Maine Offshore Wind Milestones

Hosted by
Val Stori, Project Director, OWAP

March 6, 2014
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Submit your questions at any time by typing in the Question Box and hitting Send.

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http://www.cleanenergystates.org/webinars/
Offshore Wind Accelerator Project

OWAP Objective: Address key challenges facing offshore wind in five focus areas

• Work with individual States to assist with the development of strategic, long-term policies to advance offshore wind and develop a serious process to get to OSW scale in the U.S.

• Work on regional strategies with multiple states to increase opportunities for joint funding, networking and information sharing, joint procurement, supply chain and siting cooperation.

• Work on developing new finance tools and mechanisms, including buyers’ networks and joint aggregated purchases, to provide the needed capital to scale up the offshore wind industry.

• Continue to communicate of ideas and policy developments between states and other stakeholders through OWAP.

• Work with leading European and UK policy makers to learn about the more established experience with offshore wind in those countries, and import that knowledge to US energy policy makers.
Today’s Guest Speakers

**Habib Dagher**, Professor of Civil/Structural Engineering, University of Maine

**Jeff Thaler**, Visiting Professor of Energy Policy, Law & Ethics, University of Maine
Stay Connected to OWAP!

Val Stori, Project Director
val@cleanegroup.org
facebook.com/offshorewindworks
@OSWindWorks on Twitter

Visit our website to read more about OWAP
and sign up for our e-newsletter:
http://www.cleanenergystates.org/projects/
accelerating-offshore-wind-owap/
The VolturnUS Floating Wind Turbine Technology

Prof. H. J. Dagher, Ph.D., P.E., Director
Advanced Structures and Composites Center
hd@maine.edu
(207) 581-2138

OWAP Webinar
Maine Offshore Wind Milestones

March 6, 2014

Acknowledgements: DOE, NSF, MTI
Over 30 Partners

DOE, NSF, UMaine, MTI, State of Maine
Outline

• Who are we?
• Results of the 1:8 Scale VolturnUS Testing
• The DOE Advanced Technology Demonstration Project
Advanced Structures and Composites Center

200 personnel
87,000 ft² Lab
18 years

1,400 students funded through lab

Composites Industry

Construction Industry
Global Industry Awards

- 2007 ACMA Best of Show
- 2007 ACMA People’s Choice
- 2009 ACMA Most Creative Composites Product
- 2010 ACMA Most Creative Composites Product
- 2011 ASCE Pankow Innovation Award
Annual Heating Cost (typical home)

Values from http://www.efficiencymaine.com/pace/compare-heating-options on 12/7/12
Maine Family Budget

“Family Energy”\textsuperscript{1,2} = 50\% Transportation
40\% Heating
10\% Electric Power

\textsuperscript{1} Source: Dr. George Hart, UMaine
\textsuperscript{2} Based July ’08 energy costs
\textsuperscript{3} Assumes that health care costs do not grow past 30\% of the average family budget in 2008-2018
Northeast US Offshore Wind Resource

Gulf of Maine wind resource: 156.6 gigawatts
Northeast population: 55 million

<table>
<thead>
<tr>
<th>Wind Speed at 90 m</th>
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<tbody>
<tr>
<td>m/s</td>
</tr>
<tr>
<td>11.5-12.0</td>
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<tr>
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<td>6.0-6.5</td>
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<td>0.0-6.0</td>
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</table>
Maine Timeline: 5GW Floating by 2030

Over-the-Horizon Farms

Phase 2 - 1: Prototypes

Phase 1 - 1:50 Scale

Phase 5 - 5 GW by 2030s

Phase 3 - Pilot Farm: 12 MW

Phase 4 - 500 MW Farm

DOE Advanced Technology Demonstration
#1 Technical Challenge:
Reduce the Cost of Offshore Wind

Supply Standard Offer - Historic and Projected - BHE

- Floating Offshore Wind
- Linear (Small)
- Linear (Medium)
- Linear (Large)

Cost ($/kW hr) vs. # years after 2000
VolturnUS Avoids Expensive Offshore Construction Assets
3 Hulls, 60 Metocean Conditions

All viable!
Choice depends on local conditions
VolturnUS Paradigm Shift:
Use Civil Engineering versus Offshore “Oil & Gas” Assets

New England Considerations

- Limited cost-effective heavy steel fabrication capabilities.
- Limited or no access to large vessels/floating cranes.
- Significant experience constructing concrete for heavy bridges.
- Highly efficient modular construction.

Access to better wind resource

>50% gross Capacity Factors farther offshore

> 9 m/s wind
Construction of VolturnUS 1:8 at UMaine Offshore Wind Lab
VolturnUS 1:8 Tow-out Validated
Scaling Studies:
✓ 1:8 scale waves at Castine
✓ Reduce rotor to scale wind thrust

Challenges:
1. Can we have a good scaled experiment?
2. Can we characterize the environment accurately enough to verify numerical models?
5.9 degree maximum inclination during the storm

1:8th Scale

8.8’

November 1, 2013 1:59PM
Operational Footage From The Winter Storm "Electra"

December 15, 2013
Castine, ME
DeepCLIDAR Built, Deployed, Validated

Direction Sector: All

U >= 0

intercept: 0.0
Slope: 0.983
Rsq(hour): 0.99
Rsq(10 min): 0.986
N: 504

Dr. Habib Daghe, Director
Advanced Structures and Composites Center
hd@umit.maine.edu
composites.umaine.edu
(207) 581-2138
### Wave Height vs. Return Period

<table>
<thead>
<tr>
<th>Wave (m)</th>
<th>Return Period (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.0</td>
<td>50</td>
</tr>
<tr>
<td>19.5</td>
<td>100</td>
</tr>
<tr>
<td>21.5</td>
<td><strong>Measured - scaled</strong></td>
</tr>
<tr>
<td>22.3</td>
<td>500</td>
</tr>
</tbody>
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>100 Years Return Period Waves
Max acceleration = 0.165g
Max inclination = 5.9 degrees
Environment for Model Correlation Study

Nov. 27, 2013, 12:51:54 PM to 1:51:58 PM

- $U_{avg} = 15.4 \, m/s$, $U_{max} = 23.6 \, m/s$
- $H_s = 1.6 \, m$, $T_p = 5.2 \, s$, $H_{max} = 2.6 \, m$

Produces rated thrust
Between 100-500 years RP
Removed Technology Risk: Close Agreement Measured vs Simulation

Base Sway acceleration

Base Heave acceleration
Platform Angular Acceleration

Measured vs Simulation

Tower Base Roll Acceleration

IMU 2 Angular Acceleration (rad/s²)

Data
FAST
New England Aqua Ventus I Is Ready!

- Technology Innovation that drives down cost
- 1:8 pilot success
- PPA
- Lease
- Contractor
- Interconnect
- Permits (2015)

DOE Advanced Technology Demonstration Projects

2013 – 50% design
2014 – 100% design
2015 – Start construction
2017 – Turbines connect grid
20-year Power Purchase Agreement: Maine Aqua Ventus, LP formed

Maine PUC Proposal Submitted August 2013
23 cents/kWh Term Sheet Decision January 2014

Maine Aqua Ventus GP, LLC
Cianbro
Emera
Maine Prime Technologies

20 Partners
Visual and Sound Models at Site
Environmental Baselining at Test Site

Community and Stakeholder Outreach 2010-2014
In Castine, Maine, on June 13, 2013, at noontime, the first offshore wind electrons started to flow into the US electricity grid.

2017- Pilot Project
2020’s – Commercial Floating Farms

Thank you!

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