Term	Meaning
BECCS	Bioenergy with Carbon Capture and Sequestration
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CARB	California Air Resources Board
CCS	Carbon Capture and Sequestration
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CPR	Critical Project Review
CPUC	California Public Utilities Commission
DOE	U.S. Department of Energy
EPIC	Electric Program Investment Charge
E3	Energy and Environmental Economics, Inc.
GIS	Geographic Information Systems
GHG	Greenhouse Gas
IRP	Integrated Resource Plan
PATHWAY	E3's Decarbonization and Cost Analysis Model
PEM	Proton Exchange Membrane
RESOLVE	E3's Renewable Energy Solutions Model
SB	Senate Bill
SMR	Steam Methane Reforming
TAC	Technical Advisory Committee
UHS	Underground Hydrogen Storage

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

Exhibit A
Scope of Work
Energy and Environmental Economics, Inc.

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

A. Purpose of Agreement

The purpose of this Agreement is to fund analysis of the role of hydrogen produced from renewable energy for electric sector applications in California's decarbonizing electric system and develop policy recommendations to help the Electric Program Investment Charge (EPIC) Program prioritize investments to support complementary hydrogen programs. To achieve this, the project will conduct (a) technoeconomic analysis of various hydrogen production and end-use conversion technologies, equipment, and subcomponents; (b) development of analytical models incorporating this technoeconomic data that allows for assessment of cost-competitive use-cases and roles for hydrogen in the electric sector and other, non-electric sectors of California's economy; and finally (c) assessment of environmental impacts, available mitigation strategies, and equity impacts associated with hydrogen production and consumption.

B. Problem/ Solution Statement

Problem

California has established aggressive goals for greenhouse gas (GHG) reductions, both in the electric sector and economywide. Senate Bill (SB) 100 requires that 100% of retail electricity sales be supplied by zero-carbon resources by 2045, and the SB 100 Joint Agency Report identified electrolytic, "green" hydrogen as one potential emerging technology to support these decarbonization goals and reliability and resilience of the state's electric supply. In addition to these policies, SB 1075, SB 1369, and recent funding from the Infrastructure Investment and Jobs Act and the California Governor's Office of Business and Economic Development indicates increasing interest at both the federal and state level to support development of hydrogen projects.

The key challenges to deploying hydrogen at low cost and large scale are hydrogen storage and transport. Specifically, solving the problem of how to store hydrogen and transport it from where it is produced to end users. Storage is a non-trivial task in California specifically as the geologic salt formations that have been commercially demonstrated to store hydrogen are not available in California. Additionally, hydrogen technologies are nascent: production (e.g., electrolyzers), transportation, storage (e.g., underground storage), and end-use conversion technologies (e.g., fuel cells) all require investment, research and development to identify, evaluate, and support the competitiveness of hydrogen production from renewable electricity and end-use conversion for economy-wide and electric sector applications. Understanding which applications and use cases should take priority will help drive that investment, research, development, and demonstration in the right direction.

Solution

This project will develop a dataset of what geologic formations in California could enable low-cost hydrogen storage; will develop new datasets for projected costs and performance of hydrogen technologies from production to end-use; and will develop new computational tools that enable determination of the optimal configuration of hydrogen production, storage, transport and end use equipment to serve California's decarbonizing electric sector. Using these updated tools, Energy and Environmental Economics, Inc. (E3) will explore a number of sensitivities to

clarify in which sectors and in which applications hydrogen is most cost competitive. These sensitivities will provide insight into where support is needed along the hydrogen lifecycle to increase or achieve cost competitiveness. E3 has an extensive history working with California state agencies to develop analytical datasets and tools, in particular related to economywide decarbonization (California Air Resources Board [CARB] Scoping Plan) and long-term electric sector planning (California Public Utilities Commission Integrated Resource Plan [CPUC IRP]) and would bring to bear this expertise to identify the role, cost-effectiveness, and performance targets necessary for hydrogen to play a key role in California's decarbonized energy system. The Recipient will bring an unbiased and independent perspective to these research questions to ensure that the overall project research and final products represent an independent expert perspective that policymakers will find credible and actionable.

C. Goals and Objectives of the Agreement

Agreement Goals

The goals of this Agreement are to build upon the work the California Energy Commission (CEC) has funded as part of California's hydrogen roadmap and develop new data, scenarios and a modeling framework to support effective policymaking to advance investment and research into hydrogen and its infrastructure to help decarbonize California's energy system.

