

Delaware's Wind Resource

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Environmental Footprint Workgroup
30 July 2008

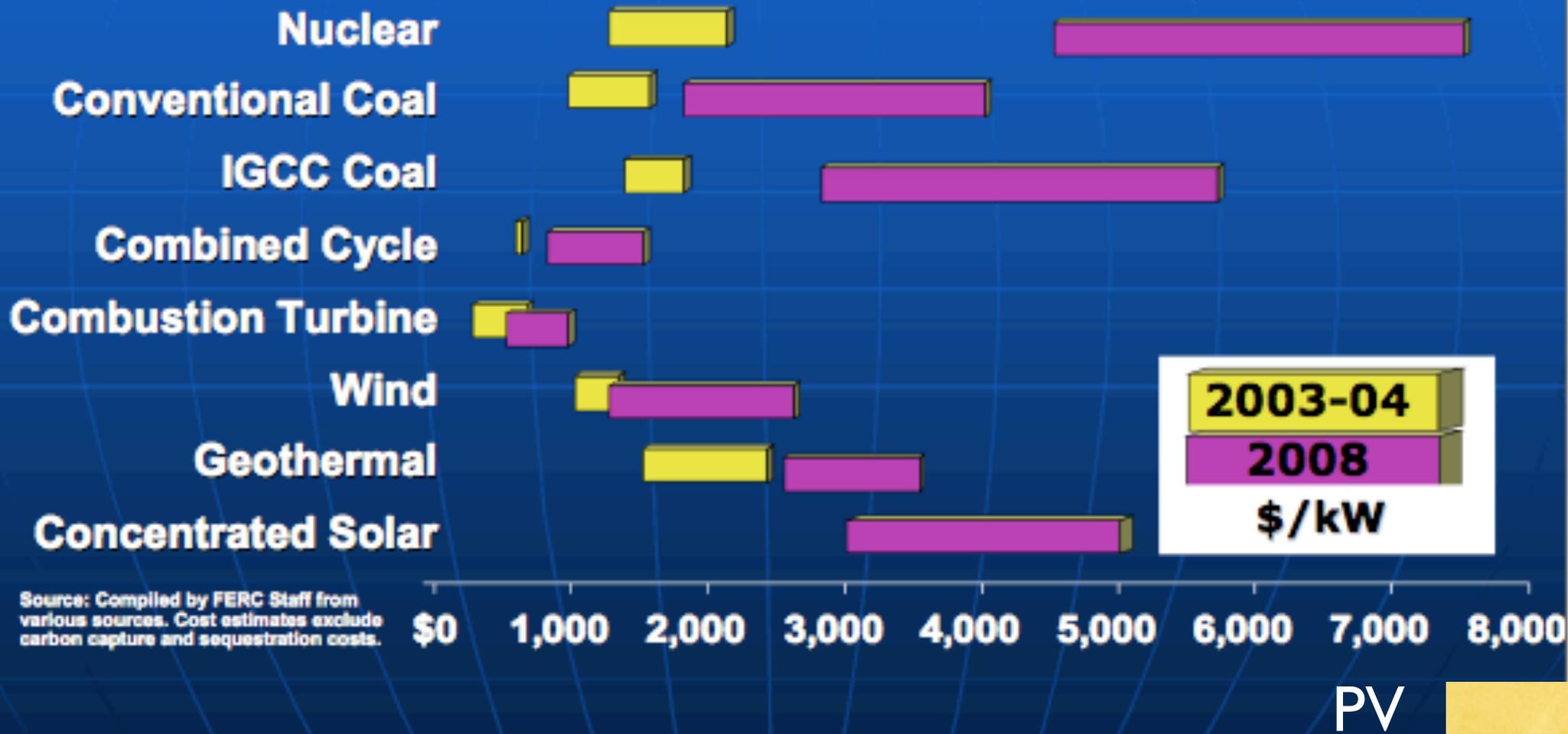
What are Delaware's Low-Footprint Resources?

- Power sources
 - Solar (rooftop PV)
 - Offshore wind (0 -50 m)
 - Future no-CO₂ resources
- Managing facilities
 - Transmission to level renewables
 - Storage via vehicles
 - Load management (eg. DLC)

What is “Low footprint”?

- With large CO₂ increases, Delaware becomes a small string of islands
- To stop climate change, worldwide emissions need to be reduced by 60 to 80%
- So improvements like 10% to 20% are helpful if additive (e.g. conservation) but not helpful if new generation (e.g. change coal to natural gas)

Estimated Cost of New Generation



FERC Office of Enforcement, Increasing Costs in Electric Markets, Item No.: A-3, June 19, 2008

