California Energy Commission
May 8, 2025 Business Meeting
Backup Materials for Barr Engineering Co. dba Barr Engineering Co. - Midwest

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

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

[PROPOSED]

RESOLUTION NO: 25-0508-03h

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION: Barr Engineering Co. dba Barr Engineering Co. - Midwest

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-24-044 with Barr Engineering Co. dba Barr Engineering Co. Midwest for a $3,252,000 grant. This agreement will fund the development and demonstration of a novel barrier coating, optimized to resist scaling and corrosion when used to line piping in Salton Sea geothermal power plants for demonstration at a geothermal power plant in Imperial County; 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 8, 2025.

AYE:
NAY:
ABSENT:
ABSTAIN:

Dated:

_____
Kristine Banaag
Secretariat

STATE OF CALIFORNIA
CALIFORNIA ENERGY COMMISSION

CEC-270 (Revised 01/2024)

GRANT REQUEST FORM (GRF)

A. New Agreement Number

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

New Agreement Number: EPC-24-044

B. Division Information

1. Division Name: ERDD
2. Agreement Manager: Chuck Gentry
3. MS-:43
4. Phone Number: 916-776-0761

C. Recipient's Information

1. Recipient's Legal Name: Barr Engineering Co. dba Barr Engineering Co. - Midwest
2. Federal ID Number: 41-0905995

D. Title of Project

Title of project: Preventing Scaling and Corrosion in Geothermal Facilities with Novel Lubricant-Infused Barrier Coating

E. Term and Amount

1. Start Date: 5/15/2025
2. End Date: 11/1/2029
3. Amount: $3,252,000.00

F. Business Meeting Information

1. Are the ARFVTP agreements $75K and under delegated to Executive Director? No
2. The Proposed Business Meeting Date: 04/10/25
3. Consent or Discussion? Consent
4. Business Meeting Presenter Name: Chuck Gentry
5. Time Needed for Business Meeting: N/A.
6. The email subscription topic is: EPIC (Electric Program Investment Charge).

Agenda Item Subject and Description:

Barr Engineering Co. dba Barr Engineering Co. - Midwest. Proposed resolution approving agreement EPC-24-044 with Barr Engineering Co. dba Barr Engineering Co. - Midwest for a $3,252,000 grant, and adopting staff's recommendation that this action is exempt from CEQA. This agreement will fund the development and demonstration of a novel barrier coating, optimized to resist scaling and corrosion when used to line piping in Salton Sea geothermal power plants for demonstration at a geothermal power plant in Imperial County. (EPIC Funding) Contact: Chuck Gentry

G. California Environmental Quality Act (CEQA) Compliance

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

   If yes, skip to question 2.

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

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

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

a) Agreement **IS** exempt?

Yes

Statutory Exemption?
No

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

PRC section number: None

CCR section number: None

Categorical Exemption?
Yes

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

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

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

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

California Code of Regulations, title 14, section 15301: The project involves minor alteration of an existing facility. The site is an existing geothermal power plant that includes brine processing facilities, geothermal production wells, and electricity generation facilities. Small metal sheets painted with the barrier coating will be secured inside sections of pipe and other sections of pipe will have the interior surface painted with the barrier coating. A limited number of these 1 meter sections of pipe will be installed in a geothermal process flow or test loop. These tests will be used to measure the performance of the superhydrophobic lubricant-infused composite barrier coating technology. This installation will not expand the existing use of the facility and will not have a significant effect on the environment.

California Code of Regulations, title 14, section 15306: This project involves data collection and research activities which do not result in a serious or major disturbance to an environmental resource.

For these reasons, the proposed project will have no significant effect on the environment and is categorically exempt under sections 15301 and 15306.
The project will not impact an environmental resource of hazardous or critical concern where designated, precisely mapped, and officially adopted pursuant to law by federal, state, or local agencies; does not involve any cumulative impacts of

successive projects of the same type in the same place that might be considered significant; does not involve unusual circumstances that might have a significant effect on the environment; will not result in damage to scenic resources within a highway officially designated as a state scenic highway; the project site is not included on any list compiled pursuant to Government Code section 65962.5; and the project will not cause a substantial adverse change in the significance of a historical resource. Therefore, none of the exceptions to categorical exemptions listed in CEQA Guidelines section 15300.2 apply to this project, and this project will not have a significant effect on the environment.

b) Agreement **IS NOT** exempt.