Ratepayer Benefits:[2] This Agreement will result in the ratepayer benefits of (a) greater electricity reliability and (b) lower costs, by advancing the stakeholders' ability to evaluate existing and emerging technologies to support the State's decarbonization goals. Emerging technologies and pathways, such as renewable hydrogen, enable a wider range of technology options that enable clean, affordable and reliable electricity for customers. This agreement will also support increased (c) equity in production and utilization of hydrogen by providing an environmental assessment specific to California's disadvantaged communities.

Technological Advancement and Breakthroughs:[3] This Agreement will lead to technological advancement and breakthroughs to overcome barriers to the achievement of the State of California's statutory energy goals by advancing the analytical tools and data available to stakeholders to direct investment and research into existing and emerging technologies such as hydrogen. To date, policymakers have been informed by a range of electric sector-focused analytical tools (e.g., production simulation, capacity expansion), but these have not been tightly coupled to non-electric sector demands; with the potential development of renewable hydrogen, the electric and non-electric sectors become more tightly linked, requiring innovative data and modeling to support continued evidence-based policymaking.

[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.

Agreement Objectives

The objectives of this Agreement are to:

- Review existing policies and programs supporting hydrogen infrastructure development, to identify incremental investment and research opportunities to be supported by the EPIC program.
- Develop a technology and cost review of hydrogen infrastructure to support policymaking and identify key cost reduction and performance goals that may make hydrogen infrastructure more cost-competitive.
- Develop site and technology assessments of storage and transportation options in California, determining best opportunities for each.
- Develop a new modeling framework—leveraging many of the State's existing data and modeling tools—to enable analysis of electrolytic and renewable hydrogen production pathways, as well as the interaction of electric and non-electric sector applications for hydrogen.
- Assess the customer affordability, environmental, and equity impacts of potential hydrogen infrastructure investments.

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 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 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 the following:
  - 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.

Exhibit A
Scope of Work
Energy and Environmental Economics, Inc.

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: Hydrogen Policy and Program Review

The goal of this task is to develop a review of current state and federal policies and programs that support development of hydrogen.

The Recipient shall:

- Review existing California policies and programs supporting development of hydrogen infrastructure and technologies, including The Hydrogen Program, proposed California Renewable Hydrogen Hub, and U.S. DOE hydrogen hubs.
- Review policies and programs in neighboring states supporting development of hydrogen infrastructure and other generation and end use technologies.
- Review existing federal policies, tax incentives and programs supporting development of hydrogen infrastructure and other generation and end use technologies.
- Identify key synergies and gaps in existing programs to identify 1) areas of opportunity for this assessment and 2) EPIC Program investment opportunities in research, development, and demonstration activities.
- Summarize the Task 2 findings in a *Hydrogen Policy and Program Review Report.*

Products:

- Hydrogen Policy and Program Review Report (draft and final)

TASK 3: TECHNOECONOMIC ANALYSIS OF HYDROGEN INFRASTRUCTURE

The goal of this task is to develop selected technical and cost characteristics for various priority components of hydrogen infrastructure, including an assessment of the competitiveness of different existing and emerging technologies. This analysis will include detailed assessment of priority components and technologies, and an overview of others. This assessment includes, but is not limited to:

- Production
  - Electrolysis (alkaline)
  - Electrolysis (proton exchange membrane [PEM])
  - Electrolysis (solid oxide)
  - Methane reformation with carbon capture and sequestration (CCS)
  - Biomass gasification with CCS
- Transportation
  - Pipelines
  - Truck (liquified)
- Storage
  - Underground salt cavern
  - Converted natural gas reservoir (e.g., underground depleted hydrocarbon reservoir converted to hydrogen use)
  - Underground Lined Rock Cavern
  - Underground Pipe Storage

    - Above-ground/pressurized tank
- Consumption
    - Electric sector
        - Fuel cell (solid oxide)
        - Fuel cell (PEM)
        - Hydrogen-retrofit combustion turbine
    - New-build hydrogen combustion turbine
        - Transportation
        - Light duty vehicles
        - Medium- and heavy-duty vehicles
        - Aviation
        - Rail
- Chemical Feedstock
    - Ammonia
    - Methanol

The Recipient shall:

- Work with the CEC and TAC to develop the list of priority components for which to provide a detailed techno-economic assessment.
- Assemble relevant technical and cost projection information for 2025-2050 on hydrogen production, storage (tank and underground), and power generation technologies based on NREL research, development, and analysis on technology advancements and collaborations within the DOE and national lab system, using publicly available datasets, and through collaborations with leading industrial consortia;
    - Hydrogen production conversion efficiency
    - Hydrogen throughput
    - Pipeline rights of way
    - Current natural gas pipelines and underground storage facilities that could be compatible with hydrogen blending or retrofit
    - Parasitic losses
    - Carbon capture rates (where applicable)
    - Physical lifetime (as a function of system configuration)
    - Operating constraints (e.g., minimum production, minimum generation, flexibility)
    - Hydrogen consumption efficiency (e.g., heat rate)
    - Land use requirements, leakage and contamination risk, and life cycle environmental impacts
    - Capital cost
    - Fixed operating and maintenance cost
    - Variable operating and maintenance cost
    - Applicable investment and production tax credits
- Identify criteria to select which key technological advancements drive cost competitiveness.
- Review and summarize possible end-use applications for hydrogen produced in the state of California, including the electricity sector, heavy duty transportation, pipeline blending, and industrial applications.
- Apply the technical information on electrolyzer/thermochemical hydrogen production, storage, and power generation advances to develop a draft list of key technological advances, evaluated relative to the screening criteria.

- Review policy and technology advancements to identify at least 5 advancements that can help bring down hydrogen generation, storage, infrastructure and end use equipment costs.
- Coordinate with CAM, CEC staff, TAC, and other key stakeholders to finalize the list of key advances in electrolyzer, transportation, storage, and power generation technology.
- Estimate the potential effects of each advancement on the levelized costs of hydrogen production using standardized discounted cash flow analysis frameworks for each item in the final list.
- Summarize the Task 3 findings in a *Report on Hydrogen Generation, Storage, Transportation and End Use Technologies, Key Advancements and Cost Projections.*

Products:

- Report on Hydrogen Generation, Storage, Transportation and End Use Technologies, Key Advancements and Cost Projections (draft and final)

TASK 4: ASSESS TECHNOECONOMIC POTENTIAL FOR UNDERGROUND HYDROGEN STORAGE

The goal of this task is to develop site selection criteria to identify viable underground hydrogen storage sites in California based on technical characteristics (e.g., microbiology, geochemistry, hydrodynamics and geomechanics) and estimate the cost associated with constructing and converting these sites for hydrogen storage. This is critical because the cost of building hydrogen pipelines used only for the electricity sector is likely to be very high, and the cost of tank storage is also likely to be very high. Therefore, if and where one can develop in-state underground hydrogen storage will be critical to determining if using hydrogen in the electricity sector is cost-effective.

The Recipient shall:

- Perform a literature review of existing site selection criteria for underground hydrogen storage in Northern and Southern California in porous media across several technical areas such as microbiology, geochemistry, hydrodynamics and geomechanics.
- Develop site selection criteria to enable screening analysis of potential underground hydrogen storage (UHS) sites in California and neighboring states, excluding sites where hydrogen storage is prohibitive or not favorable.
- Produce a *Map of Potential Underground Hydrogen Storage Sites and Production Facilities.*
- Estimate maximum allowable injection and extraction rates, estimate potential leak/loss rate of hydrogen due to hydrodynamics, and estimate working gas capacity.
- Estimate the cost associated with converting a gas field to a hydrogen storage site, including sensitivity analysis to estimate the impact of using different cushion gases on site suitability.
- Assess high-level cost data, performance and extraction rates for out-of-state hydrogen storage salt formations and in-state lined rock caverns.
- Summarize the Task 4 findings in a *Report on Technoeconomic Potential Underground Hydrogen Storage Sites in California.*
- Prepare and submit a *CPR Report #1* in accordance with subtask 1.3 (CPR Meetings)
- Participate in a CPR meeting

Products:

- Report on Technoeconomic Potential Underground Hydrogen Storage Sites in California (draft and final)
- Map of Potential Underground Hydrogen Storage Sites and Production Facilities
- CPR Report #1

TASK 5: DEVELOP HYDROGEN PRODUCTION, INFRASTRUCTURE AND END-USE SCENARIOS

The goal of this task is to leverage economywide scenarios (e.g., from CARB Scoping Plan) to identify key applications for hydrogen outside the electric sector, such as transportation and industry, that may affect the competitiveness of hydrogen for electric sector applications.

The Recipient shall:

- Review economywide scenarios from the CARB Scoping Plan to develop baseline hydrogen utilization.
- Identify key transportation, building, industrial, and other non-electric sector applications for hydrogen from 2025-2050, by scenario.
- Review and update scenario design based on meetings with CAM, CEC staff, TAC, and other key stakeholders and policymakers.
- Summarize the Task 5 findings in a *California Economy Hydrogen Scenarios Presentation Slide Deck.*
- Present findings in the *California Economy Hydrogen Scenarios Presentation* to CEC staff.

