



Renewable Energy Research Laboratory

Hull Offshore Wind



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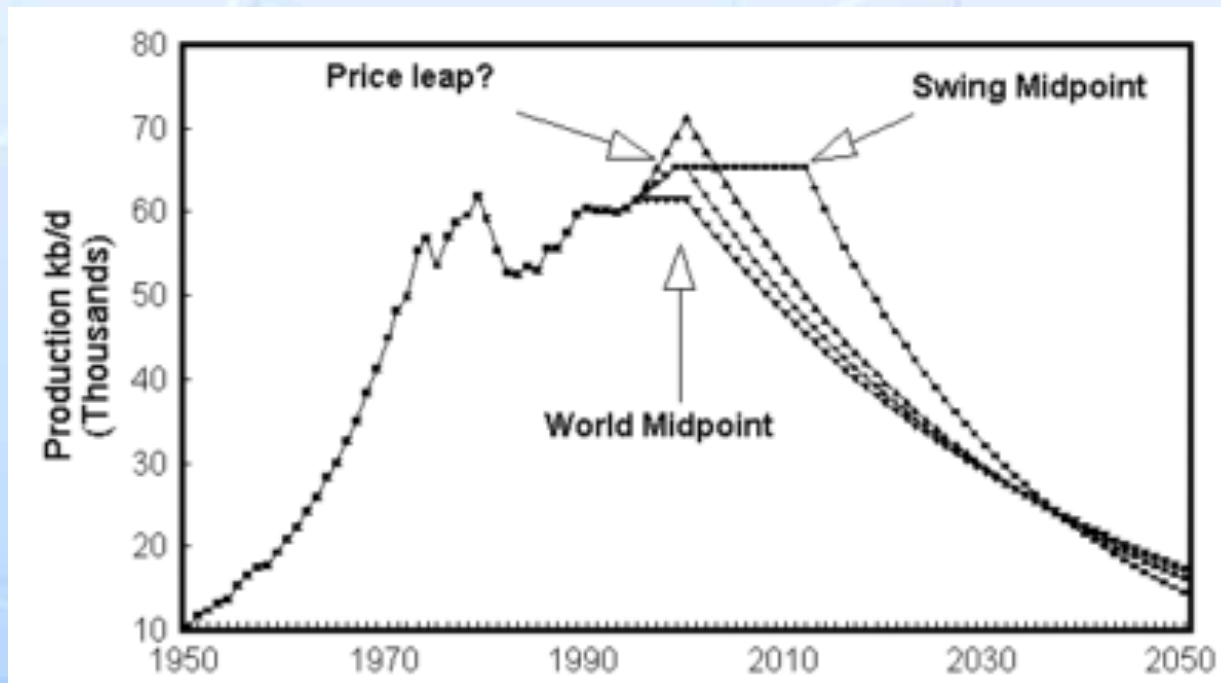
Context

- **Price** for conventional energy will continue to rise
- **Supply** of conventional energy will become more problematic



Context

- Conventional energy supply:
 - Limited petroleum reserves world wide (“peak oil”)





Context

- Conventional energy supply:
 - Geopolitical instability:
 - US consumes 25% annual world oil production
 - 6% proven petroleum reserves are in North America
 - 66% proven oil reserves are in Middle East
 - Draw your own conclusions



Burning pipeline in Iraq



Context

- Conventional energy supply:
 - Environmental degradation, e.g. from coal mining:





Context

- Conventional energy supply:
 - Climate change:
 - Melting glaciers
 - Sea level rise
 - Increased storm severity



Retreating glacier, (Iceland 2005)



Winter storm and flooding, Atlantic Ave, Hull, January, 2005 (photo: M. Fournier)



Renewable Energy

- The alternative to the present situation
 - Electricity from **wind** one of best options
- Supported in principle by most people
- Incentives in Massachusetts
- In practice, implementation has been slow
- Except in Hull!



Why Wind Energy in Hull?