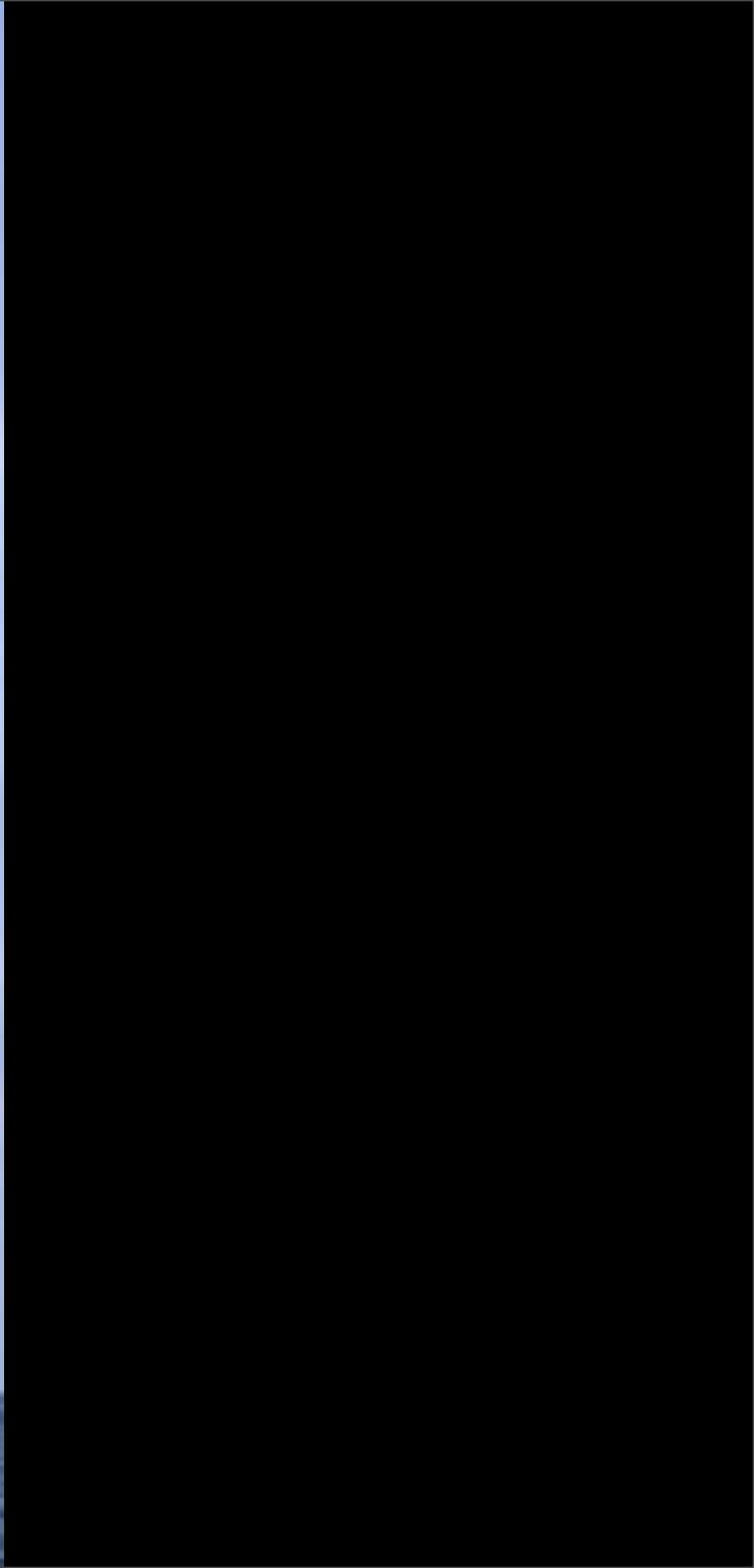
DE Solar potential

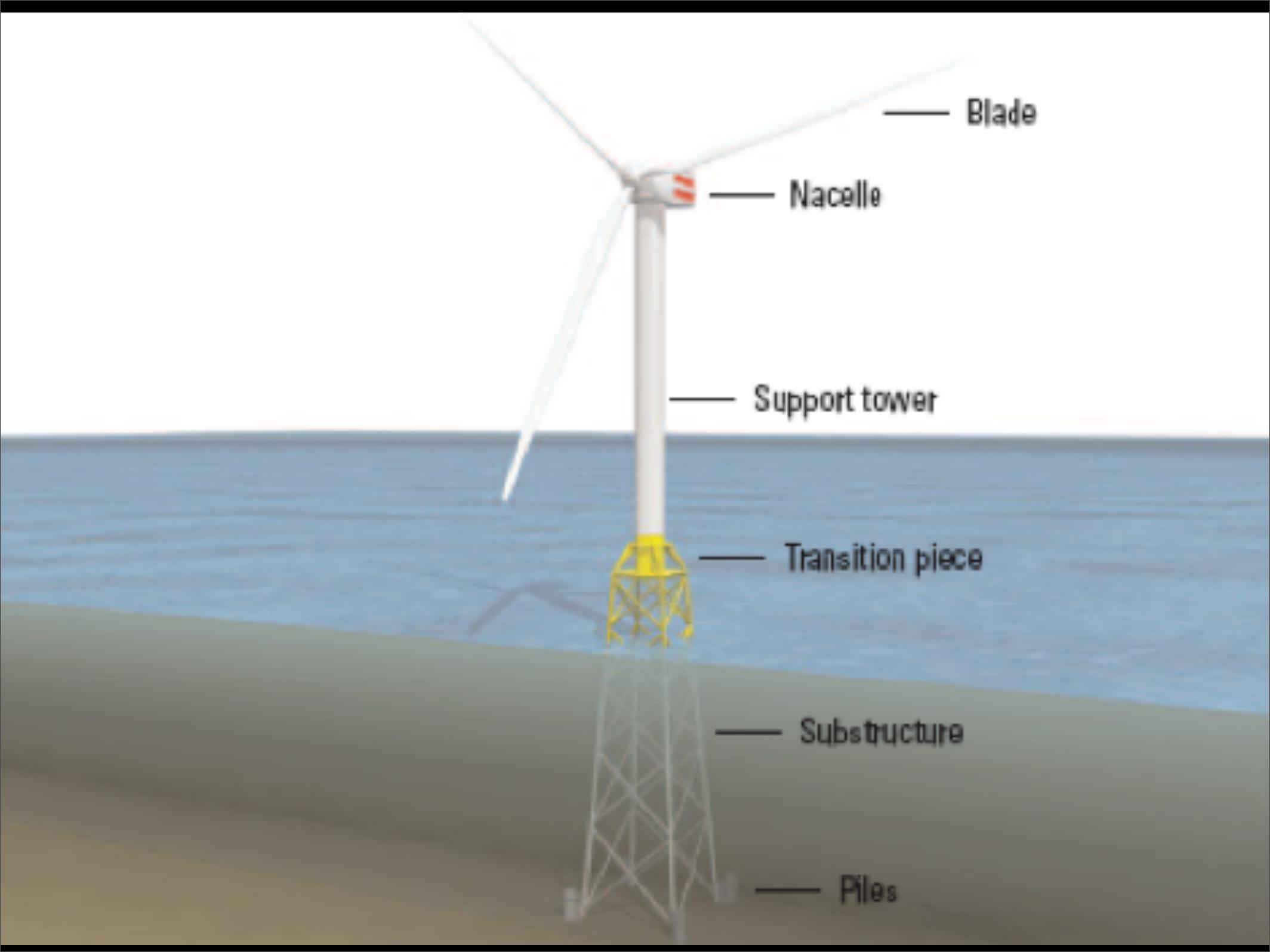
	Average load (MW)	Rooftop PV Capacity	Average output at 16% CF	Solar as % of load
Newark*	49.7	57.5	9.2	18
Delaware	1318	1797	288	22

