

VCERC Offshore Wind Studies: Key Findings and the Next Big Step

Virginia Commission on Energy and Environment

Richmond, VA

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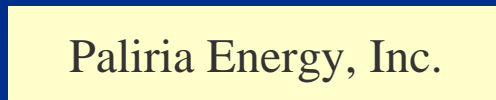
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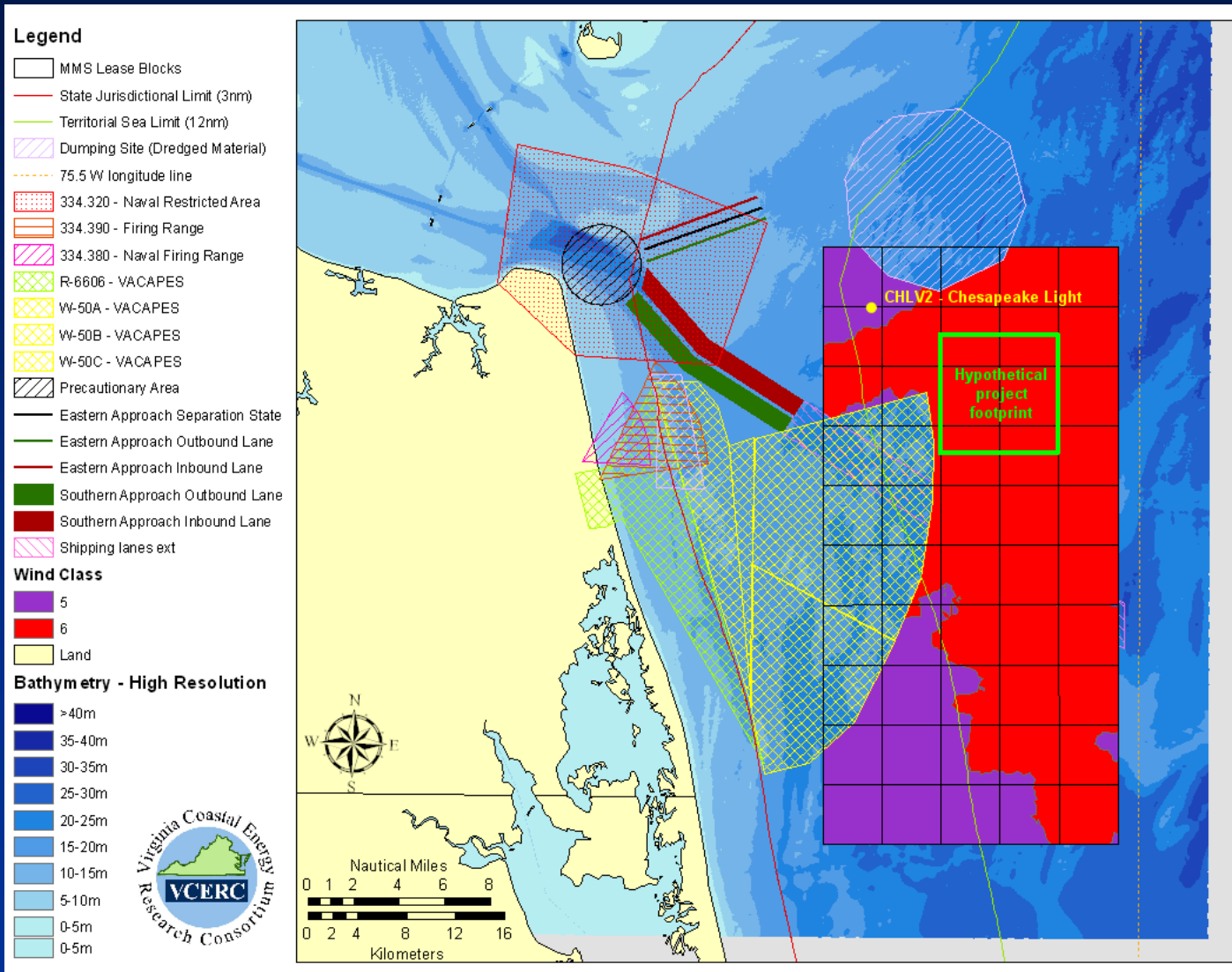
Initial VCERC Projects

Funded by State Budget in FY2007-08



1. **Feasibility-level design and economic assessment**
for a hypothetical reference baseline offshore wind power project
2. **Preliminary mapping of offshore areas**
suitable for offshore wind power development, with identification of military training areas, shipping lanes, commercial fishing grounds, and marine and avian habitats
3. **Evaluation of economic development potential**
of commercial offshore wind power development and associated workforce training needs, and planning for an ocean test bed
4. **Feasibility-level design and economic assessment**
for an algae-to-biodiesel culture and processing system

VCERC Project 1: Feasibility-Level Design and Economic Assessment



VCERC Project 1: Feasibility-Level Design and Economic Assessment

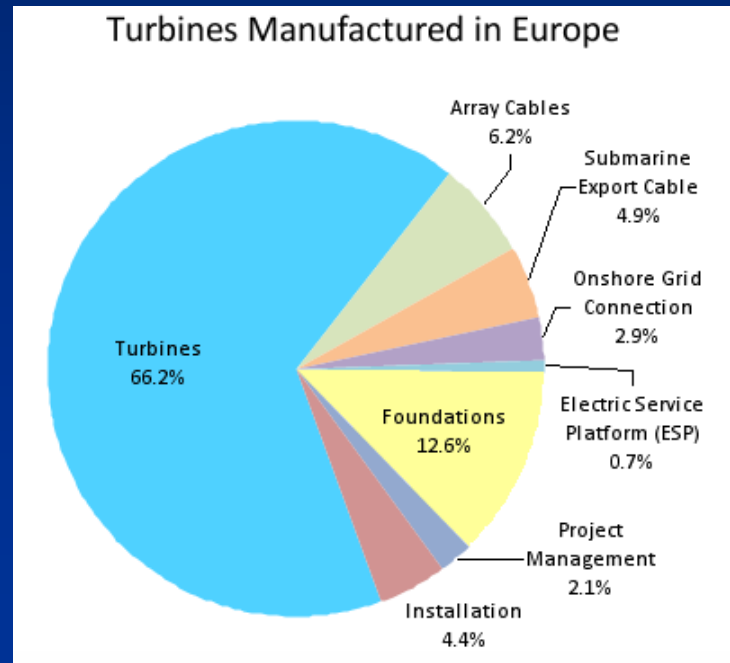
Capital cost estimated in March 2008 dollars using NREL parametric model for wind turbine & tower, Virginia maritime supplier bids for foundations & installation, and published data for balance of plant

- *Plant cost at offshore busbar : \$ 1,763 million*
- *Transmission cost to Fentress : \$ 153 million*
- *Total plant investment : \$ 1,916 million (~ \$3,260 / kW)*

