Floating Frontiers: Offshore Wind In the US

ENVIRONMENTAL CONSIDERATIONS

THE BUSINESS NETWORK FOR OFFSHORE WIND

ABSTRACT

The Business Network for Offshore Wind (the Network) is a national nonprofit solely focused on US offshore wind. The Network helps advance offshore wind markets and innovations by connecting stakeholders to discuss issues and develop strategies. It addresses challenges facing offshore wind projects and aims to mitigate potential bottlenecks and risks with the capacity to delay development.

It has taken over a decade for offshore wind to be viewed positively on the US East Coast. As a result of many conversations and partnerships, the pipeline consists of 1.8 GWs of projects fully supported by state-backed financing or power purchase agreements. With NY, NJ and CT expected to award an additional 2.1 GW by this time next year, an offshore wind market is emerging on the east coast.

As the east coast industry expands and more lease sites are identified, sites will be located further offshore and floating offshore wind technology will be implemented. Floating platform technology opens offshore wind to historically unattainable markets, especially in deep water locations unsuitable for fixed bottom foundations. Floating offshore wind is rapidly developing in Europe and Asia and is equally applicable for the US deep water coastlines. The nearest deep water to shore is along the west coast, Hawaii and some northeastern states. More distant deep water is located east of the mid-Atlantic and southeastern states. Now is the time to create federal and state policies that responsibly support the shared use of deep water ocean areas to include floating offshore wind.

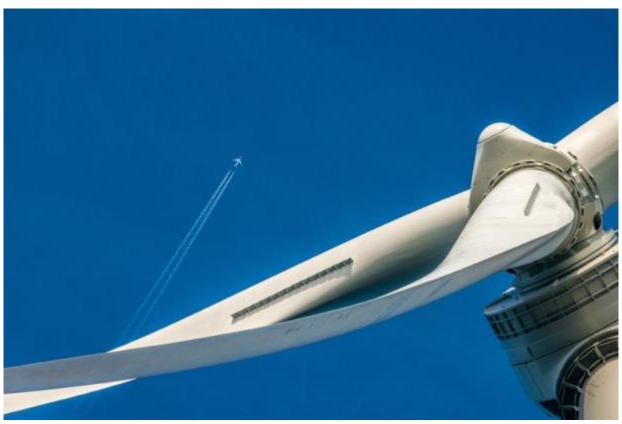
On June 11th, 2018, the Network convened the first of many conversations under a new series – **Floating Frontiers: Offshore Wind in the US** – a discussion on floating offshore wind. The purpose of the meeting was to explore offshore wind as a contributor to meeting climate change goals and its inclusion in state plans and policies to diversify clean energy sources. The discussion included sharing international experiences and identifying elements requiring further discussion. The setting provided an opportunity for participants to exchange ideas around regional cooperation, creating a community dialogue and developing solutions for a path forward.

While the event was hosted in California, the forum was not exclusively focused on California nor any specific potential floating offshore wind project. All west coast US states were invited, including Hawaii. More than 40 subject matter experts from west coast state governments, federal government agencies, NGOs, domestic and international developers and consultants all provided experience and thoughtful commentary into the proceedings. We would like to thank all of the speakers, moderators and attendees for lending their expertise, input and time. The following is a white paper summarizing the discussion.

KEY TAKEAWAYS

The Network introduced its **Floating Frontiers: Offshore Wind in the US** series as an extension to its present activities to facilitate the readiness of the US market to accept floating offshore wind technology. The key takeaways include:

- Energy generated from floating offshore wind can contribute to the regional economy, benefit the environment and help abate adverse consequences of climate change.
- Four drivers exist on the West Coast, creating a supportive environment for the expansion of the offshore wind market:
    - Policy goals for new advanced clean energy generation
    - Retirement of existing fossil fuel and nuclear assets
    - OSW can enhance other technologies (solar, batteries)
    - The need for local job creation
- There are significant wind resources in the deeper waters along the west coast states and Hawaii and the present day proven technology, which evolved from advancements in fixed bottom offshore wind along with oil and gas technology, is a low risk option for states to include in their energy portfolios.
- Projected costs for floating wind are expected to decrease through design consolidation, scale and increased efficiencies in unit production, all contributing to a competitive price of electricity.



