California Energy Commission
October 03, 2024 Business Meeting
Backup Materials for C-Crete Technologies LLC

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

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

[PROPOSED]

RESOLUTION NO: 24-1003-07b

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION: C-Crete Technologies LLC

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-24-020 with C-Crete Technologies for a $8,500,000 grant. This agreement will develop an alternative cementitious binder for manufacturing concrete. This first-of-its-kind pilot demonstration in San Leandro aims to turn naturally occurring, abundant non-carbonate rocks, such as zeolite, into cementitious binders using a novel activation technology that eliminates energy and GHG emission-intensive Ordinary Portland Cement in conventional concrete; 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 October 3, 2024.

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-24-020

B. Division Information

1. Division Name: ERDD
2. Agreement Manager: Maryam Haddad
3. MS-: 51
4. Phone Number:

C. Recipient's Information

1. Recipient's Legal Name: C-Crete Technologies LLC
2. Federal ID Number: 27-2513329

D. Title of Project

Title of project: Scale-up Manufacturing of Next-Generation Cementitious Binders Using Non-Carbonate Rocks

E. Term and Amount

1. Start Date: 11/1/2024
2. End Date: 3/31/2029
3. Amount: $8,500,000.00

F. Business Meeting Information

1. Are the ARFVTP agreements $75K and under delegated to Executive Director? No
2. The Proposed Business Meeting Date: 10/3/2024 .
3. Consent or Discussion? Discussion
4. Business Meeting Presenter Name: Anish Gautam
5. Time Needed for Business Meeting: 5 minutes.
6. The email subscription topic is: EPIC (Electric Program Investment Charge).

Agenda Item Subject and Description:

C-Crete Technologies LLC. Proposed resolution approving agreement EPC-24-020 with C-Crete Technologies LLC for a $8,500,000 grant, and adopting staff's recommendation that this action is exempt from CEQA. This agreement will develop an alternative cementitious binder for manufacturing concrete. The first-of-its-kind pilot demonstration in San Leandro aims to turn naturally occurring, abundant non-carbonate rocks, such as zeolite, into cementitious binders using a novel activation technology that eliminates energy and GHG emission-intensive Ordinary Portland Cement in conventional concrete. (EPIC funding) Contact: Anish Gautam

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, 15305, 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 provides that projects which consist of the operation, repair, maintenance, permitting, licensing, or minor alteration of existing public or private structures, facilities, mechanical equipment, or topographical features, and which have negligible or no expansion of existing or former use, are categorically exempt from the provisions of the California Environmental Quality Act (CEQA). This project involves a pilot demonstration at an existing facility for manufacturing cementitious binders for cement production. All work will occur within existing facilities. Therefore, this project is exempt from CEQA under section 15301.

California Code of Regulations, title 14, section 15305 provides that projects which consist of installation of small new equipment and facilities in small structures are categorically exempt from the provisions of CEQA. This project involves mechanical design studies, engineering analyses, and fabrication of new equipment to demonstrate a novel technology for manufacturing cementitious binders at an existing facility. Therefore, this project is exempt from CEQA under section 15305.

California Code of Regulations, title 14, section 15306 provides that projects which consist of basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an

environmental resource are categorically exempt from the provisions of CEQA. This project involves basic data collection, research, experimental management, and resource evaluation activities which do not result in serious or major disturbance to an environmental source. This project involves mechanical design studies and engineering analyses of technology to manufacture cementitious binders for making cement. Technology demonstration activities will be in a controlled environment at existing facilities. This work will not result in a serious or major disturbance to an environmental resource. Therefore, this project is exempt from CEQA under section 15306.

This project does not involve impacts on any particularly sensitive environment; 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.

