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VLO Comments Regarding California Advanced Wind Technology

Additional submitted attachment is included below.

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Summary Response

Date	November 12, 2020
From	Mr. S.A.Shelley, VP Energy and Renewables VL Offshore, LLC
To	Ms. Silvia Palma-Rojas Californian Energy Commission
Subject	Response to TN235191, Draft Research Concept on Advance to Next-Generation Offshore Wind Energy Technology
References	[1] TN 235191, Draft Research Concept on Advance to Next-Generation Offshore Wind Energy Technology [2] NREL-TP-5000-72981 The Vineyard Wind Power Purchase Agreement [3] DOE F 241.3 WindFloat Pacific Project, Final Technical / Scientific Report [4] Daily Astorian, November 25, 2015, WindFloat Power Too Expensive for Utilities (by Hillary Borrud) [5] https://www.edp.com/innovation/windfloat, WindFloat Atlantic Pre-Commercial Phase [6] DOE/GO-102016-4917 U.S. Department of Energy Wind Energy Technologies Office, Offshore Wind Projects, Funding in the United States Fiscal Years 2006 – 2016 [7] GL Hassan 700694 USPO-R-03E Assessment of Wind Offshore Port Readiness [8] OTC-28700-MS Comparing Levelized Cost of Energy for a 200 MW Floating Wind Farm using Vertical and Horizontal Axis Turbines in the Northeast U.S.A. [9] https://eventsribe.com/2020/rd-symposium/ [10] https://phys.org/news/2019-01-erosion-turbine-blades-artificial-intelligence.html [11] https://weatherguardwind.com/leading-edge-erosion/ [12] California Hydrogen Business Council White Paper, The Case for Power to Gas, the Case for Hydrogen [13] NREL-TP-5000-75618 Cost of Floating Offshore Wind Using Aqua Ventus
Attachments	None

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Dear Ms. Palma-Rojas;

I thank you and your colleagues at the California Energy Commission (CEC) for their time and commitment to advancing toward achieving California's renewable energy goals.

After attending the on-line workshop in October, I drafted a few comments and responses to both the Draft Research Concept [1] and some of the open discussion during various session. I kindly submit my comments in the following sections for CEC consideration.

I. CEC Study Objectives

According to the Draft [1], the objectives of the project are the development and pilot demonstration of innovative floating offshore wind (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 may affect sensitive species and habitats. In particular, the expected research project(s) will be technology pilot demonstration, with a technology readiness TRL5 at the beginning of the project. More specific objectives are as follow:

1. Innovate manufacturing/assembly processes and materials for FOSW component(s) (e.g. substructure, foundation and support substructure) to validate the expected benefits, such as LCoE reduction lower or equal to $75/MWh.
2. Test and validate a monitoring system for FOSW applications that support reduction of installation and Operating and Maintenance (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 manufacturing/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 environmental-friendly FOSW projects in California.

II. VLO Comments Regarding Innovative Components (1 above)

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. Defining the total system LCoE input parameters and as many financial parameters as much as possible will allow for a much more robust comparison and evaluation of different technologies.

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 [2]. In the case of the WindFloat Pacific project proposed in 2016, LCoE values were similarly obscured for commercial reasons and could only be approximately determined from published research [3] or news reports [4].

The $75 /MWh target value is achievable with large, fixed windfarms offshore Europe, areas with relatively shallow water depths and near to supporting infrastructure. Offshore California the water depths increase rapidly, and California has extremely limited offshore infrastructure to support a highly efficient offshore wind farm fabrication and installation campaign that will make it especially difficult to achieve the target value. In addition, existing substructure designs still rely upon substantial grants (in the case of WindFloat Atlantic, over 1 million Euro granted per MW [5]) in order to continue installations and it is uncertain if legacy substructure designs can be scaled sufficiently to achieve economies of scale and required LCoE target values without continued subsidies.

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 [6]. Such engineering included, for example, developing software and procedures to analyze the fully coupled motions and loads of the turbines and platforms. 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.

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 [7]. For the WindFloat Pacific project proposed for Oregon in 2016, the consortium decided that the substructure was too big to build in the U.S. and would instead be built overseas then transported to the U.S. [3].

For a large windfarm of 1 GW size, using 10 MW wind turbines, for example, would result in fabricating 100 substructures overseas: There would be no California fabrication job benefits to a foreign build strategy of this kind. 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 [6].

