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

[PROPOSED]

RESOLUTION NO: 25-1112-XX

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-25-035 with Alliance for Sustainable Energy, LLC (as the manager and operator for the National Renewable Energy Laboratory) for a $3,249,955.00 grant to develop a standardized concept design for a floating, high-voltage direct-current (HVDC) substation for California conditions considering electrical and structural performance, cost, risk, environmental impact, grid integration, supply chain, and logistics; 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

STATE OF CALIFORNIA
CALIFORNIA ENERGY COMMISSION

CEC-270 (Revised 01/2024)

GRANT REQUEST FORM (GRF)

A. New Agreement Number

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

New Agreement Number: EPC-25-035

B. Division Information

1. Division Name: ERDD
2. Agreement Manager: Nathan Lubega
3. MS-:None
4. Phone Number: 916-633-0048

C. Recipient's Information

1. Recipient's Legal Name: Alliance for Sustainable Energy, LLC
2. Federal ID Number: 26-1939342

D. Title of Project

Title of project: A Reference Floating HVDC Substation Design for California

E. Term and Amount

1. Start Date: 10/31/2025
2. End Date: 3/31/2029
3. Amount: $3,249,955.00

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: EPIC (Electric Program Investment Charge)

Agenda Item Subject and Description:

Alliance for Sustainable Energy, LLC. Proposed resolution approving agreement EPC-25-035 with Alliance for Sustainable Energy, LLC (as the manager and operator for the National Renewable Energy Laboratory) for a $3,249,955.00 grant to develop a standardized concept design for a floating, high-voltage direct-current (HVDC) substation for California conditions considering electrical and structural performance, cost, risk, environmental impact, grid integration, supply chain, and logistics. (EPIC funding) Contact: Nathan Lubega

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?
Yes

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: Cal. Code Regs., tit. 14, § 15262

Categorical Exemption?
Yes

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

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

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

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

California Code of Regulations, title 14, section 15306, Information Collection, provides that projects which consist of basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource are categorically exempt from the provisions of CEQA. This project involves a paper design and digital modeling of a concept floating high voltage direct current substation for floating offshore wind. The design and modeling of the substation will involve basic data collection, research, and modeling at an existing national lab facility in Colorado, existing commercial office buildings, and university campus buildings located in California. Therefore, the project is exempt from the provisions of CEQA under section 15306.

The grant project does not include any in-ocean-water testing of substation designs, mooring, or any other equipment. The project does not include any environmental sampling (e.g., water or biota sampling, geotechnical drilling) in the environment, including in the ocean and ocean floor. This grant involves only feasibility or planning studies for possible future actions that appropriate agencies boards, or commissions have not approved, adopted, or funded. Environmental factors of this research have been considered. Therefore, the project is exempt from CEQA under the statutory exemption, Cal. Code Regs., tit 14, Section 15262, Feasibility and Planning Studies. California Code of Regulations, title 14, section 15301, Existing Facilities, provides an exemption from CEQA for the operation, repair, maintenance, permitting, leasing,

licensing, or minor alteration of existing structures, facilities, mechanical equipment or topographical features involving negligible or no expansion of use beyond that existing. This project will conduct research, paper studies, and computer modeling within already existing research, office, and laboratory facilities. There will be negligible or no expansion of existing use. Therefore, the project falls within section 15301 and will not have a significant effect on the environment.

This project does not involve impacts on any particularly sensitive environment; does not involve any cumulative impacts of successive projects of the same type in the same place that might be considered significant; does not involve unusual circumstances that might have a significant effect on the environment; will not result in damage to scenic resources within a highway officially designated as a state scenic highway; the project site is not included on any list compiled pursuant to Government Code section 65962.5; and the project will not cause a substantial adverse change in the significance of a historical resource. Therefore, none of the exceptions to categorical exemptions listed in CEQA Guidelines section 15300.2 apply, 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
DNV Energy USA Inc.	$ 910,907	**$**1,682,478
Cal Poly Humboldt Sponsored Programs Foundation	$ 250,742	**$**0
Hitachi Energy USA Inc.	$ 97,500	**$**39,900

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
No vendors to report	**$**	**$**

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
Aibel AS
Relevant Qualified 7C Fisheries & Tribal Representatives (SB 286 comp.)

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	$ 3,250,000

TOTAL Amount: $ 3,249,955

R&D Program Area: ESB: Renewables

Explanation for "Other" selection Not applicable

Reimbursement Contract #: Not applicable

Federal Agreement #: 101

M. Recipient's Contact Information

1. Recipient's Administrator/Officer

Name: Erin Hensley

Address: 15013 Denver West Pkwy

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

Phone: 303-384-7989

E-Mail: Erin.Hensley@nrel.gov

2. Recipient's Project Manager

Name: Ericka Lozon

Address: 15013 Denver West Pkwy

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

Phone: 269-384-9883

E-Mail: Ericka.Lozon@nrel.gov

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: Nathan Lubega

Approval Date: 9/29/2025

Branch Manager: Kevin Uy

Approval Date: 9/29/2025

Director: Jonah Steinbuck delegated to Branch Manager

Approval Date: 9/29/2025

Exhibit A
Scope of Work
Alliance for Sustainable Energy, LLC

TASK AND ACRONYM/TERM LISTS

Task List

Task #	CPR[1]	Task Name
1		General Project Tasks
2		California Considerations and Stakeholders
3	X	Technology Feasibility and Design Basis
4		Design Exploration
5	X	Reference Design Development
6		Impact Assessments
7		Evaluation of Project Benefits
8		Technology/Knowledge Transfer Activities