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. 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
Trimeric Corporation	$ 99,500	$0
ClimateEarth	$ 16,000	$0

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
TBD - Installation Contractor	$98,444	$0

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
No key partners to report

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	22-23	301.001J	$ 5,590,366
EPIC	23-24	301.001K	$ 2,909,634

TOTAL Amount: $ 8,500,000

R&D Program Area: ICMB: IAW

Explanation for “Other” selection Not applicable

Reimbursement Contract #: Not applicable

Federal Agreement #: 101

M. Recipient’s Contact Information

1. Recipient’s Administrator/Officer

Name: Rouzbeh Savary

Address: 14421 Catalina St

City, State, Zip: San Leandro, CA 94577-5515

Phone: 617-872-6507

E-Mail: rouzbeh@ccretetech.com

3. Recipient's Project Manager

Name: Rouzbeh Savary

Address: 14421 Catalina St

City, State, Zip: San Leandro, CA 94577-5515

Phone: 617-872-6507

E-Mail: rouzbeh@ccretetech.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-22-301r2
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	No

Approved By

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

Agreement Manager: Maryam Haddad

Approval Date: 8/20/2024

Branch Manager: Cody Taylor

Approval Date: 8/22/2024

Director: Cody Taylor on behalf of Director

Approval Date: 8/22/2024

Exhibit A
Scope of Work
C-Crete Technologies LLC (dba C-Crete)

I. TASK ACRONYM/TERM LISTS

A. Task List

Task #	CPR[1]	Task Name
1		General Project Tasks
2	X	Design, Engineering Construction and Installation of the Pilot Plant
3	X	Test Unit Start-up, Commission and Operation of the Pilot Test Facility
4		Development of Test Plans
5	X	Parametric Testing of Operating Conditions
6		Analyze the Long-Term Performance Data and Decommission
7	X	Fabrication and Testing of Zeolite-Based Binders, Mortars and Concrete
8		Incorporation of Activated Zeolite to Ready Mix Batch Plants and Pouring Cast-in-Place Concrete
9	X	TEA, LCA, and EPD Analyses
10		Evaluation of Project Benefits
11		Technology/Knowledge Transfer Activities

B. Acronym/Term List

Acronym/Term	Meaning
AASHTO	American Association of Highway and Transportation Officials
ACI	American Concrete Institute
ASTM	American Society for Testing and Materials
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CCUS	Carbon Capture, Utilization, and Storage
CEC	California Energy Commission
CPR	Critical Project Review
CO_2	Carbon Dioxide
EPD	Environmental Product Declaration
FOAK	First-Of-A-Kind
GHG	Green House Gas
LCA	Life Cycle Analysis
M&V	Measurement and Verification
OPC	Ordinary Portland Cement
PFD	Process Flow Diagrams
TAC	Technical Advisory Committee
TEA	Techno-Economic Analysis

[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
C-Crete Technologies LLC (dba C-Crete)

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

A. Purpose of Agreement

The purpose of this Agreement is to fund the development, scale-up, and testing of a first-of-a-kind (FOAK) pilot demonstration unit to directly activate non-carbonate rocks such as zeolite to cementitious binders devoid of Ordinary Portland Cement (OPC) and its carbon dioxide (CO_2) emissions while rivaling/exceeding OPC in performance. The outcome will be the construction of a demonstration-scale activation plant that can make industrially relevant amounts of cementitious binders as well as scaleup and optimization of various processes of the plant. When fully integrated, this technology platform allows for the conversion of various non-carbonate rocks into cementitious binders, representing 100% replacement of OPC in conventional concrete.

Problem / Solution Statement

Problem

California's cement and concrete industries result in significant emissions state-wide. They are difficult to decarbonize due to complex, high-temperature processing that cannot imminently rely on electrification. Thus, like many other hard-to-abate sectors, these industries lag behind in meeting emissions reduction goals.

Solution

The Recipient has developed a novel activation technology capable of converting various passive non-carbonate rocks into active cementitious binders that react with water and CO2 at industry-leading efficiencies using renewable electricity. This pathway opens a suite of opportunities to transform naturally occurring abundant rocks into valuable end products such as a cementitious binder, as it is a key ingredient to concrete and many construction projects traditionally produced with OPC. One example of such non-carbonate rocks in zeolite, primarily made of Si and Al, two of the most abundant elements on Earth's crust. Only in California (in the Mojave Desert), billion tons of zeolite rocks are available and they are mainly on the surface easily accessible via open pit mining. The proposed two step activation pathway will use electricity (not fossil fuels) to first pulverize the rocks to a desired particle size, followed by mixing them with a small amount of proprietary activators, which are manufactured separately via our electrical reactor. This would result in a 25 percent or greater reduction in fossil fuel use from equipment electrification and a 25 percent or greater reduction in facility-level GHG emissions. Central Concrete/Vulcan Materials in California, the industry partner for this project, is interested in this platform technology for its ability to create concrete without Portland cement and its associated CO_2.

