



**CALIFORNIA
ENERGY COMMISSION**



**California Energy Commission
November 12, 2025 Business Meeting
Backup Materials for Sofar Ocean 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

[PROPOSED]

RESOLUTION NO: 25-1112-XX

STATE OF CALIFORNIA

**STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION**

RESOLUTION: Sofar Ocean 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-25-038 with Sofar Ocean Technologies, Inc. for a \$2,993,427 grant. This project will develop and test a novel, multi-modal system for detecting entanglements in floating offshore wind infrastructure at pre-established test sites in the San Francisco Bay and off the coasts of Half Moon Bay and San Francisco. This novel system will integrate sensors with artificial intelligence and machine learning algorithms to enhance the efficacy of entanglement detection; 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 November 12, 2025.

AYE:

NAY:

ABSENT:

ABSTAIN:

Dated:

Kim Todd
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-25-038

B. Division Information

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

C. Recipient's Information

1. Recipient's Legal Name: Sofar Ocean Technologies, Inc.
2. Federal ID Number: 45-5149267

D. Title of Project

Title of project: SEA-Scan: Structural and Environmental Algorithms for Sensing of Offshore Systems

E. Term and Amount

1. Start Date: 12/1/2025
2. End Date: 12/1/2029
3. Amount: \$2,993,427.00

F. Business Meeting Information

1. Are the ARFVTP agreements \$75K and under delegated to Executive Director? No
2. The Proposed Business Meeting Date: 11/12/2025.
3. Consent or Discussion? Discussion
4. Business Meeting Presenter Name: Nathan Lubega
5. Time Needed for Business Meeting: 5 minutes.
6. The email subscription topic is: Electric Program Investment Charge (EPIC)

Agenda Item Subject and Description:

Sofar Ocean Technologies, Inc.

Proposed resolution approving agreement EPC-25-038 with Sofar Ocean Technologies, Inc. for a \$2,993,427 grant, and adopting staff's recommendation that this action is exempt from CEQA. This project will develop and test a novel, multi-modal system for detecting entanglements in floating offshore wind infrastructure at pre-established test sites in the San Francisco Bay and off the coasts of Half Moon Bay and San Francisco. This novel system will integrate sensors with artificial intelligence and machine learning algorithms to enhance the efficacy of the entanglement detection.

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":

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

a) Agreement **IS** exempt?

Yes

Statutory Exemption?

No

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

PRC section number: None

CCR section number: None

Categorical Exemption?

Yes

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

CCR section number: Cal. Code Regs., tit. 14, § 15301; Cal. Code Regs., tit. 14, § 15303; Cal. Code Regs., tit. 14, § 15306;

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

No

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

Cal. Code Regs., tit. 14, sec. 15301 provides that projects which consist of the operation, repair, maintenance, permitting, leasing, licensing, or minor alteration of existing public or private structures, facilities, mechanical equipment, or topographical features, and which involve negligible or no expansion of use beyond that existing at the time of the lead agency's determination, are categorically exempt from the provisions of CEQA.

Cal. Code Regs., tit. 14, sec. 15303 provides that projects which consist of construction and location of limited numbers of new, small facilities or structures; installation of small new equipment and facilities in small structures; and the conversion of existing small structures from one use to another where only minor modifications are made in the exterior of the structure, are categorically exempt from the provisions of CEQA.

This project will involve environmental monitoring technologies research which will be conducted at an existing facility and at open ocean locations near San Francisco where the recipient regularly tests moored systems. This project will involve developing and deploying Spotter Buoys to existing infrastructure with Smart Mooring cables that contain various components for testing (hydrophones, Inertial Measurement Units, etc.) to study their behavior. These are established and permitted test sites that have been previously established for this purpose and won't



require any additional infrastructure to complete the testing. This project will use existing attachments and will not involve any anchoring or modifications to the sea floor. Accordingly, there will be negligible to no expansion of the existing use of the facilities and locations at project sites.

Cal. Code Regs., tit. 14, sec. 15306 provides that projects which consist of basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource are exempt from the provisions of CEQA. This project will involve receiving data from passive monitoring devices attached to pre-existing infrastructure at permitted test sites to evaluate disturbances in California coastal waters. These passive monitoring devices will be similar to existing monitoring devices already attached to existing infrastructure and will not have a serious or major disturbance to an environmental resource.

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, 15303, and 15306.

Additionally, 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. Is this project considered “Infrastructure”?

No

I. Subcontractors

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

Subcontractor Legal Company Name	CEC Funds	Match Funds
The Leland Stanford Junior University	\$ 950,000	\$500,000
Alliance for Sustainable Energy, LLC	\$ 50,000	\$0
Applied Ocean Sciences, LLC	\$ 20,000	\$0