Acronym/Term List

Acronym/Term	Meaning
ABS	American Bureau of Shipping
ARIES	Advanced Research on Integrated Energy Systems, recipient's advanced energy research platform
CAISO	California Independent System Operator
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CEC	California Energy Commission
CPR	Critical Project Review
DNV	DNV Group, comprising DNV Energy USA Inc. and DNV USA Inc.
EMT	Electromagnetic Transient
GW	Gigawatt
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
km	Kilometer
kV	Kilo-Volt
LCOE	Levelized Cost of Energy
OEM	Original Equipment Manufacturer
OpenFAST	The recipient's tool for coupled aero-servo-hydro-elastic modeling of offshore structures
ORBIT	The recipient's Offshore Renewables Balance of System and Installation Tool
RAFT	Response Amplitudes of Floating Turbines, The recipient's frequency-domain analysis tool for floating systems

[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
Alliance for Sustainable Energy, LLC

Acronym/Term	Meaning
RAO	Response Amplitude Operator (transfer function of relationship between wave exciting force and floating system movement)
Recipient	Alliance for Sustainable Energy, LLC
SESAM	DNV's suite of software for hydrodynamic and structural analysis of ocean structures
TAC	Technical Advisory Committee
WOMBAT	The recipient's Windfarm Operations and Maintenance Cost-Benefit Analysis Tool

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

A. Purpose of Agreement

The purpose of this Agreement is to fund the development of a reference (standard open-source concept design) floating High Voltage Direct Current (HVDC) substation design for California conditions considering electrical and structural performance, cost, risk, environmental impact, grid integration, supply chain, and logistics.

B. Problem/ Solution Statement

Problem

Traditionally, offshore wind farms have relied on High Voltage Alternating Current (HVAC) grid connections. However, HVAC transmission is impacted by reactive power losses, which decreases efficiency and requires costly AC filtering especially as the distance to shore increases. HVAC can also contribute to grid instability due to the variable output and limited control over voltage and frequency. HVDC transmission is purely active power, so there are no reactive power losses, and the efficiency is higher. Additionally, HVDC offers the potential for increased power flow control, which is critical for maintaining the stability and reliability of the grid. This is particularly crucial for reliable energy sources where the energy generation is variable. However, HVDC technology is nascent and requires further research to bring costs down.

California's offshore wind energy areas pose further challenges. The water depths are deep, ranging from 550 to 1300 m, where fixed-bottom substations are not feasible. Floating substations will be required, which results in the additional challenge of accommodating wind, wave, and current-induced motions in the floating environment. HVDC substations require large and heavy AC/DC converters, which must be supported by the floating platform. Additionally, HVDC technology can be sensitive to floating motions and accelerations. The substation's mooring system must be designed to constrain the motions, considering also the impacts on the attached intra-array and export cables. This creates a complex system engineering problem that requires balancing considerations in platform stability, HVDC equipment robustness, mooring stiffness, and cable excursions.

Solution

The Recipient has developed a strategy to design a floating HVDC substation that is specifically tuned to California's needs. HVDC grid connections for California offshore wind offer improved

electrical efficiency and increased grid stability, which is especially critical as offshore wind farms increase in prevalence and are located further from shore. This research is needed to responsibly meet California's ambitious wind energy goals while lowering transmission losses and limiting grid strain.

To accomplish this, the Recipient will broadly explore design options for a floating HVDC substation, including various options for the platform, mooring system, cables, and electrical equipment. These options will be designed within a California-specific framework that captures considerations in logistics, supply chain, transmission, environmental impact, and cost, then evaluated and compared. The most promising design will be further developed as a reference design, with rigorous dynamic loads[2] analysis in coupled simulations. Nested optimizations of the design's subsystems will ensure an optimal balance in electrical, platform, mooring, and cable considerations to minimize cost. To support grid benefits, electrical control configurations and vendor-neutral communication protocol will be explored and verified through simulations. The reference design will be broadly shared through design reports and input files for tools, enabling widespread use of the design.

Ultimately, this project will develop the first open-source reference floating HVDC substation and accompanying design process that moves the nascent HVDC industry forward. This open-source design process will encourage developers and industry towards standardized approaches that minimize costs and environmental impacts, consider supply chain and logistics factors, and support grid reliability. By lowering barriers to floating HVDC substations, this research will pave the way for floating wind farms that lower the cost of energy while providing improved grid stability and reliability.

C. Goals and Objectives of the Agreement

Agreement Goals

The goals of this Agreement are to:

- Develop a floating HVDC substation design suitable for California's wind farm capacities, water depths, and metocean conditions;
- Characterize California's HVDC substation design considerations into framework that captures constraints in logistics, supply chain, transmission, cost, and feedback from key stakeholders on their concerns and priorities;
- Identify floating substation design tradeoffs in platform stability, electrical infrastructure robustness, and permissible offsets for the mooring systems and cables;
- Develop floating HVDC substation design recommendations and best practices, through recommended design constraints and critical load cases;
- Demonstrate floating substation installation and maintenance innovations that consider California's port and vessel capabilities;
- Verify the electrical efficiency and grid ancillary benefits of HVDC-connected offshore wind farms;
- Assess the readiness of HVDC substations for the California supply chain, global supply chain, and workforce; and

[2] Dynamic loads refers to forces that change over time, such as waves, currents, wind and cause motion, vibration, or impact on offshore structures

- Evaluate the environmental impacts of floating HVDC substations and outline mitigation strategies.

