Virginia's Offshore Wind Resource: Size, Economics, and Future Development

Virginia Commission on Energy and Environment

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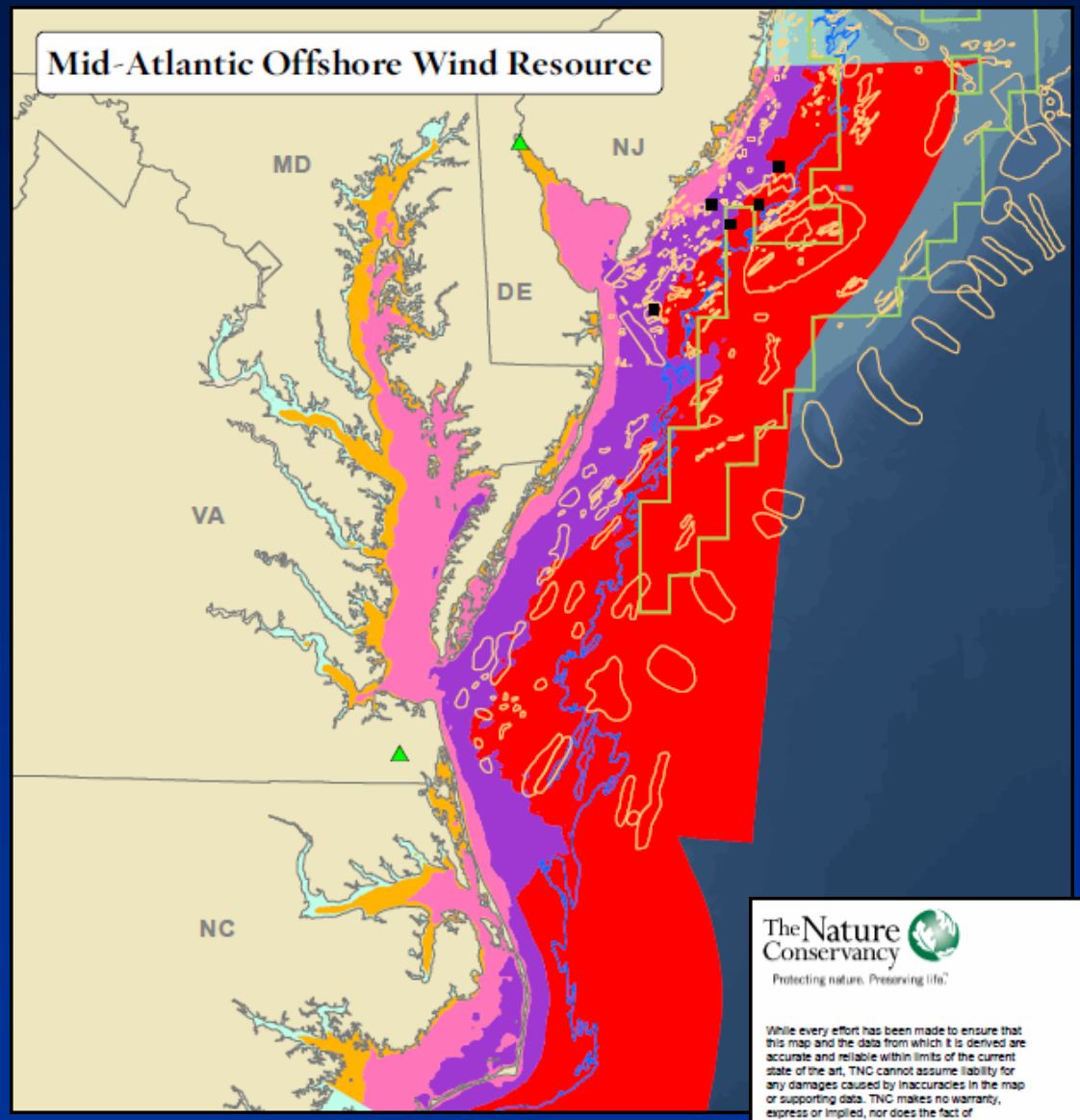
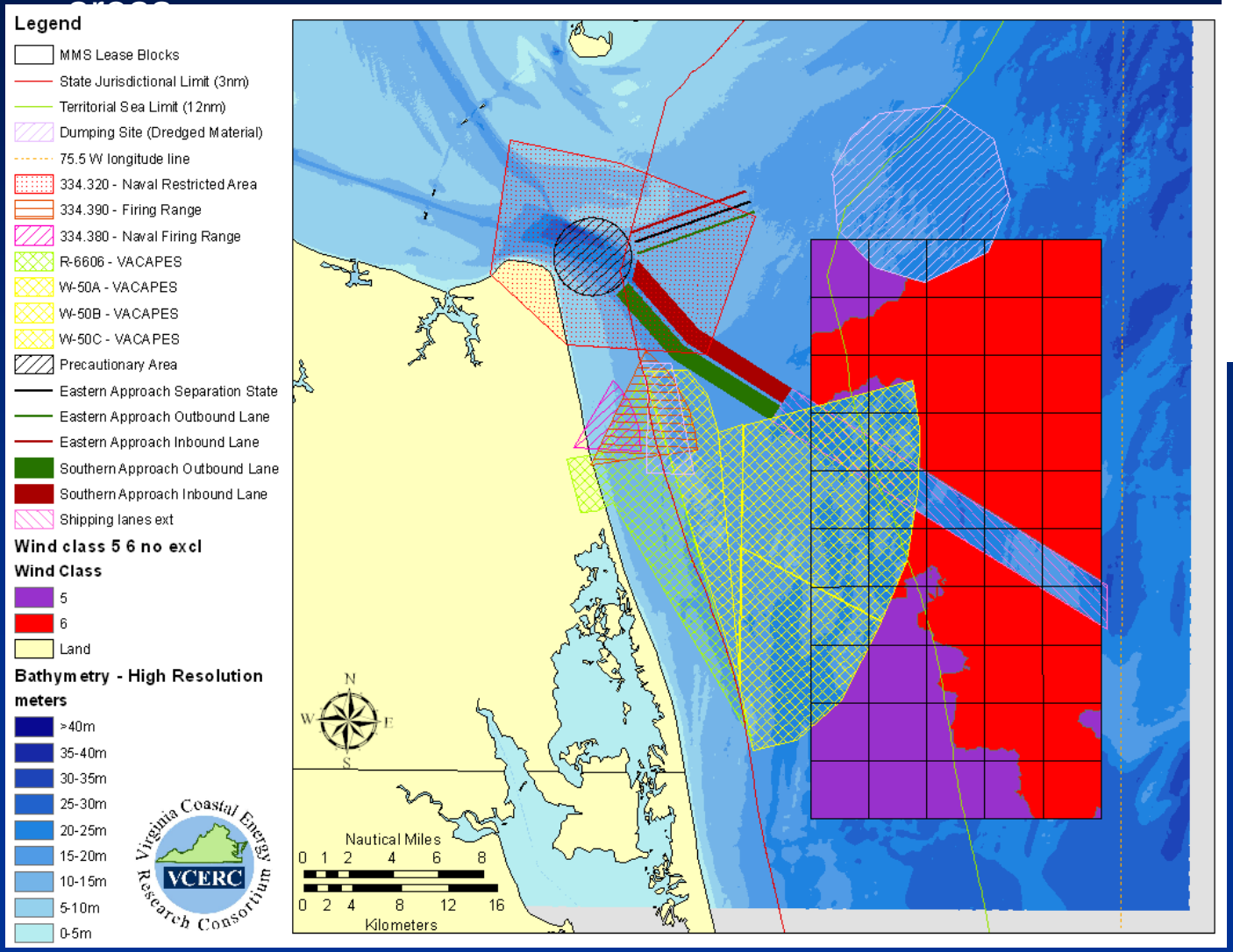
Virginia's Realistic Near-Term Offshore Wind Development Potential

Greatest Near-Term Mid-Atlantic Offshore Wind Potential is off Dominion's VA-NC Service Area



GIS Analysis and Mapping of Resource

- Focus on 50 MMS lease blocks and avoid all excluded areas



MMS lease blocks are 4.8 km x 4.8 km, with each block having 7 x 7 turbines.

