Marine Renewable Energy Update: Progress and Prospects at Year-End 2010

Joint Commission on Technology and Science
Energy Advisory Committee

General Assembly Building

Richmond, VA

11 January 2011

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Initial VCERC Projects
Funded by State Budget in FY2007-08

Virginia Tech | Old Dominion University

1. **Feasibility-level design and economic assessment**
   for a hypothetical reference baseline offshore wind power project

James Madison University | Virginia Institute of Marine Science VIMS | Old Dominion University

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

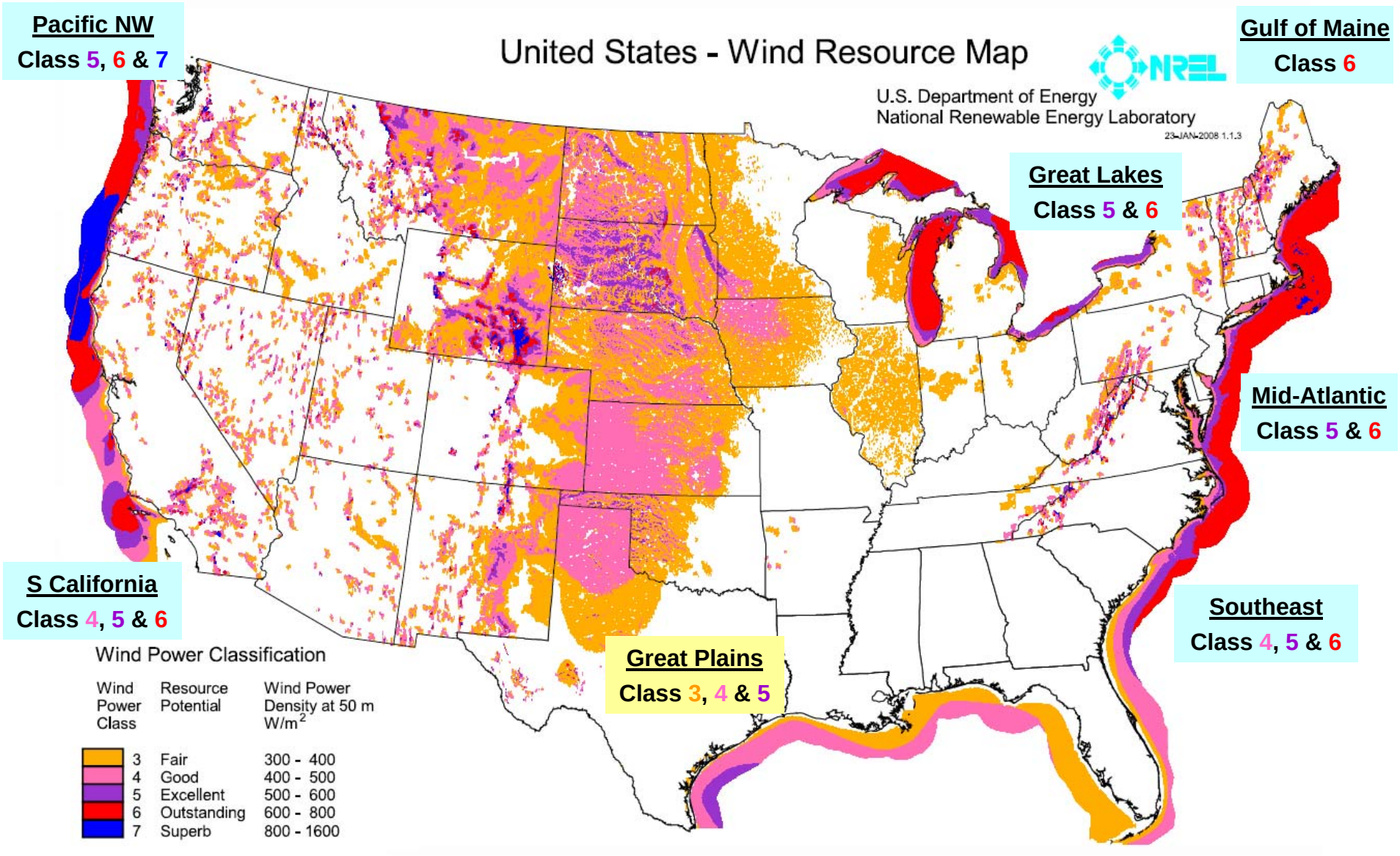
Virginia Tech | SAIC From Science to Solutions™ | NSU Norfolk State University | James Madison University | Paliria Energy, Inc.

3. **Evaluation of economic development potential**
   of commercial offshore wind power development and associated workforce training needs, and planning for an ocean test bed

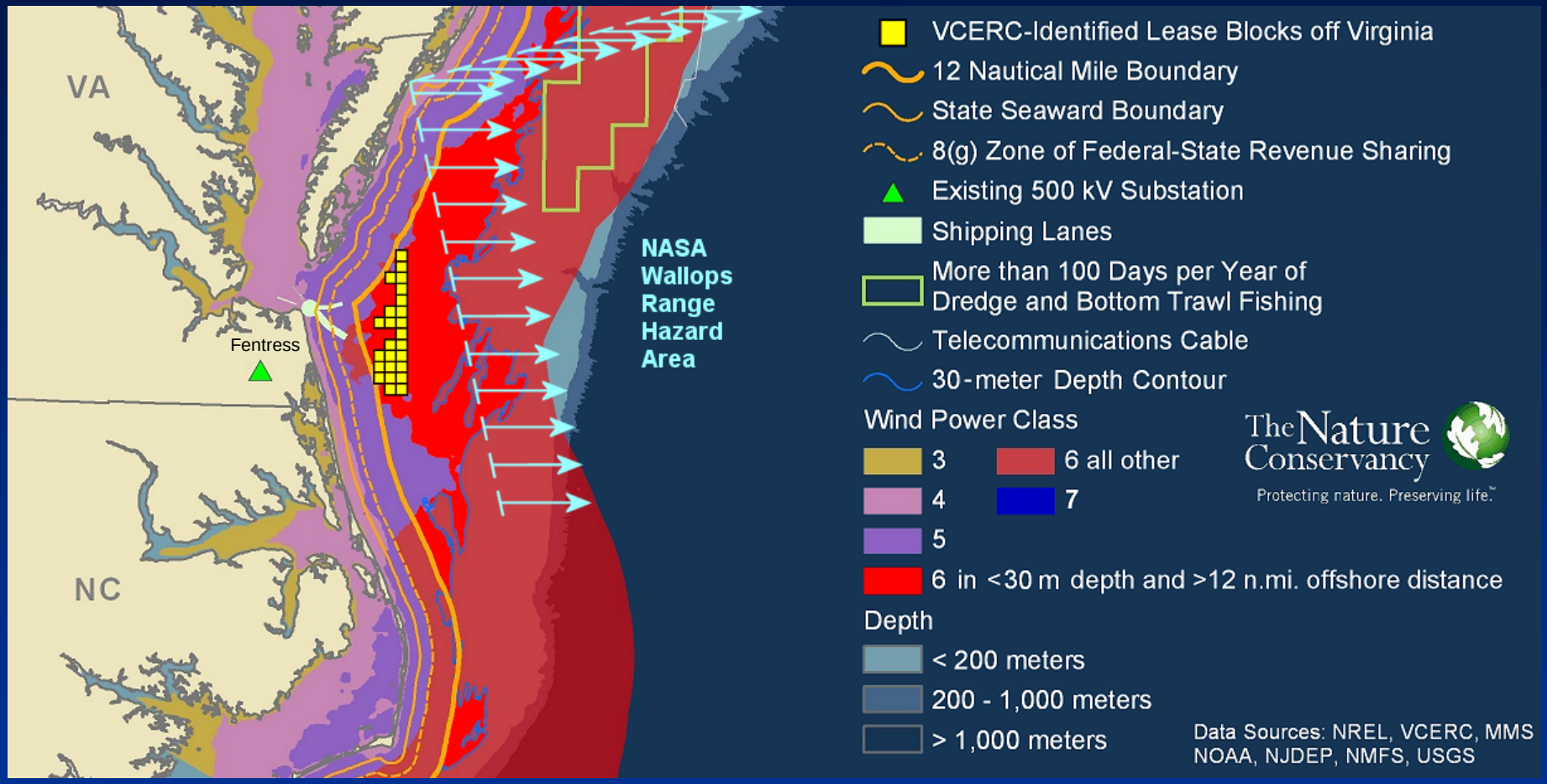
Old Dominion University

4. **Feasibility-level design and economic assessment**
   for an algae-to-biodiesel culture and processing system