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

Yes or 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	Yes or No
Negative Declaration	Yes or No
Mitigated Negative Declaration	Yes or No
Environmental Impact Report	Yes or No
Statement of Overriding Considerations	Yes or No
None	Yes or No

H. Is this project considered "Infrastructure"?

No

I. 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
DOE- Pacific Northwest National Laboratory	$ 1,600,000	**$**0
Hell's Kitchen Geothermal, LLC	$ 95,000	**$**200,000
Dry Surface Technologies LLC	$ 600,000	**$**600,000
BioBlend Renewable Resources, LLC	$ 60,000	**$**180,000
J. D. Rush Company Inc.	$ 97,000	**$**97,000

J. 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
Sigma-Aldrich Sales, Inc. and/or Gelest, Inc.	**$ 10,014**	**$ 5,892**
Dry Surface Technologies LLC	**$ 11,272**	**$ 11,272**
McMaster-Carr Supply Company	**$ 1,658**	**$ 0**
TBD	**$ 8,089**	**$ 5,600**

K. 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
Hudson Ranch Power I LLC

L. 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	23-24	301.001K	$ 3,252,000

TOTAL Amount: $ 3,252,000

R&D Program Area: ESB: Renewables

Explanation for "Other" selection Not applicable

Reimbursement Contract #: Not applicable

Federal Agreement #: Not applicable

M. Recipient's Contact Information

1. Recipient's Administrator/Officer

Name: Daniel Palo

Address: 170 S Main St Ste 500

City, State, Zip: Salt Lake City, UT 84101-1660

Phone: 801-333-8421

E-Mail: dpalo@barr.com

3. Recipient's Project Manager

Name: Chad Haugen

Address: 4300 Marketpointe Dr Ste 200

City, State, Zip: Minneapolis, MN 55435-5422

Phone: 218-779-9776

E-Mail: chaugen@barr.com

N. Selection Process Used

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

Selection Process	Additional Information
Competitive Solicitation #	GFO-23-304
First Come First Served Solicitation #	Not applicable
Other	Not applicable

O. Attached Items

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

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

Approved By

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

Agreement Manager: Chuck Gentry

Approval Date: 01/31/2025

Branch Manager: Kevin Uy

Approval Date: 01/31/2025

Director: Kevin Uy for Angela Gould

Approval Date: 01/31/2025

EXHIBIT A
Scope of Work
Barr Engineering Co. dba Barr Engineering Co. - Midwest

I. TASK ACRONYM/TERM LISTS

A. Task List

Task #	CPR[1]	Task Name
1		General Project Tasks
2		SLIC Coating Design
3		SLIC Coating Formulation and Lab Testing
4	X	Short-Term Field Testing Select SLIC Variations
5		Measurement and Analysis for Short-Term Field Tests
6		Initial Techno-Economic Analysis
7		SLIC Coating Design Optimization
8		Compatibility with Scale Cleaning Methods Lab Testing
9	X	Medium-Term Field Testing Optimized SLIC Variations
10		Measurement and Analysis for Medium-Term Field Tests
11		Updated Techno-Economic Analysis
12		Final Optimization of SLIC Coating Formula
13		Optimize Coating Application in Pipes Lab Testing
14	X	Long-Term Field Testing SLIC-coated Pipes
15		Measurement and Analysis for Long-Term Field Tests
16		Finalize Techno-Economic Analysis
17		Evaluation of Project Benefits
18		Technology Transfer Activities

B. Acronym/Term List

Acronym/Term	Meaning
CAM	Commission Agreement Manager
CAPEX	Capital expenditure
CAO	Commission Agreement Officer
CEC	California Energy Commission
CPR	Critical Project Review
OPEX	Operational Expenditure
TAC	Technical Advisory Committee
TEA	Techno-economic analysis
SLIC	Superhydrophobic Lubricant-Infused Composite

[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.

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

A. Purpose of Agreement

The purpose of this Agreement is to fund development and field test validation of a novel lubricant-infused scaling and corrosion resistant coating. The coating will be optimized for and tested in the harsh conditions found in a geothermal energy production plant in the Salton Sea geothermal field. This technology has the potential to reduce the costs of developing and maintaining geothermal power plants which will help achieve the State of California's statutory energy goals.

