Deepwater Offshore Wind Program in Maine

A DOE, NSF & NIST – funded program

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Outline

Bird's-eye view:

1. Floating platforms
2. DeepCwind Consortium (DOE Funded)
3. UMaine Offshore Wind Laboratory

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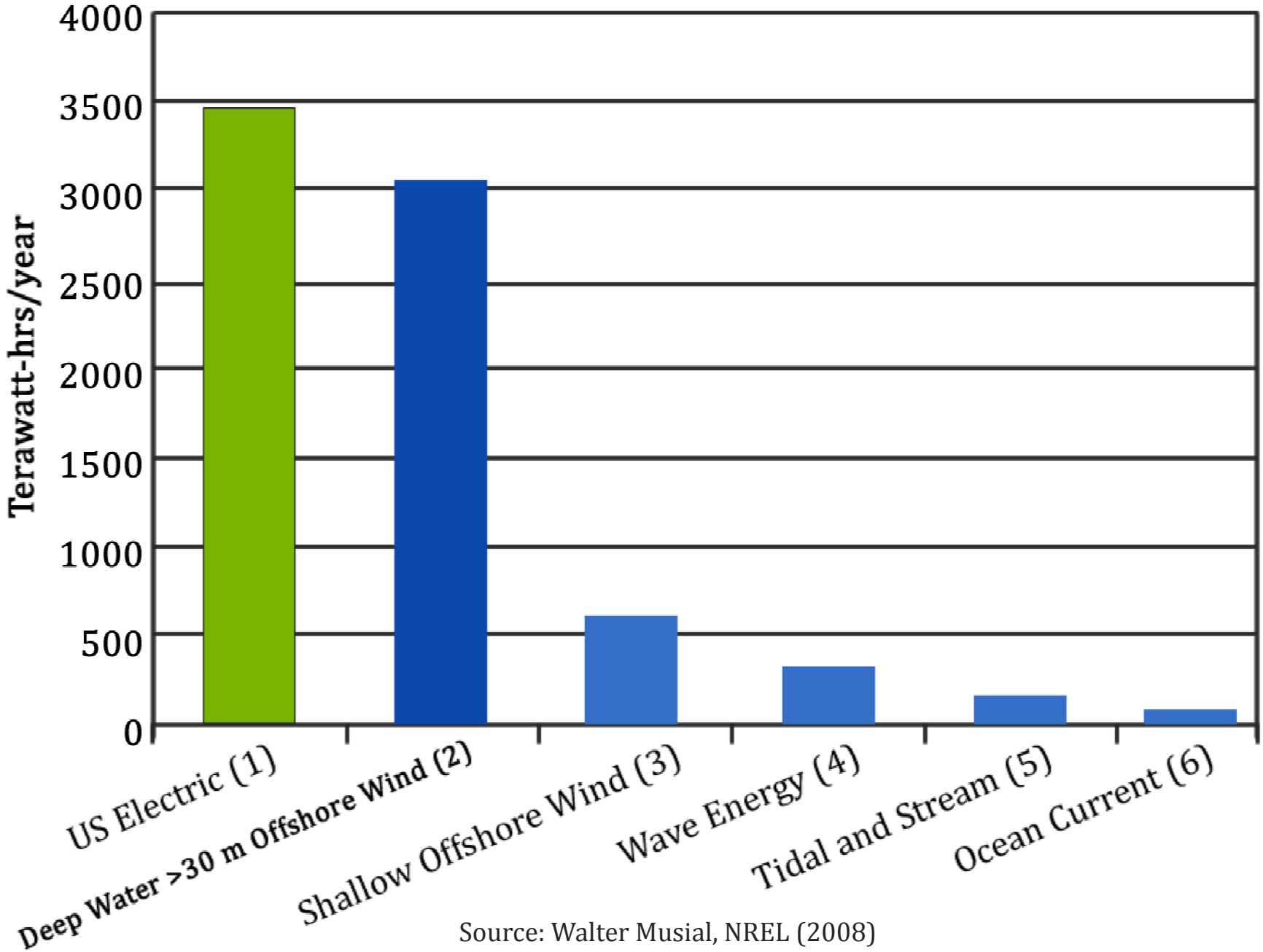
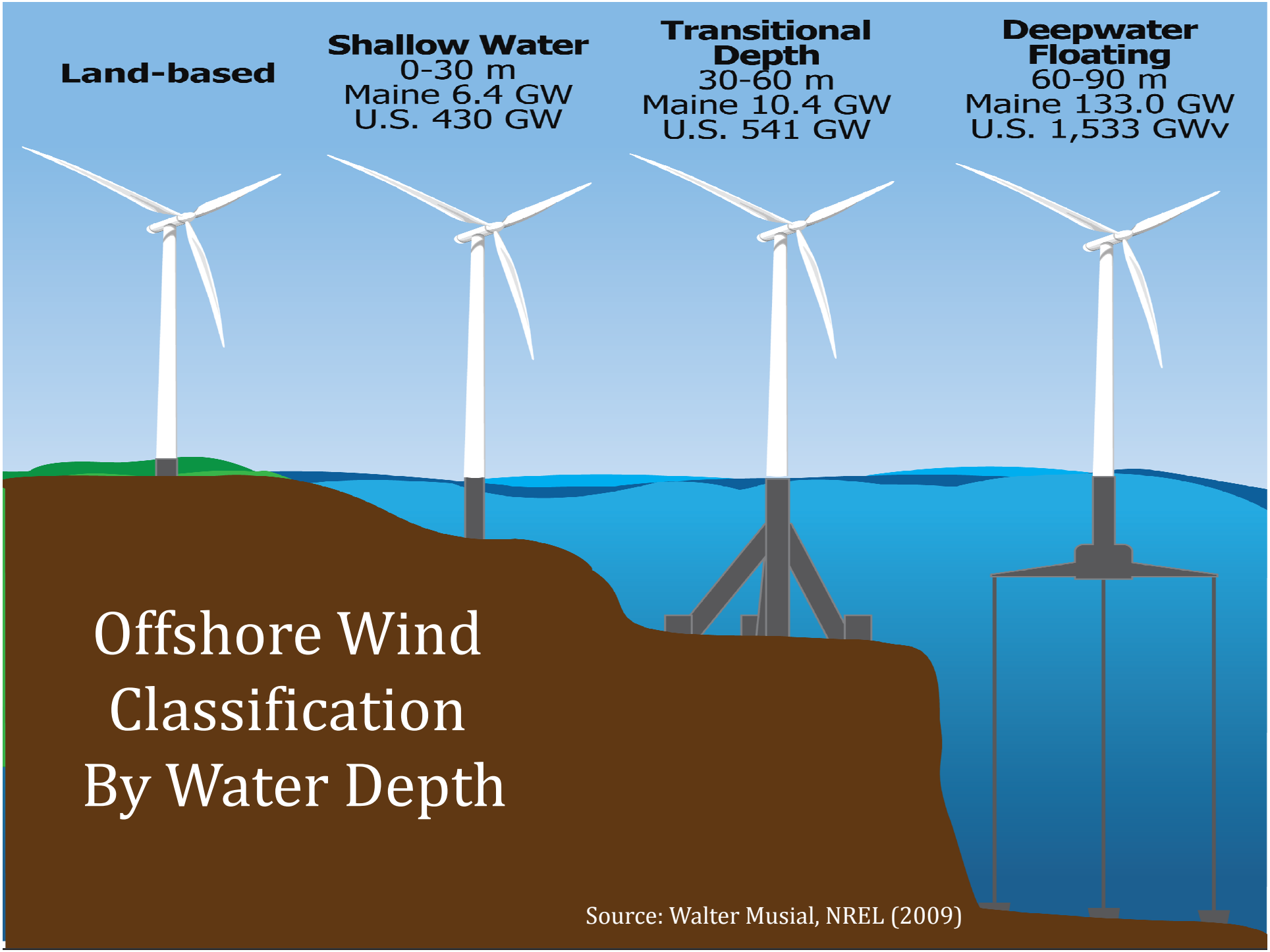
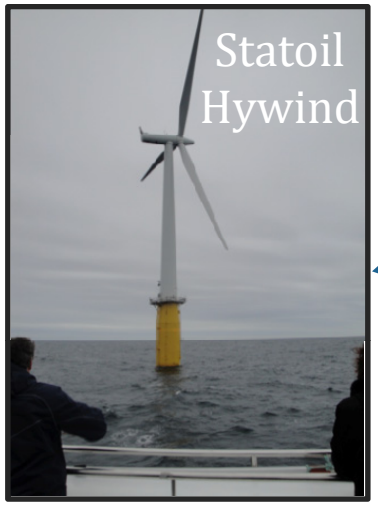
U.S. Ocean Energy Resources