U.S. Offshore Wind Resources

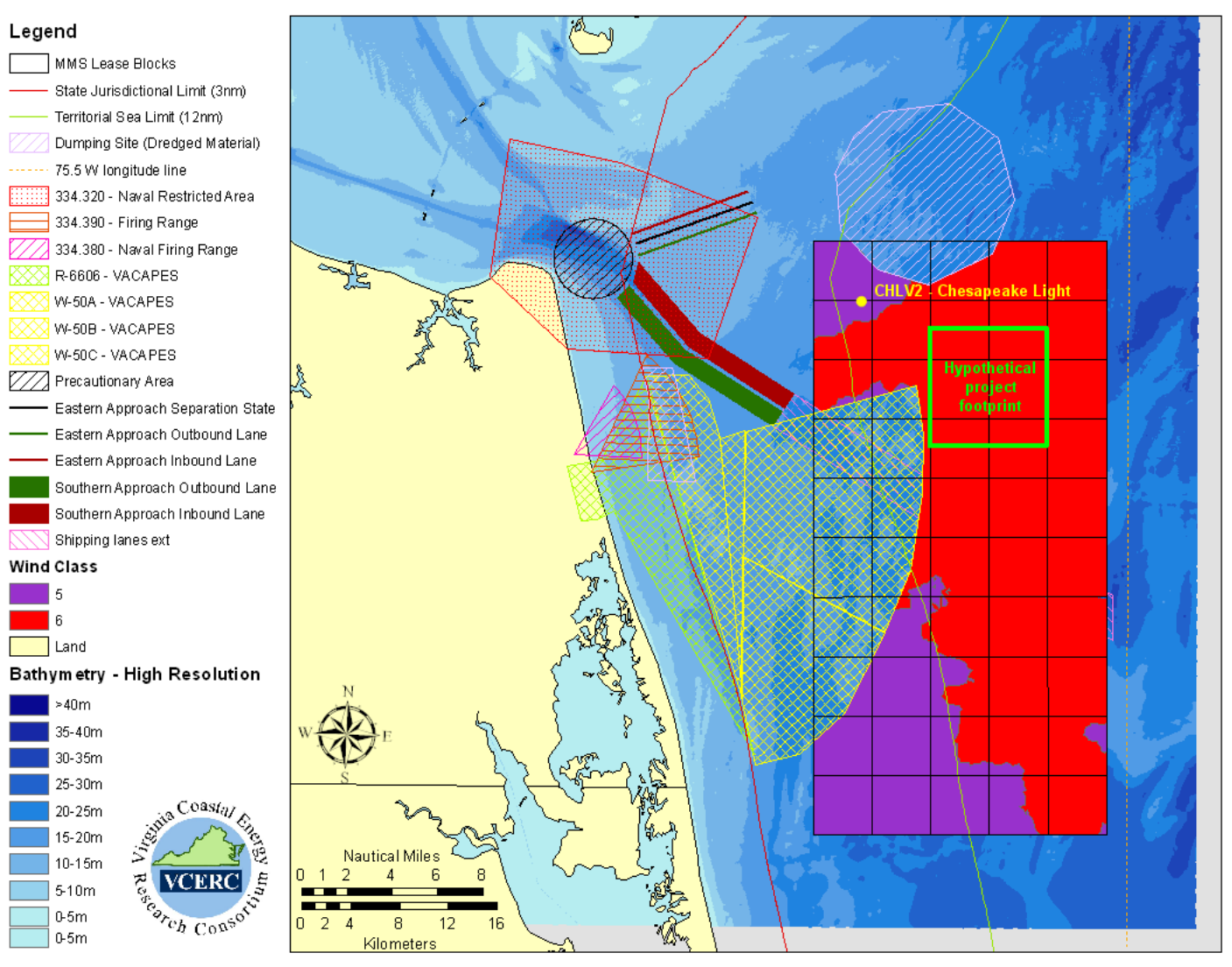


Virginia's Offshore Wind Potential is Large; Is it Cost-Competitive with Fossil Fuel Generation?



VCERC identified 25 MMS lease blocks that appeared to have minimal conflict with existing uses by the Navy, NASA-Wallops, commercial shipping, or commercial fishing. These are all beyond 12 nautical miles offshore and in water depths less than 100 ft, and could support 3,200 MW of wind capacity generating 11 TWh/yr, or 10% of VA's annual energy demand.

Hypothetical Offshore Wind Project Location for Cost & Performance Evaluation



Offshore Wind Project Cost Estimated by VCERC Cost Model

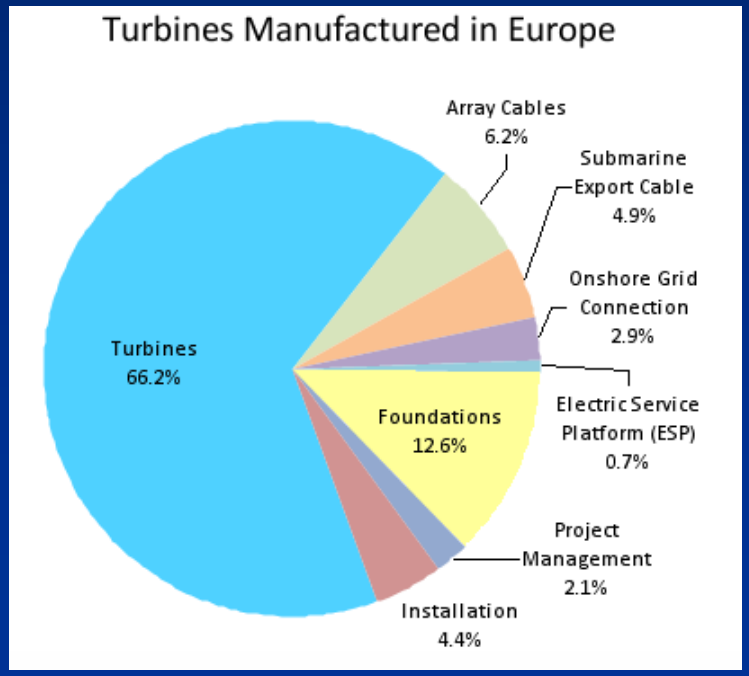
Capital cost estimated in March 2008 dollars using NREL parametric model for wind turbine & tower, Virginia maritime supplier bids for foundations & installation, and published data for balance of plant

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

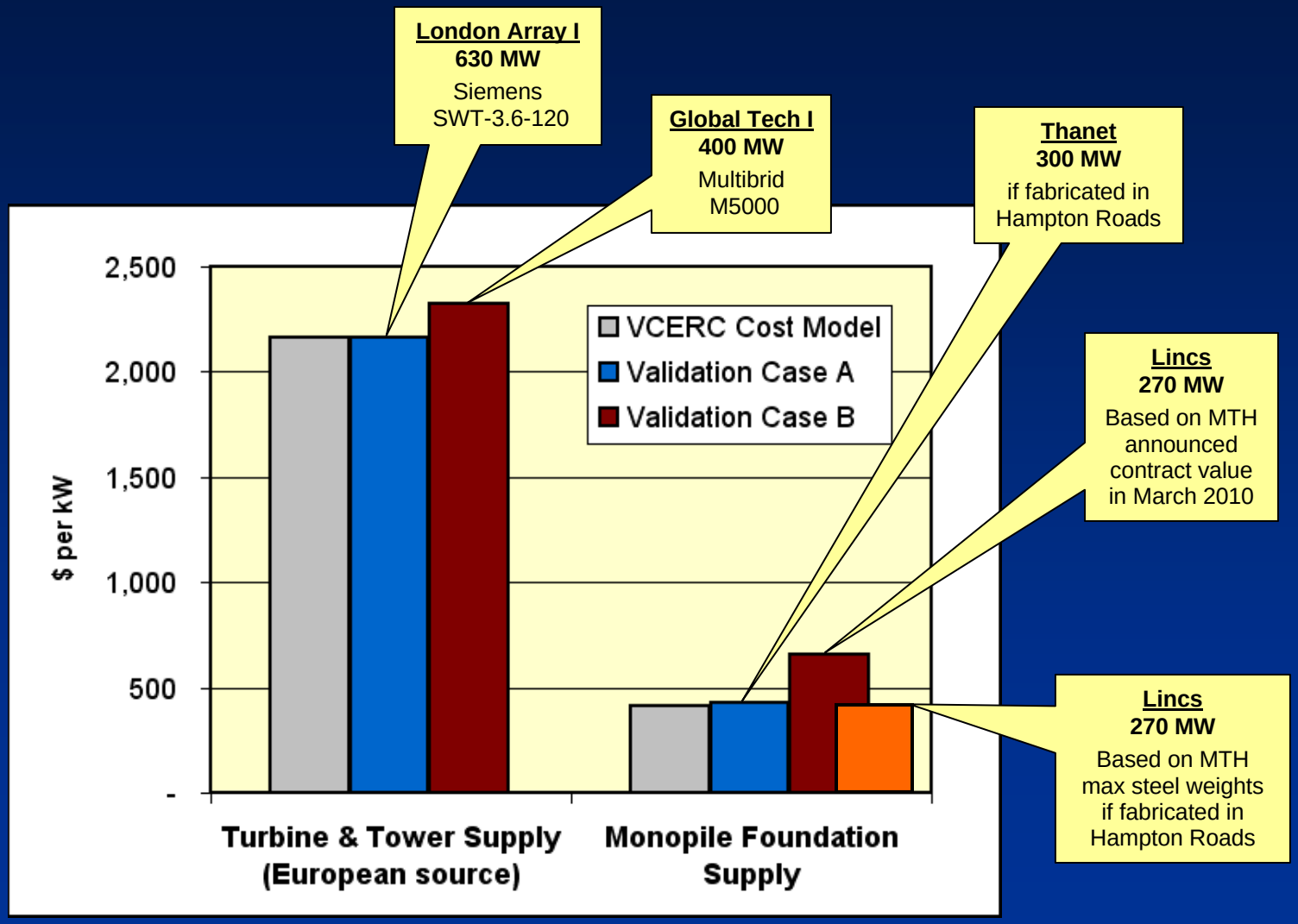
588 MW installed rated capacity *(7 x 7 turbines per lease block)*