Products:

- California Economy Hydrogen Scenarios Presentation Slide Deck

TASK 6: DEVELOP FUELS OPTIMIZATION MODEL

The goal of this task is to develop a Hydrogen Fuels Optimization Model. This tool would extend and interconnect the existing PATHWAYS (economywide decarbonization scenario planning tool, used by CARB Scoping Plan) and RESOLVE (electric sector capacity expansion tool, used by CPUC IRP) to enable the study of the cost-competitiveness of hydrogen for both non-electric and electric sector applications. This would allow E3 to co-optimize the deployment of zero-carbon resources, infrastructure and end-uses for the electricity and the fuel sectors of the California energy system. This analysis will also include a comparison of hydrogen with other zero carbon technologies (e.g., long-duration energy storage, carbon capture and sequestration and other clean energy generation technologies), and electric sector use cases (e.g. reliability, energy, decarbonization and other grid services).

The Recipient shall:

- Develop electrolytic fuels pathways model to enable simulation of electrolytic or thermochemical hydrogen production (bioenergy with carbon capture and storage, steam methane reformation, etc.), transportation, storage and consumption to meet demand from non-electric and electric sector applications.
- Develop optimization-based methods to calculate least-cost allocation of fuels across sectors of the economy, including non-electric and electric sector applications.

- Incorporate technoeconomic data on hydrogen infrastructure and underground hydrogen storage sites from previous tasks into the RESOLVE modeling framework.
- Develop scenario- and least-cost optimization-based methods to calculate the various pipeline and storage infrastructure deployment scenarios in order to link hydrogen. production with end uses in the electricity and other sectors in California, using known locations and costs of where infrastructure can be developed/retrofitted.
- Develop the ability to co-optimize the least-cost expansion of the zero-carbon electricity and fuels systems using RESOLVE.
- Incorporate modeling of various electric sector hydrogen applications (e.g., fuel cells, H_2 combustion turbine retrofits, new H_2 combustion), in coordination with existing public electric sector planning datasets (i.e., CPUC IRP).
- Summarize the Task 6 findings in a *California Hydrogen Fuels Optimization Model Formulation and Technical Guide.*

Products:

- California Hydrogen Fuels Optimization Model Formulation and Technical Guide

TASK 7: HYDROGEN INFRASTRUCTURE SCENARIO ANALYSIS

The goal of this task is to use the data, scenarios and modeling framework developed in previous tasks to assess various scenarios for hydrogen production and consumption in California. This task will identify cost competitive production and electric sector applications, as well as potential cost and performance metrics needed for different hydrogen infrastructure technologies to make these scenarios viable in the near-, medium- and long-term.

The Recipient shall:

- Utilize modeling framework to develop various least-cost hydrogen production and consumption scenarios.
- Test sensitivities of scenarios to cost reductions due to technological advancements developed in Task 3 to understand which technological advancements lead to the greatest increase in cost competitiveness across all use cases.
- Compare electric sector resource portfolios with hydrogen to those with other zero carbon technologies, based on metrics including but not limited to:
    - Total resource build
    - Total resource cost
    - Annual GHG emissions
    - Annual RPS and SB 100 policy attainment
- Run electric sector reliability (loss-of-load probability) models to assess the impact of hydrogen on maintaining system resource adequacy in a decarbonized electric sector, compared to other zero carbon technologies.
- Assess potential customer cost and affordability impacts by hydrogen scenario.
- Report metrics, including but not limited to:
    - Allocation of hydrogen across sectors of the economy, by scenario
    - Total hydrogen infrastructure investment (production, transportation, storage, power generation, etc.), by scenario
    - Hydrogen infrastructure utilization rate, by scenario
- Summarize the Task 7 findings in a *California Hydrogen Infrastructure Scenarios Presentation Slide Deck.*

- *Present findings in the California Hydrogen Infrastructure Scenarios Presentation to CEC staff.*

Products:
- California Hydrogen Infrastructure Scenarios Presentation Slide Deck

TASK 8: ENVIRONMENTAL IMPACTS ASSESSMENT AND MITIGATION STRATEGIES
The goal of this task is to assess the environmental impact of various hydrogen infrastructure and review potential mitigation strategies. Specifically, E3 proposes to develop an assessment of the negative environmental impacts resulting from the deployment of various energy technologies, in various configurations. E3 will also provide recommendations to mitigate these impacts within the context of research and development needs in the field, considering equity implications of these impacts on disadvantaged communities in California.

