



**CALIFORNIA
ENERGY COMMISSION**



**California Energy Commission
July 26, 2023 Business Meeting
Backup Materials for Agenda Item No 11c:
Alliance for Sustainable Energy, 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

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION: Alliance for Sustainable Energy, 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-23-008 with Alliance for Sustainable Energy, LLC, as the manager and operator for the National Renewable Energy Laboratory, for a \$2,560,000 grant to fund the development of comprehensive shared-mooring solutions for floating offshore wind turbines that minimize the cost, risk, and footprint of gigawatt-scale floating wind farms in California conditions; and

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

CERTIFICATION

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

AYE:

NAY:

ABSENT:

ABSTAIN:

Dated:

Kristine Banaag
Secretariat



GRANT REQUEST FORM (GRF)

A. New Agreement Number

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

New Agreement Number: EPC-23-008

B. Division Information

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

C. Recipient's Information

1. Recipient's Legal Name: Alliance for Sustainable Energy, LLC
2. Federal ID Number: 44-0545878

D. Title of Project

Title of project: Comprehensive Shared-Mooring Solutions to Minimize the Cost, Risk, and Footprint of GW-Scale Floating Wind Farms

E. Term and Amount

1. Start Date: 8/1/2023
2. End Date: 3/31/2027
3. Amount: \$2,560,000.00

F. Business Meeting Information

1. Are the ARFVTP agreements \$75K and under delegated to Executive Director? No
2. The Proposed Business Meeting Date: 7/12/2023 .
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: Enter the email subscription topic name.

Agenda Item Subject and Description:

Alliance for Sustainable Energy, LLC. Proposed resolution approving agreement EPC-23-008 with Alliance for Sustainable Energy, LLC, as the manager and operator for the National Renewable Energy Laboratory, for a \$2,560,000 grant to fund the development of comprehensive shared-mooring solutions for floating offshore wind turbines that minimize the cost, risk, and footprint of gigawatt-scale floating wind farms in California conditions, and adopting staff's determination that this project is exempt from CEQA. (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 technical research of shared mooring line configurations for floating offshore wind farms in California and wave basin testing in existing facilities out of state. 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.

Additionally, Cal. Code Regs. tit. 14, sect. 15306 applies, because this project also involves basic data collection, research, experimental management, and resource evaluation activities which do not result in serious or major disturbance to an environmental resource.

The project will not impact an environmental resource of hazardous or critical concern where designated, precisely mapped, and officially adopted pursuant to law by federal, state, or local agencies; does not involve any cumulative impacts of successive projects of the same type in the same place that might be considered significant; does not involve unusual circumstances that might have a significant effect on the environment; will not result in damage to scenic resources within a highway officially designated as a state scenic highway; the project site is not included on any list compiled pursuant to Government Code section 65962.5; and the project will not cause a substantial adverse change in the significance of a historical resource. Therefore, none of the exceptions to categorical exemptions listed in



CEQA Guidelines section 15300.2 apply to this project, and this project will not have a significant effect on the environment.

b) Agreement **IS NOT** exempt.

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

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
Principle Power Inc.	\$ 464,839	\$93,073
Delmar Systems, Inc.	\$ 296,400	\$118,400
University of Iowa	\$ 211,971	\$49,294
Humboldt State University Sponsored Programs Foundation	\$ 138,762	\$18,679
Triple HS, Inc. d.b.a. H. T. Harvey & Associates	\$ 99,997	\$20,496
American Bureau of Shipping	\$ 70,000	\$7,000
Texas A&M University	\$ 75,000	\$7,500
Qualisys Cameras		\$49,294

I. Vendors and Sellers for Equipment and Materials/Miscellaneous

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

Vendor/Seller Legal Company Name	CEC Funds	Match Funds
No vendors to report	\$	\$

J. Key Partners



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

Key Partner Legal Company Name
No key partners to report

K. Budget Information

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

Funding Source	Funding Year of Appropriation	Budget List Number	Amount
EPIC	21-22	301.001I	\$ 2,560,000

