U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

1865 THE UNIVERSITY OF MAINE

New England Aqua Ventus I

Budget Period 2

Advanced Offshore Wind Technology Demonstration Project

Project ID T27

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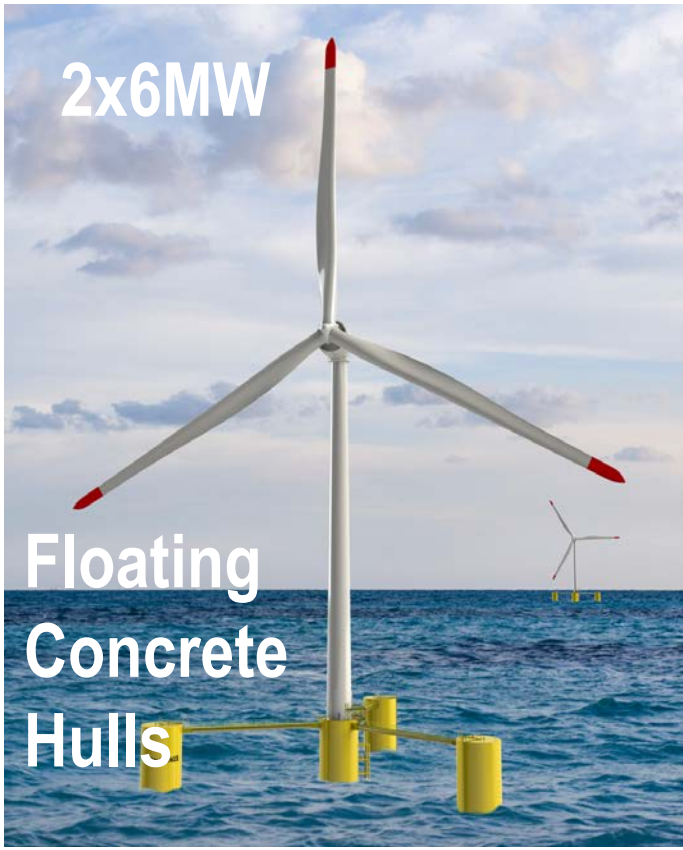


FY17-FY18 Wind Office Project Organization

"Enabling Wind Energy Options Nationwide"

Technology Development

- Atmosphere to Electrons
- Offshore Wind
- Distributed Wind
- Testing Infrastructure
- Standards Support and International Engagement
- Advanced Components, Reliability, and Manufacturing

Market Acceleration & Deployment

- Stakeholder Engagement, Workforce Development, and Human Use Considerations
- Environmental Research
- Grid Integration
- Regulatory and Siting

Analysis and Modeling (cross-cutting)

Project Overview

New England Aqua Ventus I
Advanced Offshore Wind Technology Demonstration Project

Technology Summary:

- Floating concrete semi-submersible floating wind technology
  - Designed for mass production and large scale turbines
  - Domestic production methods
  - LCOE for utility-scale <8 c/kWh
  - American Bureau of Shipping Classification received
  - Demonstrated in 2013 offshore Maine at 1/8th Scale

Period of Performance:

- October 2016 to Dec 2020*

*Budget Period 2

Technology Impact:

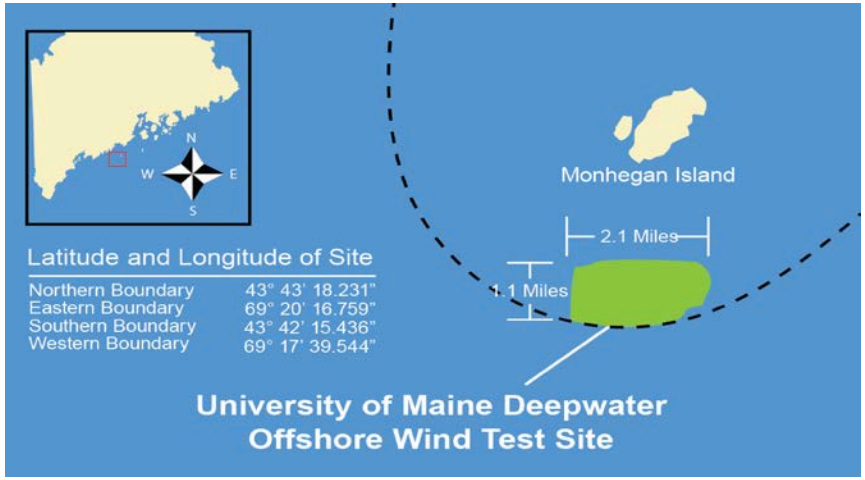
- Accesses >60% of US offshore wind resource
- Less sensitive to site specifics
- Domestic production methods leads to increase in local content
- Project location- Northeast - dense population, high electricity costs

Project Goals (BP2):

- Complete all necessary technical, permitting, and financial project development activities to proceed to Final Investment Decision And construction of the first floating commercial wind turbine in the US.