B. Problem/ Solution Statement

Problem

In geothermal power plants the environment is highly corrosive and saline. Corrosion and scaling are the largest contributors to operation and maintenance costs in these facilities. Scale formation blocks pipes and prevents free-flowing operation within the plant while corrosion degrades metals until they must be repaired or replaced. These challenges are exacerbated when introducing process steps to capture lithium and other minerals from geothermal process flows. Today, geothermal operators use expensive nickel-rich steel alloys and even titanium piping to prevent corrosion in key functional areas. The capital expenditures required to install these pipes make expansion of California's geothermal power production economically tenuous. Numerous geothermal energy and mineral extraction efforts, including those in California, have failed because scaling and corrosion overwhelm existing protection technologies.

Solution

The Recipient and their associated technical and industrial team have developed a novel superhydrophobic lubricant-infused composite (SLIC) barrier coating that can be used to line piping in Salton Sea geothermal power plants. The coating is the result of nearly a decade of investment by the Department of Energy to develop a new class of materials with a durably lubricated surface. The technological advancements in the SLIC coating result in a surface that is 10 times more nonstick than Teflon®. The harsh conditions in Salton Sea geothermal brines mean that uncoated metals, including stainless steel, begin to form scale in just hours while SLIC's lubricated surface remains clean. The slippery nature of the coating also means that any scale that does form will not be durably attached and can be removed with low-intensity cleaning.

The largest impact SLIC will have on geothermal power plant operations is in capital expenditure for piping. With SLIC as a barrier lining coating, lower cost metals like carbon steel can be used instead of corrosion resistant alloys, which can cost up to 10 times more. Replacing these high-cost metals could result in $50-100 million in reduced capital costs at a 50 MW power plant while also reducing maintenance and operation costs and increasing reliability. Reducing cost to build and operate geothermal power generation will allow more rapid expansion of California's geothermal power capacity and allow California utilities to meet their statutory requirement to increase their procurement of renewable energy resources.

C. Goals and Objectives of the Agreement

Agreement Goals

The goals of this Agreement are to:

- Modify the existing SLIC coating system's formula so it is optimized for the harsh conditions of geothermal energy process flows.
- Validate the coating's performance through field testing at a geothermal power plant in the Salton Sea geothermal field.
- Demonstrate that SLIC can reduce the construction, operation, and maintenance costs of combined geothermal power and mineral production so more of these valuable resources can be used to meet California's ambitious clean energy requirements.

Ratepayer Benefits:[2] This Agreement will result in the ratepayer benefits of greater electricity reliability and lower costs by reducing the time that geothermal power plants must shut down annually for cleaning and repair of scaling and corrosion and by reducing operational and maintenance costs. Currently, geothermal power facilities must shut down for a short period annually to remove accumulated scale and repair or replace corroded pipes. Every 5 years, the plant must shut down for a much longer maintenance and service period. The costs of these shutdowns are passed on to California ratepayers. Developing this novel corrosion and scaling resistant coating will reduce the frequency and length of maintenance periods. Preventing unwanted scale accumulation will also reduce the likelihood of unplanned stoppages, thus making electricity supply more reliable.

By far the greatest benefit to ratepayers will be the significant reduction in capital expenditure required to develop and deploy additional electricity generating geothermal wells. One of the greatest costs for any new geothermal plant is high quality corrosion resistant alloy steel piping. Lower grade steel costs 10 times less than nickel-rich alloy steel but cannot currently be used because the Salton Sea geothermal brine is too corrosive. Developing a coating that can prevent scaling and corrosion, even on lower cost steel, would allow a significant portion of a new or existing plant's pipe to be replaced at low cost. This would allow development of further geothermal energy resources to accelerate. The increased supply of renewable energy generated in California from this expansion will reduce costs to ratepayers.

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 finally overcoming two of the most vexing problems that have prevented utilization of geothermal energy from the Salton Sea field. Accumulation of scale and rapid corrosion are hallmarks of every effort to extract geothermal energy in this area over the last century. No advancement in chemistry, materials science or metallurgy has succeeded enough to reduce the deleterious effects of highly saline brine. However, the SLIC coating may be the significant breakthrough that is needed because it may resist accumulation on the surface better than any prior coating thanks to a durable lubricating layer at the surface. Typically, surface lubrication would wash away under flow. The SLIC coating, however, has a unique combination of nanostructured surface texture and chemistry and subsurface porosity that holds the lubricant at the surface for extended periods. This remarkable surface property is

[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.

achievable in a low-cost, nontoxic, self-healing coating that is as easy to apply as any typical paint using readily available application equipment. Further maturation of this nascent technology and validation in real world field tests are necessary to prove that this innovation can effectively and efficiently prevent geothermal scaling and corrosion.