TOTAL Amount: \$ 2,560,000

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: Erin Hensley

Address: 15013 Denver West Pkwy

City, State, Zip: Golden, CO 80401-3111

Phone: 303-384-7989

E-Mail: erin.hensley@nrel.gov

3. Recipient's Project Manager

Name: Matthew Hall

Address: 15013 Denver West Pkwy

City, State, Zip: Lakewood, CO 80401-3111

Phone: 720-364-0424

E-Mail: matthew.hall@nrel.gov

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: Chuck Gentry

Approval Date: 6/2/2023

Branch Manager: Kevin Uy

Approval Date: 6/2/2023

Director: Delegated to Branch Manager

Approval Date: 6/2/2023

Exhibit A
Scope of Work Template
Alliance for Sustainable Energy, LLC

I. TASK ACRONYM/TERM LISTS

A. Task List

Task #	CPR ¹	Task Name
1		General Project Tasks
2		Design Basis
3		Conceptual Design Advancement
4	X	Feasibility and Acceptability Considerations
5		Design Convergence and Refinement
6		Reliability Analysis and Improvement
7		Economic and Environmental Evaluation
8		Evaluation of Project Benefits
9		Technology/Knowledge Transfer Activities

B. Acronym/Term List

Acronym/Term	Meaning
ABS	American Bureau of Shipping
AIP	Approval in Principle
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CEC	California Energy Commission
CPR	Critical Project Review
FAD	Fish Aggregating Device
FLORIS	FLOW Redirection and Induction in Steady State - wake modeling and wind farm controls software
GW	Gigawatt
IEA	International Energy Agency
LCOE	Levelized Cost of Energy
MW	Megawatt
NOWRDC	National Offshore Wind Research and Development Consortium
Recipient	Alliance for Sustainable Energy, LLC
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.

Exhibit A
Scope of Work Template
Alliance for Sustainable Energy, LLC

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

A. Purpose of Agreement

The purpose of this Agreement is to develop a comprehensive shared-mooring solutions that minimizes the cost, risk, and footprint of Gigawatt (GW)-scale floating wind farms in California conditions.

B. Problem/ Solution Statement

Problem

Floating wind farms typically secure each wind turbine with three or more mooring lines and anchors. The 500-1300 meter water depths in California offshore wind lease areas require longer mooring lines to reach the seabed. This increases the material use, cost, and footprint size of the mooring system. Spacing requirements can also result in fewer turbines fitting within a lease area. These efficiency and spacing challenges directly affect the cost and spatial feasibility of achieving California's offshore wind targets.

Safety and reliability of floating wind farm mooring systems is a key concern. With hundreds of mooring lines and anchors, safe and efficient maintenance approaches are essential. The overall installation must be resilient to the risk of seismic activity in California, which can cause anchors to shake, displace, or come loose. Lastly, the mooring systems must be designed to minimize potential environmental impacts related to seabed disturbance and marine mammal entanglement.

Solution

The Recipient has developed a mooring technology concept that strategically combines shared mooring lines and shared anchors with installation and maintenance innovations to achieve significant reductions in mooring system costs, failure risks, and environmental impact metrics. This project will advance this shared-mooring technology concept through modeling and lab testing to produce a comprehensive solution to the aforementioned mooring challenges.

The central innovation of the proposed technology is the use of specific shared-mooring configurations that achieve improved material and cost efficiency in deep water while simultaneously increasing system resilience against localized failures. These configurations can enable mooring cost reductions on the order of 40% yet provide a level of redundancy against localized mooring or anchoring failures. In addition, installation and maintenance innovations will be matched with the unique properties of shared mooring systems to minimize vessel and infrastructure demands, thus significantly reducing operations and maintenance costs. These benefits will be achieved by following a comprehensive design development process that includes insights from a range of technology experts as well as guidance from specialists in regional constraints, stakeholder priorities, and environmental impact concerns. The

Exhibit A
Scope of Work Template
Alliance for Sustainable Energy, LLC

resulting mooring design solutions, which will be made publicly available, will comprehensively address the challenges of mooring GW-scale floating wind farms in California site conditions.

Advancing this technology with rigorous design, analysis, experimental validation, and optimization processes will deliver a breakthrough in mooring system efficiency and resilience. The resulting mooring solutions will thereby overcome cost, feasibility, and reliability barriers to achieving the state's offshore wind energy targets.

