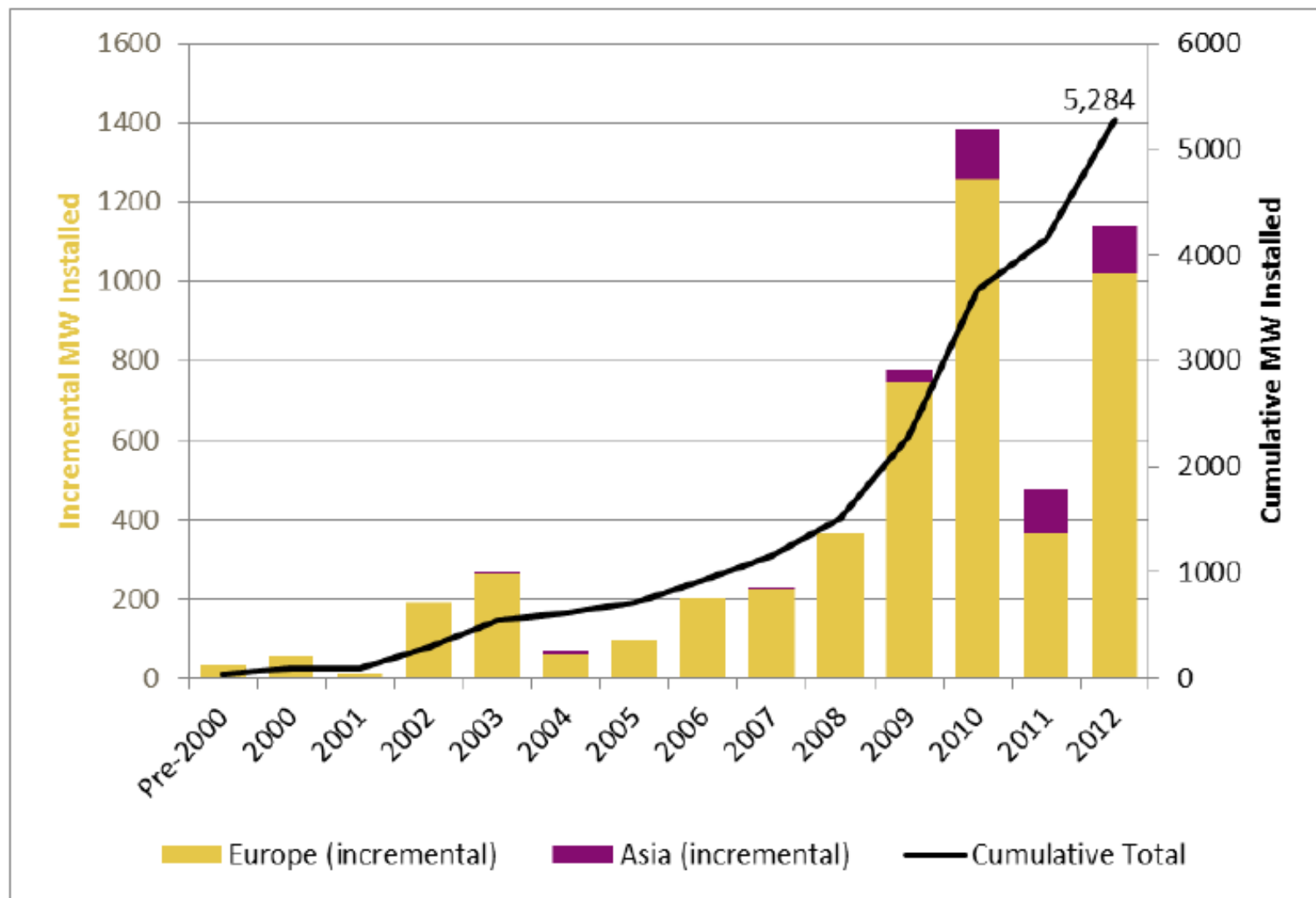


Offshore Wind Development

Prof. Leonard Bohmann

Growth in Offshore Wind

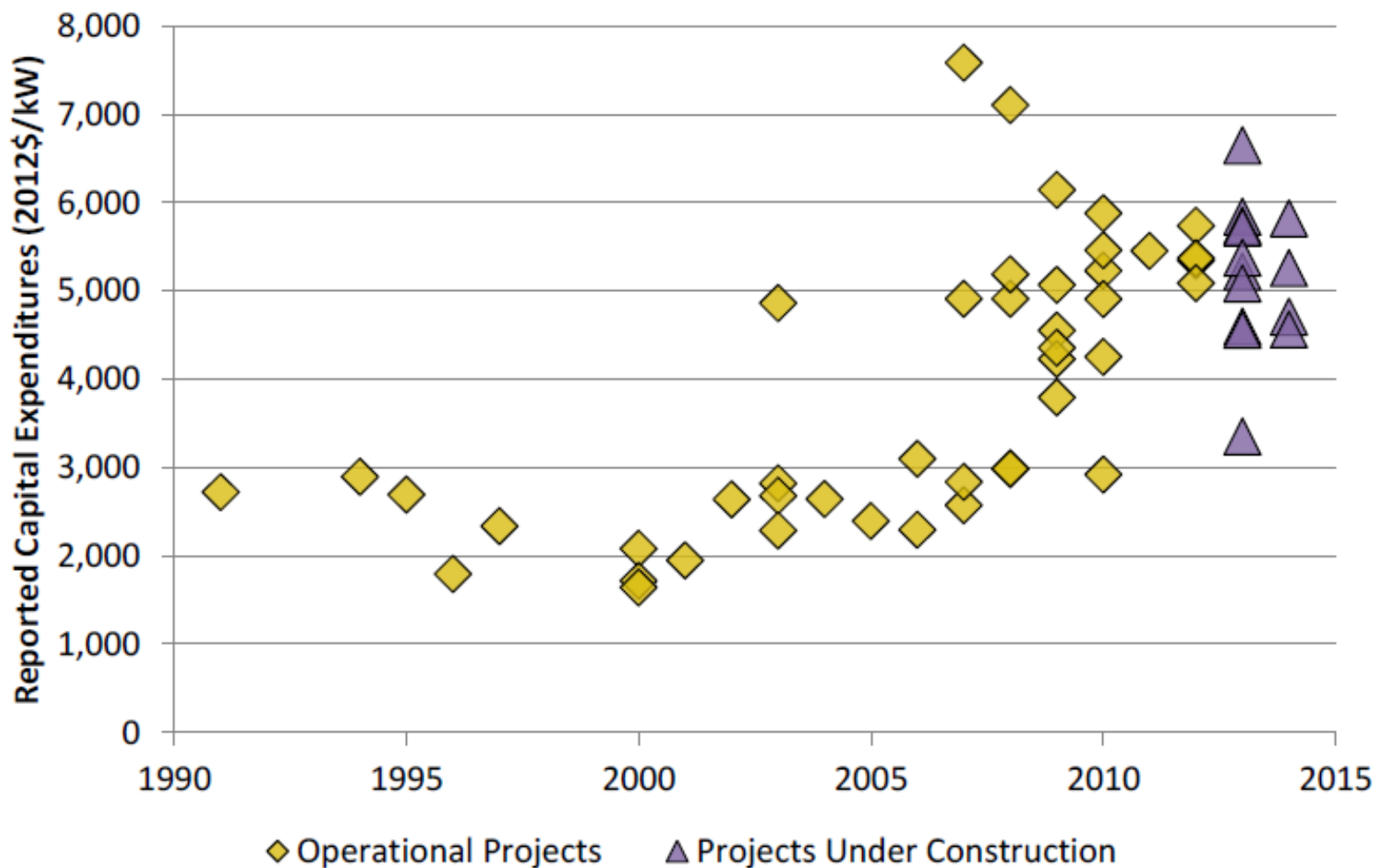


<http://wind.energy-goc>

Note: Shows capacity in the year it was installed but not necessarily grid-connected. Includes commercial, test, and intertidal projects.

Source: Navigant analysis of data provided by NREL and BTM

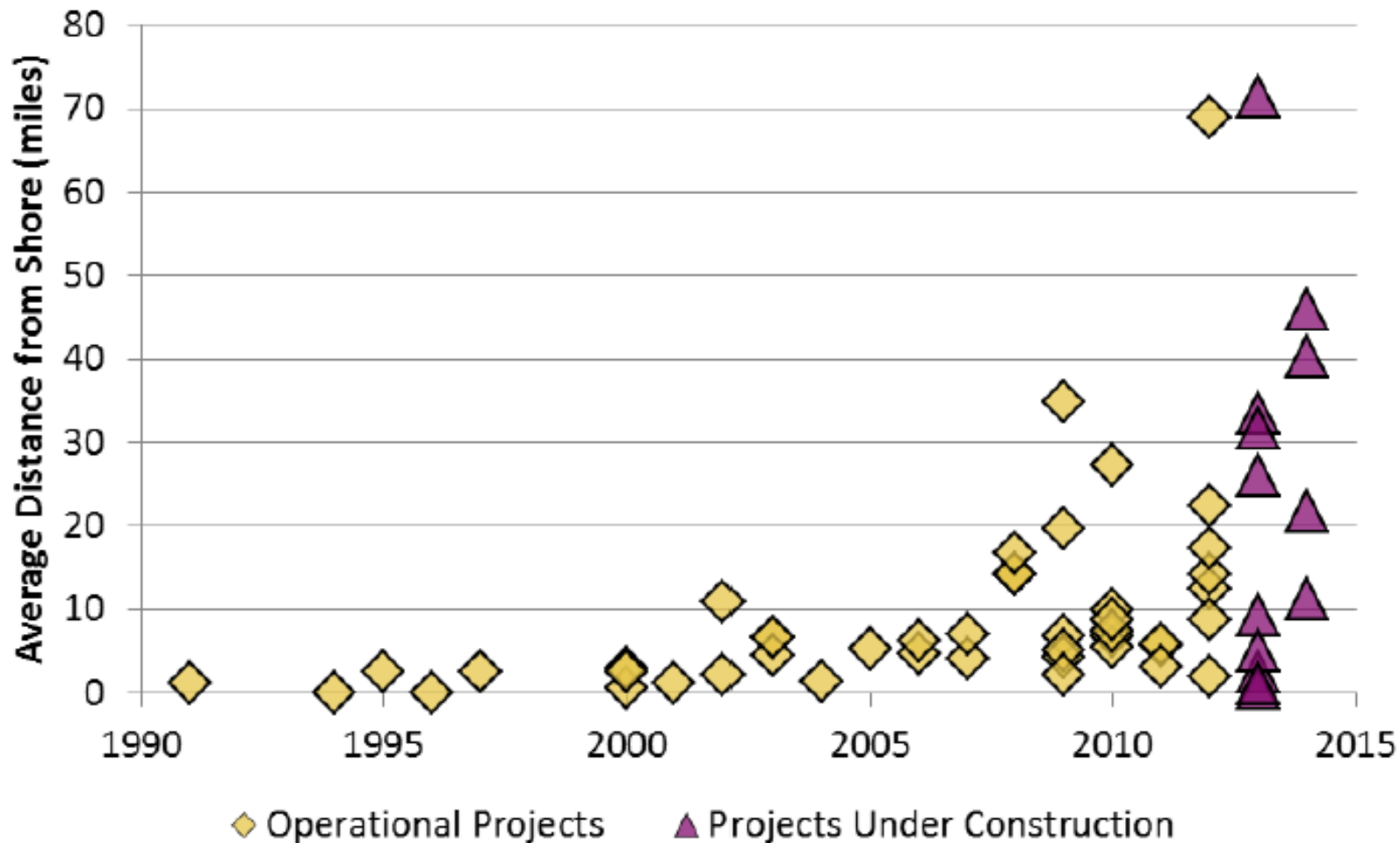
Cost trends of offshore wind



Note: Data was not available for all projects. Capital costs were inflated to 2012 currency in original currency and converted to U.S. dollars using 2012 average exchange rates. BARD Offshore I was excluded due to a cost overrun of more than 1 billion Euros.