Turbines spaced 685 m apart (7.6 rotor diameters)

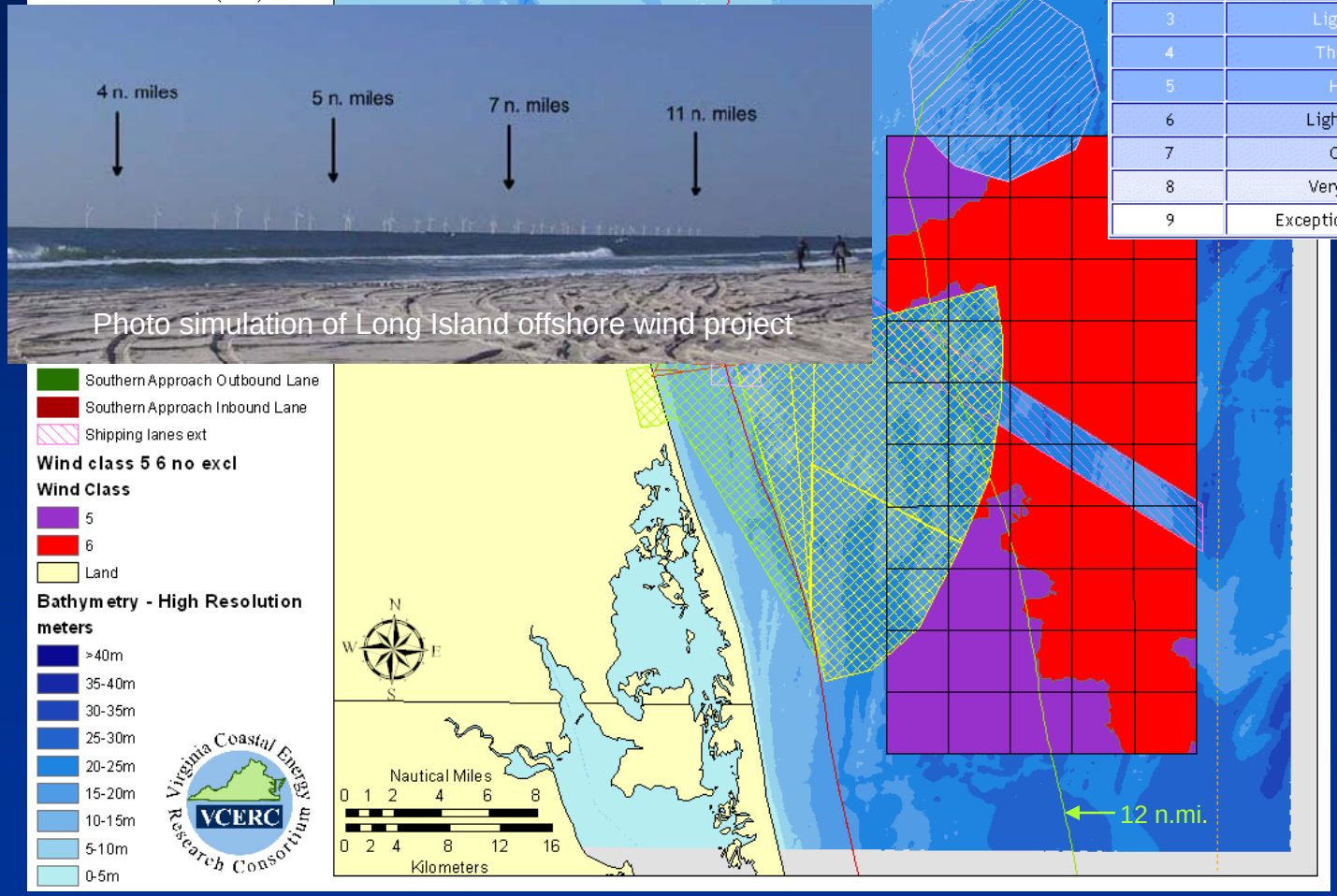
Each lease block could contain 49 turbines

= 147 MW per block with Vestas model V-90 3 MW

= 6.4 MW per km^2

GIS layers and calculations by James Madison University

Class 6 Winds are Largely Beyond the Visual Horizon



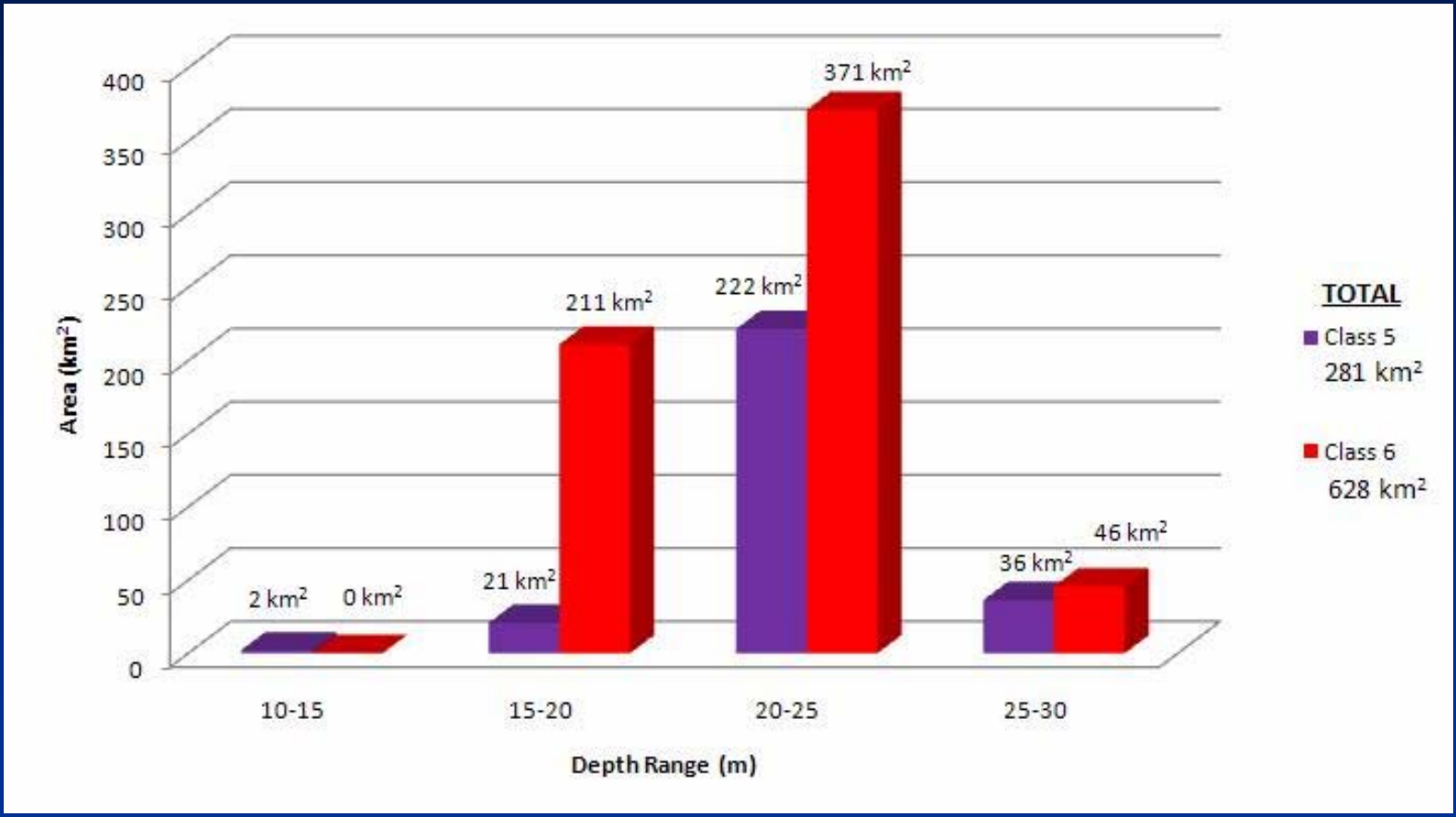
Meteorological Optical Range Table		
Code No.	Weather	Distance
0	Dense fog	Less than 50
1	Thick fog	50 - 200 yards
2	Moderate	200 - 500 yards
3	Light fog	500 - 1000 yards
4	Thin fog	.5 - 1.0 nm
5	Haze	1.0 - 2.0 nm
6	Light Haze	2.0 - 5.5 nm
7	Clear	5.5 - 11.0 nm
8	Very Clear	11.0 - 27.0 nm
9	Exceptionally Clear	Over 27.0

Beyond the Territorial Sea Limit of 12 n.mi., turbines would be barely visible, and then only on the clearest days.

Total available area of Class 6 beyond 12 n.mi. is 575.6 sq.km (142,500 acres); could support 3,680 MW of wind capacity.

