

Virginia's Wind Resources on Land and Offshore – Key VCERC Study Findings

Virginia Offshore Wind Supply Chain Educational Forum

The Cultural Arts Center at Glen Allen

Glen Allen, VA

07 December 2010



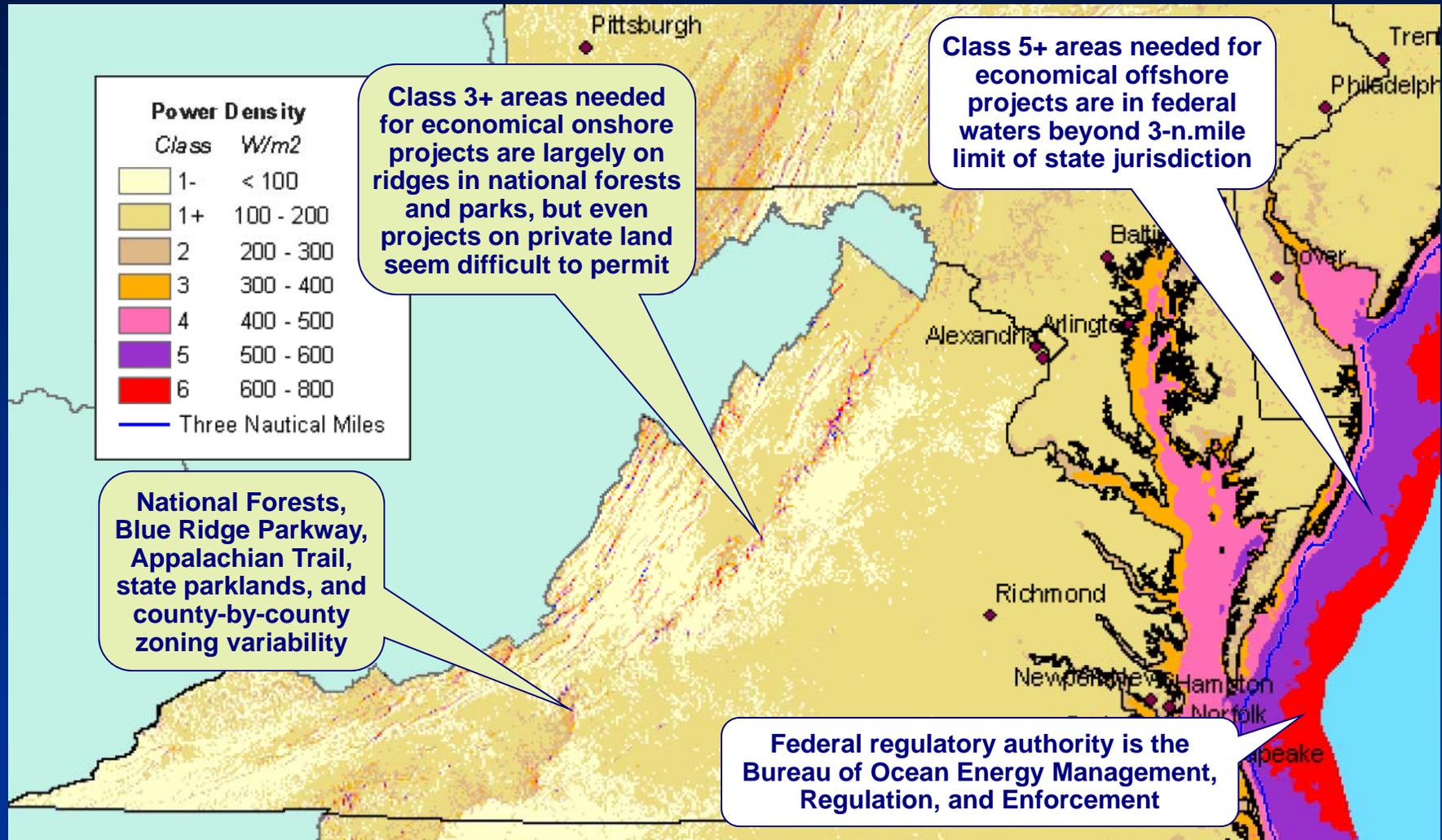
George Hagerman

VCERC Director of Offshore Wind Research
Virginia Tech Advanced Research Institute

Jonathan Miles

Technical Director
VCERC Virginia Wind Energy Center
James Madison University

Comparing Key Aspects of Land-Based and Offshore Wind Energy Resources in Virginia



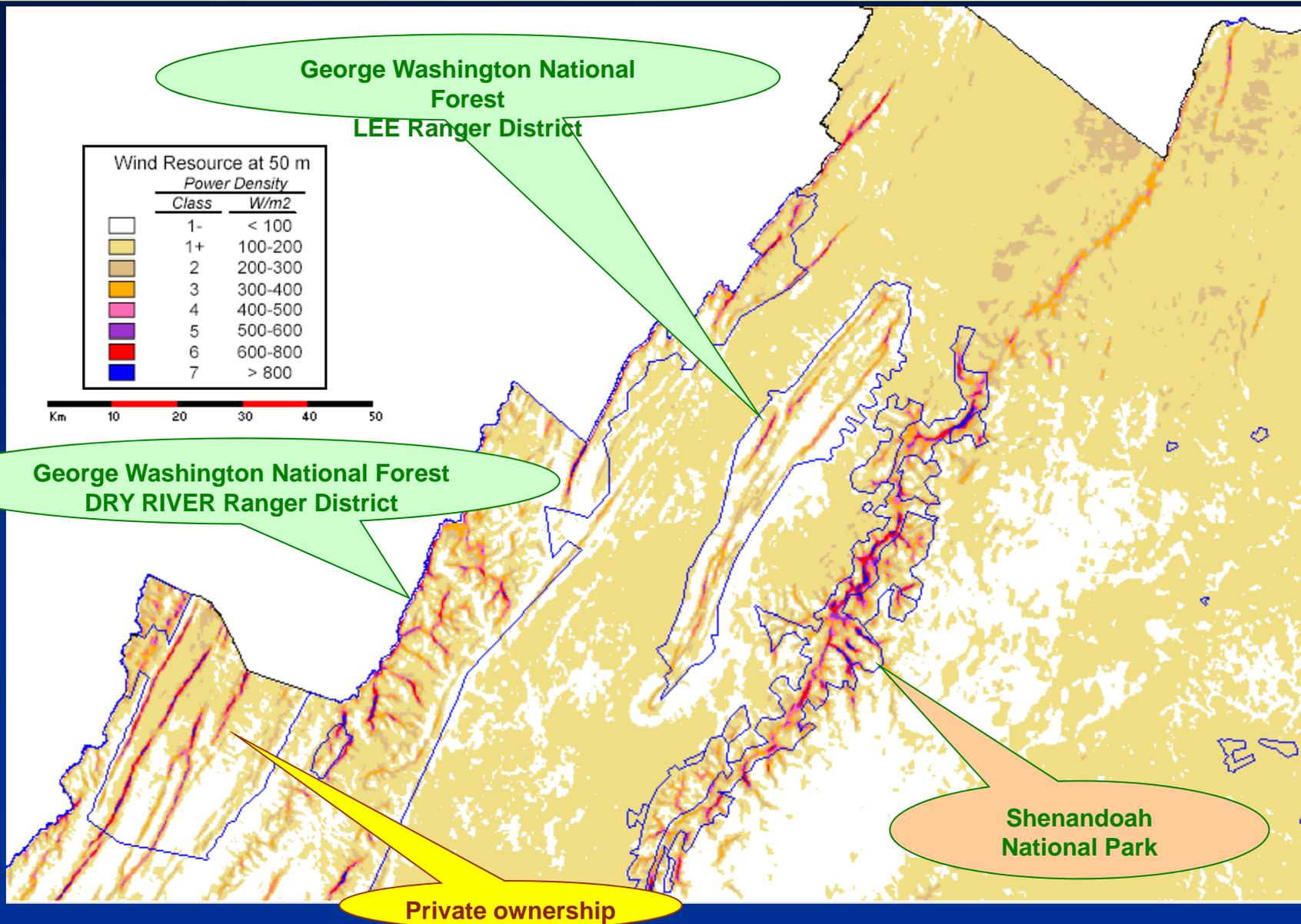
Source: http://gcep.stanford.edu/pdfs/energy_workshops_04_04/wind_bailey.pdf

Ownership of Virginia's Wind Energy Areas

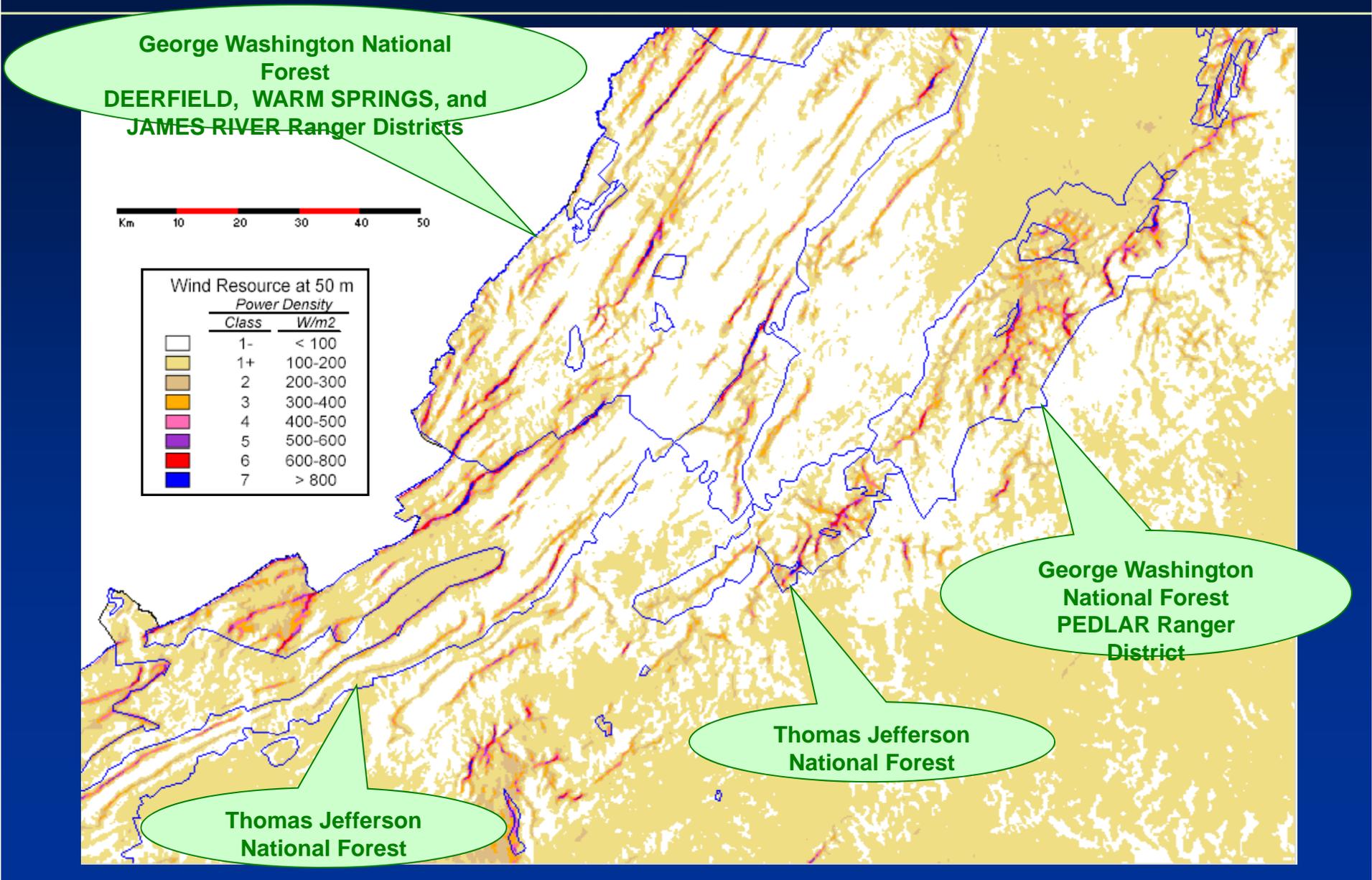
Owner	Area (sq. km) in Wind Power Density Class					Distribution Class 3+
	3	4	5	6	7	
<i>National Park Service</i>	119	67	35	29		2.9%
<i>Fish and Wildlife Service</i>	80	7				1.0%
<i>Forest Service</i>	598	291	145	102	36	13.5%
<i>Department of Defense</i>	33					0.4%
<i>Federal Land (other)</i>						0.0%
<i>StatePark</i>	5	2	1	1		0.1%
<i>Park (other)</i>						0.0%
<i>Mine Lands</i>	7	2	1	1		0.1%
<i>Virginia (other)</i>	844	265	61	38		14.0%
<i>Waterbody</i>	50	46				1.1%
<i>Offshore (3 nautical miles)</i>	277	823	566			19.3%
<i>Chesapeake Bay</i>	923	3,018	181			47.6%
Total	2,936	4,521	990	171	36	100.0%

