Offshore Wind: Consideration for CMANC Stakeholders

January 10, 2019

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Source: www.equinor.com

Typical Offshore Wind Farm Life Cycle

5? Years

- Offshore Wind Master Plans
- Desktop Studies
- Permitting

1 Year

- Metocean (resource) observations
- Environmental Assessments
- Protected Species
- Site Assessment Plan

2 Years

- Geophysical/ geotechnical Investigation
- Archaeologic Clearance
- Foundation Design
- Cable Risk Study
- Construction Operations Plan

2 Years

- Importation
- Manufacture
- Transportation
- Cable Installation
- Shoreside infrastructure

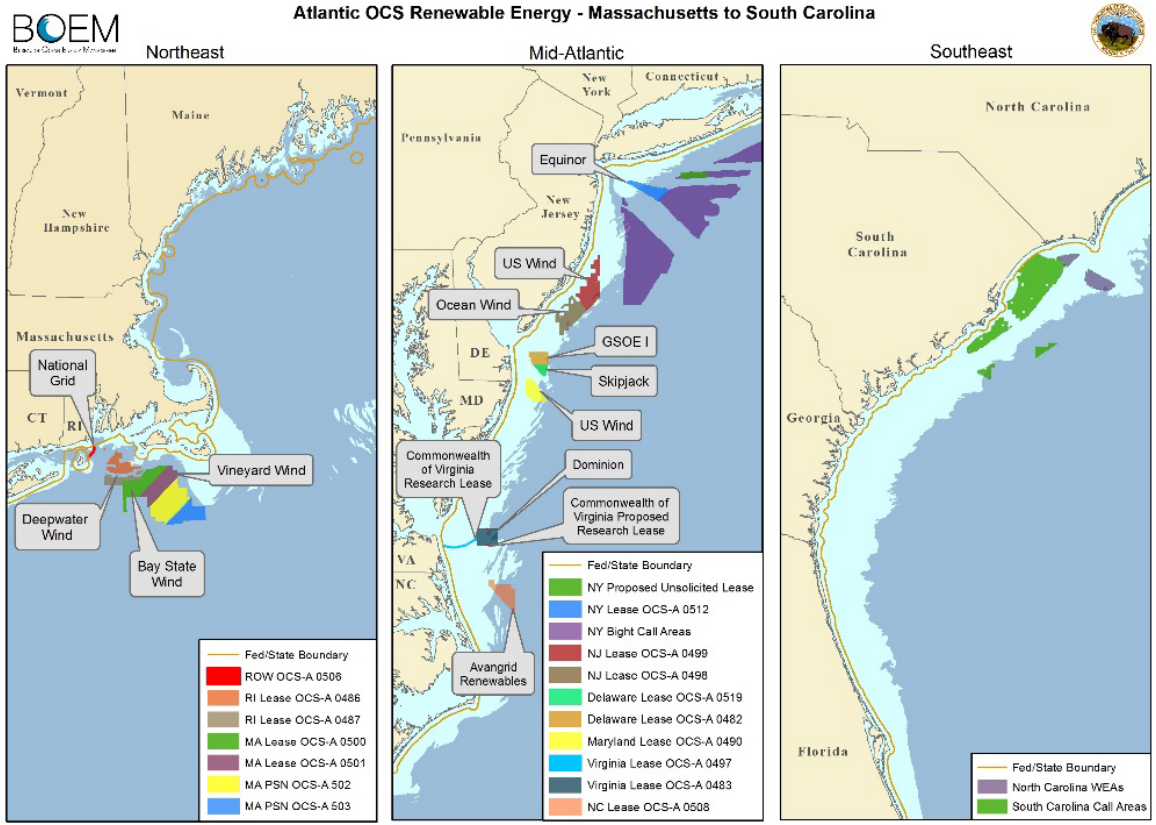
25 Years

- Maintenance
- Monitoring
- Environmental Monitoring

US East Coast OWF Developments

Lease developments underway from Massachusetts to North Carolina:

- MA = >4,800 MW
- NY = 2,400 MW
- NJ = 3,500 MW
- RI = 400 MW
- CT = 200 MW
- MD = 390 MW
- VA = 12 MW
- NC = 1,500 MW



Projects Moving Forward (East Coast)