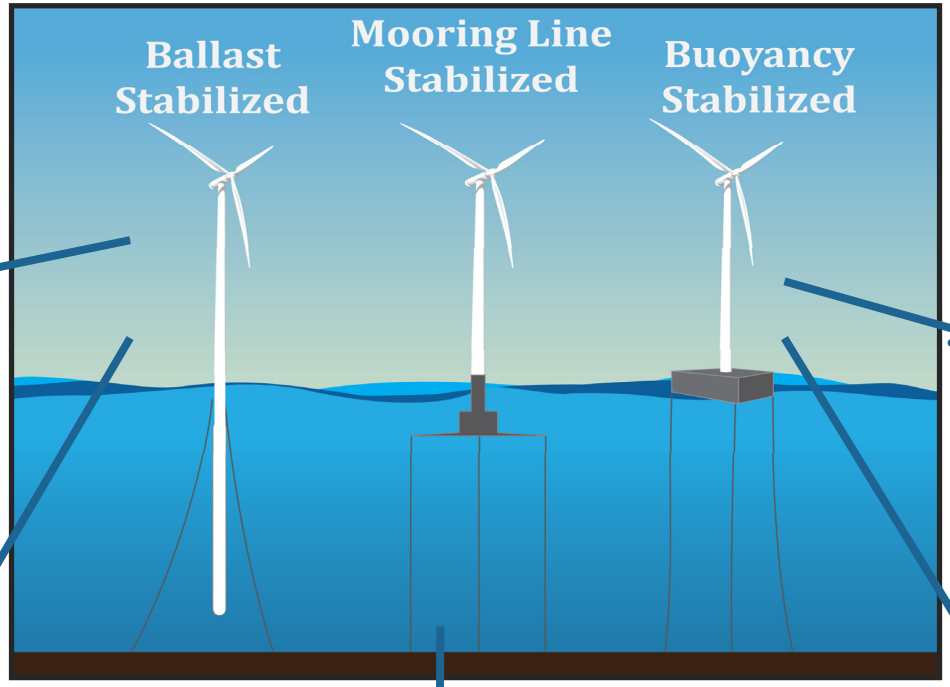


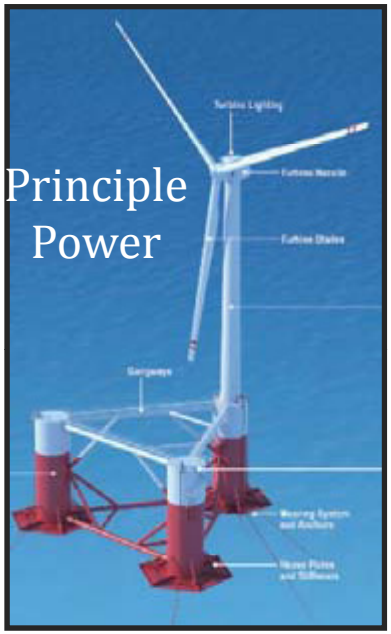
Source: Walter Musial, NREL (2008)

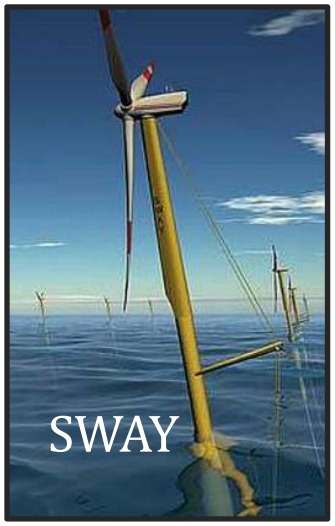

Land-based
Shallow Water
0-30 m
Maine 6.4 GW
U.S. 430 GW
Transitional Depth
30-60 m
Maine 10.4 GW
U.S. 541 GW
Deepwater Floating
60-90 m
Maine 133.0 GW
U.S. 1,533 GWv
Offshore Wind Classification By Water Depth
Source: Walter Musial, NREL (2009)

Floating Wind Turbines (>200ft): Design Space Based On Stability









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Statoil Hywind 2.3 MW
213 ft to hub, 20'-27' Diam., Rotor Diam 270'

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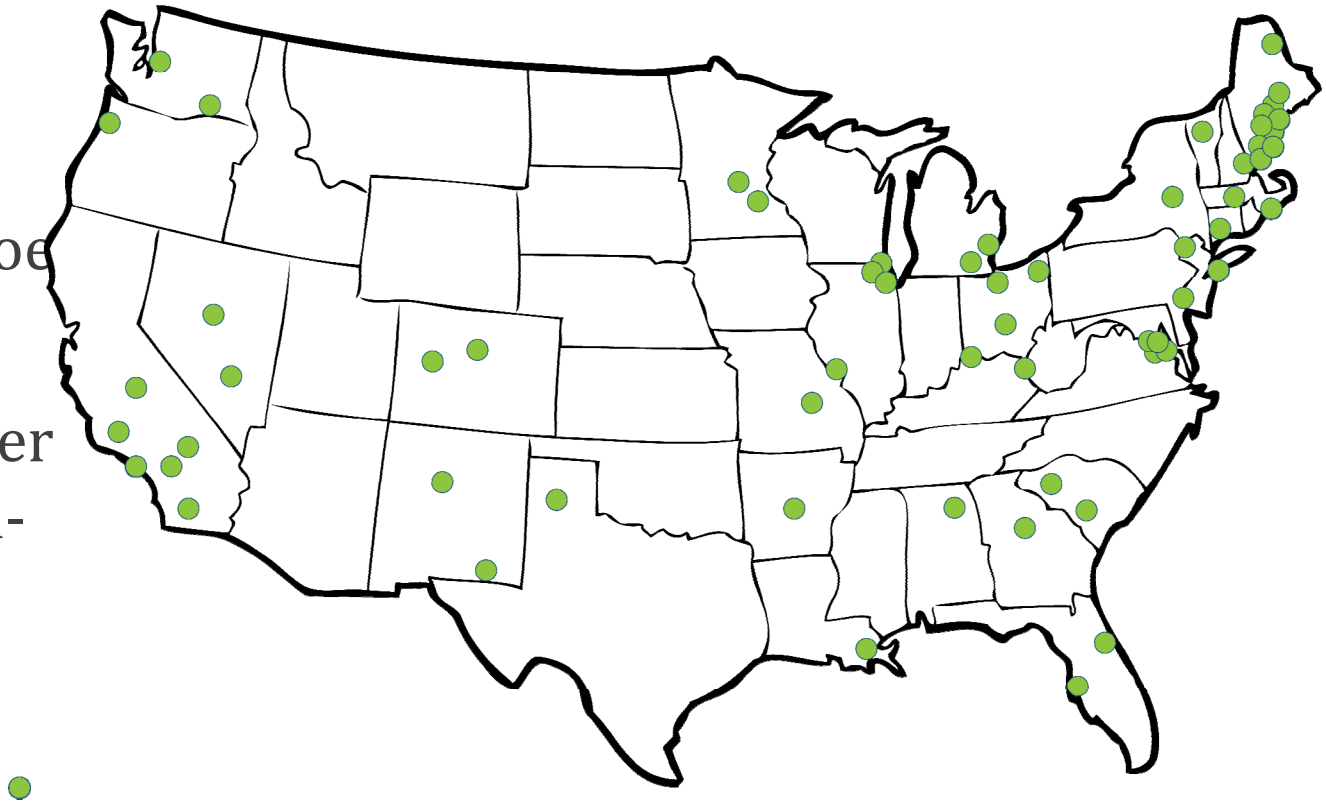
DeepCwind Consortium
DOE Contract January 2010