Two-thirds of Virginia's Class 3+ wind energy resources are located in the state waters of the Chesapeake Bay and Atlantic Ocean. Of the remaining third on shore, more than half are located on publicly used Federal lands.

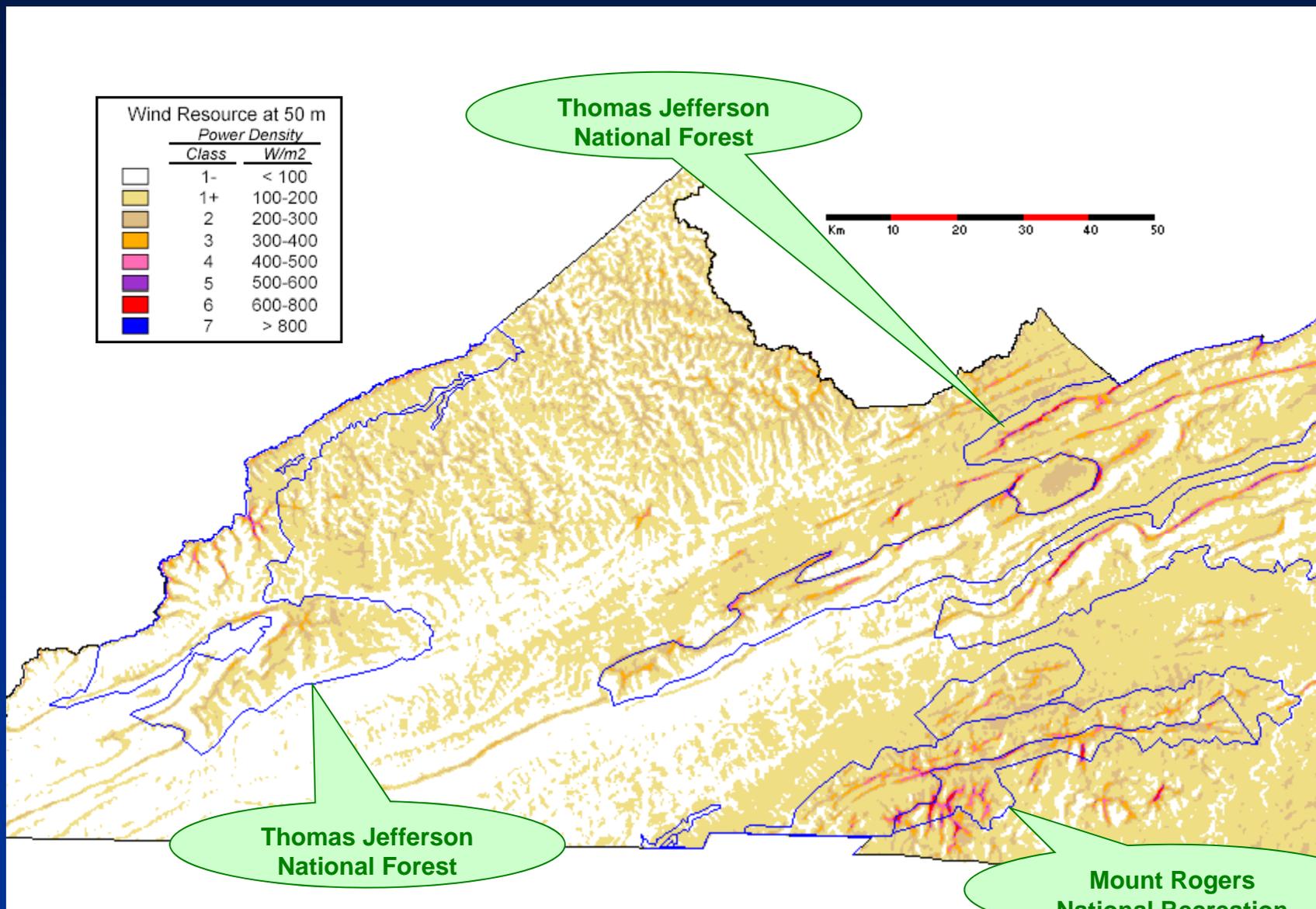
Wind Resources in Harrisonburg Vicinity



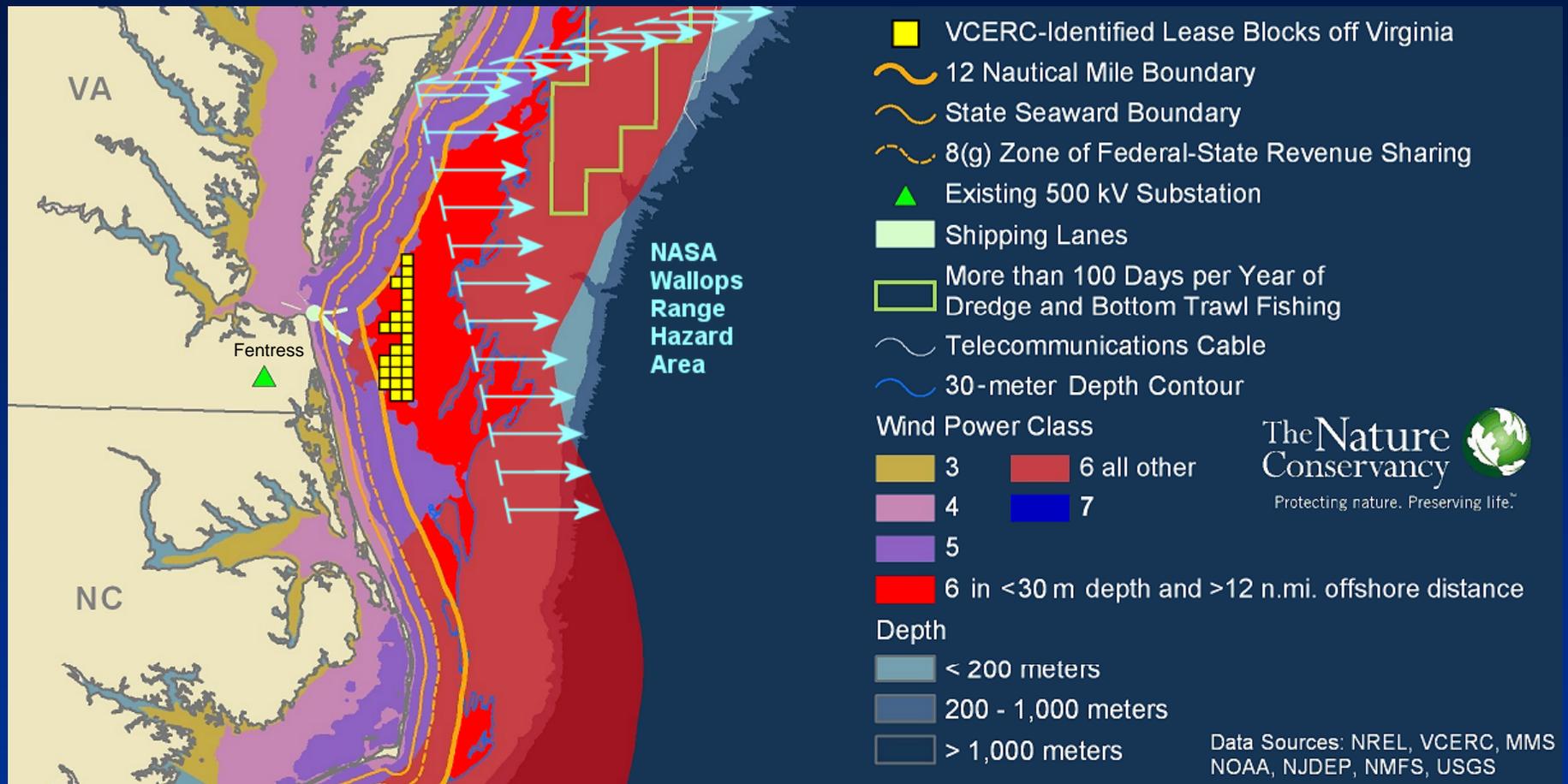
Wind Resources in Lexington Vicinity



Wind Resources in Roanoke Vicinity



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

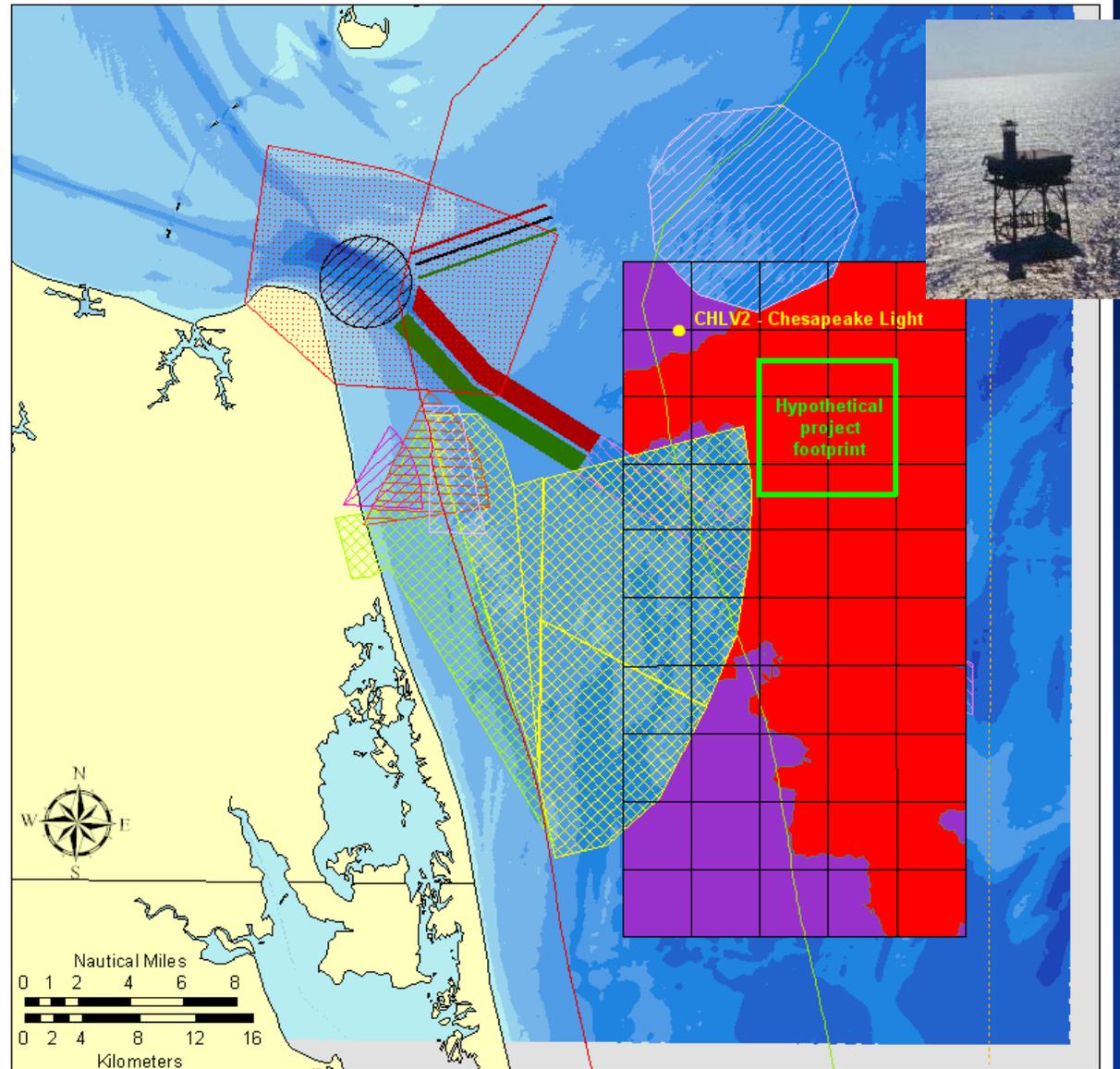


VCERC identified 25 MMS lease blocks that appeared to have minimal conflict with existing uses by the Navy, NASA-Wallops, commercial shipping, or commercial fishing. These are all beyond 12 nautical miles offshore and in water depths less than 100 ft, and could support 3,200 MW of wind capacity generating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

Hypothetical Offshore Wind Project Location for Cost & Performance Evaluation

Legend

-  MMS Lease Blocks
 -  State Jurisdictional Limit (3nm)
 -  Territorial Sea Limit (12nm)
 -  Dumping Site (Dredged Material)