38% annual capacity factor

20% PJM summer capacity factor *(JJA 3pm – 6pm)*



VCERC Modeled Capital Costs Compared with European Project Data for Major Cost Centers



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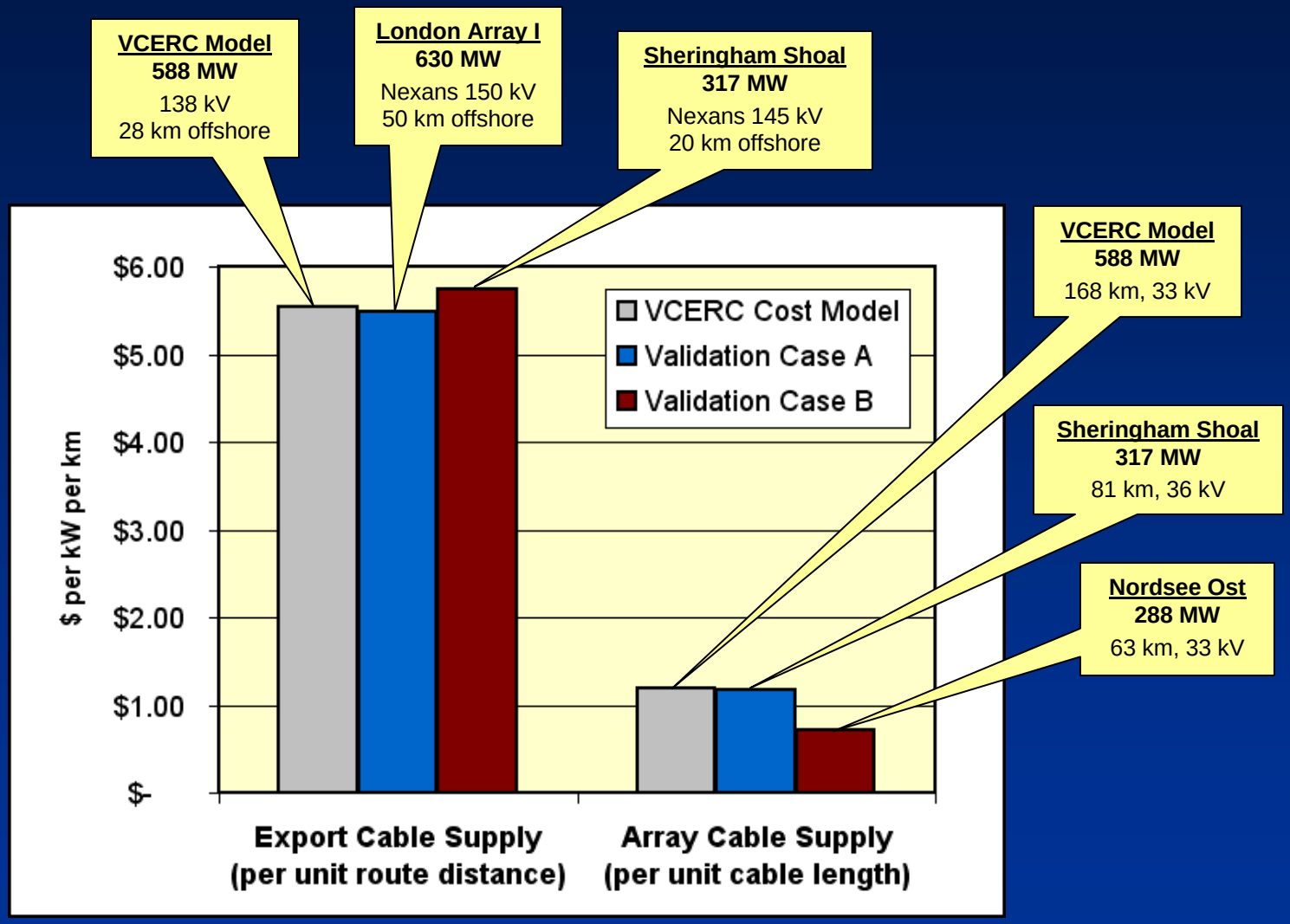
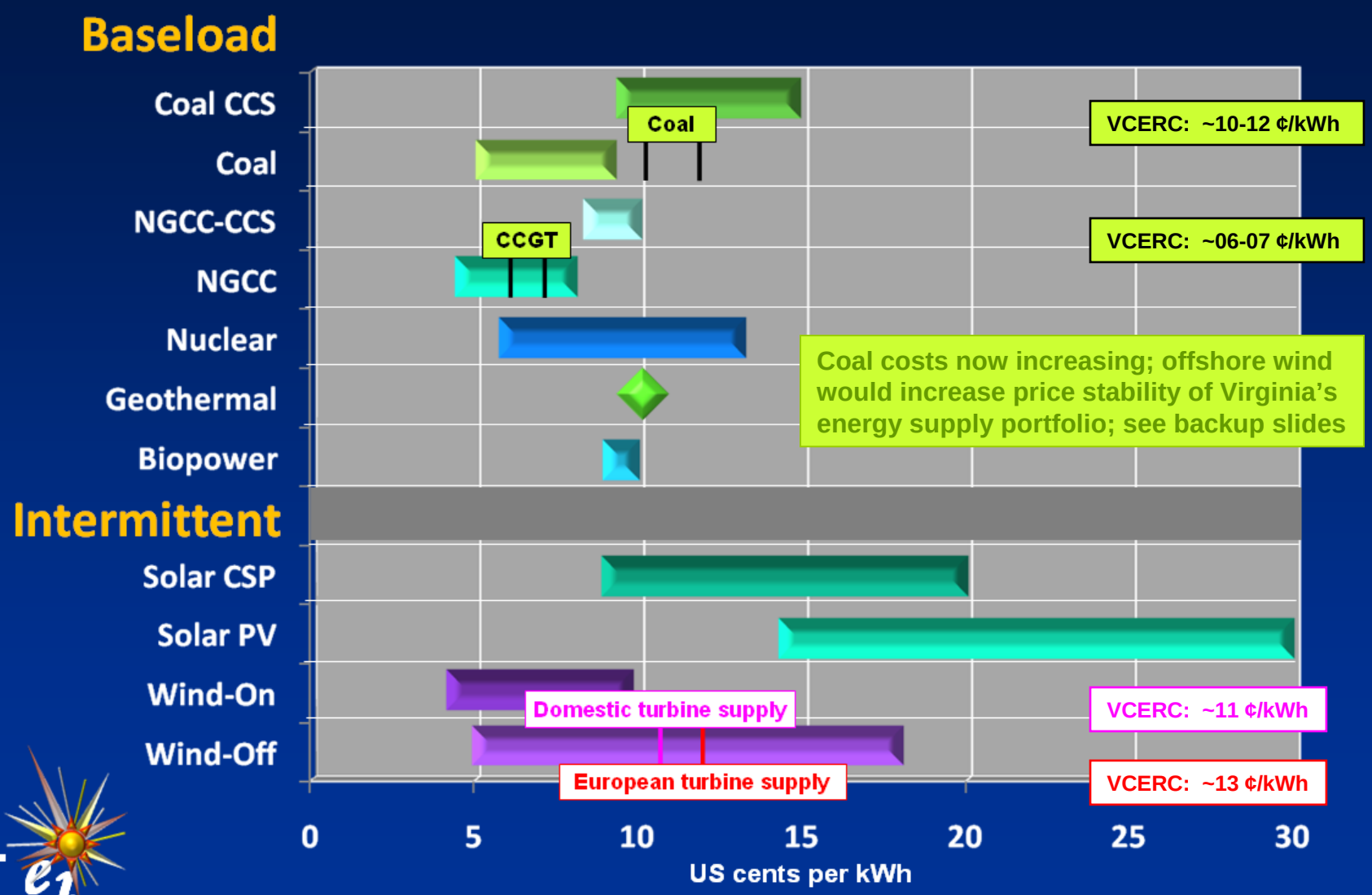


