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DRAFT RESEARCH CONCEPT

"ADVANCE TO NEXT-GENERATION OFFSHORE WIND ENERGY TECHNOLOGY"

Summary of Public Discussion

On October 22, 2020, California Energy Commission staff held a scoping workshop titled "Advance to Next-Generation Offshore Wind Energy Technology." The objective of the workshop was to seek public comments from offshore wind energy researchers, industry, and other stakeholders on the draft research concept "Advance to Next-Generation Offshore Wind Energy Technology" for potential applied research projects that facilitate the deployment of floating offshore wind energy (FOSW) and result in increased cost competitiveness, performance, and reliability, while increasing the knowledge of the environmental and wildlife impacts of FOSW in California.

Feedback and suggestions gathered from experts and stakeholders during this workshop are informing research concepts and funding initiatives for the Electric Program Investment Charge (EPIC) interim and full fourth investment plans.

Staff received oral and written comments during the workshop. Written comments were received through November 16, 2020. Staff will consider the comments in forthcoming solicitations.

Research Concept

The objective of the project under this draft research concept is the development and pilot demonstration of innovative FOSW component(s), tool(s), and installation processes that advance the readiness and cost-competitiveness of FOSW in California, while increasing the understanding of how FOSW installation and deployments may affect sensitive species and habitats. The expected research project includes a FOSW technology pilot demonstration; with a technology readiness TRL5 at the beginning of the project and advancing to TRL7-8. TRL5 represents the bridge from scientific

research to engineering, where a high-fidelity lab-scale system is tested in a relevant environment. TRL7-8 represents the end of true system development.

The specific objectives of the proposed research are the following:

1. Spur innovation in manufacturing/assembly processes and materials for FOSW component(s) (e.g. substructure, foundation and support substructure) and demonstrate readiness and cost-competitiveness at a pilot scale to validate the expected benefits, such as LCOE reduction and increase the understanding of potential environmental and wildlife impacts of FOSW projects.
2. Test and validate a monitoring system for FOSW applications that support reduction of installation and O&M costs and increase commercial readiness.
3. Develop tools or methods for assessing and monitoring the environmental impacts (e.g. on marine biodiversity or habitat, currents and upwelling) related to assembly processes and operation of FOSW component(s).
4. Build a consortium that works on the development of parallel solutions for technical and environmental challenges that facilitate the deployment of cost effective and environmentally-friendly FOSW projects in California.

Envisioned requirements for the proposed research include:

- Meeting the specific objectives mentioned above.
- For field testing and validation, securing a site and associated permissions, with permitting and site assessments underway or complete, and all construction engineering and hardware selection underway.
- For test facilities, demonstrating commitment of the testing site manager to collaborate with the project.
- Identifying solutions for the end-of-life of the FOSW component(s) developed, tested, and installed under the proposed project.

Envisioned metrics include:

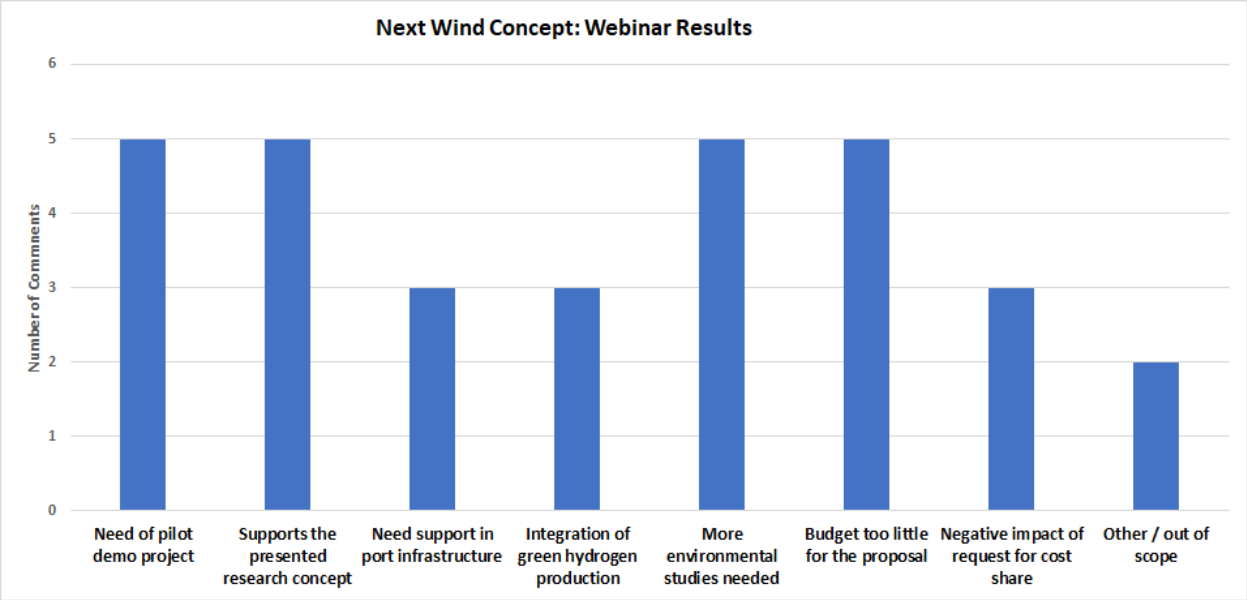
- Demonstrating how the innovative technology and tools will contribute to a LCOE for offshore wind energy lower or equal to $75/MWh.
- Advancing the FOSW and monitoring technology to TRL7-8.