Source: NREL analysis⁹

Distance to shore trends

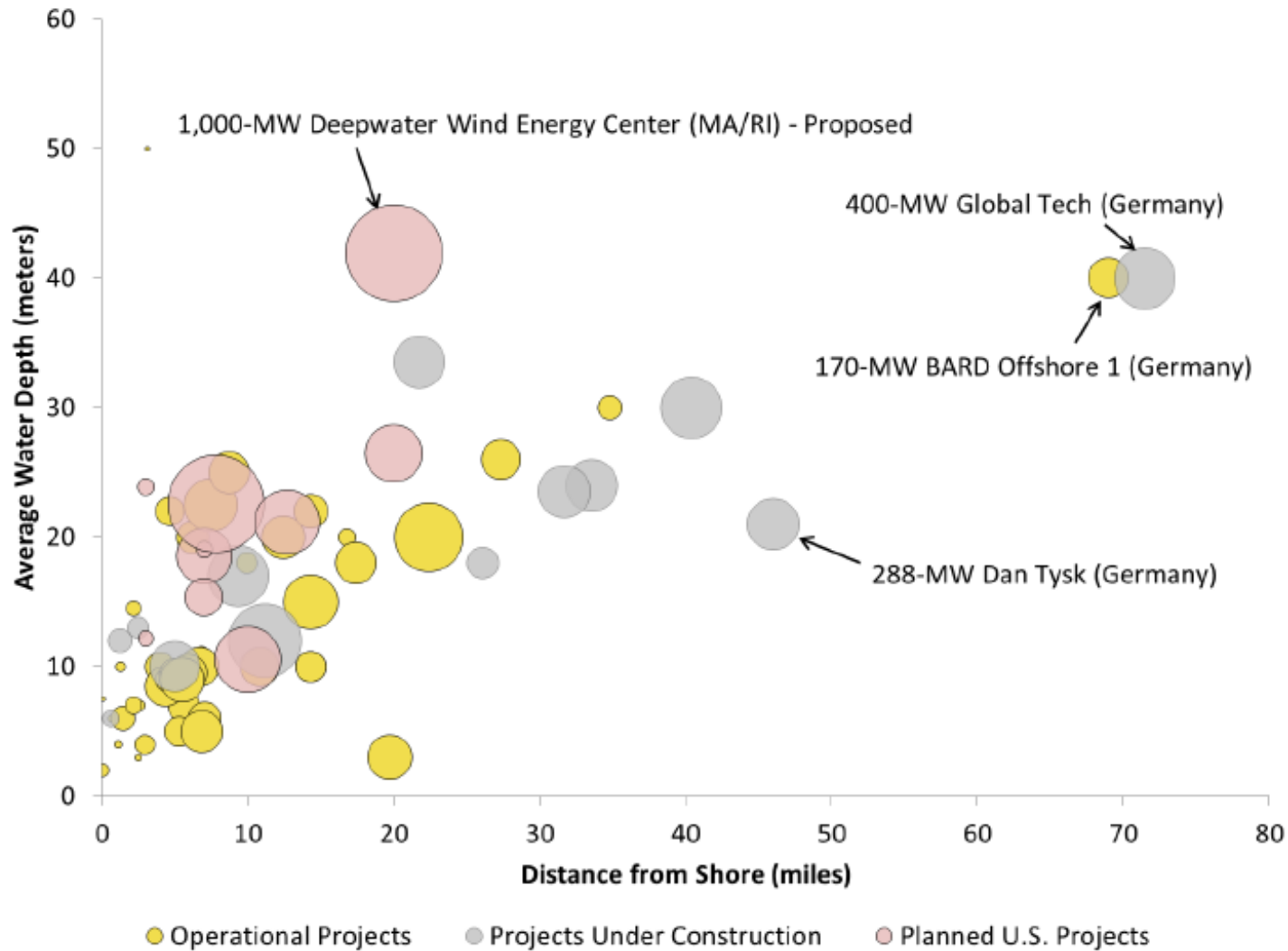


<http://wind.energy.gov>

Note: Multi-phase projects were combined and are reported at the latest year when turbines were added at the project site. Expansions or phases of existing projects sites currently under construction were omitted to avoid skewing the data.

Source: Navigant analysis of data provided by NREL and BTM

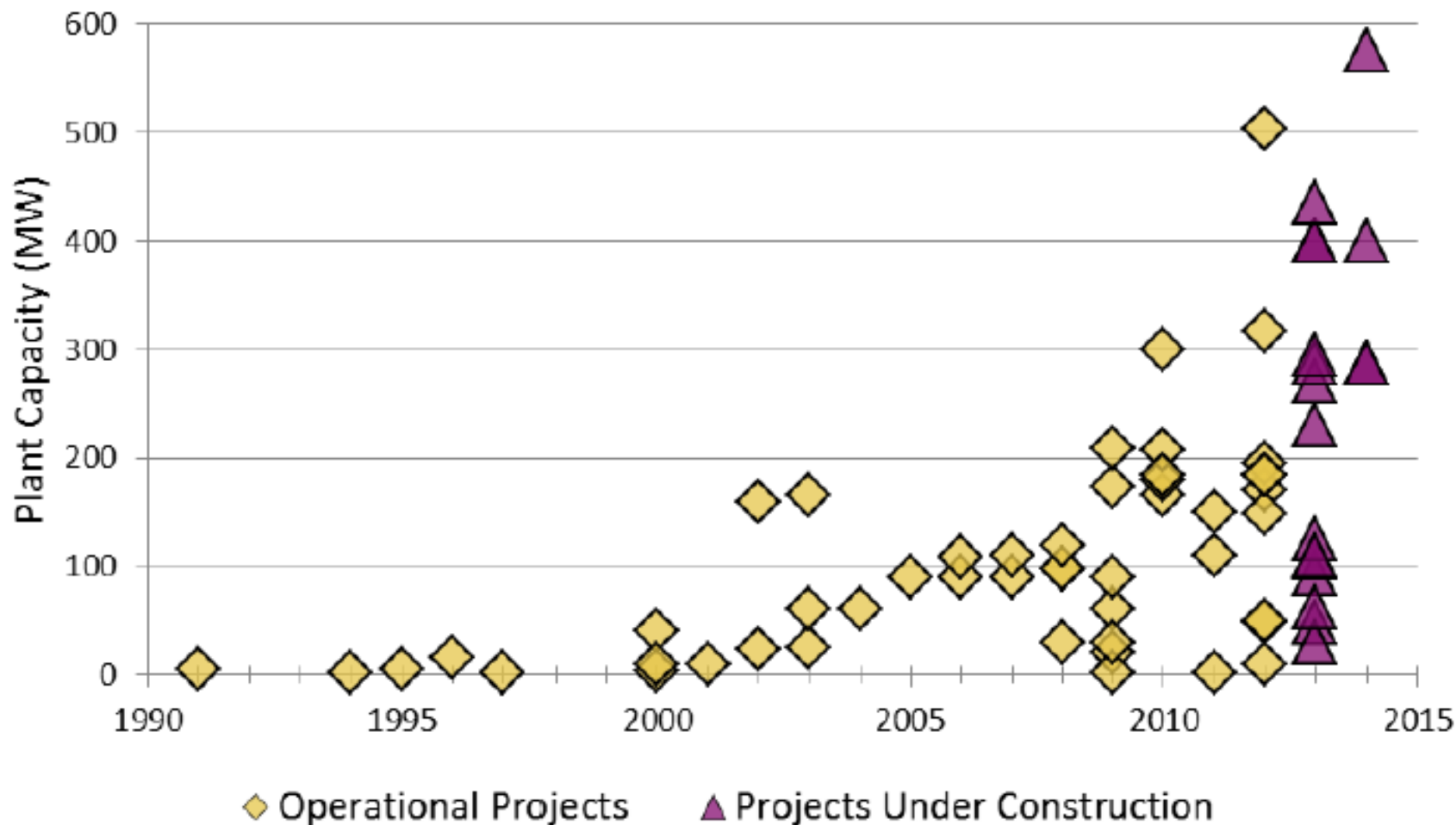
Depth and distance to shore



Note: Bubble size indicates projects' relative capacities; several projects are labeled for scale. Multi-phase projects were combined to show cumulative project capacity.

Source: Navigant analysis of data provided by NREL and BTM

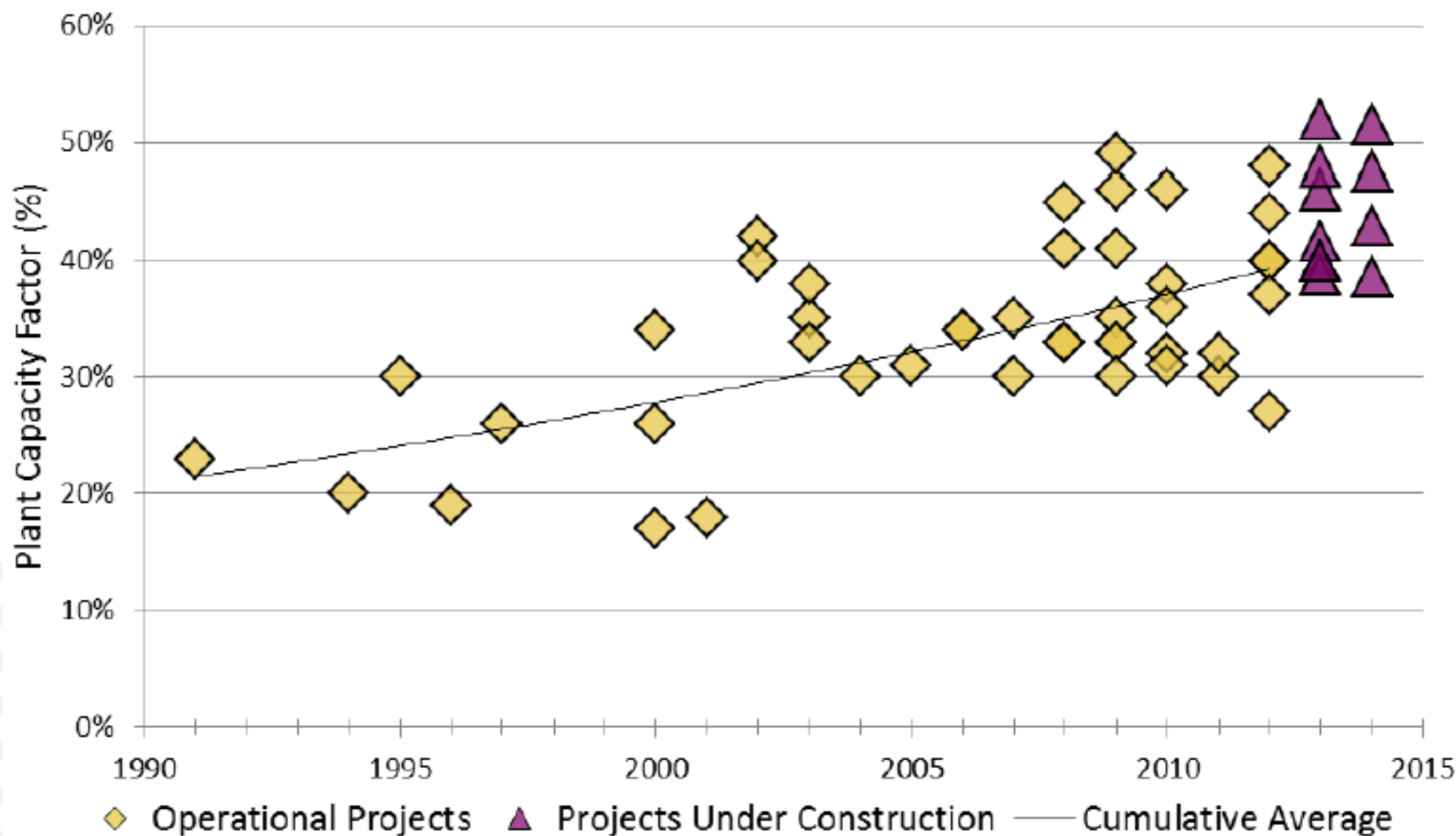
Plant capacity over time



<http://wind.energy-goc>

Note: Plant capacities are shown for the year each project reached completion. Multi-phase projects were combined to show cumulative project capacity and are reported at the latest year when turbines were added at the project site.