VCERC Results Compared with Recent National Academy of Sciences Study

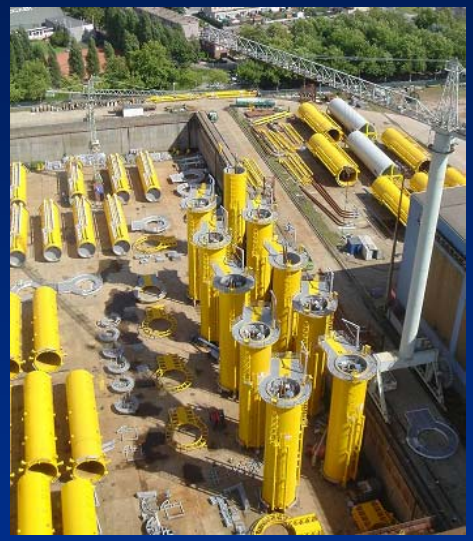


MIT Energy Initiative

National Academy, America's Energy Future, 2009

Virginia Offshore Wind Development Authority Established to Provide Enabling Infrastructure

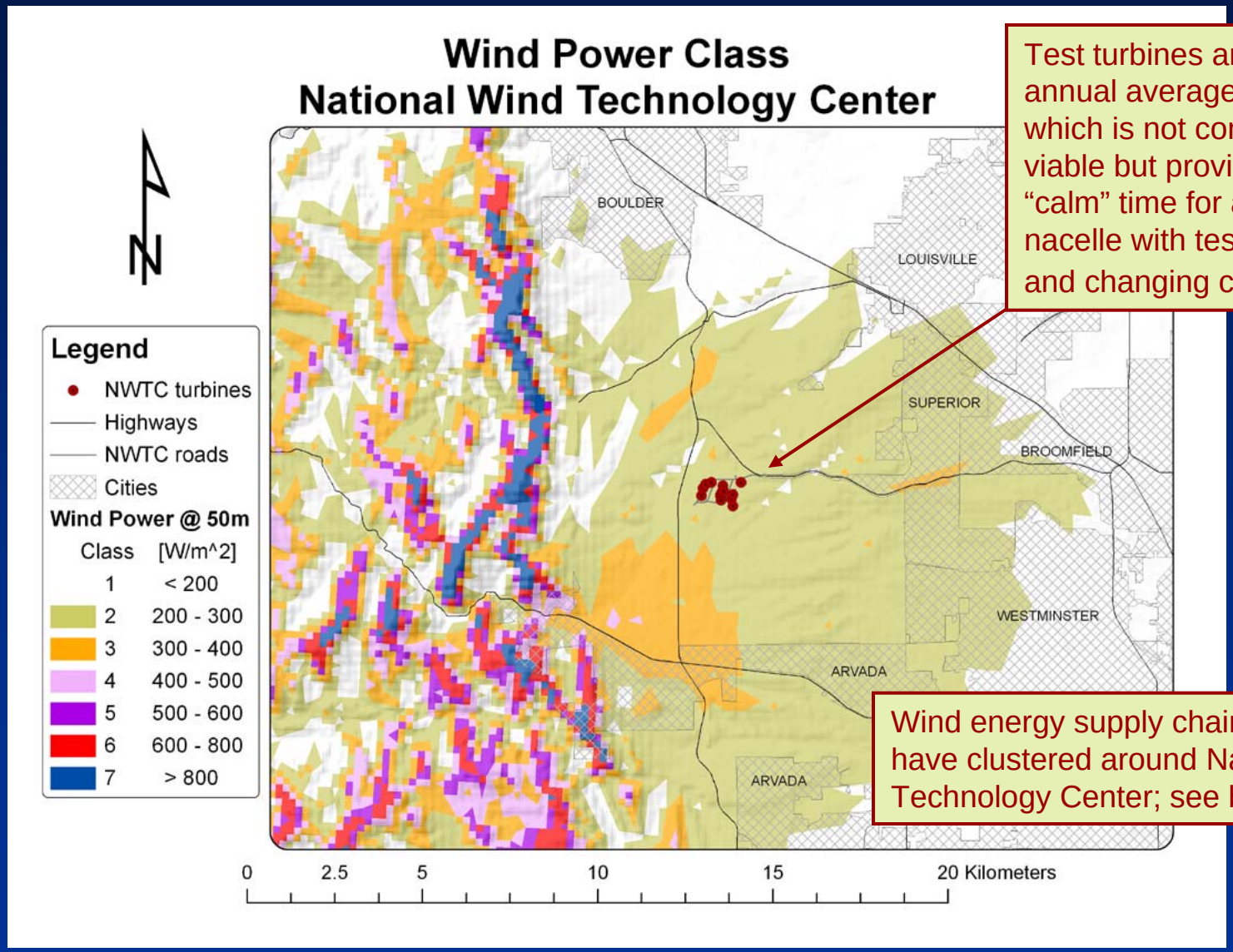
Before making a **~$2 billion investment** (as would be needed for a 600 MW project in federal waters) or a **$500 million investment** in a Hampton Roads turbine manufacturing complex, ***full-scale offshore testing must be done*** (costing **$60-75 million** over 5 yrs)



Virginia's Concept for a National Offshore Wind Technology Center in Hampton Roads

In response to a recent Department of Energy Request for Information (RFI), Virginia has suggested the concept of a National Offshore Wind Test Center, developed in three stages that would offer progressively more energetic wind climates and more challenging conditions for turbine access. The Stage II test pads would be cited at least 1 km south of the CBBT.

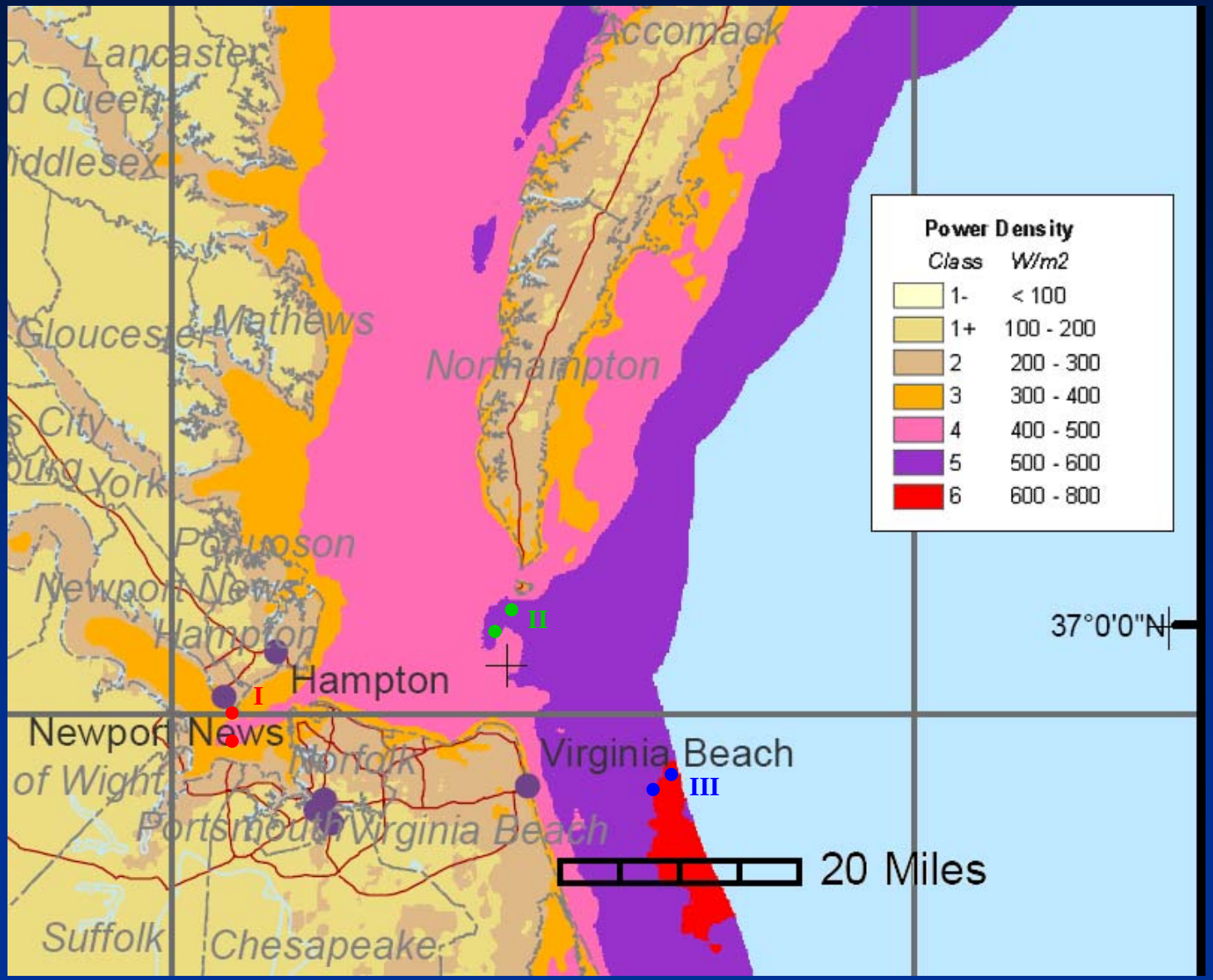
Hampton Roads NOWTC
Would be Similar to NWTC in Colorado