Another disadvantage to very large FOSW systems, is that the larger the turbines are the further they will need to be located offshore to avoid resident complaints and litigation about sight line or noise issues (see for example the history of the Cape wind project). However, as wind farms move further offshore, mooring and export cable costs increase correspondingly.

Furthermore, exceptionally large horizontal axis wind turbines (HAWTs) require more spacing between platforms which also increases the cost of in-field power cable costs.

Gray whales migrate along the California coast and putting a large floating wind farm far offshore, with the resultant large mooring spread and in-field cable arrangement is somewhat akin to placing a convoluted web of wires across many miles in the middle of the whale migration path. Those mooring lines and power cables are not static and move in response to platform motions. Therefore, CEC may wish to consider additional research on how to mitigate the possibility of mooring line or power cable impact on whales. A whale may be able to avoid a static line, but a mooring line that is constantly moving or is suddenly pulled taut as the whale passes may be difficult for the whale to avoid and prevent injury.

Large scale vertical axis wind turbines (VAWTs), currently in development, can be deployed far offshore with a much smaller “web” footprint than HAWTs, because the inter turbine spacing required for VAWTs is much less than that for HAWTs [8].

Another means to reduce the large entrapment “web” is to develop vertical mooring systems. The present legacy floating offshore wind substructures use catenary mooring which result in very wide mooring spreads. A vertical mooring system does not cast a wide net, and if coupled with a VAWT turbine will greatly reduce the maze of lines that a migrating whale would need to navigate.

Mooring in the geologically active seabed offshore California will also require additional engineering analysis and design. Again, legacy floating wind substructures have been installed in relatively stable geologic areas using either drag embedded anchors (WindFloat) or suction piles (HyWind Scotland). It would need to be determined whether such anchoring solutions will be able to maintain holding power during a seismic event offshore California, or whether a novel anchoring solution will be required. Obtaining additional seabed soil data available for offshore California would facilitate anchor engineering specific for FOSW applications.

III. VLO Comments Regarding Monitoring for O&M (2 above)

It may be possible for CEC to coordinate with some of the research undertaken by the National Offshore Wind Research Consortium [9]. There is a lot applied research towards digital twins, optimizing platform production in response to changes in site conditions, condition based monitoring and many other elements in order to reduce O&M costs while increasing revenue through more controlled power production.

However, one area that is still somewhat overlooked is the problem with blade erosion. While there have been some advancements in using artificial intelligence in solving the problem [10], much work remains [11]. This may be an area in which CEC could focus expertise that has applications locally and globally.

IV. VLO Comments Regarding Environmental Impacts (3 above)

There is still much to be discovered and learned about the deep ocean environment and biosphere offshore California and VLO encourages research efforts in this area.

V. VLO Comments Regarding Building Consortiums (4 above)

There are a limited number of horizontal wind turbine suppliers with certified turbines rated at 10 MW or higher. However, suppliers of wind turbines for offshore in the range between 5 MW to 8 MW are much more numerous. If a project focuses on exceptionally large turbines, then the project may be commercially limited. Such considerations about supply, support and of course, fabrication, should be considered for successful consortiums.

VI. VLO Comments Regarding Lesson Transfer from South Korea FOSW to California

During the open discussion it was commented that lessons learned from South Korea's FOSW project could be directly applicable to California. While some lessons will be transferable, it should be noted that the environmental, political, and logistical conditions of the South Korean FOSW farm differ from California in some significant ways (Table 1).

Table 1: Differences between Locations that Affect FOSW Design

Parameter	California	South Korea
Environmental	▪ Moderate metocean conditions ▪ High currents ▪ Very deep water ▪ Seismically active seabeds ▪ Along whale migration path	▪ Extreme metocean conditions (frequent typhoons occur) likely ▪ Seismically inactive seabeds ▪ Relatively shallow water
Political	▪ Objections from coastal residents likely ▪ Residents question the need for offshore windfarms	▪ Objections from local fishery groups
Logistical	▪ Extremely limited capability to build, integrate then install FOSW units	▪ Expansive, highly capable, low-cost fabrication, integration, and installation capability near site

VII. Increasing the Value of Offshore Wind with Hydrogen

Another point of discussion raised was the possibility of combining FOSW in California with other renewable energy technologies, such as hydrogen gas generation. This could result in technology synergies at the local level as California has several projects and initiatives underway that produce hydrogen to supply heavy transport, energy storage, industry, and fuel cell vehicles (Fig. 1).

