California Energy Commission
July 26, 2023 Business Meeting
Backup Materials for Agenda Item No 11b:
RCAM Technologies, Inc.

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

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

RESOLUTION NO: 23-0726-11b

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION: RCAM Technologies, Inc.

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

RESOLVED, that the CEC approves agreement EPC-23-003 with RCAM Technologies, Inc. for a $3,699,424 grant to advance the design and development of two 3D concrete printed anchors for floating offshore wind energy systems, suitable for a California Wind Energy Area. This project will develop a lower cost anchor that facilitates local concrete manufacturing in California ports and minimizes environmental impacts during installation and operation; and

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

CERTIFICATION

The undersigned Secretariat to the CEC does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the CEC held on July 26, 2023.

AYE:
NAY:
ABSENT:
ABSTAIN:

Dated:

_____
Liza Lopez
Secretariat

STATE OF CALIFORNIA
CALIFORNIA ENERGY COMMISSION

CEC-270 (Revised 9/2022)

GRANT REQUEST FORM (GRF)

A. New Agreement Number

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

New Agreement Number: EPC-23-003

B. Division Information

1. Division Name: ERDD
2. Agreement Manager: Michelle Slocombe
3. MS-:None
4. Phone Number: 916-776-0745

C. Recipient's Information

1. Recipient's Legal Name: RCAM Technologies, Inc.
2. Federal ID Number: 85-3257046

D. Title of Project

Title of project: Low-Cost, Environmentally-Friendly, Concrete Anchors Made In California

E. Term and Amount

1. Start Date: 8/1/2023
2. End Date: 3/31/2027
3. Amount: $3,699,424.00

F. Business Meeting Information

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

Agenda Item Subject and Description:

RCAM Technologies, Inc. Proposed resolution approving agreement EPC-23-003 with RCAM Technologies, Inc. for a $3,699,424 grant to advance the design and development of two 3D concrete printed anchors for floating offshore wind energy systems, suitable for a California Wind Energy Area, and adopting staff's determination that this action is exempt from CEQA. This project will develop a lower cost anchor that facilitates local concrete manufacturing in California ports and minimizes environmental impacts during installation and operation. (EPIC funding) Contact: Mark Danielson (Staff Presentation: 5 minutes)

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 ;

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.

This project will involve research and desktop studies conducted at existing locations and testing facilities. Therefore, there will be negligible to no expansion of the existing use of the facilities. For these reasons, the project will not have a significant effect on the environment. Therefore, the project is categorically exempt under California Code of Regulations, title 14 section 15301.

b) Agreement **IS NOT** exempt.

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

No

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

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

H. Subcontractors

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

Subcontractor Legal Company Name	CEC Funds	Match Funds
The Regents of the University of California, U.C. Irvine	$ 99,000	**$**0
WSP USA, Inc.	$ 449,976	**$**0
The Regents of the University of California, U.C. San Diego	$ 1,200,000	**$**240,000

I. Vendors and Sellers for Equipment and Materials/Miscellaneous

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

Vendor/Seller Legal Company Name	CEC Funds	Match Funds
UL Services Group, LLC	**$**50,000	**$**0
InterMoor, Inc.	**$**62,000	**$**0

J. Key Partners

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

Key Partner Legal Company Name
No key partners to report

K. Budget Information

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

Funding Source	Funding Year of Appropriation	Budget List Number	Amount
EPIC	21-22	301.001I	$ 3,699,424

TOTAL Amount: $ 3,699,424

R&D Program Area: EGRB: Renewables

Explanation for "Other" selection Not applicable

Reimbursement Contract #: Not applicable

Federal Agreement #: Not applicable

L. Recipient's Contact Information

1. Recipient's Administrator/Officer

Name: Gabriel Falzone

Address: 2840 S Mansfield Ave

City, State, Zip: Los Angeles, CA 90016-3906

Phone: 510-381-1118

E-Mail: gabriel.falzone@rcamtechnologies.com

3. Recipient's Project Manager

Name: Gabriel Falzone

Address: 2840 S Mansfield Ave

City, State, Zip: Los Angeles, CA 90016-3906

Phone: 510-381-1118

E-Mail: gabriel.falzone@rcamtechnologies.com

M. Selection Process Used

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

Selection Process	Additional Information
Competitive Solicitation #	GFO-22-402
First Come First Served Solicitation #	Not applicable
Other	Not applicable

N. Attached Items

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

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

Approved By

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

Agreement Manager: Daphne Molin for Michelle Slocombe

Approval Date: 5/26/2023

Branch Manager: Kevin Uy

Approval Date: 6/1/2023

Director: Kevin Uy for Jonah Steinbuck

Approval Date: 6/1/2023

EXHIBIT A
Scope of Work
RCAM Technologies, Inc.

I. TASK ACRONYM/TERM LISTS

A. Task List

Task #	CPR [1]	Task Name
1		General Project Tasks
2		Establish Design Basis for Anchors in California Wind Energy Areas
3		Preliminary Front End Engineering Design and Down-Selection of Suction and Torpedo Anchor Concepts
4		Proof-of-Concept Additive Manufacturing of Down-Selected Suction Anchors and Torpedo Anchors at Scales up to 1/2
5	X	Front End Engineering Design of Concrete Suction Anchors and Torpedo Anchors
6		California Concrete Anchor Manufacturing Planning, Production Layout and Costing
7		Assess Environmental Impacts of Anchor Alternatives
8		Lifecycle and Economic Assessment of Anchors
9	X	Material Property Characterization, Penetration, and Pullout Testing
10		Plan Concrete Anchor Qualification, Structural Testing, and Ocean Testing
11		Design, Fabricate, and Structurally Test a 1/2 Scale Anchor
12		Fabricate a 2/3 Scale Prototype Anchor
13		Evaluation of Project Benefits
14		Technology/Knowledge Transfer Activities

B. Acronym/Term List

Acronym/Term	Meaning
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CEC	California Energy Commission
CPR	Critical Project Review
FEED	Front End Engineering Design
FOSW	Floating Offshore Wind
Pre-FEED	Preliminary Front End Engineering Design
Recipient	RCAM Technologies, Inc.
SA	Suction Anchor
TA	Torpedo Anchor
TAC	Technical Advisory Committee

[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.