- Good wind resource
- Municipal light department
 - Few intrinsic barriers
 - Economics of wind are attractive
- Pragmatic and far sighted light board and operations manager





Why Consider Offshore Wind Turbines in Hull?

- **Stabilization** of electricity **prices** through greater use of wind energy
- **Limited** space for additional wind turbines on **land**
- **Substantial** potential for **offshore** wind turbines
- **Responsible** choice
- Challenge and excitement!



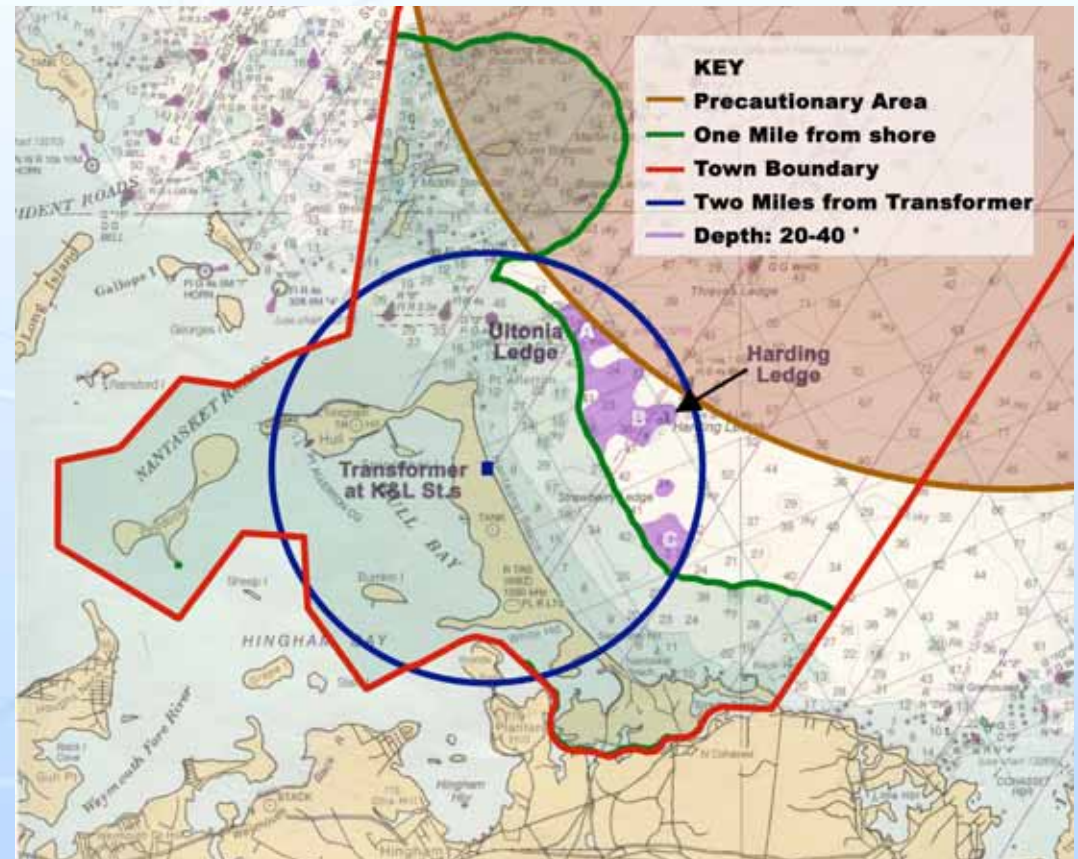
The Proposed Hull Offshore Wind Project

- Four wind turbines
 - 3-5 MW (295' - 417' rotor diameter)
 - (Hull Wind 2: 1.8 MW, 262' rotor)
- Installed in vicinity of Harding Ledge
- 12 - 20 MW total generating capacity
- Energy production (on average) could approach 100% of Hull's electricity consumption



Preliminary Siting Constraints

- In Hull's waters
- Suitable for commercial turbines
 - 20-40 ft deep
- Outside shipping lanes
- We initially chose these distances:
 - > 1 mile from shore
 - < 2 miles from proposed connection point





Siting Criteria (1)

- Avoid or minimize impacts on :
 - Marine environment
 - Human activities
 - Fishing, boating, etc...
 - Ship and airplane traffic





Siting Criteria (2)

- Allow a feasible landfall
- Minimize transmission line length
- Maximize wind speeds
- Minimize cost of energy





Study Phase

- Feasibility
 - Projected costs vs. benefits
- Turbine design basis
 - Input to cost estimates
- Studies for permits
- Fatal flaws?