J. Vendors and Sellers for Equipment and Materials/Miscellaneous

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

Vendor/Seller Legal Company Name	CEC Funds	Match Funds
TBD - BM system without nodes (includes float and attachments)	\$ 8,000	\$ 0
TBD -Assembly, In-Line Node, BM RBR Pressure 20m	\$ 6,267	\$ 0
TBD - Assembly, Smart Mooring Cable, 10-Meter	\$ 4,072	\$ 0
TBD - FG, Spotter, BM SM, Whitelisted, No Cellular	\$ 3,650	\$ 0
TBD - Edge Impulse dev seats for project duration	\$ 40,000	\$ 0
TBD - R&D material budget (Spotter component parts e.g. cables, housing, hardware, wiring/electronics, etc.)	\$ 45,000	\$ 0
TBD - Service and consumables	\$ 25,000	\$ 0
TBD - R&D material budget	\$ 25,000	\$ 0
TBD - Bristlemouth Jumper 400mm (black)	\$ 1,298	\$ 0
TBD - Assembly, In-Line Float	\$ 3,824	\$ 0
TBD - AOA Borealis Compete Node	\$ 6,900	\$ 0
TBD - Assembly, In-Line Node, load cell prototype	\$ 10,000	\$ 0
TBD - Assembly, In-Line Node, ADCP 600kHz prototype	\$ 30,000	\$ 0
Vendors/Sellers of The Leland Stanford Junior University		



<i>The Leland Stanford Junior University -Graduate Student Tuition</i>	\$ 0	\$ 286,958
<i>TBD - Publication Costs</i>	\$ 2,000	\$ 0
<i>TBD – Strain Gages</i>	\$ 2,000	\$ 0
<i>TBD - Laboratory Equipment (Small benchtop items such as cables)</i>	\$ 2,500	\$ 0
<i>TBD - Specimen Building Materials</i>	\$ 4,499	\$ 0
<i>TBD - Laboratory Consumables</i>	\$ 5,410	\$ 0
<i>TBD - Accelerometers</i>	\$ 2,500	\$ 0

K. Key Partners

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

Key Partner Legal Company Name
No key partners to report

L. Budget Information

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

Funding Source	Funding Year of Appropriation	Budget List Number	Amount
EPIC	24-25	301.001L	\$ 2,993,427

TOTAL Amount: \$ 2,993,427

R&D Program Area: ESB: Renewables

Explanation for “Other” selection Not applicable

Reimbursement Contract #: Not applicable

Federal Agreement #: Not applicable

M. Recipient’s Contact Information

1. Recipient’s Administrator/Officer

Name: Justin Greenberg

Address: Pier 28 Annex

City, State, Zip: San Francisco, CA 94105

Phone: 541-301-5648

E-Mail: justin.greenberg@sofarocean.com



2. Recipient's Project Manager

Name: Justin Greenberg

Address: Pier 28 Annex

City, State, Zip: San Francisco, CA 94105

Phone: 541-301-5648

E-Mail: justin.greenberg@sofaroccean.com

N. Selection Process Used

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

Selection Process	Additional Information
Competitive Solicitation #	GFO-24-307
First Come First Served Solicitation #	Not applicable
Other	Not applicable

O. Attached Items

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

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

Approved By

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

Agreement Manager: Chuck Gentry

Approval Date: 10/3/2025

Branch Manager: Kevin Uy

Approval Date: 10/3/2025

Director: Jonah Steinbuck (Delegated to Branch Manager)

Approval Date: 10/3/2025

Exhibit A
Scope of Work
Sofar Ocean Technologies, Inc.

I. TASK AND ACRONYM/TERM LISTS

A. Task List

Task #	CPR ¹	Task Name
1		General Project Tasks
2	X	Surface and Deep-water Sensor Integration
3	X	Edge AI/ML Intelligence Module
4		ML Entanglement Classification
5		Sub-sea Digital Twin and Structural Integrity
6		Ocean-Water Demonstration Testing of Integrated System
7		Report on Entanglement Mitigation Approaches
8		Evaluation of Project Benefits
9		Technology/Knowledge Transfer Activities

B. Acronym/Term List

Acronym/Term	Meaning
AI	Artificial Intelligence
ADCP	Acoustic Doppler Current Profiler
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CEC	California Energy Commission
CPR	Critical Project Review
FOSW	Floating Offshore Wind
LCOE	Levelized Cost of Energy
ML	Machine Learning
MSM	Motion Sensing Module
TAC	Technical Advisory Committee
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 fund the development and deployment of a multi-modal fusion approach to entanglement monitoring for floating offshore wind (FOSW) infrastructure. The project includes hardware development and data modeling/analytics development to translate the data collected by buoys into actionable information (e.g., a notification of potential fishing gear entanglement).

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

Sofar Ocean Technologies, Inc.

B. Problem/ Solution Statement

Problem

As floating offshore wind deployment accelerates, the complexity of managing transmission systems and infrastructure integrity grows significantly. Entanglements with marine debris, discarded fishing gear, and marine wildlife pose major operational risks that can lead to costly downtimes, equipment damage, and environmental hazards. Without real-time monitoring capabilities, frequent and burdensome manual inspections are required. Existing monitoring technologies are expensive, often resulting in point-wise rather than high-resolution spatial measurements of the surrounding metocean conditions, or splicing into the mooring line and affecting its structural properties. The difficulty of entanglement detection is exacerbated by the complex, noisy normal conditions encompassing platform motions and wave/current loading. Given that FOSW infrastructure currently does not exist along the U.S. West Coast, and that they will be at presently unseen depths, existing data on the effects of entanglement, needed to classify and identify different types of abnormalities, is limited. Monitoring-to-date has focused on easier to detect animal entanglements, while entanglements due to fishing gear and other marine debris remain much more challenging to detect due to their low signal-to-noise ratio, where the data needs to be extracted from already noisy and constantly changing normal conditions.