Partners:

- University of Maine, Cianbro Corp. + 15 Subs and Vendors



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

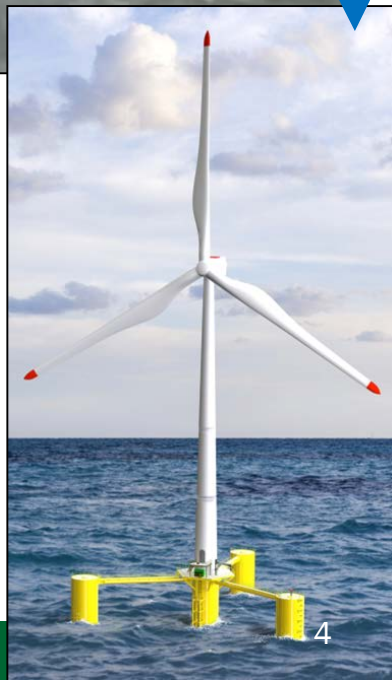
Future

Phase 3: (2016-2022)

Build a demonstration-scale project (two full-scale turbines) to prove out the technology at a manageable size: *Aqua Ventus 1*

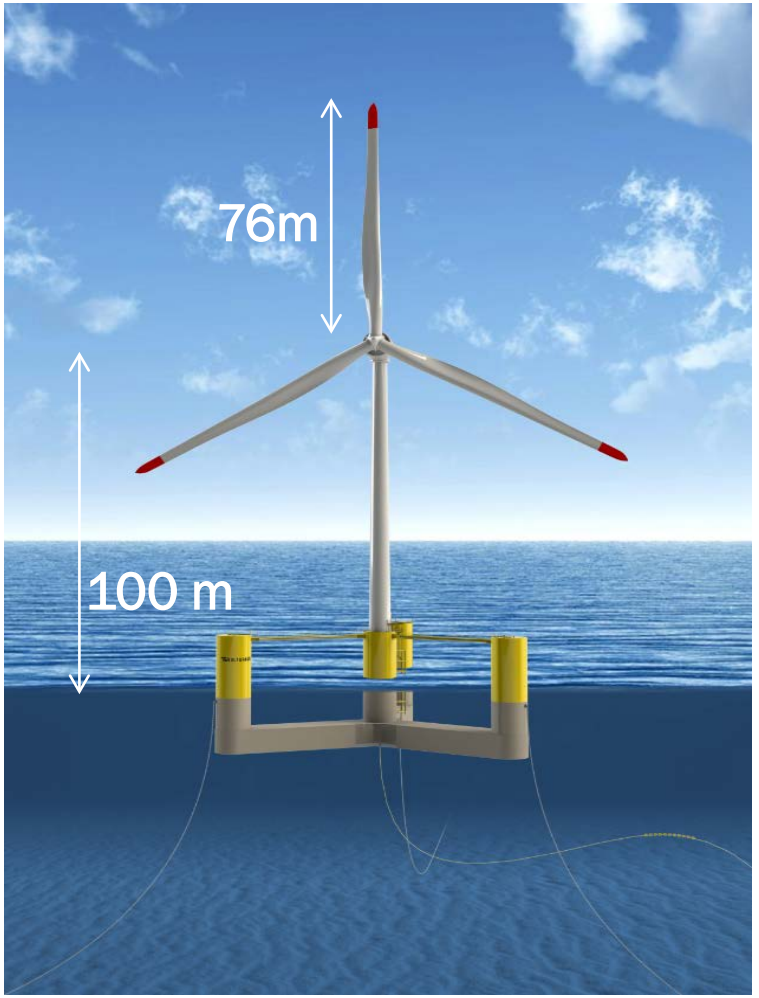
Phase 4: (2023+)