B. Goals and Objectives of the Agreement

Agreement Goals

The goals of this Agreement are to:

- To develop a first-of-a-kind (FOAK) pilot demonstration to turn naturally-occurring abundant "non-carbonate" rocks such as zeolite into cementitious binders for replacing 100% of Portland cement in cast-in-place concrete.

- Design, engineer, install and operate a >20 tons/day feed FOAK pilot facility at the recipient's site.
- Perform a full parametric study and long runs (>6 months) in the FOAK pilot facility to find the optimum range conditions for creating representative zeolite-based binder,
- Perform fabrication and testing of several presentative zeolite-based binders and concrete in accordance with industry-accepted ASTM, ACI and AASHTO standards.
- Incorporate activated zeolite to ready mix batch plant of industry-leading concrete manufacturers such as Central Concrete/Vulcan Materials and pour at least 10 cubic yards of concrete for a case study.
- Interface with an industry-leading concrete manufacturer such as Central Concrete/Vulcan Materials to uncover and remove barriers such as implementation, scale-up and commercial adoption of our Portland-cement-free zeolite binder technology and perform Measurement and Verification (M&V).
- Perform Techno-Economic Analysis (TEA), Life Cycle Analysis (LCA), and Environmental Product Declaration (EPD) developments to facilitate modular commercial plant design, market penetration and commercialization of this new Portland cement-free binder

Ratepayer Benefits:[2] This Agreement will result in the ratepayer benefits of greater electricity reliability, lower costs, or increased safety by reducing overgeneration, reducing CO_2 emissions state-wide, and stabilizing the renewables grid. The recipient's technology can switch on and off, taking advantage of overgeneration to reduce overall electricity cost and stabilize by adding a controllable load. Additionally, the recipient's technology can remove the entire 8 million metric tons of CO_2 produced by the California cement industry annually, mitigating some of the impacts of climate change for California residents.

Technological Advancement and Breakthroughs: This Agreement will lead to technological advancement and breakthroughs to overcome barriers (including but not limited to implementation, scale-up and commercial adoption) to the achievement of the State of California's statutory energy goals by demonstrating and validating the incorporation of highly efficient, electricity-driven alternative binders in heavy Green House Gas (GHG) emission producing cement industry, thus removing barriers to commercial adoption of this technology. State-wide adoption of alternative binder technology in the cement and concrete manufacturing sector will expand renewable energy demand and generation to help meet California's goal of 100% renewable energy and zero-carbon electricity by 2045.

Agreement Objectives

The objectives of this Agreement are to:

- Design, commission and operate a FOAK pilot plant that utilizes zeolite to manufacture Portland cement-free binder with a capacity of 20 tons/day
- Stable operation of all key equipment and entire plant at >90% capacity.
- Stable operation of the entire pilot plant for at least 6 months, followed by M&V.
- Meeting at least all ASTM C1157 performance standards (General Construction use) for the binder product obtained from the long run of the pilot

[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).

- Demonstrate that the Portland cement-free binder produced herein can be incorporated into industrial concrete production processes such as ready-mix batch plants through testing at the industrial partner's facility in San Francisco.
- Successful demonstration of a pilot cast-in-place concrete via pouring our zeolite-base concrete into a prototypical small single-floor concrete house.
- Development of comprehensive TEA, LCA and EPD reports for the product to facilitate market entry, commercialization and adoption.