Solution

The recipient will develop a novel, multi-modal system for detecting entanglements in FOSW infrastructure. The ultimate vision of the technology is to deliver a network of sensors and an interface that notifies FOSW operators of potential entanglements and actionable information such as the location, potential cause of entanglement, and justification for entanglement notification.

To support the monitoring of FOSW mooring lines, this project will: (A) integrate sensors into the mature Spotter sensing system including, motion sensors, and acoustic doppler current profiler (ADCP)s, and develop and test inexpensive accelerometers along the mooring lines that are tethered in a robust yet lightweight fashion so as not to interfere with mooring to critical infrastructure; and (B) develop a low-power edge artificial intelligence/machine learning (AI/ML) node for on-board processing and ML training, limiting data transmission expenses to shore; and (C) develop machine learning algorithms, previously applied in structural health monitoring, to enhance anomaly detection and characterization of fishing gear entanglements from marine animal detection in noisy, difficult-to-detect settings; and (D) integrate the data and ML with a physics-based numerical digital twin² to alleviate data-limited constraints, enhancing the efficacy of the entanglement detection. Additionally, the digital twin will be used to output information on estimated mooring damage and remaining fatigue life. The integrated hardware and algorithms will be systematically assessed in a tiered testing plan, ranging from the use of existing historical and experimental data, laboratory-scale experiments, and field ocean water testing, where differing abnormalities will be actuated on the mooring line to assess the ML prediction

² A digital twin is a digital model representing real-world conditions and is built with in-situ data. The digital twin enables the analysis of physical phenomena and the ability to simulate and predict the impact of changing conditions on the environment.

Exhibit A

Scope of Work

Sofar Ocean Technologies, Inc.

accuracy.

C. Goals and Objectives of the Agreement

Agreement Goals

The goals of this Agreement are to:

- Design, configure and validate a comprehensive detection system that integrates Spotter buoys, sensors, and a suite of other monitoring tools to enable continuous entanglement monitoring in California Wind Energy Areas (WEAs).
- Develop an Edge AI Intelligence Module with embedded processing power sufficient for anomaly detection and characterization.
- Create an AI/ML Classification Algorithm for detecting and extracting entanglement signals from environmental noise.
- Establish a below-surface Digital Twin to model the steady state and contextualize possible structural failures.
- Test the final system at an open ocean test site.

Ratepayer Benefits:³ This Agreement will result in the ratepayer benefits of greater electricity reliability, lower costs, and increased safety by enabling early, targeted detection of infrastructure issues, reducing manual inspection costs, and preventing costly damage from undetected entanglements. This detection will be conducted at an accuracy currently unavailable due to data limitations. These benefits will potentially reduce downtimes, alert FOSW personnel to potentially dangerous conditions beneath the water's surface, and reduce Levelized Cost of Energy (LCOE) by reducing the need for costly journeys to manually inspect infrastructure for entanglements.

Technological Advancement and Breakthroughs:⁴ This Agreement is intended to drive technological advancement and breakthroughs that help overcome barriers to achieving California's statutory energy goals by developing: [i] novel, cost-effective multi-modal sensing approaches that are distributed spatially in the surrounding environment and along the mooring lines, [ii] low-power edge processing capabilities, reducing data transmission and costs from hard-to-reach sites, and [iii] novel algorithms and modeling techniques that overcome limitations and barriers of continuous and noisy subsea infrastructure monitoring.

Agreement Objectives

The objectives of this Agreement are to:

- Build a ready-to-deploy, "plug-and-play" Multi-Modal Fusion sensing platform that can be commercially produced and integrated with the FOSW platforms, and capable of

³ 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).

⁴ California Public Resources Code, Section 25711.5(a) also requires EPIC-funded projects to lead to technological advancement and breakthroughs to overcome barriers that prevent the achievement of the state's statutory and energy goals.

Exhibit A Scope of Work Sofar Ocean Technologies, Inc.

compensating for the effects of biofouling, that has completed rigorous validation testing of the new Motion Sensing Module with combined depth and thermal cycles in hydrostatic pressure/thermal immersion testing chambers as well as real world field testing campaigns. Additionally, it will be designed for simple moorings/attachments to the FOSW infrastructure with a range of flexible and lightweight integration options.

- Develop an integration-ready Edge AI Intelligence Module capable of consuming data from all sensors via the Bristlemouth protocol and running constant intensive deep learning inference models at < 250 mW total average power consumption, with embedded processing power sufficient for supporting ML models for anomaly detection and characterization.
- Develop open-source data and machine learning algorithms capable of identifying features in the data, entanglement detection, and classification of entanglement source, with < 0.1 false-positive prediction rate, validated through laboratory scaled bench testing.
- Develop a subsea digital twin with online model updating and structural integrity trackers, assessed based on comparison of historical data and model error (< 5% mean squared error), as well as real-time compatibility; i.e., algorithms with computational speed (e.g., less than 100~200 Hz per time step), numerical damping, and stability when integrated with sensors.

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.