Ratepayer Benefits:[3] This Agreement will result in the ratepayer benefits of greater electrical reliability and lower costs by enabling HVDC transmission for California's offshore wind farms. HVDC reduces transmission losses and increases electrical efficiency compared to traditional HVAC. Previous studies have estimated that HVDC reduces transmission costs by 30% at a 150 km distance to shore. This presents a cost benefit especially for California's future offshore wind farms, which may be located further from shore. Additionally, HVDC transmission enables grid ancillary benefits that contribute to electrical reliability and resilience. HVDC offers greater power flow control and grid ancillary benefits, which are increasingly necessary as the percentage of reliable energy sources in the grid increases.

Technological Advancement and Breakthroughs:[4] 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 designing the first open-source floating HVDC substation for California's conditions and advancing the technology readiness of HVDC transmission for California offshore wind. Current research into floating HVDC substations is preliminary and mostly proprietary. There are a range of floating platforms for other applications, but they have not yet been applied to substations and lack consideration for California's specific challenges. This project will highlight and elevate critical substation design challenges, related to California's supply chain, ports and vessels, transmission, and environment. With a rigorous design exploration and optimization process, the project will determine the least-cost combination of platforms and subsystems while considering California-specific design conditions and constraints. Through open-source sharing of the final reference design in models and reports, the design information will be broadly accessible and encourage industry towards standardized designs.

Agreement Objectives

The objectives of this Agreement are to:

- Design a floating HVDC substation that meets design guidelines in California's metocean conditions. Verify the performance through coupled loads analysis and check against constraints.
- Assess the transmission costs of HVDC and HVAC, demonstrating cost reductions as the distance to shore increases, targeting 30% reduction at a 150 km transmission distance
- Assess the Levelized Cost of Energy (LCOE) of an HVDC and HVAC connected California offshore wind farm, targeting 3% reduction in LCOE
- Determine the electrical losses of the HVDC substation across varying wind conditions, targeting a 2% reduction in losses

[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.

- Assess the electrical efficiency of the HVDC substation compared to HVAC
- Quantify voltage and frequency drops during grid fault scenarios to demonstrate benefits to grid stability

TASK 1 GENERAL PROJECT TASKS

PRODUCTS

Subtask 1.1 Products

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

The Recipient shall:

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

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

For products that require a final version only

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

For all products

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

Instructions for Submitting Electronic Files and Developing Software:

- **Electronic File Format**

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

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

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

- **Software Application Development**

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

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

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

MEETINGS

Subtask 1.2 Kick-off Meeting

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

The Recipient shall:

- Attend a "Kick-off" meeting with the CAM, and other CEC staff relevant to the Agreement. The Recipient's Project Manager and any other individuals deemed necessary by the CAM or the Project Manager shall participate in this meeting. The administrative and technical aspects of the Agreement will be discussed at the meeting. Prior to the meeting, the CAM will provide an agenda to all potential meeting

participants. The meeting may take place in person or by electronic conferencing (e.g., Teams, Zoom), with approval of the CAM.

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

- The CAM's expectations for accomplishing tasks described in the Scope of Work;
- An updated Project Schedule;
- Terms and conditions of the Agreement;
- Invoicing and auditing procedures;
- Travel;
- Equipment purchases;
- Administrative and Technical products (subtask 1.1);
- CPR meetings (subtask 1.3);
- Monthly Calls (subtask 1.5)
- Quarterly Progress reports (subtask 1.6)
- Final Report (subtask 1.7)
- Match funds (subtask 1.8);
- Permit documentation (subtask 1.9);
- Subawards (subtask 1.10);
- Technical Advisory Committee meetings (subtasks 1.11 and 1.12);
- Agreement changes;
- Performance Evaluations; and
- Any other relevant topics.

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

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

The CAM shall:

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

Recipient Products:

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

CAM Product:

- Kick-off Meeting Agenda

Subtask 1.3 Critical Project Review (CPR) Meetings

The goal of this subtask is to determine if the project should continue to receive CEC funding, and if so whether any modifications must be made to the tasks, products, schedule, or budget. CPR meetings provide the opportunity for frank discussions between the CEC and the Recipient. As determined by the CAM, discussions may include project status, challenges, successes, advisory group findings and recommendations, final report preparation, and progress on technical transfer and production readiness activities (if applicable). Participants will include the CAM and the Recipient and may include the CAO and any other individuals selected by the CAM to provide support to the CEC.
CPR meetings generally take place at key, predetermined points in the Agreement, as determined by the CAM and as shown in the Task List on page 1 of this Exhibit.
However, the CAM may schedule additional CPR meetings as necessary. The budget may be reallocated to cover the additional costs borne by the Recipient, but the overall Agreement amount will not increase. CPR meetings generally take place at the CEC, but they may take place at another location, or may be conducted via electronic conferencing (e.g., WebEx) as determined by the CAM.

The Recipient shall:

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

The CAM shall:

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

Recipient Products:

- CPR Report(s)

CAM Products:

- CPR Agenda(s)
- Progress Determination

Subtask 1.4 Final Meeting

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

The Recipient shall:

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

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

Products:

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

MONTHLY CALLS, REPORTS AND INVOICES

Subtask 1.5 Monthly Calls

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

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

The CAM shall:

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

The Recipient shall:

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

Product:

- Email to CAM concurring with call summary notes.

