WOODS HOLE OCEANOGRAPHIC INSTITUTION AND
Offshore Wind Energy

Positioning WHOI to lead basic and applied science discoveries relevant to Offshore Wind Energy
Background

2014 RI/Mass Offshore Wind Energy Federal Lease areas
Background

2014 RI/Mass Offshore Wind Energy Federal Lease areas

- Proposed Cape Wind Location... now abandoned
- Pioneer Array
- MVCO
- Woods Hole
- Deepwater/Orsted
- Orsted
- Vineyard Wind
- NES-LTER Transect
Background

Why Massachusetts?
Background

August 12, 2016: Governor Charlie Baker (R) signs Massachusetts legislation for 1600 MW.
First Major U.S. Wind Farm will be...

Vineyard Wind Lease Area

- 106 Turbines
- Construction starts this Spring
A Really Big Deal

15 separate lease areas in the Middle Atlantic Bight
High Population Density = High Demand

15 separate lease areas in the Middle Atlantic Bight

Power Purchase Agreements for 3000 MW
Requires 500+ turbines by 2030
A Really, Really Big Deal

Last Thursday...

Record-Breaking $405 Million Auction Proves Offshore Wind Is The Rare Bipartisan Success Story

Last week’s record-breaking auction for development rights to three offshore wind lease areas off Massachusetts’ coast netted nearly a half-billion dollars, heralding the technology’s arrival as an extremely attractive corporate investment, and cementing its status: Offshore wind is America’s biggest bipartisan energy success story.

The Bureau of Ocean Energy Management (BOEM) auction lasted 32 rounds over two days, and the three winning companies bid a collective $405.1 million for the rights to develop offshore wind across nearly 390,000 acres south of Martha’s Vineyard. The three lease areas could host up to 4.1 gigawatts (GW) of generation capacity, enough to supply roughly 1.5 million homes.
A Really, Really Big Deal

First Major U.S. Wind Farm will be...

**Vineyard Wind Lease Area**

- Estimated cost to build: $2 billion
- Price for power: 6.2 cents/kWh
A Really, Really Big Deal

The graph shows the cost of energy/MWh over different time periods, ranging from 1980-1990 to the future. The cost decreases significantly with time. Notable milestones include:

- 1.2 MW: $600
- 1.5 MW: $480
- 30 m, 50 m, 70 m, 80 m, 100 m, 125 m, 150 m
- Offshore
- Future

The graph also includes comments such as "Really, Really Big Deal."
Outline

• Background
• A look at the industry
• What can our role be?
• Near-term opportunities
• A Long Term Plan
What is the ‘industry’?

A convergence of disparate groups...
What is the ‘industry’?

European Markets have led the way.

Borssele 700 MW
strike price = 8.6 cents/kWhr

July 6, 2016 (Netherlands)

Denmark:
September 12, 2016
Danish Near Shore 350 MW  6.0¢/kWhr

November 9, 2016
Kriegers Flak  600 MW  4.99¢/kWhr

Germany:
April 13, 2017
Direct Energy Market Pricing
Borkum Riffgrund West II: 240 MW
He Dreih:  900 MW
Gode Wind 03:  110 MW
Northern Energy OWP  240 MW

UK
September, 2017
Hornsea II:  1386 MW  7.6 ¢/kWhr
Triton Knoll:  860 MW  9.9 ¢/kWhr
Moray:  950 MW  7.6 ¢/kWhr
What is the ‘industry’?

Half the cost, and most of the risk, is IN the ocean.
Profiles in Concern

Thomas Brostrøm
CEO, Ørsted US

Site Characterization
Accuracy and Costs

Design life and extreme events

Marine Mammals/
Fisheries Mitigation

Construction Delays
Profiles in Concern

Thomas Brostrøm
CEO, Ørsted US

Site Characterization
Accuracy and Costs

Design life and extreme events

Marine Mammals/
Fisheries Mitigation

Construction Delays

Risk

$
Profiles in Concern

How research can help...

- DOE FOA-0001767 (R&D consortium)
  - The offshore wind as fuel
  - The offshore wind design criteria
- DOE FOA-0001924 (Advanced Wind R&D)
  - Includes Avian and Marine Mammal Mitigation Testing
Profiles in Concern

A $40 million DOE and industry led group focused on lowering costs.
Profiles in Concern

Rodney Cluck, BOEM
Chief of Environmental Sciences

What is the effect of development on the OCS?

