Introduction to Floating Wind Technology and Markets

October 13, 2022
Webinar Logistics

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Presentation Roadmap

- Webinar Logistics
- WFO and CESA Introductions
- Overview of Global Floating Offshore Wind Industry
  Presentation by Adrienne Downey of Hexicon Group
- Fireside Chat w/ California Energy Commissioner Kourtney Vaccaro
- Q & A
- Conclusion of Webinar
Webinar Panelists

Sam Schacht
Clean Energy States Alliance

Mike Matthews
World Forum Offshore Wind

Adrienne Downey
Hexicon

Kourtney Vaccaro
California Energy Commission
Offshore Wind Accelerator Project (OWAP)

OWAP supports the development of the offshore wind market and informs the policies that enable a just transition to clean energy by:

1. Engaging states in information sharing and networking to advance cross-learning and regional cooperation
2. Engaging with community-based organizations to promote equitable offshore wind development
3. Communicating with a wide range of stakeholders to advance the public discourse
OWAP Learning Exchange

Our OWAP Learning Exchange aims to:

- **Educate** an American audience about the advancement of the European offshore wind industry and share lessons learned
- **Host** a peer-to-peer forum for EU and U.S. officials to exchange and learn
- **Strengthen** ties among the U.S. states actively engaged in offshore wind development
World Forum Offshore Wind (WFO)

- Global non-profit with 95-plus members and counting
- HQ in Hamburg, offices in Taiwan, Japan, and the U.S.
- FOWC focuses has four main areas of focus: O&M, insurance, moorings, and cable and floating substations
- Join us!
Floating Offshore Wind Committee (FOWC)

- FOWC focuses has four main areas of focus: O&M, insurance, moorings, and cable and floating substations
- Recent whitepapers on moorings systems, O&M challenges and opportunities, and insurability of FOWTs
Start of Hexicon Group Presentation

- World leader in floating offshore wind
- Member of WFO
GROWING RENEWABLE ENERGY IS THE PILLAR OF GLOBAL CO₂ REDUCTIONS

Renewables expected to constitute ~70% by 2050

Global electricity generation mix, %

- Coal
- Gas
- Nuclear
- Oil
- Solar
- Wind
- Other renewables
- Bioenergy

Global CO₂ emission, billion tons

- Efficiency
- Renewables
- CCUS²
- Other²

Source: Bloomberg New Energy Finance 2021

1) Sustainable development scenario (bottom line), relative to stated policies scenario (top line)
2) Carbon capture, utilisation and storage
3) Includes fuel switching, nuclear and other
**WHY POLICY-MAKERS ARE LOOKING TO FLOATING WIND**

- **Enormous resource potential**
- **Superior wind conditions**
- **Minimized environmental footprint**
- **Industrialisation potential**

Deep-water wind is key to unlocking effective renewable energy

<table>
<thead>
<tr>
<th>Deep water (&gt;60m)</th>
<th>Shallow water (30–60m)</th>
<th>Onshore (30–40%)</th>
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<tbody>
<tr>
<td>Offshore floating wind 50–60%</td>
<td>Offshore bottom-fixed 45–50%</td>
<td></td>
</tr>
<tr>
<td>70–80%, Floating (&gt;60m depth)</td>
<td>20–30%, Bottom-fixed (&lt;60m depth)</td>
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1) Europe, US, Japan and Taiwan included based on Carbon Trust and Industrial Technology Research Institute.  
2) Capacity factor may vary from project to project

Source: Wood Mackenzie Power & Renewables: The Momentum of Floating Wind and its Outlook Implications (Dec 19); Fortune Business Insights
THE RACE FOR FLOATING IS ON – SIGNIFICANT GROWTH AHEAD

New floating wind installations, Global (MW)

<table>
<thead>
<tr>
<th>Year</th>
<th>2021</th>
<th>2022e</th>
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<th>2026e</th>
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<td>96</td>
<td>101</td>
<td>330</td>
<td>1048</td>
<td>1166</td>
<td>1400</td>
<td>2838</td>
<td>4900</td>
<td>6900</td>
<td>9900</td>
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Roadmap of floating offshore wind commercialisation
- Demo and trial phase (2009–2020)
- Pre-commercial phase (2021–2025)
- Commercial phase (from 2026 onward)