Subtask 1.6 Quarterly Progress Reports and Invoices

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

The Recipient shall:

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

Recipient Products:

- Quarterly Progress Reports
- Invoices

CAM Product:

- Invoice template

Subtask 1.7 Final Report

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

Subtask 1.7.1 Final Report Outline

The Recipient shall:

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

Recipient Products:

- Final Report Outline (draft and final)

CAM Products:

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

Subtask 1.7.2 Final Report

The Recipient shall:

- Prepare a *Final Report* for this Agreement in accordance with the approved Final Report Outline, Energy Commission Style Manual, and Final Report Template provided by the CAM with the following considerations:
    - Ensure that the report includes the following items, in the following order:
        - Cover page (**required**)
        - Credits page on the reverse side of cover with legal disclaimer (**required**)
        - Acknowledgements page (optional)
        - Preface (**required**)
        - Abstract, keywords, and citation page (**required**)
        - Table of Contents (**required**, followed by List of Figures and List of Tables, if needed)
        - Executive summary (**required**)
        - Body of the report (**required**)
        - References (if applicable)
        - Glossary/Acronyms (If more than 10 acronyms or abbreviations are used, it is required.)
        - Bibliography (if applicable)
        - Appendices (if applicable) (Create a separate volume if very large.)
        - Attachments (if applicable)

- Submit a draft of the Executive Summary to the TAC for review and comment.
- Develop and submit a *Summary of TAC Comments on Draft Final Report* received on the Executive Summary. For each comment received, the Recipient will identify in the summary the following:
    - Comments the Recipient proposes to incorporate.
    - Comments the Recipient does propose to incorporate and an explanation for why.
- Submit a draft of the report to the CAM for review and comment. The CAM will provide written comments to the Recipient on the draft product within 15 days of receipt.
- Incorporate all CAM comments into the *Final Report*. If the Recipient disagrees with any comment, provide a *Written Responses to Comments* explaining why the comments were not incorporated into the final product.
- Submit the revised *Final Report* electronically with any Written Responses to Comments within 10 days of receipt of CAM's Written Comments on the Draft Final Report, unless the CAM specifies a longer time period or approves a request for additional time.

Products:

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

CAM Product:

- Written Comments on the Draft Final Report

MATCH FUNDS, PERMITS, AND SUBAWARDS

Subtask 1.8 Match Funds

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

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

The Recipient shall:

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

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

    - A list of the match funds that identifies:
        - The amount of cash match funds, their source(s) (including a contact name,

address, and telephone number), and the task(s) to which the match funds will be applied.

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

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

Products:

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

Subtask 1.9 Permits

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

The Recipient shall:

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

  The list of permits and the schedule for obtaining them will be discussed at the Kick-off meeting (subtask 1.2), and a timetable for submitting the updated list, schedule, and copies of the permits will be developed. The impact on the project if the permits are not

obtained in a timely fashion or are denied will also be discussed. If applicable, permits will be included as a line item in progress reports and will be a topic at CPR meetings.
- If during the course of the Agreement additional permits become necessary, then provide the CAM with an *Updated List of Permits* (including the appropriate information on each permit) and an *Updated Schedule for Acquiring Permits*.
- Send the CAM a *Copy of Each Approved Permit*.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the CAM within 5 days. Either of these events may trigger a CPR meeting.

Products:

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

Subtask 1.10 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
    - 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
- List of TAC Members
- Documentation of TAC Member Commitment

Subtask 1.12 TAC Meetings

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

The Recipient shall:

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

The TAC shall:

- Help set the project team's goals and contribute to the development and evaluation of its statement of proposed objectives as the project evolves.
- Provide a credible and objective sounding board on the wide range of technical and financial barriers and opportunities.

- Help identify key areas where the project has a competitive advantage, value proposition, or strength upon which to build.
- Advocate on behalf of the project in its effort to build partnerships, governmental support and relationships with a national spectrum of influential leaders.
- Ask probing questions that ensure a long-term perspective on decision-making and progress toward the project's strategic goals.
- Review and provide comments to proposed project performance metrics.
- Review and provide comments to proposed project Draft Technology Transfer Plan.

Products:

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

Subtask 1.13 Project Performance Metrics

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

The Recipient shall:

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

Products:

- TAC Performance Metrics Summary
- Project Performance Metrics Results

Exhibit A
Scope of Work
Alliance for Sustainable Energy, LLC

TECHNICAL TASKS

TASK 2 CALIFORNIA CONSIDERATIONS AND STAKEHOLDERS

The goal of this task is to characterize key considerations and challenges for floating offshore substation design specific to California.

TASK 2.1 California Considerations

The goal of this task is to identify California-specific design considerations to include transmission, environmental, supply chain, ports, vessels, workforce, and logistics.

The Recipient shall:

- Map out the California and relevant global supply chain for critical substation Tier 1 (direct supplier) components and determine supply chain strengths and weaknesses.
- Outline key considerations for California/West Coast transmission, drawing from the West Coast Offshore Wind Transmission Study[5] or other relevant research as approved by the CAM.
- Expand the Recipient's existing West Coast ports and vessels knowledge database to reflect key considerations for HVDC substation design.
- Update and expand the workforce occupational map for Offshore Substation Assembly to ensure it is representative of floating HVDC substations and analyze the labor market dynamics of key areas to meet the needs of the workforce.
- Outline recommendations for substation installation, operations, maintenance logistics, and decommissioning.
- Outline key considerations in federal, state, and municipal permitting related to HVDC substations. Determine design modifications that might mitigate permitting challenges.
- Identify all applicable federal, state, and local financial incentives related to HVDC substations and determine potential benefits to local communities.
- Provide an overview of environmental concerns in California wind lease areas, related to floating offshore wind development based on a review of existing and published literature.
- Prepare *California HVDC Substation Design Considerations* that summarizes the above considerations in supply chain, workforce, logistics, stakeholder concerns, permitting, transmission, and environmental concerns as they relate to HVDC substation design.