How can effects be mitigated?
Profiles in Concern

Rodney Cluck, BOEM
Chief of Environmental Sciences

What is the effect of development on the OCS?

How can effects be mitigated?
Profiles in Concern

Actions thus far:

- Environmental sampling (RODEO)
  - Species monitoring
  - Underwater noise assessments
- NAS Atlantic Fisheries and Wind Panel
- OCS Radar Mitigation

Other potential topic areas:

- EM Cable effects
- Marine Mammal takings
- Ecosystem monitoring, user conflicts

Accepting ideas for 2020-2022 studies:
https://www.boem.gov/Invitation-for-Input/
Deadline tomorrow!
Profiles in Concern

Chris Oliver, NOAA-NMFS
Assistant Administrator for NOAA Fisheries

What is the effect of development on Fisheries?

How to maintain effectiveness of core survey operations?
Profiles in Concern

Chris Oliver, NOAA-NMFS
Assistant Administrator for NOAA Fisheries

What is the effect of development on fisheries?

How to maintain effectiveness of core survey operations?

Uncertainty
Outline

- Background
- A look at the industry
- What can our role be?
- Near-term opportunities
- A Long Term Plan
What can our role be?

Every day, we develop and use cutting edge techniques and engineering solutions to achieve our mission.
State of the Practice

State of the Art
State of the Practice

State of the Art

Become a fully qualified Marine Mammal Observer in just 4 days!
State of the Practice

State of the Art
## What can our role be?

<table>
<thead>
<tr>
<th>AREA</th>
<th>STATE OF THE PRACTICE</th>
<th>STATE OF THE ART</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geophysics</td>
<td>“Big Boat” surveys</td>
<td>AUV-based surveys</td>
</tr>
<tr>
<td></td>
<td>Costly, deep, site-specific surveys</td>
<td>Economical, high-resolution subsurface imaging</td>
</tr>
<tr>
<td>Marine Mammals</td>
<td>Ship-based observers</td>
<td>Real-time acoustic tracking</td>
</tr>
<tr>
<td>Atmospheric</td>
<td>Cup Anemometers</td>
<td>Advanced, remote sensing</td>
</tr>
<tr>
<td></td>
<td>Coarse resolution wind forecast</td>
<td>data-constrained high-resolution short-term forecasts</td>
</tr>
<tr>
<td></td>
<td>products</td>
<td></td>
</tr>
<tr>
<td>Geotechnical</td>
<td>Bore holes for coring</td>
<td>Down bore hole remote sensing</td>
</tr>
<tr>
<td></td>
<td>Cone Penetrometer Testing</td>
<td></td>
</tr>
<tr>
<td>Construction/O&amp;M</td>
<td>Ship-based transits and survey efforts</td>
<td>Onsite surveys/presence via AUV docking stations</td>
</tr>
<tr>
<td></td>
<td>Divers</td>
<td>AUV structural/cable surveys</td>
</tr>
<tr>
<td></td>
<td>Static noise thresholds</td>
<td>Soundscape monitoring</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Quarterly animal surveys</td>
<td>Integrated ecosystem assessments (e.g. LTER)</td>
</tr>
<tr>
<td></td>
<td>Trawl surveys</td>
<td>HABCAM-type ‘no take’ assessments</td>
</tr>
<tr>
<td>Data</td>
<td>Individual data sets</td>
<td>Integrated Big Data</td>
</tr>
</tbody>
</table>

---

**Data**

- Individual data sets
- Integrated Big Data
What Can Our Role Be?

WHOI can:

Transition new technology into the industry.

Contribute to the understanding of OSW as a new ocean user.
Outline

- Background
- A look at the industry
- What can our role be?
- Near-term opportunities
- A Long Term Plan
“Let me know when there is something to propose to...”
Offshore Wind Energy Research Program

Call for proposals: Friday, 18 January 2019 at 5:00 pm.

Description
The purpose of Offshore Wind Energy Research Program (OWERP) is to fund projects that develop and establish WHOI technologies or analysis methods as transferable to the emerging offshore wind energy community. This effort is jointly funded by WHOI and the Massachusetts Clean Energy Center (MassCEC: https://www.masscec.com) as a means of pushing new methods or developed techniques of observing or modelling the sea floor, ocean, and atmospheric environments developed at WHOI past the ‘burden of proof’ for commercialization and use by industry.