Acronym/Term	Meaning
TRL	Technology Readiness Level
WEA	Wind Energy Area

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

A. Purpose of Agreement

The purpose of this Agreement is to advance the design and development of two floating offshore wind anchors for a California Wind Energy Area (WEA) using automated 3D concrete printing technology that will use lower-cost and lower-carbon materials and enable localized production at in-state ports. This will be accomplished through Front End Engineering Design (FEED), engineering, environmental and technoeconomic analysis, prototype fabrication, and laboratory, structural, and geotechnical testing of two innovative concrete anchor concepts for California floating offshore wind (FOSW) plants.

B. Problem/ Solution Statement

Problem

California's WEAs have several unique anchor and mooring challenges, including being up to five times deeper than any other FOSW installations to date (1,500m vs. 300m). The much deeper waters require anchors with omnidirectional load capacity for potential installation in mooring configurations that are more cost effective and minimize potential marine entanglement, such as semi-taut mooring, tension-leg platforms, and anchors shared between multiple turbines or mooring lines. Furthermore, to minimize disturbance to benthic habitats, anchors should be installed quietly within a small footprint, and be recoverable or be able to be embedded deeply below the mudline and cut off at the end of service. California's WEAs also have a high likelihood of severe seismic activity that can liquify seabeds, resulting in loss of load capacity or catastrophic failure. In addition, anchors are the third most expensive FOSW component to manufacture after the turbine and floating platform. The cost of manufacturing and installing anchors and mooring contribute to up to 20 percent of wind plant capital expenditures or approximately $0.5M to $1M per installed anchor. California's deeper waters, limited availability of installation vessels, active wave environment, and limited heavy-steel-fabrication supply chain will further increase manufacturing, installation, and retrieval costs of anchors in California FOSW plants.

Solution

The Recipient has developed two innovative concepts for low cost, locally manufacturable concrete anchors that improve upon conventional steel suction anchors and torpedo anchors. Suction anchors (SAs) and torpedo anchors (TAs) are the ideal leading anchor types for California's very deep WEAs because they will provide high omnidirectional load capacities suitable for all mooring configurations, can be installed

with a high degree of accuracy in the California WEAs' predominantly clay seabeds, are proven in oil and gas applications and at a European floating wind plant, and have potentially superior resistance to seismic events. These innovative anchor concepts will reduce costs by replacing steel with concrete that is fabricated using automated manufacturing methods such as 3D concrete printing, automated shotcrete construction, and casting using 3D printed formwork. Regarding environmental impact, SAs can be installed quietly and are recoverable at the end of service, while TAs are embedded deeply below the mudline and can be cut off at the end of service. The performance characteristics of these two anchor designs, their manufacturability in California ports, and their potential to reduce environmental impacts due to accurate installation, and the ability to enable efficient mooring line configurations make them promising candidates for installation in California WEAs.

C. Goals and Objectives of the Agreement

Agreement Goals

The goals of this Agreement are to:

1. Advance the design of and develop two 3D-printed concrete anchor concepts that minimize costs and environmental impacts and are suitable for California WEAs.
2. Establish anchor design criteria suitable for California WEAs.
3. Validate anchor manufacturability in California ports and potential economic benefits to California.
4. Assess potential marine environmental impacts and identify methods of mitigation.
5. Assess anchor lifecycle and economic impacts compared to baseline steel anchors.

Ratepayer Benefits:[2] This Agreement will result in ratepayer benefits by contributing to cost reductions in California's offshore wind deployments and by increasing grid resiliency and reliability of FOSW through development of low-cost, locally manufactured concrete anchor technologies. The anchors will be designed for superior resilience against seismic events and other California WEA-specific conditions and will have a long (30+ year) service life, decreasing the need for frequent disruptive replacements. The FOSW anchors will also enable non-energy benefits such as reduced GHG emissions from anchor manufacturing, improved manufacturing safety, reduced environmental disturbance due to more efficient mooring line configurations enabled by the anchors, and increased in-state economic activity and job creation due to on-site anchor fabrication. These anchors will reduce costs by up to 82 percent compared to conventional steel anchors, reduce manufacturing GHG emissions by up to 96 percent compared to steel

[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).

anchors, and will be able to be manufactured in California ports, bringing more economic activity in-state.

Technological Advancement and Breakthroughs:[3] This Agreement will lead to technological advancement and breakthroughs to overcome barriers to the achievement of the State of California's statutory energy goals by advancing the design, proving the manufacturing feasibility, and performing critical laboratory testing (to de-risk) of two innovative low-cost concrete anchor technologies for California offshore wind plants.

Agreement Objectives

The objectives of this Agreement are to:

1. Advance both concrete SAs and concrete TAs concepts from technological readiness level (TRL) 2 to TRL 4 through Pre-FEED.
2. Down-select to one SA design and one TA design for further development with TAC feedback.
3. Complete proof-of-concept manufacturing trials, FEED, technoeconomic analysis, lifecycle emissions and economic analysis, and laboratory geotechnical testing for the down-selected SA and TA designs.
4. Assess the marine environmental impacts of the project's down-selected SA and TA designs compared to currently available anchor technologies and develop a plan for mitigation of environmental impacts.
5. Down-select between the SA and TA for further development with TAC feedback.
6. Advance the down-selected anchor from TRL 4 to TRL 5 by performing laboratory structural testing at up to 1/2 scale, fabricating an anchor prototype at the largest size possible within manufacturing and logistical constraints (up to 2/3 scale), and developing a technology qualification plan.

