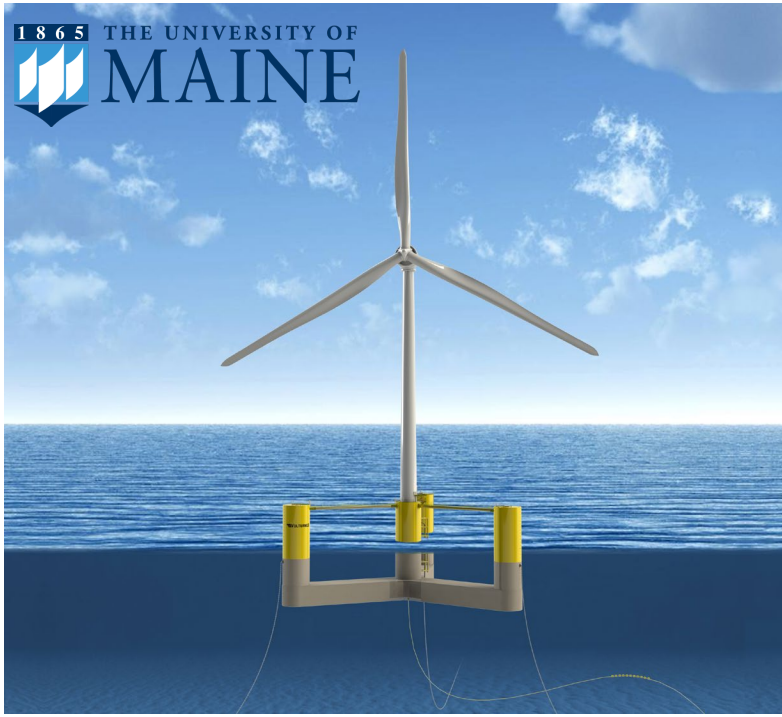
U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

2021 PROJECT PEER REVIEW

U.S. DEPARTMENT OF ENERGY
WIND ENERGY TECHNOLOGIES OFFICE



T01 - New England Aqua Ventus I

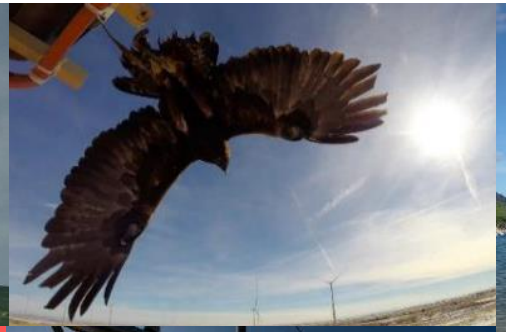
DOE Grants: DE-EE-0005990 and DE-EE-0008965
Advanced Offshore Wind Technology Demonstration Project

Dr. Habib Dagher, PE and Dr. Anthony Viselli, PE

University of Maine Advanced Structures and Composites Center

August 2nd, 2021







FY21 Peer Review - Project Overview

Project Summary:

- Design, permit, finance, and construct the first floating commercial scale wind turbine in the US.
- Project site off Maine in the Northeast US
- Patented Floating concrete semi-submersible floating wind technology
  - Designed for mass production and large scale turbines
  - Domestic production methods
  - LCOE for utility-scale <5.7¢/kWh
  - American Bureau of Shipping Classification received
  - Demonstrated in 2013 offshore Maine at 1/8th Scale
- Key project partners:
  - University of Maine
  - New England Aqua Ventus (NEAV) - Joint Venture between RWE Renewables and Diamond Offshore Wind
  - +15 subcontractors and vendors

Project Start: October 2016
Expected Completion: November 2023
Period of Performance: 7 years

DOE Share:	$45.75M
Cost Share:	$125.7M
Total Project Budget:	$171.5M

Key Project Personnel:
Dr. Habib Dagher, PE, PI, Director
Dr. Anthony Viselli, PE, Co-PI and design lead