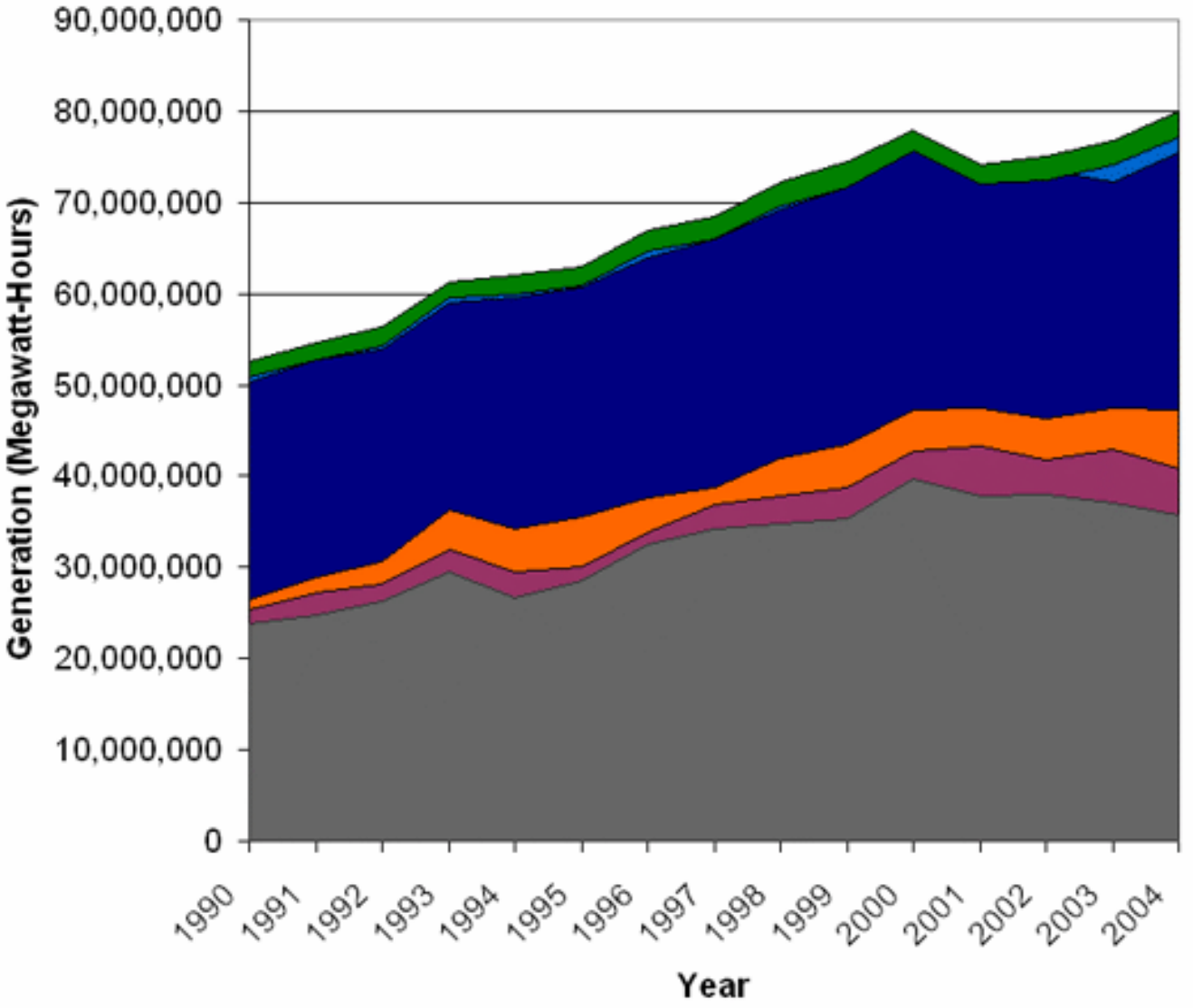
Preliminary GIS Calculations

- At density of 6.4 MW per km^2, could support ~4.5 GW, avoiding all excluded areas



Assuming capacity factors of 35% for Class 5 and 40% for Class 6, annual generation potential is ~5,500 and ~14,100 GWh/yr from Class 5 and Class 6 areas, respectively.

Near-Term Offshore Wind Generation Potential Compared with Virginia's Other Electricity Sources



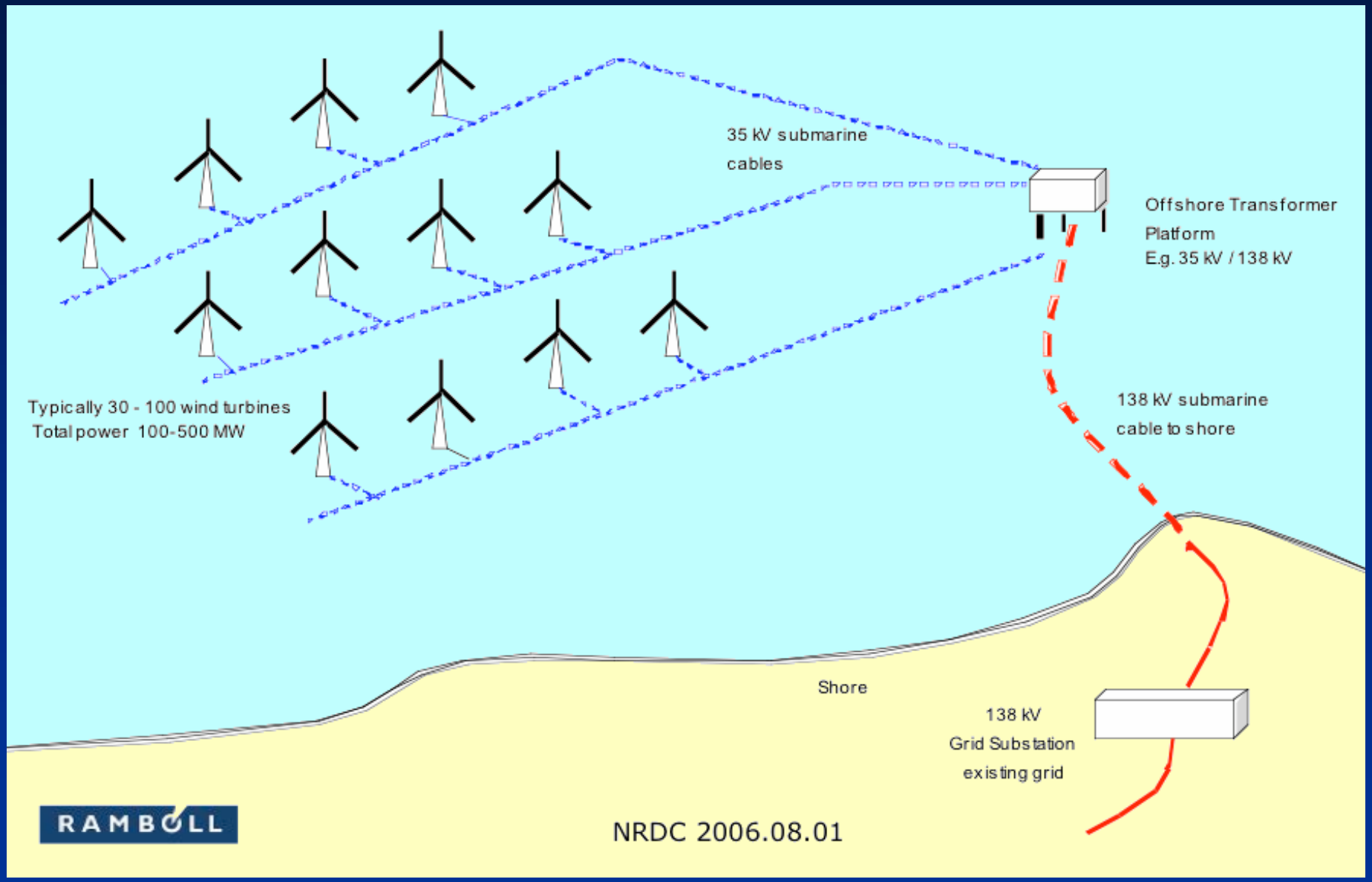
At 17,900 GWh per year, offshore wind power in non-excluded areas within 50 MMS lease blocks off Virginia Beach has the potential to become Virginia's third largest electricity source.

Class 6 offshore wind potential

Class 5 offshore wind potential

Offshore Wind Project Layout and Construction

Typical Offshore Wind Farm Layout



Monopile Foundations Driven into Seabed and Transition Pieces Grouted on Top

Horns Rev 2-MW Turbines Installed Using Self-Propelled *A2 SEA* Vessels

North Hoyle 2-MW Turbines Installed Using Towed *Seacore* Jack-Up Rigs

Wind as Hedge Against Future Price Increases in PJM

PJM Energizes About One-Fifth of the U.S. Gross Domestic Product

6,038 transmission substations

KEY STATISTICS

PJM member companies	390+
millions of people served	51
peak load in megawatts	135,000
MWs of generating capacity	163,806
miles of transmission lines	56,070
GWh of annual energy	700,000
generation sources	1,271
square miles of territory	164,260
area served	13 states + DC

26% of generation in Eastern Interconnection

23% of load in Eastern Interconnection

19% of transmission assets in Eastern Interconnection

19% of U.S. GDP produced in PJM

Financial Assumptions

- Taxes and depreciation
  - *Composite tax rate: 38.8% (35% Federal, 5.85% State)*
  - *General depreciation declining balance is used*
    - GDS life of 15 years for conventional fuels
    - GDS life of 5 years (bonus depreciation) for wind
- Project financing
  - *100% of the plant is financed up front*
    - 43.2% Debt and 56.8% Equity
    - Debt interest rate: 5.586%
    - Equity rate of return: 13.75% common, 7.174% preferred
    - Includes 3-year construction loan (7.5% debt rate)
  - *Debt is paid monthly, equity quarterly*
  - *Financing term: 25 years*
  - *Service life: 25 years for gas, wind; 50 years for coal*