35 partners

- Verify coupled hydrodynamic/aeroe stic models
- Evaluate deepwater platform designs in-situ.



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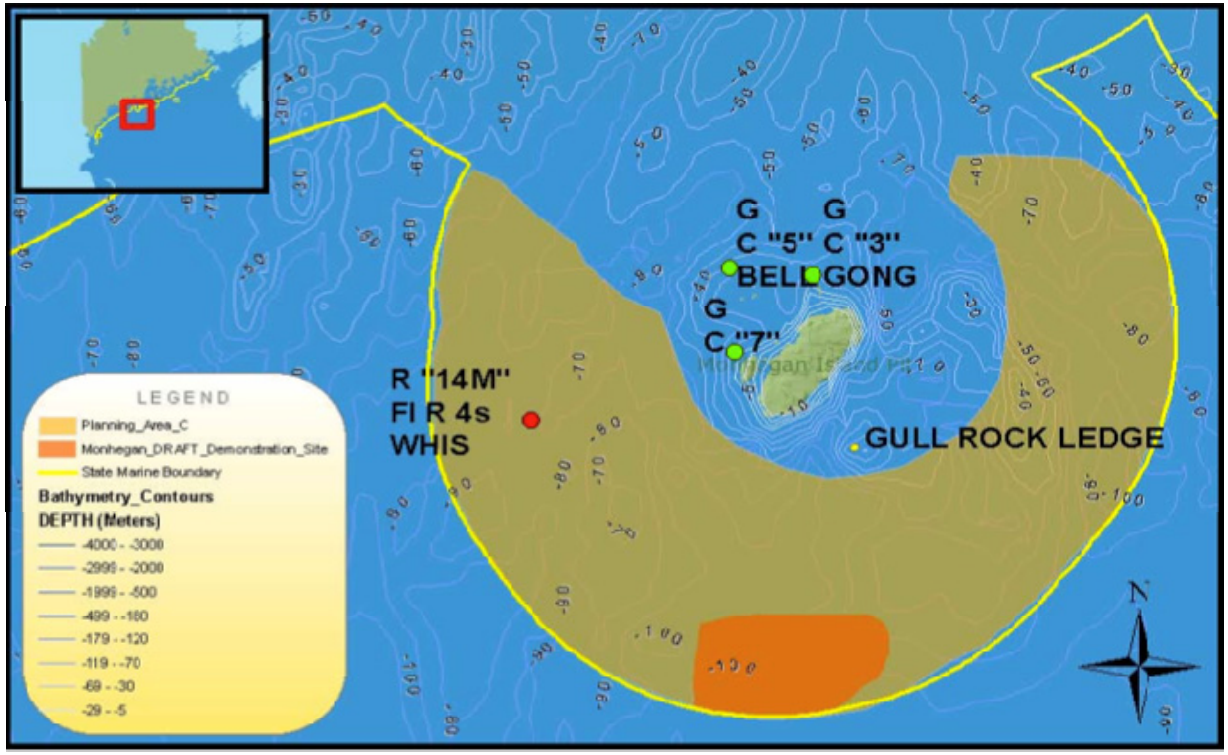
UMaine Deepwater Testbed

- Established Dec '09
- 9 years metocean data
- Sediment data for modeling of sediment-anchor interaction.



Testbed open to federal, academic and industrial partners.

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Ecological Data

- Benthic invertebrates
- Fish
- Marine mammals
- Birds and bats

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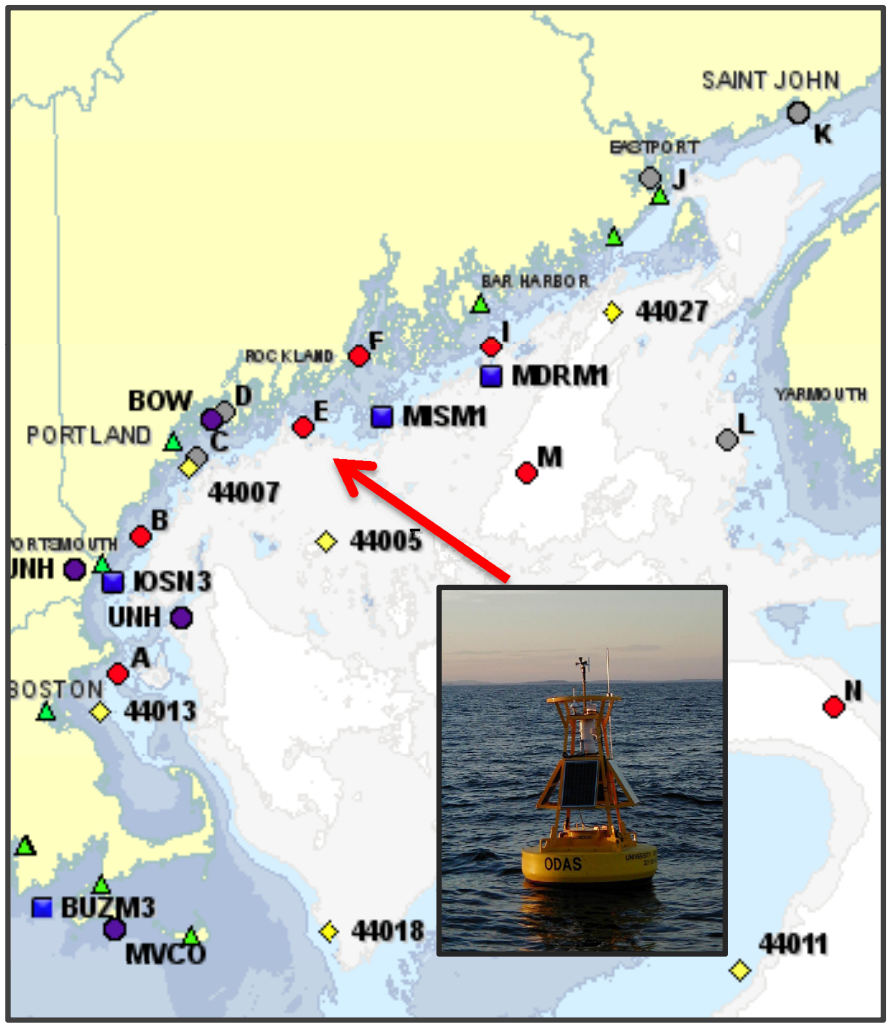
GoMOOS Wind and Wave Data