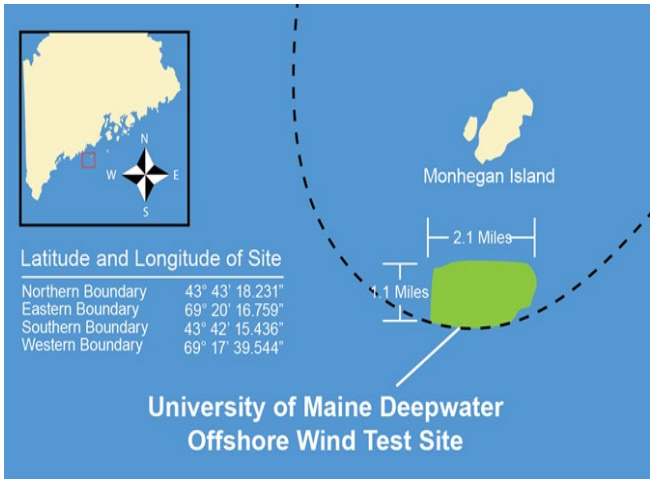
Key DOE Personnel:
Nathan McKenzie
Daniel Beals
Nicholas Massey
Roak Parker

Project Objective(s) 2019-2020:

- Select project developer for the project responsible for overall financing
- Obtain Power Purchase Agreement (PPA) with State of Maine
- Turbine due diligence and preliminary design to support selection in 2021
- Prepare for NEPA review in 2021

Overall Project Objectives (life of project):

- Design, permit, finance, and construct the first floating commercial scale wind turbine in the US.



Technology Pathway To Full Commercialization

Past

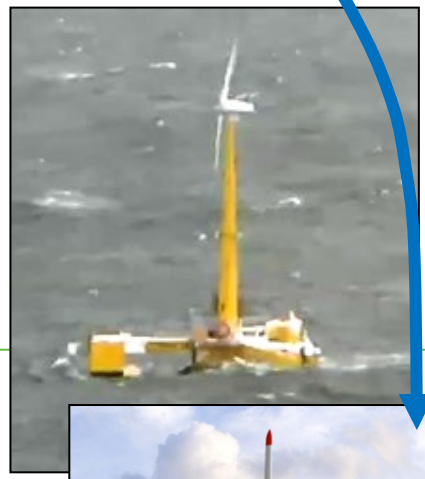
Phase 1:(2010-2013)

Modeling & 1:50 scale Laboratory Work

Phase 2: (2013-2015)

Deployment of 1:8 Scale

>$25 million invested to date



Future

Phase 3: (2016-2023)

Build a demonstration-scale project (single 10+MW turbine) to prove out the technology at a manageable size: *New England Aqua Ventus 1*

Phase 4: (2023+)

Build on experience with demonstration project to enable commercial scale projects

Project Impact: First Commercial Floating Wind Turbine Deployed in the US

1. Demonstration of New Floating Wind Technology:

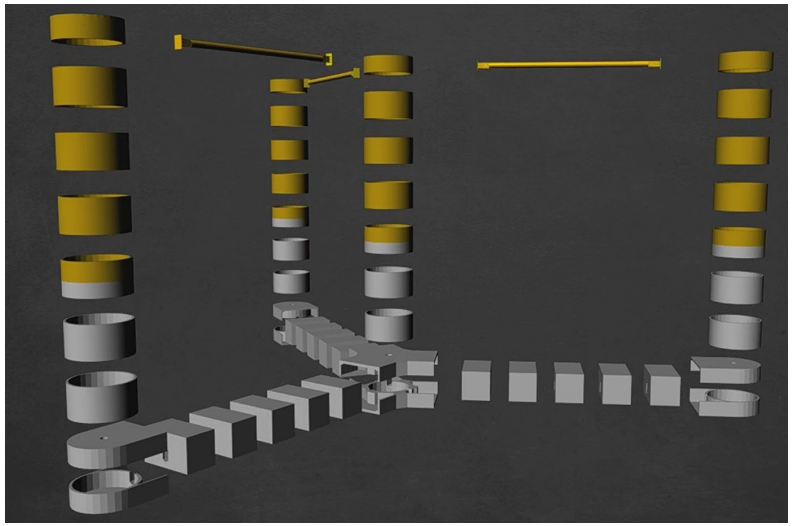
- Accesses approximately 60% of US offshore wind resource
- Reduced LCOE- 5.7¢/kW-hr
- Less sensitive to site specifics
- Domestic production methods leads to increase in local content
- Project location- Northeast - dense population, high electricity costs