Location/State	Project Name	Developer
Maryland	Skipjack	Ørsted
Maryland	Maryland Offshore Wind	US Wind
Massachusetts	Bay State Wind	Ørsted & Eversource
Massachusetts	Block Island	Ørsted
Massachusetts	Vineyard Wind	Vineyard Wind (Copenhagen Infrastructure Partners & Avangrid)
New Jersey	Ocean Wind	Ørsted
New Jersey	Atlantic Shores Offshore Wind	Atlantic Shores Offshore Wind (EDF Renewables & Shell New Energies)
New York	South Fork Wind Farm	Deepwater Wind
New York	Empire Wind	Equinor
Rhode Island & Connecticut	Revolution Wind	Ørsted
Virginia	Coastal Virginia Offshore Wind	Ørsted & Dominion Energy

Projects Leased but Not Started (East Coast)

Location/State	Project Name	Developer
North Carolina	Kitty Hawk	Copenhagen Infrastructure Partners & Avangrid
Massachusetts	TBD	Equinor
Massachusetts	TBD	Mayflower (Shell)
Massachusetts	TBD	Vineyard Wind

2020-2023+ US East Coast (Expected Operational Year)

2020

1. Vineyard Wind (MA)

2021

2. Ørsted BSW (MA)
3. Ørsted (DWW) SFWF (NY)
4. EDF/US Wind MD (MD)

2022

5. Ørsted (DWW) Skipjack (MD)

2023

6. Ørsted (DWW) Revolution Wind (RI & CT)
7. Equinor Empire Wind (NY)
8. Ørsted Ocean Wind (NJ)

- 2023+
  1. Avangrid Kitty Hawk (NC)
  2. US Wind New Jersey (NJ)
  3. Ørsted DWW Garden State Offshore Energy (NJ)
  4. Dominion Energy Coastal Virginia (VA)
  5. Equinor 520(MA)
  6. Mayflower Wind 521 (Shell) (MA)
  7. Vineyard Wind 522 (MA)
  8. NY Bight Area (NY)
  9. NY Bight Area (NY)
  10. NY Bight Area (NY)
  11. NY Bight Area (NY)
  12. Wilmington West(NC)
  13. Wilmington East (NC)
  14. Grand Strand (SC)
  15. Winyah (SC)
  16. Cape Romain (SC)
  17. Charleston (SC)
  18. CALIFORNIA!!!
      - 3 potential areas

East Coast Lessons Learned

- Local infrastructure:
  - Need to develop port facilities for import & assembly
  - Need to train workforce
  - Need to import vessels (or construct them)
  - If domestic manufacture, logistics/infrastructure for transportation
- Construction Conditions
  - Weather
  - Boulder fields & scour
  - Marine protected species
  - Wrenches left in the turbine (whoops)

2020-2023 US West Coast

- CA = Renewables: 50%(2026), 60%(2030), 100%(2045)
  - Currently 32% from renewables
    - Onshore Wind
    - Hydro
    - Solar
  - BOEM soliciting call for lease area nominations & information now
- HI = 100% Renewable Energy by 2045
- OR = Failed Coos Bay OWF by Principle Power
- WA = Lower Wind Speeds / No Interest Currently

Navy study of offshore wind farm sites

The U.S. Navy sent the Bureau of Ocean Energy Management this map in February. According to the Navy's assessment, large swaths of California's coast are deemed off limits to offshore wind farms.

San Diego Union-Tribune

Fixed

- In less then 180’ water depth
- Full survey
- Stakeholders
- Cost competitive
- 30 MW USA, US Department of Energy predicts 22 GW by 2030
- 15 GW EU, 25 GW by 2020