*Newark potential from CEEP Solar rooftop draft study

How to calculate wind potential

- Current technology is 0 - 30 meters depth
- Prototyped to 50 m (in water now)
- Bottom anchored to 100 m
- Exclude shipping lanes, bird flyways, etc





Blade

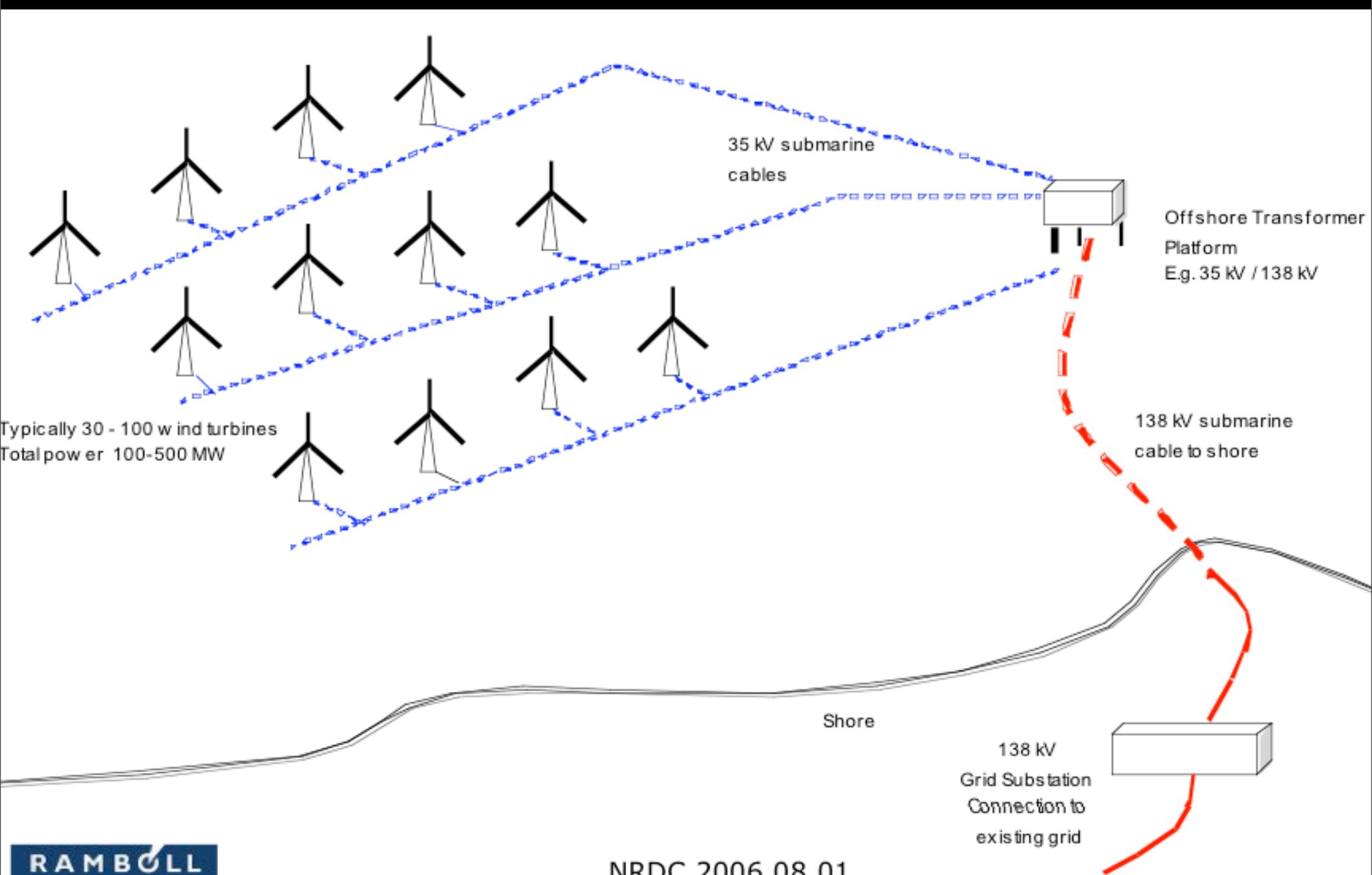
Nacelle

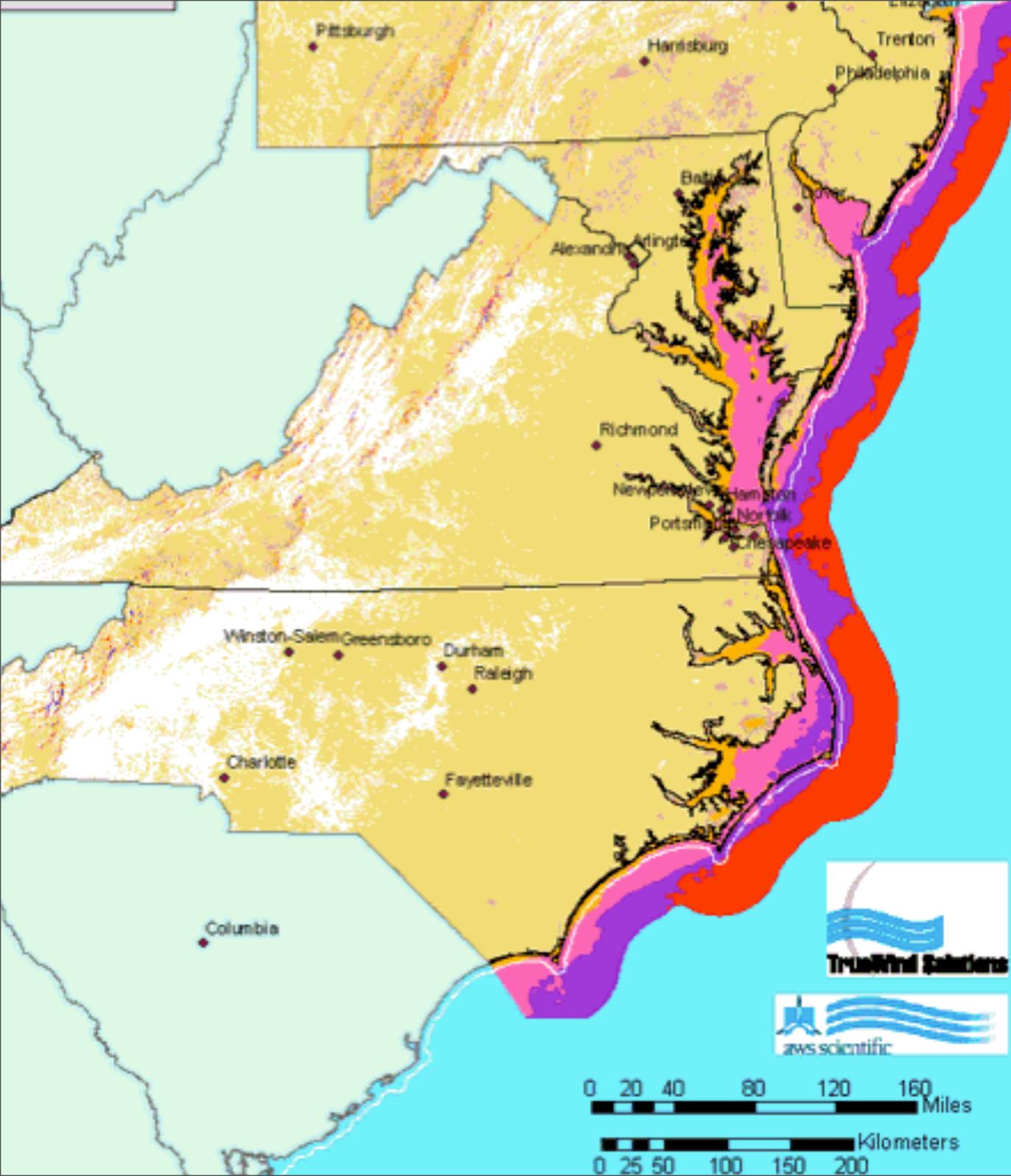
Support tower

Transition piece

Substructure

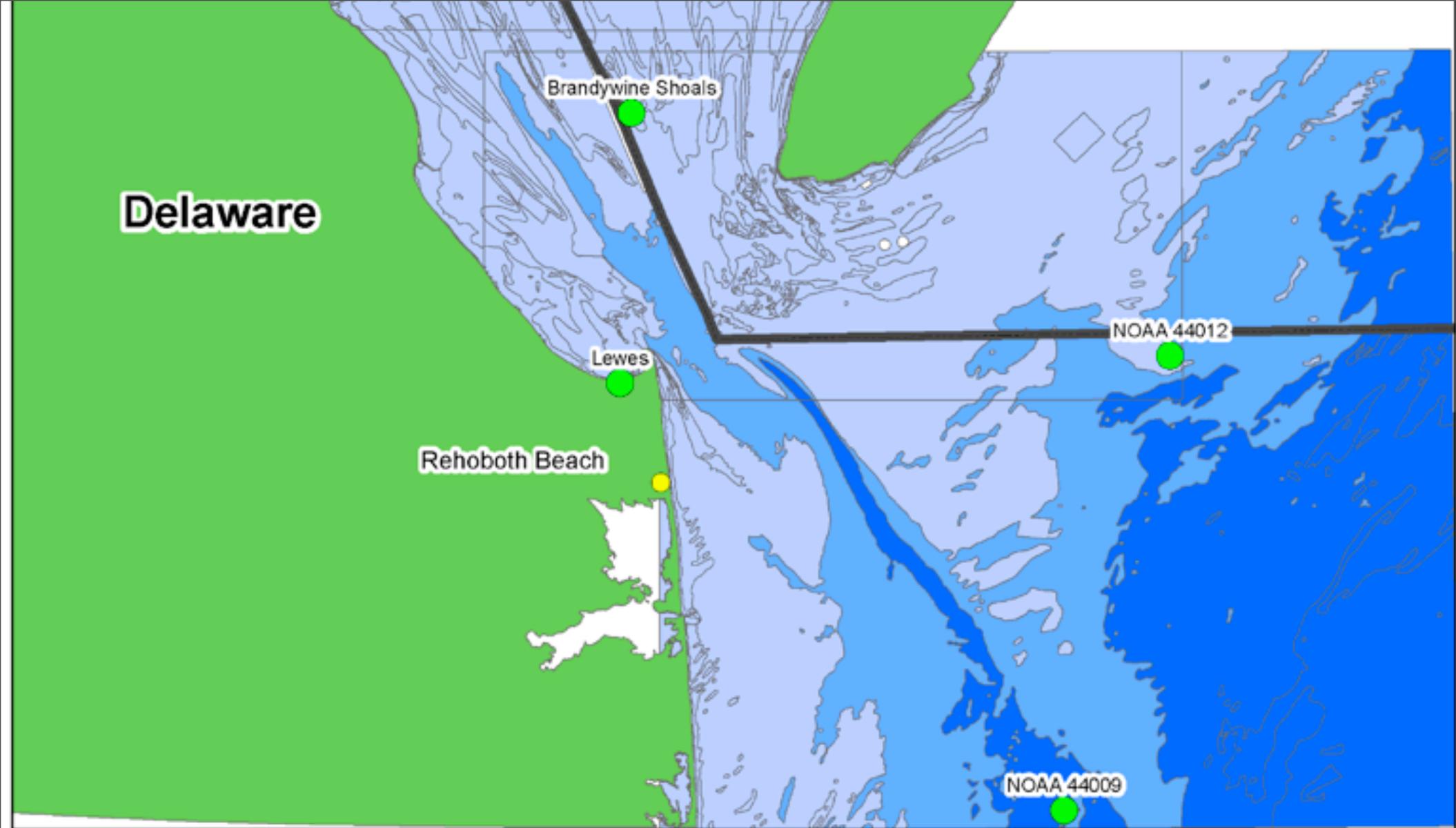
Piles





Where is the wind?

- Red and purple are economic
- Some ridgetops on land, but ...