 -  75.5 W longitude line
 -  334.320 - Naval Restricted Area
 -  334.390 - Firing Range
 -  334.380 - Naval Firing Range
 -  R-6606 - VACAPES
 -  W-50A - VACAPES
 -  W-50B - VACAPES
 -  W-50C - VACAPES
 -  Precautionary Area
 -  Eastern Approach Separation State
 -  Eastern Approach Outbound Lane
 -  Eastern Approach Inbound Lane
 -  Southern Approach Outbound Lane
 -  Southern Approach Inbound Lane
 -  Shipping lanes ext
- Wind Class**
-  5
 -  6
 -  Land
- Bathymetry - High Resolution**
-  >40m
 -  35-40m
 -  30-35m
 -  25-30m
 -  20-25m
 -  15-20m
 -  10-15m
 -  5-10m
 -  0-5m
 -  0-5m



Offshore Wind Project Cost Estimated by VCERC Cost Model

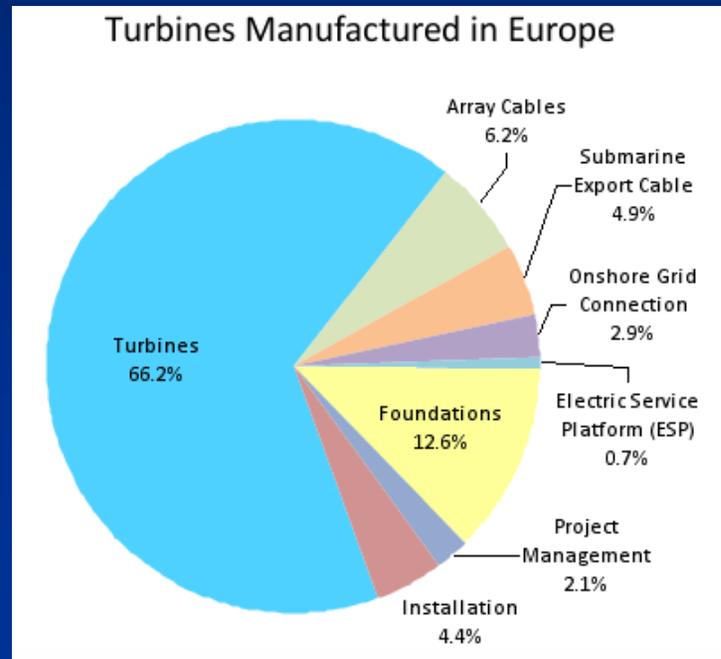
Capital cost estimated in March 2008 dollars using NREL parametric model for wind turbine & tower, Virginia maritime supplier bids for foundations & installation, and published data for balance of plant

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

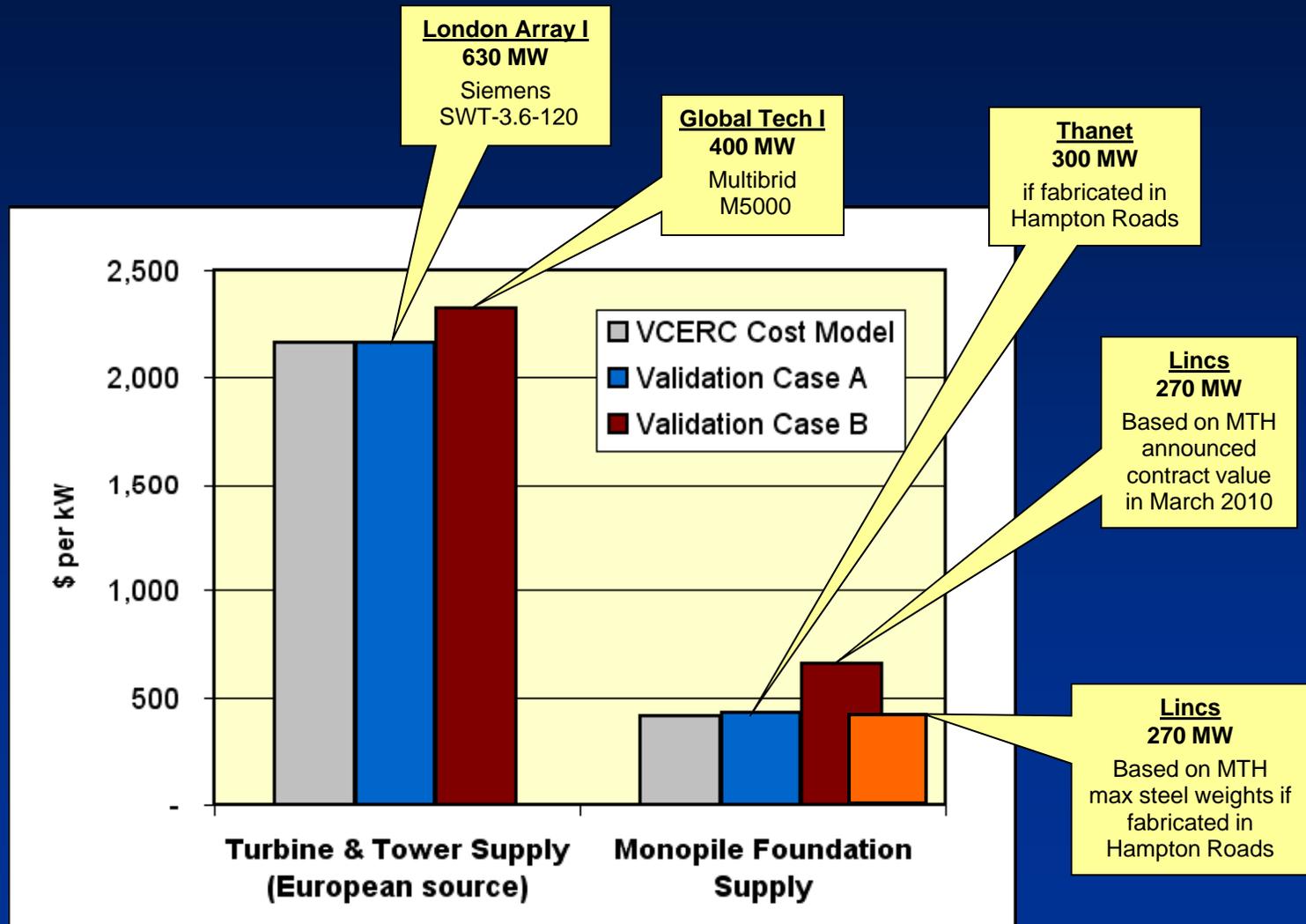
588 MW installed
rated capacity
(7 x 7 turbines
per lease block)