Principle Partners

- Hull Municipal Light Plant (HMLP)
- Massachusetts Technology Collaborative (MTC)
 - Administrator of MA Renewable Energy Trust Fund
 - Financial support
- UMass/Amherst RERL
 - Engineering
 - Wind/waves
 - Feasibility/layout/visualizations
 - Structural dynamic modeling
- ESS, Inc.
 - Environmental studies



Other Contractors

- AMEC Paragon, Houston
 - Support structure design
- Prof. Jason DeJong (UMass and UC Davis)
 - Soil/support structure interactions
- GZA Geoenvironmental
 - Offshore soil sampling
- MIT's Laboratory for Energy and the Environment
 - Environmental benefits (reduction in air pollutants)



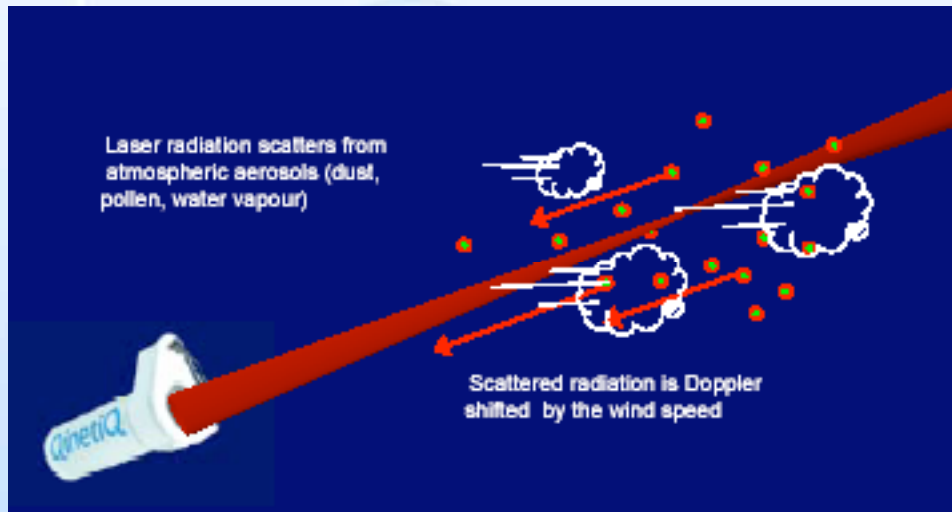
Wind Resource Assessment

- Used for:
 - Energy production estimates
 - Design of wind turbines and support structures
- Data from:
 - Monitoring on Little Brewster island and WBZ towers
 - Historical data from Boston Harbor and offshore buoys
- Mathematical projections