III. TASK 1 GENERAL PROJECT TASKS

PRODUCTS

Subtask 1.1 Products

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

The Recipient shall:

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

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

For products that require a final version only

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

For all products

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

Instructions for Submitting Electronic Files and Developing Software:

  - **Electronic File Format**

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

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

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

- **Software Application Development**

Use the following standard Application Architecture components in compatible versions for any software application development required by this Agreement (e.g., databases, models, modeling tools), unless the CAM approves other software applications such as open source programs:

- Microsoft ASP.NET framework (version 3.5 and up). Recommend 4.0.
- Microsoft Internet Information Services (IIS), (version 6 and up) Recommend 7.5.
- Visual Studio.NET (version 2008 and up). Recommend 2010.
- C# Programming Language with Presentation (UI), Business Object and Data Layers.
- SQL (Structured Query Language).
- Microsoft SQL Server 2008, Stored Procedures. Recommend 2008 R2.
- Microsoft SQL Reporting Services. Recommend 2008 R2.
- XML (external interfaces).

Any exceptions to the Electronic File Format requirements above must be approved in writing by the CAM. The CAM will consult with the CEC's Information Technology Services Branch to determine whether the exceptions are allowable.

MEETINGS

Subtask 1.2 Kick-off Meeting

The goal of this subtask is to establish the lines of communication and procedures for implementing this Agreement.

The Recipient shall:

- Attend a "Kick-off" meeting with the CAM, the Commission Agreement Officer (CAO), and any other CEC staff relevant to the Agreement. The Recipient will

bring its Project Manager and any other individuals designated by the CAM to this meeting. The administrative and technical aspects of the Agreement will be discussed at the meeting. Prior to the meeting, the CAM will provide an agenda to all potential meeting participants. The meeting may take place in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

The administrative portion of the meeting will include discussion of the following:
- Terms and conditions of the Agreement;
- Invoicing and auditing procedures;
- Administrative products (subtask 1.1);
- CPR meetings (subtask 1.3);
- Match fund documentation (subtask 1.7);
- Permit documentation (subtask 1.8);
- Subcontracts (subtask 1.9); and
- Any other relevant topics.

The technical portion of the meeting will include discussion of the following:
- The CAM's expectations for accomplishing tasks described in the Scope of Work;
- An updated Project Schedule;
- Technical products (subtask 1.1);
- Progress reports (subtask 1.5);
- Final Report (subtask 1.6);
- Technical Advisory Committee meetings (subtasks 1.10 and 1.11); and
- Any other relevant topics.

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

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

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

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

CAM Product:

- Kick-off Meeting Agenda

Subtask 1.3 Critical Project Review (CPR) Meetings

The goal of this subtask is to determine if the project should continue to receive CEC funding, and if so whether any modifications must be made to the tasks, products, schedule, or budget. CPR meetings provide the opportunity for frank discussions between the CEC and the Recipient. As determined by the CAM, discussions may include project status, challenges, successes, advisory group findings and recommendations, final report preparation, and progress on technical transfer and production readiness activities (if applicable). Participants will include the CAM and the Recipient and may include the CAO and any other individuals selected by the CAM to provide support to the CEC.

CPR meetings generally take place at key, predetermined points in the Agreement, as determined by the CAM and as shown in the Task List on page 1 of this Exhibit. However, the CAM may schedule additional CPR meetings as necessary. The budget will be reallocated to cover the additional costs borne by the Recipient, but the overall Agreement amount will not increase. CPR meetings generally take place at the CEC, but they may take place at another location, or may be conducted via electronic conferencing (e.g., WebEx) as determined by the CAM.

The Recipient shall:

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

The CAM shall:

- Determine the location, date, and time of each CPR meeting with the Recipient's input.
- Send the Recipient a *CPR Agenda* with a list of expected CPR participants in advance of the CPR meeting. If applicable, the agenda will include a discussion of match funding and permits.
- Conduct and make a record of each CPR meeting. Provide the Recipient with a schedule for providing a Progress Determination on continuation of the project.
- Determine whether to continue the project, and if so whether modifications are needed to the tasks, schedule, products, or budget for the remainder of the Agreement. If the CAM concludes that satisfactory progress is not being made, this conclusion will be referred to the Deputy Director of the Energy Research and Development Division.

- Provide the Recipient with a *Progress Determination* on continuation of the project, in accordance with the schedule. The Progress Determination may include a requirement that the Recipient revise one or more products.

Recipient Products:

- CPR Report(s)

CAM Products:

- CPR Agenda(s)
- Progress Determination

Subtask 1.4 Final Meeting

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

The Recipient shall:

- Meet with CEC staff to present project findings, conclusions, and recommendations. The final meeting must be completed during the closeout of this Agreement. This meeting will be attended by the Recipient and CAM, at a minimum. The meeting may occur in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

  The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be divided into two separate meetings at the CAM's discretion.
  - The technical portion of the meeting will involve the presentation of findings, conclusions, and recommended next steps (if any) for the Agreement. The CAM will determine the appropriate meeting participants.
  - The administrative portion of the meeting will involve a discussion with the CAM and the CAO of the following Agreement closeout items:
    - Disposition of any procured equipment.
    - The CEC's request for specific "generated" data (not already provided in Agreement products).
    - Need to document the Recipient's disclosure of "subject inventions" developed under the Agreement.
    - "Surviving" Agreement provisions such as repayment provisions and confidential products.
    - Final invoicing and release of retention.
- Prepare a *Final Meeting Agreement Summary* that documents any agreement made between the Recipient and Commission staff during the meeting.
- Prepare a *Schedule for Completing Agreement Closeout Activities*.
- Provide copies of *All Final Products* on a USB memory stick, organized by the tasks in the Agreement.