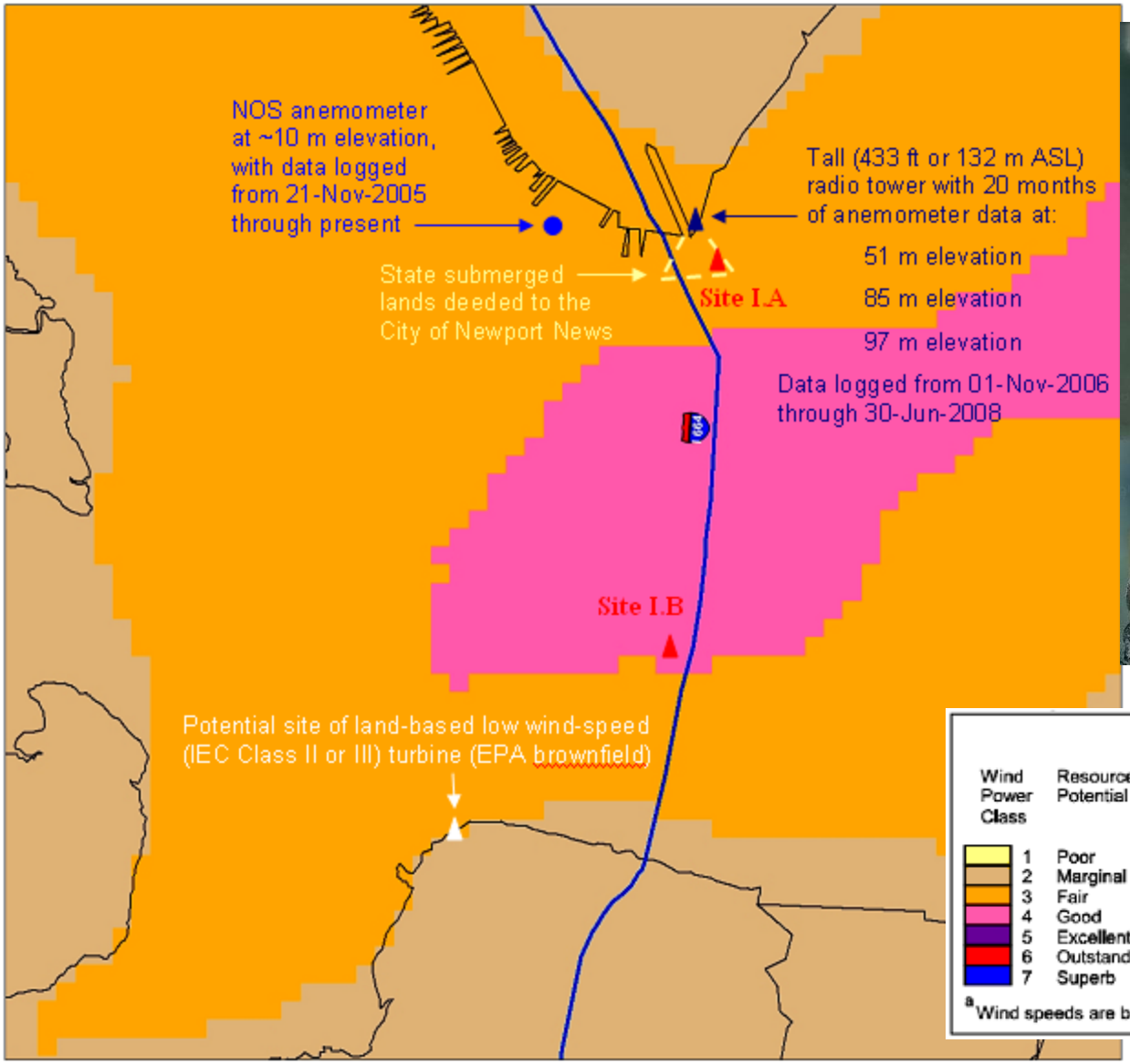
Test turbines are in Class 2 annual average wind resource, which is not commercially viable but provides sufficient "calm" time for accessing nacelle with test equipment and changing components

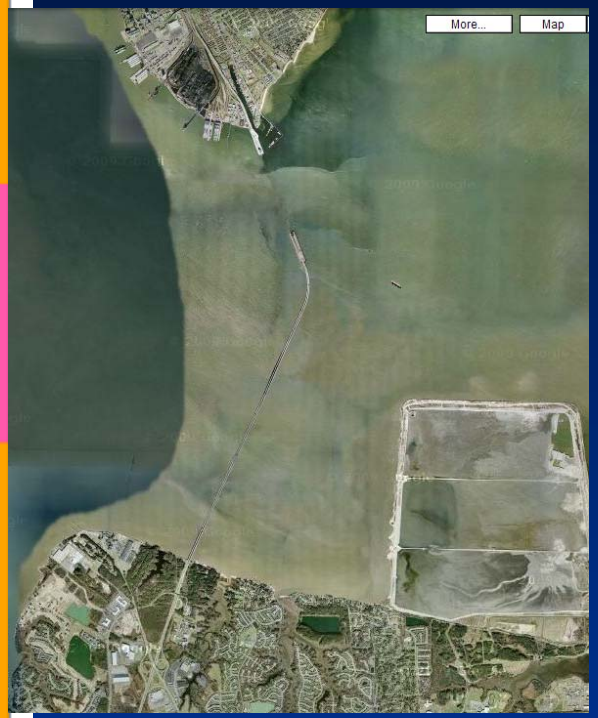
Wind energy supply chain investments have clustered around National Wind Technology Center; see backup slides

Virginia Concept for Staged NOWTC with Progressively More Energetic Wind Resources



Stage I Potential Test Pad Locations





Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m²	Wind Speed[a] at 50 m m/s	Wind Speed[a] at 50 m mph
1	Poor	0 - 200	0.0 - 5.6	0.0 - 12.5
2	Marginal	200 - 300	5.6 - 6.4	12.5 - 14.3
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	> 800	> 8.8	> 19.7

[a] Wind speeds are based on a Weibull k value of 2.0

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

Focus of Stage I Turbines would be Supply Chain Qualification and Workforce Training