- Washington State, rich in hydro-generated power, also recognizes that its commitment to decarbonize needs to go beyond present hydro sources. Floating offshore wind could contribute with diversification in its energy portfolio, while simultaneously using the port infrastructure to create the business case for supporting floating offshore wind.
- Washington State encourages clean energy entrepreneurship and innovation with its $130M clean energy fund that may be used for research and development as well as demonstration facilities for offshore wind.
- California is seeking high levels of electrification while some aging waterfront traditional generation stations are retiring. However, perceived conflicts of use off central and southern California by the US military are curtailing immediate large-scale floating offshore wind deployments.
- In contrast, the Humboldt County community in Northern California views floating offshore wind as a solution to energy security and other challenges.
- Permitting should be more straightforward and requires more public funding of industry-focused research and reduced regulatory overlap with interagency cooperative agreements or regulatory reform.

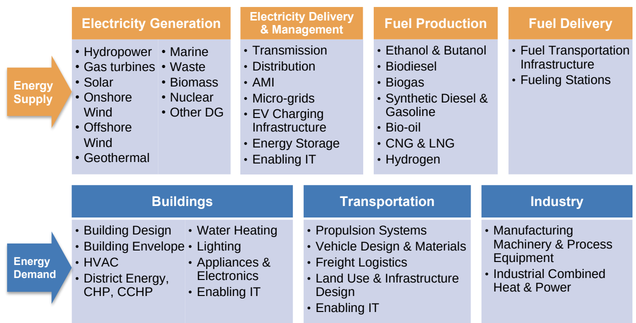
Projected costs for floating wind are expected to decrease through design consolidation, scale and increased efficiencies in unit production, all contributing to a competitive price of electricity.

- Relevant environmental data takes time to acquire: data is available, however, its relevance is limited by discrepancies in formatting and geographic information. However, gaps in data exist. Marine spatial planning could be a tool to help resolve the data gaps and regional variations.
- Marine spatial planning efforts would reduce the need for redundant data collection and putting all data collected to date and other information together will benefit all groups involved in offshore wind projects.
- Climate change is a threat to much of the marine and avian life found along the west coast states. Introducing a no carbon alternative power generation such as offshore wind is considered a welcome approach to help address the overall consequences of climate change. However, local communities bare responsibility for the wildlife immediately around any future installation of floating offshore wind farms. Examples of concern include: bird species flying at heights that coincide with the rotating blade areas, and marine species that may be prone to 'entanglement' from the debris or waste caught on the dynamic cables or mooring lines. Site-specific avoidance for vulnerable birds and marine wildlife is required - possibly with aid of new technology along with study and monitoring.
- Although the west coast including Hawaii offers abundant resources for floating offshore wind energy, a possible progressive approach is to start with a 'pre-commercial' or first small size commercial scale project before embracing scale from a series of 'mature commercial projects' with the target of very low cost of power. An initial small-scale commercial project could help with filling gaps in the data and providing overall confidence in the integration of offshore wind as the newest of shared users of the Pacific Ocean.

GLOBAL MARKET FOR ADVANCED "CLEAN" ENERGY

Clean Energy is a rapidly growing global sector with a market size of $1,400B. The global growth rate of clean energy is 7 percent as compared to world's growth of 3 percent. Clean energy within the US has now created 3.4 million jobs, which is more than twice that of the nation's established hotel and hospitality sector that has 1.4 million jobs.

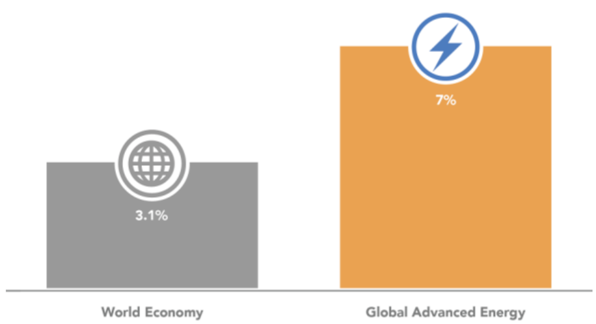
What is Advanced Energy?