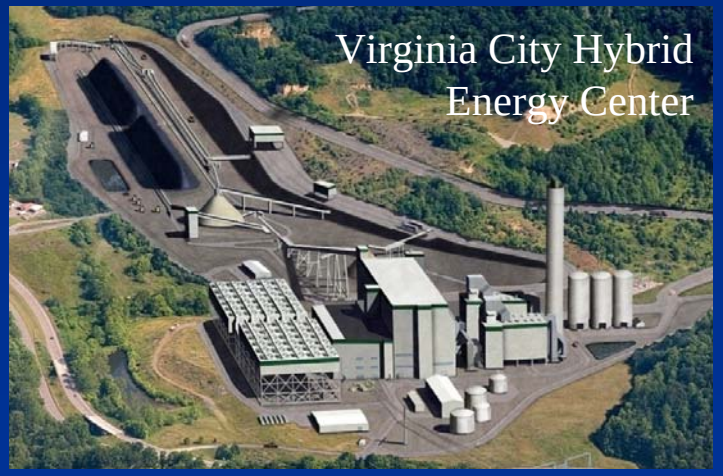
Buckingham County
Combined Cycle Gas-Fired Project

- Capital cost basis
  - *As published in PUE-2008-00014 (Filed 03/11/2008)*
  - *Plant Cost $614 million*
  - *Transmission Cost $5.1 million*
- 580 MW rated capacity
- 89.9% annual operational capacity factor
- Plant heat rate: 6.09 MMBtu per MWhr
- 25 plant operators
- Emissions
  - *CO_2 1,829,088 ton/year*
  - *No_x 178 ton/year*
- Actual in-service date: 2011 (used 2012 for all projects)

Possum Point #6

Wise County Coal-Fired Project

- Capital cost basis
  - *As published in PUE-2007-00066 (Filed 03/31/2008) & PUE-2007-00111 (Filed 12/03/2007)*
  - *Plant Cost $1.8 billion*
  - *Transmission Cost $23 million*
- 585 MW rated capacity
- 98.9% annual operational capacity factor
- Plant heat rate: 10.00 MMBtu per MWhr
- Coal heat content: 15.4 MMBTU per short ton
- 75 plant operators
- Emissions
  - *CO_2 4,838,060 ton/year*
  - *NO_x 1,755 ton/year*
  - *SO_x 3,009 ton/year*
- Actual in-service date: 2013 (used 2012 for all projects)



V90-3MW Offshore Wind Project

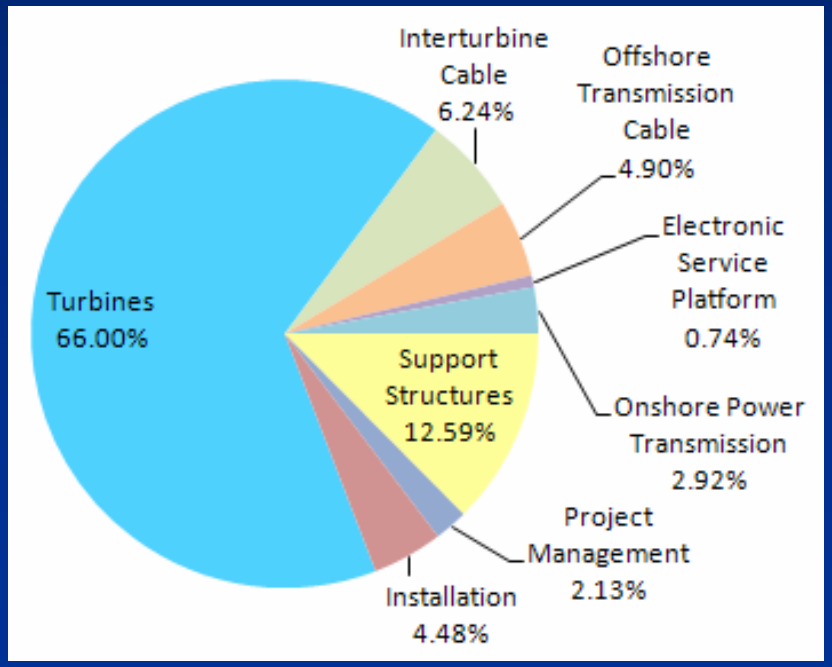
Capital cost estimated in March 2008 dollars using Virginia maritime supplier bids and published data

- *Plant cost at offshore busbar : $ 1,748 million*
- *Transmission cost to Fentress : $ 153 million*
- *Total plant investment : $ 1,901 million (~ $3,230 / kW)*