<u>Workshop Agenda</u>

- Introduction
- CEC staff presentation on the draft research concept
- Open discussion based on eight prepared questions
- Q&A

Figure 1 depicts the number of public comments received per subject. Among the discussed subjects are the need of support for a pilot project in California, support to the research concept, and the need for environmental studies.

Figure 1: Distribution of Received Comments per Subject



Main Comments on Prepared Questions

Oral comments were received during the workshop on October 22, 2020. Written comments were submitted to 19-ERDD-01 to the project title "Research Idea Exchange" through November 16, 2020.

1. **Which key research areas were not (fully) addressed in the draft research concept, but should be taken into consideration?**

- Levelized cost of energy (LCOE) should be considered as a top priority.

- Impacts on seafood supply and economic development of local ports, harbors, and communities should be taken into consideration.

- Innovative ideas of storage technologies and offshore wind energy should be included in the research areas.

- It is suggested specific research on early demonstrations with up with 30MW per technology where such project is early stage with individual units that break new grounds for industry and workforce development, as well as pre-commercial projects (100-300MW) where budget permits. Additional development and investment need of the local supply chain and local infrastructure are also needed.

- It may be beneficial for CEC to specify all the components and parameters to be included in the LCOE calculation. For instance, some consortiums do not include any pre-project costs, such as permitting, regulatory approvals or site surveys in the LCOE values. Other consortiums will include everything from start of planning to

decommissioning at project end. Also, CEC may want to define the project duration, discount rates and inflation rates to be used as these financial factors have a big impact on LCOE values. The target value of $75/ MWh is achievable with the largest wind farms offshore. However, while this value is often touted by producers for various projects it is difficult to independently verify.

- Research is also needed to test the material performance at both materials and structural scales. Some observations: Corrosion is a major issue for steel structures. Stronger and tougher materials are needed for offshore wind structures. Advanced manufacturing methods must be coupled with testing the performance of the structural components made by this manufacturing approach. The field performance of offshore turbine structures needs to be monitored long term. Such performance includes cracking, damage, deformation, degradation, and deterioration. Life cycle assessment is needed to compare and evaluate the impacts of different materials (conventional vs. new) and manufacturing technologies. While this is a rapidly emerging area with lots of exciting new technologies being developed, it becomes crucial to educate and train the next-generation workforce so they're well prepared to enter this industry. Applied university research can be a great vehicle for this mission to bring much broader impacts to the industry as well as the general public.

- The CEC research concept is critical to facilitating the deployment of floating offshore wind energy and increasing the cost competitiveness, performance, reliability, and knowledge of the environmental and wildlife impacts of FOSW in California.

- A large-scale industry will not materialize without state leadership and action. Furthermore, slow, incremental development of offshore wind at a scale of a few turbines at a time is a failing approach. The fact there are no offshore wind turbines online in California today despite the massive need and value of this resource is cause for aggressive and comprehensive planning, not small, timid steps.

2. What type of innovation is needed in design and material science that support the improvement of substructure and foundation components?

- Materials for sub structures and foundations that can be manufactured in a faster manner, using local materials. It can be stronger and more durable materials, especially for its harsh complex ocean environment, which require less energy to be produced and hopefully have lower carbon footprint as well. For instance, recycled materials from previous projects would be a great direction to go as well.

- Three-dimensional concrete printing technologies for both onshore and offshore wind fixed-bottom and floating structures have a very strong value proposition. As the concerns about greenhouse gases (GHG) increases, there is a research opportunity in the development of materials with low GHG emissions and cost, and high durability and marine corrosion resistance.

- Funding is needed for research in multi turbine anchoring designs and strategies, as well as the fabrication processes to accommodate for module fabrication within the local supply chain for both steel and concrete.