(Source: Navigant Research for Advanced Energy Economy)

It is evident the market demand for clean energy is increasing. In the United States, both state policy and private sector procurement is driving the growth of advanced clean energy. If 20 states meet their current climate change goals, the nation can achieve 80 percent of its Paris climate change commitment.

Growing Faster Than the World Economy – Global Growth Rate, 2016

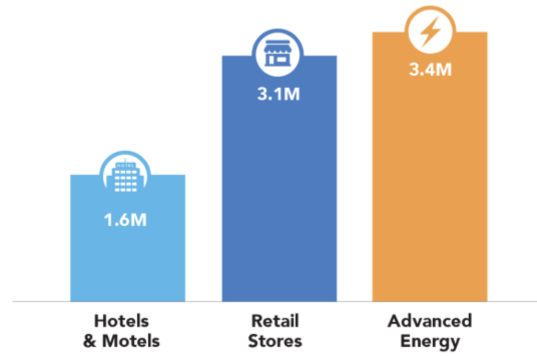


(Source: Navigant Research for Advanced Energy Economy)

Beyond the number of well-paid and long lasting, non-seasonal jobs that floating offshore wind may provide there are other drivers for floating offshore wind which include:

- western states looking to form a regional grid operator creating the way for a 100% clean grid
- retirement of historical fossil fuel based power generators and nuclear power plants
- growing trend in decentralized renewable energy generation
- increased customer choice and greater options of supply to meet customer needs
- introduction of novel clean energy initiatives such as zero emission vehicles (ZEV)
- carbon taxation or CAP and invest policies (e.g., Washington State)

Advanced Energy is a Major US Employer: US Jobs by Industry



(Source: Navigant Research for Advanced Energy Economy)

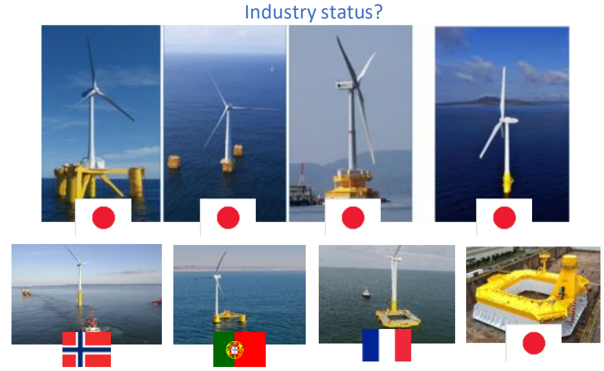
FLOATING OSW IN THE GLOBAL MARKET

Towards the end of 2017, the Network learned there were 54 different floating offshore wind design systems at various stages of consideration. Floating offshore wind opens new geographical markets and the technology has evolved from experience in oil and gas and fixed bottom offshore wind. Presently viable designs include spar, semi-submersible and barge. Additionally, the tension leg semi-submersible design is viable but remains untested.

In the future, we expect fewer designs dependent on versatility and availability of manufacturing materials. Europe possesses the world's largest floating offshore wind potential estimated at 4,000 GW while the USA is calculated as 2,450 GW and Asia is estimated at 500 GW.

Countries with full-scale demonstrator experience in floating offshore wind include: Japan, France, Scotland, Portugal, Denmark, Sweden, Norway, Ireland, Taiwan and South Korea. Currently, five pilot farms are under development (three in France, one in Scotland and one in Portugal.) There are commercial-scale tenders upcoming in France (2019) and several commercial-scale farms under development worldwide.