Agreement Objectives

The objectives of this Agreement are to:

- Test SLIC coatings against standard and competing scaling and corrosion control coatings in field tests at a geothermal facility in the Salton Sea field.
- Optimize the coating based on field and laboratory test results so it can meet all functional requirements in geothermal power plants.
- Reduce scale accumulation on the interior of in-service pipes such that the interval between maintenance cleaning is at least doubled.
- Conduct and continuously update advance techno-economic analyses to prove that deploying SLIC in geothermal plants will provide significant cost savings with return on investment of less than 5 years.
- Fully engage the team's industry partners to develop a commercialization roadmap that can be followed after the conclusion of this effort to bring the SLIC technology to market.

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, and other CEC staff relevant to the

Agreement. The Recipient's Project Manager and any other individuals deemed necessary by the CAM or the Project Manager shall participate in 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., Teams, Zoom), with approval of the CAM.

The Kick-off meeting will include discussion of the following:

- The CAM's expectations for accomplishing tasks described in the Scope of Work;
- An updated Project Schedule;
- Terms and conditions of the Agreement;
- Invoicing and auditing procedures;
- Travel;
- Equipment purchases;
- Administrative and Technical products (subtask 1.1);
- CPR meetings (subtask 1.3);
- Monthly Calls (subtask 1.5)
- Quarterly Progress reports (subtask 1.6)
- Final Report (subtask 1.7)
- Match funds (subtask 1.8);
- Permit documentation (subtask 1.9);
- Subawards(subtask 1.10);
- Technical Advisory Committee meetings (subtasks 1.11 and 1.12);
- Agreement changes;
- Performance Evaluations; 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 may 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 may 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. A determination of unsatisfactory progress This may result in project delays, including a potential Stop Work Order, while the CEC determines whether the project should continue.
- 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 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* organized by the tasks in the Agreement.

Products:

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

MONTHLY CALLS, REPORTS AND INVOICES

Subtask 1.5 Monthly Calls

The goal of this task is to have calls at least monthly between the CAM and Recipient to verify that satisfactory and continued progress is made towards achieving the objectives of this Agreement on time and within budget.

The objectives of this task are to verbally summarize activities performed during the reporting period, to identify activities planned for the next reporting period, to identify issues that may affect performance and expenditures, to verify match funds are being proportionally spent concurrently or in advance of CEC funds or are being spent in accordance with an approved Match Funding Spending Plan, to form the basis for determining whether invoices are consistent with work performed, and to answer any other questions from the CAM. Monthly calls might not be held on those months when a quarterly progress report is submitted or the CAM determines that a monthly call is unnecessary.

The CAM shall:

- Schedule monthly calls.
- Provide questions to the Recipient prior to the monthly call.

- Provide call summary notes to Recipient of items discussed during call.

The Recipient shall:

- Review the questions provided by CAM prior to the monthly call
- Provide verbal answers to the CAM during the call.

Product:

- Email to CAM concurring with call summary notes.

Subtask 1.6 Quarterly 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 *Quarterly 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 reporting period, 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. Progress reports are due to the CAM the 10th day of each January, April, July, and October. The Quarterly Progress Report template can be found on the ECAMS Resources webpage available at: https://www.energy.ca.gov/media/4691
- Submit a monthly or quarterly *Invoice* on the invoice template(s) provided by the CAM.

Recipient Products:

- Quarterly Progress Reports
- Invoices

CAM Product:

- Invoice template

Subtask 1.7 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 1.7.1 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 Products:

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

Subtask 1.7.2 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 SUBAWARDS

Subtask 1.8 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. 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 application 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 application 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 1.9 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 1.10 Subawards

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

The Recipient shall:

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

Products:

- Subawards *(if requested by the CAM)*

TECHNICAL ADVISORY COMMITTEE

Subtask 1.11 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 1.12.
- 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 1.12 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 1.13 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

TASK 2 SLIC COATING DESIGN

The goal of this task is to modify the design of the SLIC coating system to make it more effective at preventing scaling and corrosion in a geothermal environment.