C. Goals and Objectives of the Agreement

Agreement Goals

The goals of this Agreement are to:

- Design a shared mooring system for a GW-scale floating wind farm in California lease area site conditions that minimizes costs, failure risks, and environmental impacts.
- Follow a comprehensive design process that integrates mooring design and logistics analysis with a wide range of additional considerations including local infrastructure projections, diverse stakeholder input, and expert environmental impact guidance.
- Demonstrate and validate through modeling and lab testing, the synergistic benefits of combining shared mooring line and shared anchor techniques to simultaneously increase mooring system efficiency and resilience to anchoring disruptions and failures.
- Demonstrate through modeling installation and maintenance innovations for shared mooring systems that can reduce vessel and infrastructure demands and overall operating costs.
- Characterize stakeholder concerns and environmental impact metrics specific to offshore wind mooring systems in California and demonstrate environmental benefits of shared mooring systems.

Ratepayer Benefits:² This Agreement will result in the ratepayer benefits of lower costs and greater electricity reliability.

California's offshore wind targets of 2–5 GW by 2030 and 25 GW by 2045 set the stage for a significant portion of California's electricity supply to come from floating wind farms in the next two decades. The mooring innovations in this project offer reductions in these wind farms' levelized cost of energy by (1) maximizing power generation by

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).

Exhibit A
Scope of Work Template
Alliance for Sustainable Energy, LLC

allowing more wind turbines to be fit within a given lease area, (2) reducing up-front material and installation costs for mooring systems (estimated at 5% of Levelized Cost of Energy (LCOE)), (3) reducing operations and maintenance costs for mooring systems, and (4) improving reliability by reducing turbine downtime due to mooring system failures or operations and maintenance.

The redundancy and resilience inherent in the mooring system designs will also provide greater reliability in electricity generation by reducing the potential of individual failures to cascade into larger failures that disrupt overall production of a wind farm. Unlike most floating wind mooring systems deployed to date, the proposed mooring technology will make it possible for all turbines in an array to continue power production even when one mooring line or anchor fails. This characteristic is beneficial to any wind farm and especially valuable in California where seismic risks increase the probability of anchoring disruptions.

Technological Advancement and Breakthroughs: 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 a comprehensive shared mooring system solution that minimizes costs, failure risks, and environmental impacts. The core technology innovation is the strategic use of shared mooring lines and shared anchors, combined with innovative installation and maintenance techniques—all optimized for the specific conditions of California offshore wind areas. The combined expertise and constituent technologies of the project team will enable a breakthrough in simultaneously improving mooring system efficiency and resilience for California conditions.

Agreement Objectives

The objectives of this Agreement are to:

- Design a shared mooring system for a GW-scale floating wind farm in California lease area site conditions that meets American Bureau of Shipping (ABS) design guidelines. This performance will be checked by coupled loads analysis using state-of-the-art simulation tools.
- Validate performance predictions of the shared mooring system through scaled wave basin testing of a representative portion of the design.
- Develop installation and maintenance methods for the shared mooring system design that reduce vessel operations by 50% relative to conventional designs and methods.
- Assess risks and resiliency of the shared mooring system design and demonstrate “redundant” behavior to mooring line and anchor failures through modeling and scaled wave basin testing.
- Obtain Approval in Principle of the design from the ABS.
- Assess costs of the shared mooring system design and demonstrate 40% reduction in combined component, installation, and maintenance costs compared to a baseline non-shared mooring system design.

Exhibit A
Scope of Work Template
Alliance for Sustainable Energy, LLC

- Assess potential environmental impacts of the shared mooring system design and demonstrate 50% overall reduction in environmental impact metrics compared to a baseline non-shared mooring system design.

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:

Exhibit A
Scope of Work Template
Alliance for Sustainable Energy, LLC

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

Exhibit A
Scope of Work Template
Alliance for Sustainable Energy, LLC

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*.

Exhibit A
Scope of Work Template
Alliance for Sustainable Energy, LLC

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.

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Scope of Work Template
Alliance for Sustainable Energy, LLC

- 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.

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Alliance for Sustainable Energy, LLC

- Prepare a *Final Meeting Agreement Summary* that documents any agreement made between the Recipient and Commission staff during the meeting.
- Prepare a *Schedule for Completing Agreement Closeout Activities*.
- Provide copies of *All Final Products* on a USB memory stick, organized by the tasks in the Agreement.

Products:

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

REPORTS AND INVOICES

Subtask 1.5 Progress Reports and Invoices

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

The Recipient shall:

- Submit a monthly *Progress Report* to the CAM. Each progress report must:
 - Summarize progress made on all Agreement activities as specified in the scope of work for the preceding month, including accomplishments, problems, milestones, products, schedule, fiscal status, and an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. See the Progress Report Format Attachment for the recommended specifications.
- Submit a monthly or quarterly *Invoice* that follows the instructions in the “Payment of Funds” section of the terms and conditions, including a financial report on Match Funds and in-state expenditures.