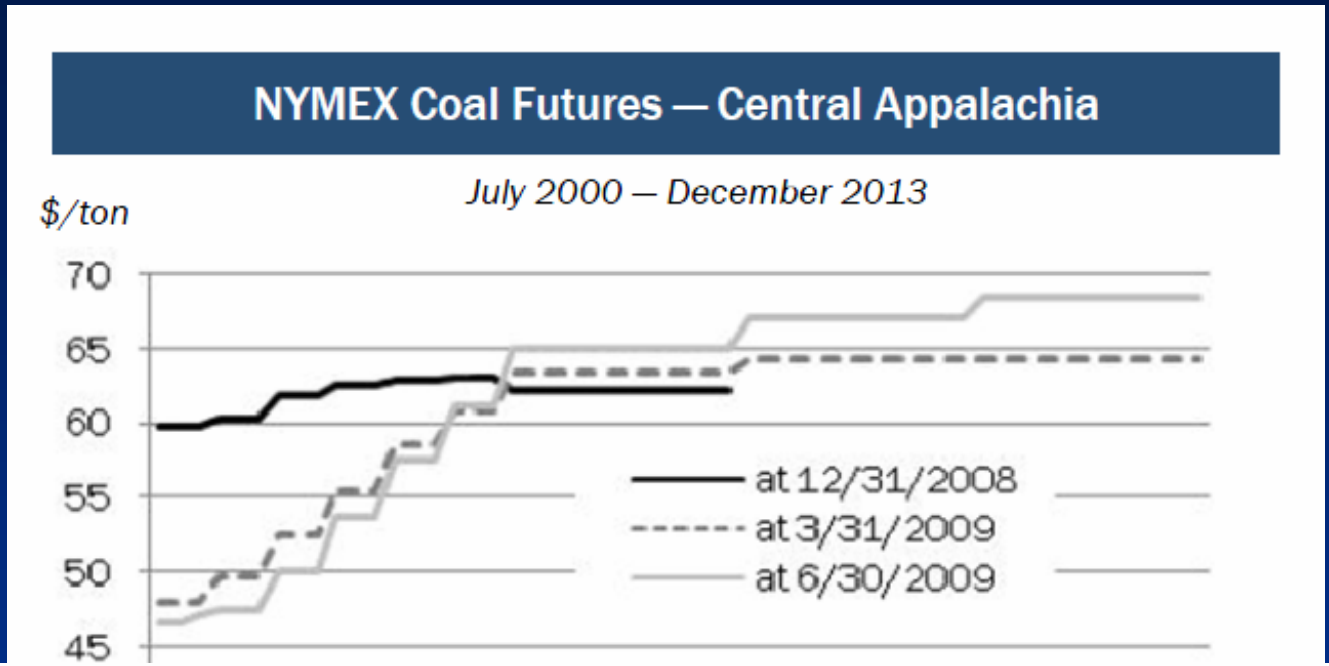
588 MW installed rated capacity

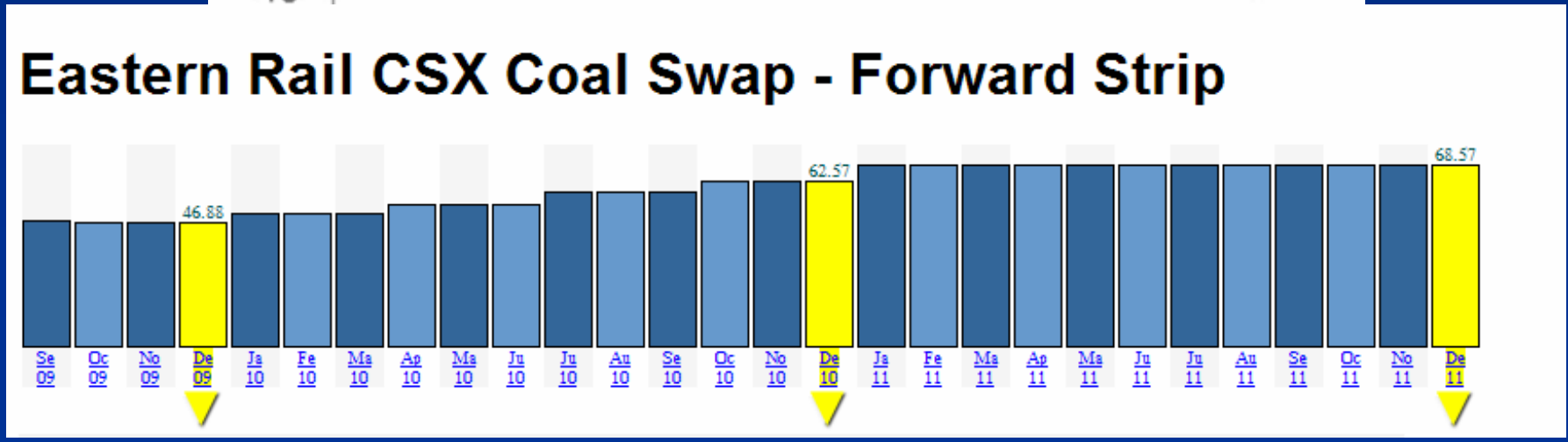
38% annual capacity factor

20% PJM capacity factor

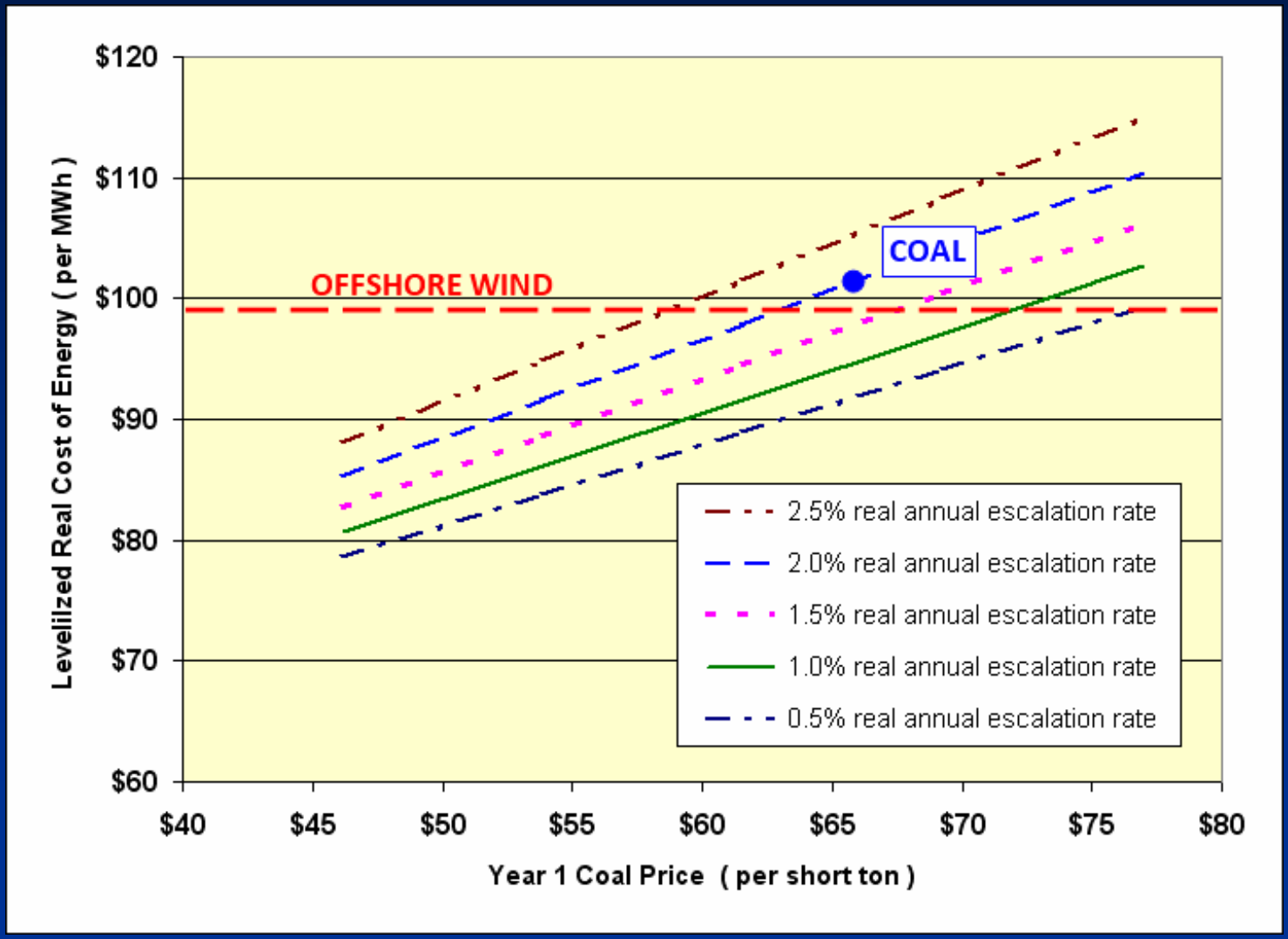


Projected Coal Prices by 2012

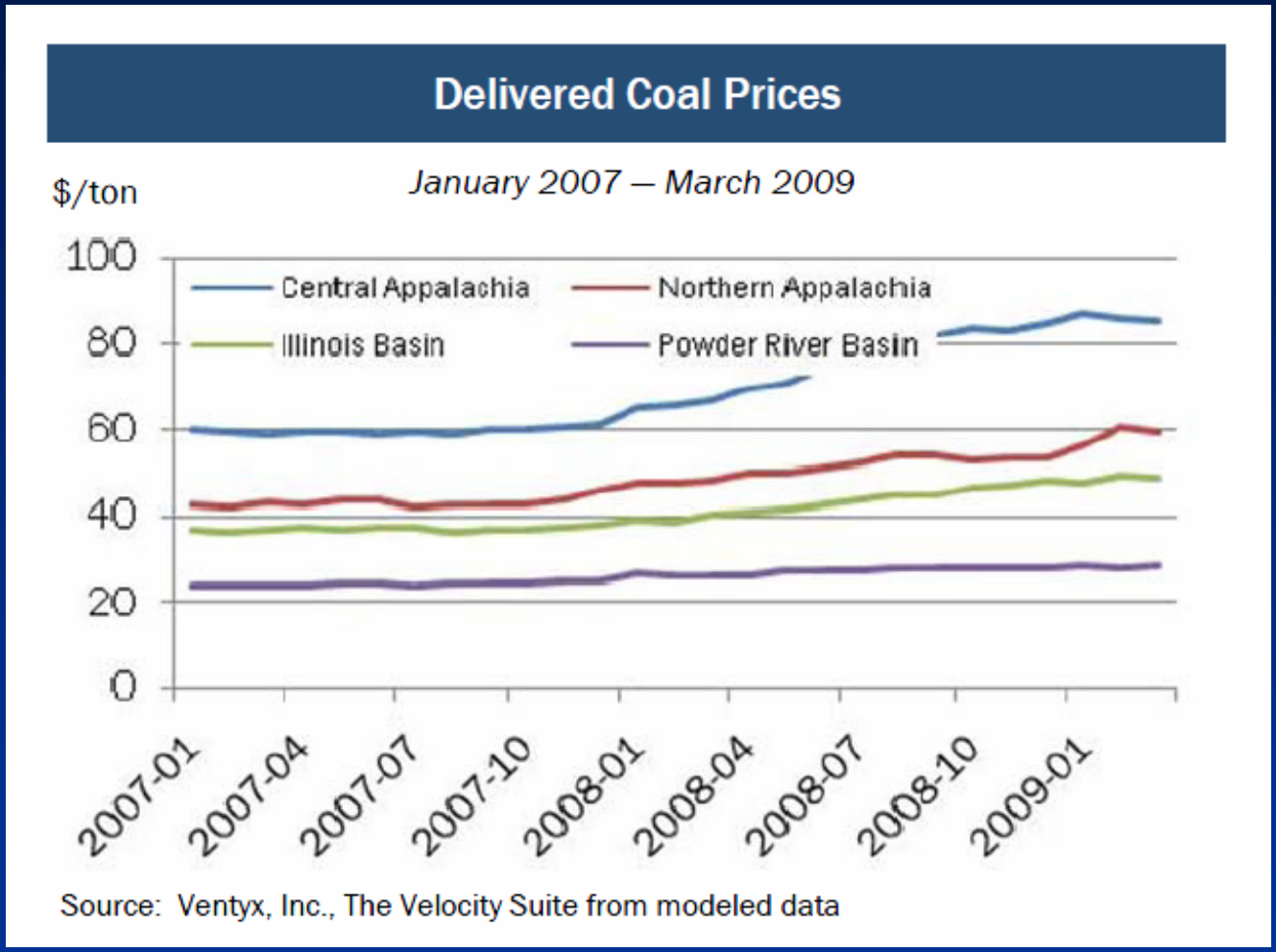




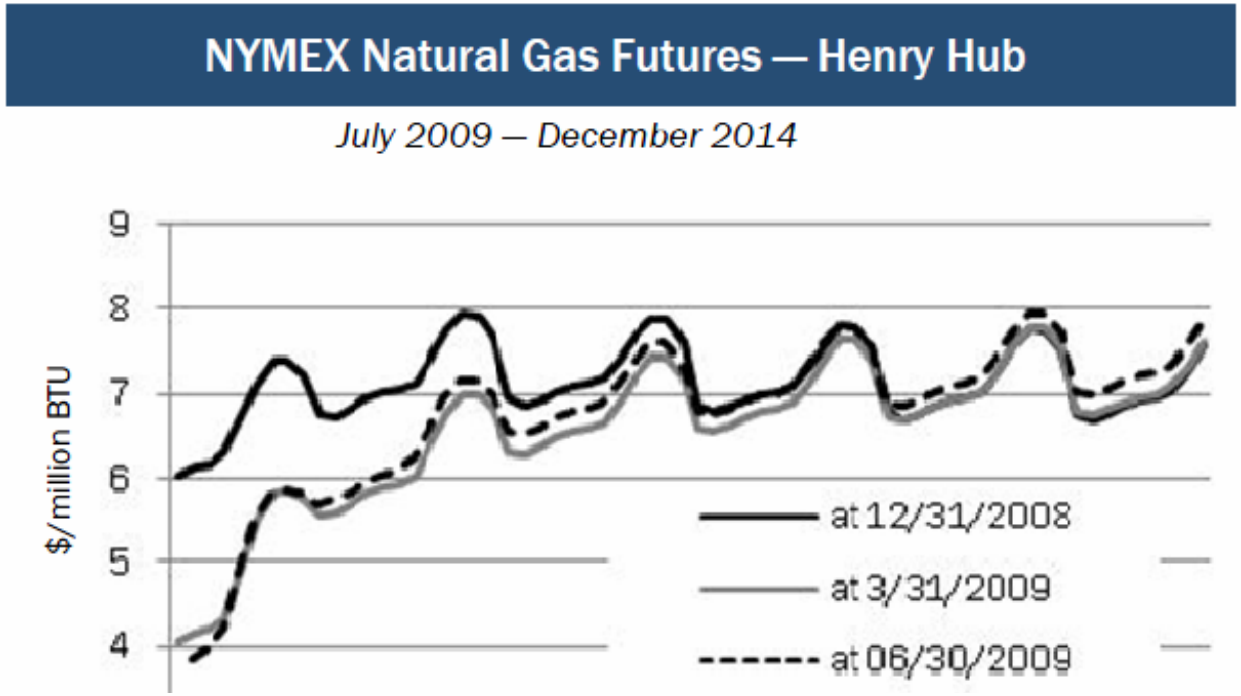
New Offshore Wind Compared with New Coal



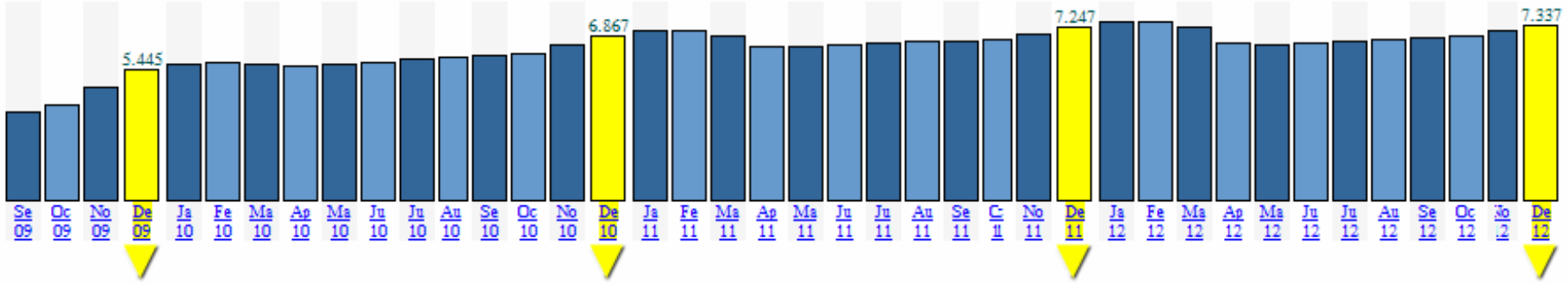
Delivered Coal Prices Already Seem to Exceed Projections



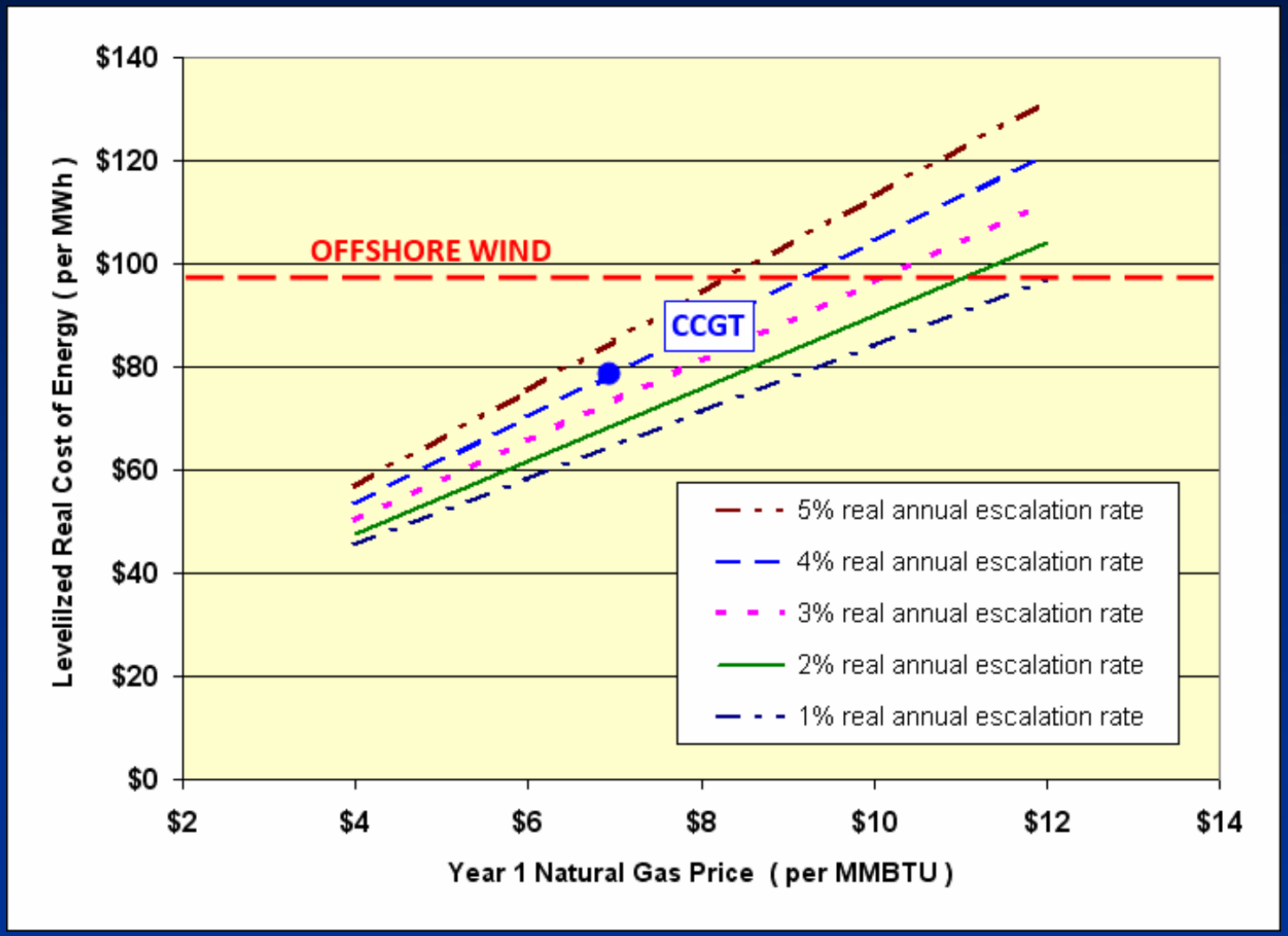
Projected Natural Prices by 2012



Henry Hub Natural Gas Swap - Forward Strip



New Offshore Wind Compared with New CCGT



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

From the Editor

This second EMI focuses on the quantitative assessment of key risks affecting the valuation of electricity generation assets. Mike King and Jim Heidell outline the stochastic model NERA has developed to help investors gain insights into the critical valuation issues surrounding fossil fuel generation plants. Challenges for valuing fossil fuel plants will increase going forward as the result of the potential impact of greenhouse gas regulation and policies designed to encourage the development of renewable generating technology. These environmental policies are prominent in many jurisdictions world-wide, providing wide applicability for the techniques discussed in this edition.