Irene Vorrink 16.8 MW offshore wind project built in shallow Dutch waters

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

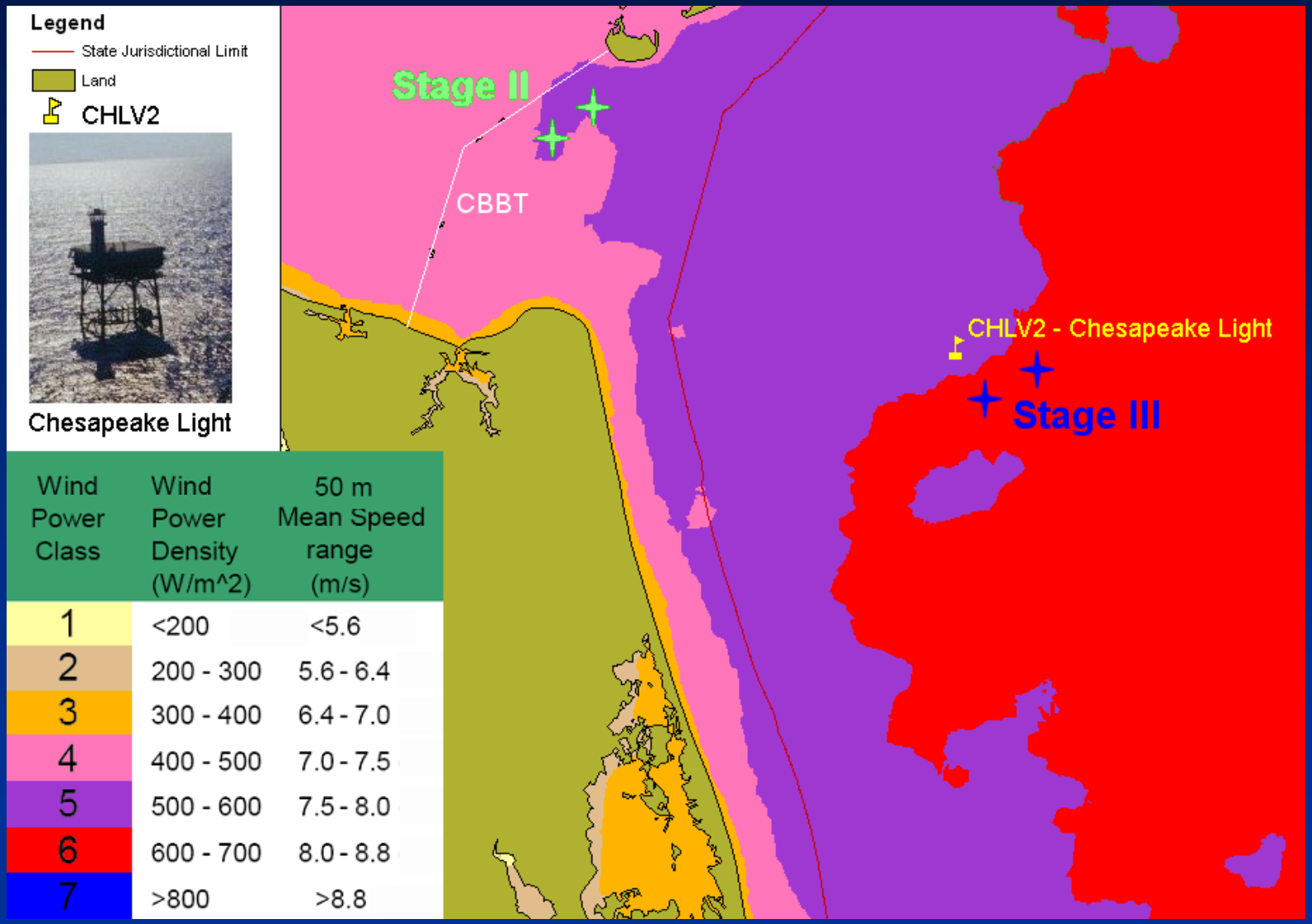
Ballast Nedam
Offshore

P.O. Box 1451
3430 BL Nieuwegein
The Netherlands

Telephone +31 30 2 85 37 27
Telefax +31 30 2 85 48 41
Website www.bnoffshore.com

Site I.A turbine could be accessed by footbridge from walkway on Newport News wave screen

Stages II and III Potential Test Pad Locations



Wind Power Class	Wind Power Density (W/m^2)	50 m Mean Speed range (m/s)
1	<200	<5.6
2	200 - 300	5.6 - 6.4
3	300 - 400	6.4 - 7.0
4	400 - 500	7.0 - 7.5
5	500 - 600	7.5 - 8.0
6	600 - 700	8.0 - 8.8
7	>800	>8.8

Early, Meaningful Engagement of Local Stakeholders Essential to Success

Thank You!

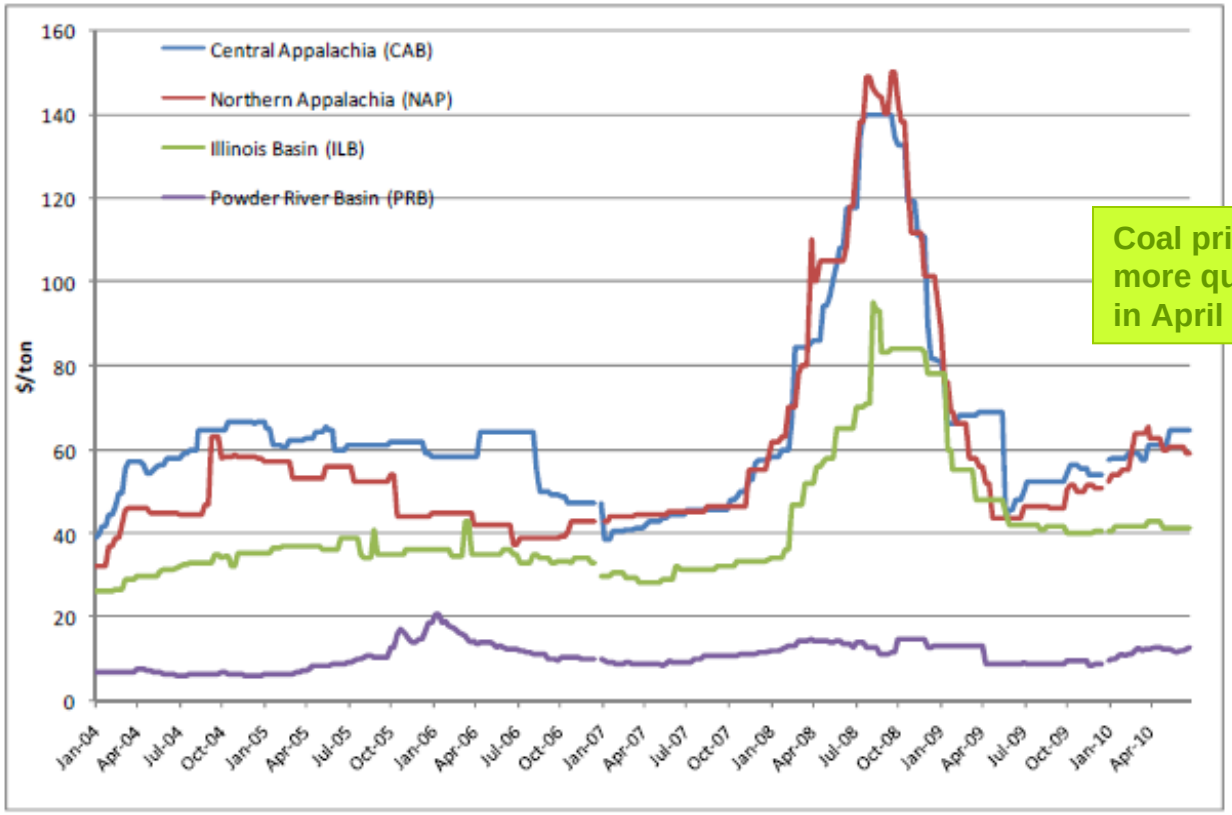
PDF of Virginia response to DOE RFI is posted at:
http://media2.wavy.com/html/PDFs/71410%20Virginia%20DOE%20Offshore%20Wind%20RFI%20Response%20Final.pdf

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

Any questions?

Email: hagerman@vt.edu

Historical Volatility in Coal Prices



Source: Energy Information Administration (EIA), Platt's

Coal prices are rebounding more quickly than assumed in April 2010 VCERC report

Source: Edison Electric Institute: Q2 2010 Financial Update: Fuel (www.eei.org/whatwedo/DataAnalysis/IndusFinanAnalysis/Documents/2010_Q2_Fuel_Final.pdf)

NERA Study of Fossil Generation Portfolio in PJM

Issue No. 2
April 2009

NERA
Economic Consulting

Energy Market
Insights

Valuing Fossil Fuel Generation Assets in a Green Economy

by James Heidell & Mike King

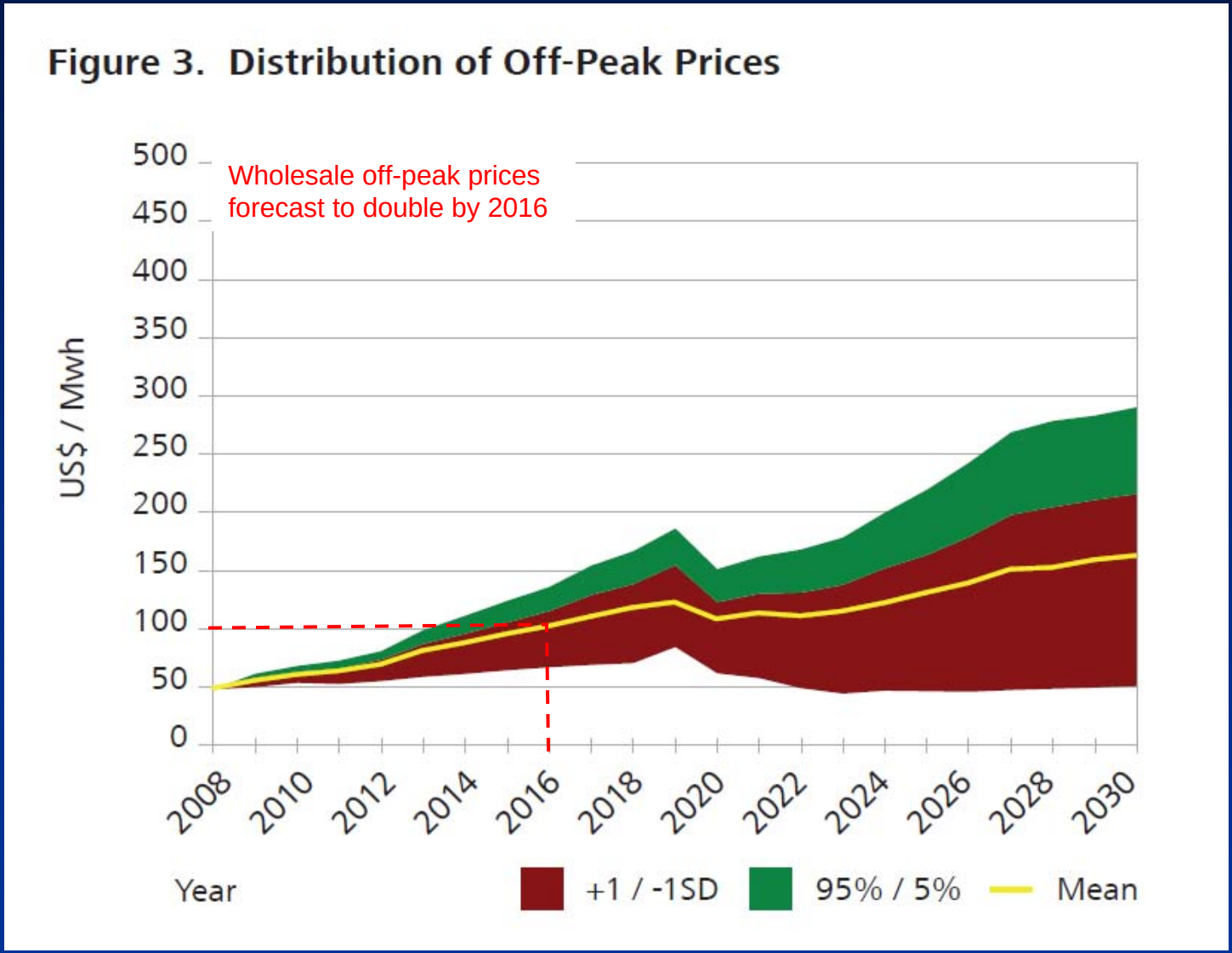
Virginia imports approximately one-third of the power needed to meet state-wide demand from the PJM regional market.