Figure 1 Shell Hydrogen Fueling Station, Torrance, CA (2018)

Hydrogen is a growing source for alternative, green energy, particularly in the energy storage and transportation sector. Besides California, Japan, Korea, Australia, and several countries in Europe are aggressively developing hydrogen technology. Much of the energy to produce clean hydrogen is coming from wind power (onshore in Australia and mostly offshore in Europe).

Coupling offshore renewable energy with hydrogen technology, will dramatically increase green hydrogen production and revenue overall. By taking advantage of offshore wind energy and the available water supply offshore. A hybrid configuration could then:

Option 1: Utilize wind energy to generate hydrogen (H2) as a product to sell (Fig. 2)

Option 2: Utilize H2 generated offshore as an energy storage buffer and couple with fuel cells to boost peak power supply (Fig. 3)

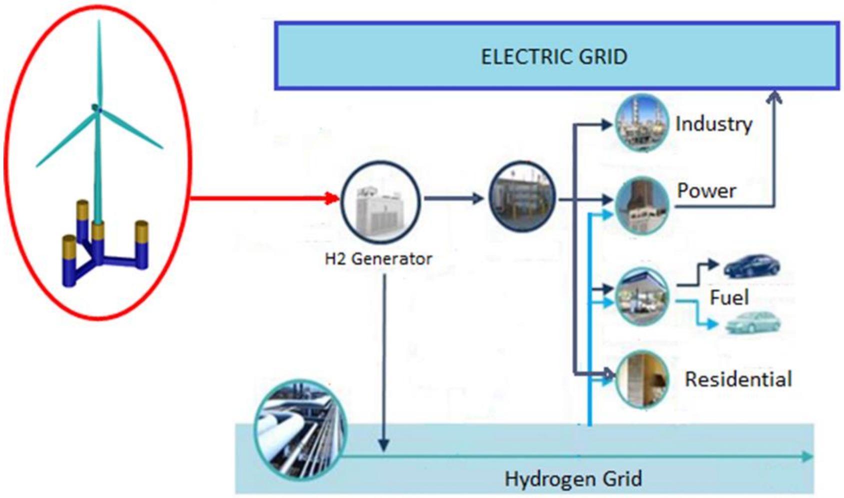

Figure 2 Hybrid Offshore Wind and Hydrogen Supply System [12]

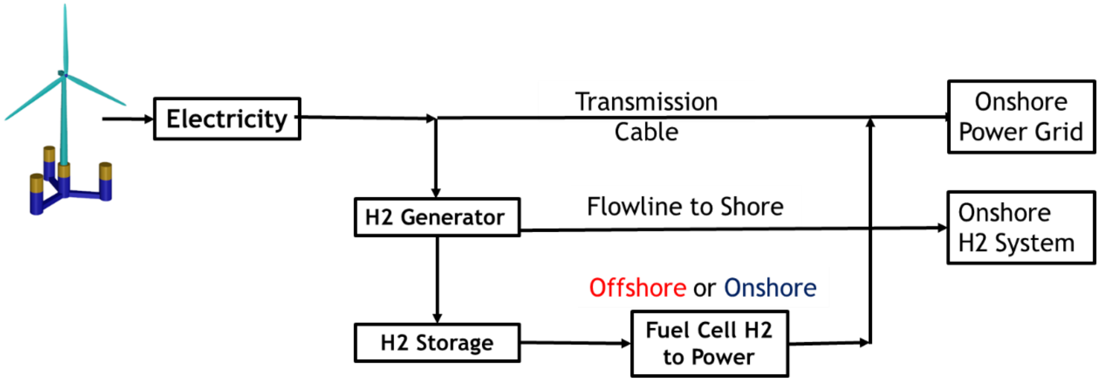

Figure 3 Hybrid Energy System with Storage

If one were to combine near shore, smaller FOSW with hydrogen technology then one could, for instance, incrementally prove FOSW technology while simultaneously realizing higher revenues. A quick analysis of 5x6MW FOSW units offshore California is considered. For 30 MW floating offshore wind power, with 42% capacity factor (300 MWh generation per year) a consortium can generate revenue as follows (Table 2).

	Table 2 Revenue Comparison – Pure Wind or Combined Wind and Hydrogen (Hybrid)	
	Direct Sale of Electricity (Transmission)	Produce Hydrogen for Sale (Option 1, H2 Generator)
Wholesale price	$0.09 / kWh	$7.36 / kg
Approximate Gross Revenue	$27,000 / day	$44,000 / day

I have provided several comments that I hope will be helpful as California develops and enacts its offshore renewable energy plans.

If you have any questions, please do not hesitate to call, or email me.

Sincerely,

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