Wind Data Collection

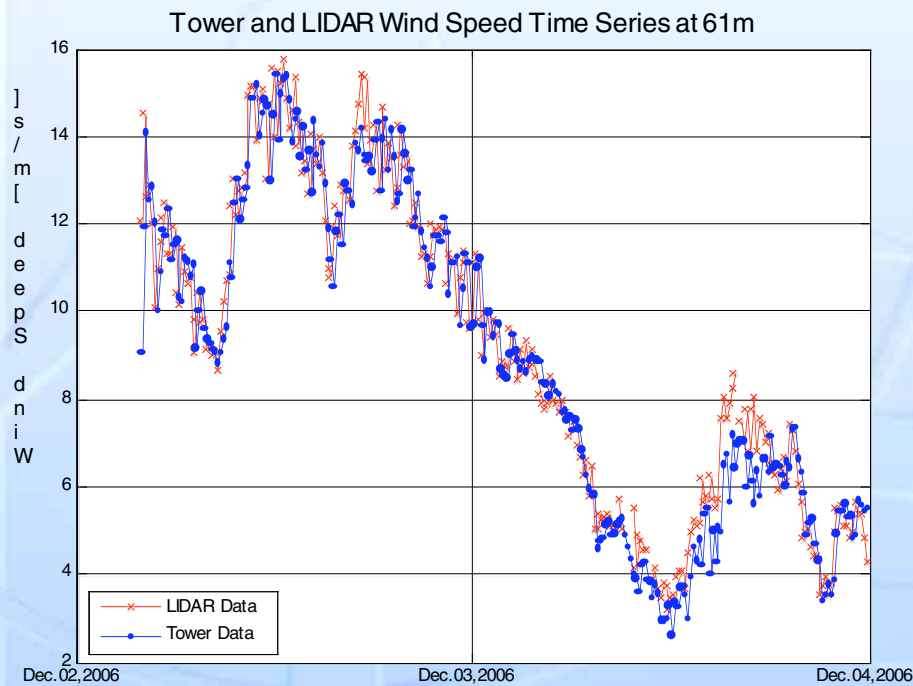
- Conventional anemometry and LIDAR





WBZ Tower/LIDAR

- Comparisons:





Little Brewster

- Location and data collection:

Little Brewster Island



Harding Ledge

Anemometer



Aerial view of Little Brewster



Waves

- Information on waves needed for preliminary design and cost estimates of support structure:

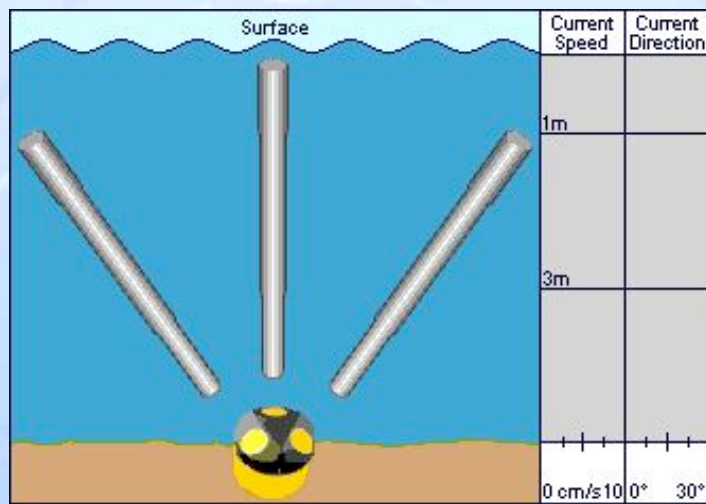


Waves on Offshore Wind Turbine in England

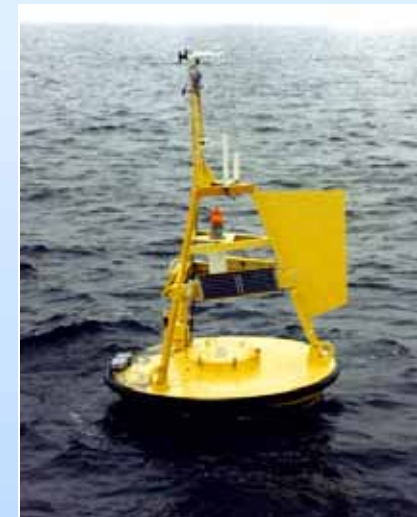


Wave Data

- Monitoring using a Sontek “acoustic Doppler profiler” (ADP) in vicinity of Harding Ledge
- Correlations with offshore buoys