38% annual
capacity factor

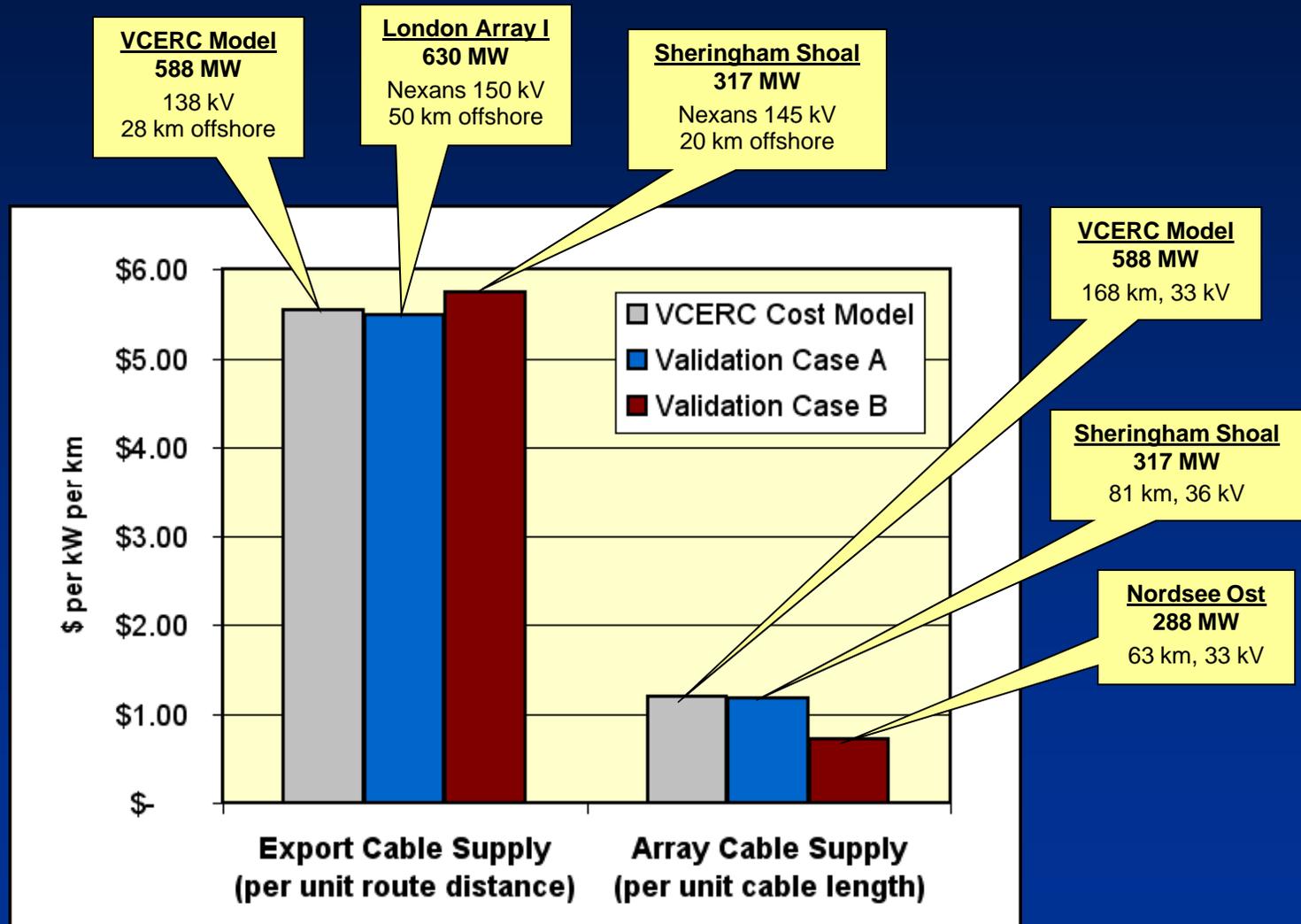
20% PJM summer
capacity factor
(JJA 3pm – 6pm)



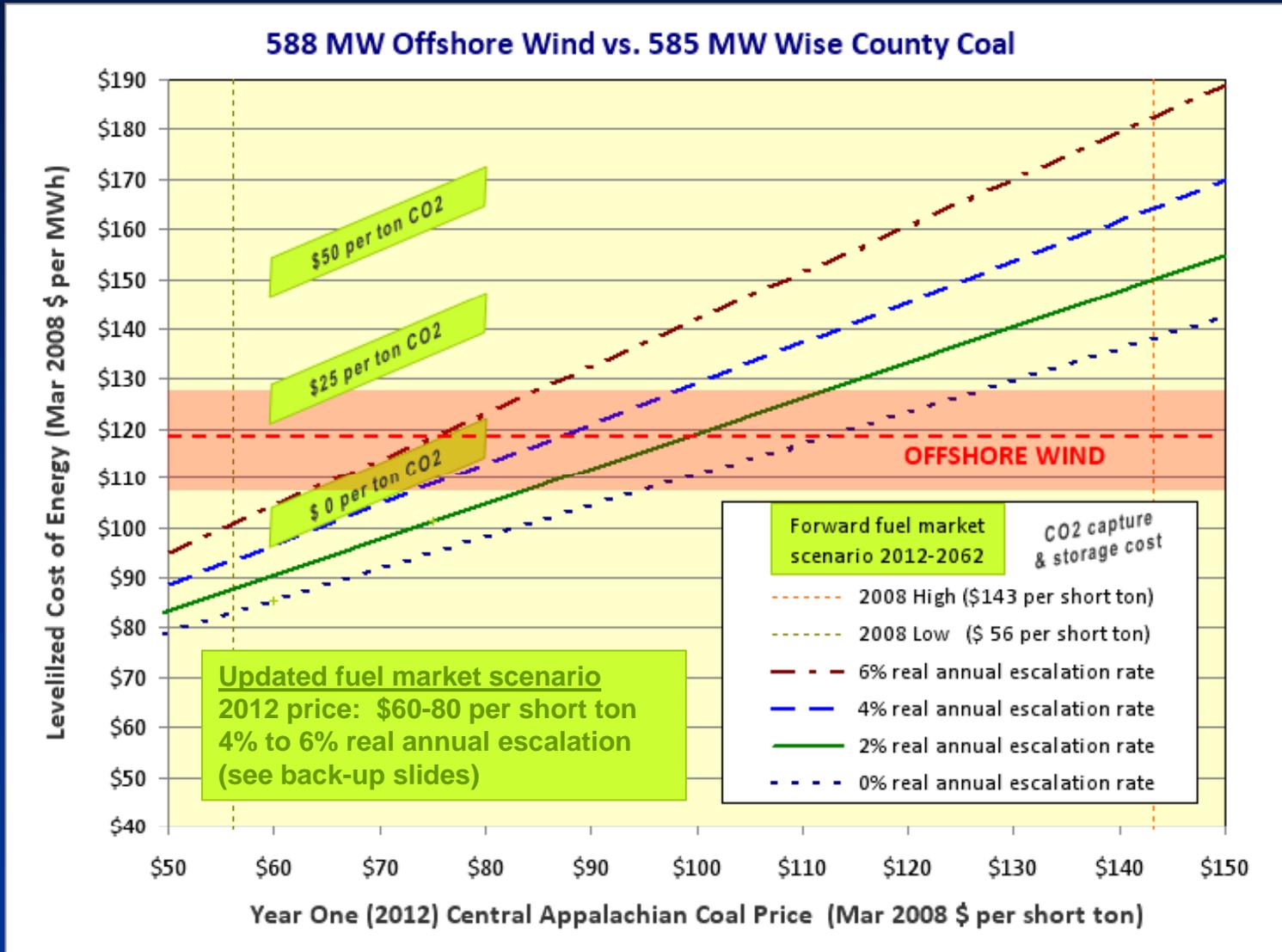
VCERC Modeled Capital Costs Compared with European Project Data for Major Cost Centers



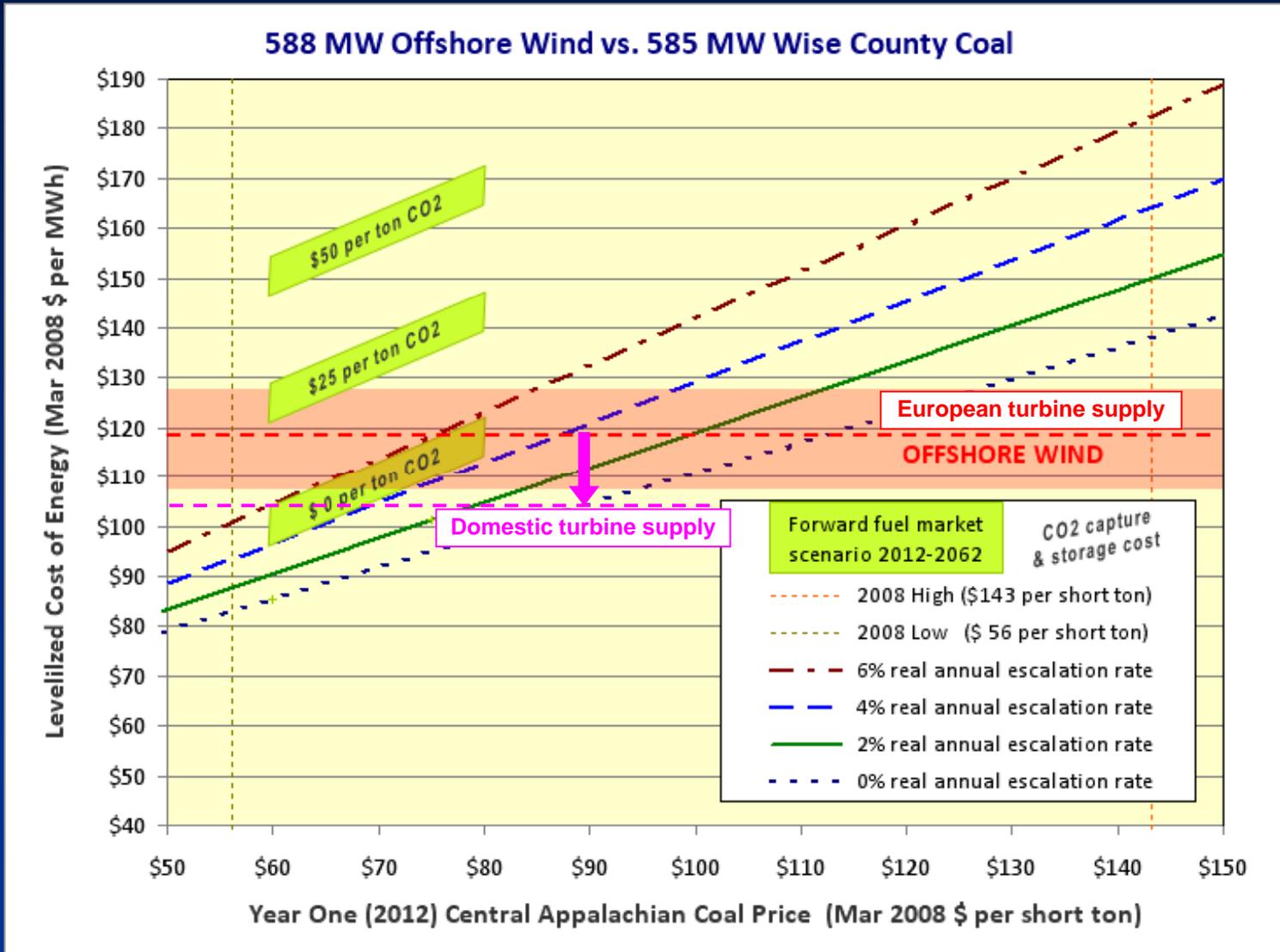
VCERC Modeled Capital Costs Compared with European Project Data for Major Cost Centers