Exhibit A

Scope of Work

Sofar Ocean Technologies, Inc.

- 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.

Exhibit A
Scope of Work
Sofar Ocean Technologies, Inc.

MEETINGS

Subtask 1.2 Kick-off Meeting

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

The Recipient shall:

- Attend a “Kick-off” meeting with the CAM, and other CEC staff relevant to the Agreement. The Recipient’s Project Manager and any other individuals deemed necessary by the CAM or the Project Manager shall participate in this meeting. The administrative and technical aspects of the Agreement will be discussed at the meeting. Prior to the meeting, the CAM will provide an agenda to all potential meeting participants. The meeting may take place in person or by electronic conferencing (e.g., Teams, Zoom), with approval of the CAM.

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

- The CAM’s expectations for accomplishing tasks described in the Scope of Work;
 - An updated Project Schedule;
 - Terms and conditions of the Agreement;
 - Invoicing and auditing procedures;
 - Travel;
 - Equipment purchases;
 - Administrative and Technical products (subtask 1.1);
 - CPR meetings (subtask 1.3);
 - Monthly Calls (subtask 1.5)
 - Quarterly Progress reports (subtask 1.6)
 - Final Report (subtask 1.7)
 - Match funds (subtask 1.8);
 - Permit documentation (subtask 1.9);
 - Subawards(subtask 1.10);
 - Technical Advisory Committee meetings (subtasks 1.11 and 1.12);
 - Agreement changes;
 - Performance Evaluations; and
 - Any other relevant topics.
- Provide *Kick-off Meeting Presentation* to include but not limited to:
 - Project overview (i.e. project description, goals and objectives, technical tasks, expected benefits, etc.)
 - Project schedule that identifies milestones
 - List of potential risk factors and hurdles, and mitigation strategy
 - Provide an *Updated Project Schedule, Match Funds Status Letter, and Permit Status Letter*, as needed to reflect any changes in the documents.

The CAM shall:

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

Recipient Products:

- Kick-off Meeting Presentation
- Updated Project Schedule (*if applicable*)

Exhibit A

Scope of Work

Sofar Ocean Technologies, Inc.

- Match Funds Status Letter (subtask 1.8) (*if applicable*)
- Permit Status Letter (subtask 1.9) (*if applicable*)

CAM Product:

- Kick-off Meeting Agenda

Subtask 1.3 Critical Project Review (CPR) Meetings

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

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

The Recipient shall:

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

The CAM shall:

- Determine the location, date, and time of each CPR meeting with the Recipient's input.
- Send the Recipient a *CPR Agenda* with a list of expected CPR participants in advance of the CPR meeting. If applicable, the agenda may include a discussion of match funding and permits.
- Conduct and make a record of each CPR meeting. Provide the Recipient with a schedule for providing a Progress Determination on continuation of the project.
- Determine whether to continue the project, and if so whether modifications are needed to the tasks, schedule, products, or budget for the remainder of the Agreement. A determination of unsatisfactory progress This may result in project delays, including a potential Stop Work Order, while the CEC determines whether the project should continue.
- Provide the Recipient with a *Progress Determination* on continuation of the project, in accordance with the schedule. The Progress Determination may include a requirement that the Recipient revise one or more products.

Recipient Products:

- CPR Report(s)

Exhibit A

Scope of Work

Sofar Ocean Technologies, Inc.

CAM Products:

- CPR Agenda(s)
- Progress Determination

Subtask 1.4 Final Meeting

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

The Recipient shall:

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

The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be divided into two separate meetings at the CAM's discretion.

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

Products:

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

MONTHLY CALLS, REPORTS AND INVOICES

Subtask 1.5 Monthly Calls

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

Exhibit A

Scope of Work

Sofar Ocean Technologies, Inc.

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

The CAM shall:

- Schedule monthly calls.
- Provide questions to the Recipient prior to the monthly call.
- Provide call summary notes to Recipient of items discussed during call.

The Recipient shall:

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

Product:

- Email to CAM concurring with call summary notes.

Subtask 1.6 Quarterly Progress Reports and Invoices

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

The Recipient shall:

- Submit a *Quarterly Progress Report* to the CAM. Each progress report must:
 - Summarize progress made on all Agreement activities as specified in the scope of work for the reporting period, including accomplishments, problems, milestones, products, schedule, fiscal status, and an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. Progress reports are due to the CAM the 10th day of each January, April, July, and October. The Quarterly Progress Report template can be found on the ECAMS Resources webpage available at:
<https://www.energy.ca.gov/media/4691>
- Submit a monthly or quarterly *Invoice* on the invoice template(s) provided by the CAM.

Recipient Products:

- Quarterly Progress Reports
- Invoices

CAM Product:

- Invoice template

Subtask 1.7 Final Report

The goal of this subtask is to prepare a comprehensive Final Report that describes the original purpose, approach, results, and conclusions of the work performed under this Agreement.

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When creating the Final Report Outline and the Final Report, the Recipient must use the CEC Style Manual provided by the CAM.