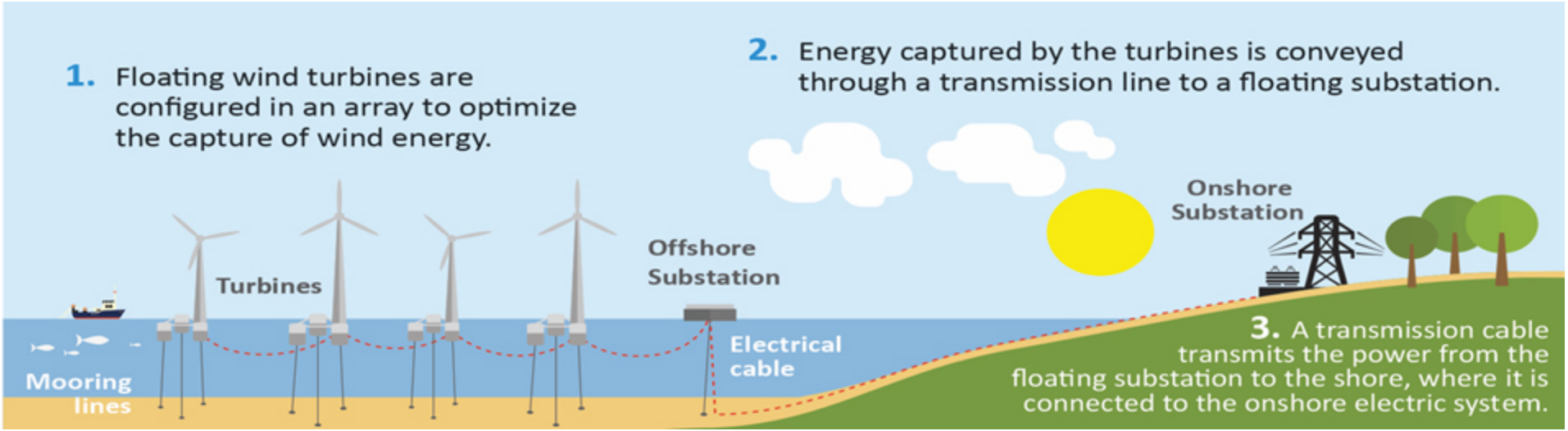
Floating

- Greater than 180’ water depth
- Geotechnical component smaller
- Differences view 15/20 miles & fisheries
- Costly (pre-commercial stage)
- 30 MW demonstration complete (Hywind Scotland)

Floating future

- USA capacity 58% > 60 meters
- Europe & Global capacity 80% > 60 meters
- Potential floating EU estimated at 4000 GW
- Hywind Demonstration project:
  - Scotland 30 MW / 5 turbines at 300’ to 400’ water depth
  - Powering 20,000 households
- Cost reduced by 60-70% since first pilot
- Further cost reduction of 40 – 50% expected
- 9 floating projects planned for 2021-2023 (338 MW)

BOEM Graphical Representation of a Floating Wind Project

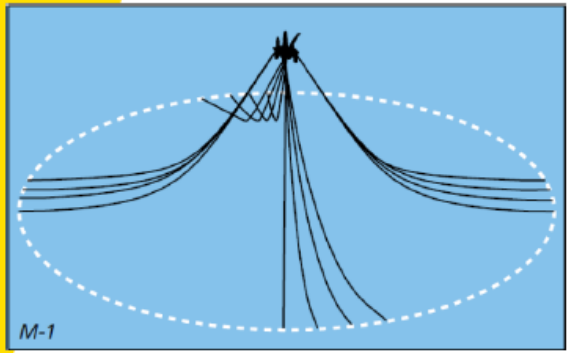


Not represented here is the considerations for import/fabrication, construction/assembly, transportation, maintenance facilities.

Not to scale – typical expectation is for project to be >25 NM from shore. Cable catenaries between turbines, sub-station and to shore will be significant considerations.