- It may be beneficial for CEC to specify all the components and parameters to be included in the LCOE calculation.

3. Floating substructures have been demonstrated outside California's environment and context; what are the R&D opportunities to reduce costs of floating substructures for potential projects in California?

- Floating sub structures have been demonstrated outside of California, but not in this size. This research also gives an opportunity to California to evaluate the current supply chain, facilities, which have ocean access, etc. Infrastructure and what kind of manufacturing methods are you using are two areas that should be looked at.

- Sandia Laboratories has developed a floating Vertical Axis wind turbine design which took 4 years to develop and is now complete. Advancement of this concept is now being led at University of Dallas by Todd Griffith, funded by US Dept. of Energy. CEC should consider promoting this technology.

- Support to emergent floating structure technology demonstration in the California environment is needed, otherwise the market will be dictated by a first to market philosophy rather than identifying and using the most appropriate technology.

- The Commission should refrain from focusing funds on floating platform technologies. This work is already underway in the private sector by individual companies. It is recommended avoiding investing in research and development that would duplicate research already underway in Europe.

- The examples for FOSW components should also explicitly list mooring and anchoring systems as an example project for clarity.

4. What type of innovation is needed in design and material science that supports the improvement of inter-array and export cables?

- Cierco has worked on alternative array grid layouts and there are opportunities to explore this area. There could be a decentralization of the otherwise large substations to more modest group transformer strategies, connecting smaller 5-9-unit clusters in a radial "spoke" cabling layout. This could have large cost reduction impact on floating intermediary transformer platforms and the overall grid design.

- Research on mooring systems and cabling should build off global research to determine the best approaches and systems for the California offshore wind environment.

5. **What environmental studies are needed to complement current studies and support the deployment of FOSW in California? Please provide details.**

- California AWEA recommends continued investment into research on potential environmental impacts. This should include research on not only monitoring and validation of potential mitigation technologies and strategies, but also on pre-permitting/pre-development surveys that will facilitate project siting and permitting in the future. They also recommend engaging with the Pacific Offshore Wind Energy Research collaboration of environmental NGOs and wind developers to help identify priority research topics and questions.

- There is a need to study all species and habitants, thus being more encompassing and holistic. It is dubious at best to develop offshore wind in this area or if offshore wind is necessary.

- There is real value in enabling studies that allow for primary data collection. There is insufficient information about the specifics within benthic habitat. The CEC will find real value in collecting primary data through core samples to investigate the specific geology in the already identified areas.

- Incorporating passive acoustic monitoring during all phases of development to record the ambient noise and detect vocalizations from high frequency marine mammals. Testing and evaluation of various benthic sampling approaches and techniques. Novel habitat modelling approaches and techniques which will increase our understanding of habitat.

- There is still much to be discovered and learned about the deep ocean environment and biosphere offshore California. The CEC may wish to consider additional research on how to mitigate the possibility of mooring line or power cable impact on whales.

- The draft research concept outlines the need to mitigate or minimize disruption to wildlife and ecosystems, but a full conceptualization of research needs on this topic will require a great deal more detail. In particular, project managers will have to determine whether the siting of FOSW structures will displace species; disrupt species' behavior; or alter the density, distribution and diversity of prey species. CEC research initiatives, BOEM research, studies from the Schatz Center at Humboldt State, and other relevant wildlife and habitat studies must present a complete picture of the risks posed by FOSW activities to marine and coastal species and ecosystems.

- Construction and deployment activities must safeguard valuable and vulnerable ocean and terrestrial habitats, fish and wildlife, cultural resources, and communities.

6. **What would be the appropriate level of project funding that would leverage private investments associated with the research proposed in this draft concept?**

- If the CEC is looking for innovation with high-risk concepts, that will discourage companies from participating. It might be possible to have a scale for match funding. For FOSW, you might want a smaller grant size. One size may not fit all.

- From a manufacturing perspective, pilot-scale projects could be for components. We can't connect anchors to a pilot scale wind turbine system. Pilot scale is possible, but a lot of care must be taken with the definition.

- If the funding is intended to put hardware in the water, you are looking at a large sum of money. I think it needs to be a realization, that this probably will not happen because of the amount of money required. It will be prohibitive. I want to stress expectations; The CEC cannot really expect an installation for FOSW considering the amount of money on the table.

- There might be a way to scale down these designs. Specify the details of modeling. Don't let the stakeholder define these metrics.

- There is a mismatch between proposed budget and the language around pilot scale. I would also like to push for a raise in the budget for this potential project. This is difficult for early-stage design.