Products:

- Progress Reports
- Invoices

Subtask 1.6 Final Report

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

Subtask 1.6.1 Final Report Outline

The Recipient shall:

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

Exhibit A
Scope of Work Template
Alliance for Sustainable Energy, LLC

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.

Exhibit A
Scope of Work Template
Alliance for Sustainable Energy, LLC

- 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

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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

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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:

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- 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.

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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.

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- 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

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IV. TECHNICAL TASKS

TASK 2 DESIGN BASIS

The goal of this task is to set up the basic floating wind turbine design and to gather and organize the relevant site conditions—all of which will be used as the basis for designing shared mooring solutions and evaluating their performance.

Subtask 2.1 Baseline Floating Wind Turbine Design

The goals of this subtask are to set up the design model of the floating wind turbine system, which will be the International Energy Agency (IEA) 15 MW reference turbine on an upscaled three-column semisubmersible platform, and to provide an initial baseline mooring system design with individual mooring lines, representative of a conventional non-shared mooring approach to serve as a basis for comparison.

The Recipient shall:

- Upscale the INO WINDMOOR 12 MW semisubmersible floating wind turbine platform design to support the IEA 15 MW reference turbine.
- Create initial designs for the mooring lines and dynamic power cables of the upscaled platform in 600-meters water depth by adapting designs from the ongoing Floating Wind Array Design project and the completed Shared Mooring Systems for Deep-Water Floating Wind Farms project.
- Integrate this upscaled platform design with the IEA 15 MW reference turbine in the Recipient's simulation tools (OpenFAST and RAFT) and organize the associated input files to be uploaded to a publicly available repository.
- Provide a *Notification of Baseline Floating Wind Turbine Design Files Upload* to the CAM.

Products:

- Notification of Baseline Floating Wind Turbine Design Files Upload

Subtask 2.2 Site and Regional Conditions

The goal of this subtask is to establish the site-specific information upon which to base the subsequent design development of shared-mooring and shared-anchor configurations.

The Recipient shall:

- Consult with the project team, TAC, and CAM to select the area of focus for the design effort (for example, Northern California lease area OCS-P0651).
- Compile time-series and statistical data on site metocean conditions that can be used for subsequent loads analyses, energy production analyses, and logistics simulations using existing data sources (e.g., ERA5 hindcast data).
- Gather available spatial information including bathymetry, seismic activity, vessel activity, marine ecosystem data, fishing activity, and lease area boundaries into a

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common geographic information systems (GIS) realization for use in subsequent design activities.

- Gather and interpret available soil information for California lease areas to create summary maps that categorize soil type with respect to anchoring compatibility. This effort will use soil geotechnical profile information where available and use generic site-appropriate soil profiles where data is unavailable.
- Identify applicable stakeholder groups relevant to mooring design choices, such as fishing, Coast Guard, environmental organizations, and local supply chain.
- Conduct a literature review and hold consultation meetings with experts about potential interactions between mooring systems and species/habitats of concern, focusing on effects to the benthic (e.g., anchor disturbance) and photic zone (e.g., mooring colonization, Fish Aggregating Device (FAD) effect), and the effects of construction and operations on marine mammals and sea turtles, including noise and secondary entanglement.
- Prepare a draft *Design Basis Report* which includes overviews and methodological summaries of the efforts in this Task, including but not limited to:
 - Selected site for further project study.
 - Wind, wave, and current conditions at the site.
 - Extreme condition statistics (storm conditions at different return periods) at the site.
 - Seabed description including bathymetry and soil information at the site.
 - Seismic activity as relevant to anchor holding capacity risks at the site.
 - Available data on stakeholders and other ocean users including fishing types/locations, shipping, and other vessel traffic in the vicinity of the site.
 - Environmental interactions literature review with spatial summary images.
 - Baseline floating wind turbine design (developed in Subtask 2.1)
- Submit the draft *Design Basis Report* to the CAM for feedback and incorporate changes as requested in the final *Design Basis Report*.

Products:

- Design Basis Report (draft and final)

TASK 3 CONCEPTUAL DESIGN ADVANCEMENT

The goal of this task is to explore a range of design options for shared-mooring and shared-anchor configurations and advance the understanding of these options so that the best configurations for California lease areas can be identified.