588 MW installed
rated capacity
(7 x 7 turbines
per lease block)

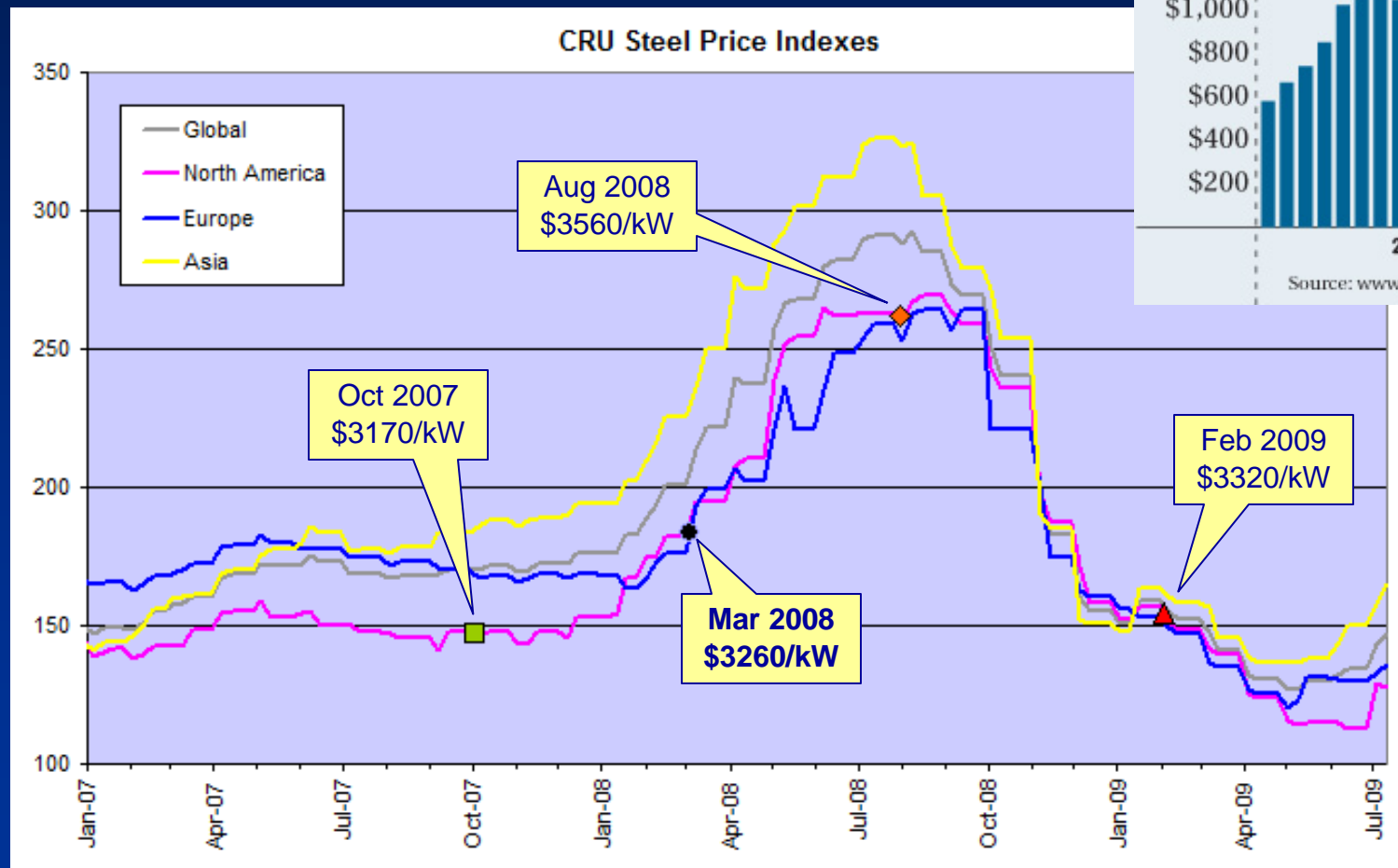
38% annual
capacity factor

20% PJM
capacity factor
(peak hours)



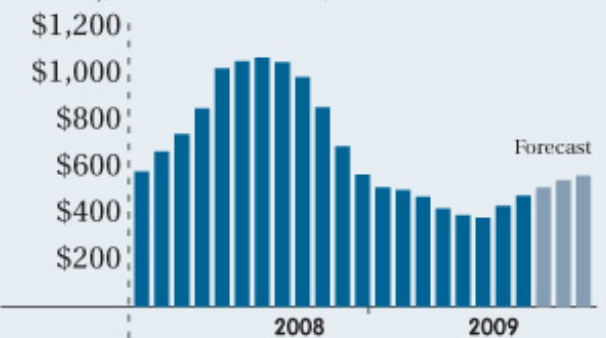
Steel Price History and Near-Term Forecast

Turbine, tower, and foundation supply contracts placed any time between mid-2007 and end-2009 for hypothetical 2012 in-service date would yield cost of ~ \$3,000 – \$3,600 per kW

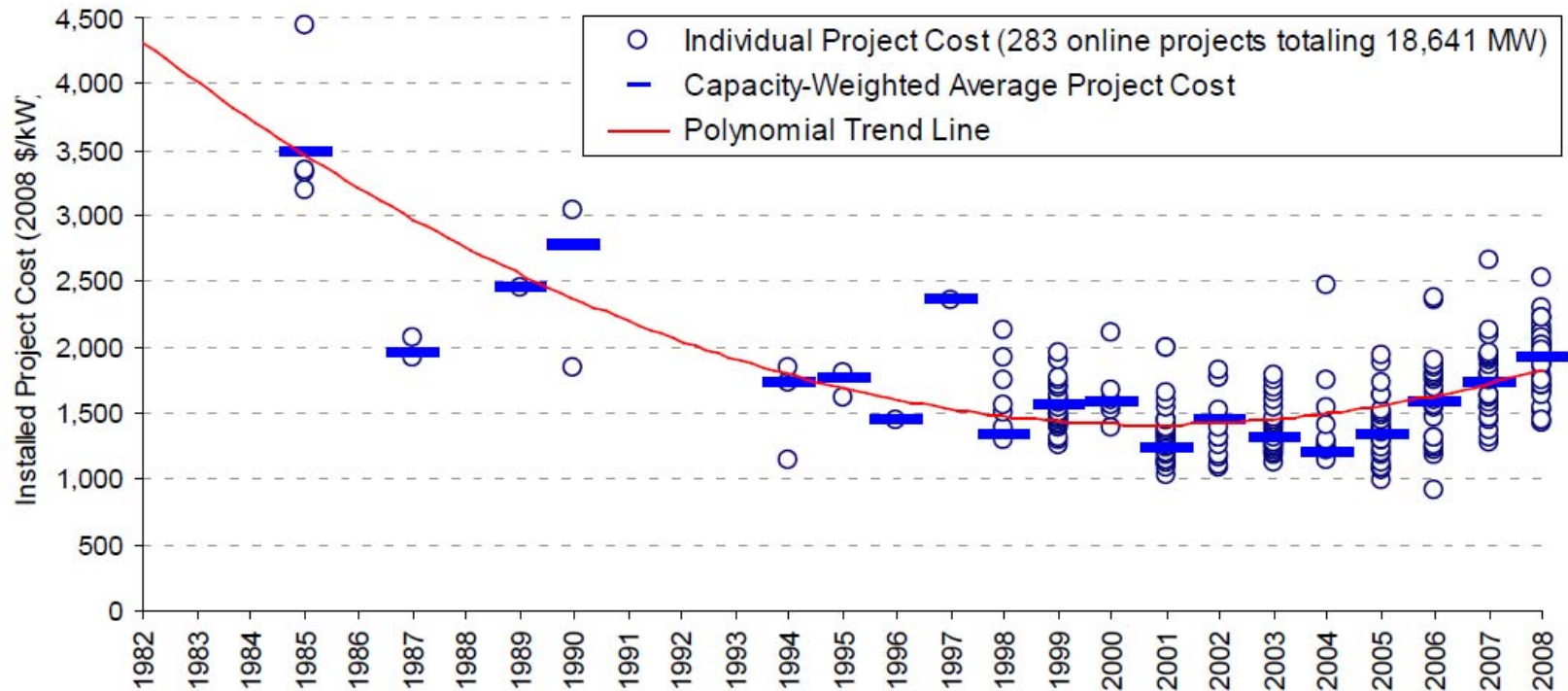


Steel sheet price rebound will be gradual

(monthly, hot-rolled steel sheet, \$/ton)



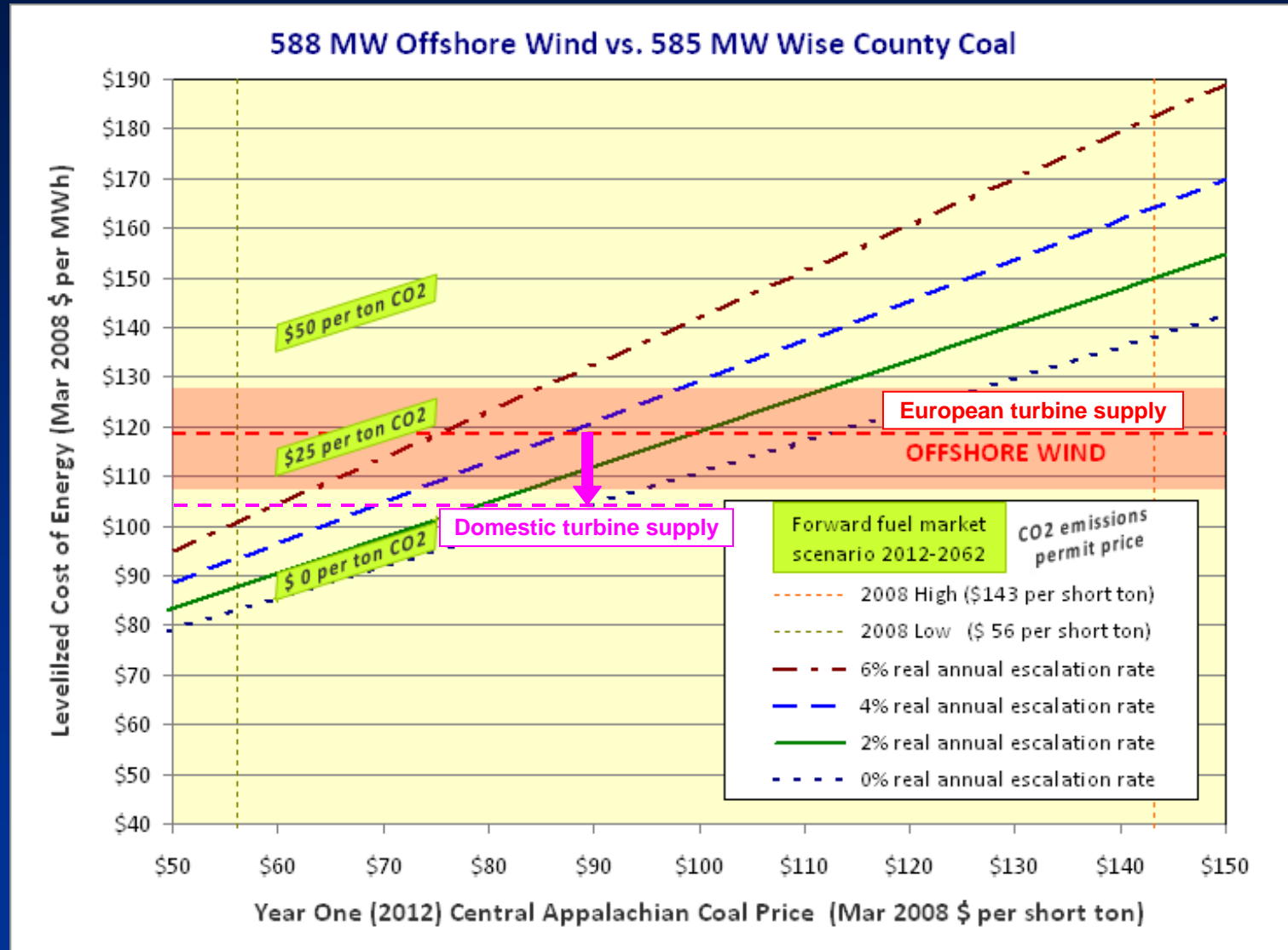
European and US Real Project Data Support VCERC Hypothetical Cost Estimate