Products:

- California HVDC Substation Design Considerations report

TASK 2.2 California Stakeholder Engagement

This task is focused on gathering feedback from key stakeholders on their concerns and priorities related to floating HVDC substations off the coast of California.

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[5] Douville, Travis C., Arkema, Katherine K., Boos, Elise C., et al., "West Coast Offshore Wind Transmission Study," (2025), https://doi.org/10.2172/2500279

The Recipient shall:

- Engage with California Native American Tribal communities, ocean users, and key California stakeholders to identify concerns that could inform HVDC substation design, installation, and operation. Key stakeholders may include:
    - Environmental protection groups
    - California Wind Energy Area lease holders
    - Ports
    - Coastal and port communities
    - Local electric utilities
    - Jurisdictional entities (Federal, state and local governments) relating to offshore wind development in California
    - Regulators and policy experts
    - Fishing industry members
- Develop stakeholder engagement plan including identification of strategies and tools (e.g., in person, online, interviews, telephone, written surveys, social media etc.) to engage stakeholders and communities based on the differing geographic locations, level and type of benefits and impacts, and interest in project. Develop list of questions and interview materials, including factsheets and presentations.
- Conduct interviews and gather information on their priorities and concerns, and invite key stakeholders to participate in the Technical Advisory Committee in accordance with subtask 1.11, as appropriate.
- Prepare *Stakeholder Engagement report* that summarizes the results from stakeholder interviews.

Products:

- Stakeholder Engagement report

TASK 3 TECHNOLOGY FEASIBILITY AND DESIGN BASIS

The goal of this task is to identify feasible concepts and system architectures for California's floating HVDC substations and develop a set of design requirements to adhere to.

TASK 3.1 California Design Framework

The goal of this task is to develop a California-specific design framework that captures the considerations from Task 2.

The Recipient shall:

- Translate the California considerations identified in Task 2.1 into quantitative constraints and metrics that can be numerically captured in the substation design process by gathering information about supply chain, vessels, workforce, and port capacities.
- Synthesize the constraints into a quantitative summary of the available infrastructure as it relates to floating HVDC substations and determine critical restrictions for the design.
- Review California transmission and environmental considerations to identify attributes for a successful design (e.g. minimize environmental impact, maximize transmission efficiency), and develop metrics that reflect these considerations. The metrics and factors considered may include:

  - Vessel capacity and availability
  - Port capacity and limitations
  - Workforce capacity
  - Transmission considerations
  - Supply chain considerations
  - Environmental impacts

- Prepare *California Design Framework Summary Spreadsheet* that outlines the constraints and metrics for the substation design based on California considerations. This spreadsheet will contain categories for transmission, environmental, supply chain, ports, vessels, workforce, and logistics. Within each category, the Recipient will list HVDC substation design constraints and metrics, and with explanations of the rational for each.
- Share Draft California Design Framework with TAC and solicit feedback. Adjust accordingly.

Products:

- California Design Framework Summary Spreadsheet (draft and final)

TASK 3.2 Conceptual Design

The goal of this task is to identify substation design concepts and score their feasibility according to the California design framework and technology readiness level.

The Recipient shall:

- Identify existing concepts for subsystems within the substation design, including electrical architecture, platform options, mooring systems, and subsea cable configurations.
- Apply the California Design Framework from Task 3.1 to score the feasibility of the various options and the technology readiness level.
- Prepare *Technology Feasibility Assessment Summary Report* that overviews conceptual design options for the electrical equipment, platform, mooring system, and cables. For each design option, the report will provide a score on the feasibility and technology readiness, and a justification. The feasibility scores will account for considerations from the California Design Framework developed in subtask 3.1, including installation, logistics, stakeholder considerations, supply chain, etc.

Products:

- Technology Feasibility Assessment Summary Report

TASK 3.3 Design Basis

The goal of this task is to develop design requirements for the floating HVDC substation and identify critical load cases.

The Recipient shall:

- With input from the TAC, identify an existing California lease area or future area to focus on for the design effort (for example, Northern California lease area OCS-P0651).

- Develop design requirements and constraints for floating HVDC substations by leveraging subrecipient's experience in a recent Joint Industry Project on floating offshore substations, or other relevant industry collaborations as approved by the CAM, as well as engage project advisors that represent electrical and platform Original Equipment Manufacturer (OEM).
- Identify critical load cases in which to evaluate the design performance. This will be based on DNV Standards[6] (DNV-ST-0145 and DNV-ST-0119), ABS standards[7] (ABS Requirements for Offshore Substations and Electrical Service Platforms) and any future standards that may be identified or developed as approved by the CAM.
- Apply Recipient's existing database on California metocean (meteorology and ocean) data to determine the specific wind, wave, and current assumptions for each load case.
- Identify assumptions for bathymetry and soil data.
- Prepare a *Design Basis* report that includes overviews, methodologies, and summarizes the efforts in this Task, including but not limited to;
    - Design requirements
    - Constraints
    - Critical load cases
    - Site conditions (metocean conditions, bathymetry, soil data)
    - DNV or ABS standards identified
- Submit the draft *Design Basis Report* to the CAM for feedback and incorporate changes as requested in the final *Design Basis Report*.
- Prepare and submit a CPR Report #1 and participate in the CPR meeting in accordance with subtask 1.3.

Products:

- Design Basis Report (draft and final)
- CPR Report #1

TASK 4 DESIGN EXPLORATION

The goal of this task is to explore a range of design concepts for the substation, including potential shared mooring[8] options, and integrate with floating wind farm designs.