- 9 years of GoMOOS data
  - Wind six readings/hour (8 min)
  - Wind direction
  - Wave one reading/hour (20min)
  - Current
- Other buoys, such as NOAA
- Nearest Buoy: E01 about 0.8 nmi
- Buoy with wave direction 2010

Legend:
- GoMOOS buoy
- NOAA buoy
- Regional buoy
- Inactive buoy
- NOAA C-MAN
- NOAA tides
- Lat/Lon lines

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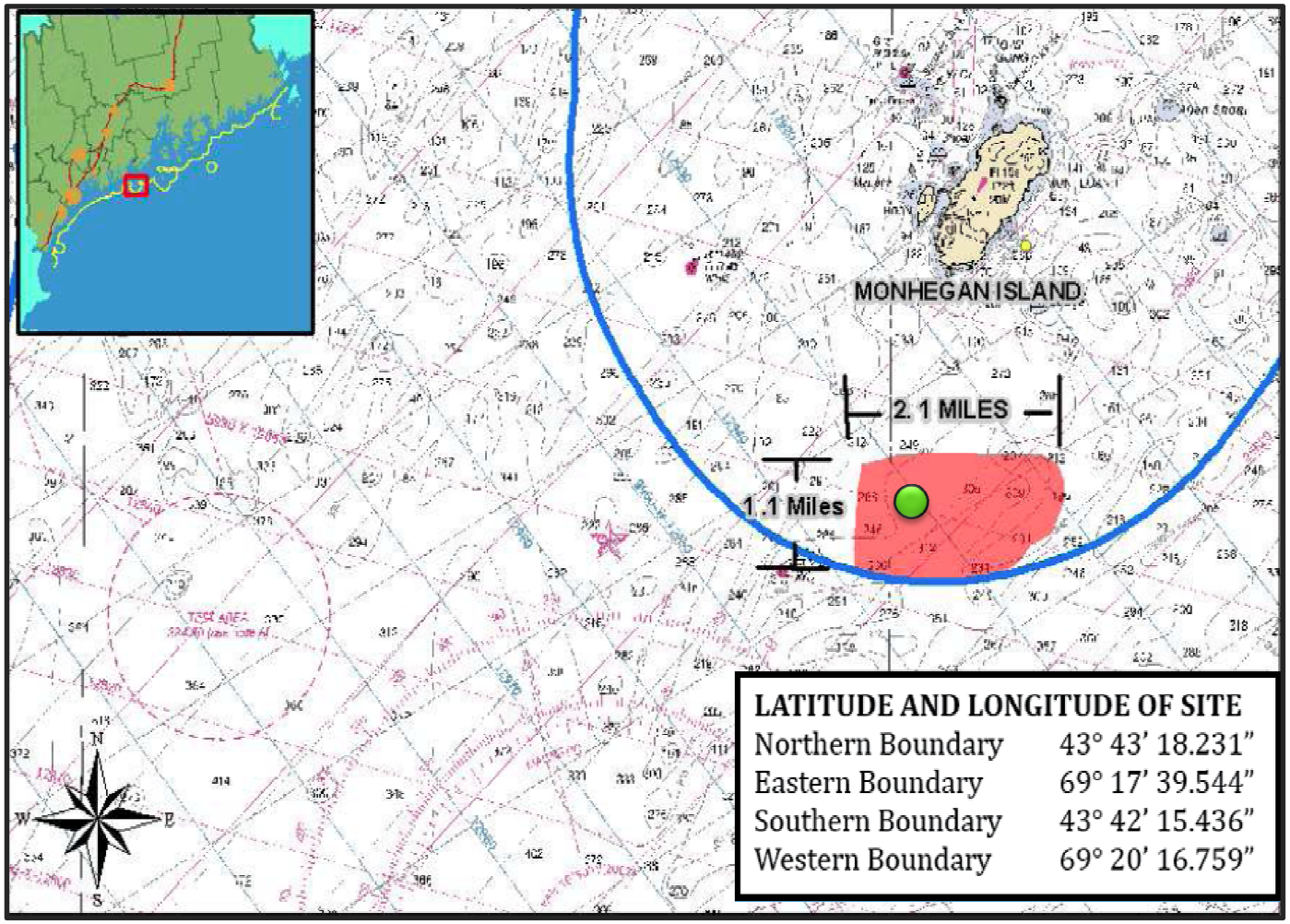
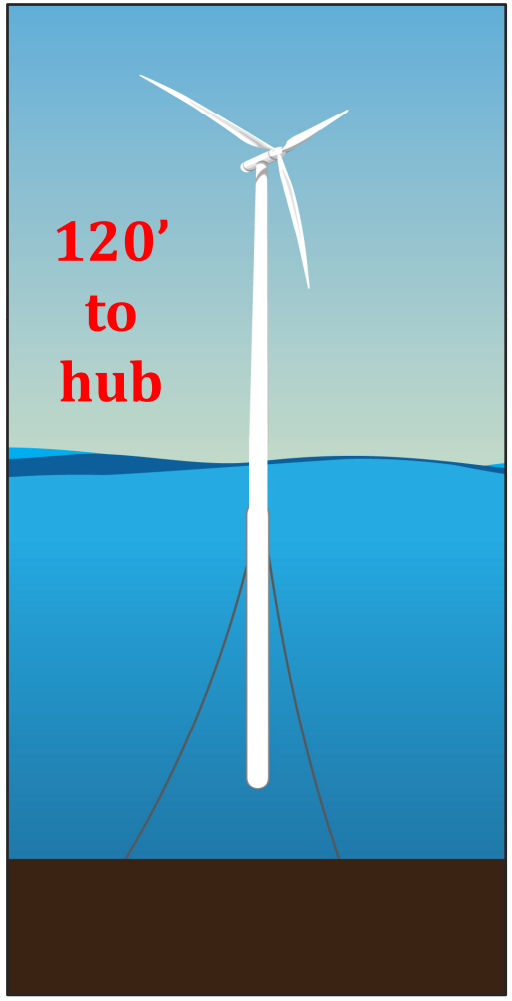
1/3 Scale Model Test 2012



LATITUDE AND LONGITUDE OF SITE

Northern Boundary	43° 43' 18.231"
Eastern Boundary	69° 17' 39.544"
Southern Boundary	43° 42' 15.436"
Western Boundary	69° 20' 16.759"