Potential Anchoring Methods

Catenary

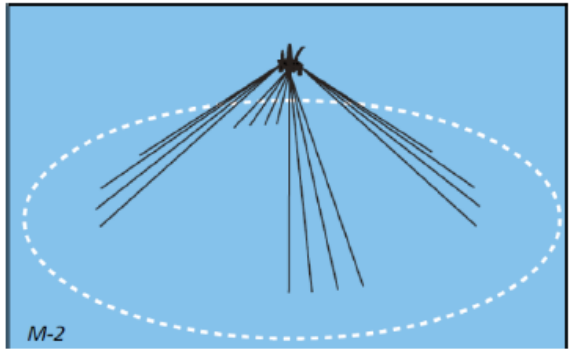


Restoring forces: weight

+ Easier installation
+ Damping effect: lower loads
+ Lower cost

- Significant spread/footprint
- Significant excursion

Taut and semi-taut leg

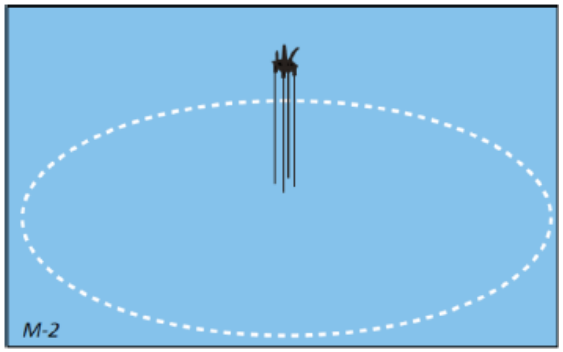


Restoring forces: elasticity

+ Higher loads in line
+ Larger units can be moored
+ Reduced excursion

- More expensive
- Medium footprint

Tension leg platform (TLP)



Restoring forces: floating reaction/tension in tendons

+ Minimal footprint
+ Minimal excursion

- Foundation challenges
- Highest cost

VRYHOF

California Drivers

- August, California passed bill SB100 for 100% carbon-free electricity
- No existing renewable energy source in California can meet “duck curve” demand
- Federal, state, municipal, and private sectors involved
- Federal agencies already investigating & de-risking sites
- Large-scale projects possible using existing shore-side grid connections available (Morro Bay, SONGS, Diablo, & Redwood City)

California Challenges

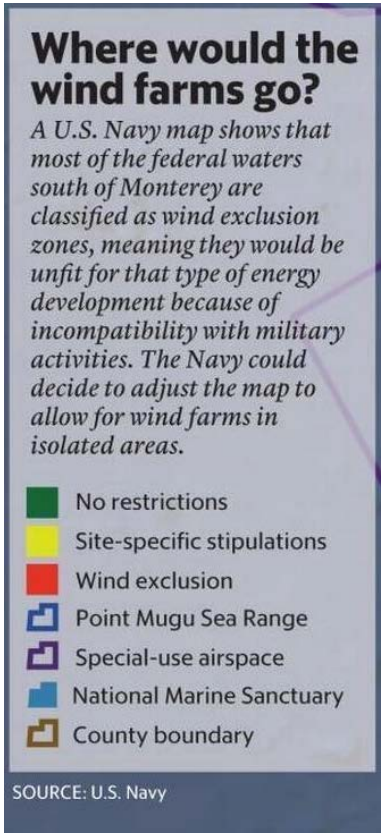
- Stakeholder engagement
- Navy & NOAA restricted areas
- Potential for impacts on commercial fishing
- Extraordinary water depth (~1500’ to ~3000’)
- Shipping traffic (near Channel Islands/SONGS)
- Port facilities need upgrading to support wind turbines

  Hywind: Turbine size 803’ total height!)

  Dry dock size, water depth, quayside, cranes, etc.
- Supply chain scaling up / installation vessel

The 800 Pound Gorillas

- The four biggest obstacles to offshore wind development in California are conflicted use with:
  - US Navy
  - NOAA Marine Sanctuaries
  - POLA/POLB Shipping Route conflicts
  - Commercial fishing conflicts