Contribution by region, new installations 2022–2031
- Europe: 59%
- Asia: 29%
- North America: 11%

Offshore wind deemed to grow
- 80% of the world’s offshore wind resource potential lies in waters deeper than 60m
- Only 121.4 MW of net floating wind capacity is in operation worldwide, accounting for 0.2% of the total installed offshore wind capacity

Source: GWEC | GLOBAL OFFSHORE WIND REPORT 2022
SCALE AND INDUSTRIALISATION OF THE VALUE CHAIN IS KEY TO GETTING COMPETITIVE LCOE

Key measures to lower LCOE

- Accelerate the scale of deployment
- Develop strategic supply chain
- Drive innovation through test and demonstration

Projected LCOE based on average project capacity

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<tbody>
<tr>
<td>Onshore wind²</td>
<td>Solar PV²</td>
<td>Offshore shallow-water wind²</td>
<td>Deep-water wind²</td>
</tr>
</tbody>
</table>

LCOE, USD/MWh  Generation, '000 TWh  LCOE, USD/MWh  Generation, '000 TWh  LCOE, USD/MWh  Generation, '000 TWh  LCOE, USD/MWh  Generation, '000 TWh

Global weighted average LCOE in year of commissioning (USD / MWh)


2) Full lines represent the global weighted average LCOE in year of commissioning (USD / MWh), while the dotted lines represent the 5th percentile LCOE globally – the highest quality projects.
MULTIPLE FOUNDATION CONCEPTS EXIST TODAY

1. SEMI-SUBMERSIBLE
   - Buoyancy stabilised platform floating semi-submerged on the sea surface
   - Anchored to the seabed with catenary mooring lines
   - Low draft allows for more flexible application and simpler installation
   - Relatively low risk in execution

2. BARGE
   - Large displacement buoyancy stabilized platform
   - Low draft allows for more flexible application and simpler installation
   - Large structure exposed to wave loading and risk of greater motions
   - Large but simple geometry to fabricate

3. SPAR
   - Cylindrical ballast-stabilised structure
   - Stability from lower centre of gravity than the centre of buoyancy
   - Simple structure is relatively easy to fabricate and provides good stability
   - Large draft creates logistical challenges for assembly, transport and installation

4. TENSION LEG PLATFORM
   - Semi-submerged structure anchored to the seabed with tensioned mooring lines
   - Shallow draft and tension stability allows for a smaller and lighter structure
   - Design implies increased stresses on the tendon and anchor system
   - Challenges with installation and higher operational risks if a tendon fails

Source: DNV, Floating offshore wind: the next five years, 2022
Floating wind has developed from the oil and gas sector which has used semi-submersible floating foundations for many decades.

In 2009 Equinor installed the first full-size floating turbine. The 2.3MW Hywind turbine was built with a SPAR foundation.

In 2011 Principle Power installed their Windfloat solution which utilises a semi-submersible structure.

In 2021 the largest floating wind park in the world was fully installed. A 50MW park outside the coast of Scotland using the Windfloat semi-submersible structure.

In 2011 Hexicon wins the UK’s first competitive commercial floating wind CfD Award for its 32 MW TwinHub project in the Celtic Sea, signaling a record-breaking strike price of <$120/MWh via its TwinWind technology.
USA Offshore Wind: 30 GW by 2030 and 110 GW by 2050

Our path forward will help achieve the first ever national offshore wind goal to deploy 30 gigawatts of offshore wind by 2030, which would create nearly 80,000 jobs.

- **42 MW** Currently Installed
- **19.5 GW** Under Contract
- **77.4 GW** State Goals by 2045
- **15 GW** by 2035 Floating Wind Shot™
- **65 GW** by 2050 Floating Potential
California: 2–5 GW by 2030 and 25 GW by 2045

Preparation a Strategic Plan for Offshore Wind Energy Development Staff Workshop

October 6, 2022

https://efiling.energy.ca.gov/
Docket no. 17–MISC–01

https://caoffshorewind.databasin.org/
Fireside Chat

California: 2–5 GW by 2030 and 25 GW by 2045

California Energy Commissioner
Kourtney Vaccaro & Adrienne Downey of Hexicon
Thank you!

Photo credit: RWE