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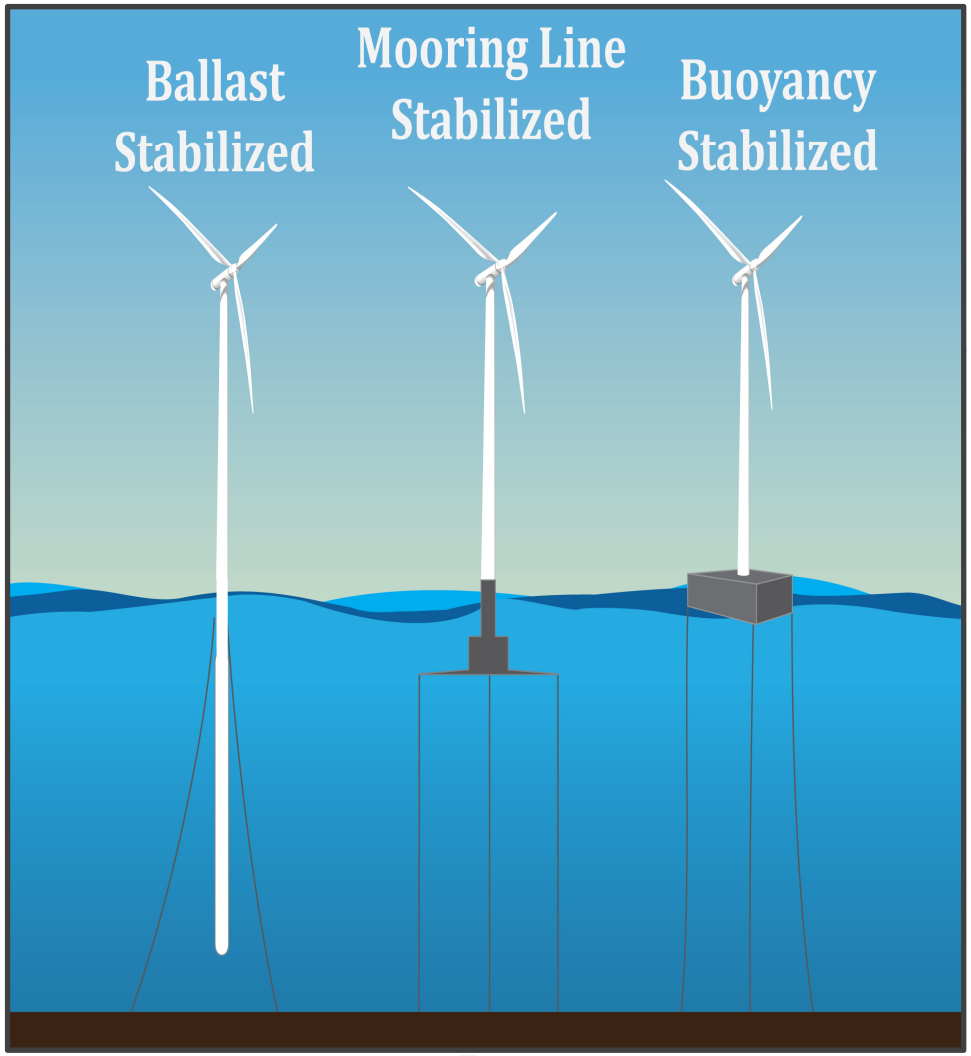
Design



- RFI platform concepts
- Tank tests at 1/50th scale
- 1/3rd scale
- Full-scale
- 25 MW pilot farm
- 500 MW farm

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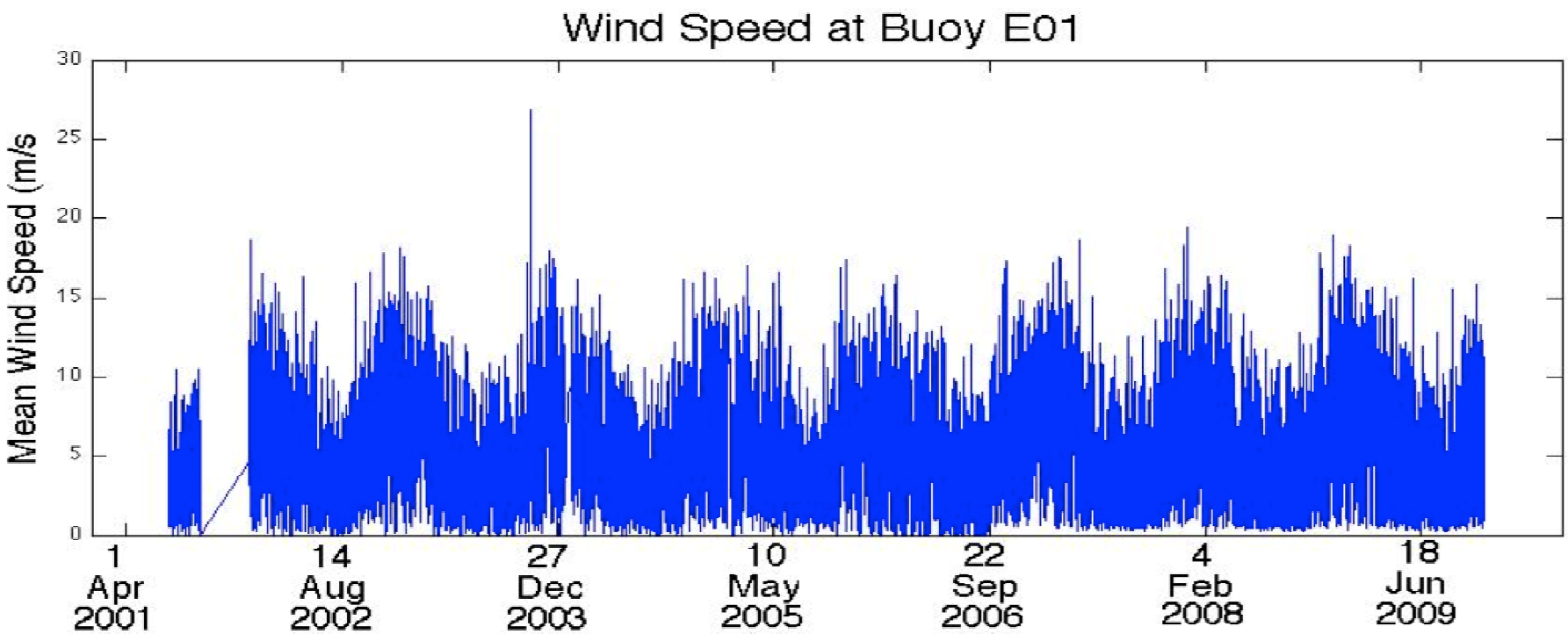
Recorded Wind Speeds at 4 m above Sea Level



Mean 8-min wind speed at 4m = 5.62 m/s
Mean 8-min wind speed at 90m = 8.70 m/s (power-law coeff. 0.14)
Floating LIDAR

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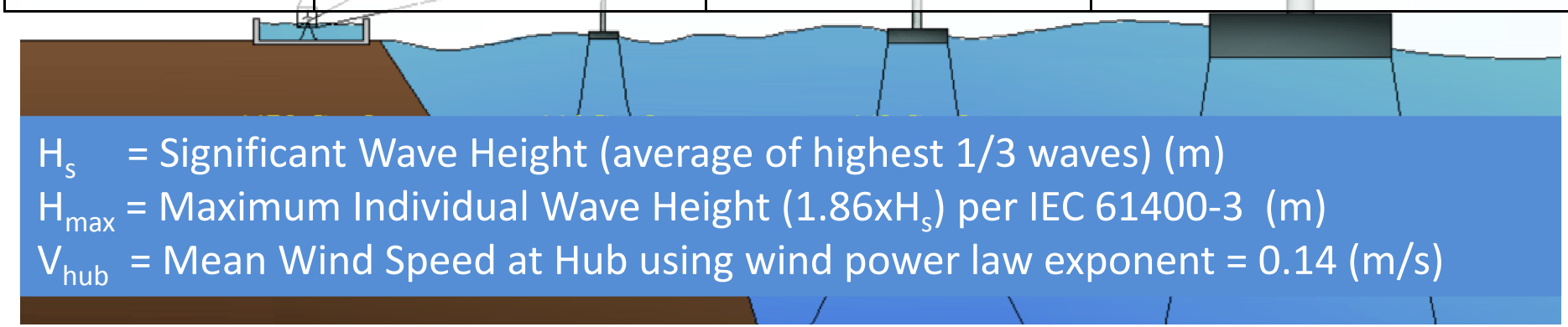
Design Conditions at Test Site