2. Provide a living laboratory opportunity for the DOE and industry to assess FOWT design and environmental questions

3. Enable technology for commercial projects

UMaine Patented Hull Technology

Serial Production using 5 Concrete Module Types.
Production of one Hull per Week < $1M/MW

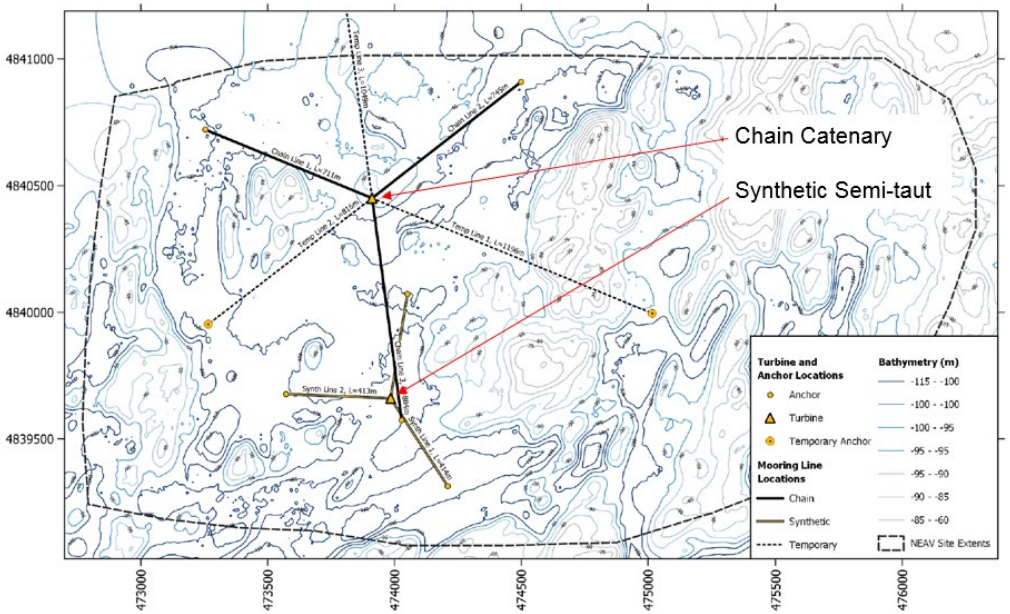


Accomplishments and Progress

1. ABS Approval of FOWT Design for 6MW Received 10/17
2. State of Maine PPA Negotiated and Signed 11/19
3. Project Developer Selected: RWE Renewables/ Diamond Offshore Wind/ Mitsubishi- $100M Investment 8/20
4. Preliminary Design of FOWTs with Larger More Relevant 10+MW WTGs and Due Diligence Completed 3/21
5. Geophysical Study of Anchor Site and Cable Route Completed 3/21
6. Cable Landing Point Selected 7/21
7. Turbine Selection of Larger More Relevant 10+MW WTG Near Completion 8/21
8. FOWT Front End Engineering and Design for larger 10+MW WTG Underway
9. Two Mooring System Designs developed: Catenary Chain and Synthetic Rope Semi-taut. 4/21
10. Project Description Completed and Public Scoping Begun 5/21