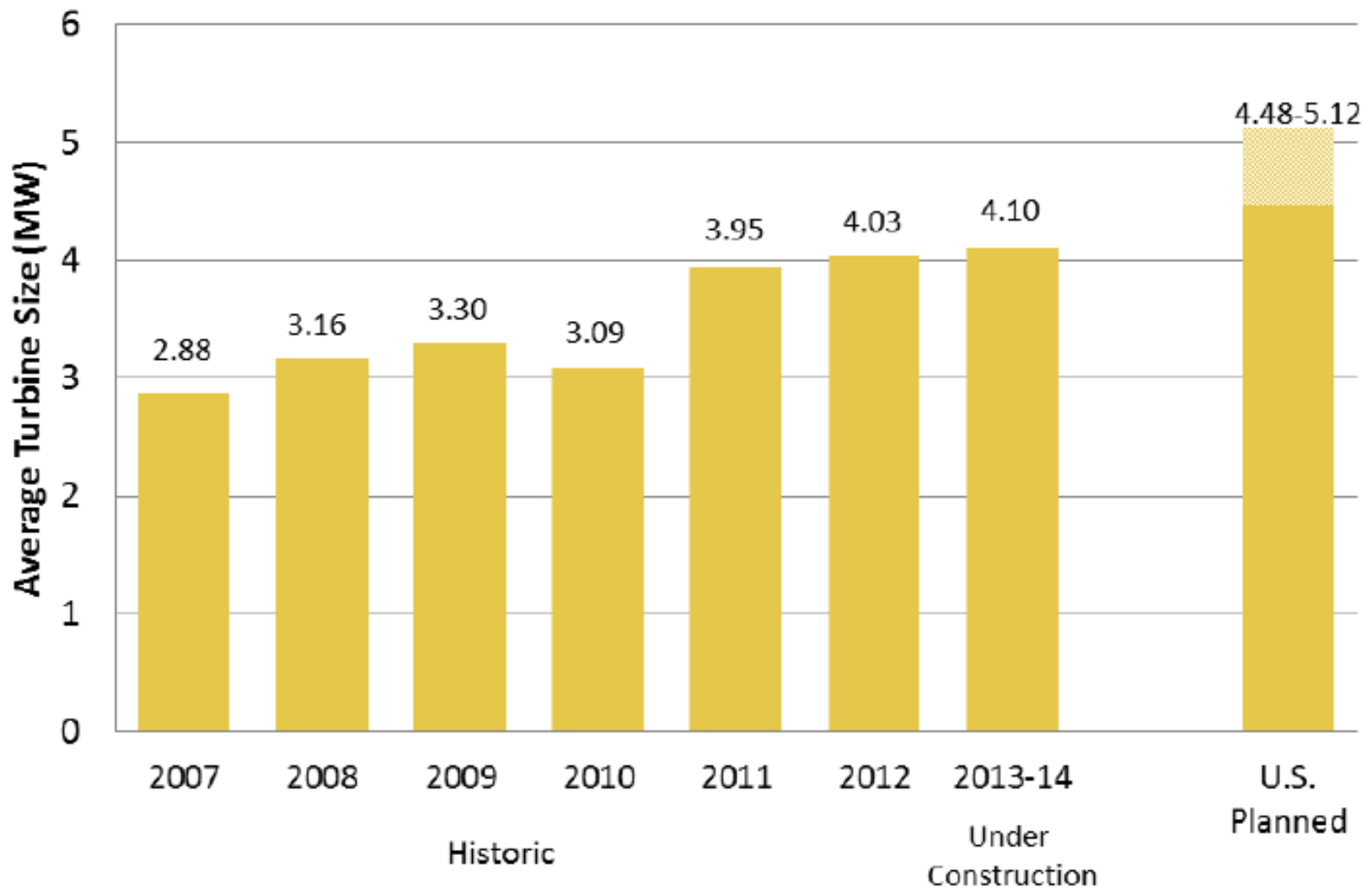
Capacity factors over time



Note: Plant capacity factors are shown for the year each project reached completion. Multi-phase projects were combined to show a single capacity factor and are reported at the latest year when turbines were added at the project site.

Source: Navigant analysis of data provided by NREL and BTM

Turbine size over time



Note: Average turbine size is based on an annual capacity-weighted figure – each individual turbine installed is factored into the annual average.

Source: Navigant analysis of data provided by NREL and BTM

Hub heights over time



<http://wind.energy.gov>

Note: Plant hub heights are shown for the year each project reached completion. Multi-phase projects were combined to show a single hub height and are reported for the latest year turbines were added.

Source: Navigant analysis of data provided by NREL and BTM

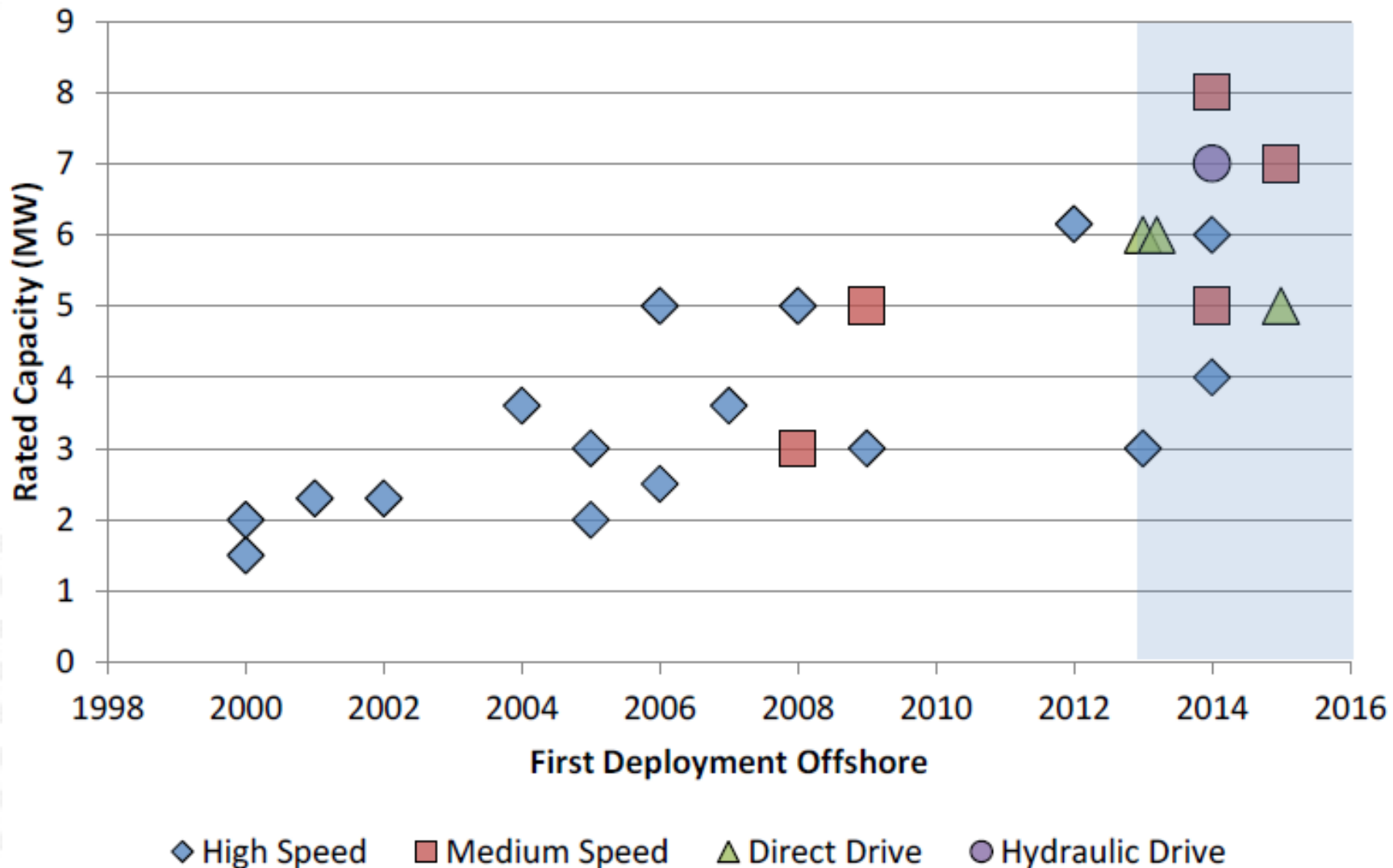
Rotor diameter over time



<http://wind.energy.gov>

Note: Rotor diameters are shown for the year each project reached completion. Multi-phase projects were combined to show a single rotor diameter and are reported for the latest year when turbines were added.
Source: Navigant analysis of data provided by NREL and BTM