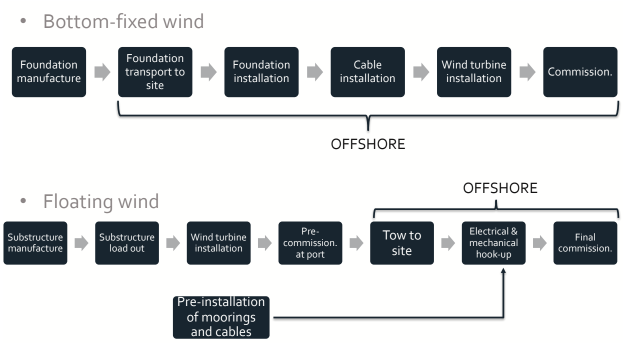
Industry status?



(Source: Ideol)

Floating offshore wind is being embraced by nations that do not have previous experience in fixed bottom offshore wind. Japan will likely complete the first commercial floating offshore wind farm by 2023. Floating offshore wind has a 67 percent capacity factor. Price is trending downward with projections estimated at $80-$100MWh in the 2025-2028 time period (Pre-commercial at $80-120MWh; mature commercial at $60-80MWh; and aggressive price projections at $50-70MWh). Production improvements and onshore installation phases contribute to cost savings. The downward pricing trend will be accelerated as the adoption of the technology is scaled up from prototype, pre-commercial, first commercial, and eventually mature commercial.

Life Cycle Phases: Compared to Bottom-Fixed Wind



(Source: Catapult Offshore Renewable Energy)

Environmental monitoring activities in Europe focus on visual impact, underwater noise (background, platform and propagation), marine mammals, platform colonization, bats and seabirds. Results from field studies and theoretical studies were used to identify significant environmental interactions. Upon side-by-side comparisons of permitting requirements, it is evident that many countries require a similar set of data.

Permitting requirements

Permitting Requirement	Scotland	France	Japan	U.S.
Key federal approval(s)	Marine License, Section 36 Consent	Maritime concession, Loi sur L'eau authorization, License to operate	METI Certification	BOEM Commercial Lease + fed/state permits
Environmental document required	EIA/ES	EIA	EIA	EA/EIS, SAP
Specific requirements for floating?	No	No	No	No
Years of data collection	2 years	Minimum of 1, 2 recommended	EIA process of 4 years	2+
Overall time to approval: studies -> consent	3 – 3.5 years	3.5 – 4.5 years	5+ years	3-5 years

(Source: DNV GL)

Equinor's 5-spar floating offshore wind facility in eastern Scottish waters provides insights into the preparatory steps required for permitting. The four-year preparation period consisted of two years of data collection followed by a year of assessment. Within this period, many topics were assessed including: collision risk; interference and the spread of the moorings; positive impact resulting from the wind farm. To date, the turbines withstood periods of extreme weather including 17 meter waves and 60 knot winds without adversely affecting performance in its production of 17 GWhs.

OFFSHORE WIND CAN CONTRIBUTE TO STATE CLEAN ENERGY

Floating offshore wind can produce one of the cleanest forms of electricity, thereby contributing to state and national climate solutions while simultaneously diversifying a state's energy mix. Environmental impact assessment conducted for floating offshore wind in Europe may not be directly relevant or comparable for the Pacific along the US west coast, in part because there are different wildlife species that are found in the California Current.

Spotlight on Washington State: Traditionally the state has focused on its inherent natural resources, which has resulted in an abundance of low cost hydro electricity generation. However, some opportunities are emerging that may encourage interest in floating offshore wind. Factors such as a state-wide non-hydro 15% clean energy Renewable Portfolio Standards (RPS) that resulted in a land-based wind boom followed by a strong level of solar installation. Another factor is the 2025 scheduled retirement of coal plants and the present administration's accompanying policies to introduce 'CAP & Invests' as a form of carbon tax.

The State remains keen and intends to uphold the principles of the Paris climate accord; to maintain its commitment, the state has joined the Pacific Coast Collaborative which includes engagement of other users such as military, fisheries and tribes. Further, much of the hydro-generation is on the eastern part of the state while the load is found along the western coastal area and the existing grid requires modernization as well as the need to accommodate looming capacity issues. The State recognizes the new need to decarbonize its transportation sector, which could help stimulate the interest in finding a solution to develop floating offshore wind off the State's coast.

