



**Oregon State**  
University

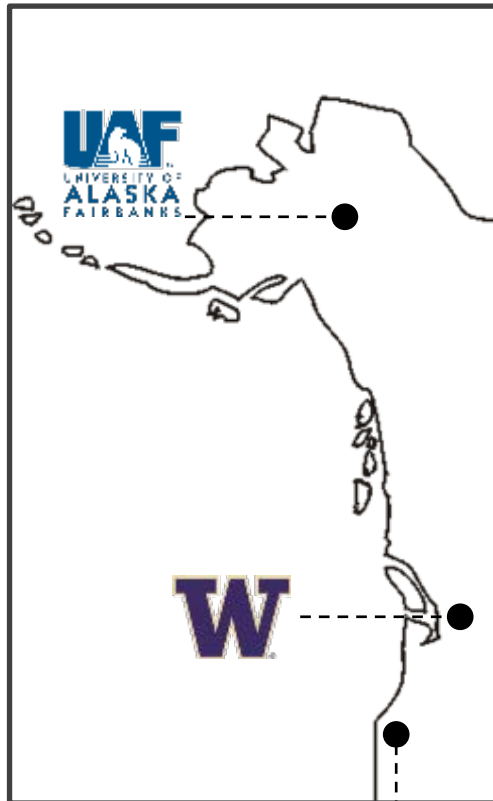
# **NNMREC Research Capabilities in Offshore Wind**