Sontek ADP

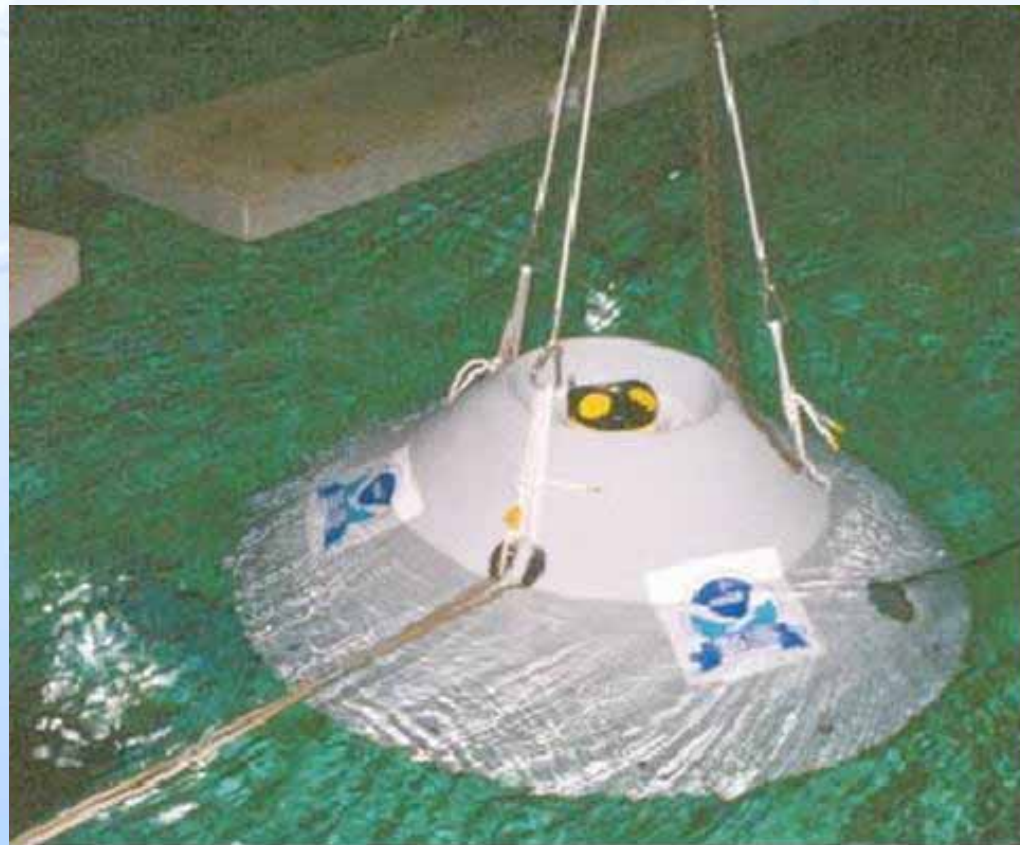


NDBC Data Buoy



ADP in Anti-Trawl Device

- Anti-trawl device will be used to protect ADP:



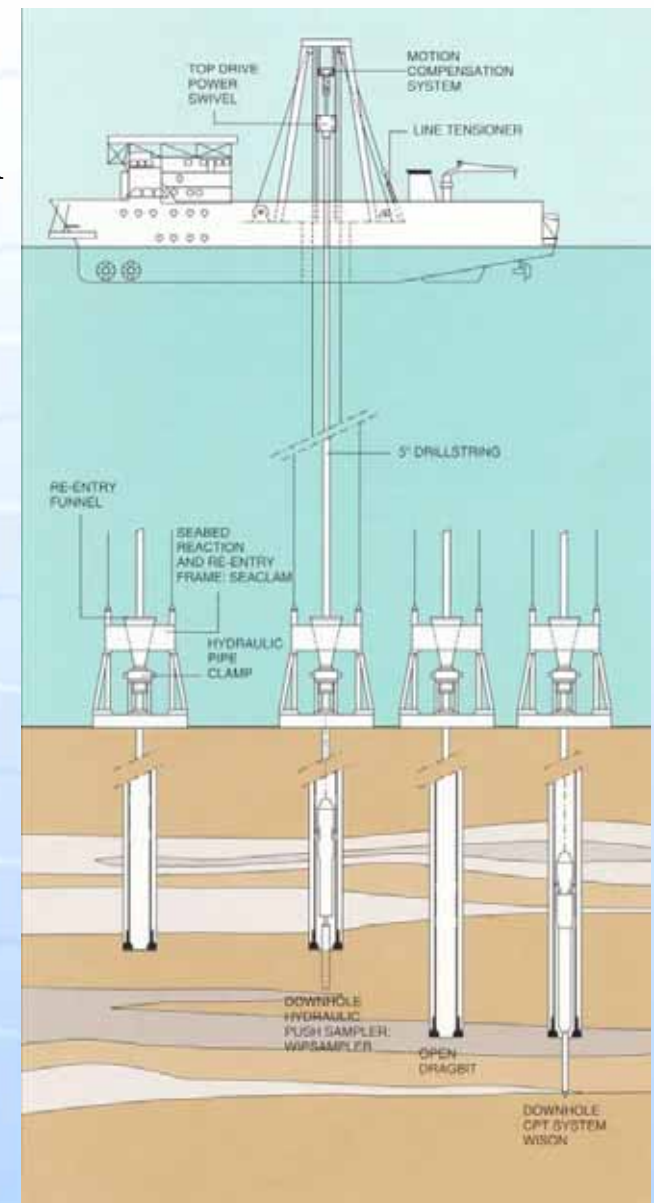


Geotechnical Investigation

- Soil data needed for preliminary design and cost estimate of support structures