Subtask 3.1 Design Methods for Large-Scale Shared Moorings

The goal of this subtask is to configure the Recipient's design tools for shared-mooring floating wind turbine arrays to support GW-scale arrays for systematic design exploration.

The Recipient shall:

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- Expand existing methods for conceptual design of shared-mooring systems to support GW-scale wind farm sizes, including the following capabilities:
 - Scalable evaluation of shared mooring system quasi-static response and natural frequencies/modes by analyzing repeated “unit cells”.
 - Evaluation of shared anchor configuration suitability over varying depths and bathymetric contours with estimation of multidirectional anchoring demands.
 - Simplified evaluation of array-level failure risks, including cascading failures.
 - Estimation of system cost.
 - Quantification of preliminary environmental impact metrics (i.e., anchor footprint area, seabed contact area, and suspended mooring line length).
- Describe the conceptual design tool improvements in a *Design Methods for GW-Scale Shared Mooring Systems Summary Report*.

Products:

- Design Methods for GW-Scale Shared Mooring Systems Summary Report

Subtask 3.2 Installation and Maintenance Innovations

The goals of this subtask are to (1) set up models for installation and maintenance operations as relevant to different mooring system options and (2) represent innovative marine operations methods so that these methods can be assessed within the design loop.

The Recipient shall:

- Set up spreadsheet-level models for calculating mooring component costs, installation requirements (e.g. vessel types and times), and staging requirements (e.g. port space), which can be applied to any mooring design.
- Characterize the available installation and maintenance innovations (e.g. use of connectors to reduce vessel needs, wet storage of replacement parts) and expand the spreadsheet-level models with these options for applicable scenarios.
- Update the computational design methods established in Subtask 3.1 to include the spreadsheet-level models.
- Prepare *Shared Mooring System Installation and Maintenance Spreadsheets* containing the final modeling assumptions for mooring component costs, and requirements for installation, staging, and maintenance, including innovations.

Products:

- Shared Mooring System Installation and Maintenance Spreadsheets

Subtask 3.3 Conceptual Design Exploration and Evaluation

The goal of this subtask is to identify and evaluate the most promising large-scale shared-mooring topology options using the methods set up in the previous subtasks.

The Recipient shall:

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- Explore and evaluate the conceptual design options for floating wind farms of 30 to 100 turbines.
- Incorporate additional considerations and constraints into the conceptual design evaluation scripts so that these considerations and constraints can be factored into conceptual design decisions. This step is timed to coincide with the completion of requisite outputs of other subtasks and will consider the following aspects at a preliminary level:
 - Spreadsheet-level models cost/logistics models from subtask 3.2,
 - Infrastructure and supply chain constraints from Subtask 4.1,
 - Stakeholder priority metrics from Subtask 4.2,
 - Environmental impact metrics from Subtask 4.3.
- Update and evaluate the design concepts based on preliminary constraints.
- Prepare a *Conceptual Designs Comparison Summary Report* that presents the conceptual designs and provides high-level comparisons of their metrics

Products:

- Conceptual Designs Comparison Summary Report

TASK 4 FEASIBILITY AND ACCEPTABILITY CONSIDERATIONS

The goal of this task is to characterize the feasibility and acceptability factors that need to be accounted for in order for a mooring design to be feasible for the regional supply chain and acceptable to local stakeholders. These factors will be distilled into specific weightings and constraints for use in the design effort. This Task occurs in parallel with Task 3 so that preliminary factors from Task 4 can be considered during the design exploration of Subtask 3.3.

Subtask 4.1 Local Infrastructure and Supply Chain

The goal of this subtask is to gather information about the supply chain and local infrastructure capacities as relates to the feasibility of different mooring system designs.

The Recipient shall:

- Collect information about supply chain capacities from the Recipient-led National Offshore Wind Research and Development Consortium (NOWRDC) “Standardized Scalable Mooring Solutions Optimized for the US Supply Chain” project and extrapolate to understand supply chain factors specific to shared mooring configurations.
- Collect port information from the Recipient-led West Coast Ports Strategy Study project, as well as other relevant studies and analyses on West Coast ports (e.g. AB 525 California ports study) and expand on details specific to mooring system design options.
- Synthesize a quantitative summary of the available infrastructure and supply chain capacities for mooring system installation and maintenance (e.g. capacities of ports, marshalling yards, vessels) and the projected growth over 10 years.