Dr. Bryony DuPont

13 MARCH 2018



# Three Institutions – Two Organizations



Marine renewable  
energy research and  
development



Marine renewable energy  
testing facilities



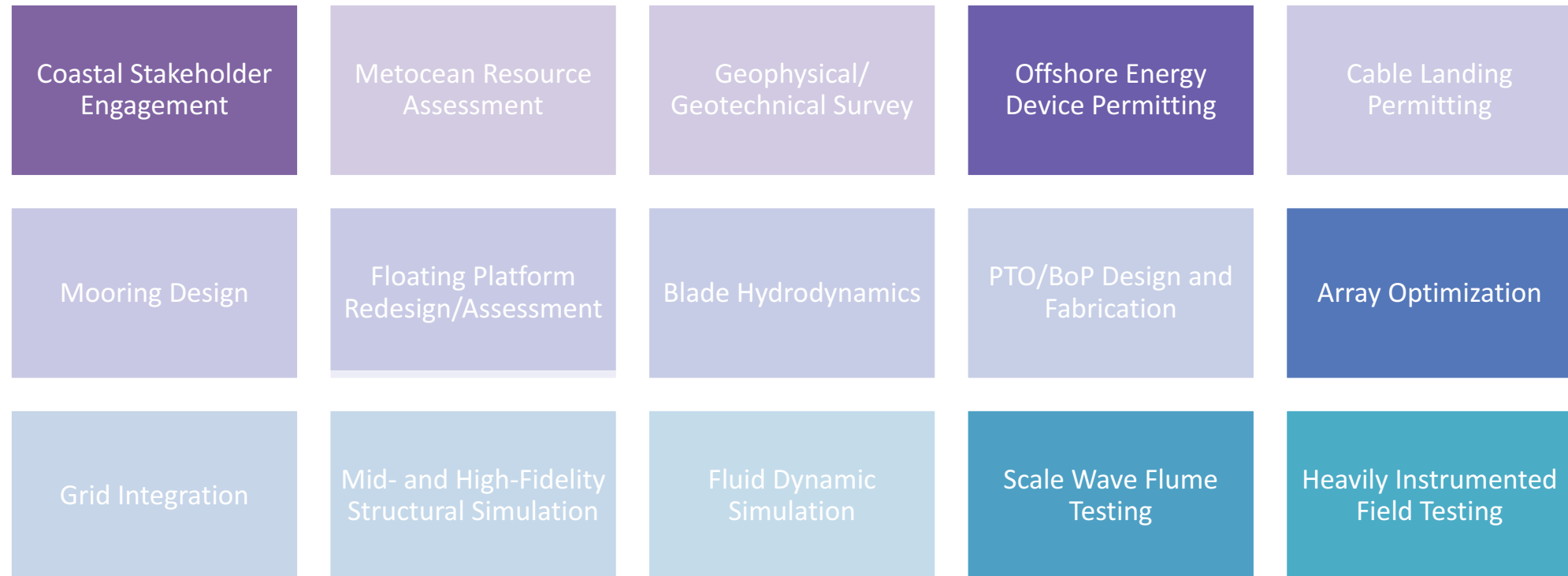


***We want to capitalize on NNMREC's 10+ years of research in offshore renewable energy to advance the state-of-the-art of offshore wind systems***

Coastal Stakeholder Engagement	Metocean Resource Assessment	Geophysical/ Geotechnical Survey	Offshore Energy Device Permitting	Cable Landing Permitting
Mooring Design	Floating Platform Redesign/Assessment	Blade Hydrodynamics	PTO/BoP Design and Fabrication	Array Optimization
Grid Integration	Mid- and High-Fidelity Structural Simulation	Fluid Dynamic Simulation	Scale Wave Flume Testing	Heavily Instrumented Field Testing



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# (1) Stakeholder Engagement

- Public perceptions of tidal energy

- **Willingness to pay for tidal energy R&D**

- International and domestic comparative studies

- Holistic design of tidal energy arrays

- Households in WA willing to pay, on average, \$1.62/month for tidal energy R&D
- 78% supportive of driving innovation through government-academic-industry partnerships





# (20) Heavily Instrumented Field Testing



- **DRESSER-RAND**  
A Siemens Business

-  **OSCILLA**  
power™

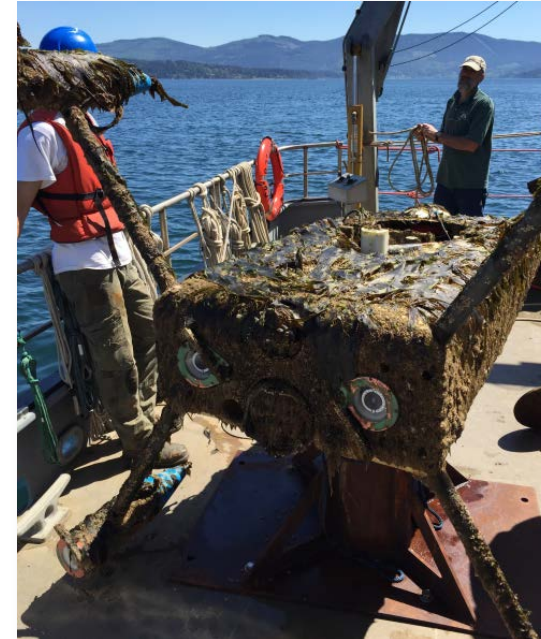
-  **CalWave**  
Power Technologies



# [4] Offshore Energy Device Permitting

- Biometrics
- **Integrated instrumentation**
- Automated fish detection
- Acoustic studies of marine energy converters

- Combine multiple sensors into a single instrumentation package
- Observe rare events and adapt at low cost
- 90% uptime over four month endurance trial