Subtask 1.7.1 Final Report Outline

The Recipient shall:

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

Recipient Products:

- Final Report Outline (draft and final)

CAM Products:

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

Subtask 1.7.2 Final Report

The Recipient shall:

- Prepare a *Final Report* for this Agreement in accordance with the approved Final Report Outline, Energy Commission Style Manual, and Final Report Template provided by the CAM with the following considerations:
 - Ensure that the report includes the following items, in the following order:
 - Cover page (**required**)
 - Credits page on the reverse side of cover with legal disclaimer (**required**)
 - Acknowledgements page (optional)
 - Preface (**required**)
 - Abstract, keywords, and citation page (**required**)
 - Table of Contents (**required**, followed by List of Figures and List of Tables, if needed)
 - Executive summary (**required**)
 - Body of the report (**required**)
 - References (if applicable)
 - Glossary/Acronyms (If more than 10 acronyms or abbreviations are used, it is required.)
 - Bibliography (if applicable)
 - Appendices (if applicable) (Create a separate volume if very large.)
 - Attachments (if applicable)
- Submit a draft of the Executive Summary to the TAC for review and comment.
- Develop and submit a *Summary of TAC Comments on Draft Final Report* received on the Executive Summary. For each comment received, the Recipient will identify in the summary the following:
 - Comments the Recipient proposes to incorporate.
 - Comments the Recipient does propose to incorporate and an explanation for why.
- Submit a draft of the report to the CAM for review and comment. The CAM will provide written comments to the Recipient on the draft product within 15 days of receipt.
- Incorporate all CAM comments into the *Final Report*. If the Recipient disagrees with any

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comment, provide a *Written Responses to Comments* explaining why the comments were not incorporated into the final product.

- Submit the revised *Final Report* electronically with any Written Responses to Comments within 10 days of receipt of CAM's Written Comments on the Draft Final Report, unless the CAM specifies a longer time period or approves a request for additional time.

Products:

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

CAM Product:

- Written Comments on the Draft Final Report

MATCH FUNDS, PERMITS, AND SUBAWARDS

Subtask 1.8 Match Funds

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

While the costs to obtain and document match funds are not reimbursable under this Agreement, the Recipient may spend match funds for this task. Match funds must be identified in writing, and the Recipient must obtain any associated commitments before incurring any costs for which the Recipient will request reimbursement.

The Recipient shall:

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

If match funds were a part of the application that led to the CEC awarding this Agreement, then provide in the letter:

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

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

Products:

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

Subtask 1.9 Permits

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

The Recipient shall:

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

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

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

Products:

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

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Subtask 1.10 Obtain and Execute Subawards and Agreements with Site Hosts

The goals of this subtask are to: (1) procure and execute subrecipients and site host agreements, as applicable, required to carry out the tasks under this Agreement; and (2) ensure that the subrecipients and site host agreements are consistent with the Agreement terms and conditions and the Recipient's own contracting policies and procedures.

The Recipient shall:

- Execute and manage subawards and coordinate subrecipients activities in accordance with the requirements of this Agreement.
- Execute and manage site host agreements, and ensure the right to use the project site throughout the term of the Agreement, as applicable. A site host agreement is not required if the Recipient is the site host.
- Notify the CEC in writing immediately, but no later than five calendar days, if there is a reasonable likelihood the project site cannot be acquired or can no longer be used for the project.
- Incorporate this Agreement by reference into each subaward.
- Include any required Energy Commission flow-down provisions in each subaward, in addition to a statement that the terms of this Agreement will prevail if they conflict with the subaward terms.
- Submit a *Subaward and Site Letter* to the CAM describing the subawards and any site host agreement needed or stating that no subawards or site host agreements are required.
- If requested by the CAM, submit a draft of each *Subaward* and any *Site Host Agreement* required to conduct the work under this Agreement.
- If requested by the CAM, submit a final copy of each executed *Subaward* and any *Site Host Agreement*.
- Notify and receive written approval from the CAM prior to adding any new subrecipient (see the terms regarding subrecipient additions in the terms and conditions).

Products:

- Subaward and Site Letter
- Draft Subawards (*if requested by the CAM*)
- Draft Site Host Agreement (*if requested by the CAM*)
- Final Subawards (*if requested by the CAM*)
- Final Site Host Agreement (*if requested by the CAM*)

TECHNICAL ADVISORY COMMITTEE

Subtask 1.11 Technical Advisory Committee (TAC)

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

- Provide guidance in project direction. The guidance may include scope and methodologies, timing, and coordination with other projects. The guidance may be based on:
 - Technical area expertise;
 - Knowledge of market applications; or

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

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

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

The Recipient shall:

- Prepare a *List of Potential TAC Members* that includes the names, companies, physical and electronic addresses, and phone numbers of potential members. The list will be discussed at the Kick-off meeting, and a schedule for recruiting members and holding the first TAC meeting will be developed.
- Recruit TAC members. Ensure that each individual understands member obligations and the TAC meeting schedule developed in subtask 1.12.
- Prepare a *List of TAC Members* once all TAC members have committed to serving on the TAC.
- Submit *Documentation of TAC Member Commitment* (such as Letters of Acceptance) from each TAC member.