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- Prepare a *Local Infrastructure and Supply Chain Summary Report* describing the assembled capacity information and projections as relevant to mooring systems.

Products:

- Local Infrastructure and Supply Chain Summary Report

Subtask 4.2 Stakeholder Priorities

The goal of this subtask is to gather information about the local stakeholders including existing ocean users and nearby communities to be used to understand the impacts that different mooring system designs could have.

The Recipient shall:

- Convene feedback meetings of stakeholder groups identified in Subtask 2.2 to present baseline and conceptual floating wind turbine mooring system information in order to obtain stakeholder feedback including comparative rankings.
- Perform an analysis of stakeholder concerns and ratings including a matrix with categorizations and weightings describing the level of importance of different factors and the level of acceptability of different design options.
- Prepare a *Stakeholder Considerations on Mooring Systems in California Summary Report* that describes the analysis.

Products:

- Stakeholder Considerations for Mooring Systems in California Summary Report

Subtask 4.3 Environmental Impact Metrics

The goal of this subtask is to gather information about the local ecosystem, existing ocean users, and nearby communities to be used to understand the impacts that different floating wind farm designs could have on the local environment and stakeholders.

The Recipient shall:

- Develop a mooring and anchoring environmental evaluation framework using criteria (quantitative where possible) based on findings from the interactions overview in Subtask 2.2. The framework will be used to compare potential interactions of different mooring and anchoring scenarios. Criteria will be based on likely interactions, including noise, benthic disturbance, colonization and aggregation effects, entanglement risks, and avoidance effects.
- Prepare an *Evaluation Framework for Mooring System Environmental Interactions Summary Report* including a matrix of considerations from each area with rankings for severity and top sensitivities identified.
- Prepare a *CPR Report* and participate in CPR meeting per subtask 1.3.

Products:

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- Evaluation Framework for Mooring System Environmental Interactions Summary Report
- CPR Report

TASK 5 DESIGN CONVERGENCE AND REFINEMENT

The goal of this task is to combine the methods and resources developed earlier in the project to advance and optimize the conceptual designs.

Subtask 5.1 Shared Mooring Topology Selection

The goal of this subtask is to use the design evaluations from Subtask 3.3 and the considerations from Task 4 to select the conceptual designs that give the greatest reduction of cost, risk and footprint.

The Recipient shall:

- Select the conceptual designs based on the criteria identified in Task 3 and application of the considerations identified in Task 4.
- Present the recommended concepts to the CAM, project partners, and TAC to receive feedback.
- Create a final selection of conceptual designs.
- Describe these designs and the rationale for selection in a *Conceptual Design Selection Summary Report*.

Products:

- Conceptual Design Selection Summary Report

Subtask 5.2 Design Workflow Integration

The goal of this subtask is to create an integrated workflow for loads analysis and refinement of the conceptual shared-mooring designs. The main effort is to bring together the Recipient's models and optimization tools with proven mooring design procedures to combine both theoretical and industrial best practices for design.

The Recipient shall:

- Hold an internal workshop with project partners to compare mooring design workflows and identify best practices for large-scale shared-mooring applications.
- Expand the Recipient's shared-mooring design and optimization tools to include additional best practices contributed by Recipient's subcontractors.
- Prepare a *Shared Mooring System Design Workflow Document* that captures the combined recommendations of the Recipient and outlines the design and optimization methodologies implemented in Recipient's tools.

Products:

- Shared Mooring System Design Workflow Document

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Subtask 5.3 Shared Mooring System Design Development

The goal of this subtask is to apply the design workflow of Subtask 5.2 to the selected conceptual designs of Subtask 5.1, progressively advancing the level of design detail and narrowing down on the improved design characteristics. This process will involve coupled loads analysis in the FAST.Farm simulation tool.

The Recipient shall:

- Perform comparisons and iterations, as necessary, on the selected designs with the following general process each time:
 - Set up design with automated design optimization tools
 - Execute automated design optimization process
 - Analyze the design performance including FAST.Farm loads analysis, cost and logistics modeling, supply chain and maintenance constraints, and stakeholder and environmental impact metrics.
 - Consider results and make down selection or design adjustment decisions.
- Create a *Shared Mooring System Design Description Document* detailing the resulting design from the completion of the process.

Products:

- Shared Mooring System Design Description Document

Subtask 5.4 Stakeholder Feedback and Design Refinement

The goal of this subtask is to receive feedback on the developed designs from stakeholders and make design adjustments to improve the designs' suitability.