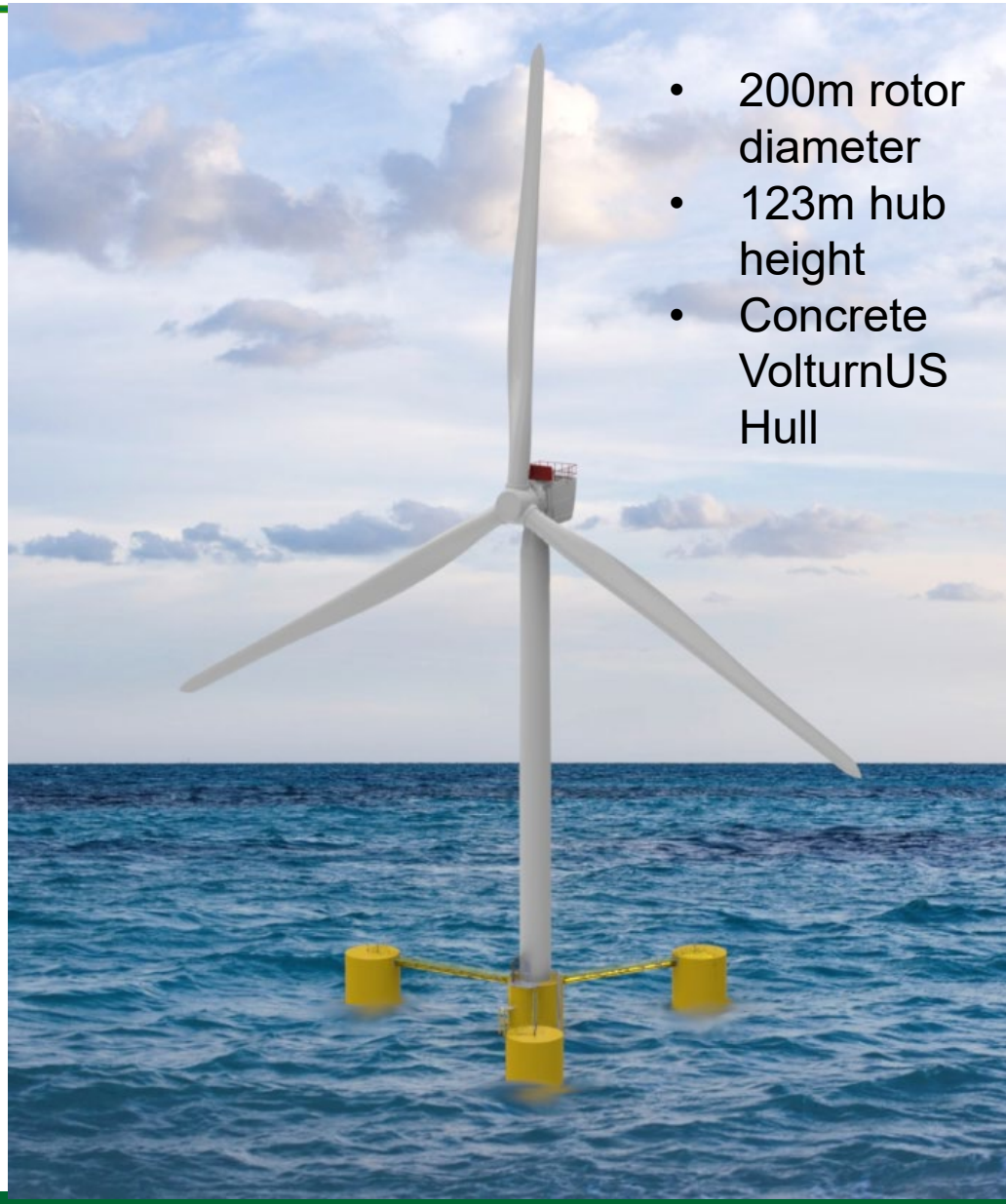
NEW ENGLAND AQUA VENTUS

https://newenglandaquaventus.com/



FEED Engineering Work for Larger 11MW Turbine Milestones

- Metocean conditions revised based on 42 year long hind cast model
- Design Loops in Progress with Turbine OEM
  - Loop 0 completed
  - Loop 1 in progress
  - Loop 2 completed by fall
- Hull sizing completed
- Mooring designs developed
  - Catenary chain
  - Semi-taut synthetic rope
  - Anchors selected
- Mechanical/ marine systems revised
- O&M and vessel access planning



Project Performance - Upcoming Activities

1. FOWT Front End Engineering ar Design- 50% Issued for Construction (IFC) Drawings Q4
2. Detailed Design and 100% IFC Drawings Q2/22
3. Receive Supplier Bids Q4/22
4. NEPA Determination and Permitting Q2/2022
5. Construction of WTG, Hull, Moo Anchors, and Cable Q3/23
6. Deployment and Connection to Grid Q4/23
7. 5-year FOWT Monitoring Q4/28