	Wind/Wave Tank			UM Deepwater Test Site			Commercial		
Geometric Scale	1/50			1/3			Full Scale		
	H_s	H_{max}	V_{hub}	H_s	H_{max}	V_{hub}	H_s	H_{max}	V_{hub}
1-yr	0.14	0.26	3.82	2.37	4.40	15.6	7.1	13.2	27.0
50-yr	0.20	0.37	5.03	3.33	7.19	20.6	10.0	18.6	35.6
100 -yr	0.21	0.39	5.16	3.50	7.75	21.1	10.5	19.5	36.5

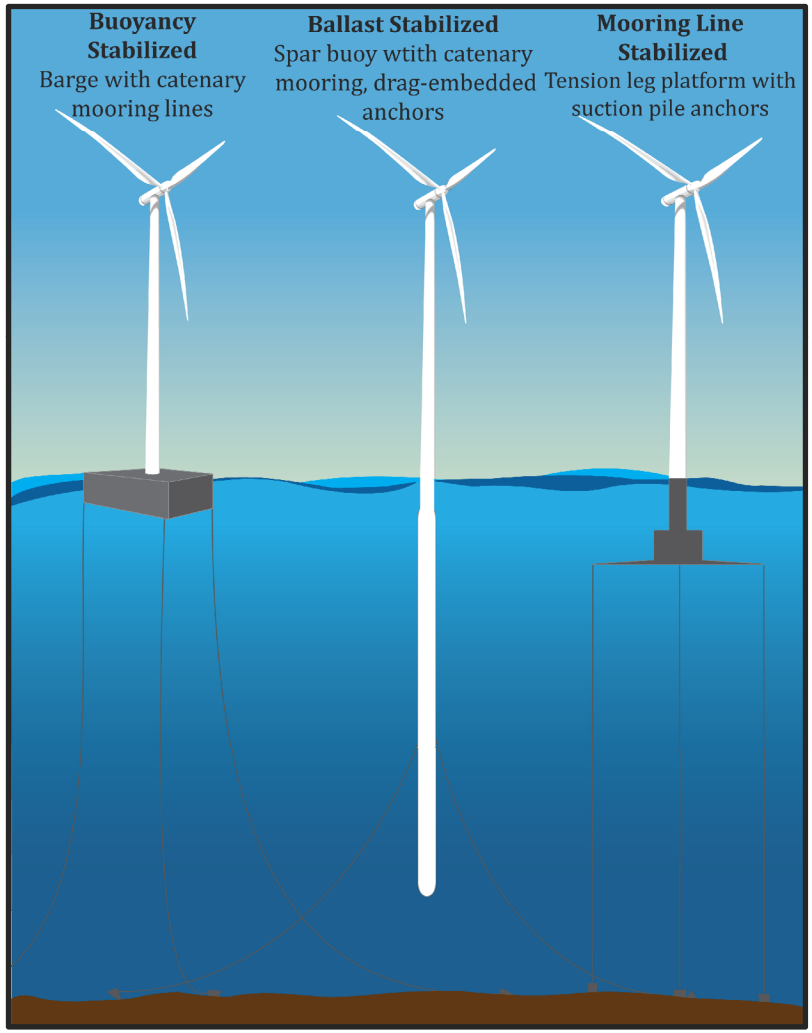


H_s = Significant Wave Height (average of highest 1/3 waves) (m)
H_{max} = Maximum Individual Wave Height ($1.86 \times H_s$) per IEC 61400-3 (m)
V_{hub} = Mean Wind Speed at Hub using wind power law exponent = 0.14 (m/s)

Deployment Period

Month	Probability of Exceeding 1/3 Scale 50 year H_s (3.3m) in one week		
	Lognormal	Weibull	Rayleigh
Jan	47%	52%	43%
Feb	67%	69%	51%
Mar	52%	56%	47%
Apr	42%	47%	42%
May	23%	28%	27%
Jun	5%	7%	9%
Jul	1%	0%	4%
Aug	0%	1%	2%
Sep	7%	4%	12%
Oct	40%	46%	40%
Nov	53%	58%	50%
Dec	73%	73%	59%

DeepCwind Consortium
3-5 MW Test in 2012-2014



Technical Goals:

- Predictive models
- Cost optimization ($3.5/W):
    - Materials
    - Manufacturing
    - Deployment
    - Maintenance

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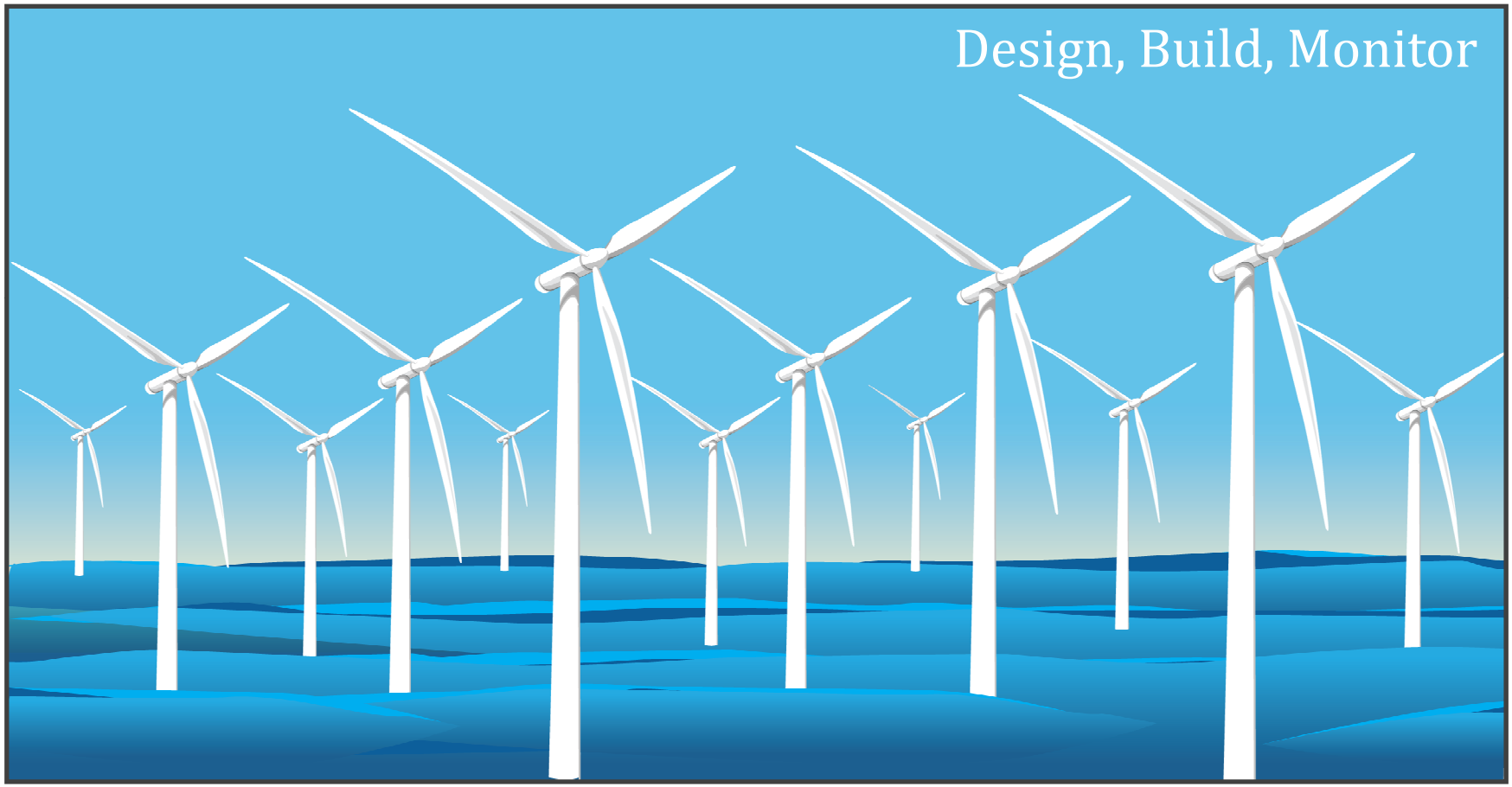
25 MW Stepping-Stone Floating Farm