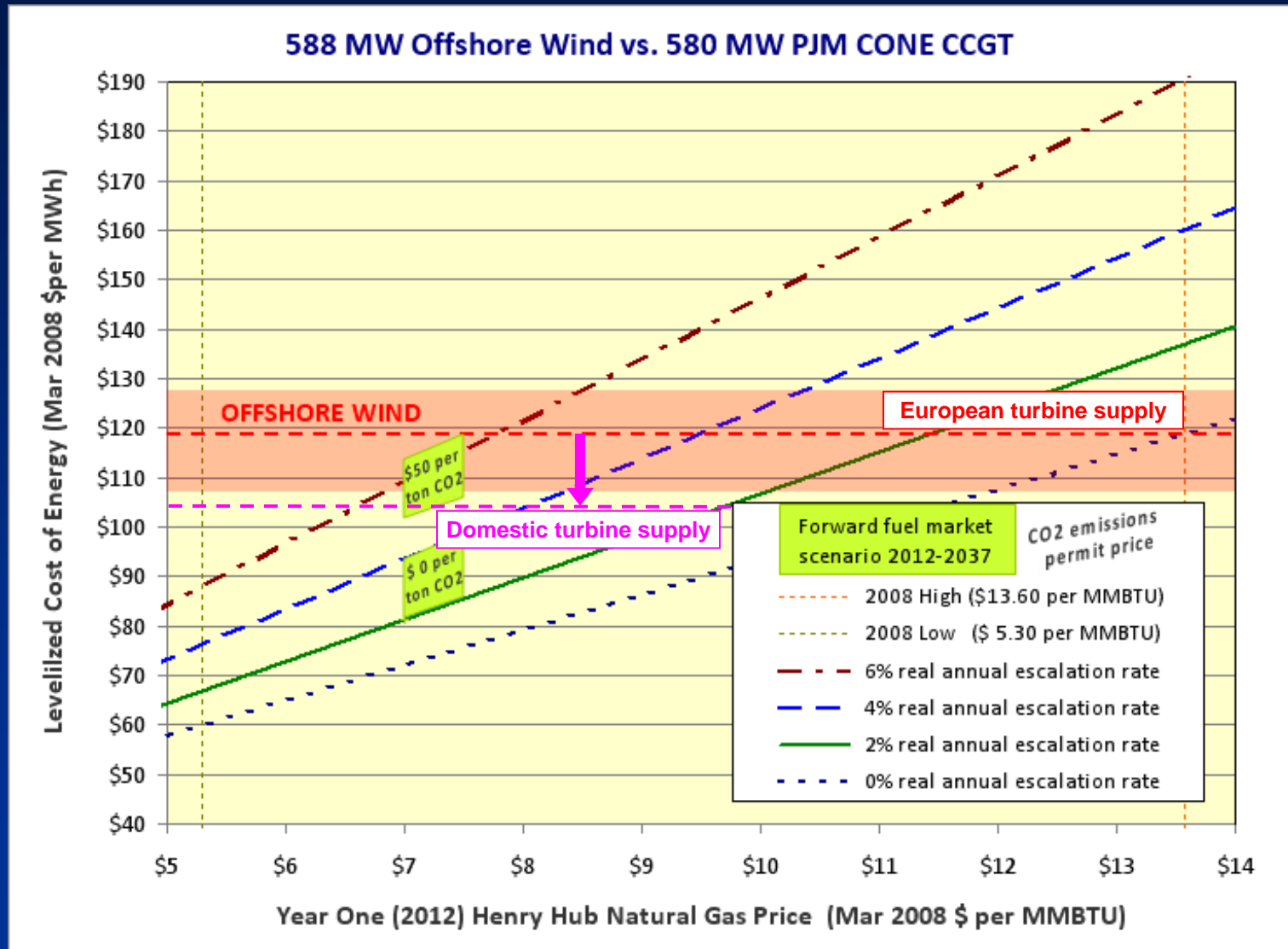
Source: Berkeley Lab database (some data points suppressed to protect confidentiality)

- Average cost of U.S. land-based wind projects in 2008: **\$1,915 / kW**
(above graph from <http://eetd.lbl.gov/EA/emp/reports/2008-wind-technologies.pdf>)
- Apply 1.75 average multiplier from ratio of European land-based and offshore project costs (see www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/Economics_of_Wind_Main_Report_FINAL-Ir.pdf for details)
- Estimated U.S. offshore project capital cost: **~\$3,350 / kW**

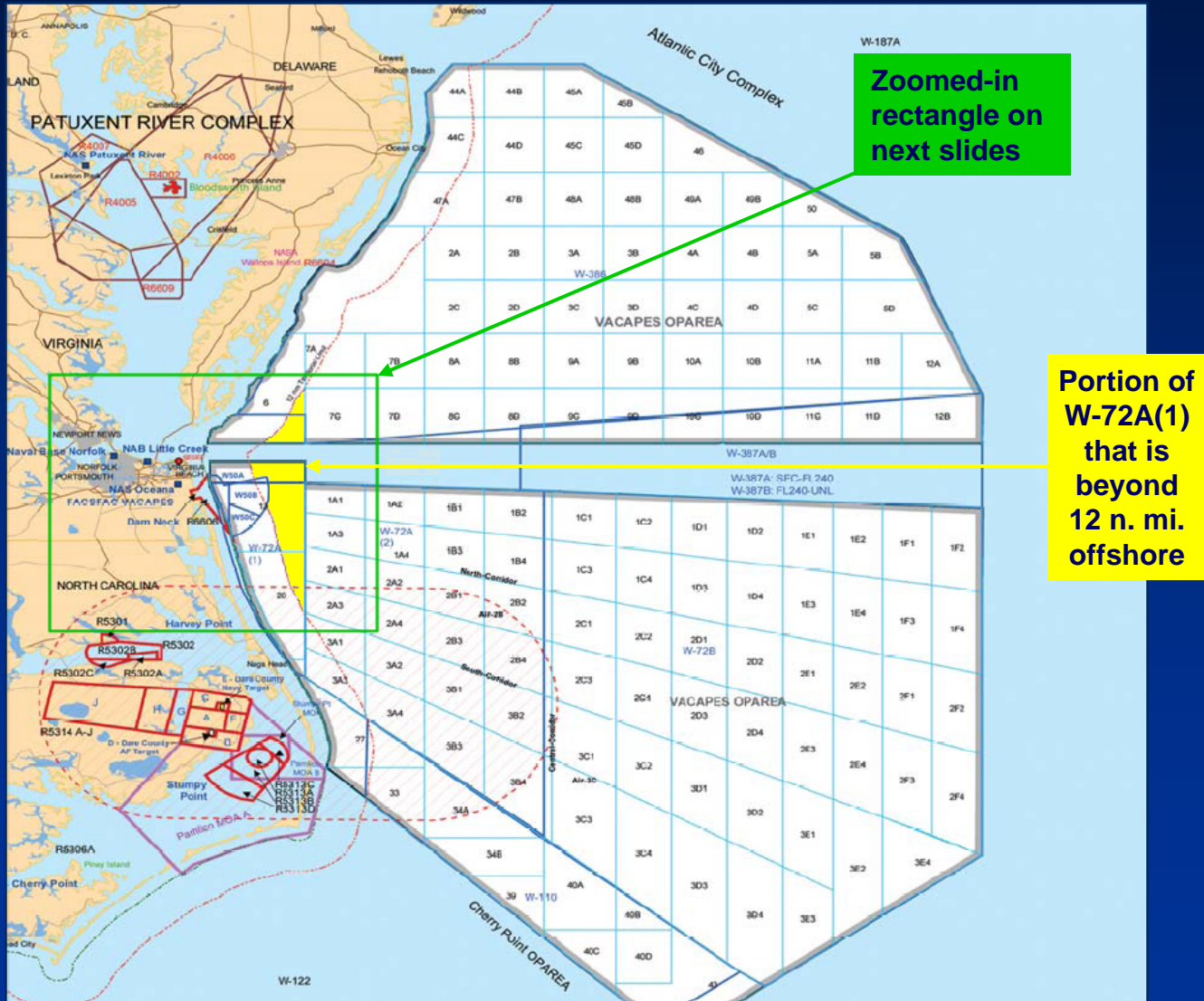
VCERC Project 1: Feasibility-Level Design and Economic Assessment