Build on experience with demonstration project to enable commercial scale projects



Technical Merit and Relevance

- On track to be first floating commercial-scale turbine deployed in the United States
- Will demonstrate floating concrete hulls by 2022
- Received Classification by the American Bureau of Shipping for 100% FEED
- Industrialized concrete hull production using conventional concrete bridge construction methods. Allows domestic content and increased local job creation
- 5-year monitoring will provide invaluable data for industry and research communities on floating wind
- Project located in Northeast - high electricity costs & active market

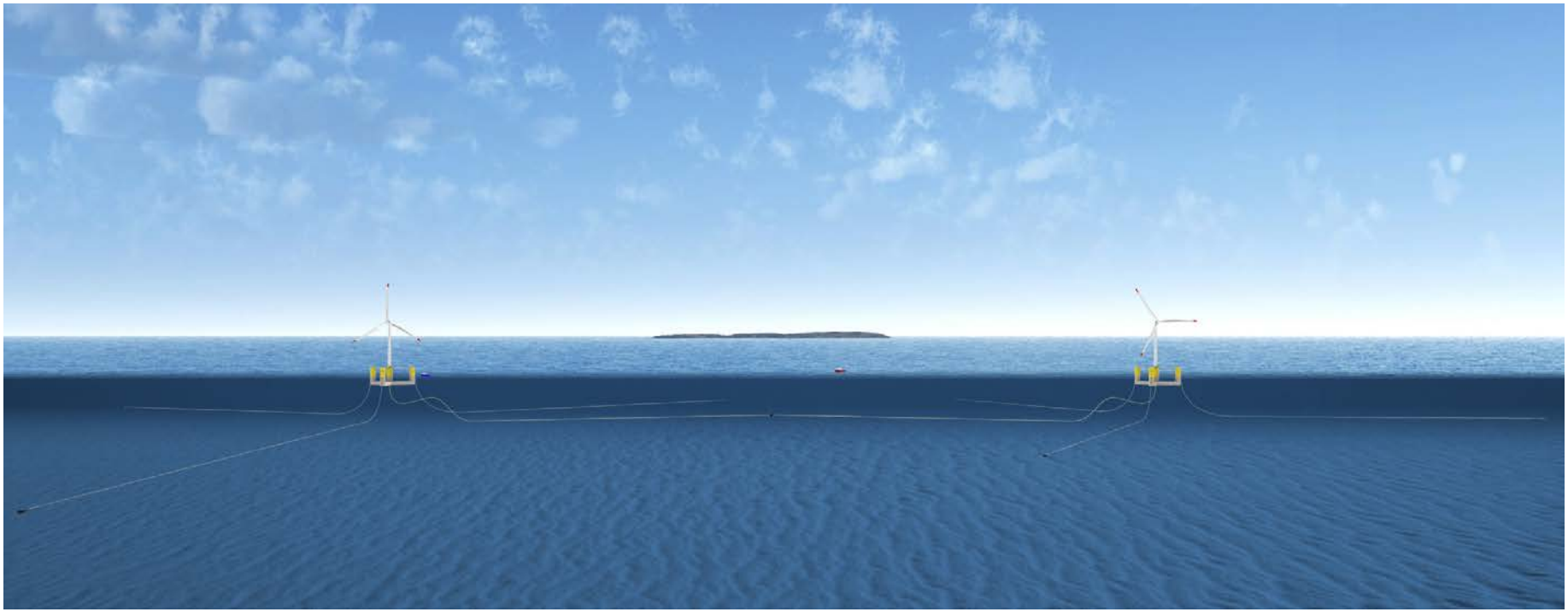


VolturnUS Floating Concrete Hull (6MW WTG)