Typical offshore soil sampling

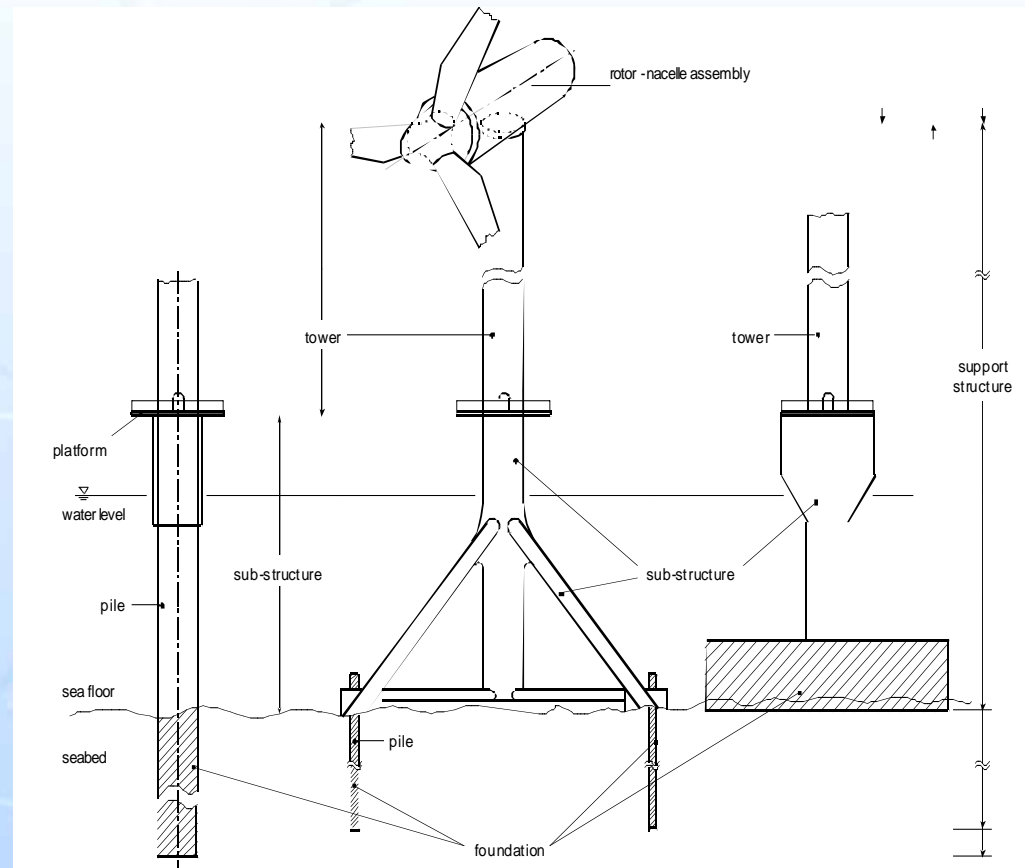
www.fugro.co.uk





Wind Turbine Support Structure

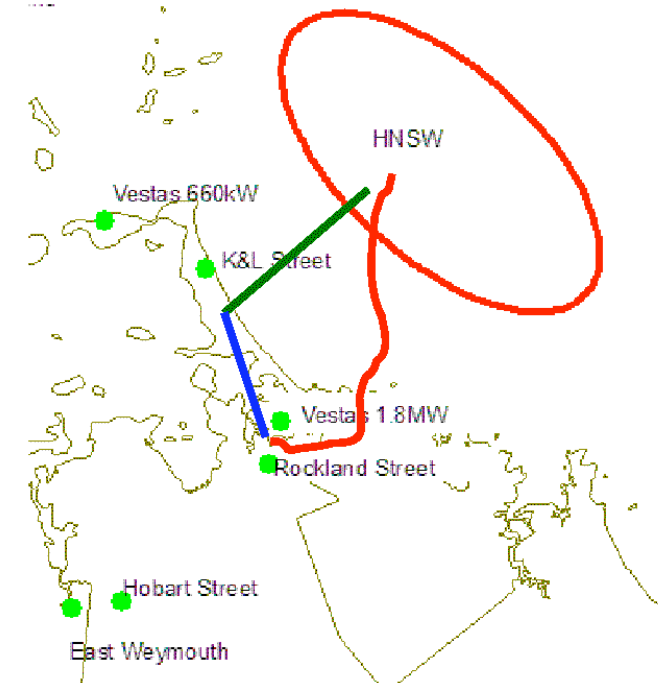
- Some offshore wind turbine support structure options →
- Type used in Hull will depend on seabed properties