Products:

- Final Meeting Agreement Summary *(if applicable)*

- Schedule for Completing Agreement Closeout Activities
- All Final Products

REPORTS AND INVOICES

Subtask 1.5 Progress Reports and Invoices

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

The Recipient shall:

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

Products:

- Progress Reports
- Invoices

Subtask 1.6 Final Report

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

Subtask 1.6.1 Final Report Outline

The Recipient shall:

- Prepare a *Final Report Outline* in accordance with the *Energy Commission Style Manual* provided by the CAM.

Recipient Products:

- Final Report Outline (draft and final)

CAM Product:

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

Subtask 1.6.2 Final Report

The Recipient shall:

- Prepare a *Final Report* for this Agreement in accordance with the approved Final Report Outline, Energy Commission Style Manual, and Final Report Template provided by the CAM with the following considerations:
  - Ensure that the report includes the following items, in the following order:
    - Cover page (**required**)
    - Credits page on the reverse side of cover with legal disclaimer (**required**)
    - Acknowledgements page (optional)
    - Preface (**required**)
    - Abstract, keywords, and citation page (**required**)
    - Table of Contents (**required**, followed by List of Figures and List of Tables, if needed)
    - Executive summary (**required**)
    - Body of the report (**required**)
    - References (if applicable)
    - Glossary/Acronyms (If more than 10 acronyms or abbreviations are used, it is required.)
    - Bibliography (if applicable)
    - Appendices (if applicable) (Create a separate volume if very large.)
    - Attachments (if applicable)
- Submit a draft of the Executive Summary to the TAC for review and comment.
- Develop and submit a *Summary of TAC Comments on Draft Final Report* received on the Executive Summary. For each comment received, the recipient will identify in the summary the following:
  - Comments the recipient proposes to incorporate.
  - Comments the recipient does propose to incorporate and an explanation for why.
- Submit a draft of the report to the CAM for review and comment. The CAM will provide written comments to the Recipient on the draft product within 15 days of receipt.
- Incorporate all CAM comments into the *Final Report*. If the Recipient disagrees with any comment, provide a *Written Responses to Comments* explaining why the comments were not incorporated into the final product.
- Submit the revised *Final Report* electronically with any Written Responses to Comments within 10 days of receipt of CAM's Written Comments on the Draft Final

Report, unless the CAM specifies a longer time period or approves a request for additional time.

Products:

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

CAM Product:

- Written Comments on the Draft Final Report

MATCH FUNDS, PERMITS, AND SUBCONTRACTS

Subtask 1.7 Match Funds

The goal of this subtask is to ensure that the Recipient obtains any match funds planned for this Agreement and applies them to the Agreement during the Agreement term.

While the costs to obtain and document match funds are not reimbursable under this Agreement, the Recipient may spend match funds for this task. The Recipient may only spend match funds during the Agreement term, either concurrently or prior to the use of CEC funds. Match funds must be identified in writing, and the Recipient must obtain any associated commitments before incurring any costs for which the Recipient will request reimbursement.

The Recipient shall:

- Prepare a *Match Funds Status Letter* that documents the match funds committed to this Agreement. If no match funds were part of the proposal that led to the CEC awarding this Agreement and none have been identified at the time this Agreement starts, then state this in the letter.

  If match funds were a part of the proposal that led to the CEC awarding this Agreement, then provide in the letter:
  - A list of the match funds that identifies:
    - The amount of cash match funds, their source(s) (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied.
    - The amount of each in-kind contribution, a description of the contribution type (e.g., property, services), the documented market or book value, the source (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or real property, the Recipient must identify its owner and provide a contact name, address, telephone number, and the address where the property is located.
    - If different from the solicitation application, provide a letter of commitment

from an authorized representative of each source of match funding that the funds or contributions have been secured.

- At the Kick-off meeting, discuss match funds and the impact on the project if they are significantly reduced or not obtained as committed. If applicable, match funds will be included as a line item in the progress reports and will be a topic at CPR meetings.
- Provide a *Supplemental Match Funds Notification Letter* to the CAM of receipt of additional match funds.
- Provide a *Match Funds Reduction Notification Letter* to the CAM if existing match funds are reduced during the course of the Agreement. Reduction of match funds may trigger a CPR meeting.

Products:

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

Subtask 1.8 Permits

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

The Recipient shall:

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

  The list of permits and the schedule for obtaining them will be discussed at the Kick-off meeting (subtask 1.2), and a timetable for submitting the updated list, schedule, and copies of the permits will be developed. The impact on the project if the permits are not obtained in a timely fashion or are denied will also be discussed. If applicable, permits will be included as a line item in progress reports and will be a topic at CPR meetings.

- If during the course of the Agreement additional permits become necessary, then provide the CAM with an *Updated List of Permits* (including the appropriate information on each permit) and an *Updated Schedule for Acquiring Permits*.
- Send the CAM a *Copy of Each Approved Permit*.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the CAM within 5 days. Either of these events may trigger a CPR meeting.