Other state specific factors include the $130M clean energy fund that may be used for research and development as well as demonstration facilities. An interest in attracting the offshore wind supply chain is also driven by the existence of the Port of Grays Harbor with its existing infrastructure and absence of bridges. There are a lot of drivers that are good for OSW, however, the introduction of floating offshore wind into Washington State's energy mix of generation types will require a holistic business case justification.

Spotlight on California: State policies are in place to reach climate goals by 2030 aided by bilateral agreements with Scotland and Denmark. Further the State is pursuing a path of 'electrification of everything'. This pathway has resulted in the utilities having an over-procurement of solar generated electricity. Consequently, there has been an accompanying market drop in price of both solar energy generation and battery storage. The California present day electrical system is defined by low cost solar, therefore other clean technologies must offer a competitive price. In California, offshore wind will compete with solar combined with battery storage.

For state policy makers, the challenge is keeping large electricity generating systems running with renewables. However, the opportunities for floating offshore wind exist when viewing the State's system as a whole, especially with the planned retirement of coastal nuclear generation systems. Further, floating offshore wind when combined with storage could act as a way to replace present day 'peaker power plants'. The key is for offshore wind to operate with storage as a peaker plant at the right price.

The main challenge to California's immediate adoption of floating offshore wind at scale is the military's perceived risk conflicting with its own use of the Pacific Ocean west of the central and south coast. In contrast, the Redwood Coast Energy Authority (RCEA) has made advancements on the north coast of California. The RCEA, a community choice aggregator, was created to help the peninsular community address its vulnerability in being at the end of the transmission grid. In the same area, Humboldt State University is home to the Schatz Energy Research Center which contributes to the community's awareness of energy issues. Winter months require peaking and RCEA's intent to introduce electricity from west to east using 150 MW floating offshore wind technology holds strong promise to provide multiple solutions. Inherent technological innovations in California may provide future opportunities for floating offshore wind such as the electrolysis of water to generate hydrogen as a supply of alternative fuel for transportation.

In summation, four drivers exist on the West Coast that are creating a supportive environment for offshore wind market expansion:

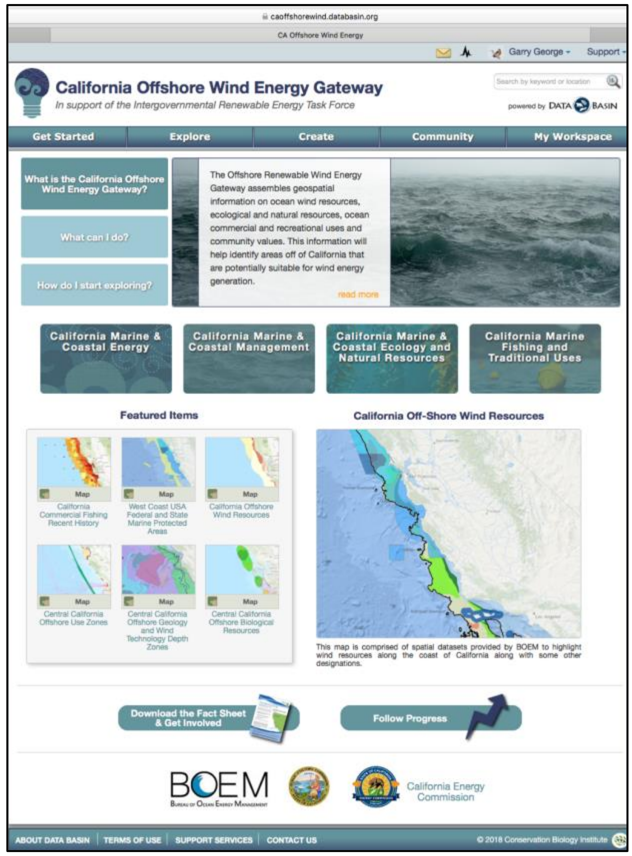
- Need for new advanced clean energy generation
- Retirement of existing fossil fuel and nuclear assets
- OSW can help other technologies (solar, batteries)
- The need for local job creation