TASK 4.1 Preliminary sizing and Design Evaluation

The goal of this task is to perform preliminary sizing and scoring of substation concepts identified in Task 3.2.

[6] DNV Standards refers to industry standards and rules developed for offshore infrastructure in Europe by Det Norske Veritas (DNV).
[7] ABS Standards refers to the American Bureau of Shipping (ABS) safety and performance standards for marine and offshore projects.
[8] Shared mooring refers to systems where offshore platforms are tethered together or to common anchor points thereby reducing the number of anchors required on the seafloor.

The Recipient shall:

- Perform preliminary design, sizing, and cost estimation of topside[9] for OEM standard HVDC voltages and configurations, such as 320 kV monopole for 1 – 1.4-Gigawatt (GW) capacity and 525 kV bipole for 1.4 – 2.2 GW capacity, or others as approved by the CAM.
- Scale Recipient's existing cost breakdown for HVDC topside and substation components (including converter, breaker, and ancillary system) for the standard configurations of 320 kV monopile and 525 kV bipole, or others as approved by the CAM.
- Perform preliminary design, sizing, and cost estimation of several platform types, mooring systems, and cable configurations, while adhering to constraints in the California design framework. Compare the benefits and drawbacks of the 320 kV and 525 kV solutions, or others as approved by the CAM, including tradeoffs between increasing capacity while also increasing topside weight and size.
- Using Recipient's existing software package, perform initial checks on performance metrics (platform stability, offsets, accelerations, tensions, etc.) and make design adjustments.
- Share preliminary design options with stakeholders and solicit feedback.
- Apply the substation design framework to holistically evaluate and score the design options and select the most promising configuration. The evaluation and down selection process will include comparisons for preliminary cost estimates, install ability, supply chain preparedness, stakeholder feedback, and other California design considerations.
- Prepare *Design Exploration and Selection Report* that outlines the developed preliminary designs and the selected design, to include the following:
    - Early specifications of topside and platform dimensions
    - Mooring line types and sizes
    - Cable configurations
    - Initial performance metrics
    - Cost metrics
    - Overview of stakeholder feedback
    - Discussion on benefits and drawbacks
    - Selection criteria for design

Products:

- Design Exploration and Selection Report (draft and final)

TASK 4.2 Evaluation of Shared Mooring Redundancy options

The goal of this task is to evaluate the benefits and drawbacks of shared mooring systems for the substation, including redundancy and cost implications.

The Recipient shall:

- Explore possible shared mooring configurations for the floating substation, drawing from the ongoing CEC grant project "Comprehensive Shared-Mooring Solutions to Minimize

[9] Topside refers to the upper part of an offshore structure that sits above the waterline and contains the electrical equipment and auxiliary systems.

the Cost, Risk, and Footprint of GW-Scale Floating Wind Farms" or other relevant research as approved by the CAM. These mooring configurations would offer another attachment point to adjacent platforms in the event of anchored line failures.
- Perform preliminary checks on mooring line tensions and substation offsets. Evaluate the benefits, cost implications, and risk of shared moorings for substations.
- Determine whether to include shared moorings based on holistic considerations including cost, environmental impact, and risk. If needed, update substation design from Task 4.1 based on the findings.
- Prepare *Shared Moorings for Floating HVDC Substations Summary Report* that outlines the developed shared mooring configurations, benefits, and drawbacks.

Products:

- Shared Moorings for Floating HVDC Substations Summary Report

TASK 4.3 INTEGRATION WITH CALIFORNIA FLOATING ARRAY DESIGNS

The goal of this task is to integrate the HVDC substation design into Recipient's existing reference array designs and optimize the positioning within the layout.

The Recipient shall:

- Adapt Recipient's existing California reference floating array designs for the selected lease area of Task 3.3. Solicit feedback from the TAC on the array designs and adjust accordingly.
- Apply Recipient's cable routing functionality and floating array design toolset to optimize the location of the substation within the array layout based on LCOE. Determine the optimal number of intra-array cable strings.
- Update the substation design from subtasks 4.1 and 4.2 based on the array layout and attached cables.
- Prepare *Integrated Floating Wind Farm and Substation Design Summary Report* that outlines the process and outcomes of optimizing the substation location within a wind farm.

Products:

- Integrated Floating Wind Farm and Substation Design Summary Report

TASK 5 REFERENCE DESIGN DEVELOPMENT

The goal of this task is to develop and refine the optimal substation configuration from Task 4 as an open-source reference concept design.

TASK 5.1 Optimization of Coupled System

The goal of this task is to optimize the complete coupled system, including platform, electrical equipment, moorings, and cables, considering design tradeoffs in constraints.

The Recipient shall:

- Optimize the design of critical HVDC electrical equipment, considering the accelerations and motion of the platform. Assess the impact of varying the allowable accelerations on the cost and sizing of the equipment.
- Develop platform design optimization routines, relying on Recipient's efficient frequency domain floating system model RAFT or other models as approved by the CAM. Set up a nested optimization of the platform, mooring system, and cables. Iterate with varied electrical equipment limitations.
- Assess the tradeoff between HVDC equipment robustness, floating platform stability, and allowable platform offsets to map a trade-space of best designs. Identify the optimal design.
- Prepare *Substation Design Optimization and Tradeoff Analysis Report* that outlines the design optimization process and key design tradeoff considerations.

Prepare and submit a CPR Report #2 and participate in the CPR meeting in accordance with subtask 1.3.