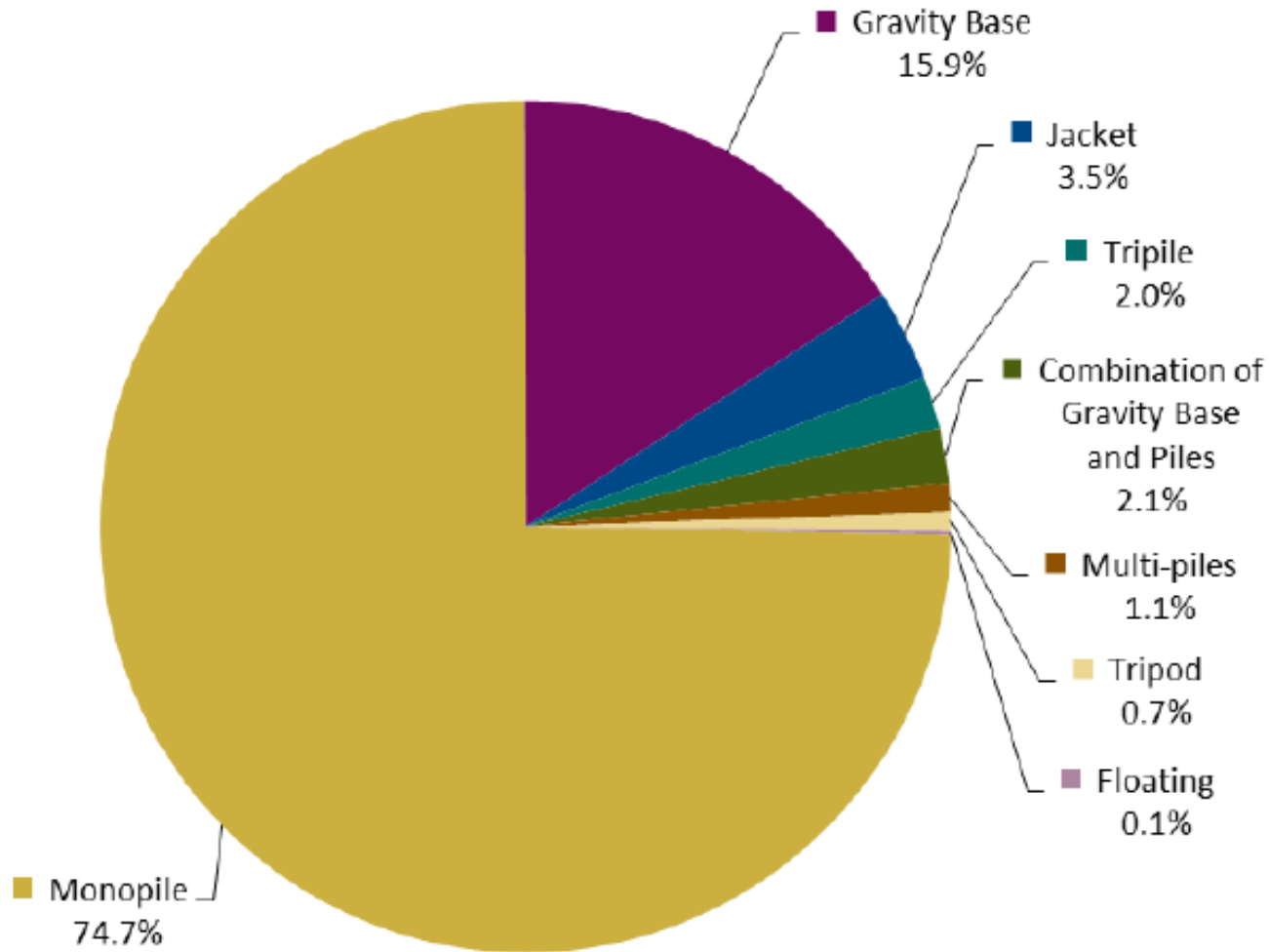
Drive train configuration prototypes



Note: Deployments after 2012 based upon wind turbine manufacturers' announced schedules.