- Conclusion: in East, the wind resources are offshore
- This map based on met towers (from AWS Truewind)



Study Area, Bathymetry and Data Buoys

Legend

- Resource Assessment Area
- Data_Buoys
- Tourist Beach Resort

Bathymetry

- 0- 18.2 m
- 18.2- 27.4 m
- > 27.4 m

0 5 10 20 Kilometers



from: Dhanju, Whitaker & Kempton

Delaware

Rehoboth Beach

Legend

— Sample Area Boundary

Visual Exclusion: Wedding Band

Visual Exclusion: Half Thumb

Shipping Lane

Beach Nourishment Borrow Area

● Tourist Beach Resort

Chemical Waste Dump

Old Explosives

Spoil Ground

Military Exclusion Area

Bird Flyway

Available Area

0 5 10 20 Kilometers

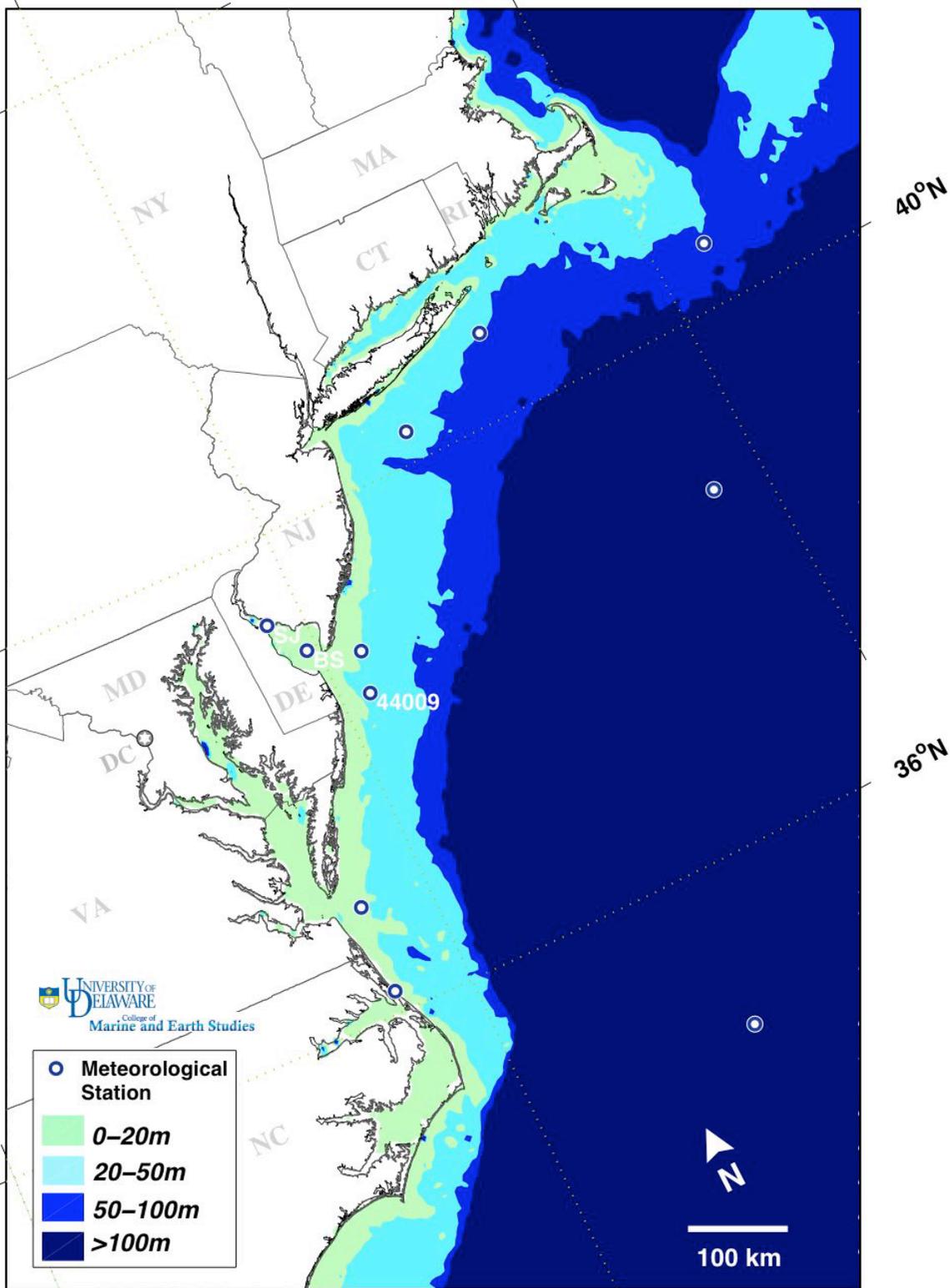


	Area (km ²)	Turbines (Count)	Installed Capacity (MW)	Capacity Factor	Average production (MW)
Delaware Bay	504	933	3359	0.36	1209
Atlantic Ocean	2386	4418	15,905	0.39	6203
Total	2890	5351	19,264		7412

from: Dhanju, Whitaker & Kempton

Compare: DE generation max now is 3,390 MW; Average DE use is 1,300 MW; value of wind > \$2B/year