Products:

- Permit Status Letter
- Updated List of Permits *(if applicable)*
- Updated Schedule for Acquiring Permits *(if applicable)*
- Copy of Each Approved Permit *(if applicable)*

Subtask 1.9 Subcontracts

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

The Recipient shall:

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

Products:

- Subcontracts *(draft if required by the CAM)*

TECHNICAL ADVISORY COMMITTEE

Subtask 1.10 Technical Advisory Committee (TAC)

The goal of this subtask is to create an advisory committee for this Agreement. The TAC should be composed of diverse professionals. The composition will vary depending on interest, availability, and need. TAC members will serve at the CAM's discretion. The purpose of the TAC is to:

- Provide guidance in project direction. The guidance may include scope and methodologies, timing, and coordination with other projects. The guidance may be based on:

  - Technical area expertise;
  - Knowledge of market applications; or
  - Linkages between the agreement work and other past, present, or future projects (both public and private sectors) that TAC members are aware of in a particular area.
- Review products and provide recommendations for needed product adjustments, refinements, or enhancements.
- Evaluate the tangible benefits of the project to the state of California, and provide recommendations as needed to enhance the benefits.
- Provide recommendations regarding information dissemination, market pathways, or commercialization strategies relevant to the project products.
- Help set the project team's goals and contribute to the development and evaluation of its statement of proposed objectives as the project evolves.
- Provide a credible and objective sounding board on the wide range of technical and financial barriers and opportunities.
- Help identify key areas where the project has a competitive advantage, value proposition, or strength upon which to build.
- Advocate, to the extent the TAC members feel is appropriate, on behalf of the project in its effort to build partnerships, governmental support, and relationships with a national spectrum of influential leaders.
- Ask probing questions that insure a long-term perspective on decision-making and progress toward the project's strategic goals.

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

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

The Recipient shall:

- Prepare a *List of Potential TAC Members* that includes the names, companies, physical and electronic addresses, and phone numbers of potential members. The list will be discussed at the Kick-off meeting, and a schedule for recruiting members and holding the first TAC meeting will be developed.
- Recruit TAC members. Ensure that each individual understands member obligations and the TAC meeting schedule developed in subtask 1.11.

- Prepare a *List of TAC Members* once all TAC members have committed to serving on the TAC.
- Submit *Documentation of TAC Member Commitment* (such as Letters of Acceptance) from each TAC member.

Products:

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

Subtask 1.11 TAC Meetings

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

The Recipient shall:

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

The TAC shall:

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

Products:

- TAC Meeting Schedule (draft and final)

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

Subtask 1.12 Project Performance Metrics

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

The Recipient shall:

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

Products:

- TAC Performance Metrics Summary
- Project Performance Metrics Results

IV. TECHNICAL TASKS

*Products that require a draft version are indicated by marking **"(draft and final)"** after the product name in the "Products" section of the task/subtask. If "(draft and final)" does not appear after the product name, only a final version of the product is required.*
***Subtask 1.1 (Products)** describes the procedure for submitting products to the CAM.*

TASK 2 ESTABLISH DESIGN BASIS FOR ANCHORS IN CALIFORNIA WIND ENERGY AREAS

The goal of this task is to establish anchor design criteria representative of California WEAs. This will include definition of a reference wind plant, assessment of seabed composition information, and calculation of design loads considering metocean conditions, and assessment of risks from seismic events. Focus will be paid to obtain information not available through typical literature reviews through discussions with local experts and OSW developers of California projects.

The Recipient shall:

- Assess seismic, metocean and soil conditions in both California WEAs.
- Define a suitable reference wind plant in one of the California WEAs (Humboldt or Morro Bay) including but not limited to:
    - Metocean conditions
    - Bathymetry
    - Expected seabed composition (soil classification, geophysical data including shear wave velocity profiles, expected shear strength profiles)
    - Seismic risk data (fault locations, expected magnitude and duration)
    - Turbine rating
    - Floating substructure type
    - Mooring configuration
    - Anchor configuration (shared or un-shared)
- Calculate anchor service loads (anchor design tensions and uplift angles at seafloor in intact and damaged conditions) considering:
    - Metocean conditions including storm events
    - Seismic conditions.
- Engage with OSW developers to secure expected turbine loads and compare it to calculated data for reference wind site.
- Prepare a *Reference Wind Site for Anchor Design Report* which summarizes the conditions of the reference wind site
- Conduct interviews with experts to ascertain available WEA seabed information required for design of suction anchors and torpedo anchors
- Compile WEA seabed information, including but not limited to:
    - Design soil profiles: upper bound, best estimate, and lower bound undrained shear strength and submerged unit weight and soil sensitivity.
- Define reference cases for seabed compositions
- Prepare a draft *California WEA Seabed Composition Report* including but not limited to:
    - Review of WEA seabed composition data

  - Compilation of WEA seabed data
  - Definition of reference cases for design of suction anchor and torpedo anchor
  - Discussion of risks and recommendations for future data collection related to anchor selection
- Communicate with OSW developers in the WEA(s) and other experts, as available, to receive site survey data as it becomes available
- Submit the draft *California WEA Seabed Composition Report* to the CAM for feedback and incorporate changes as requested in the final *California WEA Seabed Composition Report*

Products:

- Reference Wind Site for Anchor Design Report
- California WEA Seabed Composition Report (Draft and Final)

TASK 3 PRELIMINARY FRONT END ENGINEERING DESIGN AND DOWN-SELECTION OF SUCTION AND TORPEDO ANCHOR CONCEPTS

The goals of this task are to advance the conceptual designs and prove the technical feasibility and economics of steel and concrete suction anchors and torpedo anchors for California WEAs. The task will perform conceptual design, sizing, installation engineering, and costing studies for both steel reference anchors and concrete anchor concepts. The preliminary front end engineering design (Pre-FEED) studies are used as a basis for subsequent Front End Engineering Design (FEED) studies. For the purposes of this agreement, the FEED will incorporate the above actions to focus the technical requirements and costs for the project.