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 ensure 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
C-Crete Technologies LLC (dba C-Crete)

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* for each TAC Meeting 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 ensure 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

TECHNICAL TASKS

TASK 2: Design, Engineering, Construction and Installation of the Pilot Plant
The goal of this task is to generate the demonstration site engineering package, design ancillary equipment and instrumentation, and prepare the host site (the recipient's site) for installation of the FOAK pilot system

The Recipient shall:
- Prepare the Site Design Package which includes:
    - Site layout drawings that indicate system integration with the existing host facility process, the facility utilities and the overall infrastructure. This also includes utility connections and locations for the installation of instrumentation

- A bill of materials identifying the ancillary equipment and materials such as pressure/flow regulators, valves, pipe and fittings required for the installation
- Specifications for the instrumentation per the design (e.g. piping, conveyer belt, and silo with at least 20-ton capacity) to manufacture Portland cement-free binder with a capacity of 20 tons/day
- Description of any other activities and/or resources required to decommission and remove pre-existing equipment and support installation of the pilot system. This includes disconnecting and unbolting the machines from the ground, and using a forklift to put them on a truck for potential disposal.
- *Site Preparation and Equipment Procurement Memo* that includes a procurement plan, anticipated timeline and relevant progress updates for all equipment, materials, and permits needed for the project.

- Calculate and prepare a modeling package for the pilot demonstration system, which includes process modeling, process flow diagrams (PFD), mass and energy balance, identification of bottlenecks and plans for mitigation, and safety protocols.
- Prepare *Design and Engineering Summary for FOAK Pilot Plant Documents* that include but not limited to high-level, non-confidential information on system design, projected timeline, and project workflows
    - High-level executive summary
    - Description of top-level assembly and integration concept for FOAK pilot plant
    - Summary of Design and Engineering package including PFD of proposed integrated plant with all equipment and balance of plant required for converting zeolite to cementitious binder
- Solicit bids from California-based equipment fabricators and establish an agreement with a selected contractor to fabricate major components of the pilot system
- Procure the ancillary equipment and materials such as pressure/flow regulators, valves, pipe and fittings required for the installation through California-based vendors
- Procure the instrumentation required to satisfy the engineering design through California-based vendors
- Solicit bids from California-based installation contractors and establish an agreement with a selected contractor capable of fulfilling the pilot system installation effort for a 20-ton/day capacity.
- Conduct a site visit and meet with the installation contractor prior to beginning installation of equipment to coordinate and review the installation scope of work
- Draft a *Construction and Installation Memo* that includes a list and specs of the selected equipment and materials, contractor scope of work, photographs of the installed equipment, and a construction retrospective
- Monitor the removal of any pre-existing equipment and supervise the installation of the pilot system and the ancillary equipment required per the installation specifications
- Prepare a *CPR Report #1* in accordance with subtask 1.3 (CPR Meetings).
- Participate in a CPR meeting

Products:

- Design and Engineering Summary for FOAK Pilot Plant Documents
- Site Preparation and Equipment Procurement Memo
- Construction and Installation Memo (draft and final)
- CPR Report #1 (draft and final)

TASK 3: Test Unit Start-up, Commission and Operation of the Pilot Test Facility

The goal of this task is to do a pre-start-up safety review for all units, followed by testing each unit to demonstrate operation at steady state and boundary conditions and finally, commissioning, testing, and validating the full pilot facility by ensuring all components work together for continued and stable operation.

The Recipient shall:

- Perform a comprehensive safety review of all units and the entire pilot plant prior to testing which includes but not limited to an assessment of chemical hazards associated with selected materials, potential physical hazards from selected equipment and machinery, an evaluation of environmental risks and waste management protocols, emergency response planning, worker safety training, personal protective equipment requirements, and risk assessment for handling flammable or reactive substances. This tasks also covers reviewing regulatory compliance with safety standards, establishing clear communication protocols, and ensuring proper ventilation and fire safety measures are crucial elements that promote both personnel safety and environmental protection throughout the testing phase.
- Designate a single master shutdown and emergency alarm to the recipient's control system. This will be done by the subcontractor.
- Validate the stable performance of the entire pilot plant
- Test all control loops for continuous operation
- Iterate and adjust control loops as needed for smooth operation
- Prepare and submit documentation for automation parameters.
    - Commission each unit for continued operation, ensuring the primary and ancillary components are operating properly within design specifications to manufacture Portland cement-free binder with a capacity of 20 tons/day
- Prepare a *Performance Report* including a memo of the comprehensive safety review and safety and operation analysis of each unit as well as learnings from the commissioning
- *Prepare Stable Test Runs Summary* for continued operation of the plant
- Prepare a *CPR Report #2* in accordance with subtask 1.3 (CPR Meetings).
- Participate in a CPR meeting

Products:

- Performance Report
- Stable Rest Runs Summary (draft and final)
- CPR Report #2 (draft and final)

TASK 4: Development of Test Plans

The goal of this task is to prepare a detailed test plan to allow for field evaluation of the pilot plant's performance for long-term operation.