When might offshore wind provide stably priced energy at a cost that is competitive with purchased wholesale power in PJM?

Case Study

The following case study highlights our assessment process for an actual portfolio of coal-fired and gas-peaking plants located in the PJM region. On a MW basis, the existing portfolio consists of approximately two-thirds coal-fired assets and one-third peaking assets. Our case study incorporates uncertainty related to fossil fuel prices, RPS standards, greenhouse gas regulations, load growth and power plant replacement costs. In the case study, each of the key variables had three associated forecasts. This created 729 potential permutations or cases.

PJM Long-Term Electricity Price Forecast



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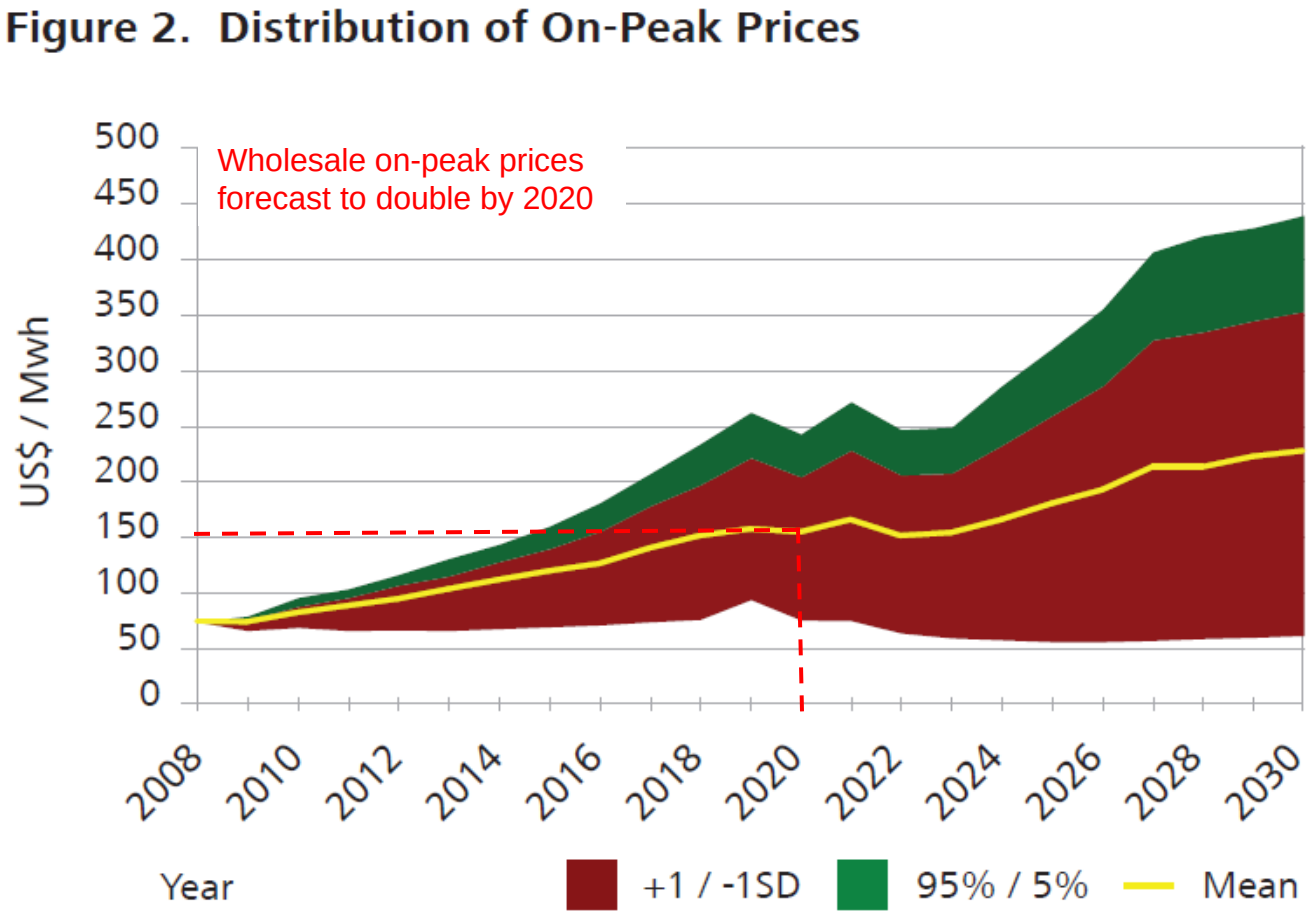
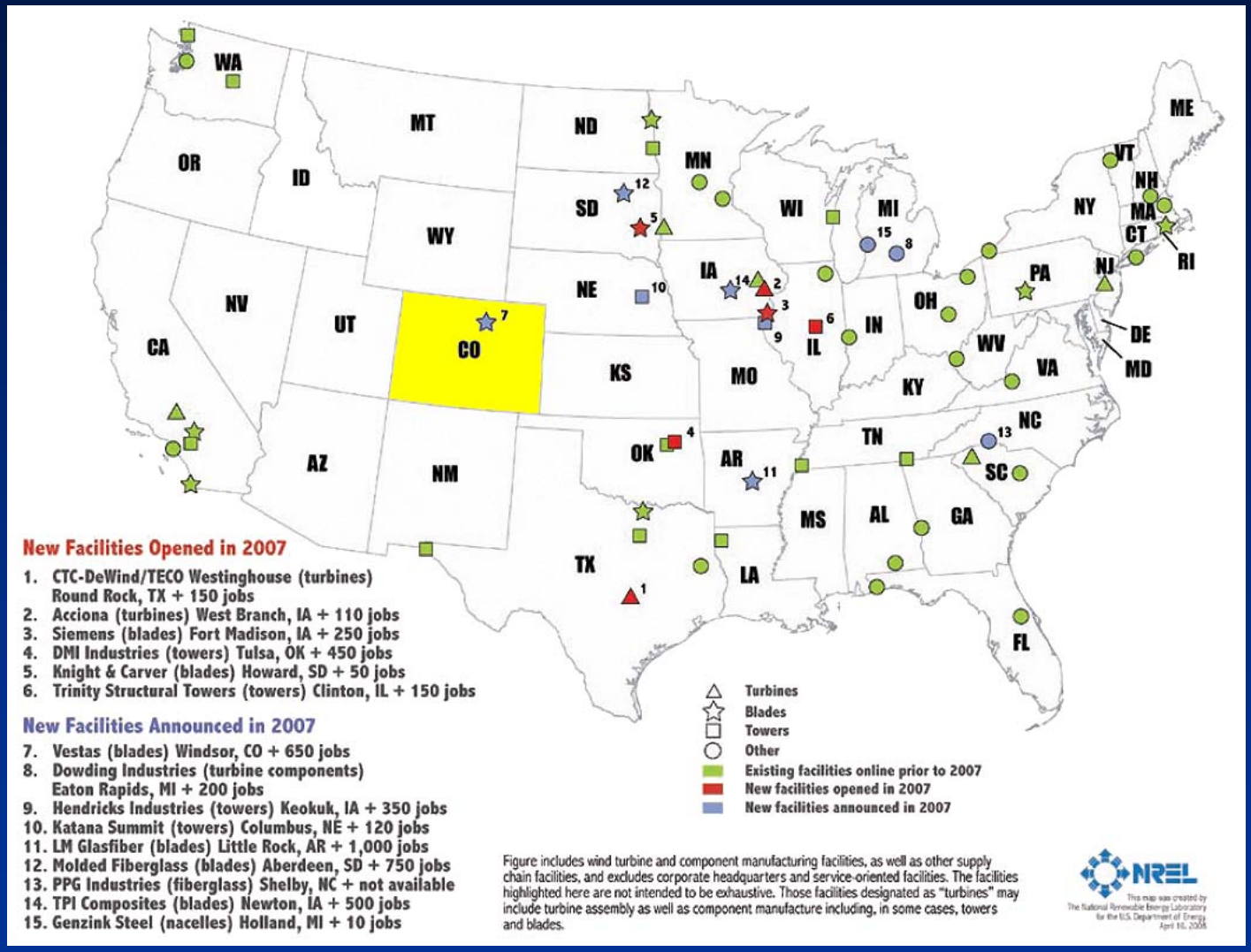
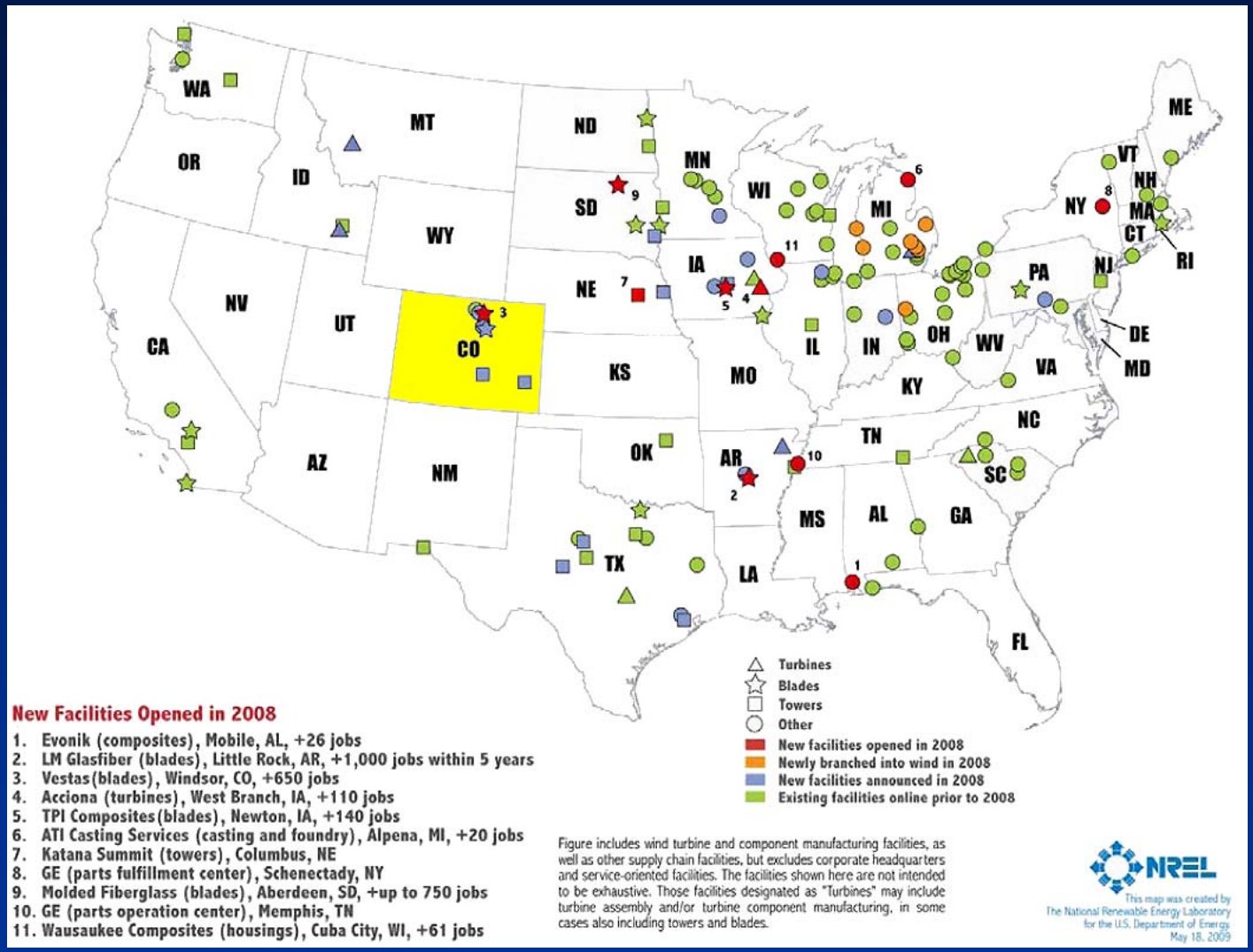