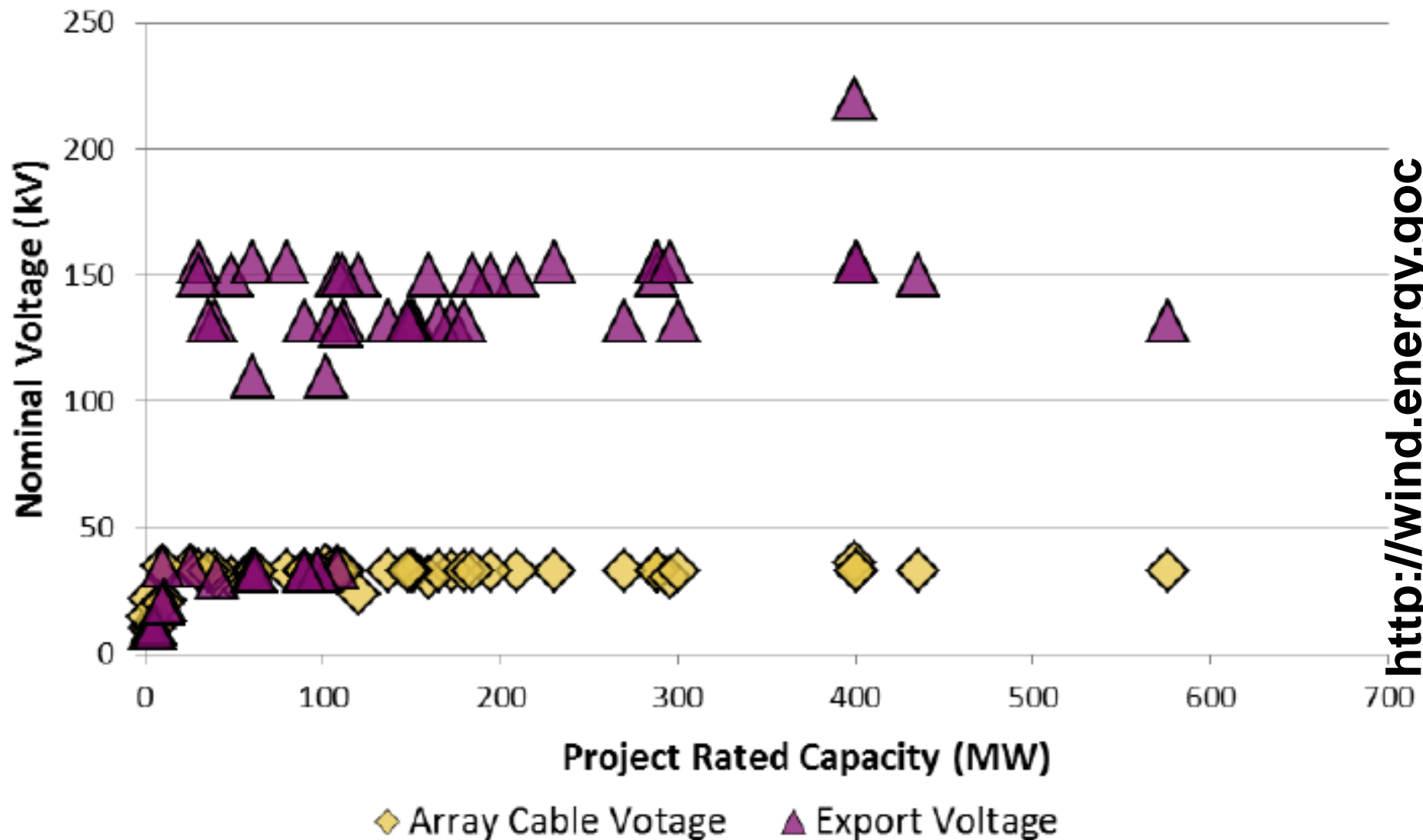
Source: NREL data

Substructures of installed turbines



<http://wind.energy-goc>

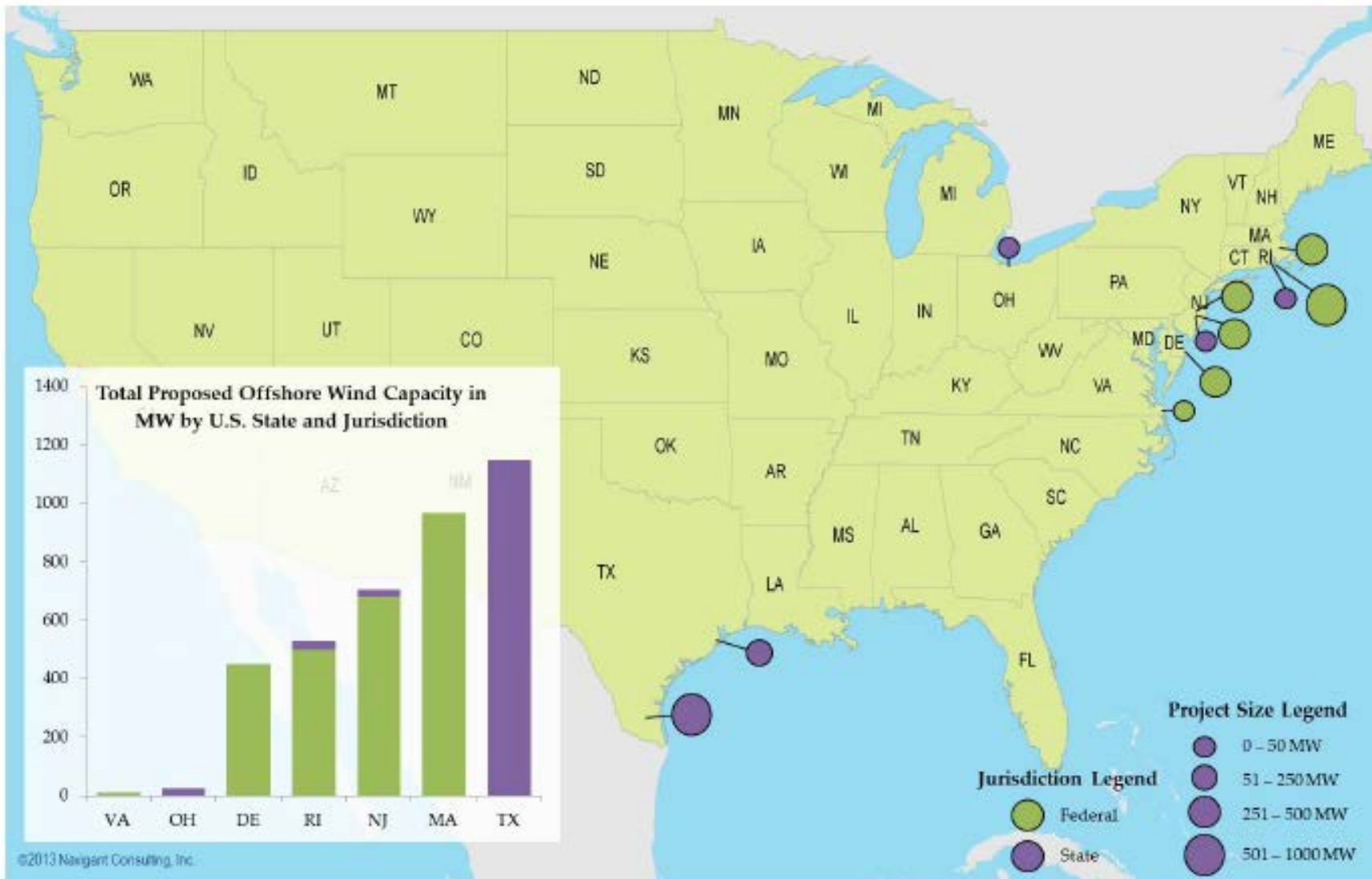
Array cable and export voltages



<http://wind.energy.goc>

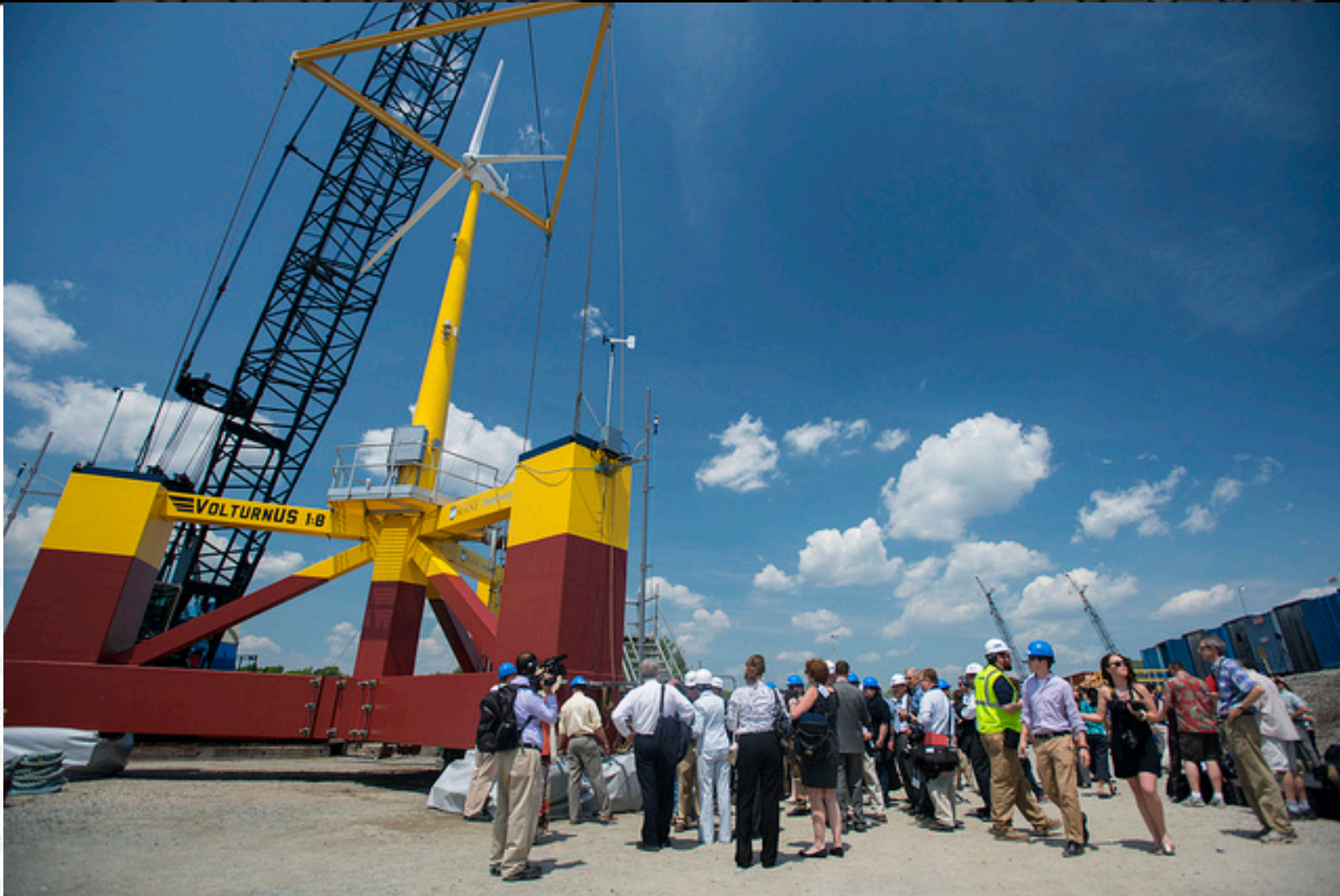
Source: NREL data

US Offshore Wind Projects



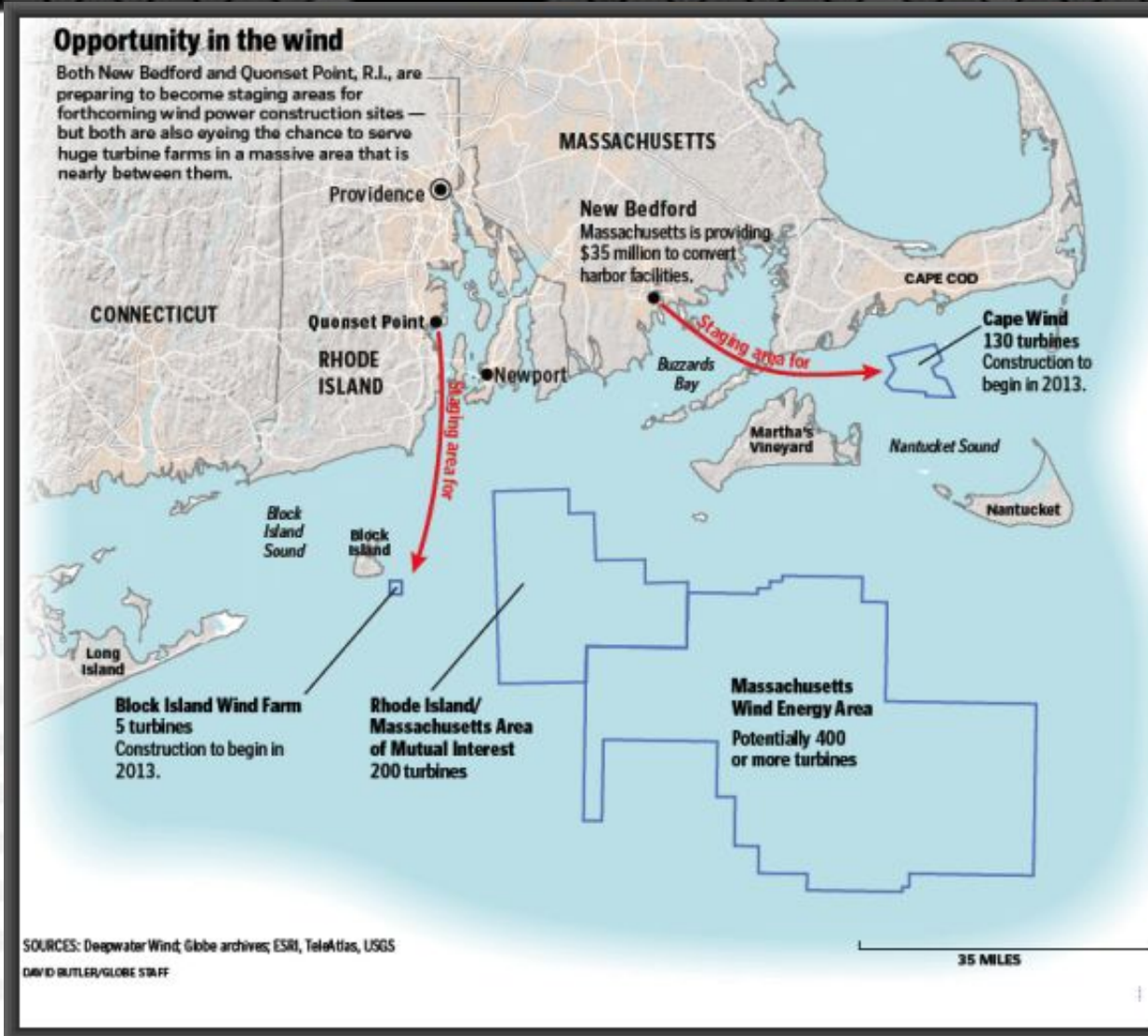
http://www1.eere.energy.gov/wind/pdfs/offshore_wind_market_and_economic_analysis_10_2013.pdf

Aqua Ventus, Monhegan Island, Maine



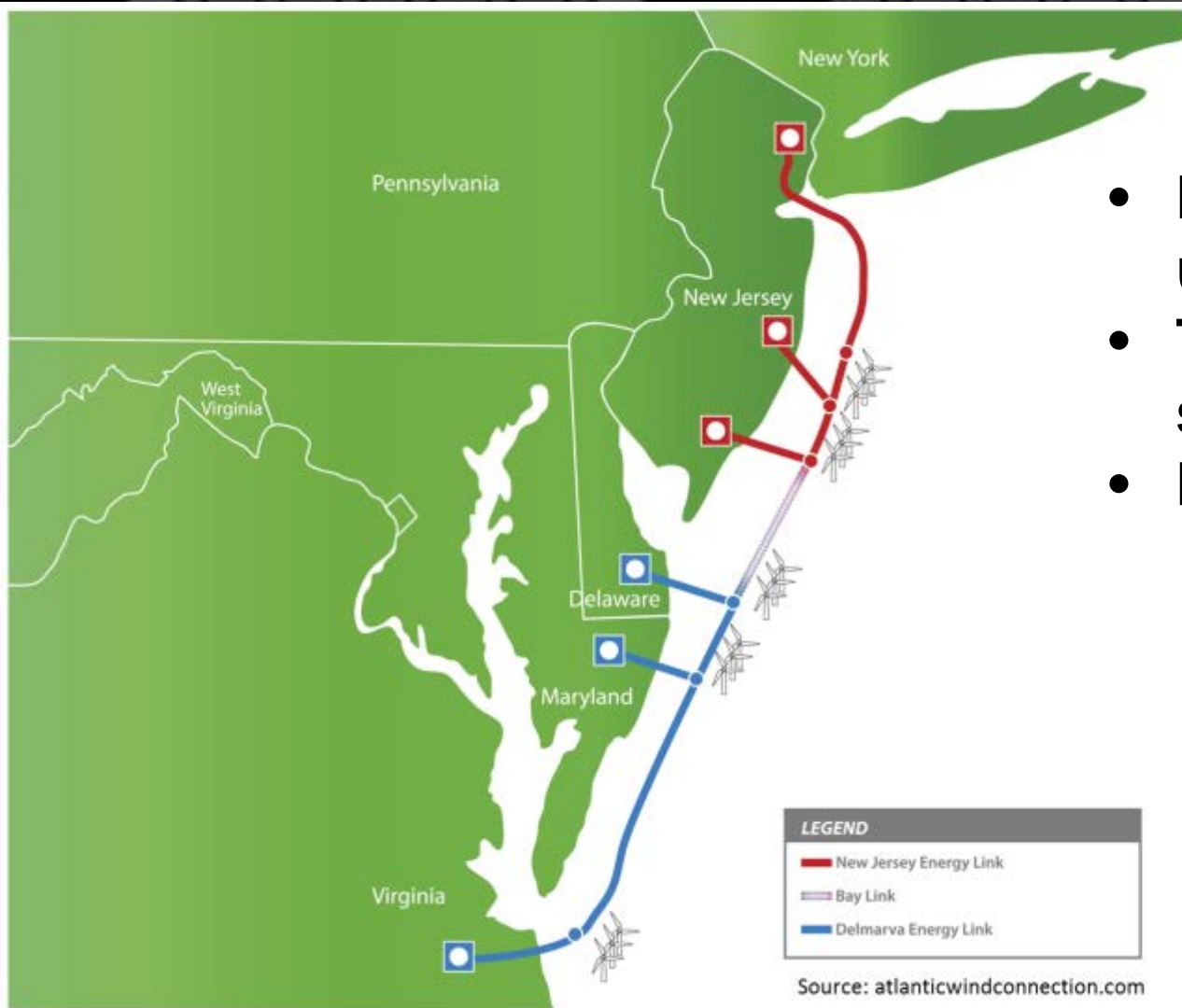
<https://umaine.edu/news/blog/2013/05/30/the-launch-of-volturnus-18/>