The Recipient shall:
- Develop a California Environmental Quality Act (CEQA) Appendix G screening checklist and narrative, including additional items of concern such as energy use (CEQA Appendix F) and environmental justice.
- Review similar projects historical CEQA documents, including environmental impact reports and Mitigated Negative Declarations, for specific impact determinations and mitigation measures.
- Conduct the screening analysis on production scenarios (2), infrastructure scenarios (3) and utilization scenarios (3), for a total of 8 screenings.
- Conduct detailed analysis on issue areas air quality and hazards for each of the scenarios above to ensure a proper level of analysis and substantial evidence.
    - Hydrogen leakage rates
    - GHG emissions impacts
    - Criteria pollutant emissions (e.g., NO_x, particulate matter) from end-use conversion
    - Hazards due to hydrogen leaks or accidental release
    - Water requirements for electrolysis and biomass gasification
    - Other potential environmental issues stemming from hydrogen generation, storage, transmission and/or use
- Suggest potential mitigation strategies for the issues uncovered during the review, considering the equity impacts on disadvantaged communities.
- Summarize the Task 8 findings in a *Draft* and *Final Hydrogen Environmental Impacts and Mitigation Strategies Report.*
- Prepare and submit a *CPR Report #2* in accordance with subtask 1.3 (CPR Meetings)
- Participate in a CPR meeting

Products:
- Hydrogen Environmental Impacts and Mitigation Strategies Report
- CPR Report #2

TASK 9: CALIFORNIA HYDROGEN POLICY RECOMMENDATIONS

The goal of this task is to use the data and modeling developed in this grant to develop policy, research, development, and demonstration recommendations for the EPIC program to enable cost-competitive hydrogen from renewable electricity and end-use in electric sector applications.

The Recipient shall:

- Synthesize key technological performance improvement and cost reduction metrics over 2025-2050.
- Summarize key non-electric and electric sector applications for hydrogen, highlighting potential value of hydrogen to support EPIC program goals:
    - Promote greater electric system reliability, such as by providing zero-carbon fuels to power zero-carbon firm generation technologies
    - Reduce GHGs and enable climate adaptation, by identifying potential pathways to convert fossil gas infrastructure to zero-carbon hydrogen infrastructure
- Suggest potentially valuable technology demonstrations and siting decisions, based on the technoeconomic review and scenario analysis in prior tasks as well as consultation with the Technical Advisory Committee.
- Build upon the gaps analysis conducted in Task 2 to suggest key program areas, investment, research initiatives, development, or demonstrations that the CEC can execute in addition to existing Federal and state policies and programs and will improve the competitiveness of hydrogen.
- Summarize the Task 9 findings in a *Hydrogen Policy Recommendations Presentation Slide Deck*.
- Present findings in the *Hydrogen Policy Recommendations Presentation* to CEC staff.

Products:

- Hydrogen Policy Recommendations Presentation Slide Deck

TASK 10: 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 11: TECHNOLOGY/KNOWLEDGE TRANSFER ACTIVITIES

The goal of this task is to ensure the scientific and techno-economic analysis and tools developed under this agreement are utilized in the energy policy, and/or planning decisions at the state and/or local levels, academic community and/or commercial sector.

The Recipient Shall:

- Develop and submit a *Knowledge Transfer Plan* that identifies the proposed activities the recipient will conduct to meet the goal of the task. The *Knowledge Transfer Plan* should include at a minimum:
    - Specific policy and planning efforts this project is expected to inform.
    - Specific stakeholder groups and energy policy and planning practitioners who will utilize the results of this project.
    - Proposed activities the recipient will conduct to ensure the tools and results from this project will be utilized and adopted by the groups identified above.
- Present the draft *Knowledge 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 *Knowledge Transfer Plan*. This document will identify:
    - TAC comments the recipient proposes to incorporate into the final *Knowledge Transfer Plan*.
    - TAC comments the recipient does not propose to incorporate with an explanation why.
- Submit the final *Knowledge Transfer Plan* to the CAM for approval.
- Implement the activities as described in the final *Knowledge Transfer Plan.*
- Develop a *Knowledge Transfer Summary Report* that includes high level summaries of the activities, results, and lessons learned of tasks performed relating to implementing the final *Knowledge Transfer Plan*. This report should not include any proprietary information.
- When directed by the CAM, develop presentation materials for CEC sponsored conference/workshop(s) on the project.
- When directed by the CAM, participate in annual EPIC symposium(s) sponsored by the 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:

- Knowledge Transfer Plan (draft and final)
- Summary of TAC Comments
- Knowledge Transfer Summary Report (draft and final)
- High Quality Digital Photographs

V. PROJECT SCHEDULE

Please see the attached Excel spreadsheet.