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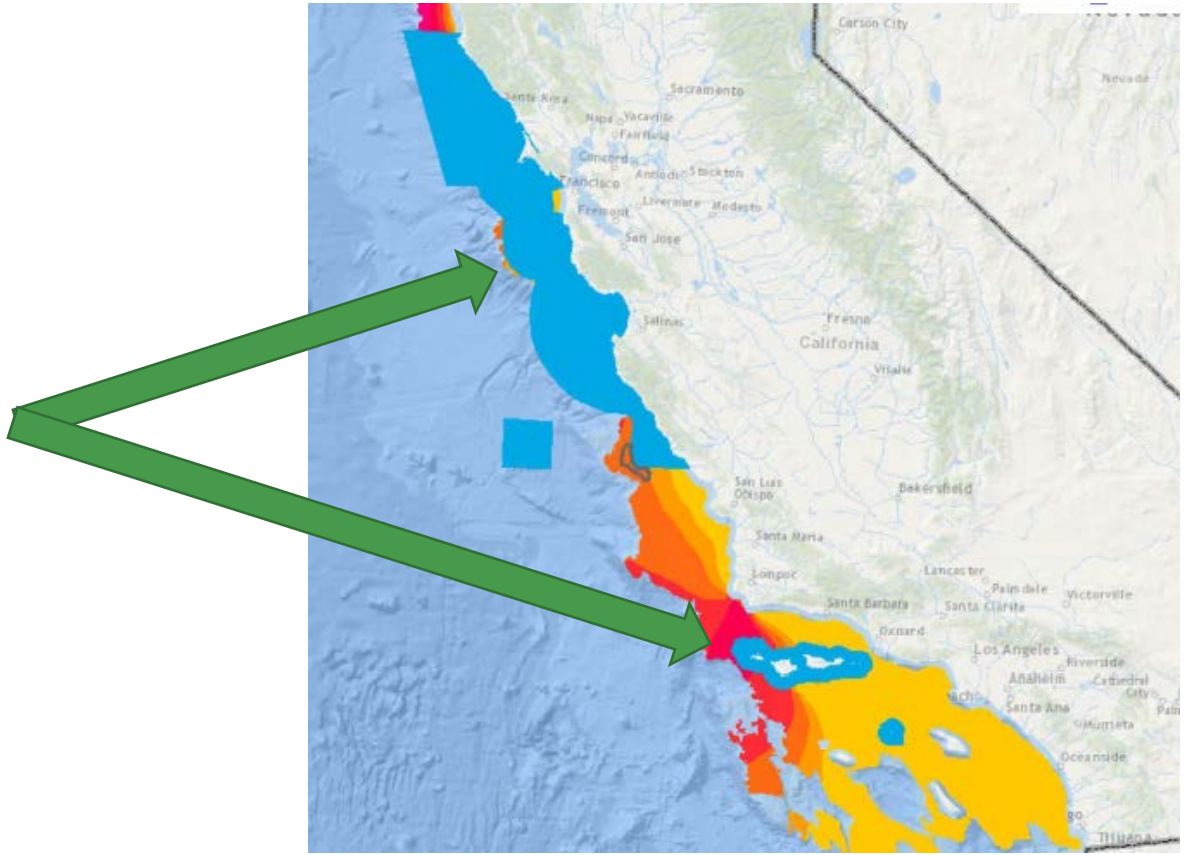

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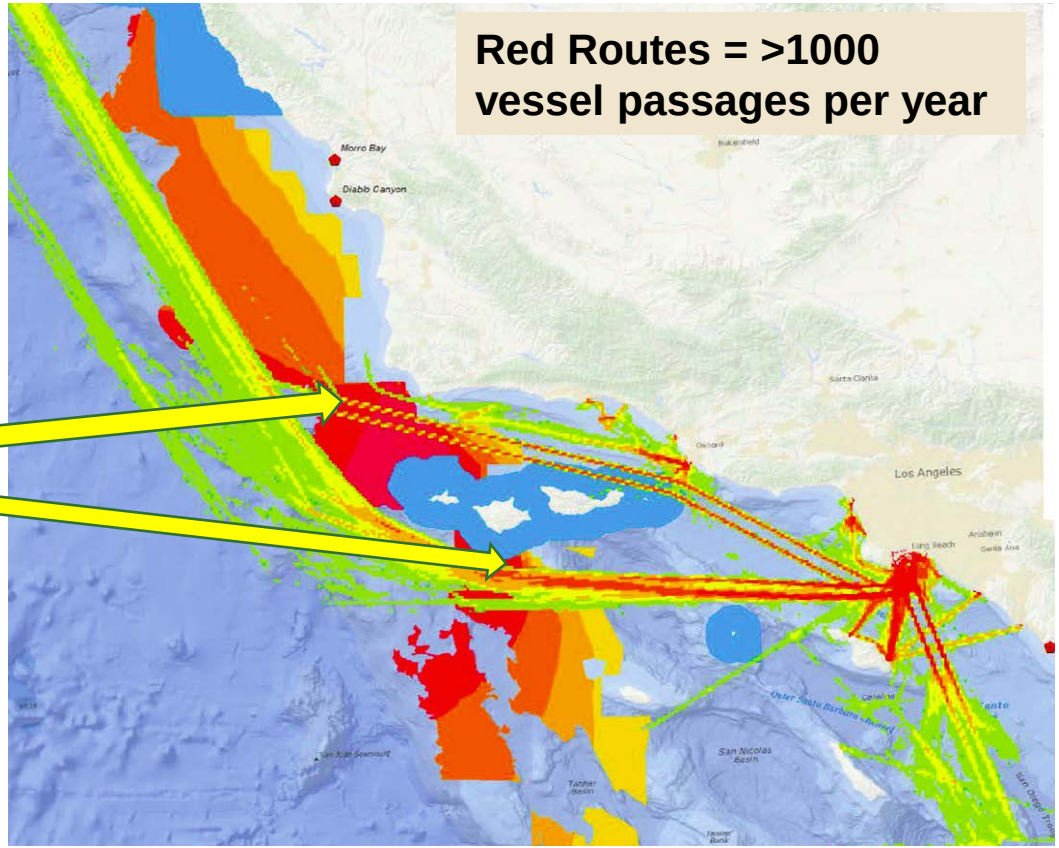