Approach and Methodology

Project Tasks to Reach Financial Close

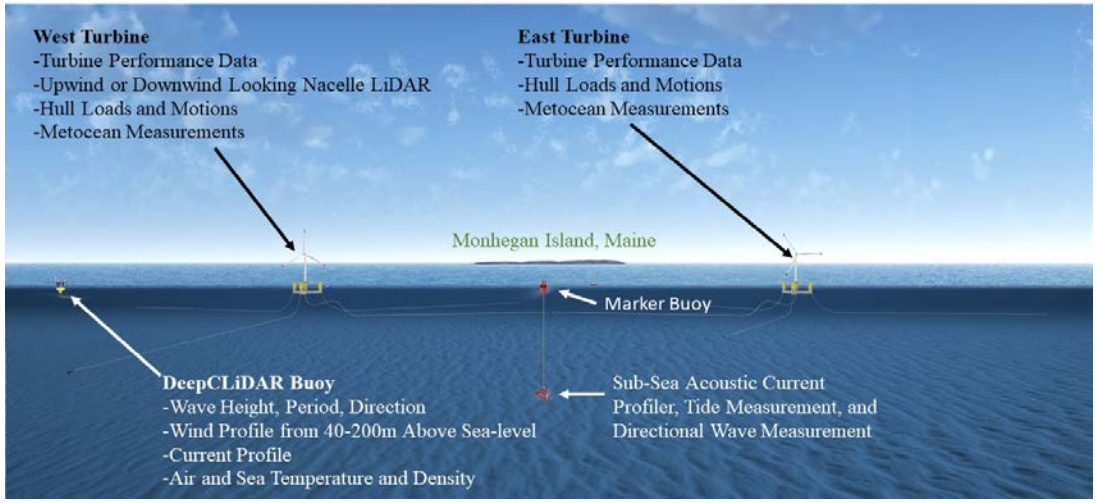
1. Finalize project design (currently at 100% FEED) and 3rd party certifications
2. Complete permitting, NEPA, and related outreach
3. Finalize construction, operations, and maintenance plans
4. Grid Interconnection agreements and design
5. Develop final project financing plan and obtain final CAPEX



Accomplishments and Progress

Selected Milestones

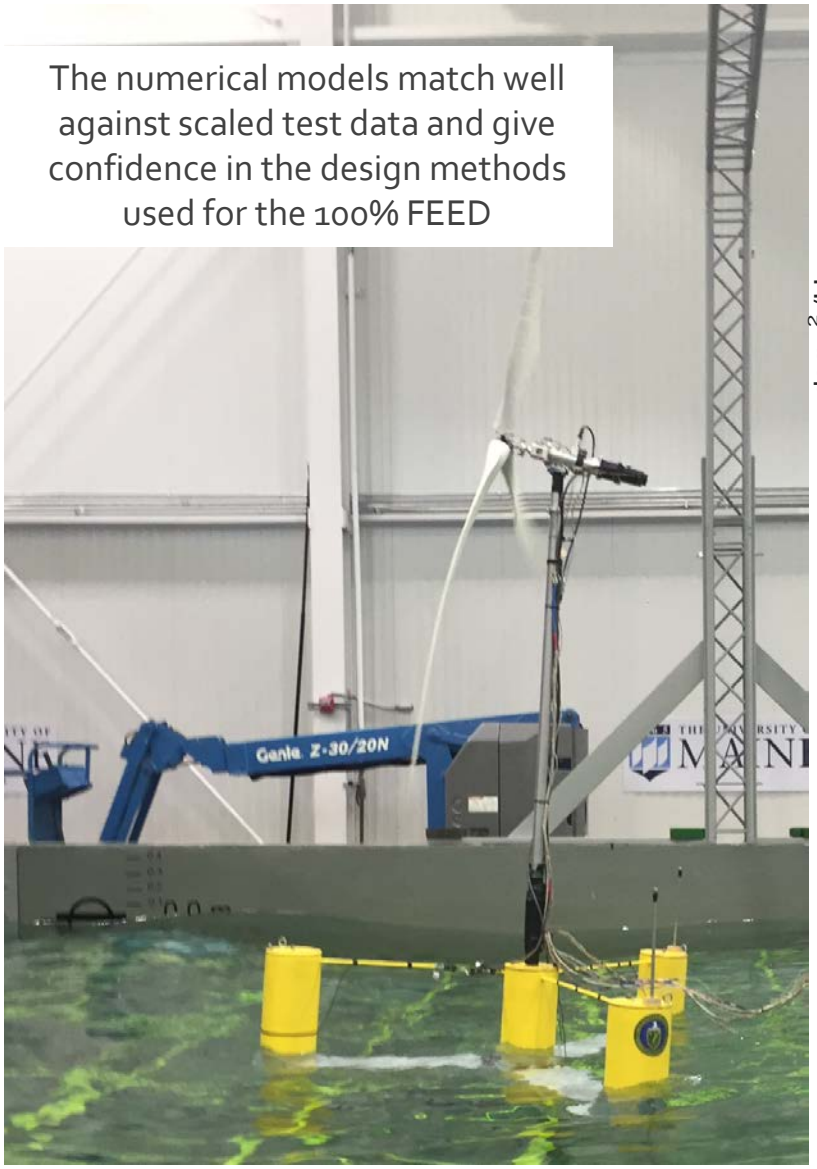
1. DeepCLiDAR Buoy deployed and hub-height wind speed collected
   - Validated by UL to meet Carbon Trust Requirements
   - Provides data needed for energy production estimates
2. 5-year Instrumentation and test plan developed with NREL
3. 6MW Turbine design integrated with hull