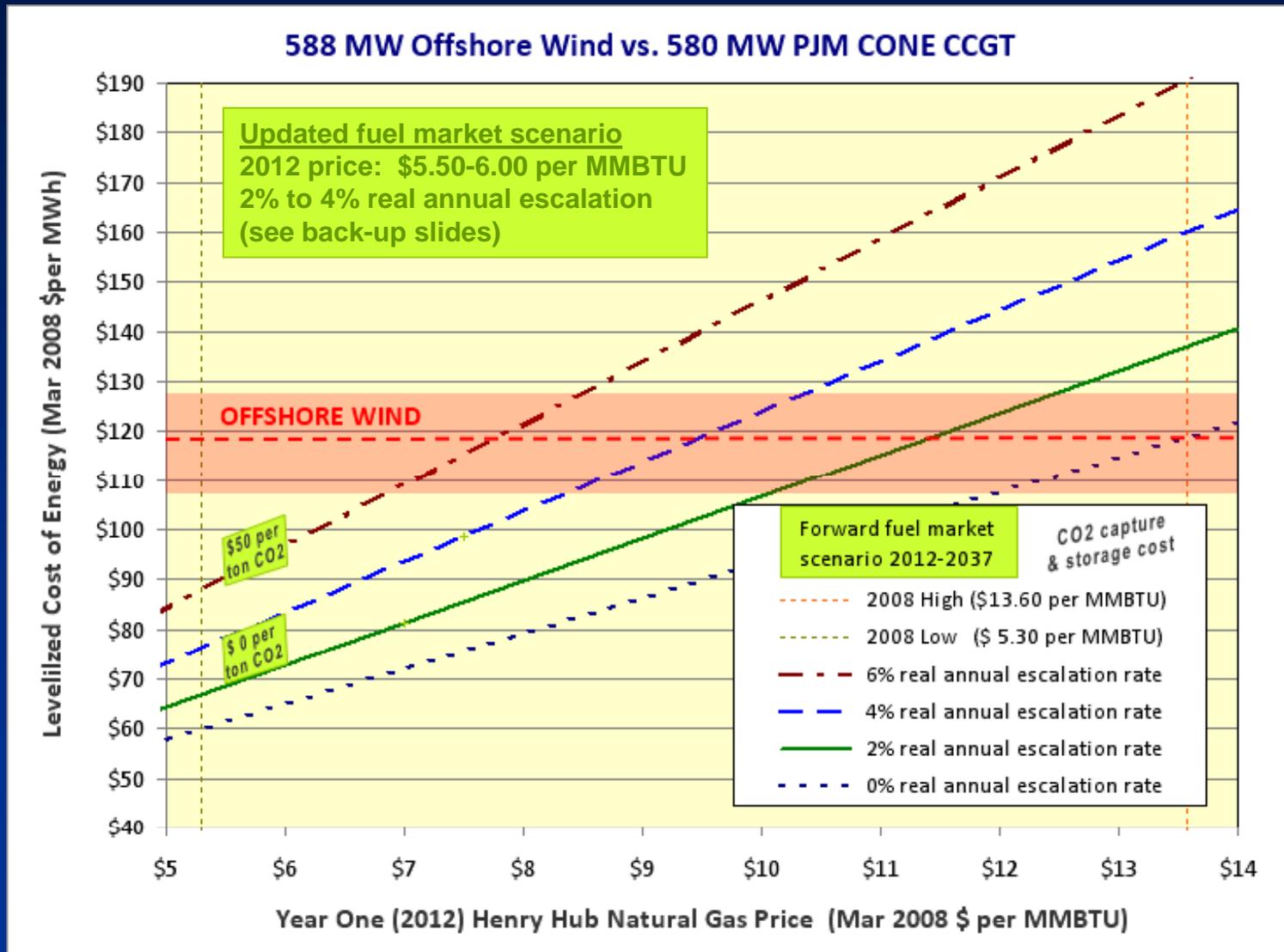
Cost of Energy Comparison Between Offshore Wind and New Coal-Fired Generation



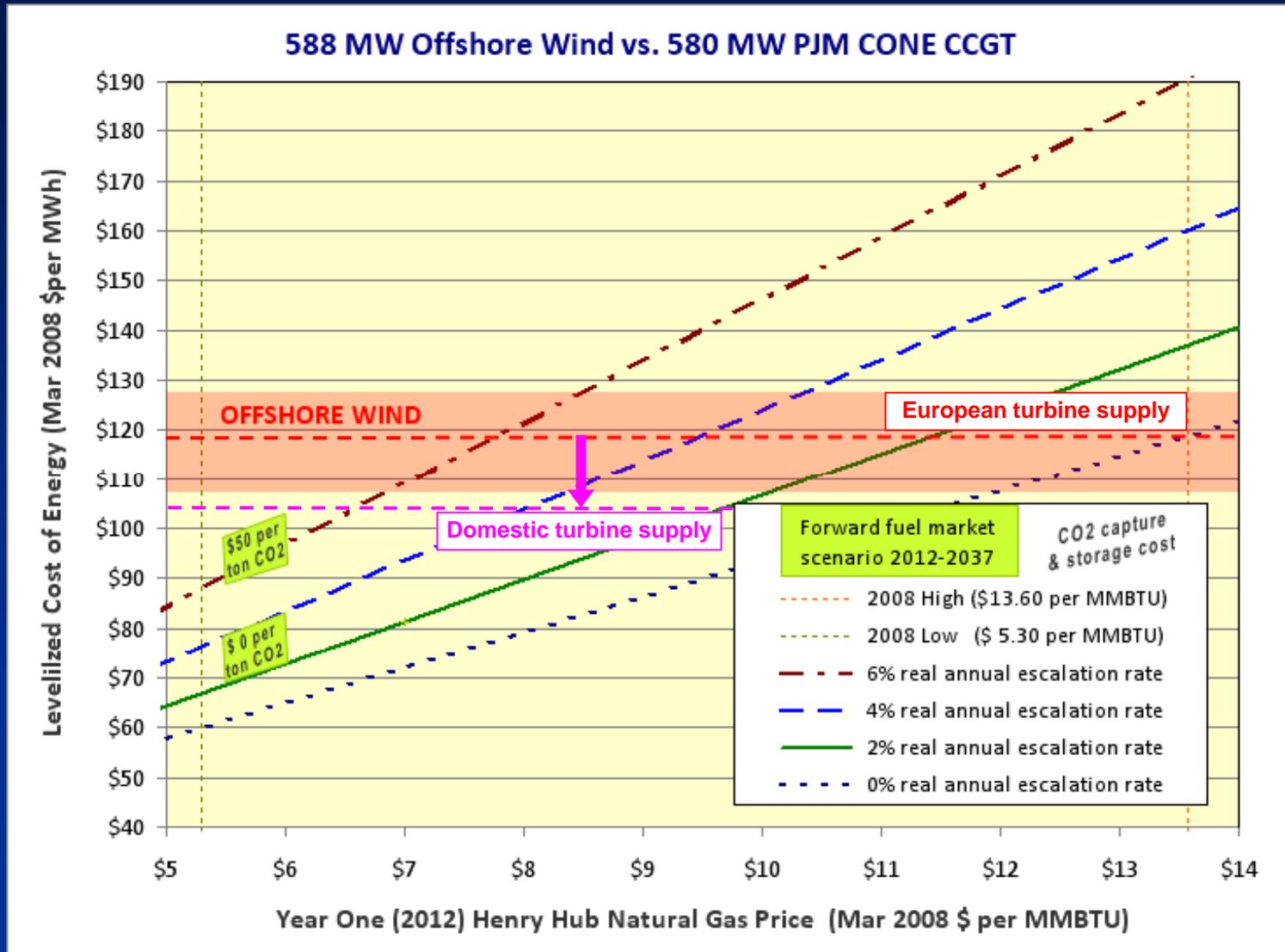
Cost of Energy Comparison Between Offshore Wind and New Coal-Fired Generation



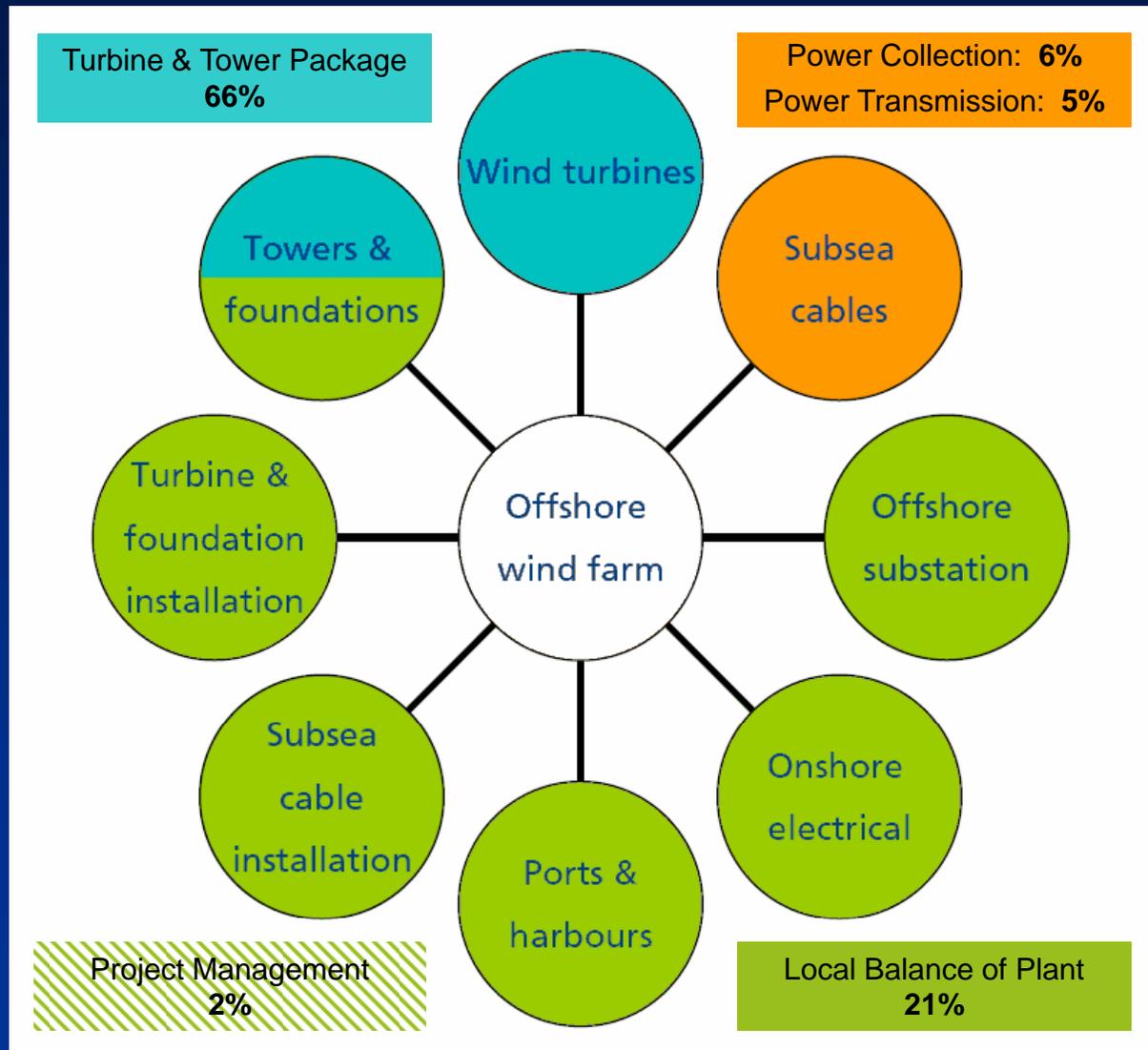
Cost of Energy Comparison Between Offshore Wind and New Gas-Fired Generation