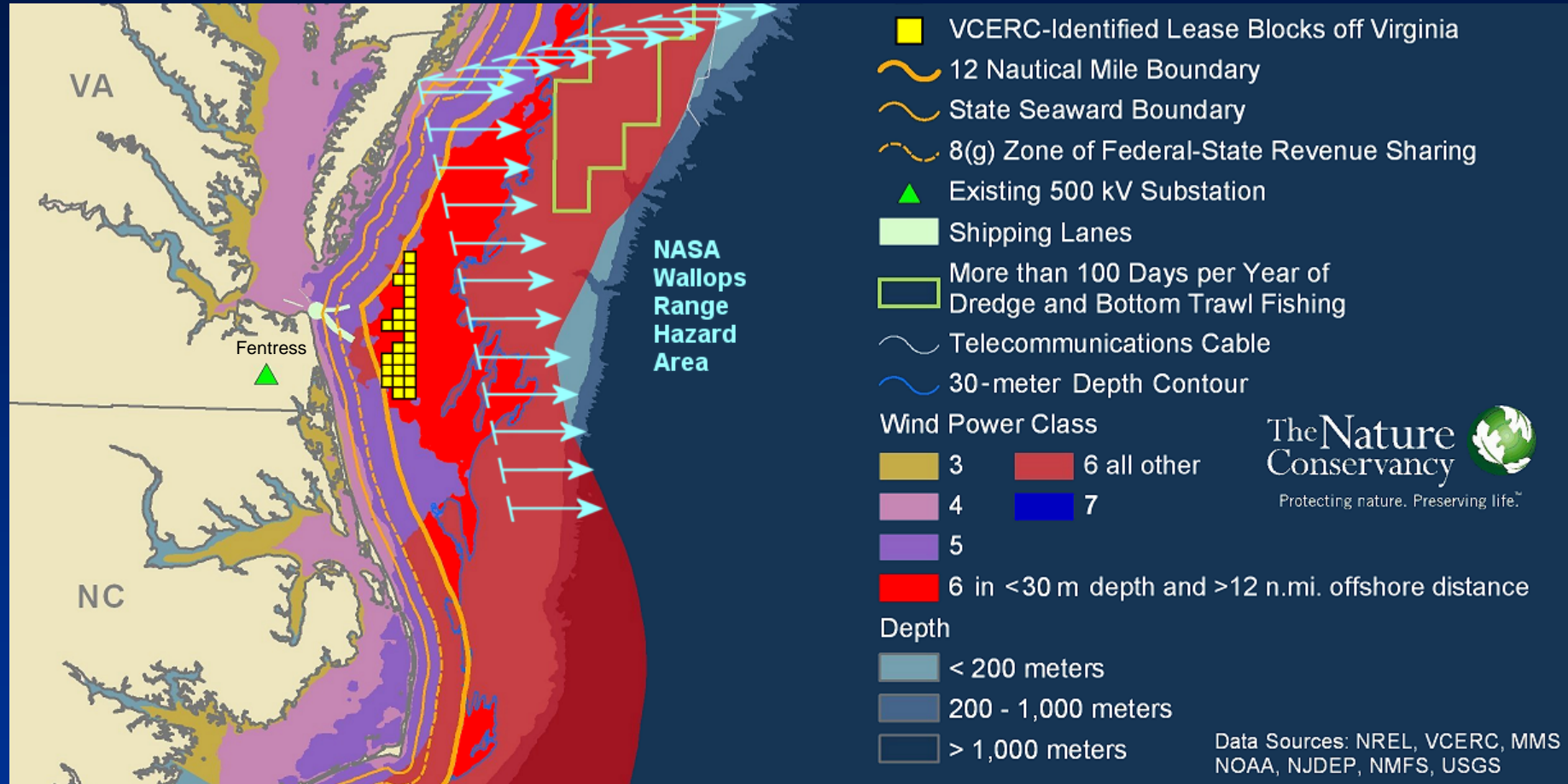
VCERC Project 1: Feasibility-Level Design and Economic Assessment