Products:

- Substation Design Optimization and Tradeoff Analysis Report
- CPR Report #2

TASK 5.2 Dynamic Loads Analysis and Refinement

The goal of this task is to simulate the performance of the complete substation design in critical design load cases and check adherence to constraints outlined in the Design Basis.

The Recipient shall:

- Develop model of platform, mooring system, and attached cables in coupled dynamic simulation tool OpenFAST or other tools as approved by the CAM.
- Run simulations of the model in California conditions for the critical load cases identified in Task 3.
- Evaluate performance according to design requirements in the Design Basis from DNV and ABS standards. Iterate on the design to satisfy requirements.
- Prepare *Reference Floating HVDC Substation Design Report* that documents the design specifications and performance, including:
    - Platform and topside dimensions, weights, and volumes
    - Mooring system line types, sizes, and lengths and anchor sizes

  - Intra-array dynamic cable global configurations (cable lengths and dimensions, buoyancy module specifications)
  - Performance results in critical load cases including:
    - Platform motions, accelerations, natural frequencies, and Response Amplitude Operator[10]
    - Mooring system tensions and fatigue life
    - Anchor loads
    - Cable tensions and curvature
- Prepare *OpenFAST Input Files of Reference Design* publicly available on GitHub

Products:

- Reference Floating HVDC Substation Design Report (draft and final)
- OpenFAST Input Files of Reference Design

TASK 5.3 Structural and Cable Design Advancement

The goal of this task is to develop a preliminary structural design for the platform and topside, and cable attachments.

The Recipient shall:

- Develop initial SESAM software models of preliminary designs to ensure alignment between OpenFAST and SESAM or other models as approved by the CAM.
- Develop detailed model of reference design's platform, mooring system, and attached cables in coupled dynamic simulation and structural tool SESAM or other tools as approved by the CAM.
- Add simple structural members to the platform and perform preliminary structural sizing
- Incorporate more detailed cable modeling with cable-platform attachments such as bend stiffeners and J-tubes.
- Evaluate the strength of the cable attachments and iterate as needed to ensure performance criteria are met in critical load cases.
- Prepare *Floating HVDC Substation Structural Design and Cable Attachments Summary Report* that details the structural elements, cable attachments, and performance results from SESAM.
- Prepare *SESAM input files of reference design* available on GitHub

Products:

- Floating HVDC Substation Structural Design and Cable Attachments Summary Report
- SESAM Input Files of Reference Design

[10] Response Amplitude Operators (RAO) refer to engineering functions that define the ratio of a floating structure's motion (surge, sway, heave, roll, pitch, yaw) in response to the amplitude of a wave causing that motion.

TASK 5.4 Electrical Control Configuration and Communication Protocol

The goal of this task is to explore vendor-neutral control configurations of HVDC offshore wind farms along with the standard communication protocol, and to analyze their contribution to ancillary grid services. Their performance is verified through high-fidelity Electromagnetic Transient *(*EMT) simulations to ensure dynamic stability and reliable operation.

The Recipient shall:

- Leverage Recipient's ARIES' high-fidelity real-time digital simulation environments to explore and evaluate the dynamic performance of HVDC and offshore wind farm configurations suitable for deployment on California's grid.
- Integrate HVDC offshore wind farm throughout the vendor-agnostic EMT models and validate its control architecture for compliance with grid codes, dynamic stability, and coordinated operation under high penetration of variable energy sources.
- Implement and analyze standardized communication frameworks between HVDC offshore wind farms and onshore transmission systems to ensure reliable control signal exchange under various conditions.
- Analyze system-level interactions between offshore wind farms, HVDC platforms, and the onshore grid using real-time digital simulations with EMT model to assess stability, controllability, and resilience**.**
- Analyze the potential impacts and benefits of the ancillary services from the HVDC offshore wind farm to the California grid at the point(s) of interconnection identified in CAISO transmission plans.
- Prepare *Electrical Control Configuration and Communication Protocol Summary Report* that outlines the electrical controls, communications, system performance, and grid impacts and benefits.

Products:

- Electrical Control Configuration and Communication Protocol Summary Report

TASK 6 IMPACT ASSESSMENTS

The goal of this task is to perform cost, supply chain, logistics, and environmental assessments of the final design and produce recommendations for areas of future improvement.

TASK 6.1 Environmental Impact Assessment

The goal of this task is to assess potential environmental impacts of the final substation design and outline modifications and mitigation strategies to reduce these impacts.

The Recipient shall:

- Conduct an environmental impact characterization of the final design to determine how the Project may affect the marine environment, wildlife, and their habitats.
- Analyze potential effects due to construction/installation, operation, and decommissioning of the Project.

- Review design specifications, as well as relevant environmental studies to determine potential effects from the developed design. This literature review will summarize and convey current findings related to potential impacts. Areas of specific interest include:
    - Impact of water-cooling system discharge on water quality and temperature
        - Risk of impingement or entrainment of sea life from the Project's water-cooling system intake
        - Potential effects of electromagnetic fields on marine species
        - Environmental impacts of the substation's mooring system and dynamic power cables. This will leverage the environmental impact framework from Recipient's CEC Shared Moorings project and include considerations for entanglement, seabed disturbance, and collision risk.
        - Impacts of installation and decommissioning of the substation, such as vessel noise

- Explore the benefits and drawbacks of possible environmental mitigation techniques, such as substation design changes to minimize environmental impact and integration of environmental monitoring technologies. Provide recommendations for developers and policymakers of mitigation strategies that best address areas of concern for HVDC substations.
- Prepare *Environmental Impact Characterization Report* that outlines environmental risk areas and mitigation strategies.