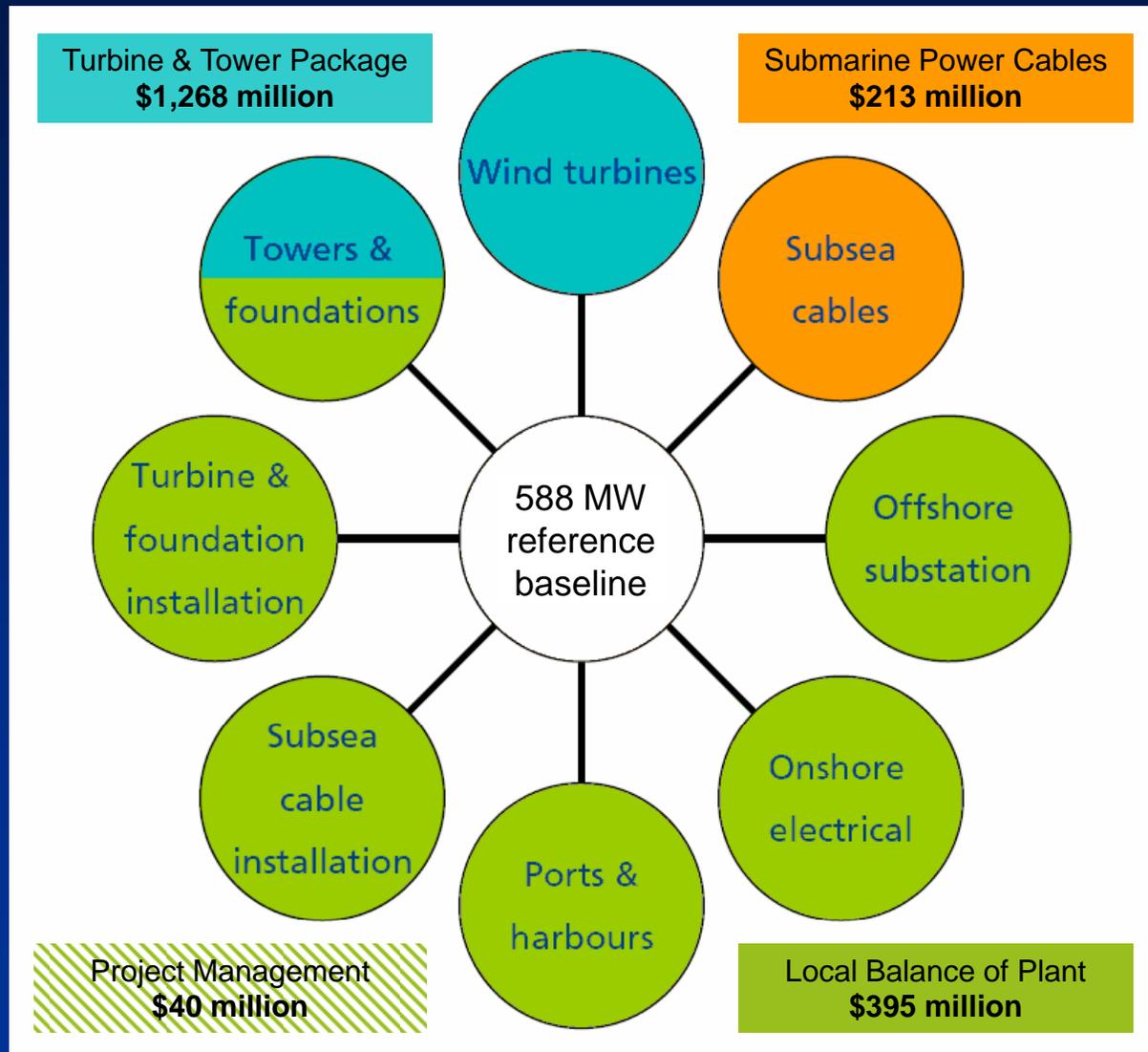
Cost of Energy Comparison Between Offshore Wind and New Gas-Fired Generation



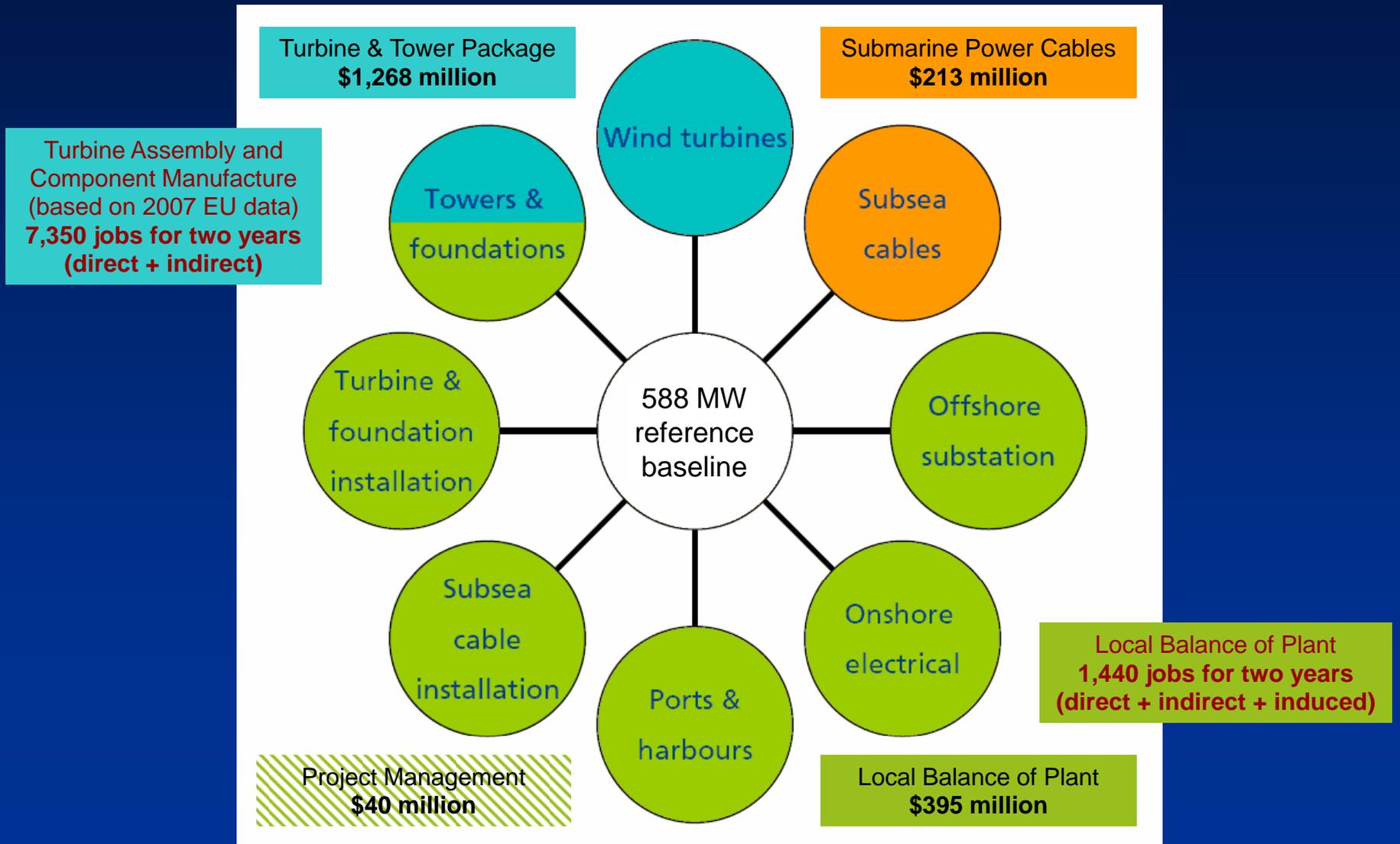
Offshore Wind Economic Development: Breakdown of Capital Investment by Percentage