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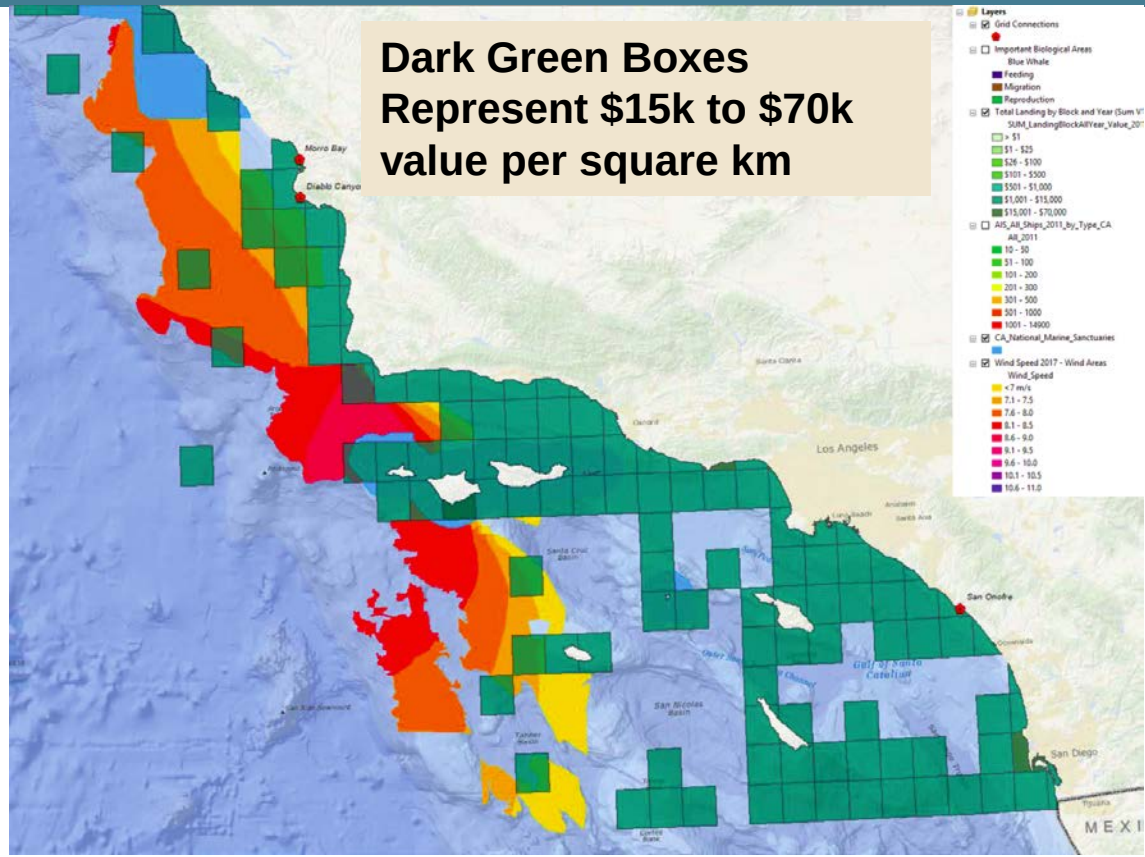

What's Happening In California?