Wind Resources of US Mid-Atlantic (MA thru NC)



UNIVERSITY OF DELAWARE
College of Marine and Earth Studies

○ Meteorological Station

0-20m

20-50m

50-100m

>100m

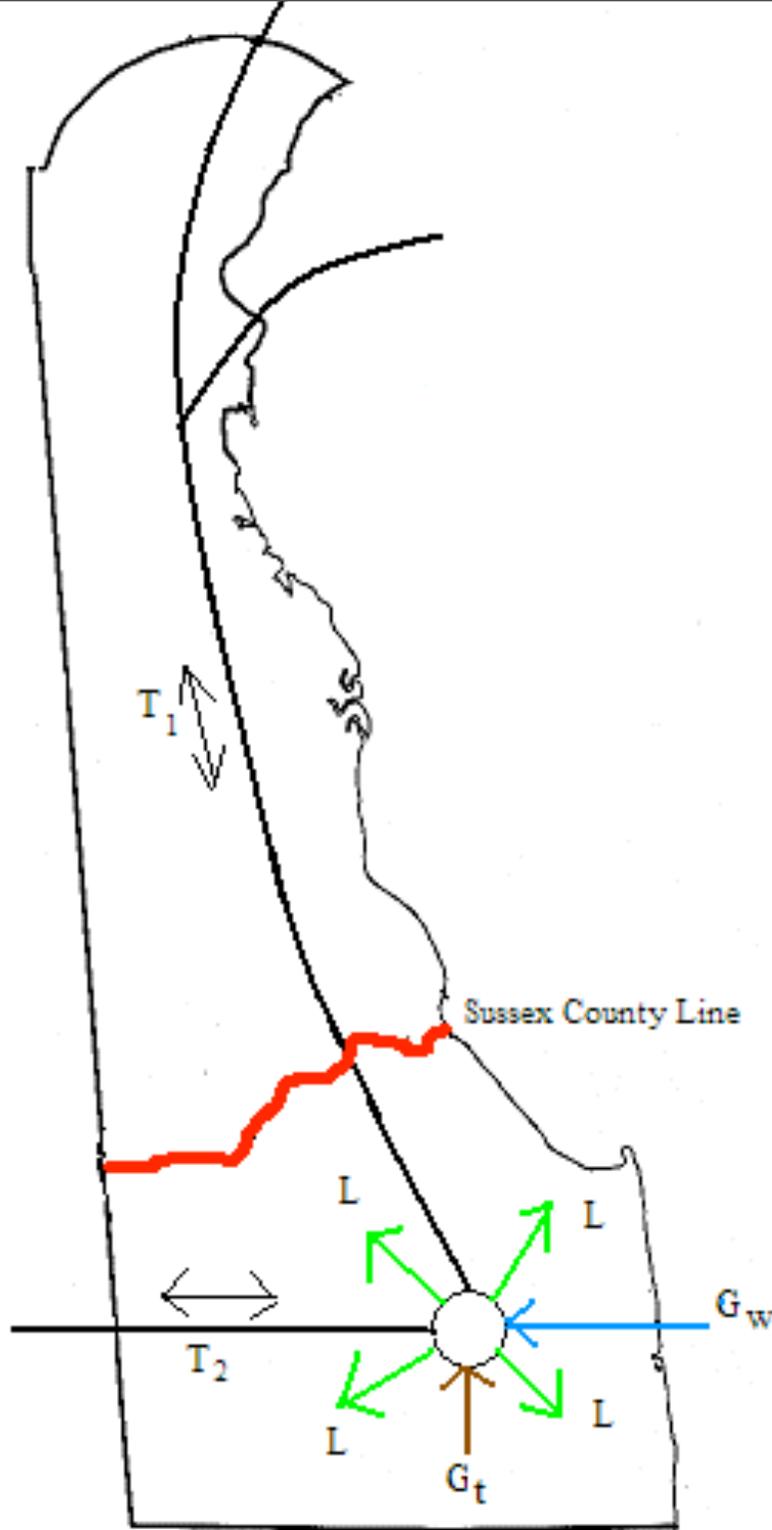
from: Kempton, Archer, Dhanju, Garvine and Jacobson, 2007, Geophysical Research Letters.

Delmarva Pen. Resource

State	Delmarva Atlantic Coastline	Potential Wind Capacity (MW)	Average wind power production (MW)	State average load in 2006 (MW)^a
Delaware	25 mile	15,905	5,286	1,319
Maryland (estimated)	31 miles	19,881	6,561	7,211
Virginia (estimated)	80 miles	51,691	17,058	12,183
DC	n.a.	0	0	1,301
Total		87,477	28,905	22,014