ADDRESSING ENVIRONMENTAL CONCERNS

Climate change is a threat to much of the marine and avian life found along western states. In fact, climate change is the greatest threat to birds with 3 out of 4 of the species negatively impacted. Introducing a no carbon alternative for power generation is considered a welcome approach to help address the overall consequences of climate change. However, local considerations are required for the wildlife immediately around any future installation of floating offshore wind farms. Examples of concern include: bird species flying at heights that coincide with the rotating blade areas, and marine species that may be prone to 'entanglement' from the debris or waste caught on the dynamic cables or mooring lines. Site-specific avoidance for vulnerable birds and marine wildlife is required.

In addition to its role as regulator for offshore wind in federal waters, BOEM contributes to addressing environmental concerns through two functions: environmental science and environmental analysis. Further, BOEM is focused on the expanding Pacific Research and Explorations of Submerged Systems (EXPRESS) program which could be introduced into the governmental emerging interagency campaign to help with coastal, submerged hazard mapping and assessment for offshore wind decisions. Two-thirds of BOEM studies are directed to the renewable energy sector and the results from the studies can feed into the federal intergovernmental agreements.

CA Offshore Wind Energy Gateway Homepage



(Image Source: Audubon)

Permitting works best when there is a broad understanding of public interest. It is seen through the lens of laws, ordinances, regulations, and standards leading to a focused understanding of impacts and potential mitigation measures.

The regulatory landscape is complex, made up of laws, ordinances, regulations and standards that fall under both 'master' and 'ancillary' permits. There can be overlaps within the permitting process due to different authorities sharing common interfaces between city and county, and coastal land, the interface between the coastal land and the territorial sea and the outer continental shelf. Obtaining a permit is not always straightforward and requires data collection, analysis, understanding the laws, assessing the data and deriving the impact under the context of the law and possibly finding a resolution in the form of either mitigation, compensation, or requesting a change in the law.

In California, little offshore wind permitting has occurred, but two DOE funded marine hydrokinetic projects have begun permitting:

- Humboldt WaveConnect Pilot Project
- CalWave Energy Test Center

The discussion matrix developed for the CalWave project is a potential best practice that could be used for offshore wind permitting. It lists the issues in a matrix by component (shore, cable run, test berths) and then contains columns:

- What information is already available?
- What are the potential impacts?
- How likely are effects to happen?
- What is the level of concern/severity if impacts occur?
- What is risk relative to other forms of infrastructure?
- What actions would avoid risk?
- What additional information is needed to define data to assess impact?

Stakeholder Issue Matrix

Topic	Studies	Effects	Likelihood	Severity	Relative Risk	Actions	Info Needed
Noise/Acoustics	Varies by species	Behavioral, injury	Hi during construction, low during operation	Moderate	High for construction, low for operation	Plan to monitor construction	Noise levels of WECs permitted
Entanglement	Long-term data for fishing net entanglement	Injury/death of cetaceans, birds	Low for buoy cables – uncertain for fishing net	High	Moderate	Periodic check of buoy cables	Risk of buoy cable entanglement
Changes in Habitat/ Reefing	For some habitats	Increases habitat for some species	Very high	Very low	Very low	Consult NMFS	Analysis of species affected
Collision Risk	Whale studies, East Coast	Injury and death	Moderate	High	Moderate	Plan to monitor construction vessels	Frequency of occurrence
Fishing Effects	CDFW catch statistics	Loss of fishing access	High – WECs will displace some fishing	Low – fishing not intense in project area	Low	Consult fishing community	Additional information on catch, fishing areas

- Assess existing data value
- Define potential impacts
- Assess sensitivity of resources
- Fit data collection plan to resources and impact potential

(Image Source: Jacobs)

This helps identify stakeholders and issues throughout the process. However, as demonstrated by these two projects, the permitting path is not straight forward but rather an extremely complex process.