VCERC Project 2: Preliminary Mapping of Offshore Areas

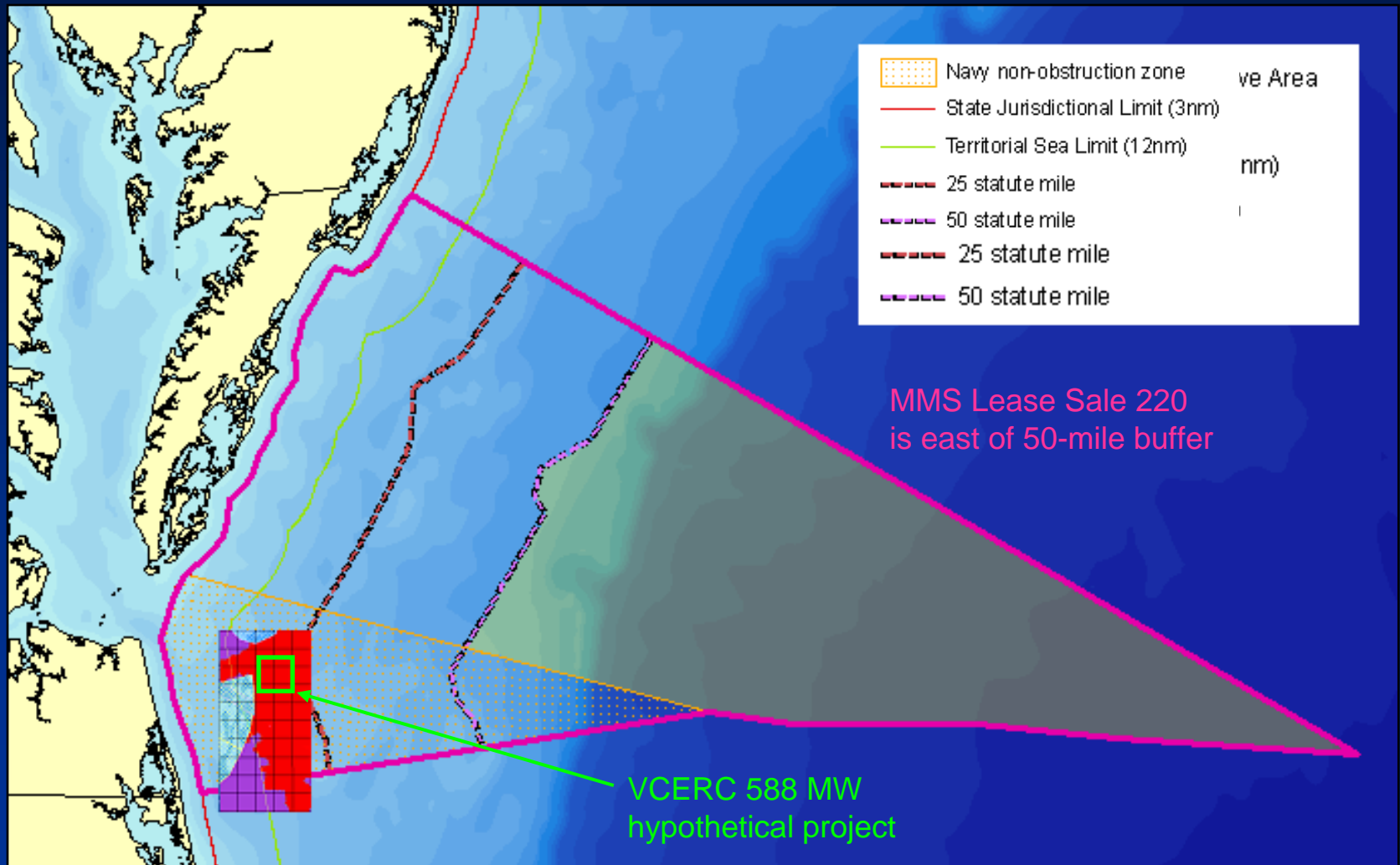


VCERC Project 2: Preliminary Mapping of Offshore Areas

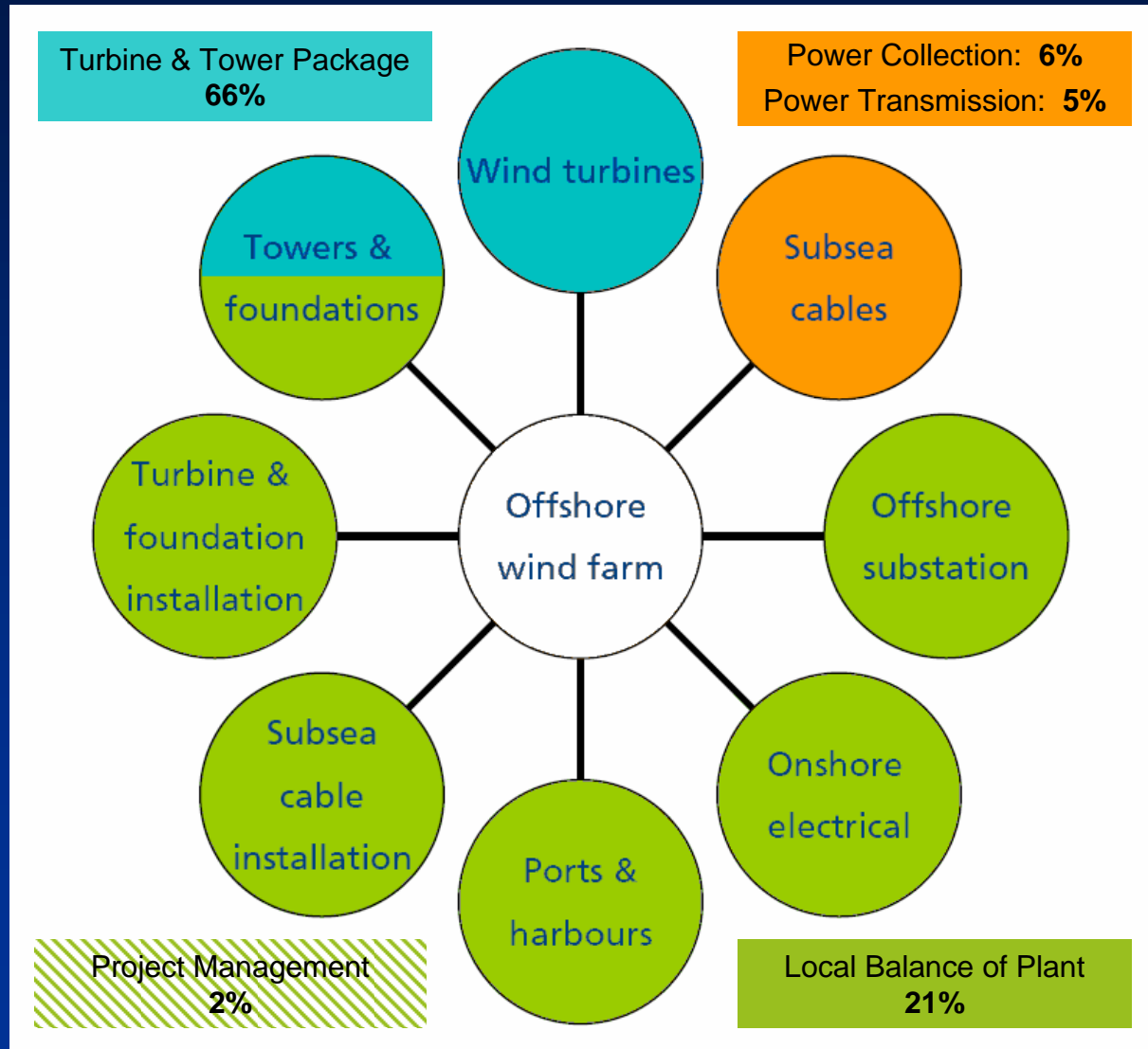


VCERC identified 25 MMS lease blocks that would not conflict with existing uses by the Navy, NASA-Wallops, commercial shipping, or commercial fishing. These are all beyond 12 nautical miles offshore with minimal visual impact, and in water depths less than 100 ft, capable of supporting 3,200 MW of offshore wind capacity generating 11 TWh per year.

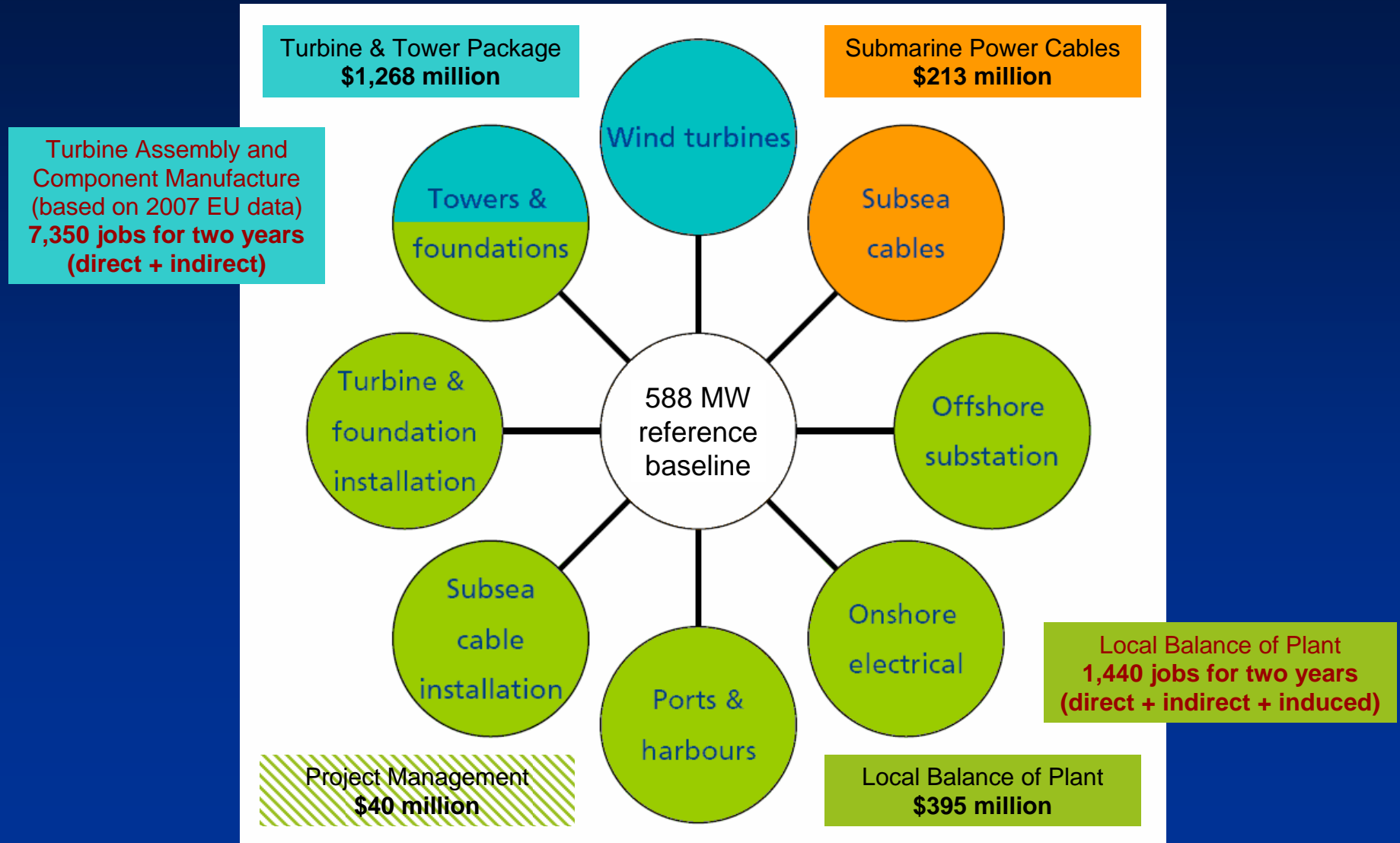
VCERC Project 2: Preliminary Mapping of Offshore Areas



VCERC Project 3: Evaluation of Economic Development Potential



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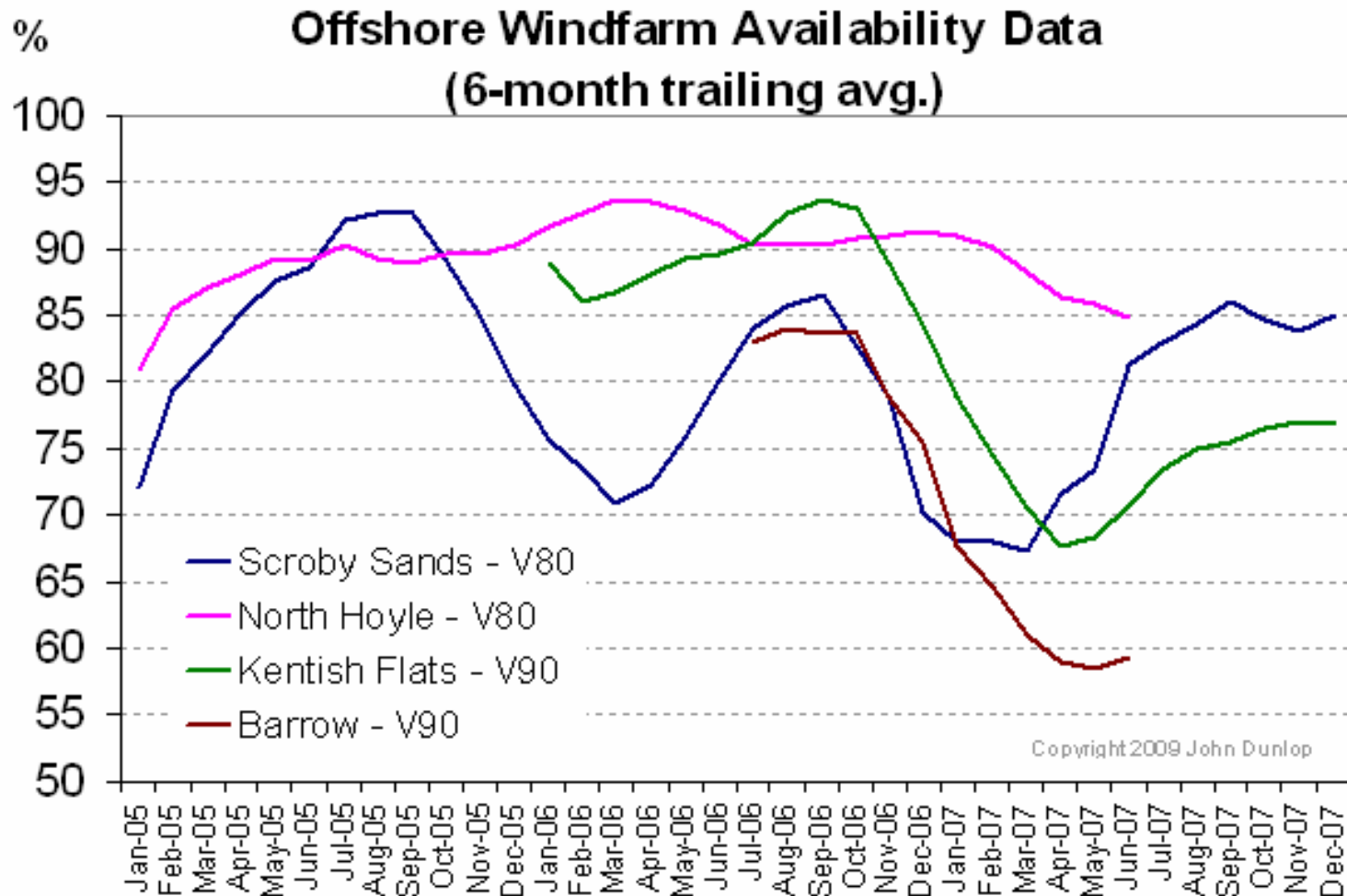
Virginia Offshore Wind Development Authority Established to Provide Enabling Infrastructure