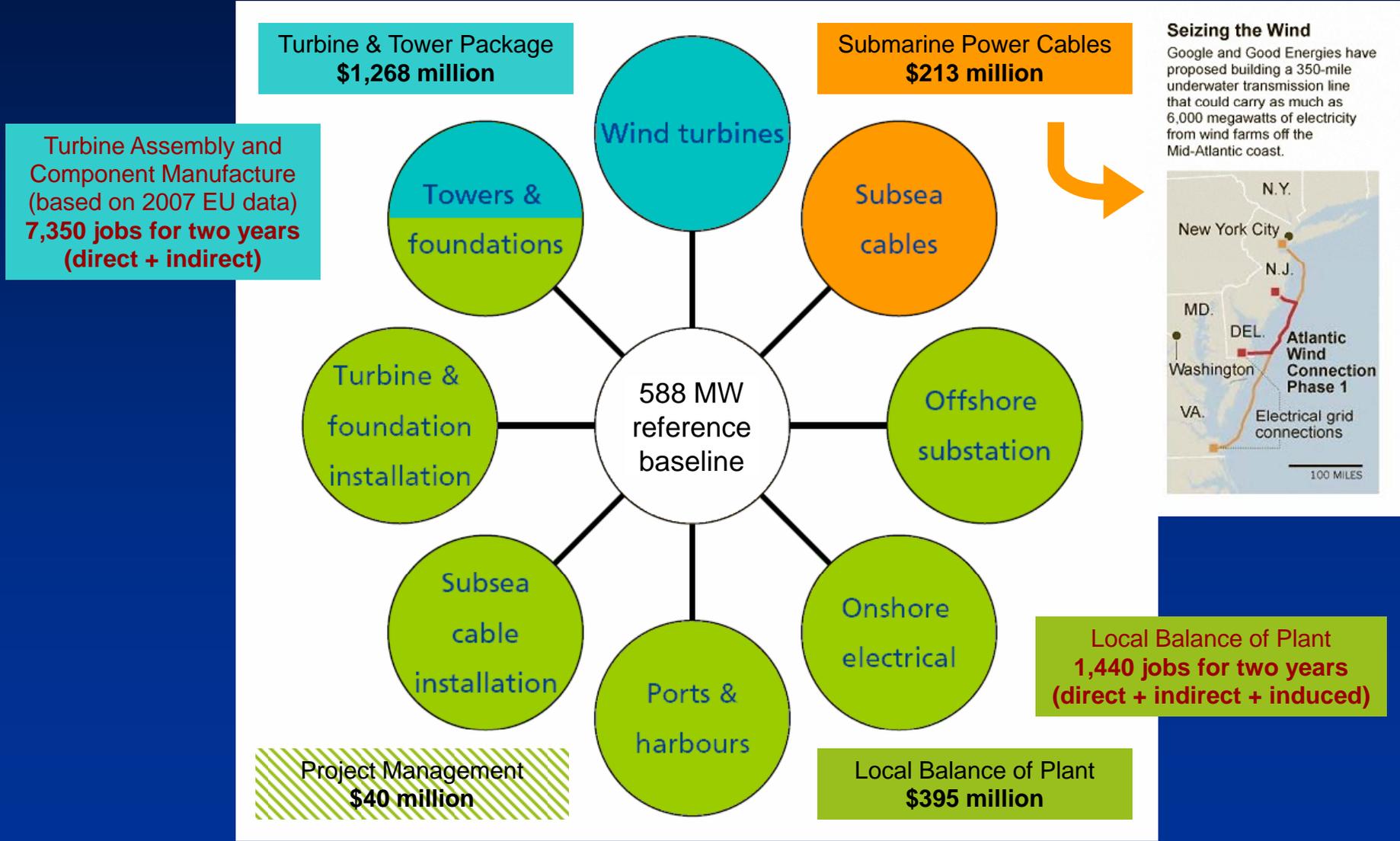
Offshore Wind Economic Development: Dollars and Jobs Breakdown for One Project



Offshore Wind Economic Development: Dollars and Jobs Breakdown for One Project



Offshore Wind Economic Development: Dollars and Jobs Breakdown for One Project



Early, Meaningful Engagement of Local Stakeholders Essential to Success



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 Test 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.

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>

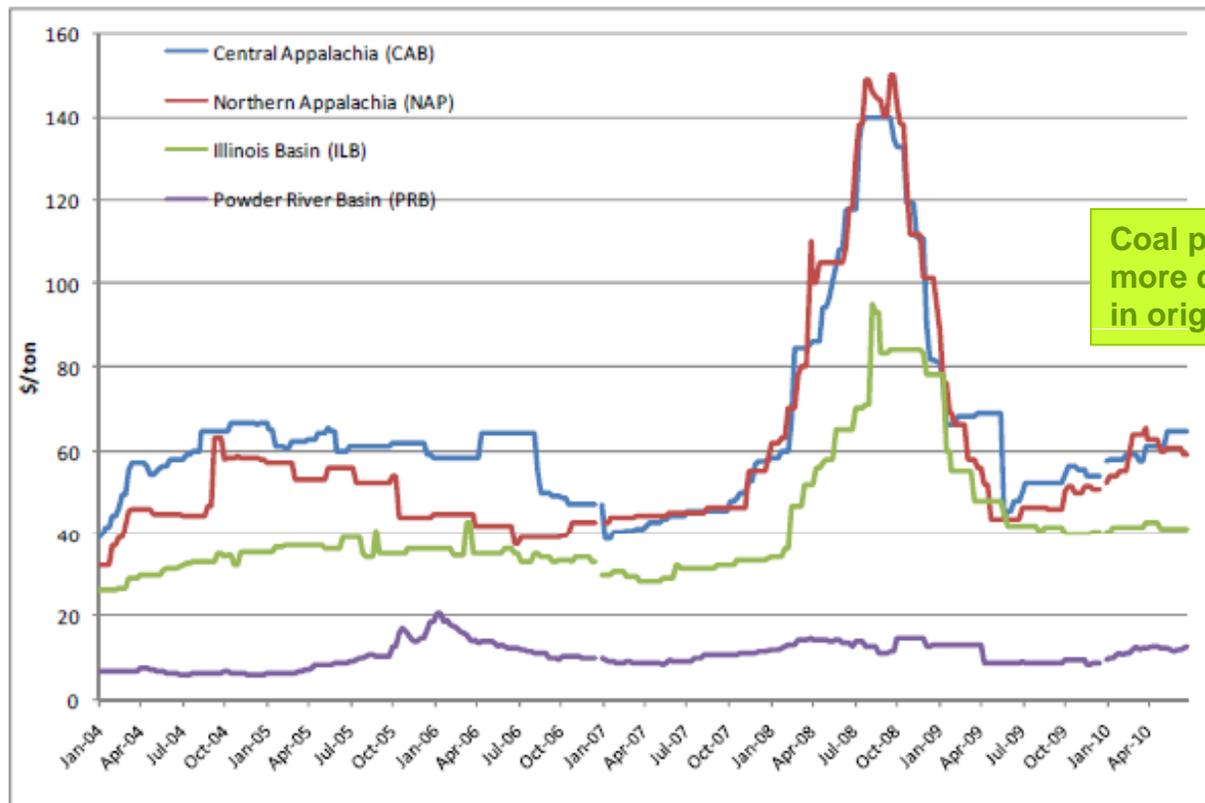
VCERC Offshore Wind Studies Final Report:

www.vcerc.org/report.htm

Any questions?