The Recipient shall:

- Prepare a detailed draft *Demonstration Test Plan* consisting of 1) drivers for the demonstration, 2) performance objectives, 3) the rationale for selection of the test conditions, 4) predicted technology performance based on the results of previous development work, 5) a test matrix showing the number of test conditions and replicated runs, 6) a description of the test procedures, facilities, equipment, and instrumentation

required for the system evaluation, 7) a description of the test procedures, and 8) a description of the data analysis procedures.

- The draft *Demonstration Test Plan* will include the M&V details to be fulfilled by the independent third-party M&V contractor (Central Concrete/Vulcan Materials). These include 1) project overview with comprehensive analyses/assessment of energy and resource inputs, 2) procedure to determine and output quality of the final binder, 3) overview of M&V activities including but not limited to monitoring key performance indicators such as raw material consumption, process efficiencies, audits and calibration of measurement instruments to ensure data accuracy verification of compliance with industry standards and environmental regulations providing a clear and transparent reporting framework that delivers actionable insights for process optimization and scaling such as baseline conditions (minimum qualities such as strength needed) and performance metrics and measurements.
- Evaluate the draft *Demonstration Test Plan* with the project team for appropriateness of instruments, parameters, operating conditions, duration of measurements, and procedures planned for comparing technical and economic performance.
- Prepare final *Demonstration Test Plan* that outlines the process to ensure all systems operate as expected and includes metrics and targets that include but are not limited to all control devices that can operate through their desired ranges, and notes from meeting with industrial M&V partner.

Products:

- Demonstration Test Plan (draft and final)

TASK 5: Parametric Testing of Operating Conditions

The goal of this task is to study parameters (such as temperature, flowrate, and compositions) phase space to collect the pilot-scale performance data in accordance with the Test Plan.

The Recipient shall:

- Study variable temperature and flowrate of zeolite feed
- Identify tolerance and homogeneity for mixing pulverized zeolite and activators
- Study zeolite composition variations
- Collaborate across the recipient's internal technical development and plant design teams to create mitigation plans (varying the temperature and flowrate) to eliminate any negative effects of zeolite composition variations
- Perform quick start-up and shutdown (around 5-10 minutes) of the plant to identify any irregularities
- Create representative binders from the product to make 2-inch mortar cubes and 4-inch by 8-inch concrete cylinders and rapidly screen their select properties such as 3 and 7-day strength, density, and slump for each parametric condition (i.e. temperature, flowrate, compositions)
- Prepare an Operating Performance Report including a memo of the high-level, non-confidential information regarding protocols applied to test the operational parameters and zeolite compositions, objectives, key findings, and mitigation plan
- Prepare a *CPR Report #3* in accordance with subtask 1.3 (CPR Meetings).
- Participate in a CPR meeting

Products:

- Operating Performance Report
- CPR Report #3 (draft and final)

TASK 6: Analyze the Long-Term Performance Data and Decommission
The goal of this task is to monitor the long-term stability and performance of the pilot facility for a period of over 6 months at around maximum (over 90 percent) capacity.

The Recipient shall:

- Gather and analyze data on the performance of the system over an extended monitoring period in accordance with the M&V aspects of the *Demonstration Test Plan*.
- In accordance with the M&V aspects of the *Demonstration Test Plan* complete independent third-party testing by the M&V partner and prepare *M&V Report by the Third Party*.
- Analyze the data and possibly modify the tests to improve the activated zeolite performance and/or identify the range of conditions that ensure optimal performance.
- Dismantle the skids and pilot facility and move all equipment to the recipient's warehouse for future use and/or make an arrangement to continue using them onsite
- Prepare *Long-term Performance Test Summary* including but not limited to objectives, methodology, measured performance indicators, environmental impact, significant trends observed in the performance data, potential issues encountered during the testing phase and their implications for plant operation and material longevity along with recommendations for future modifications based on the data analysis, brief discussion on the decommissioning process and *M&V Report by the Third Party*, and analysis of and mitigation plans for any remaining risks or barriers based on collected long-term performance data.