U.S. Wind Energy Supply Chain Map in 2007



Wiser, R., and M. Bolinger. "Annual Report on U.S. Wind Power Installation, Cost, and Performance Trends: 2007." Lawrence Berkeley National Laboratory, May 2008. http://eetd.lbl.gov/EA/emp/reports/lbnl-275e.pdf

U.S. Wind Energy Supply Chain Map in 2008



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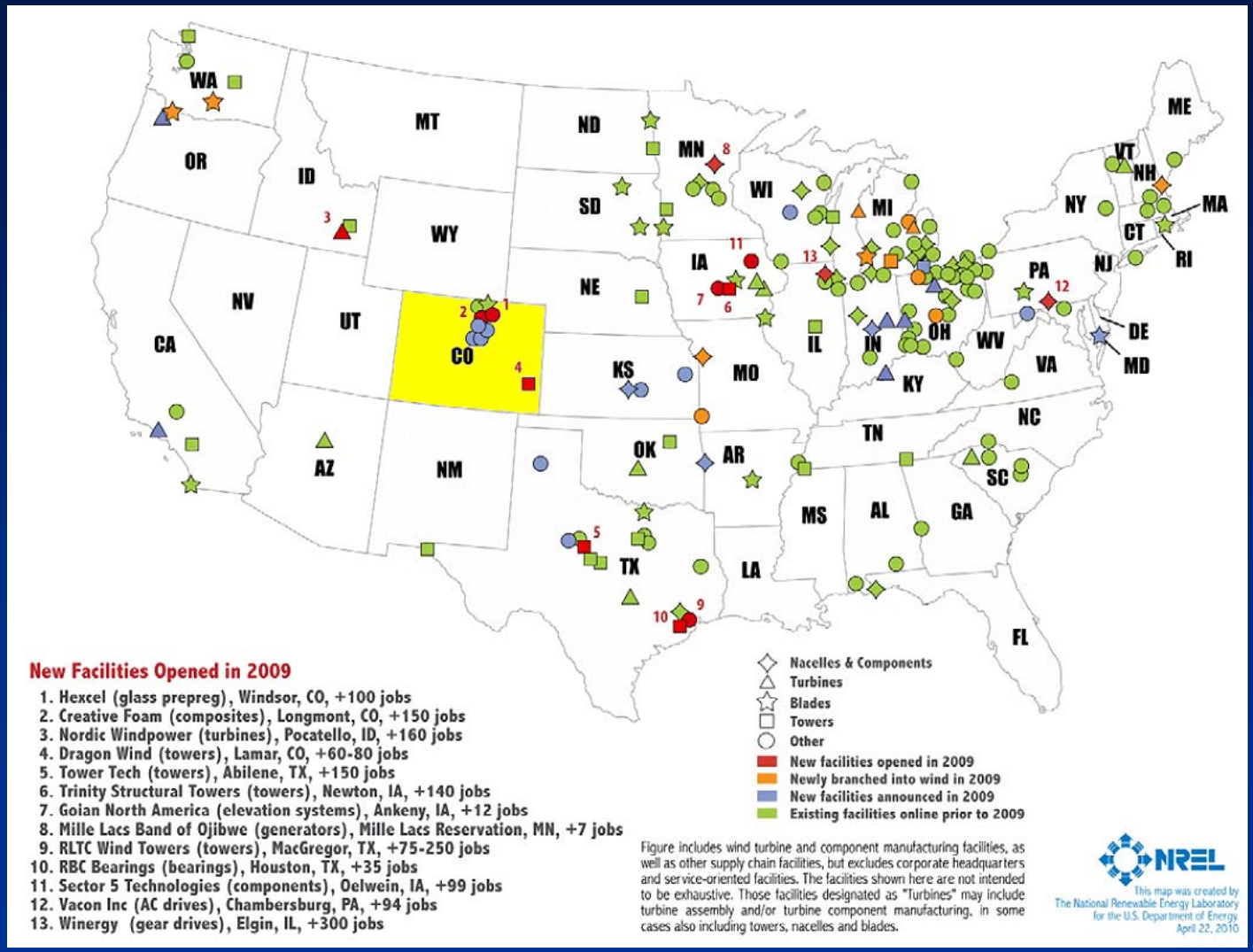

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