Stakeholder Engagement & Information Sharing

1. **Over 30 + peer reviewed journal papers. New publications submitted in FY 19-20 include:**
   1. Ward, J.C., Goupee A.J., Viselli, A.M, Dagher, H.J, "Experimental investigation into the dynamic behavior of a floating offshore wind turbine stabilized via a suspended counterweight." Ocean Engineering 228, 108906, 2021
   2. Ward, J.C., Goupee A.J., Viselli, A.M, Dagher, H.J, "The Effect of Counterweight Mass and Line Stiffness on the Global Dynamic Performance of a Hanging-Mass Floating Offshore Wind Turbine." Journal of Offshore Mechanics and Arctic Engineering 143 (5), 052001, 2021
   3. Allen, H, Goupee, A, Viselli, A, Allen C, and Dagher, H (2019). Experimental Comparison of an Annular Floating Offshore Wind Turbine Hull against Past Model Test Data. Journal of Offshore Mechanics and Artic Engineering.
   4. Viselli, A, Filippelli, M, Pettigrew, N, Dagher, H, Faessler, N (2019). Validation of the First LiDAR Wind Resource Assessment Buoy System Offshore the Northeast United States, Journal of Wind Energy. 2019;1–15. DOI 10.1002/we.2387.
   5. Viselli, A, Filippelli, M, Faessler, N (2021). Analysis of LiDAR Wind Speed and Shear Measurements Offshore in the Northeast US. Journal of Offshore Mechanics and Artic Engineering (In Review).
2. **Permitting and Outreach with Public and Fishing Industry**
3. **Significant Media Coverage of Project Progress**
4. **Active Conference Participation, for example**
   1. National Offshore Wind research and Development Consortium 2020
   2. Afloat American Offshore Wind Conference October 30th, 2020
   3. SNAME Offshore Technology Conference 2021
5. **Afloat American Offshore Wind Conference September 8-10, 2021**
   1. NEAV Updates from key researchers planed
   2. Maine offshore wind industry updates
   3. https://www.afloatsummit.com/

State of Maine
Office of Governor Janet T. Mills

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Governor Mills Applauds PUC's Approval of Maine Aqua Ventus Contract