Products:

- List of Potential TAC Members

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- List of TAC Members
- Documentation of TAC Member Commitment

Subtask 1.12 TAC Meetings

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

The Recipient shall:

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

The TAC shall:

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

Products:

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

Subtask 1.13 Project Performance Metrics

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

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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: Surface and Deep-water sensor Integration

The goals of this task are to design, configure, and validate a comprehensive detection system that integrates Spotter buoys, Motion Sensing Modules, and a suite of other monitoring tools to enable continuous entanglement monitoring in California WEAs. This task will develop a custom motion sensing module that is ready-to-deploy into the Spotter platform. Sensing modalities including Inertial Measurement Units, ADCPs, accelerometers, and pressure sensors integrated with the Bristlemouth open-source marine connectivity protocol. This system will be capable of compensating for the effects of biofouling.

The Recipient shall:

Subtask 2.1: Integrate component sensors for central processing

- Design and modify sensors so they are small, lightweight, and simple to service and replace based on digital twin estimates in *Sub-task 5.1*.
- Integrate off-the-shelf sensors with the demonstration system(s), (such as: hydrophone, ADCP, Load Cells, and bottom water level sensor).
- Integrate prototypes of the Edge Intelligence Module (*Task 3*) and Motion Sensing Module into the demonstration system(s).

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Subtask 2.2: Conduct Baseline Environmental Monitoring

- Develop a *Baseline Monitoring Test Plan* detailing setup, test conditions, and types of data to be collected.
- Deploy Prototype integrated demonstration system(s) at testing site(s) with conditions similar to WEAs.
- Maintain Spotter locations with sufficient dwell time to capture baseline data on currents, waves, and other factors to understand likely FOSW steady-state motion dynamics.
- Capture baseline oceanographic data necessary to support subsequent modeling activities in *Sub-task 5.1*.
- Capture baseline long-dwell data from Motion Sensing Modules, comparing against environmental and load cell data to monitor for drift and anomalies, and verifying retained accuracy with lab component-level testing after the field deployments.
- Provide a *Baseline Monitoring Test Report* that includes a summary of the data collected, analysis of the results, and conclusions.

Subtask 2.3: Develop the Motion Sensing Module (MSM)

- Integrate via Bristlemouth the sensors comprising the MSM—including an accelerometer, gyroscope, magnetometer, and depth/pressure sensor—in a compact marine-ready Bristlemouth module.
- Align site conditions and hardware with Digital Twin outputs from *Sub-task 5.1*.
- Design the system such that it is capable of compensating for the effects of biofouling.

Subtask 2.4: Conduct Validation Testing

- Develop a *MSM Validation Test Plan* detailing test methods, instruments used, and types of data to be collected.
- Complete rigorous validation testing according to the *MSM Validation Test Plan* of the Motion Sensing Module with combined depth and thermal cycles in hydrostatic pressure/thermal immersion testing chambers. Monitor core functionality, power consumption, and accuracy drift over the course of cycle and accelerated aging testing.
- Provide a *MSM Validation Test Report* that includes the results from testing, analysis of the results, and conclusions.

Subtask 2.5: Design Mooring Attachment System

- Design the system so it can be commercially produced in the future and connected to the FOSW platforms.
- Develop recommendations on potential attachment strategies based on likely FOSW infrastructure characteristics.

Subtask 2.6: Develop System Integration of Demonstration System

- Iterate on the prototype systems, upgrading them to include the latest versions of mooring attachment design and Motion Sensing Module. The result will be two complete field-ready sensing systems for laboratory testing in *Sub-task 4.2* and demonstration testing in *Task 6*.
- Prepare a *System Integration Report* to provide a summary of the activities and results from 2.1, 2.3, 2.5, and 2.6, including design tradeoffs, a final design overview, and system capabilities.

Subtask 2.7: Prepare a Cost Analysis

- Prepare a *Sensor Cost Analysis Report* which estimates the total per-unit cost at manufacturing scale and identifies areas of potential cost savings.
- Prepare *CPR Report #1* in accordance with subtask 1.3 (CPR Meeting).
- Participate in a CPR Meeting.

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Products:

- Baseline Monitoring Test Plan
- Baseline Monitoring Test Report
- MSM Validation Test Plan
- MSM Validation Test Report
- System Integration Report
- Sensor Cost Analysis Report
- CPR Report #1

TASK 3: Edge AI/ML Intelligence Module

This task will develop an Edge AI Intelligence Module with embedded processing power sufficient for a broad range of edge AI/ML tasks, leveraging the latest advances in embedded processors with AI/ML hardware acceleration so it will be suitable for extremely power constrained applications. The module will be able to consume data from all sensors in the Bristlemouth system via the Bristlemouth protocol, and can apply multi-modal ML/AI inference models on this data.

The Recipient shall:

Subtask 3.1: Embed System and Module Design

- Develop a prototype Edge Intelligence Module which increases power efficiency over existing solutions by leveraging the latest advances in embedded processors with AI/ML hardware acceleration.
- Implement a low cost and compact marine-ready Bristlemouth module that fully encapsulates the embedded solution in a plug-and-play module.

Subtask 3.2: Conduct Component Testing

- Develop an *Intelligence Module Component Test Plan* detailing the tests to be performed, instruments used, and performance targets.
- Conduct component-level testing to ensure the module achieves all target power and performance benchmarks and will survive the harsh marine environment for at least 4 years. Leveraging hydrostatic pressure and thermal cycling capabilities for cycle and accelerated aging testing.
- Design and conduct a suite of ML power benchmarks. These will include industry standard benchmarks as well as benchmarks designed to be more relevant to the marine sensing application space.