Commercial Offshore Wind Development



<http://www.fishingunited.com/forum/viewtopic.php?t=12516>

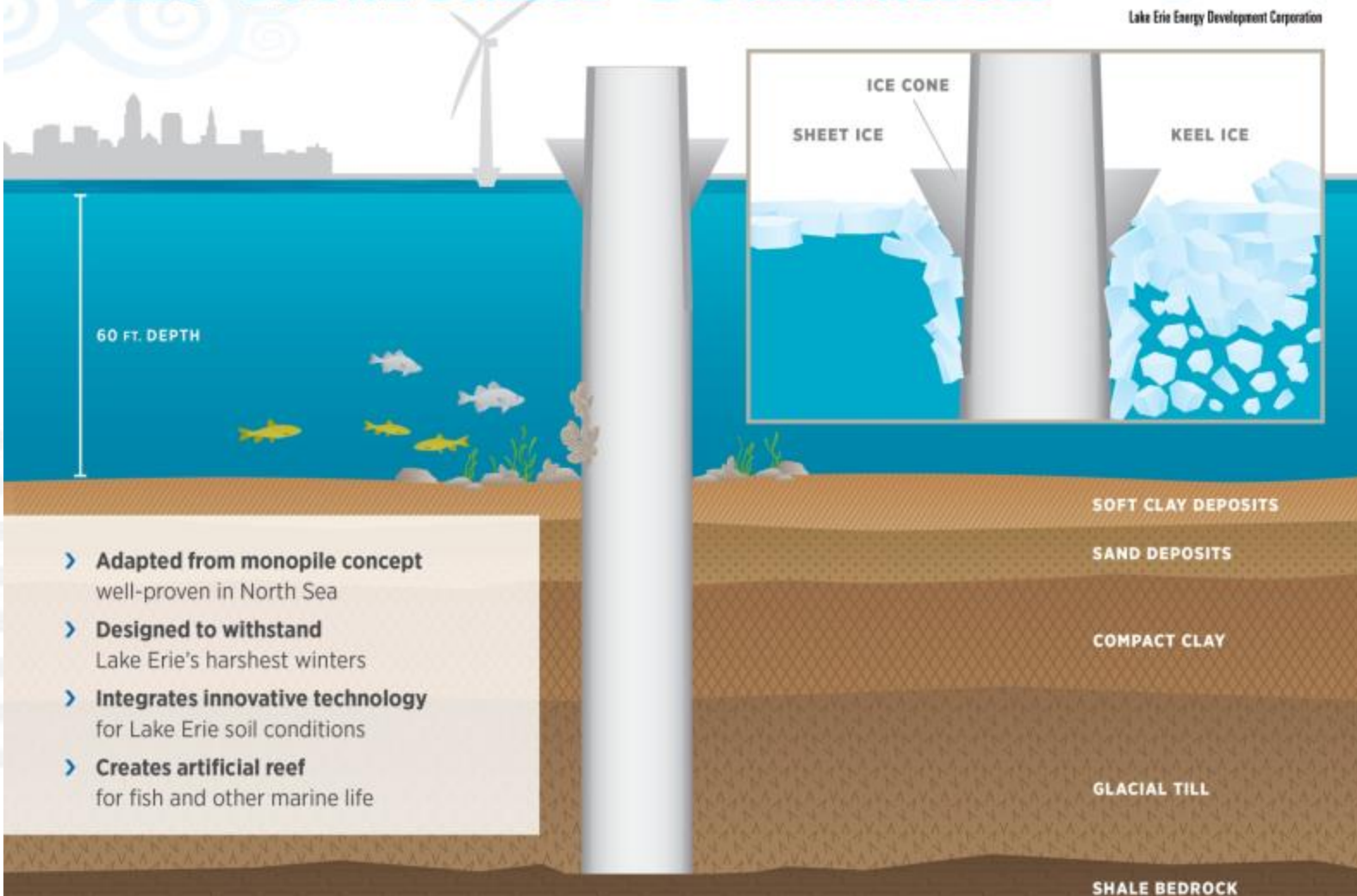
Atlantic Wind Connection



- HVDC network using VSC
- To be built in 3 stages
- Has FERC approval

Project Icebreaker, Lake Erie

The 'Icebreaker' Foundation



- › Adapted from monopile concept well-proven in North Sea
- › Designed to withstand Lake Erie's harshest winters
- › Integrates innovative technology for Lake Erie soil conditions
- › Creates artificial reef for fish and other marine life

<http://www.leedco.org/>

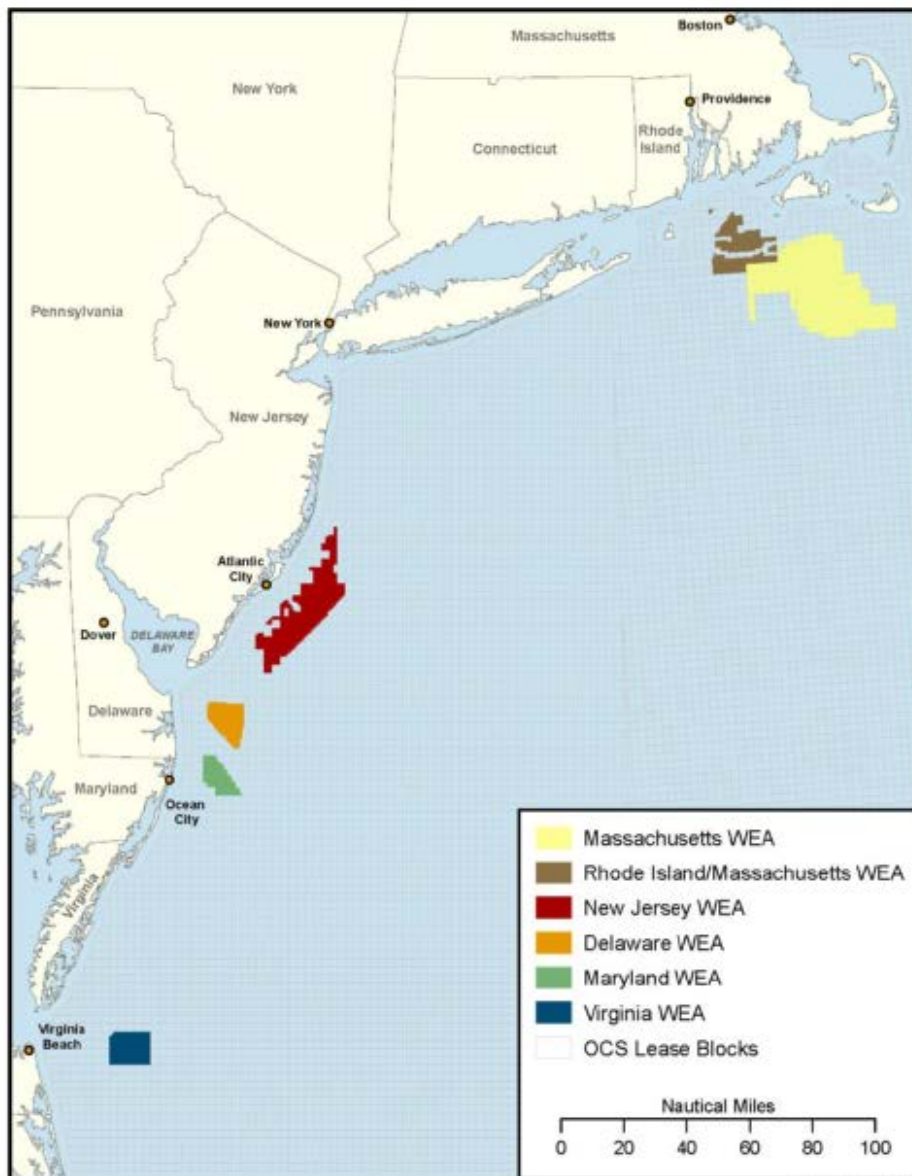
US Gulf Coast natural gas price



Source: EIA

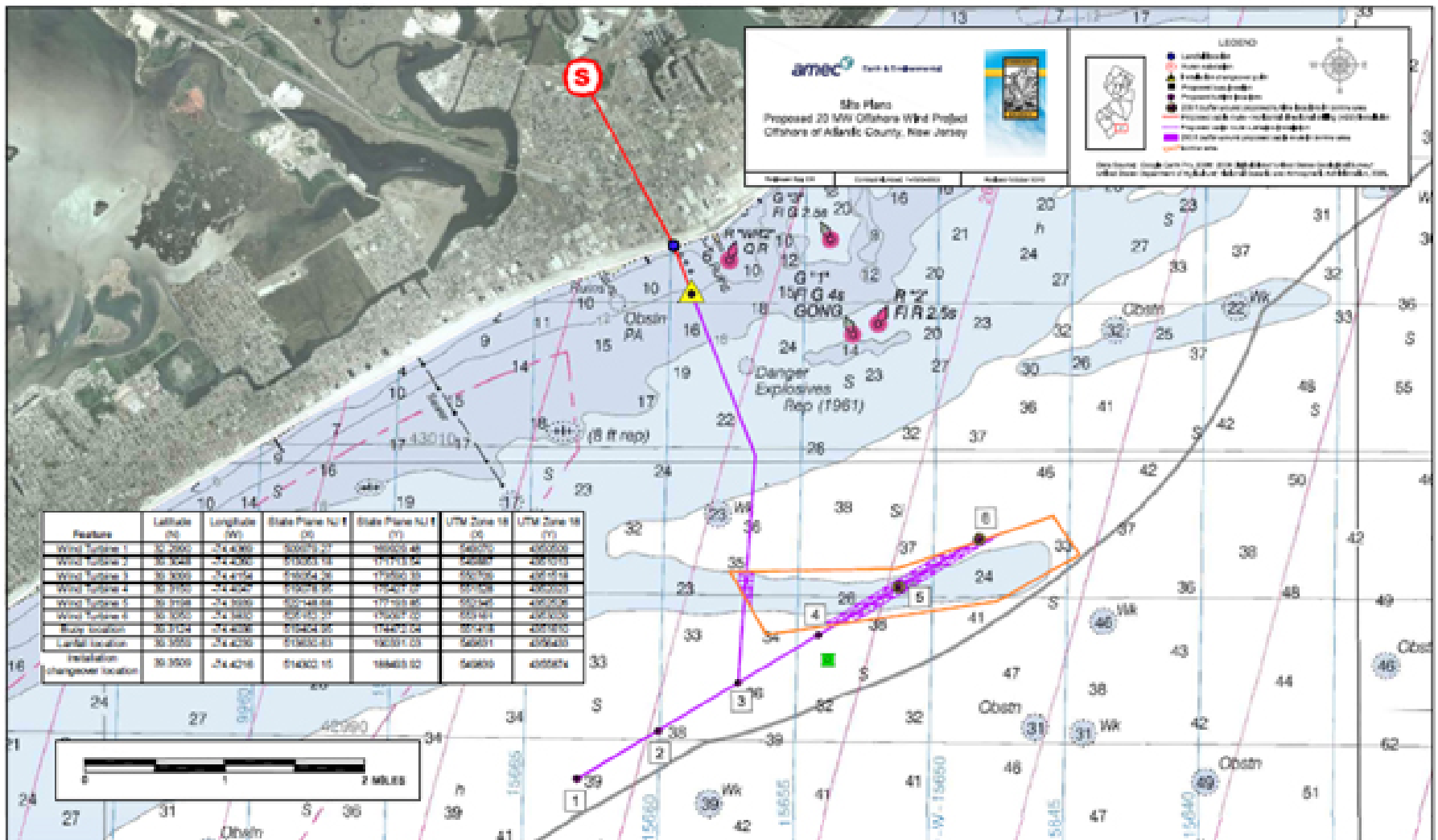
Questions?

Mid-Atlantic wind lease areas



- Bureau of Ocean Energy Management lease areas
- Deepwater Wind leased 2 tracts in brown area
- Dominion Power leased 1 tract in blue area.