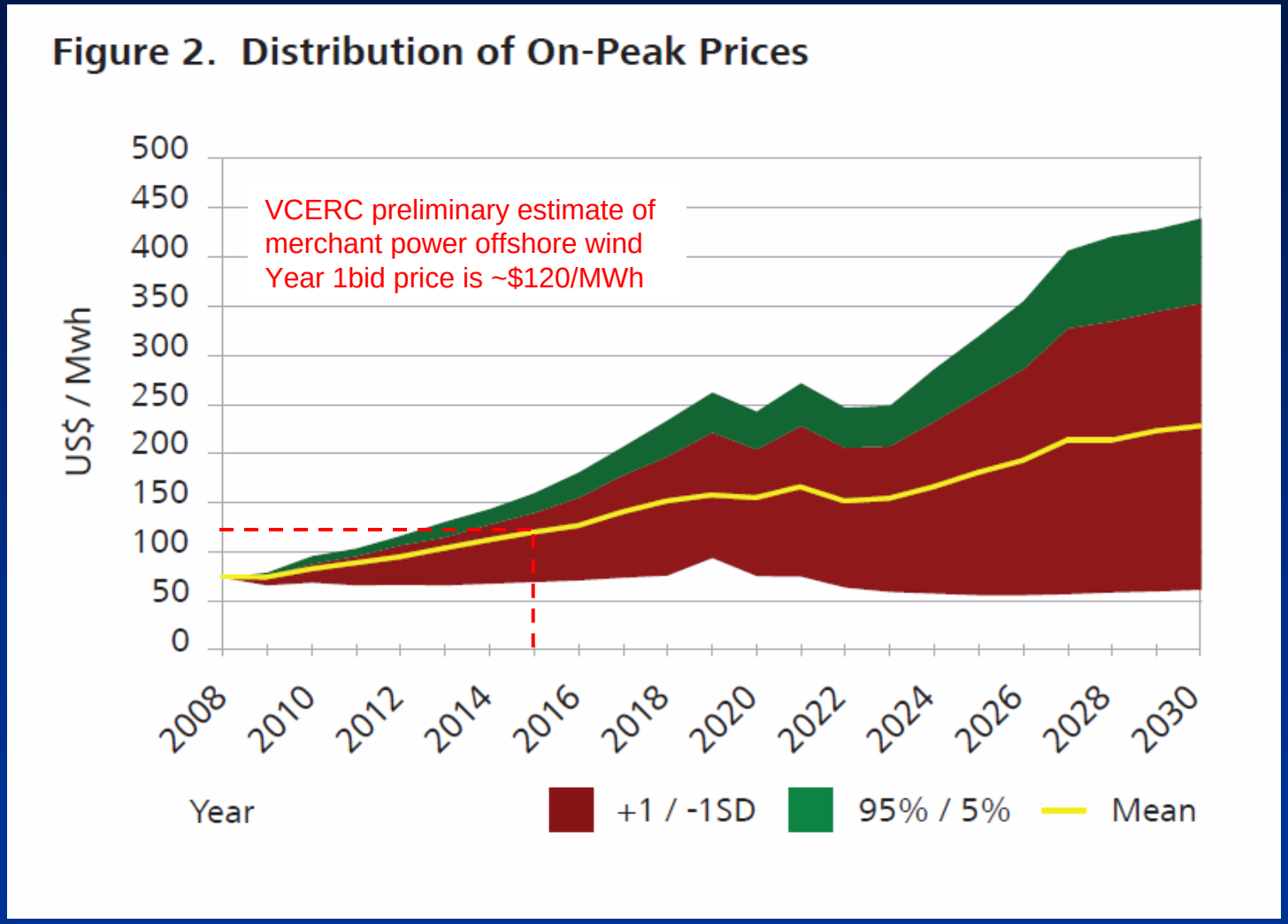
—Ann Whitfield, Editor

NERA Study of Fossil Generation Portfolio in PJM

Case Study

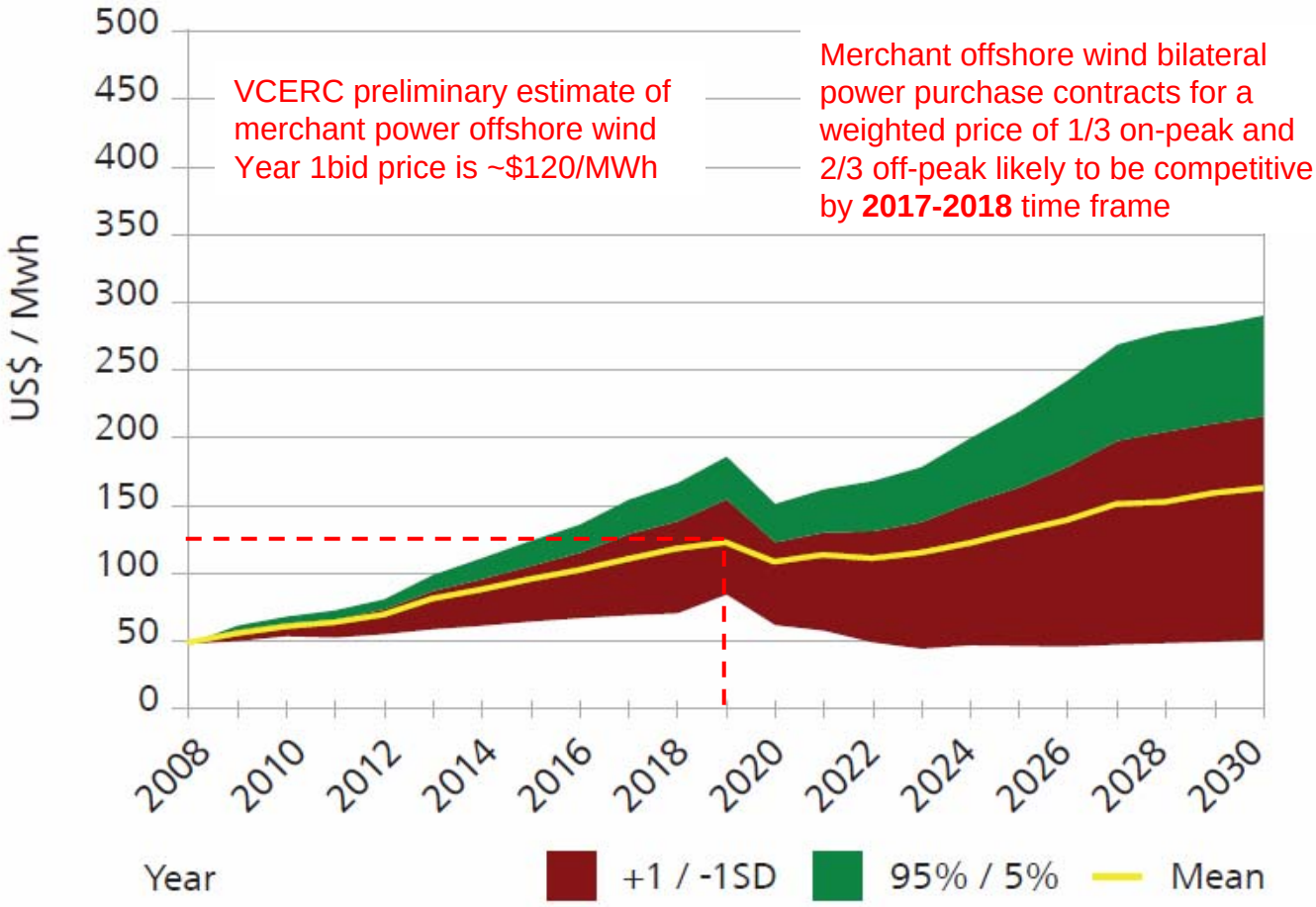
The following case study highlights our assessment process for an actual portfolio of coal-fired and gas-peaking plants located in the PJM region. On a MW basis, the existing portfolio consists of approximately two-thirds coal-fired assets and one-third peaking assets. Our case study incorporates uncertainty 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



PJM Long-Term Electricity Price Forecast

Figure 3. Distribution of Off-Peak Prices



Anticipated Commercial Development Timetable

Development of Greater Gabbard: 504 MW (UK)

December 2003
•Fluor/Airtricity JV awarded 500MW Greater Gabbard Offshore Wind Farm Project

Greater Gabbard Offshore Winds Ltd

December 2004
•Grid Connection Offer received from National Grid for connection at Sizewell, Suffolk

October 2005
•Consents application submitted

February 2007
• All onshore and offshore consents received
• Siemens selected for wind turbines