Subtask 3.3: Develop a Software Platform

- Implement firmware and web software to create an accessible developer platform that leverages the Edge Intelligence Module. Web software will integrate with the Edge Impulse cloud ML platform to allow remote training, testing and deploying Machine Learning models to the system; it will also collect training and validation data from the field remotely.

Subtask 3.4: Integrate a ML Model

- Use the developments in *Sub-task 3.3* to develop and deploy entanglement detection models developed in *Sub-task 4.2* to the Edge Intelligence Module.
- The developments in *Sub-task 3.3* will allow the teams to collaborate efficiently and rapidly on this subtask; see *Sub-task 4.2* and *Sub-task 5.2*.
- The Machine Learning models deployed to the edge will perform the feature extraction stages of the overall inference system.
- Prepare an *Intelligence Module Report* which will provide a summary of the activities and

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results from 3.1 - 3.4.

- Prepare *CPR Report #2* in accordance with subtask 1.3 (CPR Meetings).
- Participate in a CPR Meeting.

Products:

- Intelligence Module Component Test Plan
- Intelligence Module Report
- CPR Report #2

TASK 4: ML Entanglement Classification

The goal of this task is to create a hybrid edge-cloud ML Classification Algorithm for detecting, extracting, and identifying entanglement signals from environmental noise. The algorithm will also be capable of classifying marine debris including fishing gear as well as marine animal entanglements. This task will develop machine learning algorithms for entanglement characterization to detect, classify, and localize entanglement in the mooring line when triggered by the nested triggering state and then to update the digital twin model accordingly for structural damage detection. Machine learning algorithms will use adversarial learning to integrate sensor data from multiple mooring lines along with both normal and abnormal outputs from the digital twin model, in order to train the entanglement characterization model that is robust across diverse environmental conditions.

The Recipient shall:

Sub-task 4.1. Conduct Single-task learning to detect entanglement in an adversarial way

- Formulate the entanglement problem as an unsupervised domain adaptation. Design the feature extractor network based on existing data from *Sub-task 5.1*.
- Implement the “entanglement predictor network” based on existing and simulated data from *Sub-tasks 5.1*, using an unsupervised domain adaptation method with adversarial learning to infer entanglement characteristics from sensor data and digital twin data. Entanglement type predictors will be trained to ensure that the extracted features from the feature extractors can accurately classify the type of entanglement (i.e., classifying anomalies as fishing gear vs. marine animal vs. false alarm).
- Implement the “domain classifier network” to distinguish which domain the extracted features come from; i.e., sensor data versus the digital twin. The domain classifier takes the features extracted from the source domain and the target domain data as input and predicts if the feature sample comes from the source domain or not (i.e., a binary classification of data source).

Sub-task 4.2. Conduct Multi-task learning and laboratory bench testing

- Develop an *Entanglement Algorithm Bench Test Plan* detailing the tests to be performed, instruments used, and performance targets.
- Design and build laboratory-scale bench testing. Conduct first round of small-scale laboratory bench testing to collect data, develop algorithms, and evaluate performance using the Motion Sensing Module developed in *Sub-task 2.6*.
- Based on laboratory-scale testing data, train the feature extractor, entanglement type predictor, and domain classifier and evaluate the single-task networks developed in *Sub-task 4.1*.
- Based on synthetic data in *Sub-task 5.1* on different entanglement cases, design multi-task learning.
- Implement nested triggering approach. Integrate with “event”-driven trigger aligned with

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protocols in *Sub-task 3.4*. Integrate physics-based constraints of digital twin in nested triggering framework; see also *Sub-task 5.2*.

- Conduct subsequent rounds of small-scale laboratory bench testing with nested triggering.

Sub-task 4.3. Update Digital twin model and evaluate network

- Develop system identification to update the model of the digital twin; see *Sub-task 5.3*. The “structural properties network” will follow a similar design as the entanglement type predictor described in *Sub-task 4.1*, using features extracted from source domain data as input and predicting source domain labels, such as stiffness, mass, and damping, as output.
- Prepare a trade-off / sensitivity analysis with respect to the number of sensors versus accuracy and uncertainty.
- Optimize for the number of sensors and their locations based on the trade-off study and refining the adversarial learning method.
- Prepare an *Entanglement Algorithm Report* which includes a summary of the optimizations made and the trained network parameters.

Products:

- Entanglement Algorithm Bench Test Plan
- Entanglement Algorithm Report

TASK 5: Sub-Sea Digital Twin and Structural Integrity

The goal of this task is to build a sub-sea Digital Twin to provide physical principles, along with virtual data generation, to enhance entanglement detection and contextualize possible structural failures, including damage and fatigue. The digital twin will take in multi-modal indirect sensing information on current, wave loading, platform motions, and anchorage conditions (when available), along with direct sensing measurements of accelerometer motions along the mooring length, to output real-time mooring tensions. Structural integrity trackers will also monitor damage and fatigue, evaluated through a case study.