November 5, 2019

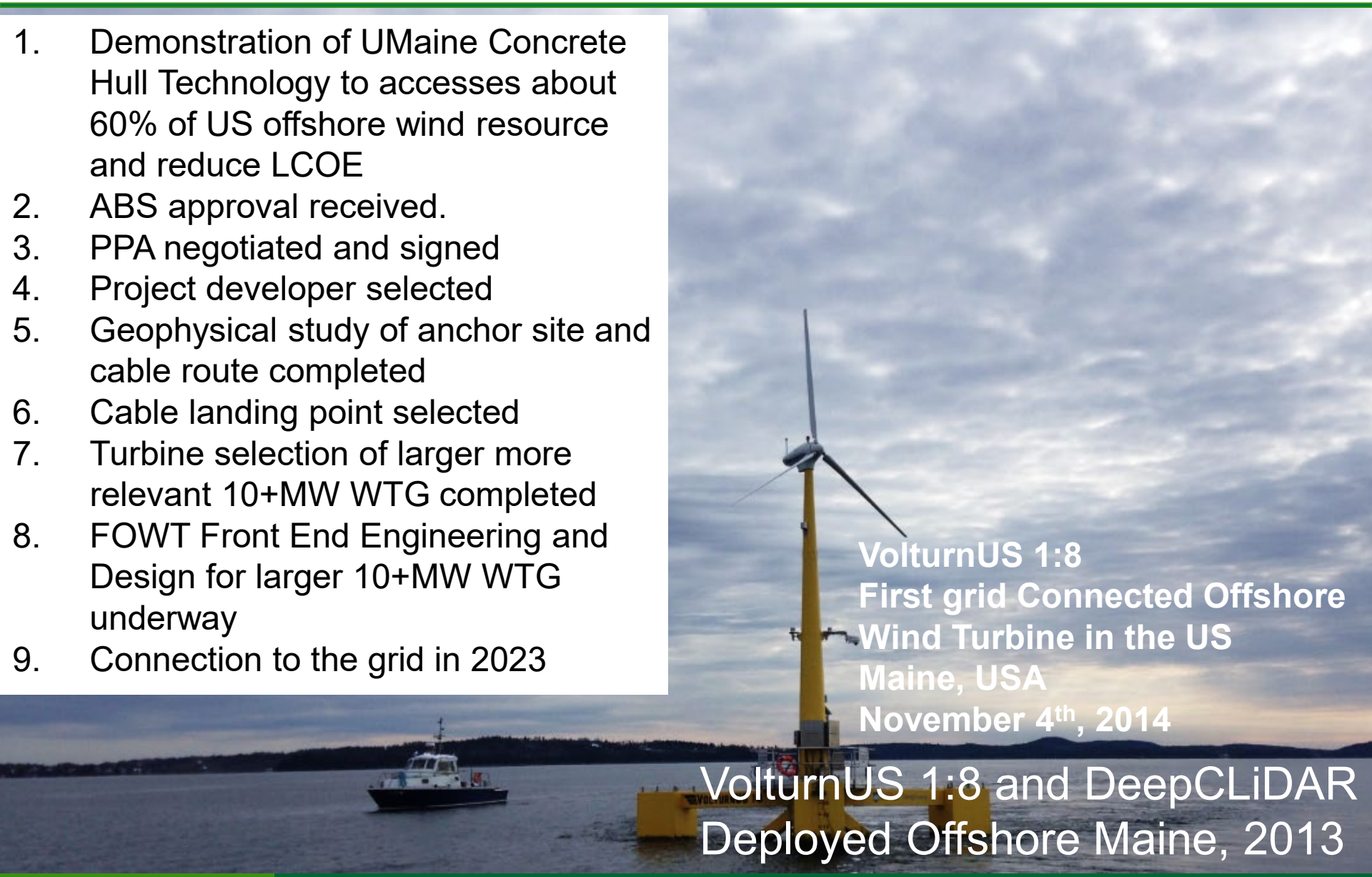
In June, Governor Mills signed bill requiring PUC to approve key contract allowing innovative project to move forward

Governor Janet Mills issued the following statement today applauding the Public Utilities Commission's (PUC) approval of a contract for Maine Aqua Ventus, a first-of-its-kind floating offshore wind pilot project spearheaded by the Advanced Structures and Composites Center at the University of Maine.

"The PUC's approval of this contract is a major milestone for our state's clean energy future. Thanks to the innovative work of the University of Maine, Aqua Ventus is poised to become the first offshore wind project in the country to feature a floating platform, an advancement that cements our state's leadership in offshore wind development and that puts Maine on the map for clean energy technology. With this key and long-overdue approval, this cutting-edge demonstration project is now on track to move forward and allow us to harness our own clean, renewable source of energy, create jobs, and strengthen our economy."

Summary

1. Demonstration of UMaine Concrete Hull Technology to accesses about 60% of US offshore wind resource and reduce LCOE
2. ABS approval received.
3. PPA negotiated and signed
4. Project developer selected
5. Geophysical study of anchor site and cable route completed
6. Cable landing point selected
7. Turbine selection of larger more relevant 10+MW WTG completed
8. FOWT Front End Engineering and Design for larger 10+MW WTG underway
9. Connection to the grid in 2023



VolturnUS 1:8 and DeepCLiDAR Deployed Offshore Maine, 2013

Program Performance –Scope and Project Schedule

Task	Completion Date
6MW Hull Design Receives ABS Approval	Q3 2017
PPA Negotiated and Signed	Q4 2019
Project Developer Selected	Q3 2020
Preliminary Design with Larger More Relevant 10+MW WTGs and Due Diligence	Q1 2021
Turbine Selection of Larger More Relevant 10+MW WTG	Q2 2021
FOWT Front End Engineering and Design	Q4 2021
Detailed Design and IFC Drawings	Q2 2022
NEPA Determination and Permitting	Q2 2022
Construction of WTG, Hull, Mooring, Anchors, and Cable	Q3 2023
Deployment and Connection to Grid	Q3 2023
5-year FOWT Monitoring	Q4 2028