The Recipient shall:

- Compile a list of requirements and specifications for a coating to be applied in geothermal piping.
    - Include technical and regulatory requirements.
- Conduct an in-depth review of currently available scaling and corrosion resistant coatings to determine most frequent failure points.

    - Determine which commercially available coatings can be acquired for competitive testing.
- Review the current design of the SLIC coating system with the project team and conduct a survey of alternative coating components that can be substituted or added to improve scaling and corrosion prevention.
    - Assess lubricants that are better able to perform at high temperature and high flow.
    - Assess alternative silica particles that can change SLIC's strength, flexibility, and porosity.
    - Consider different polymer binders with resistance to higher temperature.
- Conduct an on-paper assessment of SLIC coating changes to rank which would be most likely to result in improved scaling and corrosion prevention.
- Choose a set of SLIC variants to formulate for testing and document these choices in *Laboratory Test Plan #1*.

Products:

- Laboratory Test Plan #1

TASK 3 SLIC COATING FORMULATION AND LAB TESTING

The goal of this task is to formulate and test variants of the SLIC coating system in a laboratory setting.

The Recipient shall:

- Acquire the necessary materials and supplies to formulate variations of the SLIC coating as described in Laboratory Test Plan #1.
- Formulate SLIC coating variants and assess each for basic coating functionalities:
    - Ability to cure and form a smooth cohesive surface
    - Ability to adhere to a surface
    - Short term stability after application
- Further test SLIC coating variants that perform well in basic coating assessment for advanced coating performance:
    - Surface energy
    - Force of adhesion to relevant substrates
    - Abrasion resistance
    - Coefficient of friction
- Compile experimental test results into *Laboratory Test Results Summary #1.*
- Assess experimental results to determine which variants should be included in field testing.

Products:

- Laboratory Test Results Summary #1

TASK 4 SHORT-TERM FIELD TESTING SELECT SLIC VARIATIONS

The goal of this task is to produce SLIC coated samples and expose them to real geothermal brine conditions at an active geothermal facility in the Salton Sea geothermal field.

The Recipient shall:

- Establish verification and testing methods to demonstrate:
  - Accumulation of scale and corrosion in a short-term (less than 7 day) test.
  - Durability of the SLIC coating in real-world conditions.
- Create *Verification Plan #1* that includes but is not limited to an outline of:
  - The tests being conducted,
  - Critical metrics being validated, and
  - Measurement tools for verification.
- Produce SLIC coated samples for testing.
- Execute *Verification Plan #1* during field testing at the geothermal facility.
- Prepare a *CPR Report #1* in accordance with subtask 1.3 (CPR Meetings).
- Participate in a CPR meeting.

Products:

- Verification Plan #1
- CPR Report #1

TASK 5 MEASUREMENT AND ANALYSIS FOR SHORT-TERM FIELD TESTS

The goal of this task is to measure and quantify the amount of scaling and corrosion that occurred on test samples exposed to geothermal brine during short-term testing.

The Recipient shall:

- Analyze samples to quantify scaling by:
  - Measuring accumulated mass and thickness.
  - Recording digital images of each sample for qualitative and quantitative assessment.
  - Conducting high resolution 3D surface scanning to determine possible scale texturing, corrosion pitting, and other morphological changes in the coating.
- Prepare draft *Verification Report #1* to include:
  - High-level executive summary
  - Process and results of the field testing
  - Technical issues
  - Lessons learned from the short-term field testing.
- Submit the draft *Verification Report #1* to the CAM for feedback and incorporate changes as requested in the final *Verification Report #1*.

Products:

- Verification Report #1 (draft and final)

TASK 6 INITIAL TECHNO-ECONOMIC ANALYSIS

The goal of this task is to prepare an initial techno-economic analysis (TEA) for variants of the SLIC coating system that have undergone lab testing and short-term field testing.

The Recipient shall:

- Develop and submit an *Initial TEA of SLIC Coating System* based on laboratory data and short-term field testing results. Include capital expenditure (CAPEX) and operational expenditure (OPEX) estimates for a commercial scale plant and comparison to current methods of corrosion and scaling management at geothermal facilities.