Before making a **~\$2 billion investment** (as would be needed for a 600 MW project in federal waters) or a **\$500 million investment** in a Hampton Roads turbine manufacturing complex, ***full-scale offshore testing must be done*** (costing **\$60-75 million** over 5 yrs)



Reliability of Turbines Needs to be Proven in Full-Scale Demonstration Project



Navy and DoD Issues also can be Addressed by Full-Scale Demonstration

Offshore wind power represents the single largest renewable energy resource available to DoD facilities on the U.S. eastern seaboard

Can make a substantial contribution towards DoD goal of achieving training range sustainability and meeting SecNav 50% renewable energy 2025 goal

Need to qualify wind turbines for use in VACAPES, and a full-scale turbine demonstration project in state waters would be a key first step

DoD would benefit from a full-scale demonstration with a large-diameter turbine rotor at a location with potential exposure to a variety of radars



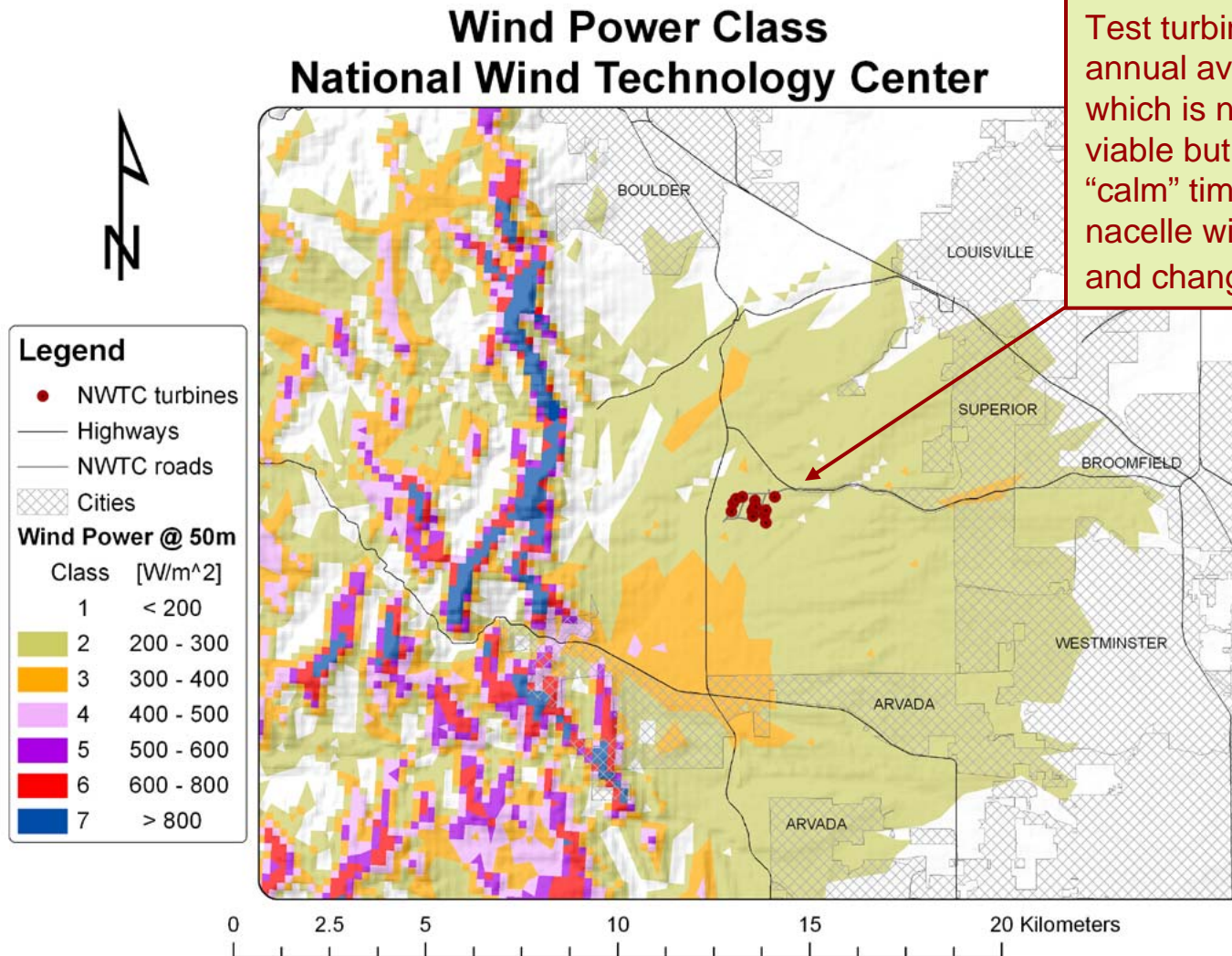
Full-scale Doppler measurements to feed into numerical simulations of radar signatures for large offshore projects

Demonstrate mitigation technologies (coatings, radar-trapping blade laminate construction)

Such qualification would have NWS, FAA, DHS, and DoD-wide (not just Navy) implications