Fisherman's Energy, Atlantic City, New Jersey

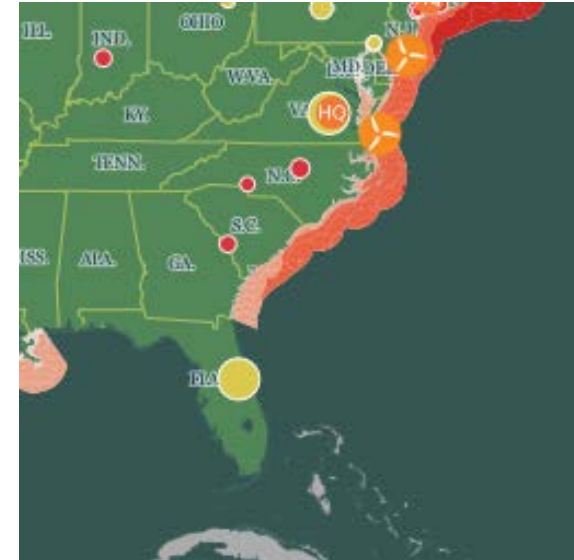


<http://www.fishermensenergy.com/atlantic-city-windfarm.php>

Virginia Offshore Wind Technology Advancement Project



<https://www.dom.com/about/stations/renewable/vowtap.jsp>



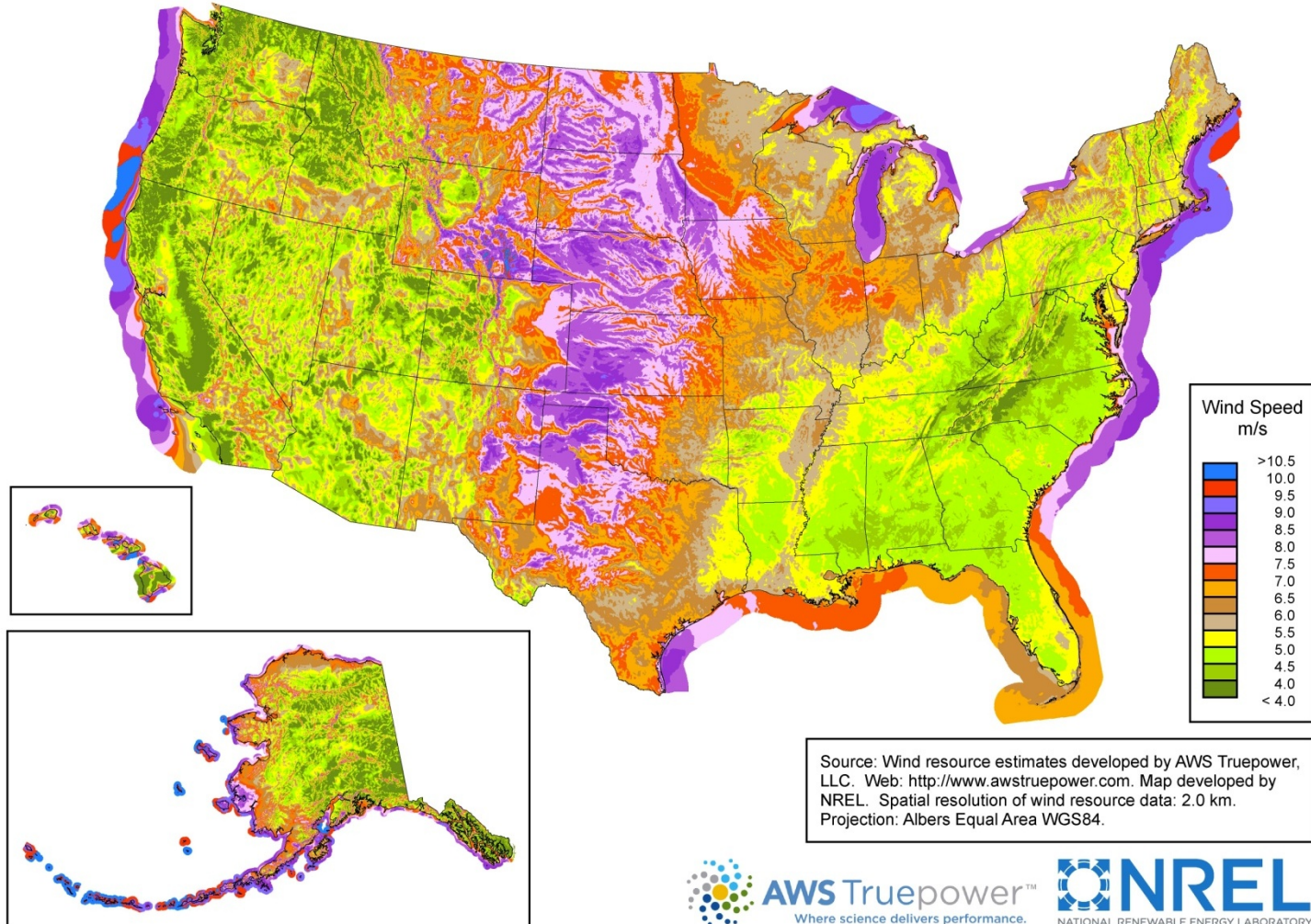
Aqua Ventus, Monhegan Island, Maine



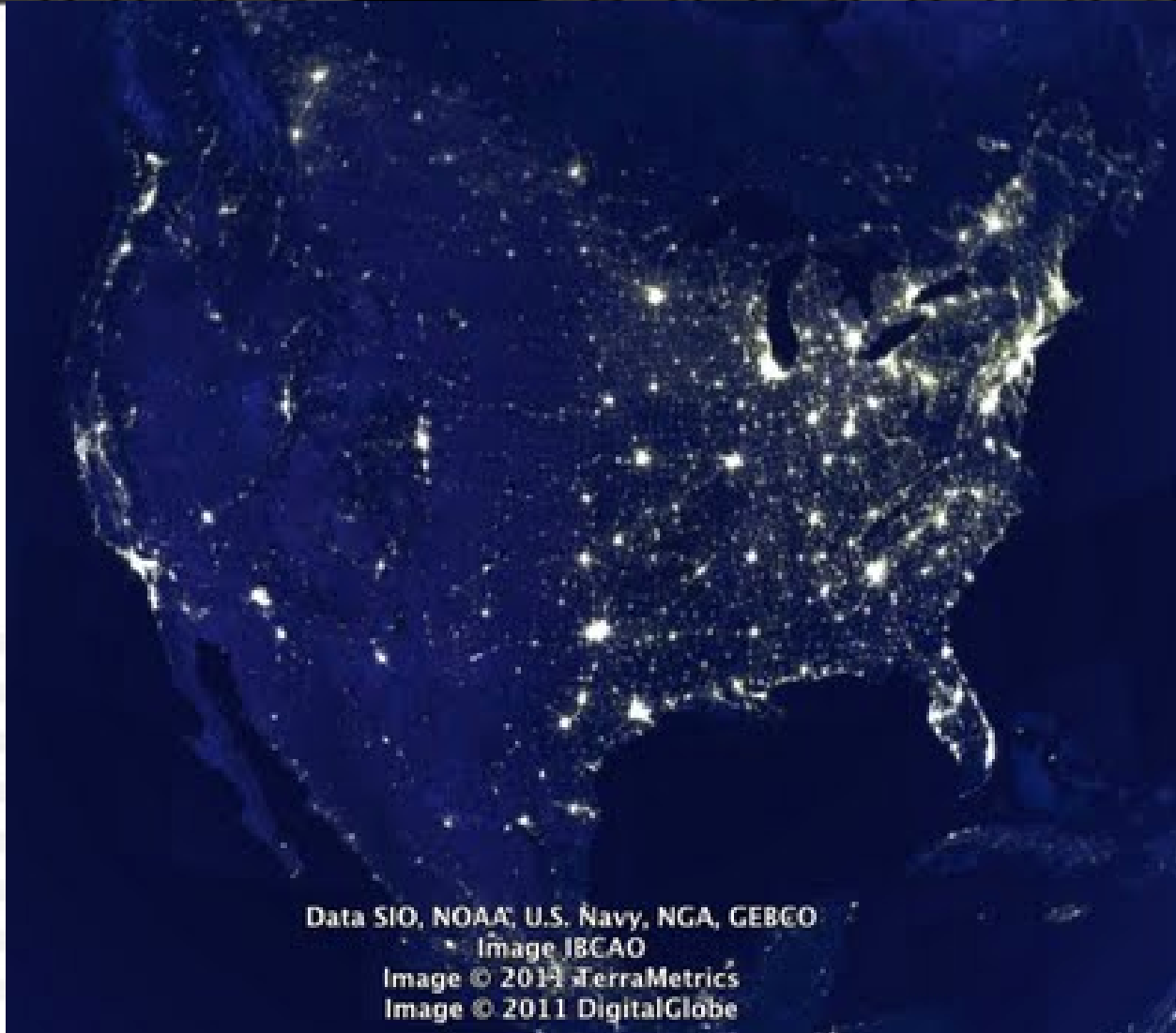
<http://www.cianbro.com/ProjectsMarkets/PowerGenerationEnergy/VolturnUS18FloatingOffshoreWindTurbine.aspx>