The Recipient shall:

- Provide an update presentation to stakeholders previously engaged in Subtask 4.2 to share information about key aspects of the solutions being developed.
- Obtain stakeholder feedback and organize feedback into a summary document.
- Complete an additional design iteration in response to accepted points of feedback, producing an update of the design relative to the end of Subtask 5.3.
- Prepare a *Preliminary Shared Mooring System Design Report* detailing the updated design and summarizing the design process, including:
 - Conceptual design selection
 - Design workflow
 - Design development and convergence process
 - Loads analysis, performance, cost models
 - Stakeholder feedback and resulting design adjustments
 - Preliminary design description and performance results

Products:

- Preliminary Shared Mooring System Design Report

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TASK 6 RELIABILITY ANALYSIS AND IMPROVMENT

The goal of this task is to experimentally validate the design performance, assess the associated risks of the design, and make responsive design improvements that achieve identified reliability targets in the final design.

Subtask 6.1 Wave Basin Test

The goal of this subtask is to validate the design behavior using a scale-model wave basin test and to check for performance in extreme waves. This will include specific validation on the effects of extreme waves propagating through the array.

The Recipient shall:

- Conduct a screening study to identify the most adverse wave conditions for the array design by manually simulating non-dispersive waves in FAST.Farm and identifying which heading causes the most severe response in the design.
- Prepare a *Wave Basin Test Plan* that subjects a representative portion of the array design (likely 4-6 turbines) to a range of operating and extreme wave conditions, including the identified worst-case non-dispersive wave scenario.
- Design and fabricate the experimental models, consisting of the following (or similar):
 - 4–6 floating platforms of the semisubmersible design established in Subtask 2.1 at approximately 1:100 scale with single-fan thrusters capable of providing the scaled rated thrust force of the IEA 15 MW wind turbine,
 - A 1:100 scale model of a portion of the shared mooring solution corresponding to 4–6 turbines with true-to-scale shared mooring lines and vertically truncated anchor lines that provide the same horizontal response.
- Execute the *Wave Basin Test Plan* at the wave basin
- Process the experimental results (floating platform and mooring system kinematics and select mooring line tensions) and compare with simulation results to validate simulation accuracy and identify any potential extreme responses caused by non-dispersive waves that were not predicted by the models.
- Prepare a *Wave Basin Testing and Validation Report* that describes the testing methodology, presents the above results, and discusses any implications for the design.

Products:

- Wave Basin Test Plan
- Wave Basin Testing and Validation Report

Subtask 6.2 Hazards Identification Workshop

The goal of this subtask is to broadly assess the risks associated with the shared mooring system design.

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The Recipient shall:

- Convene a hazards identification (HAZID) workshop for the initial design including a facilitator and scribe and subject matter experts from the review team of the design documentation.
- Prepare a *Shared Mooring System Hazards Identification Report* summarizing the workshop and a risk register of what should be addressed in Subtask 6.3 and follow-up work to ensure the resilience of the mooring system design.

Products:

- Shared Mooring System Hazards Identification Report

Subtask 6.3 Design Reliability Analysis and Optimization

The goal of this subtask is to refine the shared mooring design to ensure it achieves reliability targets based on the findings of Subtasks 6.1 and 6.2 and additional analysis.

The Recipient shall:

- Update numerical modeling assumptions based on results of the wave basin tests (6.1) to ensure the effects of extreme non-dispersive waves are captured.
- Analyze the system-level reliability of the mooring system design to confirm redundancy against all mooring failure points and characterize cascading failure risks and any other mooring failure-related hazards identified in the HAZID (6.2).
- Analyze the lifetime holding capacity of the anchors in the mooring system design using geotechnical models, accounting for calculated multidirectional loads, multiline trenching phenomena, and simplified liquefaction modeling.
- Adjust the mooring system design based on the updated modeling, system-level reliability analysis, and anchor geotechnical analysis to ensure all requirements are met and redundancy is achieved against all mooring system failure points.
- Prepare a *Final Mooring System Design Description and Reliability Report* that details the final mooring system design and the results of the reliability analyses.

Products:

- Final Mooring System Design Description and Reliability Report

Subtask 6.4 Design Review and Approval in Principle

The goal of this subtask is to obtain Approval in Principle (AIP) from ABS. It will provide a formal review of the entire design process including summation of smaller ABS reviews of each major step in the design process.