- BOEM has organized a State Task Force for planning development https://www.boem.gov/california/
- Call for Information & Nominations went out October 19, 2018.
  - This is to seek stakeholder input on potential lease areas

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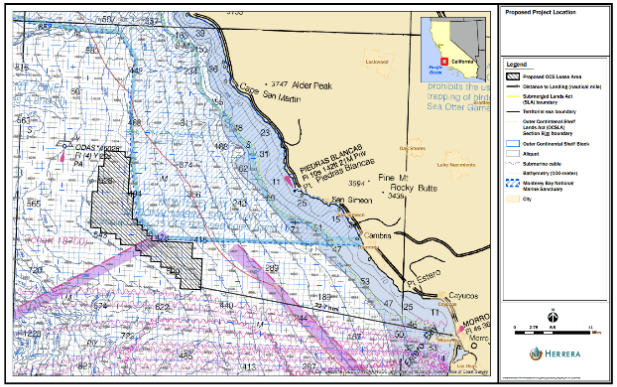
- OPEN COMMENT PERIOD NOW!
  - Until January 28
  - https://www.regulations.gov/
  - Search: BOEM-2018-0045

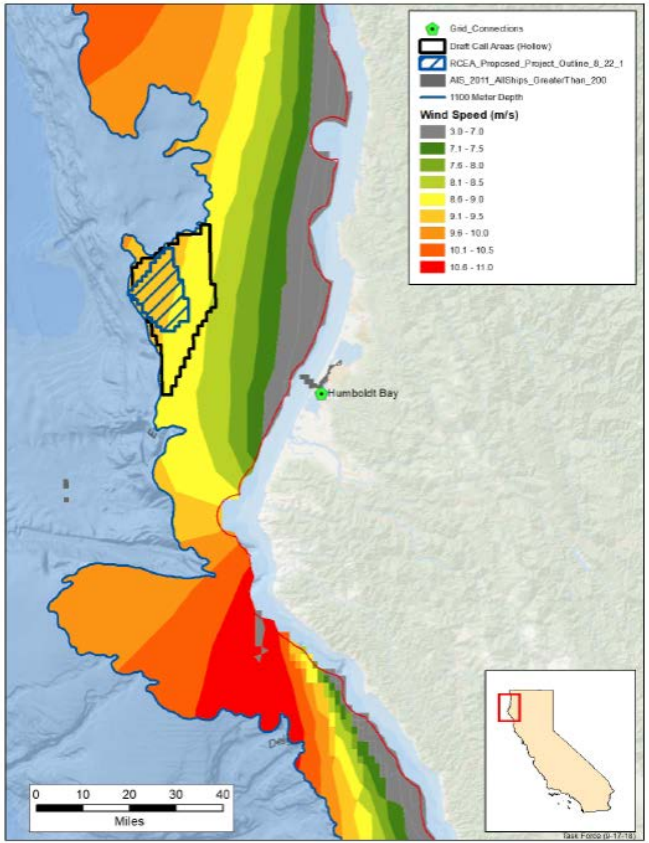
Central California

- March 2016: Trident Winds submitted an unsolicited lease application for a site off of Morro
  - 600+ MW (~100 turbines)
  - Existing infrastructure (NRL Coal Power Plant connects to the grid & Diablo Canyon Nuclear Power Plant)
  - Moderate winds for energy generation
- Since submission, other private sector developers have expressed interest in this project – therefore, BOEM will move to competitive lease via auction