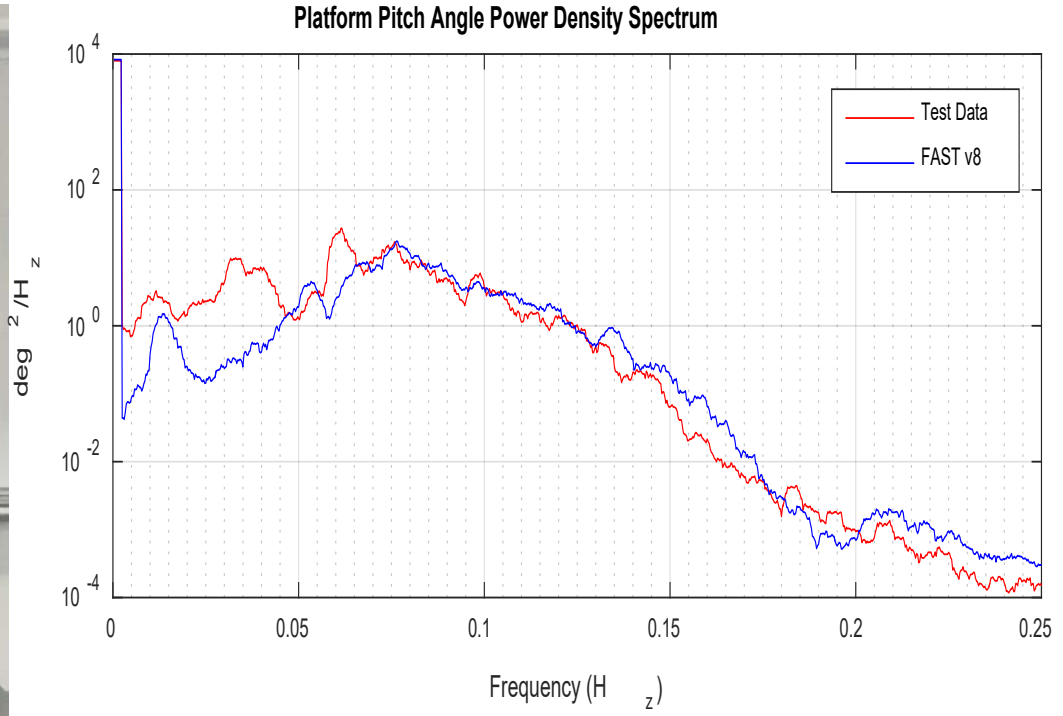


1:50 Scale Test of 6MW Hull
At UMaine W2 Wave-Wind Basin

Sample Data from ABS DLC 1.6
50-year significant wave height- 9.8m, 14.2s Peak Period
Turbine operating at 12m/s-Rated Wind Speed

The numerical models match well against scaled test data and give confidence in the design methods used for the 100% FEED





Tower Base Bending Moment (kN-m)			
	Test Data	FAST v8	% Diff
Max. Mag.	1.68E+05	1.71E+05	-1.6%
Platform Pitch Angle(deg)			
	Test Data	FAST v8	% Diff
Mean	4.1	4.2	-1.8%

ABS Hull Design Review Complete

- **ABS has reviewed 28 design reports and 96 drawings and approved the 100% Hull FEED**

- **Primary Standards:**
  1. ABS Guide for Building and Classing Floating Offshore Wind Turbine Installations", 2013/14
  2. ABS Guide for Building and Classing Gravity-Based Offshore LNG Terminals. . American Bureau of Shipping. November, 2010.
  3. ABS Guide for Building and Classing Bottom-founded Offshore Wind Turbine Installations. American Bureau of Shipping. July, 2014.