The Recipient shall:

- Perform preliminary sizing and analysis for steel suction anchors, including but not limited to:
  - Preliminary size and weight estimate
  - Suction embedment calculations
  - Embedment buckling calculation per American Petroleum Institute Recommended Practice 2A
  - Structural arrangement drawing and weight estimate
  - Fabrication cost estimate
- Perform conceptual design, preliminary sizing, and analysis for one to three concrete suction anchor concepts, including but not limited to:
  - Suction embedment calculations
  - Concrete suction anchor size and configuration estimates
  - Concrete suction anchor pad eye configuration development
- Assess and down-select one or two concrete suction anchor concepts
  - Identify risks and benefits for the concrete torpedo anchor concepts with the project team member and project advisors
  - Assess suitability for the California WEAs

  - Down-select one or two suction anchor concepts for further development
- Perform preliminary sizing of steel torpedo anchors, including but not limited to:
  - Preliminary size and weight estimate
  - Capacity and global strength analysis
  - Ballast supplier survey and cost estimates
  - Structural arrangement drawing and weight estimate
  - Pad eye configuration development
  - Fabrication cost estimate
- Perform conceptual design, preliminary sizing, and analysis of one to four concrete torpedo anchor concepts, including but not limited to:
  - Torpedo anchor size and configuration estimates
  - Capacity and global strength analysis
  - Conceptual concrete member design
  - Pad eye configuration development
  - Fabrication cost estimation
- Assess and down-select one or two concrete torpedo anchor concepts
  - Identify risks and benefits for the concrete torpedo anchor concepts with the project team members and project advisors
  - Assess suitability for the California WEAs
  - Down-select one or two torpedo anchor concepts for further development
- Perform preliminary installation engineering for California's deepwater installation sites including but not limited to:
  - Determine installation vessel requirements
  - Generate preliminary deck layouts
  - Develop method statements describing installation sequences
  - Identify needed tools, rigging and installation aides
  - Develop installation time estimates and schedule
  - Develop total installed cost estimates
  - Evaluate risks and cost saving opportunities
- Prepare a draft *Suction and Torpedo Anchor Pre-FEED Report* including but not limited to (for all anchor types):
  - Anchor design specifications
  - Fabrication cost estimates
  - Installation requirements, risks, and cost-saving opportunities
  - Total installed cost estimates
- Consult with TAC on draft *Suction and Torpedo Anchor Pre-FEED Report* to verify technical feasibility in accordance with subtask 1.10 (Technical Advisory Committee). Incorporate TAC feedback into the final *Suction and Torpedo Anchor Pre-FEED Report* as appropriate
- Submit the draft *Suction and Torpedo Anchor Pre-FEED Report* to the CAM for feedback and incorporate changes as requested in the final *Suction and Torpedo Anchor Pre-FEED Report*

Products:

- Suction and Torpedo Anchor Pre-FEED Report (Draft and Final)

TASK 4 PROOF-OF-CONCEPT ADDITIVE MANUFACTURING OF DOWN-SELECTED SUCTION ANCHORS AND TORPEDO ANCHORS AT SCALES UP TO 1/2

The goal of this task is to assess the manufacturability of the down-selected concrete suction anchor and torpedo anchor concepts at approximate scales up to 1/2 to demonstrate the manufacturing technology, inform commercial manufacturing plans, and prepare for fabrication of specimens for laboratory structural testing.

The Recipient shall:

- Fabricate a subscale concrete suction anchor using additive manufacturing (combined 3D concrete printing and automated shotcreting)
- Fabricate a subscale concrete torpedo anchor using additive manufacturing (3D concrete printing and casting into 3D printed molds)
- Prepare a *Proof-of-Concept Anchor Manufacturing Report* including but not limited to:
    - Description of the proof-of-concept anchor designs
    - Manufacturing methods and equipment
    - Quality assessment of printed anchors
    - Photographs of printed anchors
    - Recommendations on fabrication of structural testing specimens
    - Recommendations on commercial manufacturability

Products:

- Proof-of-Concept Anchor Manufacturing Report

TASK 5 FRONT END ENGINEERING DESIGN OF CONCRETE SUCTION AND CONCRETE TORPEDO ANCHORS

The goal of this task is to advance the design of the down-selected concrete suction anchors and torpedo anchors from the Pre-FEED level to the FEED level to form the basis of detailed design and engineering.

The Recipient shall:

- Define more detailed load cases for the down-selected suction and torpedo anchors in the reference wind plant including but not limited to:
    - Handling and transportation loads
    - Installation loads
    - Service loads including storm events
    - Extraction loads
- Design and analyze the down-selected concrete suction anchor, including, but not limited to:

  - Perform detailed geotechnical design of suction anchor in representative soil type to determine anchor sizing and compare to preliminary design values
  - Perform structural analysis of the concrete suction anchor under embedment, service, and extraction loads.
  - Optimize design of anchor considering performance, installation, and handling constraints
- Design and analyze the down-selected concrete torpedo anchor, including, but not limited to:
  - Perform hydrodynamic modeling to predict speed and penetration depth of torpedo anchors
  - Optimize torpedo anchor design for material efficiency and performance by changing parameters including length, diameter, nose shape, number of fins, etc.
  - Perform detailed geotechnical design of torpedo anchor in representative soil type to determine anchor sizing and compare to preliminary design values
  - Perform structural engineering of anchor under embedment, service, and extraction loads
- Prepare a draft *Concrete Suction and Torpedo Anchor FEED Report* including but not limited to (for all anchor types):
  - Anchor design specifications
  - Fabrication cost estimates
  - Installation requirements, risks, and cost-saving opportunities
  - Total installed cost estimates
- Submit the draft *Concrete Suction and Torpedo Anchor FEED Report* to the CAM for feedback and incorporate changes as requested in the final *Anchor Design Report*
- Prepare and submit a *CPR Report #1* in accordance with subtask 1.3 (CPR Meetings)
- Participate in a CPR meeting

Products:

- Concrete Suction and Torpedo Anchor FEED Report (Draft and Final)
- CPR Report #1

TASK 6 CALIFORNIA CONCRETE ANCHOR MANUFACTURING PLANNING, PRODUCTION LAYOUT, AND COSTING

The goals of this task are to estimate the manufacturing costs of the down-selected concrete torpedo or suction anchors, and to analyze and assess the potential for their production in California ports.