Email: hagerman@vt.edu or milesjj@jmu.edu

Historical Volatility in Coal Prices

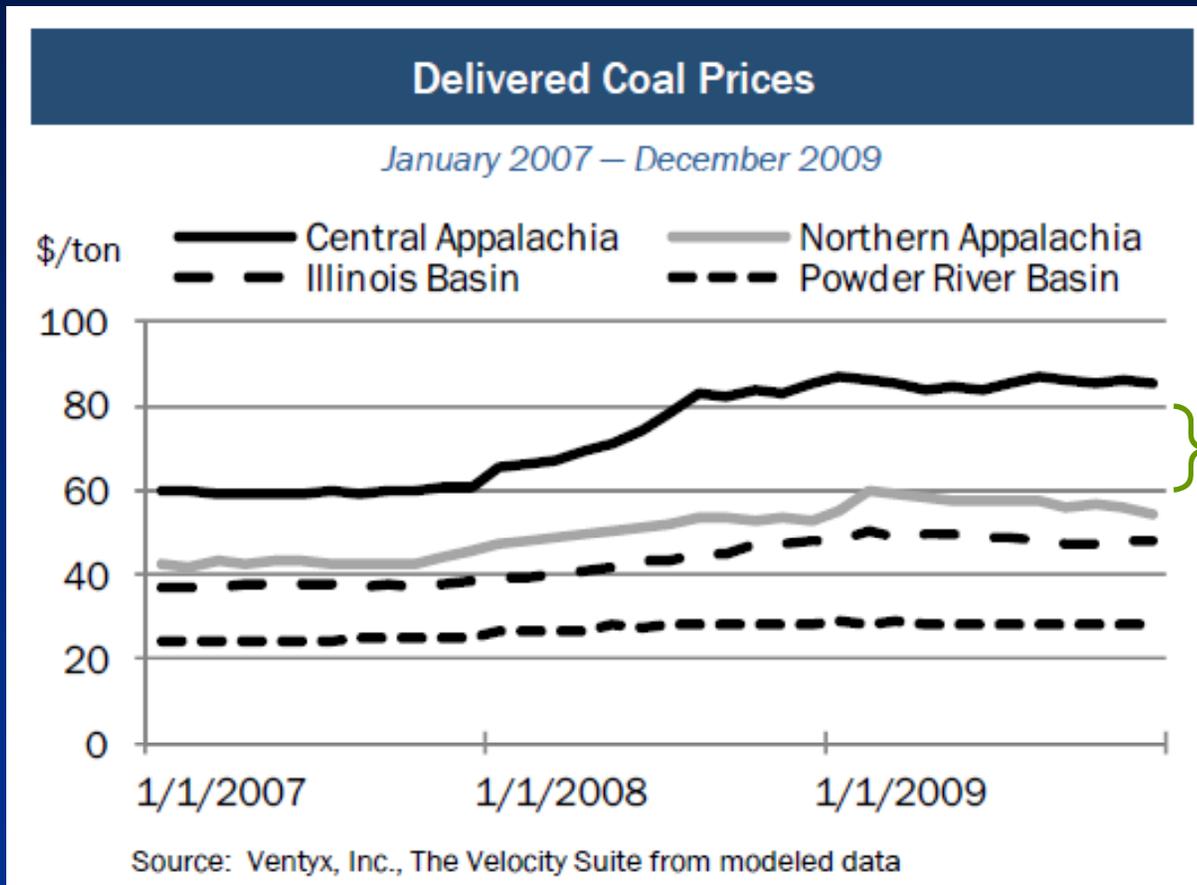


Coal prices are rebounding more quickly than assumed in original VCERC report

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

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

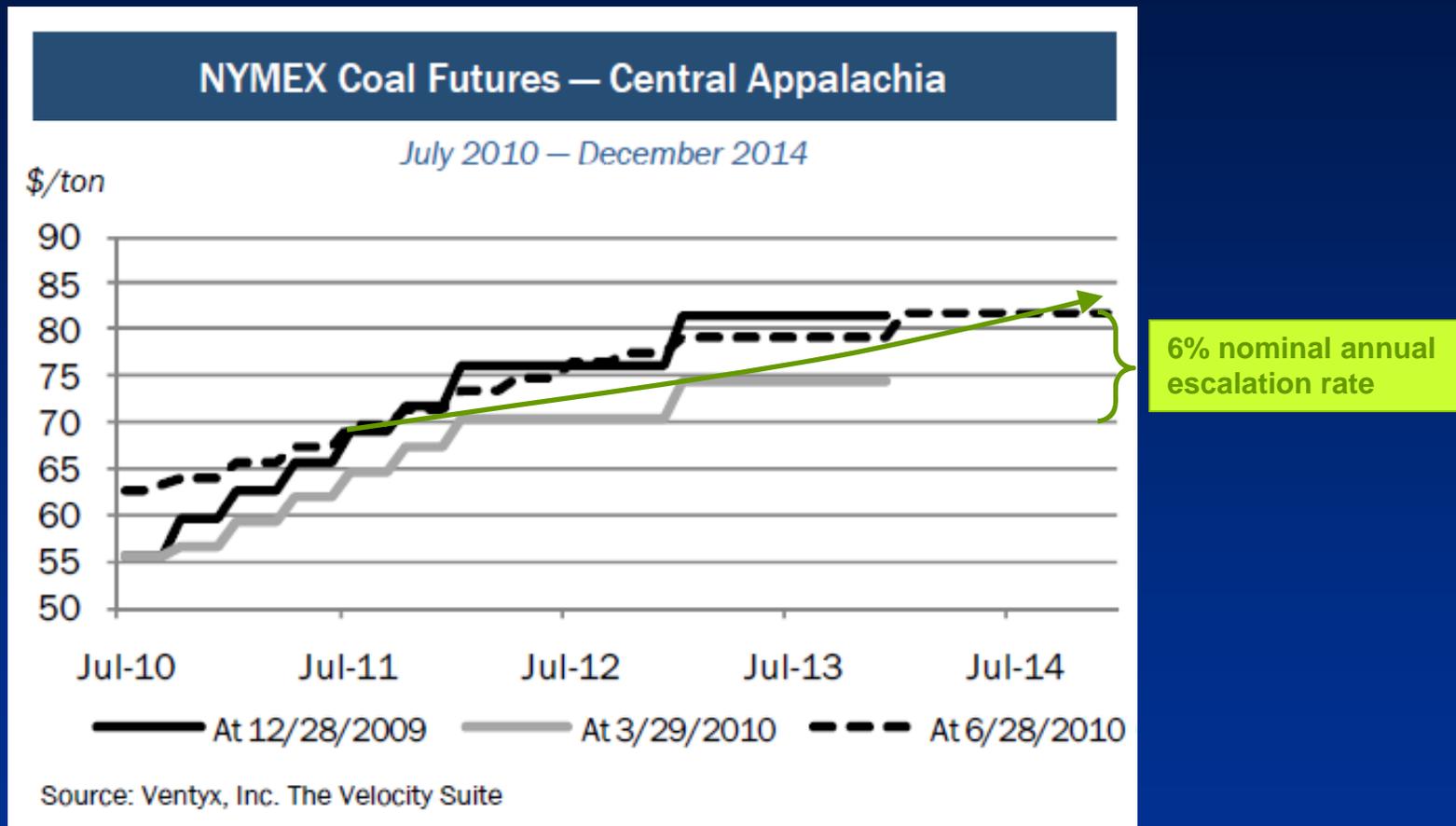
Recent Delivered Coal Prices



Assumed price range
in first year (2012)

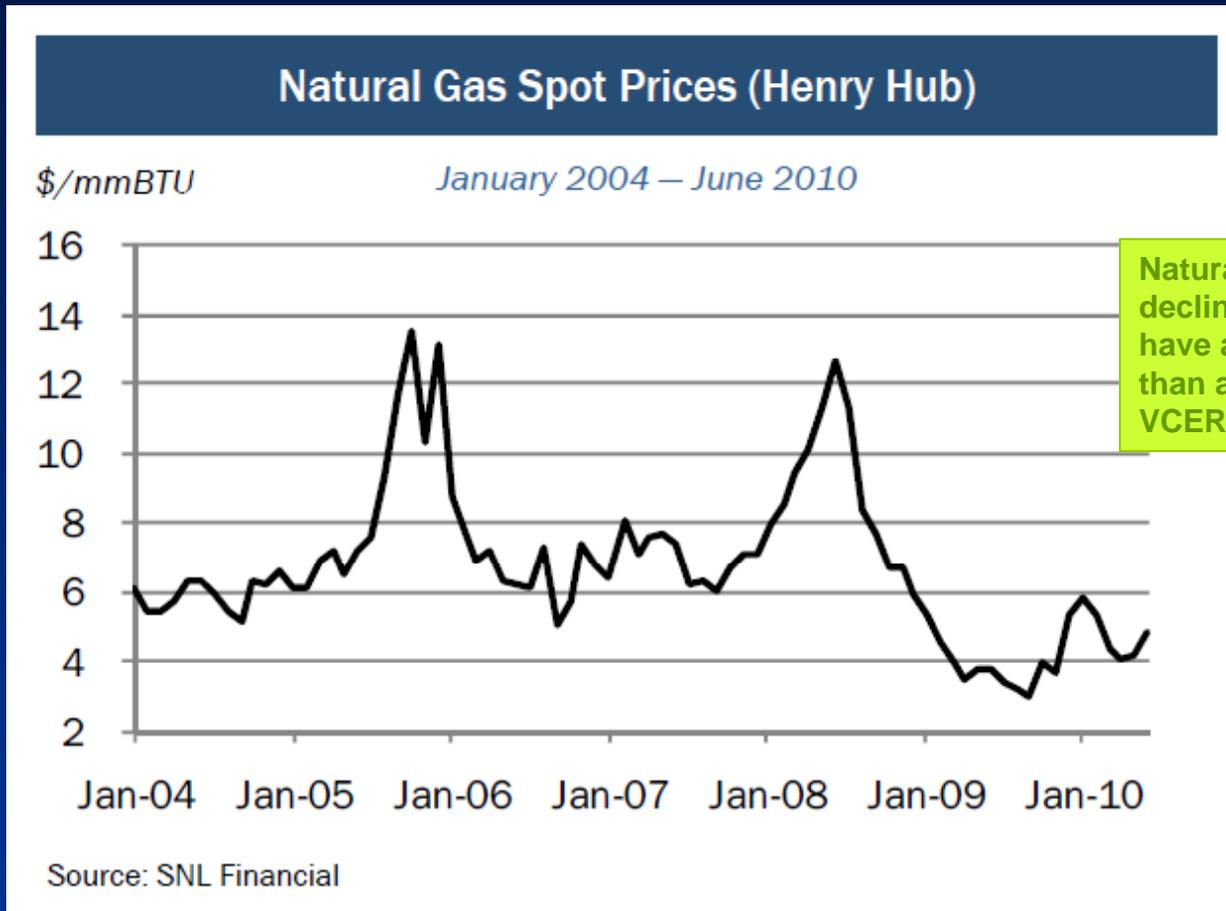
Source: Edison Electric Institute: Q2 2010 Financial Update: Fuel
(www.eei.org/whatwedo/DataAnalysis/IndusFinanAnalysis/Documents/2010_Q2_Fuel_Final.pdf)

Near-Term Forecast of Central Appalachian Coal Spot Market Prices



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

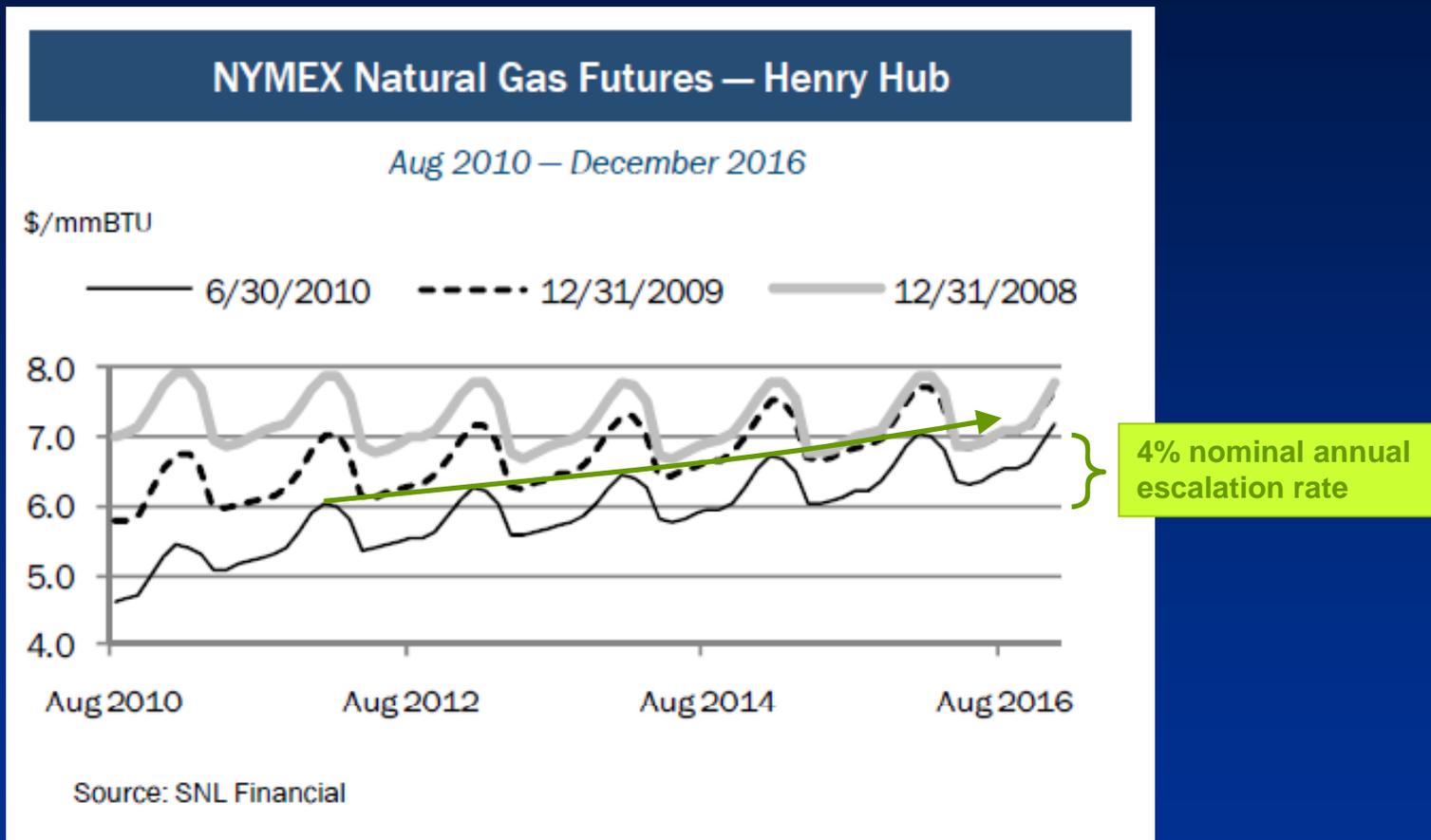
Historical Volatility in Natural Gas Prices



Natural gas prices have declined and are likely to have a lower 2012 price than assumed in original VCERC report

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

Near-Term Forecast of Henry Hub Natural Gas Spot Market Prices



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