May 2008
•Financial Close & Notice to Proceed

October 2003
•Bids submitted for UK Round 2

Airtricity FLUOR

2004
•Conceptual design
•Offshore Site Surveys
•Environmental
•Geophysical

September 2005
•Met Mast installed

Summer 2006
•Offshore geotechnical survey

October 2007
•Project definition completed
•Estimate prepared

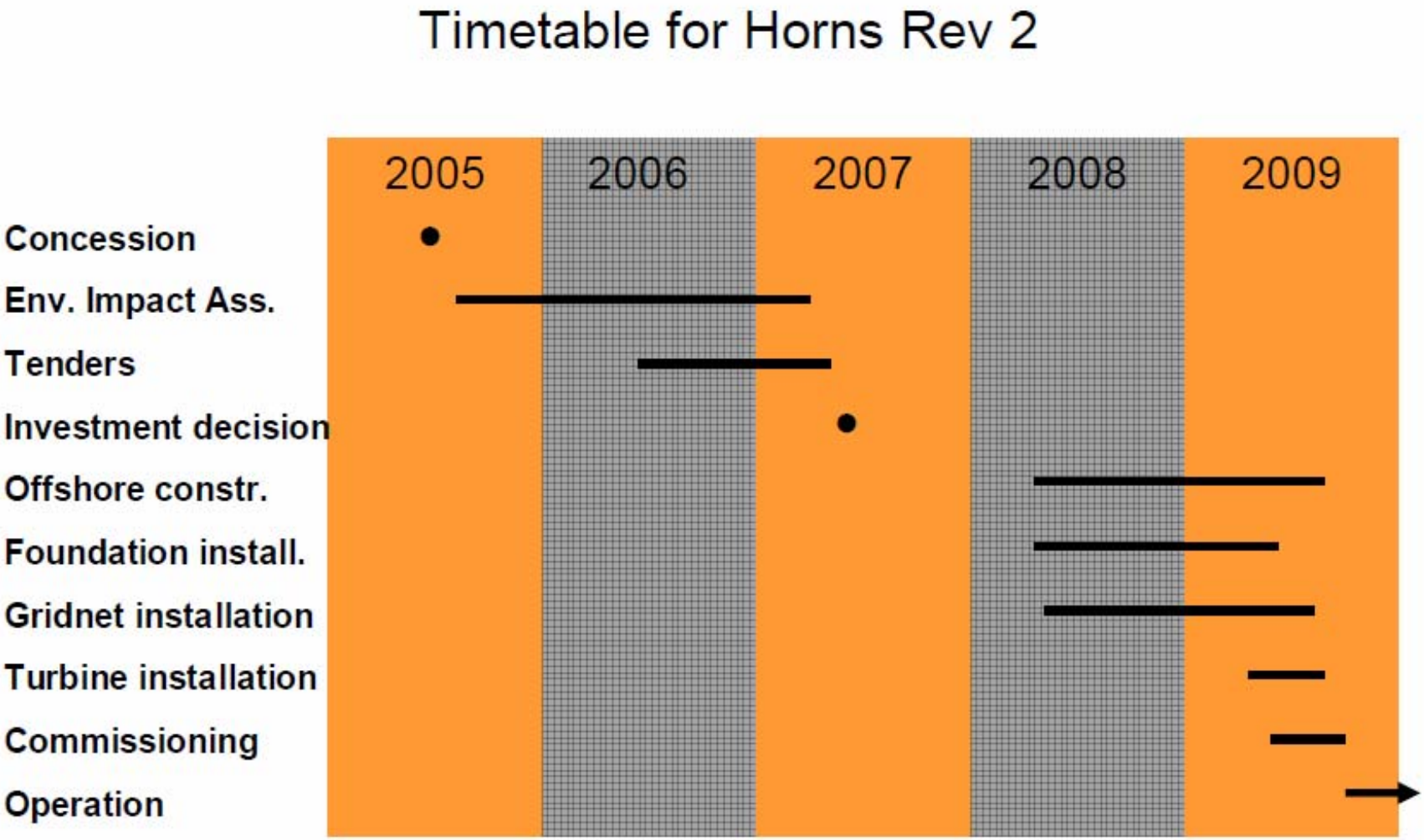
2.5 Year Build-Out

Onshore work starts: mid-2008
Offshore work starts: mid-2009
First phase power: mid-2010
Full project power: end 2011

FLUOR®

From lease award to construction start = ~4.5 years

Development of Horns Rev II: 209 MW (Denmark)

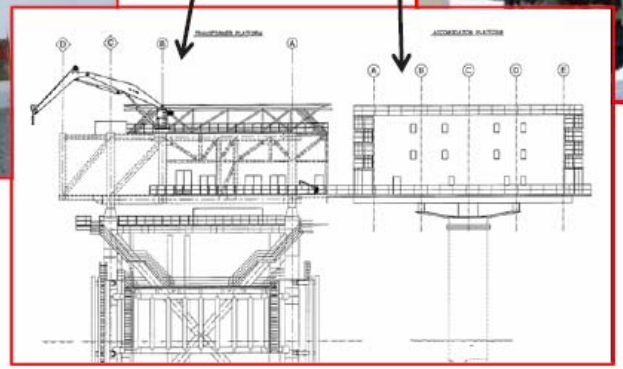


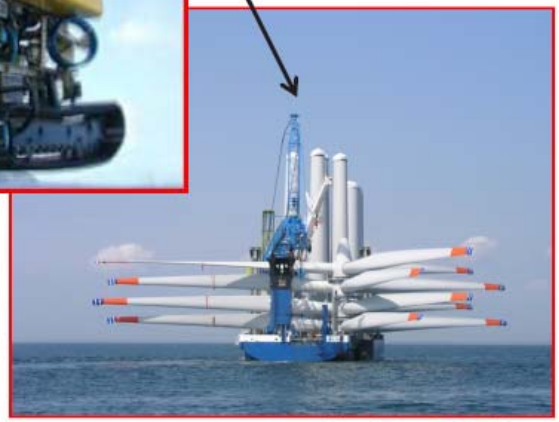
From lease award to construction start = ~2.5 years

Construction of Horns Rev II: 209 MW (Denmark)

Horns Rev 2 – Plan for construction

Task Name	2009												2010											
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Start of marine works	◆ 19-04																						
Foundation installation																							
Internal grid installation																							
Transformer installation																							
Accomodationplatform installation																							
Commissining of Transformer													◆ 01-05										
Turbine installation																							
Commissioning																							
Final take over																						◆ 15-01	





DONG energy

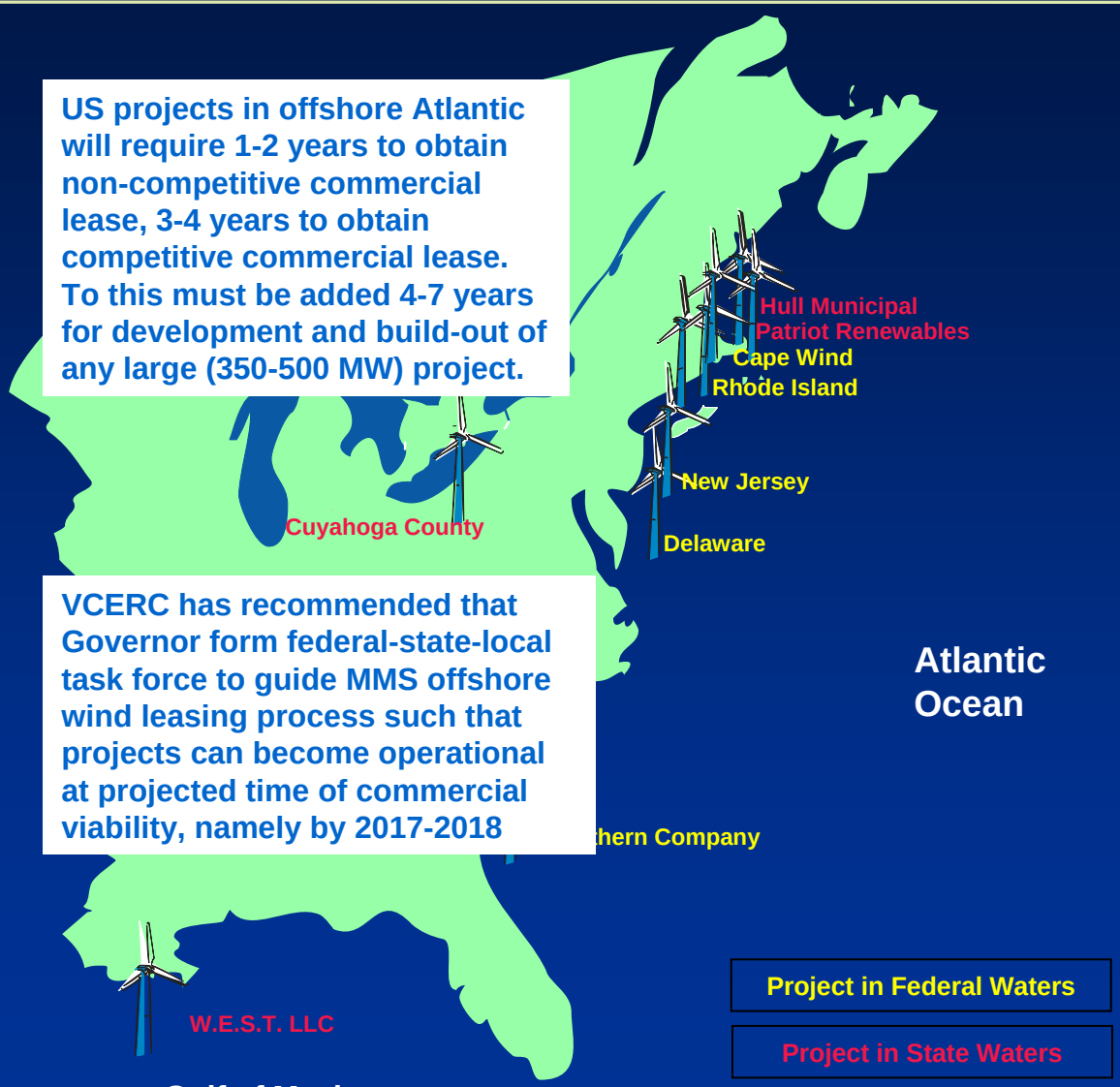
From construction start to fully commissioned = 1.5 years

US Offshore Wind Commercial Projects

US Offshore Wind Projects		
Project	**State**	**MW**
Cape Wind	MA	468
Hull Municipal	MA	15
Patriot Renewables	MA	300
Rhode Island (OER)	RI	400
New Jersey (BPU)	NJ	350
Delmarva	DE	350
Southern Company	GA	10
W.E.S.T.	TX	150
Cuyahoga County	OH	20
Total MW		2,063

US projects in offshore Atlantic will require 1-2 years to obtain non-competitive commercial lease, 3-4 years to obtain competitive commercial lease. To this must be added 4-7 years for development and build-out of any large (350-500 MW) project.

VCERC has recommended that Governor form federal-state-local task force to guide MMS offshore wind leasing process such that projects can become operational at projected time of commercial viability, namely by 2017-2018



Thank You!

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