The Recipient shall:

- Assess the commercial manufacturability of suction anchors and torpedo anchors using various additive construction methods including casting, shotcrete and 3D concrete printing
- Develop anchor manufacturing throughput targets for commercial offshore wind projects in California
- In consultation with the Technical Advisory Committee, choose either the suction or torpedo anchor that should be subjected to the manufacturing plant analysis
- Assess the production plant footprint needed for manufacturing of concrete anchors using each manufacturing method at required throughputs
- Estimate cost of commercial anchor manufacturing at one chosen California port site
- Assess ability of existing port infrastructure and upgrades needed for anchor manufacturing
- Discuss applicability of the manufacturing plan for the chosen anchor to the other anchor type
- Prepare an *Anchor Manufacturing Plan and Cost Report* which summarizes the production plant characteristics, cost estimates, port infrastructure assessment, and manufacturing plan.

Products:

- Anchor Manufacturing Plan and Cost Report

TASK 7 ASSESS ENVIRONMENTAL IMPACTS OF ANCHOR ALTERNATIVES

The goals of this task are to conduct a comparative desktop analysis of alternative anchoring design systems for floating wind platforms from publicly available data, evaluate the technical requirements for the proposed anchor design, and develop a mitigation plan for any negative impacts where design changes are not feasible.

The Recipient shall:

- Identify and evaluate commercially available anchoring systems.
- Determine the potential environmental impacts related to the commercially available anchoring systems. Impacts under analysis will include the review of potential effects on marine wildlife and habitat including but not limited to:
    - Installation noise
    - Benthic or habitat disturbances
    - Effects on marine biodiversity
    - Mammal entanglement
- Compare the proposed anchoring design to alternative anchoring designs and show how the innovation will reduce risk of environmental impacts.
- If practical, recommend potential design changes to reduce risk of environmental impacts and develop a mitigation plan for any negative impacts where design changes are not feasible.
- Prepare an *Environmental Impact and Mitigation Report* including but not limited to:
    - A baseline of current mooring and anchor technologies

  - Suggestions for potential design changes to reduce risk of environmental impacts
  - Proposed methods of mitigation for any negative impacts where design changes are not feasible

Products:

- Environmental Impact and Mitigation Report

TASK 8 LIFECYCLE AND ECONOMIC BENEFIT ASSESSMENT OF ANCHORS

The goals of this task are to assess the lifecycle emissions impacts and economic impacts of the down-selected concrete suction anchor and torpedo anchors compared to the reference steel anchors.

The Recipient shall:

- Develop a framework for cradle-to-grave lifecycle assessment of anchors for California offshore wind plants
- Compile inputs for lifecycle assessment of conventional anchors and the proposed anchor technologies, including but not limited to:
  - Bill of materials for each anchor type
  - Representative material fabrication location
  - Representative anchor manufacturing site
  - Reference wind plant location
  - Material emission factors
  - Service lifetime
  - Decommissioning approach
- Conduct a comparative cradle-to-grave lifecycle assessment of anchor technologies including but not limited to:
  - Steel suction anchors
  - Steel torpedo anchors
  - Drag embedment anchors
  - Gravity anchors
  - Concrete suction anchors
  - Concrete torpedo anchors
- Analyze the sensitivity of the calculated lifecycle global warming potential of concrete suction anchors and concrete torpedo anchors to parameters including but not limited to:
  - Material emission factors
  - % Local/imported material content
  - Decommissioning/end-of-life scenarios
  - Transportation distances
  - Installation time
- Conduct a regional and statewide economic impact assessment of offshore wind anchors using NREL's Jobs and Economic Development Impact (JEDI) model.

  - Estimate number of jobs created using conventional concrete casting and automated concrete additive manufacturing technologies
  - Assess economic impacts of steel suction anchors and torpedo anchors
  - Assess opportunities to leverage regional and California supply chains for manufacturing of concrete suction anchors and torpedo anchors
  - Consider anchor manufacturing locations in Northern California, Southern California, and the Central Coast
  - Perform sensitivity analysis to input parameters such as local content %
- Prepare a draft *Lifecycle and Economic Assessment Report* that includes, but is not limited to:
  - Lifecycle assessment study assumptions and methodology
  - Lifecycle assessment results and discussion
  - Recommendations for lifecycle impact reductions and future study
  - A description of economic assessment methodology and assumptions
  - Calculated statewide and regional economic benefits
  - Recommendations for maximizing economic benefits of anchor manufacturing
- Submit the draft *Lifecycle and Economic Assessment Report* to the CAM for feedback and incorporate changes as requested in the final *Lifecycle and Economic Assessment Report*.

Products:

- Lifecycle and Economic Assessment Report (Draft and Final)

TASK 9 MATERIAL PROPERTY CHARACTERIZATION, PENETRATION, AND PULLOUT TESTING

The goal of this task is to plan and perform subscale structural and geotechnical testing of the down-selected concrete suction anchors and torpedo anchors to de-risk critical aspects of their structural design and geotechnical performance modeling.