Products:

- Environmental Impact Characterization Report

TASK 6.2 Supply Chain Assessment

The goal of this task is to assess how well the final substation design is suited to the existing supply chain and workforce and identify areas in need of future development.

The Recipient shall:

- Compile key supply chain considerations for proposed substation design.
- Compare initial supply chain assessment to supply chain requirements of design.
- Identify supply chain areas in need of development and potential opportunities for domestic supply chain investment.
- Conduct a review of education and training programs relevant to workforce development for floating offshore substation assembly, identifying gaps and opportunities for improvement.
- Prepare *Supply Chain and Workforce Readiness Report* that summarizes key considerations in supply chain and workforce for the reference substation design. Identify critical gaps and recommendations for state policy makers, developers, and stakeholders to consider which would result in strengthening the supply chain.

Products:

- Supply Chain Readiness Report

TASK 6.3 Technoeconomic Assessment

The goal of this task is to determine the LCOE of the reference design, including detailed installation and logistics modeling.

The Recipient shall:

- Develop installation and logistics sequences for the reference design.
- Modify Recipient's cost modeling tools ORBIT and WOMBAT, or other tools as approved by the CAM, to best capture floating HVDC substation installation and maintenance
- Complete LCOE assessment in Recipient's tools using wind farm layouts from Task 4.3 for the reference floating HVDC substation design.
- Complete an LCOE assessment utilizing Recipient's existing tools for an equivalent HVAC substation.
- Prepare *Technoeconomic Assessment Report* that outlines the cost modeling assumptions and comparison results. Identify critical cost drivers and include recommendations for lowering LCOE such as future design adjustments, choice of materials, supply chain factors, etc.
- Prepare *ORBIT Input Files for Final Design* available on GitHub.
- Quantify the performance metrics in the Measurement and Verification plan including capital costs, operational costs, LCOE, system efficiency, and generation capacity. Prepare a *Measurement and Verification of Project Benefits Summary Report* that quantifies the performance for each metric.

Products:

- Technoeconomic Assessment Report
- ORBIT Input Files for Final Design
- Measurement and Verification of Project Benefits Summary Report

TASK 7: EVALUATION OF PROJECT BENEFITS *(Mandatory task)*

The goal of this task is to report the benefits resulting from this project.

The Recipient shall:

- Complete *the Initial Project Benefits Questionnaire*. The Initial Project Benefits Questionnaire shall be initially completed by the Recipient with 'Kick-off' selected for the 'Relevant data collection period' and submitted to the CAM for review and approval.
- Complete the *Annual Survey* by January 31st of each year. The Annual Survey includes but is not limited to the following information:
    - Technology commercialization progress
    - New media and publications
    - Company growth
    - Follow-on funding and awards received
- Complete the *Final Project Benefits Questionnaire*. The Final Project Benefits Questionnaire shall be completed by the Recipient with 'Final' selected for the 'Relevant data collection period' and submitted to the CAM for review and approval.
- Respond to CAM questions regarding the questionnaire drafts.

- Complete and update the project profile on the CEC's public online project and recipient directory on the Energize Innovation website (www.energizeinnovation.fund), and provide *Documentation of Project Profile on EnergizeInnovation.fund*, including the profile link.
- If the Prime Recipient is an Innovation Partner on the project, complete and update the organizational profile on the CEC's public online project and recipient directory on the Energize Innovation website (www.energizeinnovation.fund) and provide *Documentation of Organization Profile on EnergizeInnovation.fund*, including the profile link.

Products:

- Initial Project Benefits Questionnaire
- Annual Survey(s)
- Final Project Benefits Questionnaire
- Documentation of Project Profile on EnergizeInnovation.fund
- Documentation of Organization Profile on EnergizeInnovation.fund

TASK 8 Technology/Knowledge Transfer Activities *(Mandatory task)*

The goal of this task is to ensure the scientific and techno-economic analysis and tools developed under this agreement are utilized in the energy policy, and/or planning decisions at the state and/or local levels, academic community and/or commercial sector.

The Recipient Shall:

- Develop and submit a *Knowledge Transfer Plan* that identifies the proposed activities the recipient will conduct to meet the goal of the task. The *Knowledge Transfer Plan* should include at a minimum:
    - Specific policy and planning efforts this project is expected to inform.
    - Specific stakeholder groups and energy policy and planning practitioners who will utilize the results of this project.
    - Proposed activities the Recipient will conduct to ensure the tools and results from this project will be utilized and adopted by the groups identified above.
- Present the *Draft Knowledge 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 Knowledge Transfer Plan*. This document will identify:
    - TAC comments the Recipient proposes to incorporate into the *Final Knowledge Transfer Plan*.
    - TAC comments the Recipient does not propose to incorporate with and explanation why.
- Submit the *Final Knowledge Transfer Plan* to the CAM for approval.
- Implement the activities as described in the *Final Knowledge Transfer Plan.*
- Develop a *Knowledge 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 California CEC.
- Provide at least (6) six High Quality Digital Photographs (minimum resolution of 1300x500 pixels in landscape ratio) of pre and post technology installation at the project sites or related project photographs.
- Host a virtual public workshop to disseminate the reference substation design and key findings, including overviewing the design methodology, products and open-source files, and areas of future work.
- Prepare a GitHub ReadMe file on repository that overviews the design files and how they can be used.

Products:

- Knowledge Transfer Plan (draft and final)
- Summary of TAC Comments
- Technology Transfer Summary Report (draft and final)
- High Quality Digital Photographs
- ReadMe file published to GitHub