Products:

- Long-term Performance Test Summary (draft and final)
- M&V Report by the Third Party (draft and final)

TASK 7: Fabrication and Testing of Zeolite-Based Binders, Mortars and Concrete
The goal of this task is to perform fabrication and standard testing of zeolite-based mortars and concrete via analysis of the binder and samples taken from pilot plant operations to ensure martials sampled meet the rigorous technical requirements of ASTM C1157 for the product.

The Recipient shall:

- Perform standard structural and compositional characterizations on the dry zeolite, akin to those done at Portland cement
- Fabricate several representative mortar cubes or concrete cylinders or beams for various standard mechanical, durability and placing properties of concrete per ASTM, ACI and AASHTO standards. A particular focus will be placed on ASTM C1157
- Adjust the composition of the binder, yield, or purity of activators or surface area of zeolite, if desired properties such as strength, density and slump are not met,
- Collaborate across the recipient's internal technical development and plant design teams to create mitigation plans to eliminate any insufficient performance data.
- Develop Product datasheet and Materials Safety Data Sheet (MSDS)
    - Results of performance testing
    - Data package that includes product datasheet and its MSDS
- Prepare *Binders, Mortars and Concrete Performance Report* including but not limited to test objectives, the methodology employed in the fabrication process, key findings and comparative analysis with traditional materials should be included to underscore the advantages of zeolite binders

- Prepare a *CPR Report #4* in accordance with subtask 1.3 (CPR Meetings).
- Participate in a CPR meeting
-

Products:

- Binders, Mortars and Concrete Performance Report
- CPR Report #4 (draft and final)

TASK 8: Incorporation of Activated Zeolite to Ready Mix Batch Plants and Pouring Cast-in-Place Concrete

The goal of this task is to integrate Portland cement-free binder from the recipient into the workstream of their industrial partner Central Concrete/Vulcan Materials. The recipient will provide at least 20 tons of zeolite-based binder to Central Concrete to perform independent standard analytical tests as well as integration to their ready-mix batch plant for normal operation in their trucks including mixing and pouring in a prototypical small single-floor concrete house.

The Recipient shall:

- Provide a zeolite-based binder to the industrial partner.
- Provide technical assistance such as mix design, and know-how to the industrial partner as they perform independent standard ASTM/ACI/AASHTO tests (part of M&V) to assess any potential differences between zeolite-based binder and traditional Portland cement to evaluate its compatibility with their existing industrial processes.
    - Tests may include but are not limited to the evaluation of compressive strength, setting time, flowability, and slump loss during travels.
    - Prepare and evaluate at least 10 cubic yards of zeolite-based concrete in a convention drum truck, drive to a job site (or mock-up site) for at least 60 minutes, pour and monitor slump, workability, setting time and surface finish. This represents actual data and information on the operation of the recipient's product in real construction settings.
    - Assist partner in preparing formal *Analytical and Field Test Result Summary* regarding field-sampled properties (strength, slump and density) and ease and effectiveness of concrete placement in the field including setting time, temperature and surface finish. Include mitigation plans for any differences or barriers uncovered during the testing for instance, if the setting time is too long, accelerators might be needed to mitigate this barrier or if the heat of hydration is too high, ice water might be needed to decrease the heat of hydration.
- Prepare a *Performance Report* that includes a summary of the industrial partner's *Analytical and Field Test Result Summary* to test objectives, the methodology employed and results

Products:

- Performance Report
- Analytical and Field Test Result Summary

TASK 9: TEA, LCA, and EPD Analyses

The goal of this task is to assess how this project can provide quantitative information on equipment sizing, piping, unit economy and environmental footprint of the technology at a larger scale. Techno-economic analysis (TEA), life cycle assessment (LCA) and environmental

product declaration (EDP) analysis will be performed following published protocols, focusing on zeolite-based binder production cost and emissions impact. The outcomes of these analyses will then be broadly disseminated to demonstrate the efficacy of deploying this technology within the California cement/concrete industry.