The Recipient shall:

- Plan structural and geotechnical testing of concrete suction anchors and torpedo anchors to mitigate risks in anchor design and performance
- Prepare a *Structural and Geotechnical Testing Plan* that describes:
  - Test objectives
  - Procedures
  - Material properties of cast and placement conditions
  - Soil conditions representative of the two WEAs
  - Facilities and equipment
- Fabricate test articles per the *Structural and Geotechnical Testing Plan*
  - Complete structural testing of suction anchors and torpedo anchors per the *Structural and Geotechnical Testing Plan*
  - Characterize small-scale suction anchor and torpedo anchor to be used in the geotechnical centrifuge testing

- Complete geotechnical testing of suction anchors and torpedo anchors per the *Structural and Geotechnical Testing Plan*
    - Materials testing (soils, interfaces)
    - Centrifuge penetration testing of suction anchor at slow rates followed by pullout at different orientations
    - Centrifuge penetration testing of torpedo pile at high speed followed by pullout at different orientations
- Prepare a draft *Structural and Geotechnical Testing Report* including but not limited to:
    - Description of test procedures, facilities and equipment, and instrumentation
    - Test results
    - Data analysis and findings, including validation of designs and simulations with experimental results and synthesis into design charts
    - Recommendations for future testing
- Submit the draft *Structural and Geotechnical Testing Report* to the CAM for feedback and incorporate changes as requested in the final *Structural and Geotechnical Testing Report*
- Prepare and submit a *CPR Report #2* in accordance with subtask 1.3 (CPR Meetings)
- Participate in a CPR meeting

Products:

- Structural and Geotechnical Testing Plan
- Structural and Geotechnical Testing Report (Draft and Final)
- CPR Report #2

TASK 10 PLAN CONCRETE ANCHOR QUALIFICATION, STRUCTURAL TESTING, AND OCEAN TESTING

The goals of this task are: (1) down-select either the concrete suction anchor or torpedo anchor to continue development, (2) develop a qualification plan for the anchor, and (3) plan up to 1/2 scale structural testing.

The Recipient shall:

- Summarize and review project findings with the Technical Advisory Committee and the CAM
- Down-select either the concrete torpedo anchor or concrete suction anchor for qualification planning and structural testing
- Develop a qualification plan for the selected anchor
- Plan large scale (up to 1/2) laboratory structural testing of the selected anchor.
- Prepare an *Anchor Qualification and Large-Scale Testing Plan* including but not limited to:
    - Description of test objectives
    - Test procedures, facilities and equipment, and instrumentation required

- Test budget
- Test schedule

Products:

- Anchor Qualification and Large-Scale Testing Plan

TASK 11 DESIGN, FABRICATE, AND STRUCTURALLY TEST A 1/2 SCALE ANCHOR

The goal of this task is to design, fabricate, and structurally test the selected anchor.

The Recipient shall:

- Design the selected-concrete-anchor test article for structural testing at up to 1/2 scale.
- Fabricate the selected-concrete-anchor prototype at up to 1/2 scale. Structurally test the selected-concrete-anchor according to the Anchor Qualification and Large-Scale Testing Plan
  - Component testing of anchor (padeye connection for suction anchor or padeye connection and fin connection for torpedo pile)
  - Structural testing under simulated restrained conditions
- Prepare an *Anchor Structural Testing Report* including but not limited to:
  - Anchor structural and prototype designs
  - Expected anchor performance metrics
  - Photographs and description of printed anchor prototypes

Products:

- Anchor Structural Testing Report

TASK 12 FABRICATE A 2/3 SCALE PROTOTYPE ANCHOR

The goal of this task is to fabricate a large anchor prototype at up to 2/3 scale to further de-risk the anchor fabrication process for subsequent testing after the project.

The Recipient shall:

- Plan ocean testing of selected anchor at up to 2/3 scale
- Design the selected concrete anchor prototype at up to 2/3 scale
- Fabricate the selected concrete anchor prototype at up to 2/3 scale
- Prepare a *Large-Scale Anchor Prototype Report* including but not limited to:
  - Anchor structural and prototype designs
  - Expected anchor performance metrics
  - Photographs and description of printed anchor prototypes

Products:

- Large-Scale Anchor Prototype Report

TASK 13 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 at 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 14 TECHNOLOGY/KNOWLEDGE TRANSFER ACTIVITIES

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

- Scale-up analysis including manufacturing analysis, independent design verification, and process improvement efforts.

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

The Recipient Shall:

- Develop and submit a *Technology Transfer Plan* that identifies the proposed activities the recipient will conduct to accelerate the successful commercial adoption of the technology.
- Present the draft *Technology Transfer Plan* to the TAC for feedback and comments.
- Develop and submit a *Summary of TAC Comments* that summarizes comments received from the TAC members on the Draft Technology Transfer Plan. This document will identify:
  - TAC comments the recipient proposes to incorporate into the final *Technology Transfer Plan*.
  - TAC comments the recipient does not propose to incorporate with and explanation why.
- Submit the final *Technology Transfer Plan* to the CAM for approval.
- Implement activities identified in final *Technology Transfer Plan*.
- Develop and submit a *Technology Transfer Summary Report* that includes high level summaries of the activities, results, and lessons learned of tasks performed relating to implementing the Final Technology Transfer Plan. This report should not include any proprietary information.
- When directed by the CAM, develop presentation materials for an CEC-sponsored conference/workshop(s) on the project.
- 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

EXHIBIT A
Scope of Work
RCAM Technologies, Inc.

Please see the attached Excel spreadsheet.