Northern California

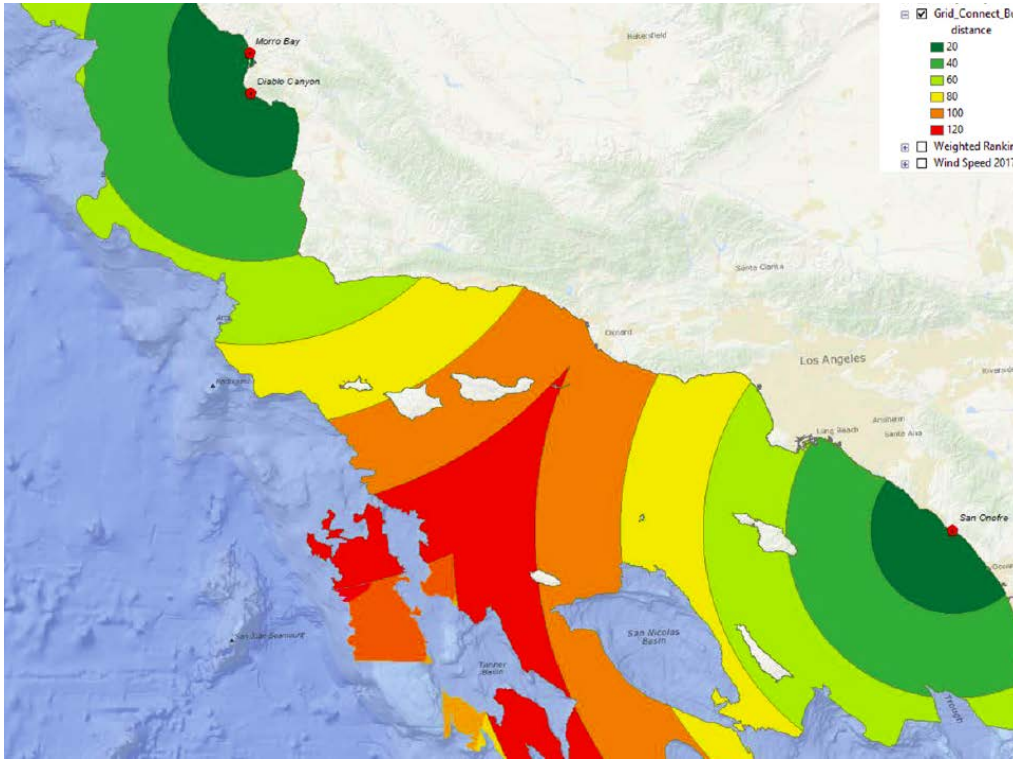
- 2018: Redwood Coast Energy Authority submitted an unsolicited lease application for a site off of Humboldt Bay
  - 120-150 MW (5-15 turbines)
  - Strong winds for energy generation
  - Humboldt Bay has a deep water port
- Since submission, other private sector developers have expressed interest in this project – therefore, BOEM will move to competitive lease via auction



Southern California

- To date, no organization has submitted an unsolicited lease bid.
- Two European developers (Ørsted and Equinor) have verbally expressed interest to BOEM about developing these areas.
- San Onofre Nuclear Power Plant's grid connection could receive power from over 200 offshore wind turbines
- Likely Southern California will be the last location to develop due to Navy, shipping and Sanctuary constraints

Distance to Onshore Grid Connection



What's Happening In California?

- California Energy Commission is fostering communication between stakeholders and coordination.
  - Workshops
  - Task Force meetings
  - https://www.energy.ca.gov/renewables/offshore_energy/documents/
- California Offshore Wind data Gateway
  - Stakeholder database hosted on https://caoffshorewind.databasin.org/

Are California Ports Ready?

- The short answer is: **No**
- Study commissioned by BOEM identified that current port infrastructure is not adequate to support the importation, fabrication, assembly, transit, and installation of offshore wind structures for California
- There looks to be considerable opportunity available, although San Francisco Bay ports likely will be challenged by the Golden Gate Bridge
- 50% of offshore wind project capital costs are operations and maintenance – therefore there are huge workforce opportunities available

What else should we know?

- BOEM's selection process is based on highest bidder. Last round of lease sales in December generated $405M for federal government (average $200/acre)
- Unlike the east coast (with numerous large areas that can be developed), California will likely only have 3-5 lease areas in the foreseeable future
- Although BOEM will set regulations and require investigations/studies, an Environmental Impact Report, etc. – they will not set regulations for stakeholder engagement/participation, local content, foreign/domestic ownership, etc.
- The fundamental driver for the developer is establishing a Power Purchase Agreement with a power utility. This is a long-term agreement to buy power from the developer and generally is required as surety for the capital loan.

Sources

- Bureau of Ocean Energy Management
- California Energy Commission
- Offshore Business Network
- Trident Wind
- Redwood City Energy Commission
- Ørsted
- Equinor
- National Renewable Energy Laboratory, Walt Newal, presentation July 11, 2018, Houston.
- U.S. Department of Energy report on offshore wind energy https://www.energy.gov/sites/prod/files/WindVision_Report_final.pdf
- Fugro knowledge base, Global offshore and onshore geotechnical and survey services

Thank-you for your time.

Now go submit a comment!!

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