Products:

- Initial TEA of SLIC Coating System

TASK 7 SLIC COATING DESIGN OPTIMIZATION

The goal of this task is to optimize the design of the SLIC coating based on results of laboratory and field testing.

The Recipient shall:

- Conduct a critical assessment of laboratory and field tests from Tasks 3, 4 and 5.
- Determine which components of the coating caused underperformance in any key criteria.
- Reassess coating formulations with the project's industry collaborators.
- Curate a refined list of additional coating components and additives that should be tested.
- Conduct an on-paper assessment of SLIC coating changes to rank which would be most likely to result in improved scaling and corrosion prevention.
- Choose a set of SLIC variants to formulate for testing and document these choices in *Laboratory Test Plan #2.*

Products:

- Laboratory Test Plan #2

TASK 8 COMPATIBILITY WITH SCALE CLEANING METHODS LAB TESTING

The goal of this task is to ensure that the final formulation of the SLIC coating is compatible with existing geothermal scale cleaning methods such as hydroblasting.

The Recipient shall:

- Acquire the necessary materials and supplies to formulate variations of the SLIC coating as described in the Laboratory Test Plan #2.
- Collect operational parameters of common scale cleaning methods that may impact SLIC coating design.
- Formulate SLIC coating variants and assess each for basic coating functionalities:
    - Ability to cure and form a smooth cohesive surface.
    - Ability to adhere to a surface.
    - Short term stability after application
- Further test SLIC coating variants that perform well in basic coating assessment for compatibility with common scale cleaning methods:
    - Hydroblasting
    - Abrasive scrubbing
    - Chemical removal
- Compile experimental test results into *Laboratory Test Results Summary #2*
- Assess experimental results to determine which variants should be included in field testing.

Products:

- Laboratory Test Results Summary #2

TASK 9 MEDIUM-TERM FIELD TESTING OPTIMIZED SLIC VARIATIONS

The goal of this task is to produce optimized SLIC coated samples and expose them to real geothermal brine conditions at an active geothermal facility in the Salton Sea geothermal field.

The Recipient shall:

- Update verification and testing methods to demonstrate:
  - Accumulation of scale and corrosion in a medium-term (about 30 day) test.
  - Durability of the SLIC coating in real-world conditions.
- Create *Verification Plan #2* to reflect:
  - The medium duration tests being conducted,
  - Critical metrics being validated, and
  - Measurement tools for verification.
- Produce SLIC coated samples for testing.
- Execute *Verification Plan #2* during field testing at the geothermal facility.
- Prepare a *CPR Report #2* in accordance with subtask 1.3 (CPR Meetings).
- Participate in a CPR meeting.

Products:

- Verification Plan #2
- CPR Report #2

TASK 10 MEASUREMENT AND ANALYSIS FOR MEDIUM-TERM FIELD TESTS

The goal of this task is to measure and quantify the amount of scaling and corrosion that occurred on test samples exposed to geothermal brine during medium-term testing.

The Recipient shall:

- Analyze samples to quantify scaling by:
  - Measuring accumulated mass and thickness.
  - Recording digital images of each sample for qualitative and quantitative assessment.
  - Conducting high resolution 3D surface scanning to determine possible scale texturing, corrosion pitting, and other morphological changes in the coating.
- Prepare the draft *Verification Report #2* to include:
  - High-level executive summary
  - Process and results of the field testing
  - Technical issues
  - Lessons learned from medium-term field testing
- Submit the draft *Verification Report #2* to the CAM for feedback and incorporate changes as requested in the final *Verification Report #2*.

Products:

- Verification Report #2 (draft and final)

TASK 11 UPDATED TECHNO-ECONOMIC ANALYSIS

The goal of this task is to prepare an updated TEA of the SLIC coating system based on results of medium-term field testing.

The Recipient shall:

- Develop and submit an *Updated TEA* of *SLIC Coating System* based on medium-term field test data. Include updated CAPEX and OPEX estimates for a commercial scale plant and comparison to current methods of corrosion and scaling management at geothermal facilities.

Products:

- Updated TEA of SLIC Coating System

TASK 12 FINAL OPTIMIZATION OF SLIC COATING FORMULA

The goal of this task is finalizing the optimal formulation(s) of the SLIC coating by conducting a thorough review of all test data to date.