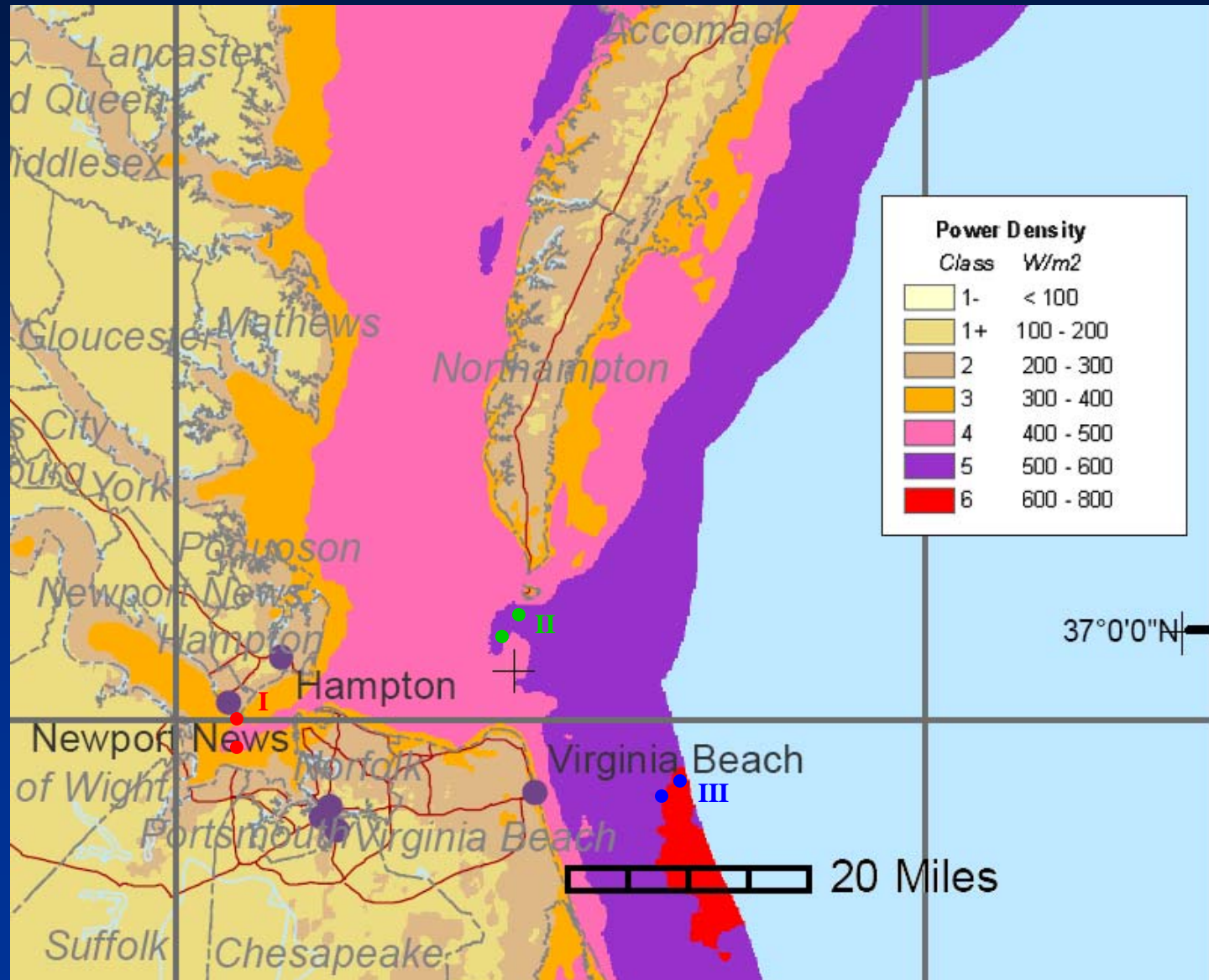
Next Step: Hampton Roads NOWTC

Similar to National Wind Test Center in Colorado

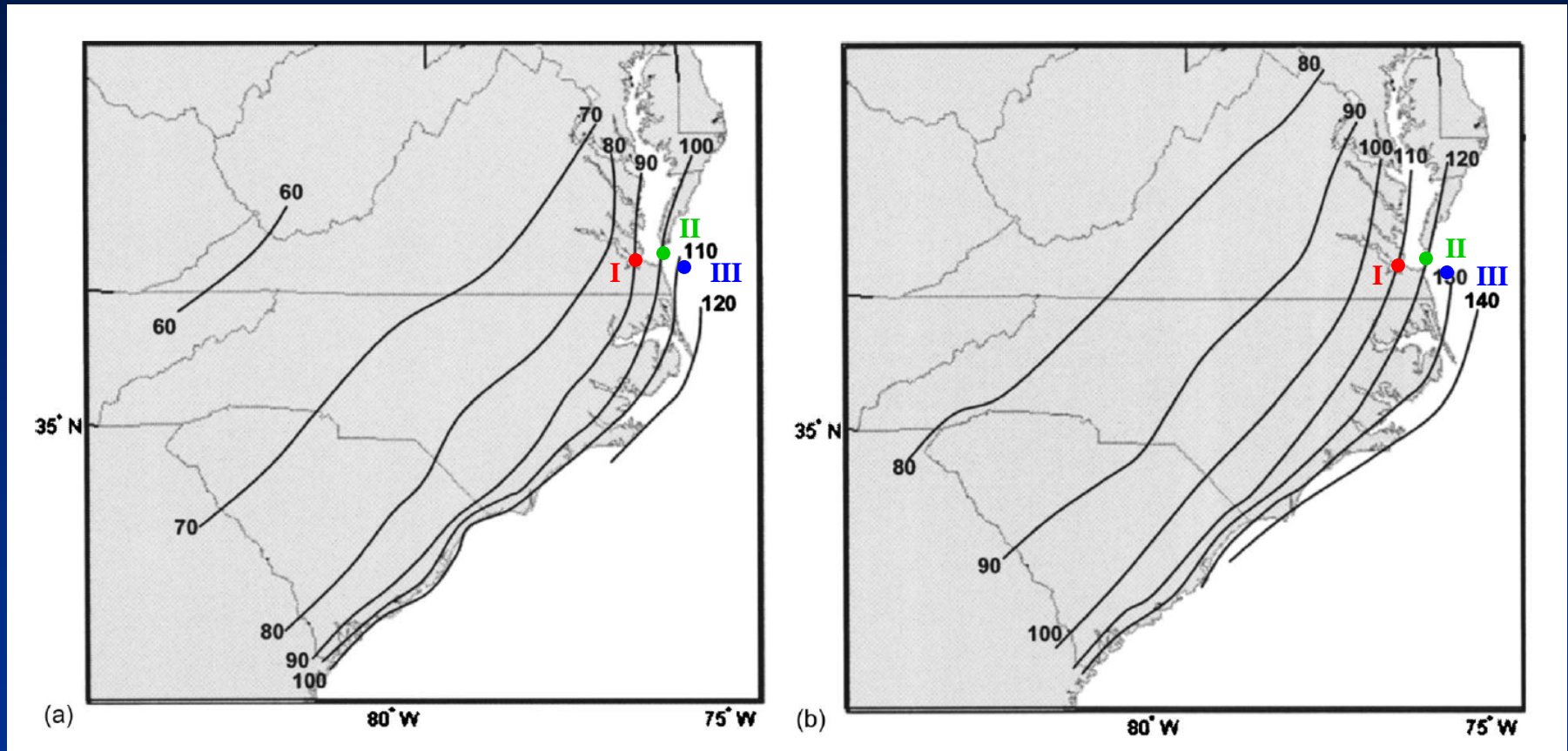


Test turbines are in Class 2 annual average wind resource, which is not commercially viable but provides sufficient “calm” time for accessing nacelle with test equipment and changing components

Virginia Concept for Staged NOWTC with Progressively More Energetic Wind Resources



Virginia Concept for Staged NOWTC with Progressively More Extreme Storm Conditions

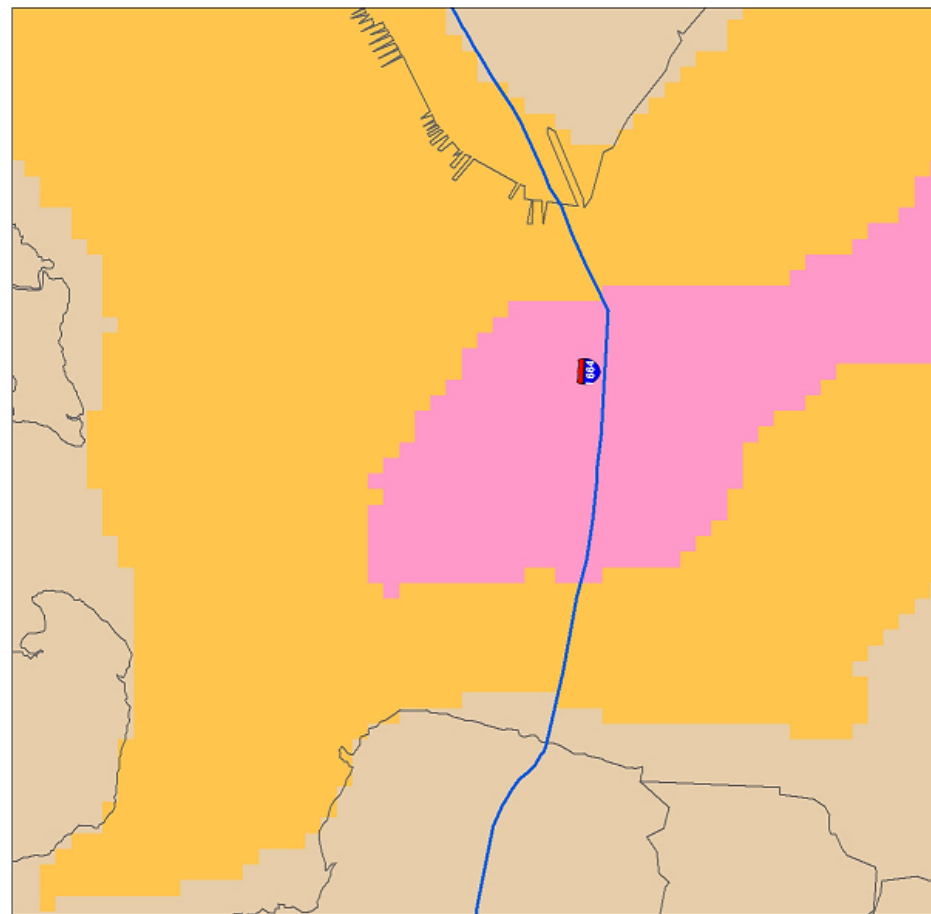


Hurricane 5-second gust wind speeds at 10 m above ground level over open terrain, in statute miles per hour (mph; $1 \text{ mph} = 0.869 \text{ knots} = 0.447 \text{ m/sec} = 1.61 \text{ km/hr}$) in VA, NC, and SC at mean storm recurrence intervals of (a) 50 and (b) 100 years. Dividing the 5-second gust speed by 1.385 yields the 10-minute mean wind speed over open water. Wind speeds at an elevation of 10 m must be extrapolated to turbine hub height using hurricane shear profile coefficients.