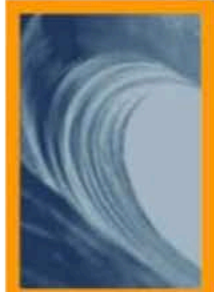
System recovery: May 2016



# (19 ) Scale Wave Flume Testing



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O. H. H I N S D A L E

W A V E R E S E A R C H L A B O R A T O R Y

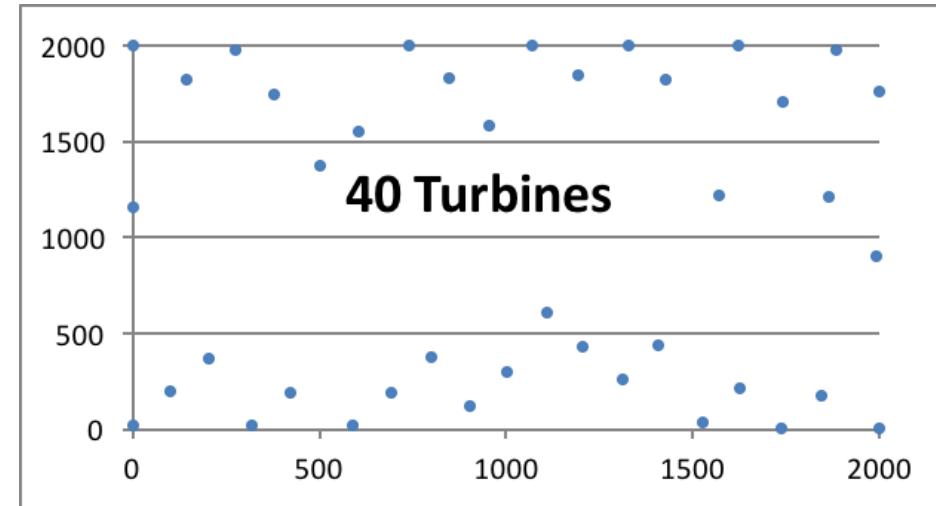
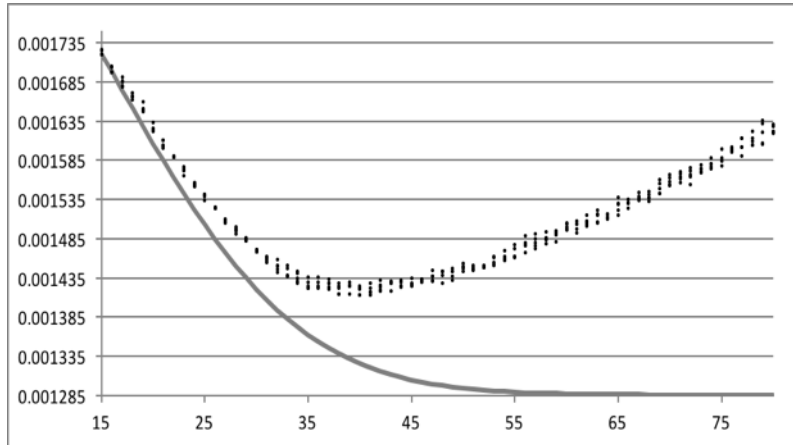
O R E G O N S T A T E U N I V E R S I T Y

- Largest nearshore experimental facility at an academic institution in the US
- Houses the Large Wave Flume and Directional Wave Basin
- Testing, Instrumentation, Near Real-Time Sensing:
  - Wave-structure interaction
  - Nearshore hydrodynamics and sediment transport
  - Marine renewable energy
  - Tsunami and coastal hazards
  - Fixed and floating structures





# [10] Array Optimization



## Models

- Wake effects
- Power development
- System costs

## Constraints

- Array area
- Minimum separation distance
- Turbine size

## Objectives

- LCOE (-Costs in + Costs out)



Bryony DuPont

[bryony.dupont@oregonstate.edu](mailto:bryony.dupont@oregonstate.edu)

Twitter: [@bryonydupont](https://twitter.com/bryonydupont)

Instagram: [@dr.dupont](https://www.instagram.com/dr.dupont)

[bryonydupont.com](http://bryonydupont.com)

# Some Considerations for Wind Plant Optimization



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Air density variation

Fixed Charge Rate

Operations and  
Maintenance Costs

Capital Costs

Annual Energy  
Production

LCOE

Replacement/Overhaul  
Costs

Turbine  
Geometry/Rotor Size

Turbulence-Induced  
Vibration

Annual Operating  
Expenses

Turbine Power  
Coefficient

Turbulence Intensity

Ocean Leasing

Environmental  
Monitoring

Fluid-Structure  
Interaction

Fatigue Modeling

Component  
Transportation

Balance of System