RFP September 2010 – 5 Years to Build

Expand to 500 MW - 1000 MW by 2020



Maine Bill LD1810, 20-year PPA

Signed Maine Public Law 270

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Summary: DeepCwind Consortium

- Can floating wind turbines compete ($/kWh) with land-based wind?
  - + better winds, deployment logistics, public acceptance, close to US population centers
  - - technology, floating platform costs, maintenance

- DeepCwind consortium adding new partners:
  - (a) RFI for model tests, (b) Turbine manufacturers,
  - (c) Developers for 25 MW Pilot farm - Sept 2010 RFP
  - (d) Offshore wind lab
  - (e) Deepwater offshore wind test site

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UMaine Offshore Wind Laboratory

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Advanced Structures & Composites Lab

- Advanced Structures and Composites Center founded in 1995 (NSF)
- Existing Lab opened in 1999.
  - 30,000 ft^2, expanded to 48,000 ft^2 in 2005
- Capacity to prototype and test full-scale structural components, up to 30 m long.
- Mechanical, environmental, NDE, manufacturing process development, all under one roof.
- Talented staff
  - 45 full time staff , including 12 Ph.D. researchers (structural & mechanical engineers, material scientists, polymer chemists, etc.)
  - 100 graduate and undergraduate research assistants.
- 95% externally funded, history of strong collaboration with industry.

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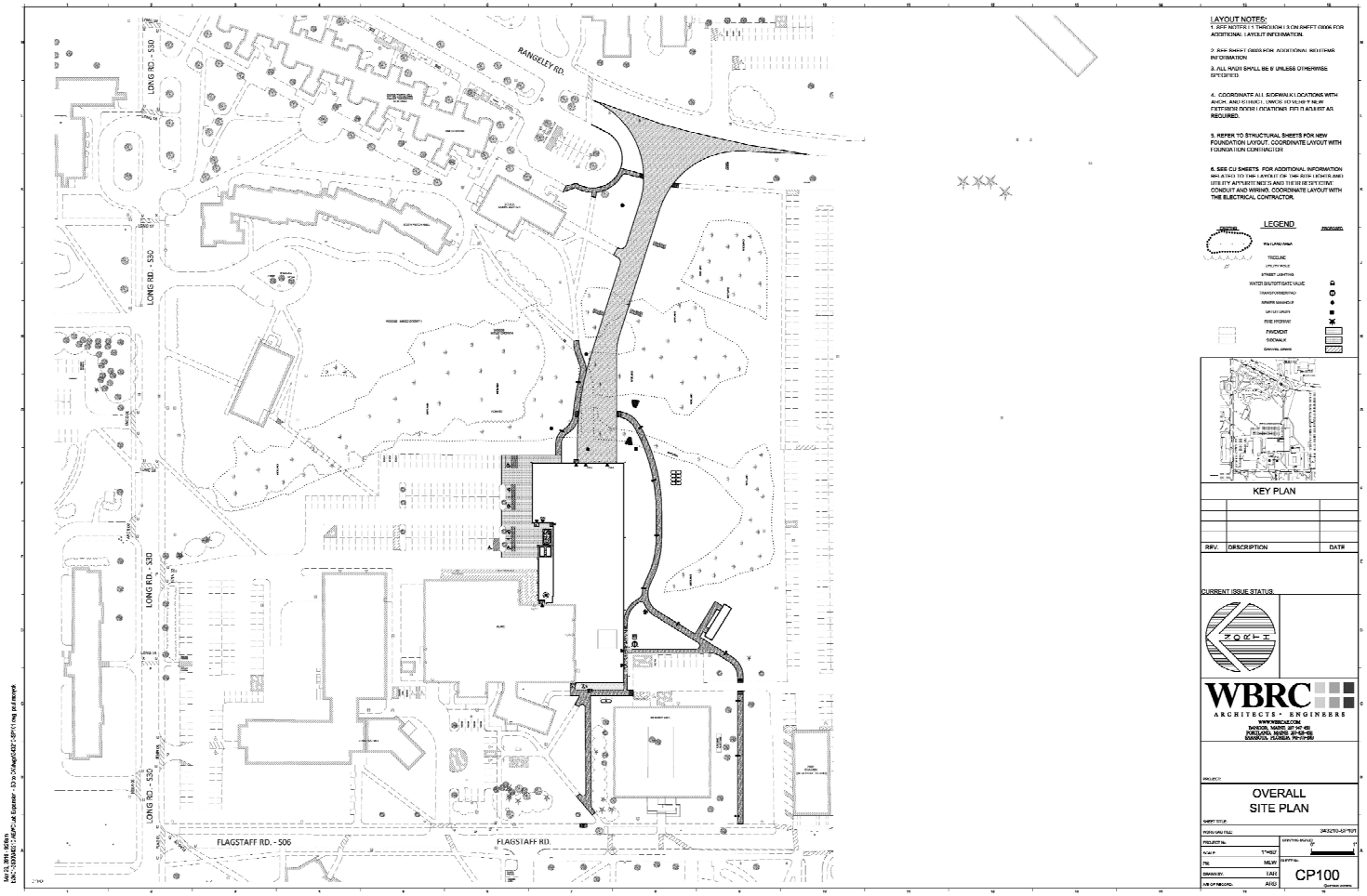
New Offshore Wind Lab Addition