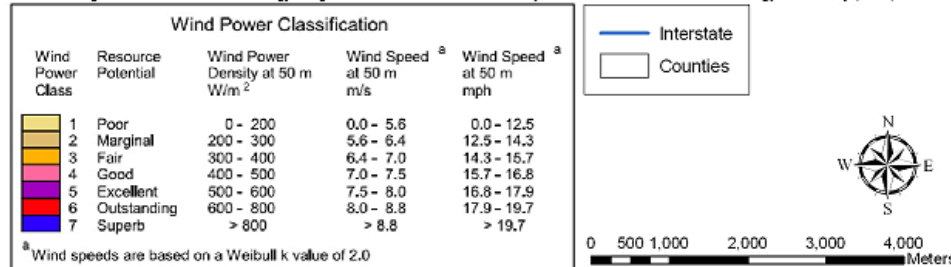
Satellite Photo View of Stage I at Monitor-Merrimac Crossing of James River



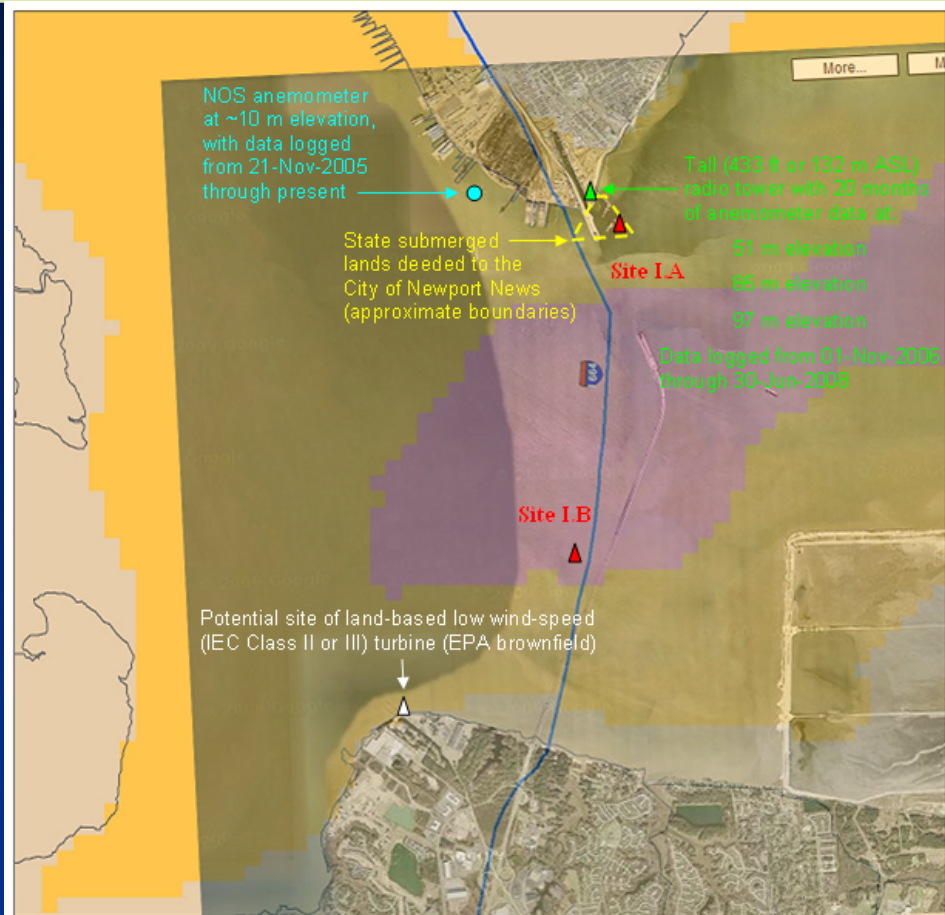
Wind Power Density Map of Stage I at Monitor-Merrimac Crossing of James River



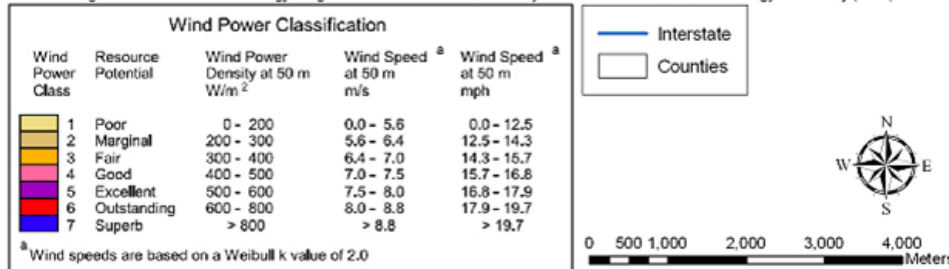
Source: Integrated Science and Technology Program at James Madison University and the National Renewable Energy Laboratory (2009)



Potential Stage I Turbine Test Pad Sites at Monitor-Merrimac Crossing of James River



Source: Integrated Science and Technology Program at James Madison University and the National Renewable Energy Laboratory (2009)



Stage I Turbines might be Accessed by Pedestrian Footbridge

Location : IJsselmeer, North-East of Lelystad, The Netherlands
Client : NUON
Construction year : 1996
Wind turbines : 28 x Nordtank 600/44
Rotor hub height : 50 m
Ballast Nedam : Foundation engineering, manufacturing and installation
Foundation : Driven Monopile
Dimensions : 19 pcs. Ø 3515 mm, length 23 - 23,5 m, weight 60 ton
9 pcs. Ø 3515 mm, length 23,6 - 24,6 m, weight 63 ton
Distance to shore : 30 m
Water depth : 1- 2 m



Offshore

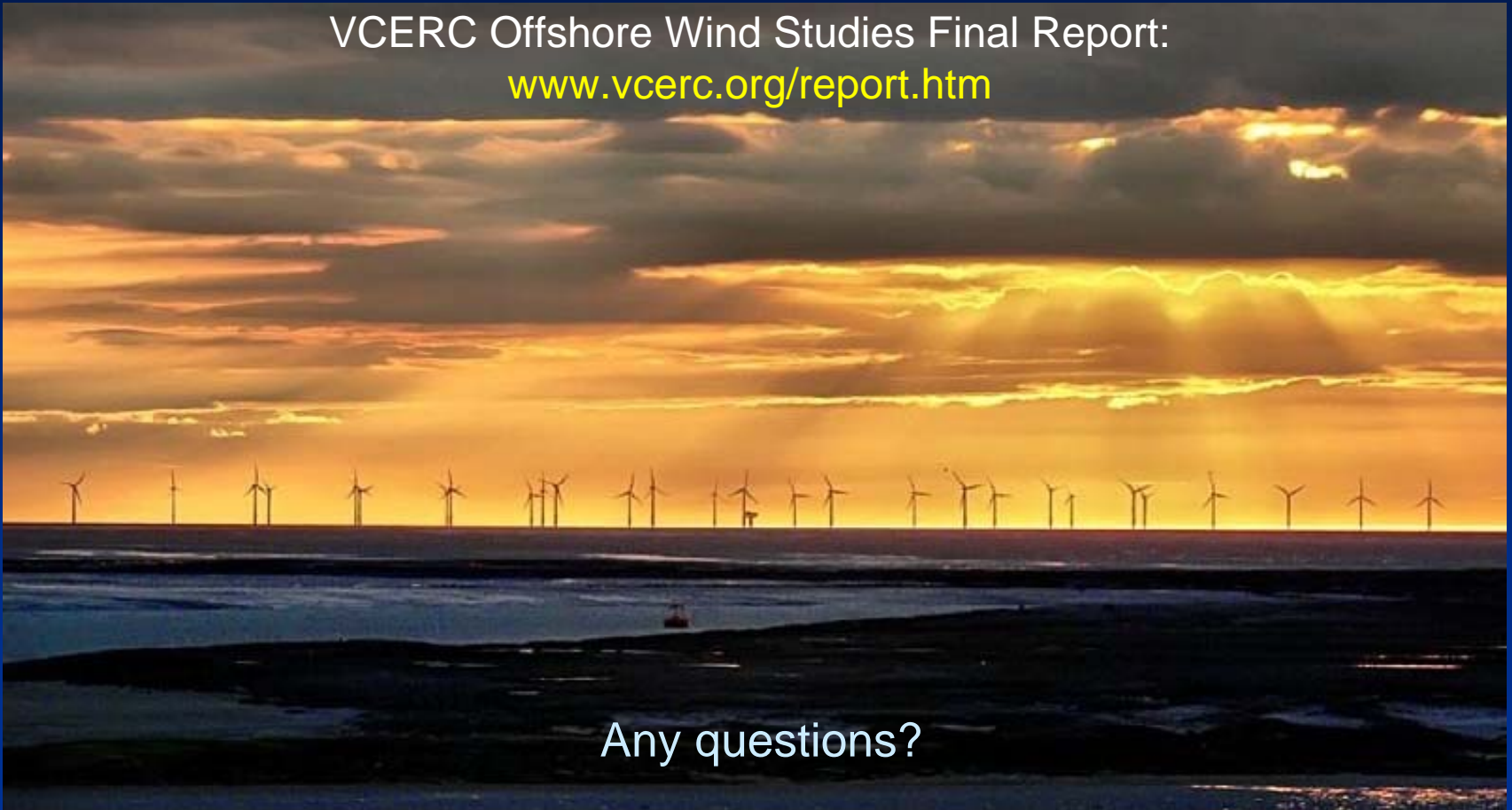
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Thank You!

VCERC Offshore Wind Studies Final Report:
www.vcerc.org/report.htm



Any questions?

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