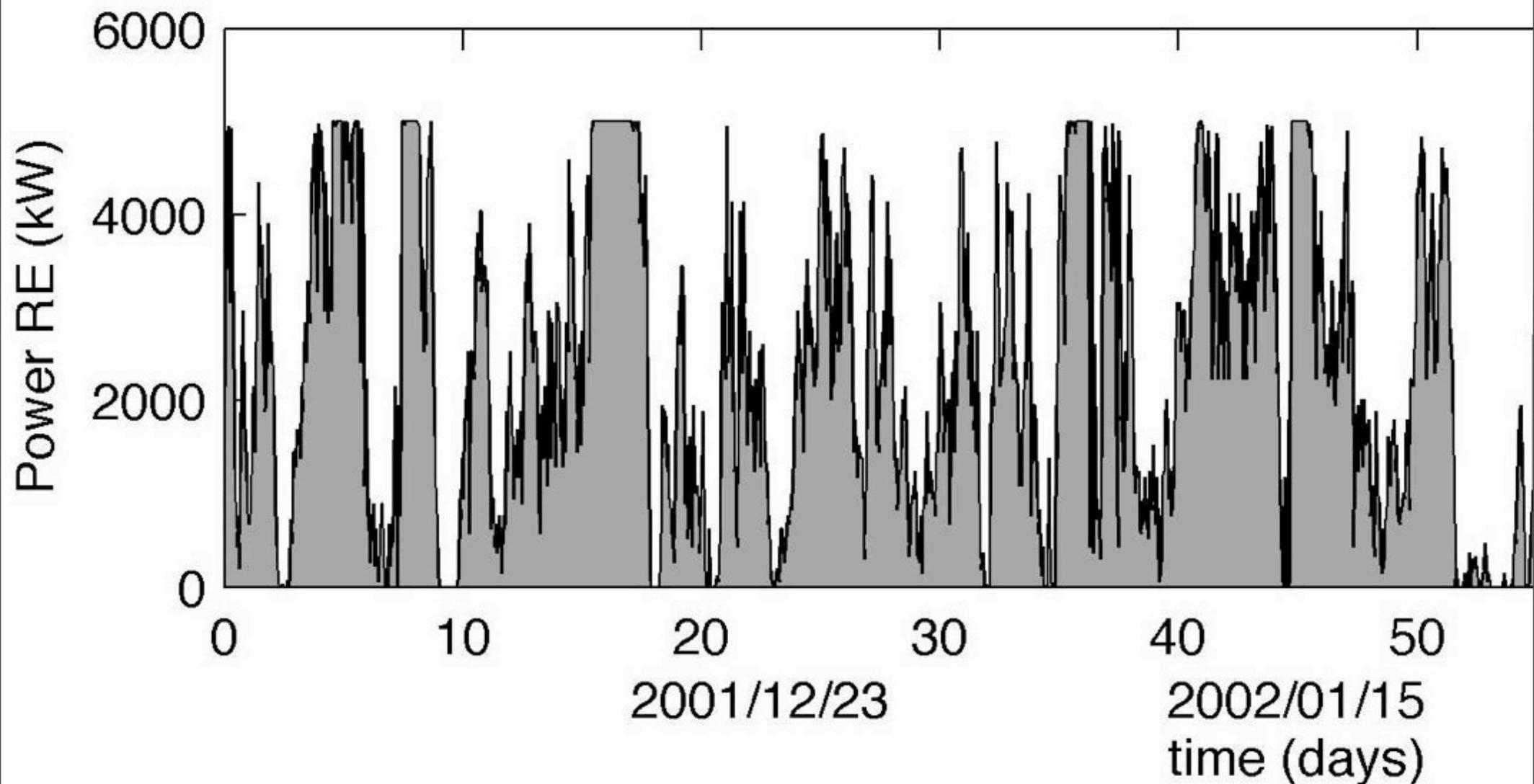
a From US EIA, State Electricity Profiles, 2006 Edition, DOE/EIA-0345.
Average load calculation (total MWh divided by 365*24)

Max/Min Power Analysis (initial estimates) by Jesse Fernandes, UD



- T = Transmission
- G = Generation (G_t =thermal, G_w =wind)
- L = Load
- Constraints limiting max G_w :
 - $G_t \geq L_{\max} - T$
 - $G_w \leq L_{\min} + T$
- Conclusion: several 1,000 MW of wind ok now, more with new PHI transmission