The Recipient shall:

- Use published protocols to develop TEA and LCA models and EPD reports.
- Incorporate performance and manufacturing data into TEA and LCA models
- Assess the techno-economic and environmental impacts of this project on the recipient's technology platform
- Prepare *Mitigation Plans and Performance Memo* that include TEA report, LAC and EPD findings and any required changes to the equipment sizing, scale of the commercial plant and supply-chain logistics. The metrics listed in below along with the quantification methods and target will be used to determine the overall project performance and actual project benefits.
    - Grinding performance (controlled particle size): conducting particle size testing of demonstration-scale; target: <10% standard deviation for target particle size.
    - Grinding scale with controllable particle size: conducting proof of grinding operation at the demonstration scale; target: 10x of the current baseline.
    - Activation Reactor scale: conducting proof of activation operation at the demonstration scale; target: 20x of current baseline.
    - Activation yield, energy, and cost: conducting process modeling and TEA; target: >95% yield, >50% lower energy, and cost parity of the final binder vs Portland cement.
    - Mechanical/Durability Properties: conducting several ASTM, ACI, and AASHTO industry standard testing protocols; target: Same or better performance.
    - CO2 emissions benefit: conducting LCA and EPD; target: >95% CO2 saving vs. conventional manufacturing of OPC.
    - Prepare a final TEA, LCA and EPD documents to be delivered to the industrial partner and CEC.
- Discuss the outcomes of TEA, LCA and EPD analyses with the industrial partner to detect/identify any new roadblocks to on-site deployment at batch plants uncovered through these analyses
- Engage in outreach activities (including but not limited to pursuing meetings, and offtake agreements led by the recipient's business development and capital projects teams to disseminate the applicability of the technology in reducing GHG emissions within the California cement industry and beyond (i.e. 25 percent or greater reduction of facility-level GHG) emissions. This will include pursuing meetings, offtake agreements, demonstration agreements, and on-site deployments. The recipient will leverage close partnerships with the California branch of the National Ready Mix Concrete Association, Central Concrete/Vulcan Materials, and other concrete companies to assist with networking and dissemination of high-level TEA, LCA and EPD.
    - Summary of progress towards project completion
    - Mitigation plans (such as changing equipment sizing, the scale of the commercial plant and supply-chain logistics) that address any risks or no-go issues uncovered through TEA, LCA and EPD development
- Prepare a *CPR Report #5* in accordance with subtask 1.3 (CPR Meetings).
- Participate in a CPR meeting

Products:

- Mitigation Plans and Performance Memo
- CPR Report #5 (draft and final)

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 TRANSFER ACTIVITIES

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

The Recipient Shall:

- Develop and submit a *Project Case Study Plan* that outlines how the Recipient will document the planning, construction, commissioning, and operation of the technology or system being demonstrated. The Project Case Study Plan should include:

  - An outline of the objectives, goals, and activities of the case study.
  - The organization that will be conducting the case study and the plan for conducting it.
  - A list of professions and practitioners involved in the technology's deployment.
  - Specific activities the recipient will take to ensure the learning that results from the project is disseminated to those professions and practitioners.
  - Presentations/webinars/training events to disseminate the results of the case study.
- Present the draft *Project Case Study Plan* to the TAC for review and comment.
- Develop and submit a *Summary of TAC Comments* that summarizes comments received from the TAC members on the draft *Project Case Study Plan*. This document will identify:
  - TAC comments the recipient proposes to incorporate into the final *Technology Transfer Plan*.
  - TAC comments the recipient does not propose to incorporate with and explanation why.
- Submit the final *Project Case Study Plan* to the CAM for approval.
- Execute the final Project Case Study Plan and develop and submit a Project Case Study.
- When directed by the CAM, develop presentation materials for a CEC sponsored conference/workshop(s) on the project.
- When directed by the CAM, participate in annual EPIC symposium(s) sponsored by the California CEC.
- Provide at least (6) six High Quality Digital Photographs (minimum resolution of 1300x500 pixels in landscape ratio) of pre and post technology installation at the project sites or related project photographs.

Products:

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

IV. PROJECT SCHEDULE

Please see the attached Excel spreadsheet.