Regulatory Fork/Lens

- **Laws, ordinances, regulations, and standards**
- **Master** permits
  - BOEM OCS lease – NEPA compliance
  - CSLC Submerged Lands Lease – CEQA compliance
  - Local land use/Coastal Development Permit
- **Ancillary** permits and authorizations
  - ESA Incidental take authorizations
  - Section 106
  - Section 401, 404
  - CZMA Consistency
  - Coast Guard Aids to Navigation

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(Image Source: Jacobs)

Analysis Fork

U.S. Department of Energy/National Renewable Energy Laboratory

- Bring information then **define data** to address issues or problems regarding **project effects** and **public interest resources**
- What is the resource sensitivity?
- What is the level of change?
- Is the change adverse?
- How can adverse change be reduced?

(Image Source: Jacobs)

A more straightforward permitting process is possible with more interagency cooperation (one stop shop permitting) and a reduction in the regulatory framework. California's thermal energy permitting process offers an example for offshore wind. Further, open and early conversations with permitting offices is invaluable.

Environmental data from evaluations of coastal power plants and desalination plants is available. Southern California – CalCOFI – ocean data collection program since 1949 and California Seafloor Mapping Program, which is USGS-led, using bathymetry for territorial sea and habitat mapping. However, there are some data issues for offshore wind CalWaveSM project was reasonably close to shore and therefore data from nearshore coastal studies were generally applicable for wave and tidal – not necessarily the case for offshore wind, with some exceptions (e.g. CalCOFI). Data collection efforts such as CalCOFI limited to coastline up to San Francisco (2x annually) and to Point Conception (4x annually). There are fewer coastal infrastructure projects in central and northern California compared to southern California so therefore, fewer data sources. Data from surveys conducted for EIRs are often not readily available. There are problems with data from EIRs and other data sources:

- Determining the provenance of the data
- Ensuring the accuracy of the data
- Obtaining raw data that could be used in new analyses

The data has potential value within a spatial management plan and could contribute to understanding the gaps for floating offshore wind. Other sources of information and data relevant for floating offshore wind include: California State Lands Commission, California Energy Commission, the West Coast Regional Planning Body, DoE's national labs, PG&E and its Central Coast CalWave project, CalCOFI seabird studies, NOAA's grey whale and Oregon State University's blue whale studies. Not all the data sources have the same level of accuracy. One approach going forward, is to consider an approach made by the UK which is to focus on permitting efforts that reduce the need for redundant data collection. It will be important to define data in relation to the issues as it relates to priority issues and determine, where possible, ahead of time, how much data is sufficient.

Marine spatial planning effort would reduce the need for redundant data collection and put all the data collected to date to date and other information together through a marine spatial planning effort will benefit all the groups involved in offshore wind projects.

Spatial Planning Efforts for Offshore Wind

- PNNL Tethys knowledge base
- California State efforts
  - Land Commission
  - Energy Commission
- West Coast Regional Planning Body
- BOEM
  - Spatial data from studies on leases, offshore rigs, pipelines
- DOE
  - National Renewable Energy Lab

(Source: Tenera Environmental)

In summary, this panel suggested that the best way to improve the process is to keep learning while making the projects happen.

RECOMMENDATIONS AND NEXT STEPS

The west coast states and Hawaii offer enormous opportunity for floating offshore wind, which could help combat climate change and contribute to the states' economies. However, the drivers and political interests in floating offshore wind differ among the states and among the north, central and south coast regions of California. Immediate deployment of large scale floating offshore wind farms in the most suitable areas off the central and south coast of California, which would achieve lowest cost of electricity, is unlikely because of perceived risks by the military. Both BOEM and the California Energy Commission continue to compile data of all kinds to help with environmental issues. A possible progressive approach is to start with a 'pre-commercial or first small size commercial scale' project before embracing a series of 'mature commercial projects' with the target of very low cost of power. An initial small scale commercial project could help fill gaps in the data and provide overall confidence in the integration of offshore wind as the newest of shared users of the Pacific Ocean.