The Recipient shall:

- Conduct a critical assessment of laboratory and field tests from Tasks 3, 4, 5, 8, 9, and 10 while balancing results of the latest techno-economic analysis from Task 11.
- Determine which SLIC formulations are highest performing across key criteria.
- Reassess coating formulations with the project's industry collaborators.
- Curate a refined list of coating variants that should be tested in final validation.
- Conduct an on-paper assessment of SLIC coating changes to rank which would be most likely to result in optimal scaling and corrosion prevention.
- Choose a set of SLIC variants to formulate for testing and document these choices in *Laboratory Test Plan #3***.**

Products:

- Laboratory Test Plan #3

TASK 13 OPTIMIZE COATING APPLICATION IN PIPES LAB TESTING

The goal of this task is to determine the optimal method to apply the SLIC coating uniformly and with durable adhesion to the inner surfaces of representative metal pipes.

The Recipient shall:

- Acquire the necessary materials and supplies to formulate variations of the SLIC coating as described in the Laboratory Test Plan #3.
- Collect representative metal pipe sections and coating requirements that may impact SLIC coating application.
- Formulate SLIC coating variants and assess each for basic coating functionalities:
    - Ability to cure and form a smooth cohesive surface on the interior of a pipe
    - Ability to adhere to pipe inner surfaces
    - Short term stability after application
- Further test SLIC coating variants that perform well in basic coating assessment for compatibility with common pipe coating methods.
- Compile experimental test results into *Laboratory Test Results Summary #3.*

- Assess experimental results to determine which variants should be included in field testing.

Products:

- Laboratory Test Results Summary #3

TASK 14 LONG-TERM FIELD TESTING SLIC-COATED PIPES

The goal of this task is coat sections of pipe with optimized SLIC coating so they can be placed into service or test loops within a geothermal power generation facility for extended duration field testing.

The Recipient shall:

- Update verification and testing methods to demonstrate:
  - Accumulation of scale and corrosion in a long-term (about 180 day) test.
  - Durability of the SLIC coating as applied to pipes in real-world conditions.
- Create *Verification Plan #3* to reflect:
  - The long duration tests being conducted,
  - Critical metrics being validated, and
  - Measurement tools for verification adjusted for coating on pipe inner surfaces.
- Produce SLIC coated pipe sections for testing.
- Install coated pipe sections for field testing at the demonstration site.
- Execute the *Verification Plan #3* during an extended field test at the geothermal facility.
- Prepare a *CPR Report #3* in accordance with subtask 1.3 (CPR Meetings).
- Participate in a CPR meeting.

Products:

- Verification Plan #3
- CPR Report #3

TASK 15 MEASUREMENT AND ANALYSIS FOR LONG-TERM FIELD TESTS

The goal of this task is to measure and quantify the amount of scaling and corrosion that occurred on SLIC-coated pipes exposed to geothermal brine during long-term testing.

The Recipient shall:

- Analyze samples to quantify scaling by:
  - Measuring accumulated mass and thickness on pipe inner surfaces.
  - Recording digital images of each sample for qualitative and quantitative assessment.
  - Conducting high resolution 3D surface scanning to determine possible scale texturing, corrosion pitting, and other morphological changes in the coating.
- Update the draft *Verification Report* to include but not limited to:
  - High-level executive summary
  - Process and results of the field testing
  - Technical issues
  - Lessons learned from the final extended duration field testing
- Submit draft *Verification Report #3* to the CAM for feedback and incorporate changes as

requested in the final *Verification Report #3*.

Products:

- Verification Report #3 (draft and final)

TASK 16 FINALIZE TECHNO-ECONOMIC ANALYSIS

The goal of this task is to prepare the final TEA based on the best performing SLIC formula used in extended field testing.

The Recipient shall:

- Develop and submit the *Final TEA* of *SLIC Coating System* based on all field and laboratory test data. Include updated CAPEX and OPEX estimates for a commercial scale plant and comparison to current methods of corrosion and scaling management at geothermal facilities.

Products:

- Final TEA of SLIC Coating System

TASK 17 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 18 TECHNOLOGY 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.
- Development of a commercialization roadmap that outlines all key milestones, decision points, and tasks to bring the SLIC coating to TRL 9 and to market as a commercialized product.

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.
- 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:

- 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.