Proposals should emphasize how the research will bring the Institution’s engineering and instrumentation expertise to bear on timely scientific and technical issues for the offshore wind energy industry. The recently published whitepapers: “The development of ocean test beds for ocean technology adaptation and integration into the emerging U.S. offshore wind energy industry” (https://hdl.handle.net/1912/10412), and the Massachusetts Research Partnership’s report: “Reaching convergence in United States
2019 Catalyst Research Opportunity

- Funding by WHOI and Mass. Clean Energy Center
- Proof of concept for innovative technological solutions for the emerging offshore wind energy industry
- Looking for Industry Partners? Contact a Catalyst team member...
Three separate RFPs:

1: Offshore wind plant technology and supporting innovations (Feb 2019)

2: Innovative methods for wind resource and site characterization

3: Advancing operations and maintenance.

https://www.nyserda.ny.gov/All%20Programs/Programs/Offshore%20Wind/Economic%20Opportunities/RD
Outline

• Background
• A look at the industry
• What can our role be?
• Near-term opportunities
• A Long Term Plan
What can our role be?

- Lead proof of concept testing of new technologies that could benefit the emerging U.S. industry.

- Establish open processes/methods to evaluate the effects and implications of the industry on the ocean.
Foundational Efforts:

A White Paper Prospectus

The Development of Ocean Test Beds
Ocean technology, adaptation and integration into the emerging U.S. offshore wind energy industry

Lead Authors
Anthony Kirincich
WHOI
Jay Borkland
Eric Hines
Tufts University
Steve Lohrenz
UMass Dartmouth

DOI: 10.1575/1912/10412

May 2018

POWER-US Partnership for Offshore Wind Energy Research

Reaching Convergence in United States Offshore Wind Energy Research:
A Multidisciplinary Framework for Innovation

A White Paper by the Massachusetts Research Partnership in Offshore Wind
The Development of Ocean Test Beds

for Ocean Technology Adaptation and Integration into the Emerging U.S. Offshore Wind Energy Industry

Pushing the State of the Art into the State of the Practice

Woods Hole Oceanographic Institution

Lead Authors
Anthony Kirincich
WHOI

Jay Borkland
Eric Hines
Tufts University

Steve Lohrenz
UMass Dartmouth

DOI: 10.1575/1912/10412

May 2018

POWER-US

PARTNERSHIP FOR OFFSHORE WIND ENERGY RESEARCH

Woods Hole, Oceanographic Institution

Tufts University
Ocean Test Beds:

State of the Art ➔ State of the Practice

- Benchmark New Technologies
- Provide a Framework for Consensus
- Connect Science, Regulation and Industry
Setting the National Agenda

Massachusetts Research Partnership in Offshore Wind
Setting the National Agenda

Statehouse briefings in 2017 and 2019 with Massachusetts Colleagues.

Agency briefings in 2018 and 2019 to expand Ocean Test Bed concept and WHOI opportunities.

Coordinate partner, agency, and industry visits to WHOI.
A Partnership for Offshore Wind Energy Research

POWER-US

Key Research Assets

- OSU Hinsdale Wave Research Lab
- UMaine Harold Alfond W2 Ocean Engineering Laboratory
- Pacific Northwest National Laboratory
- Maine Aqua Ventus
- MassCEC Wind Technology Test Center
- Woods Hole Coastal Observ. Station
- Virginia Research Leases
- Clemson Energy Innovation Center

- National Renewable Energy Laboratory
- Sandia National Laboratories SWIFT Facility
- FIU Wall of Wind
- Coastal Virginia Offshore Wind

*States colored in blue are prospective charter members.

Woods Hole Oceanographic Institution
Setting the National Agenda: Goals

**Position WHOI to:** Transition new technology into the industry

Contribute to the understanding of OSW as a new ocean user
Websites:

Internal Call Info:
https://www.whoi.edu/DoR/page.do?pid=163836

DOE Consortium:
https://www.nyserda.ny.gov/All%20Programs/Programs/Offshore%20Wind/Economic%20Opportunities/RD

BOEM Comments:
https://www.boem.gov/Invitation-for-Input/
Extra
A New Ocean Industry

...in a crowded ocean space