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East Elevation

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North Elevation

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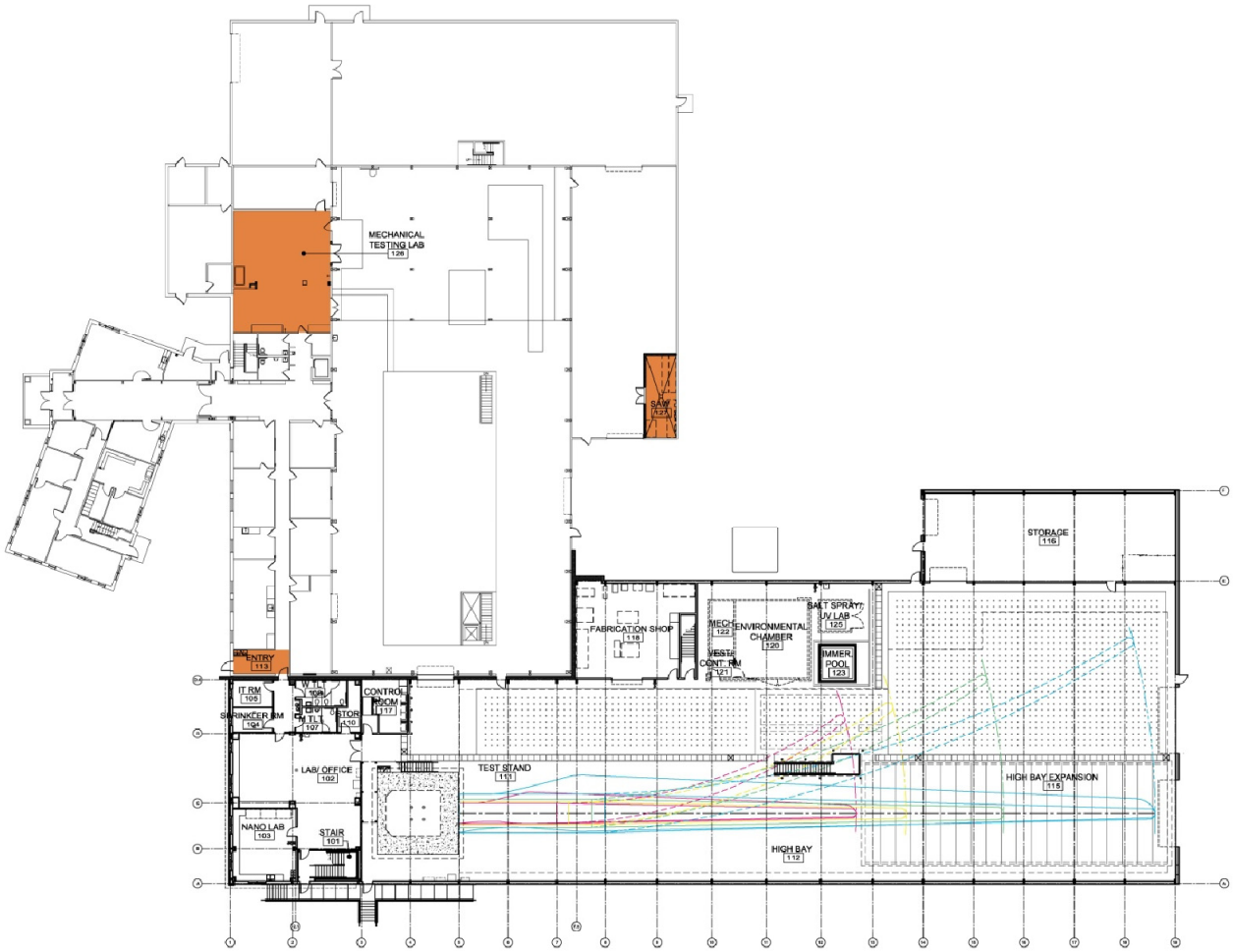
First Floor



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Wind Blade Test Stand

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Placing Stand Face Plate

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Face Plate in Place

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Wind Energy Lab Addition

- Fully-funded, $17.5 million addition
- $5 million in new equipment funding
- Open in May 2011
- 35,000 ft^2 addition
  - 70 meter windblade test stand.
  - Windblade & composite structure prototyping.
  - Environmental testing.

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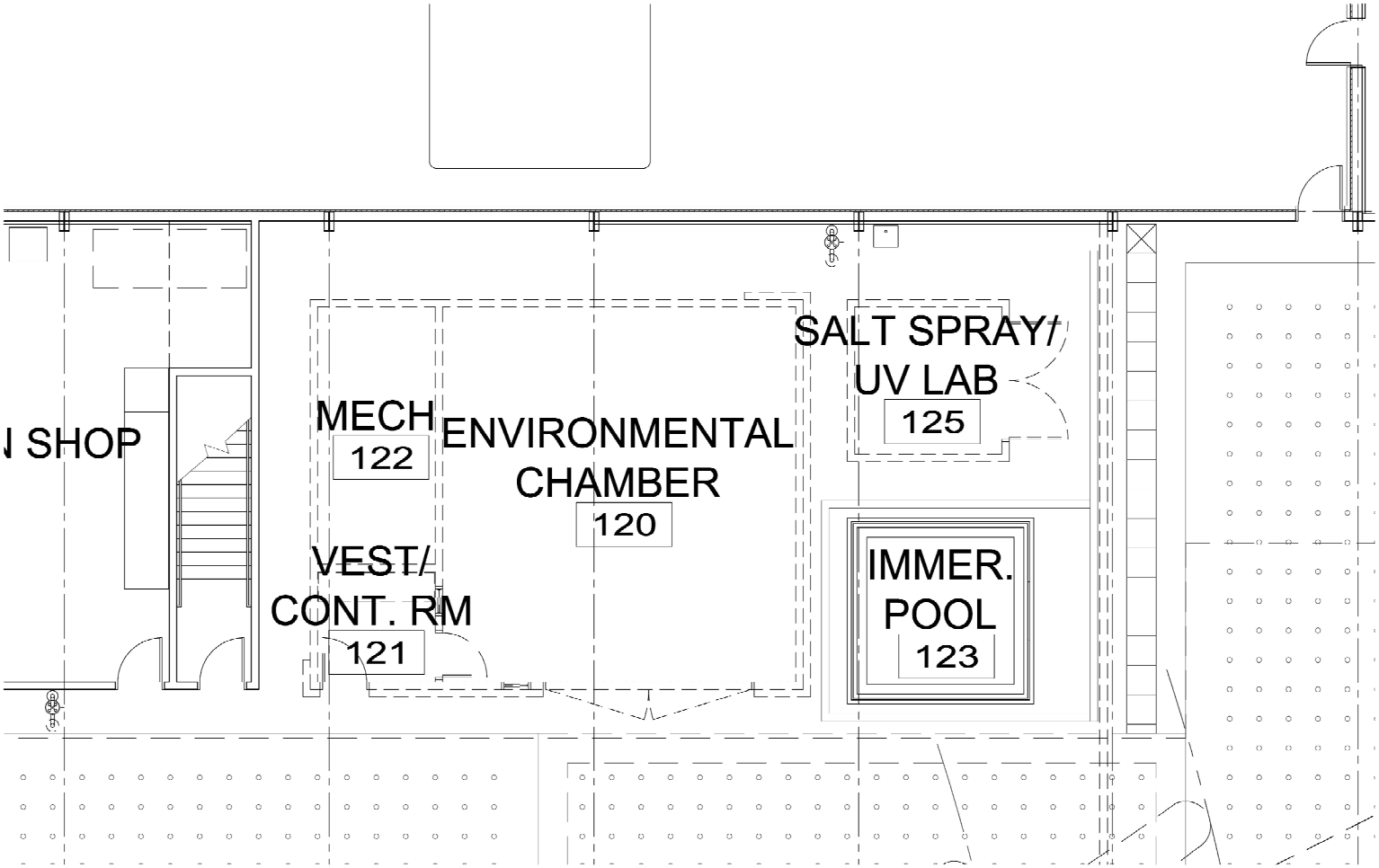
Environmental Chamber



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