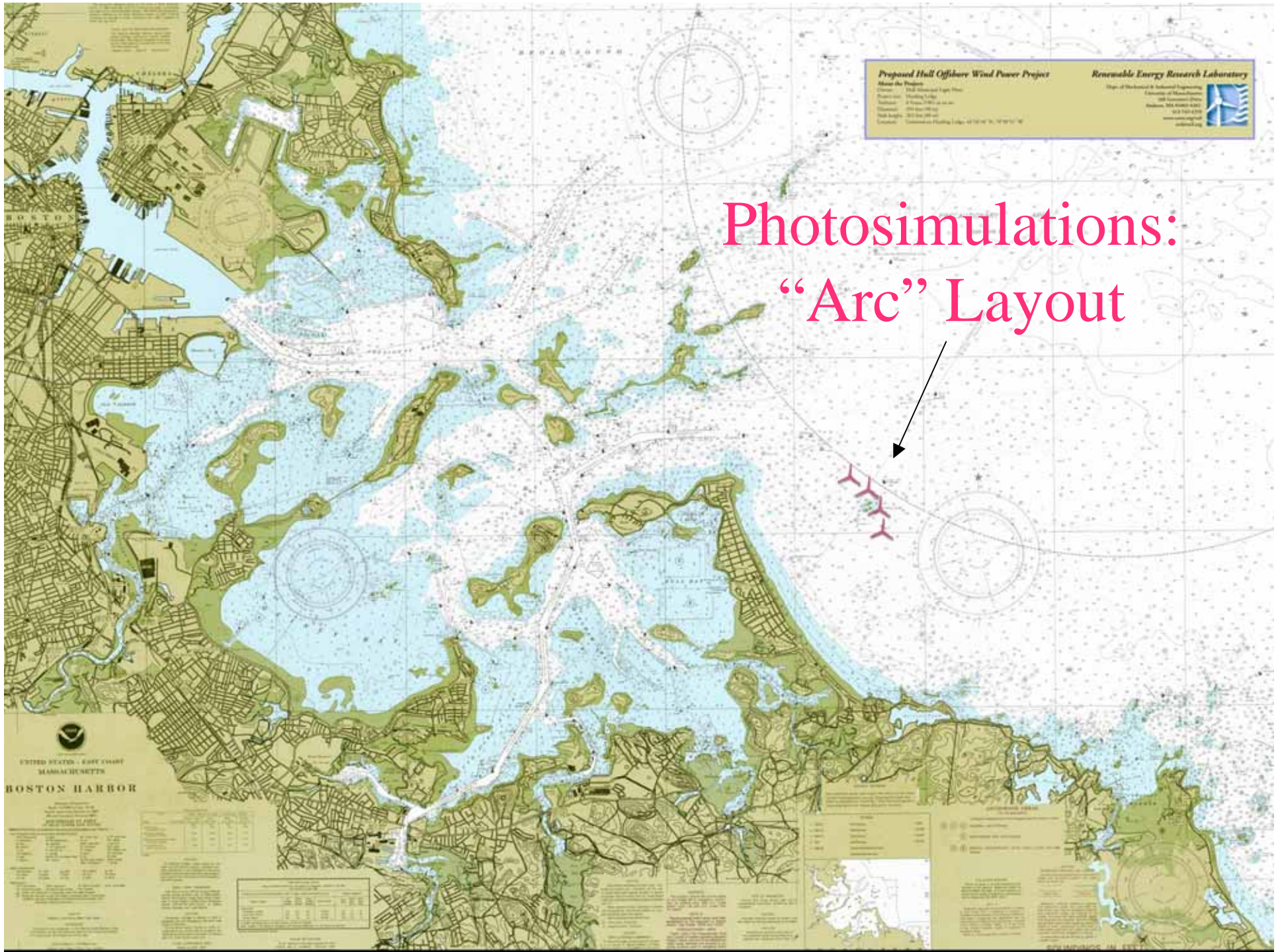


Electrical Cable

- Submarine cables to shore
- Layout needed for:
 - Cost estimates
 - Environmental impact assessments
 - Interconnection planning



Some Possible Cable Routes



Proposed Hull Offshore Wind Power Project
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Photosimulations: “Arc” Layout



Photo Simulation: (Clarion)



Photo Simulation of Hull Offshore Wind Power Project

Renewable Energy Research Laboratory



About the Project:

Owner: Hull Municipal Light Plant
Project site: Harding Ledge
Turbine: Vestas V90
Diameter: 295 feet (90 m)
Hub height: 262 feet (80 m)
Location: 42°18'16.2" N, 70°50'50.5" W

About the Photo:

Viewpoint: Clarion Hotel, second floor
Distance to turbine: ~2.2 miles
Angle of View: ~38 degrees
Location: 42°16'29.8"N, 70°51'41.6" W
Base Photo: Taken Dec. 20, 2006, #30
Apparent size and location of the turbine from this viewpoint is determined geometrically using EMD WindPro software.

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Photo Simulation: (Oceanside)



Photo Simulation of Hull Offshore Wind Power Project



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About the Photo:

Viewpoint: 4 Oceanside Drive
Distance to turbine: ~5.6 miles
Angle of View: ~38 degrees
Location: 42.26803°N 70.84785°W
Base Photo: Taken Dec. 20, 2006, #44
Apparent size and location of the turbine from this viewpoint is determined geometrically using EMD WindPro software.

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Photo Simulation: (Cohasset)



Photo Simulation of Hull Offshore Wind Power Project



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About the Photo:

Viewpoint: Cohasset, Jerusalem Rd.
Distance to turbine: ~3.3 miles
Angle of View: ~38 degrees
Location: 42.262672°N 70.814406°W
Base Photo: Taken Dec. 20, 2006, #57
Apparent size and location of the turbine from this viewpoint is determined geometrically using EMD WindPro software.

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Progress So Far

- Predevelopment engineering studies
 - Wind data collection underway
 - LIDAR monitoring on Little Brewster planned for spring
 - Wave monitoring device ordered
 - Installation planned for spring
 - Layout optimization software being finalized
 - Support structure modeling underway
 - Initial visualizations completed