Accomplishments and Progress

1. Site Control
2. All site environmental and ecological data collected
3. All wind/metocean data collected and annual energy production (AEP) calculated independently by DNV-GL
4. Visual and sound impact studies completed
5. Significant interest from European developers to invest in project
6. New State administration (Jan 1 2019) vigorously supporting project.

Project Plan and Schedule, Next Steps

Selected Milestones:

- Q3 2019 – Convert Power Purchase Agreement Term Sheet Into PPA Contract
- Q3 2020 – Submit Environmental Assessment
- Q3 2020 – All Permits Received
- Q4 2020 – DOE BP2 End - 100% FEED, Permits, PPA
- Q3 2021 – Detailed design and FID
- Q4 2021 – Start Construction
- Q4 2022 – COD Commercial Operations Date

February 28, 2019 article in Portland Press Herald

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Mills sets goal to fight climate change: 100% renewable electricity by 2050

Outlining an ambitious agenda for Maine, she joins a coalition of governors who embrace the aims of the Paris accord.

AUGUSTA — Gov. Janet Mills outlined an extensive climate agenda on Thursday, pledging to reduce greenhouse gas emissions, work toward 100 percent renewable electricity generation and to work with other governors on regional solutions.

MAINE CLIMATE COUNCIL WILL LEAD

Since taking office in January, the Mills administration has announced plans to install solar panels on the grounds of the governor's mansion and ended a LePage moratorium on wind power permits that was never enforced. The governor also used her speech to the E2Tech Council to reiterate her pledges to expand utilization of heat pumps and to "vigorously support the University of Maine to lead the country in offshore floating platform wind technology development."

Communication, Coordination, and Commercialization

- **Journal Publications**
  - Over 30 publications generated. Recent examples:

1. Viselli, A, Filippelli, M, Pettigrew, N, Dagher, H, Faessler, N (2018). Validation of the First LiDAR Wind Resource Assessment Buoy System Offshore the Northeast United States, Journal of Wind Energy (In Review).
2. Viselli, A, Filippelli, M, Faessler, N (2018). Analysis of LiDAR Wind Speed and Shear Measurements Offshore in the Northeast US. Journal of Offshore Mechanics and Artic Engineering (In Review).
3. Young A, Goupee AJ, Dagher HJ, Viselli AM (2017). Methodology for Optimizing Composite Towers for Use on Floating Wind Turbines, Journal of Renewable and Sustainable Energy 9, 033305, DOI:10.1063/1.4984259.
4. Viselli AM, Dagher HJ, Goupee AJ (2015). Model Test of a 1:8-scale Floating Wind Turbine Offshore in the Gulf of Maine. Journal of Offshore Mechanics and Artic Engineering 137(4): 041901-5.
5. Viselli AM, Dagher HJ, Goupee AJ, and Allen CK, (2015). Design and model confirmation of the intermediate scale VolturnUS floating wind turbine subjected to its extreme design conditions, Wind Energy Journal, DOI:10.1002/we.1886.
6. Viselli AM, Forristall GZ, Pearce B, and Dagher HJ (2015). Estimation of extreme wave and wind design parameters for offshore wind turbines in the Gulf of Maine using a POT method. Ocean Engineering. 104 (2015) 649–658. doi:10.1016/j.oceaneng.2015.04.086
7. Martin HR, Kimball RW, Viselli AM, Goupee AJ (2013). Methodology for wind/wave basin testing of floating offshore wind turbines. Journal of Offshore Mechanics and Arctic Engineering 136(2):021902.

- **Commercialization**
  - 7patents (U.S. and Europe) issued. More in review.
  - Maine Aqua Ventus, a commercial Joint Partnership will operate New England Aqua Ventus I and help to take technology to market.
  - Negotiations with European developers-investors ongoing for U.S. commercialization
- Community Outreach
  - Proactive engagement with community stakeholders meetings in project areas
- Conferences
  - Regular presentations at industry, academic, and government workshops and conferences (International Partnering Forum, American Wind Energy Association, International Offshore Wind Technical Conference, OMAE Conference on Ocean, Offshore, and Arctic Engineering, Society of Naval Architects and Marine Engineers)