The Recipient shall:

Sub-task 5.1. Collect data and generate synthetic data

- Collate existing field and laboratory data on mooring lines and define a matrix of site conditions.
- Based on numerical model outputs, gather information on expected mooring response representative of CA WEAs for needed accelerometer sensor specifications (amplitude, bandwidth, etc.) using expected mooring response (frequencies, mode shapes, etc.) (*Sub-task 2.1*).
- Build several numerical model archetypes and tune models to existing data and historical environmental data from the Buoy (*Sub-task 2.2*)
- Based on post-processing of existing data and expected behavioral properties of differing types of entanglement, parametrically generate synthetic data of entanglement using developed numerical models. By providing diverse scenarios of underwater normal conditions, this data will be used to initially train the ML algorithms (*Sub-task 4.1*).

Sub-task 5.2. Develop a Real-time digital twin

- Troubleshoot digital twin in a virtual environment to study effects of noise, communication delays, initialization, abrupt state changes etc. on numerical stability of

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the digital twin. To reconstruct mooring line dynamics from the sensor data, integrate digital twin as constraints to ML in *Sub-task 4.2*.

- Extend existing real-time subsea model to take in sensing information on environmental conditions. The digital twin will be integrated with the nested triggering / hardware outlined in *Sub-tasks 3.4* and *4.2*.

Sub-task 5.3. Enhance digital twin with structural integrity trackers

- Perform system identification using sensor data to support real-time updates of digital twin properties in response to evolving in-situ conditions such as marine growth or biofouling, that affect parameters like mass and drag; see also *Sub-task 4.3*.
- Integrate needed nonlinear material, damage, and fatigue models. Based on the developed structural integrity models, conduct a case study on structural integrity, where damage and fatigue models are readily available in the literature.
- Prepare a *Digital Twin Development Report* summarizing the capabilities of the digital twin, including case study results to test failure and fatigue prediction capability of the digital twin model.

Products:

- Digital Twin Development Report

TASK 6: Ocean-water Demonstration Testing of Integrated System

The goal of this task is to test and assess the integrated system in ocean water to assess the prediction accuracy of the hardware in realistic conditions. This testing culminates from a tiered testing program, distributed among *Tasks 2-5*. Component-level testing of the sensor hardware, designed for distribution along the mooring lines at depth, along with edge processing capabilities to integrate the hardware and algorithms, is described in *Tasks 2 and 3*. Laboratory testing including the ML algorithms leading up to ocean testing is described in *Task 4*. Finally, the synthesis of existing and newly collected data, as well as numerical modeling in support of the testing program, is outlined in *Task 5*.

The recipient shall:

Sub-task 6.1. Design open-water testing program

- Design test setup, including float, mooring line sensor array, surrounding Spotter buoys, etc. The float will be at a smaller scale to assess ability to detect abnormalities out of larger motions and smaller vibrations.
- Design candidate mooring attachment tethers. The range of evaluated concepts will include constrained multi-point mooring attachments and semi-rigid leashes.
- Design induced and actuated abnormalities in the mooring lines to represent realistic conditions, such as fishing gear entanglement, possible animal entrapment, etc.
- Prepare an *Open-Water Test Plan* detailing the setup, target conditions and methods to be used for testing.

Sub-task 6.2. Conduct open-water testing

- Deploy an integrated sensing system resulting from *Tasks 2-3* at the testing sites, representative of wave energy conditions associated with the California WEAs.
- Iterate with algorithms and modeling in sub-tasks 4.2 and 5.2.
- Collect passive acoustic data for analyzing presence and behavior of marine mammals.

Sub-task 6.3. Conduct Final demonstration testing

- Perform final demonstration testing of integrated systems, including edge processing,

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nested triggering, ML algorithms, and digital twin integration.

- Perform error analysis of detection accuracy.
- Via field testing on the analog mooring and analysis of the digital twin, analyze the costs and benefits of adding the additional sensors at varying locations on the mooring infrastructure.
- Analyze passive acoustic data to identify whale vocalizations to species where possible.
- Prepare an *Open-Water Test Report* which includes test results, error analysis, and lessons learned.

Products:

- Open-Water Test Plan
- Open-Water Test Report

TASK 7: Report on Entanglement Mitigation Approaches

The goal of this task is to produce a *Report* on potential mitigation measures based on the literature and findings, as well as any benefits to LCOE.

The Recipient shall:

- Investigate potential mitigation approaches based on analysis of the data, algorithmic and digital twin outputs, including system descriptions, costs, and time to deploy; gap analysis; identified opportunities for retrieval technology development; and the potential risks (such as the risk of subsequent entanglement) of each mitigation system.
- Analyze any potential benefits to LCOE that may be possible by implementing the proposed sensing technology at scale, including baseline costs.
- Prepare an *Entanglement Mitigation Approaches Report* which includes an outline of removal options based on current and proposed technologies, including analysis of marine mammal detection activities in Task 6.2-6.3. The report will also include LCOE analysis.

Products:

- Entanglement Mitigation Approaches Report

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.

Exhibit A
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Sofar Ocean Technologies, Inc.

- Complete and update the project profile on the CEC's public online project and recipient directory on the [Energize Innovation website \(www.energizeinnovation.fund\)](http://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 \(www.energizeinnovation.fund\)](http://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 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

Exhibit A
Scope of Work
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- 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(s) 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