The continuing of lessons shared between Europe and West Coast states are important as evidenced by the signing of Memorandum of Understanding between California and Denmark, and California and Scotland, respectively. Exploration and discussion of key questions include:

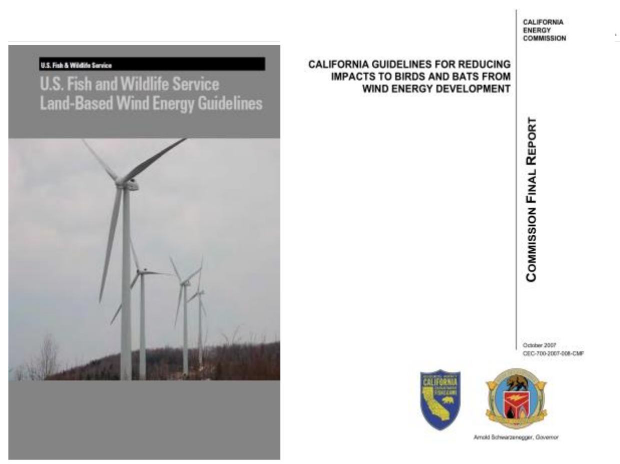
- How do permitting frameworks differentiate between fixed and floating technologies?
- How will environmental and social impacts differ?
- What can we learn by examining the recent history of existing floating projects?
- What should be considered during project development and permitting that could influence stakeholders, financing, ability to obtain a power contract, etc.?

California has experience with finding least conflict siting and could use the experience of the desert renewable energy conservation plan (DRECP) as a basis to streamlining the renewable energy permitting process for offshore wind.

California Experience with Least Conflict Siting

(Source: NRDC)

One important factor for the planning process is to remain 'inclusive' in approach and to explore all possible ways for floating offshore wind to have shared use of the ocean. It was also recommended that California encourage the creation and adoption of something similar to the US Fish and Wildlife Service Land Based Wind Energy Guidelines for offshore wind.



(Source: Audubon)

It was also recommended that new advances in technology could allow for more environmental data to be collected in a more expedited manner and there should be more money for R&D to help advance these technologies. Industry and environmental NGOs agreed that an inclusive marine spatial planning process means steel in the water and cited Block Island, RI as the standard. A marine spatial plan should be deliberate and start early in planning process. It will help identify conflicts early; bring diverse stakeholders together and streamline the project. It was recommended that a collaborative software called Sea Sketch, designed for marine spatial planning, be investigated.

Additional data collected for floating offshore wind may also be required to better understand the impacts of floating offshore wind. Data should focus on:

- Collision Risk: If the mooring system of a floating structure fails, the floater may drift off and potentially be a risk to nearby infrastructure or ships.
- Interference: The presence of floating wind structures may influence ship navigation, fishing activities, aviation and radars.
- Spread of moorings: Potential impacts to fishing and subsurface military operations–seabed impacts?–Different footprints for different mooring types.
- Lack of pile-driving activities: Typical for fixed foundation structures but not floating.
- Temporary phases: Tow-out of floating structures which are assembled in port.
- How will military (including Coast Guard)/aviation regulators) assess tow-out of floating structures assembled in port?
- Are geotech/benthic impacts potentially less intensive depending on anchor type?
- Can existing data expedite survey timelines? (e.g., Use of data from fixed offshore projects in Europe – How applicable is European/US East Coast data to the west coast?)
- Will floating structures positively impact the marine environment in a different way than fixed bottom?

All stakeholders interested in floating offshore wind within the Pacific Ocean need to remain engaged to reach a harmonized agreement in order for a smooth installation of the first floating offshore wind farm. From such a harmonized agreement, along with transparent insights gained from the initial installation, allow for adjustments and progress to be made to de-conflict areas for larger scale floating offshore wind farms. This combination of factors will positively contribute to improving the west coast states' economies and reduce the causes of climate change.

ABOUT THE NETWORK

The Business Network for Offshore Wind is a 501(c)(3) nonprofit organization solely focused on the development of the US offshore wind industry and advancement of its supply chain. It is not a trade association of many voices; it represents one leading voice for the offshore wind business community. The Network brings together developers, policymakers, academia, global experts and more than 180 member businesses for critical discussions and unprecedented networking opportunities.

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