- It's important for the Commission to understand that developers are poised and ready to do utility scale wind off the coast of California. There are still unknowns and technical challenges, but there is a noble effort to be a part of it (cost constraint). The industry is not looking for demonstration projects. I think you really need to take a look and eliminate a pilot scale in the water. Otherwise, the developers will not be interested in participating.

- The worldwide industry for offshore wind technology has already been developed so much, that the pilot project would not be necessary here.

- It should be noted that the environmental, political, and logistical conditions around the world differ from California in some significant ways.

- There were some comments during the open discussion that prototype costs for existing floating substructures were in the range of $100 million (Hywind) or $70 million (WindFloat). These values include a lot of technology development and engineering for many years ahead of the prototypes. It is highly likely that the cost of a next-generation prototype floating system will be substantially lower than existing legacy designs. This may provide an opportunity for CEC to fund a next-generation substructure and floating system, tailored to the unique challenges of California, at much lower cost than legacy designs.

- Some suggestions: 1) Reduce the minimum match share requirement from 25% to approximately 10% or less; 2) Decrease the smallest project award size to

approximately $3M (eligible projects from $3M to $5M); 3) Reduce the eligible beginning Technology Readiness level to TRL 4-5, and end of project TRL to 6-8.

7.) CEC-funded studies have recommended research projects on alternative transmission paths, such as green hydrogen production and energy storage, that avoid costly transmission upgrades in the short time. What type of research project would you identify as a critical to facilitate the deployment of alternative transmission paths in California?

- Our company was funded by an EPIC grant to build the state's first hydrogen renewable project. This project is tied to an existing wind turbine. I would encourage staff here to better understand how hydrogen can play a role and correlate that to offshore wind as well. We need to look at paper studies and various studies. Can we use electrolysis at the turbine itself? Various concepts out there that are talked about between hydrogen and wind developers that will help drive down the cost of offshore wind. We would also recommend the idea of sector coupling.

- FOSW provides natural environment to utilize hydrogen production. Some of the studies of the work that has been done already will be appropriate. I want to remind everyone of the time it takes to implement these projects and that it will be long. This needs to happen during the initial time frame. Some of the funding could become usable because these demonstrations could happen during the time of development. You can only do paper analysis in the projected time frame.

- North Coast has currently fewer permitting issues because the military is not objecting to this. But there are several issues preventing commercial development including transmission. The industry has to be prepared for multiple commercial projects to inform how to move forward.

- One of the applications we have identified is ocean energy storage. Pumped hydro storage that has been developed by Germany and demonstrated in deep water (the deeper the better). California is a large potential market for this technology and would couple very well with offshore wind. There is a lot of interest in storage and potential money from the U.S Department of Energy and private investments. Economic and long term, early investment into these technologies by the California Energy Commission could help to achieve the development that's necessary to bring these technologies to market.

8.) CEC-funded studies have also identified port infrastructure as a market barrier to deploy FOSW projects in California. Which research projects do you identify as critical to advance port readiness to support FOSW?

- Providing funding for early-stage foundation and substructure is a good approach.

- There are only a few ports in California that could support offshore wind in comparison to the east coast. In terms of identifying port infrastructure, it would help to focus on where development can happen.

- We are quite active in on and offshore wind. One of the recent projects we obtained a lot of value from is fixed bottom substructures. This is to include the printing of floating anchors. Studies are important to small companies who have limited means and resources. New technologies may make previous ports that could have been written off as potentially valuable as O & M sites.

General Comments

- It seems the CEC must be focused on a future path to longer-term economically viable offshore wind energy and answering the question, what type of research might facilitate movement toward or down that path? Commercial interests are naturally more interested in getting started down a path with a glimmer of gold at the end. Has the State of California developed a plan, or is it developing a plan that would describe or identify what the State believes would be a suitable if not preferred use of the vast wind resource potential of the Pacific Ocean off the California Coast? That is, a plan that would benefit ratepayers, taxpayers, citizens, the environment, create jobs in California, and provide an opportunity for those providing the capital to earn a decent return on their investments.

- A well-documented plan should show a clear path to a viable market in California. The CEC can train its staff or bring in consultants to quickly determine which plans are reasonably viable in bringing a technology through the commercialization process sin a reasonable amount of time. The methodology should look at where the technology is in the technology readiness level process and who funds which parts of the process.

- Some considerations: 1) California, and the U.S. west coast, is limited in the infrastructure that could be used to build, install, and support large offshore wind platforms or windfarms; 2) CEC may want to reconsider the necessity of going to very large offshore wind farms and may instead want to consider windfarms with a smaller substructure that can be built in California, providing fabrication jobs, and that can be installed and maintained using available west coast assets; large horizontal axis wind turbines require more spacing between platforms which also increases the cost of in-field power cable costs.