United States Wind Resources

United States - Land-Based and Offshore Annual Average Wind Speed at 80 m



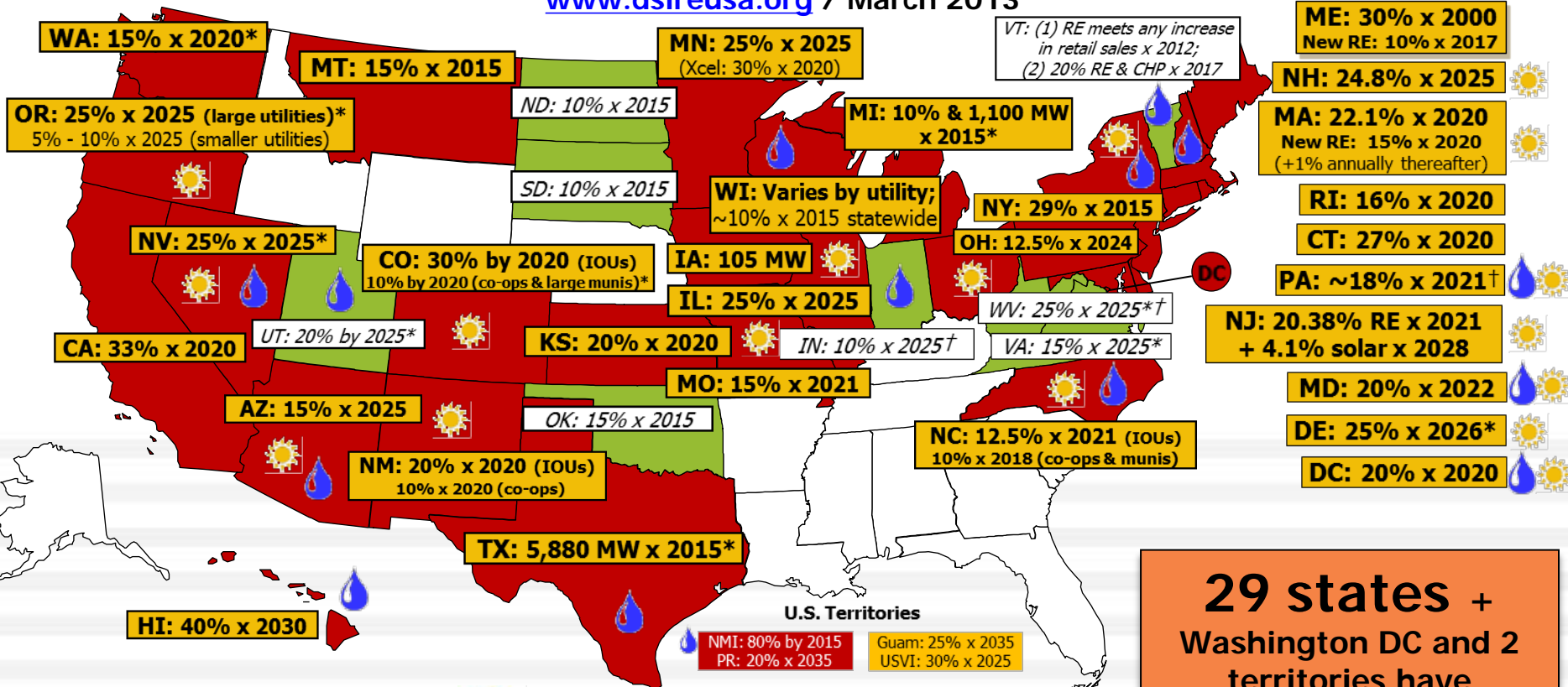
North American electric load



US Renewable Portfolio Standard

Renewable Portfolio Standard Policies

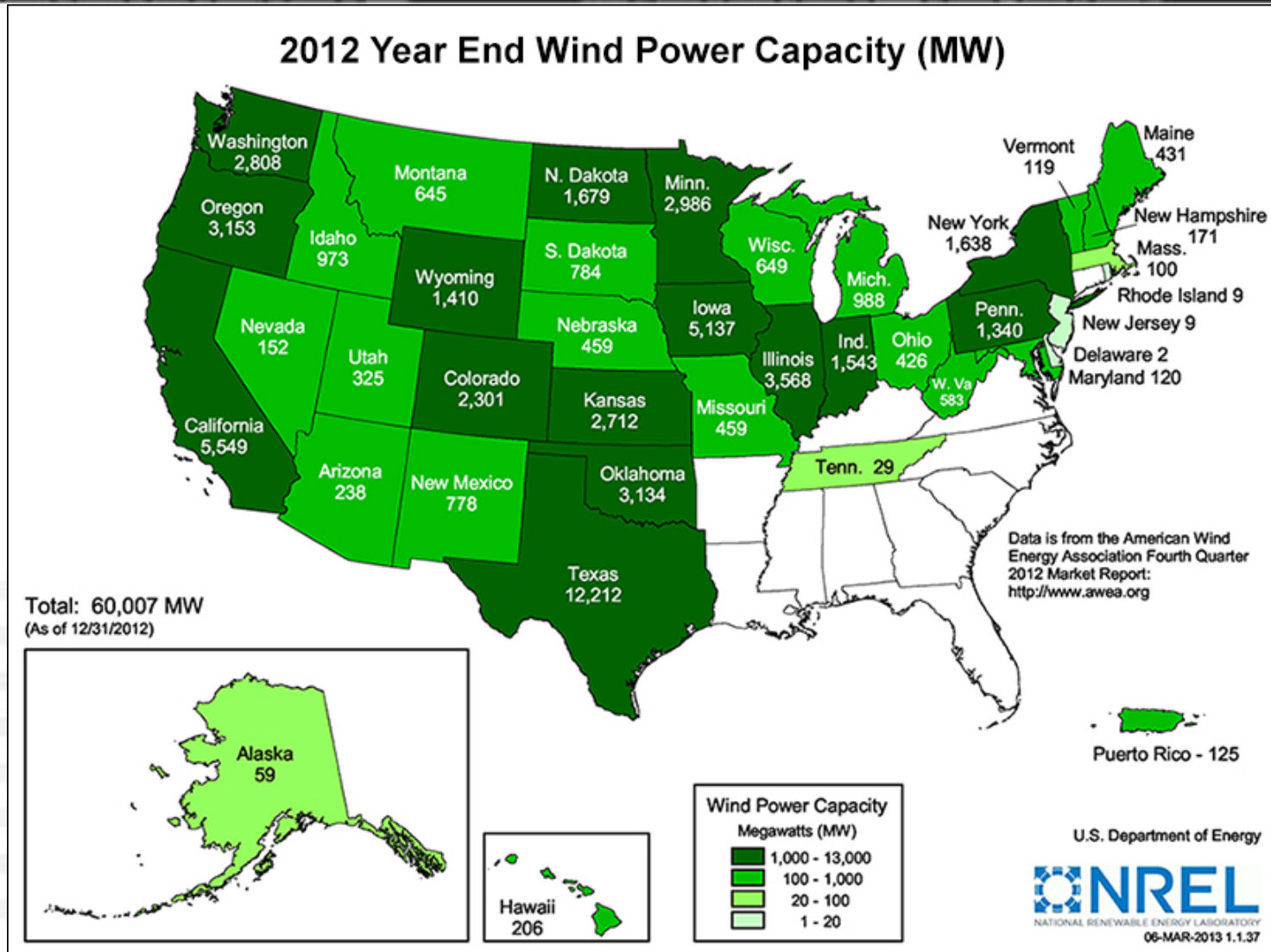
www.dsireusa.org / March 2013



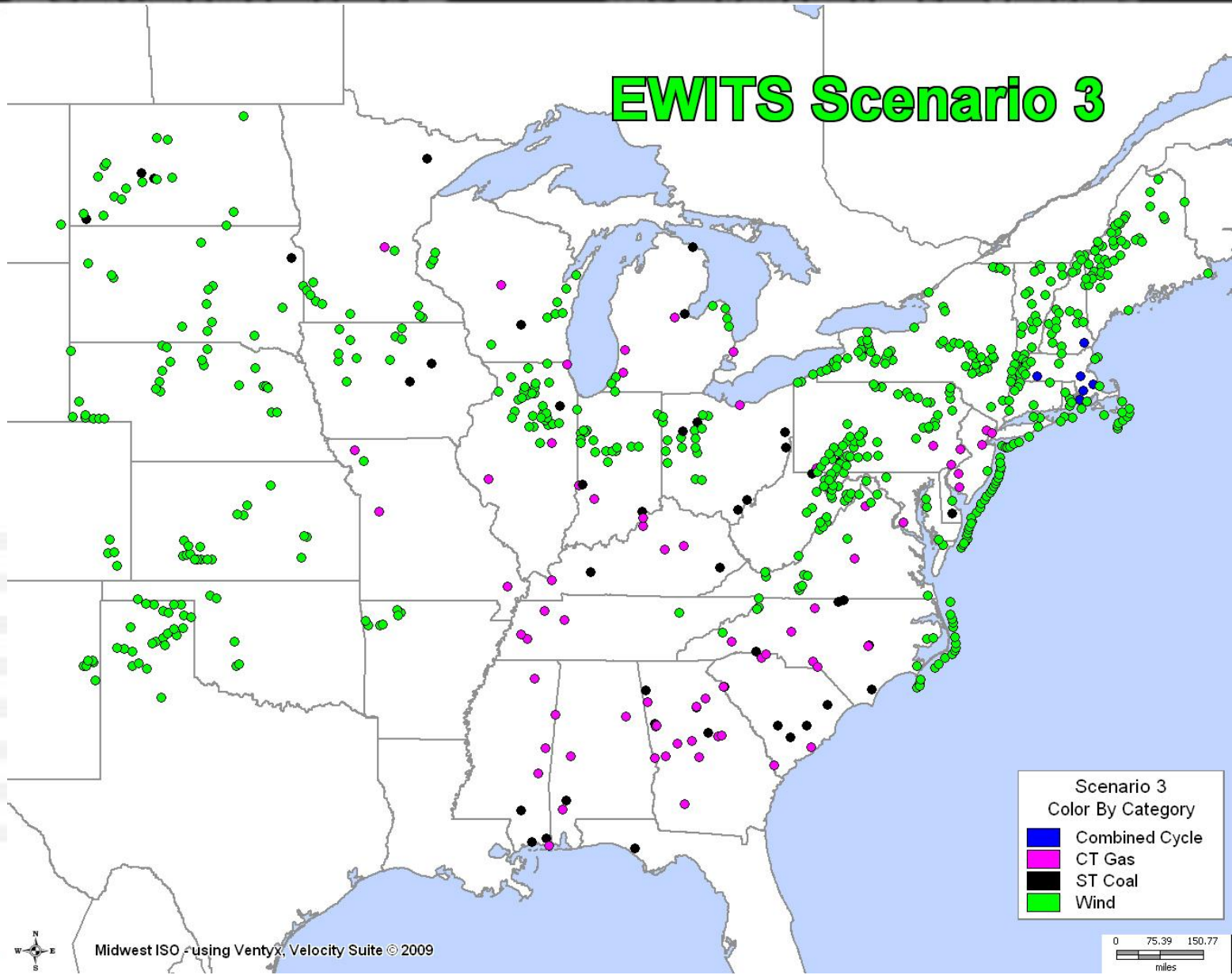
- Renewable portfolio standard
- Renewable portfolio goal
- 💧 Solar water heating eligible
- ☀️ Minimum solar or customer-sited requirement
- ✳️ Extra credit for solar or customer-sited renewables
- † Includes non-renewable alternative resources

29 states + Washington DC and 2 territories have Renewable Portfolio Standards
(8 states and 2 territories have renewable portfolio goals).

US Wind Capacity by State



EWITS Scenario 3 Generation Siting



http://www.nrel.gov/electricity/transmission/eastern_renewable.html

Challenges

- Costs
- Regulatory process – leases, permits
- Logistics – lack of ports and ships
- Transmission infrastructure

US Department of Energy

U.S. DEPARTMENT OF
ENERGY | Energy Efficiency &
Renewable Energy

Wind Program

HOME

ABOUT

RESEARCH &
DEVELOPMENT

DEPLOYMENT

FINANCIAL
OPPORTUNITIES

INFORMATION
RESOURCES

[EERE](#) » Wind Program

The Wind Program leads the nation's efforts to improve the performance, lower the costs, and accelerate the deployment of wind power technologies.

New Report on Record Wind Growth in U.S.

The Wind Program released the Wind Technologies Market Report, showcasing the rapid growth and development of the wind industry in 2012. 

▲
New Report Shows Trend
Toward Larger Offshore
Wind Systems

New Report Released on
Wind Integration

New Report on Record
Wind Growth in U.S.

▼
Distributed Wind Market
Report Released

Off Shore Demonstration Projects

<http://www1.eere.energy.gov/wind/index.html>

Statoil, Boothbay Harbor, Maine



<http://www.renewbl.com/2011/06/28/statoil-selling-onshore-wind-assets-in-norway-moves-focus-on-offshore-wind.html>

GOWind, Gulf of Mexico, Texas



<http://www.baryonyxcorp.com/>

Lake Eire Project



Wind Float, Coos Bay, Oregon



Aguçadoura WindFloat Prototype
October 2011 - Sado River near Setubal, Portugal



https://www.facebook.com/principlepower/photos_stream

Coos Bay Project



Other Offshore Projects

Galveston Offshore Wind (Costal Energy)

Boothbay Harbor, Maine project