The Recipient shall:

- Convey all design information and results to ABS for review.
- Direct ABS to review all applicable design information including wave basin test results and evaluate the design to make a judgement on Approval in Principle. If Approval is granted, three products will be provided by ABS as follows:

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- *AIP Letter* attesting to feasibility of design and approval in principle granted as class issues are concerned, allowing project to move into next approval phase.
- *Approval Road Map*, outlining list of submittals and conditions to be satisfied (as identified in this phase) to achieve full class approval.
- *Approval in Principle Certificate*

Products:

- AIP Letter
- Approval Road Map
- Approval in Principle Certificate.

TASK 7 ECONOMIC AND ENVIRONMENTAL EVALUATION

The goal of this task is to broadly evaluate the final design to characterize the final design's benefits and drawbacks relative to conventional designs (i.e., not shared mooring line) as represented by the baseline design established in Subtask 2.1 in terms of cost, material use, environmental impact, etc.

Subtask 7.1 Economic Evaluation

The goal of this subtask is to evaluate the economic performance of the developed shared-mooring solution relative to conventional mooring options. This analysis will draw on the latest Recipients offshore wind techno-economic modeling including California-specific efforts within the Recipient's West Coast Ports Strategy Study and NOWRDC project "Standardized Scalable Mooring Solutions Optimized for the US Supply Chain".

The Recipient shall:

- Using the Recipient's models developed in Tasks 2-4, calculate the complete component and installation costs of the shared-mooring design and the baseline design from Subtask 2.1 and integrate into a full capital cost estimate.
- Using models developed in Subtask 3.2, estimate the full maintenance costs of the shared-mooring design and the baseline design and integrate these estimates into a full estimate of the floating wind farm's operations and maintenance costs.
- Analyze the cost and downtime implications of reduced mooring system failure probabilities due to improved resilience in the shared mooring design.
- Using information in the Jobs and Economic Development Impact (JEDI) model, evaluate the expected economic impacts from the shared-mooring design and baseline design, with sufficient resolution to identify specific benefits to disadvantaged and low-income communities.
- Perform an overall LCOE analysis using the abovementioned Recipient models as well as the FLORIS model for calculating annual energy production.

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- Prepare a *Mooring Design Economic Evaluation Report* (draft and final) detailing the cost and economic impact methodology and the resulting evaluation of the shared-mooring design and baseline design, including:
 - Capital costs
 - Operations and maintenance costs
 - Implications of reliability improvements
 - Benefits to disadvantaged and low-income communities
 - Overall LCOE analysis

Products:

- Mooring Design Economic Evaluation Report (draft and final)

Subtask 7.2 Environmental Evaluation

The goal of this subtask is to use the framework for environmental impacts developed in Subtask 4.3 to evaluate the final mooring and anchoring design scenarios and compare the effects of different mooring and anchoring scenarios on the potential for environmental interactions.

The Recipient shall:

- Evaluate the developed shared-mooring design and the baseline design from Subtask 2.1 using the framework from Subtask 4.3, quantifying (or qualifying where necessary) the performance of each design in each area of potential environmental impact identified in Subtask 4.3.
- Prepare a *Mooring Design Environmental Effects Evaluation Report* (draft and final) detailing the methodology developed in Subtask 4.3 and the resulting evaluation of the shared mooring system design and baseline mooring system design.

Products:

- Mooring Design Environmental Effects Evaluation Report (draft and final)

Subtask 7.3 Results Dissemination

The goal of this subtask is to prepare final peer-reviewed reports of the project's outcomes and publish the developed design definitions in open-source repositories.

The Recipient shall:

- Consolidate the modeling input files for the final shared mooring system design and upload files into a publicly available repository.
- Provide a *Notification of Shared Mooring Design Input Files Upload* to the CAM.
- Prepare a *Shared Mooring System Design Report* (draft and final) that describes the final shared mooring system design including the design methodology, performance results, and full description of the design.

Exhibit A
Scope of Work Template
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Products:

- Notification of Shared Mooring Design Input Files Upload
- Shared Mooring System Design Report (draft and final)

TASK 8: 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](http://www.energizeinnovation.fund) 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](http://www.energizeinnovation.fund) 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

Exhibit A
Scope of Work Template
Alliance for Sustainable Energy, LLC

TASK 9 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)

Exhibit A
Scope of Work Template
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- High Quality Digital Photographs

V. PROJECT SCHEDULE

Please see the attached Excel spreadsheet.