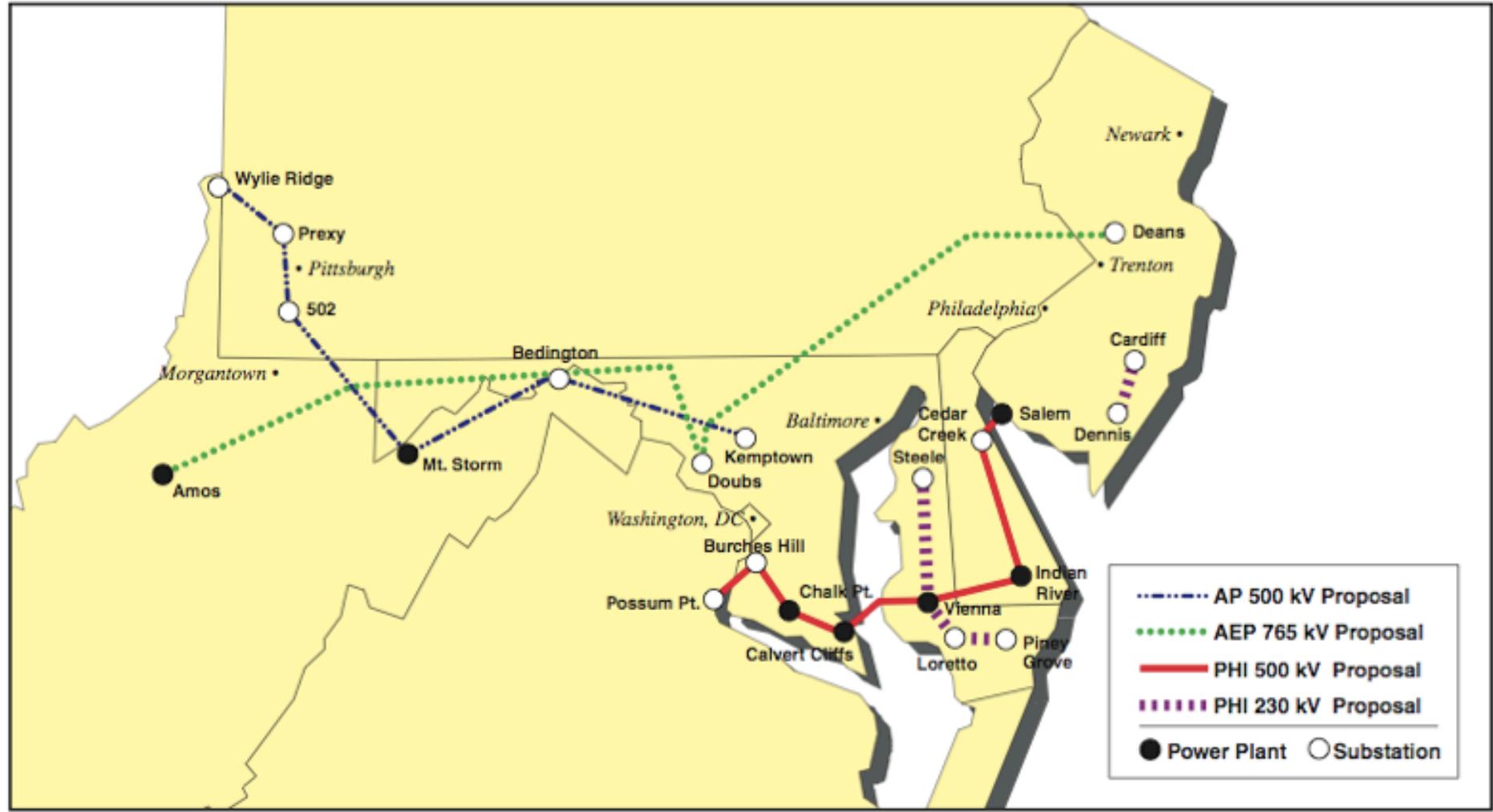
Offshore wind fluctuations



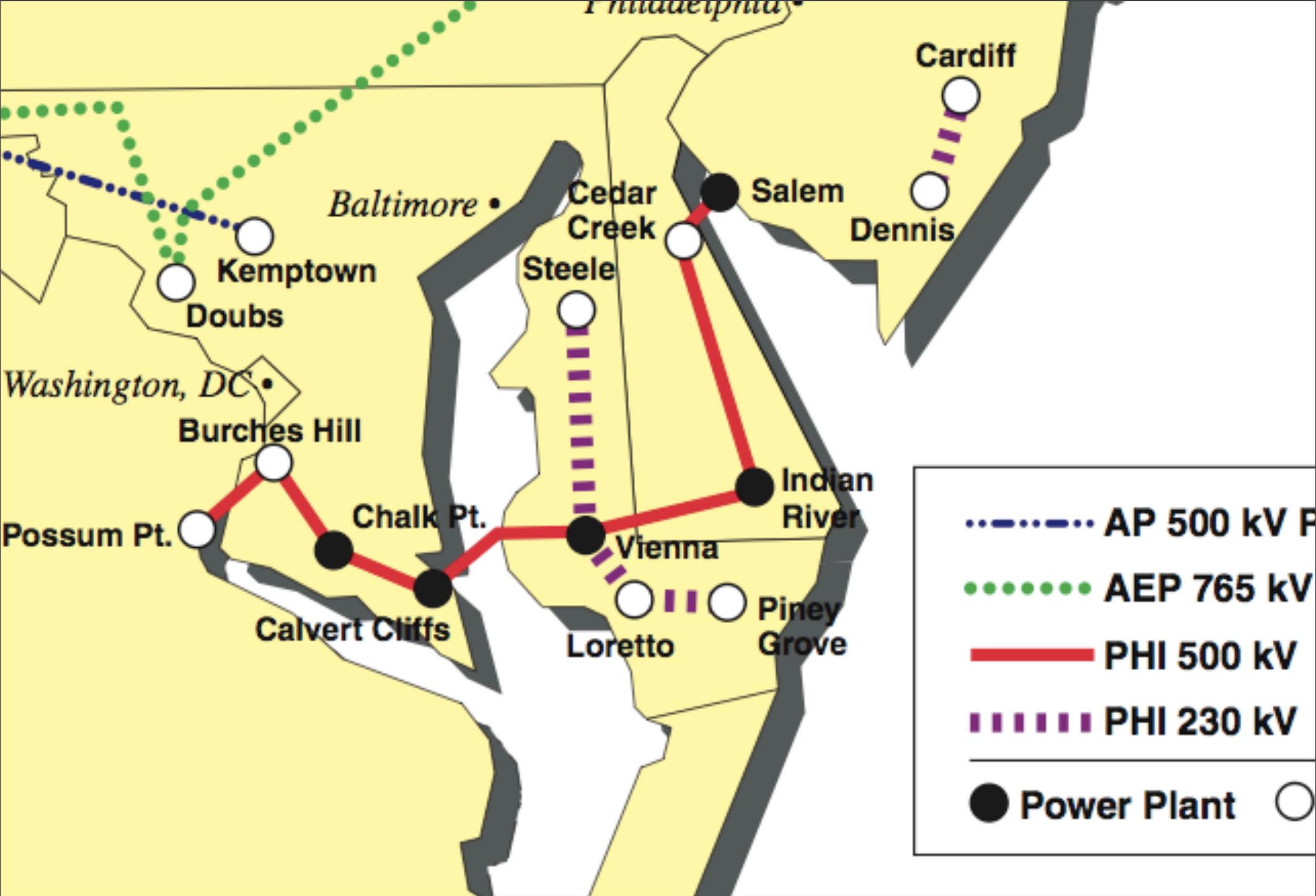
PHI's Proposed Mid-Atlantic Power Pathway

PHI's proposed transmission line is a separate and complementary transmission path for consideration by the PJM. It would address transmission needs in Northern Virginia, Washington, D.C., Maryland, the Delmarva Peninsula and New Jersey power markets.

PHI Future Transmission Projects – March 2006

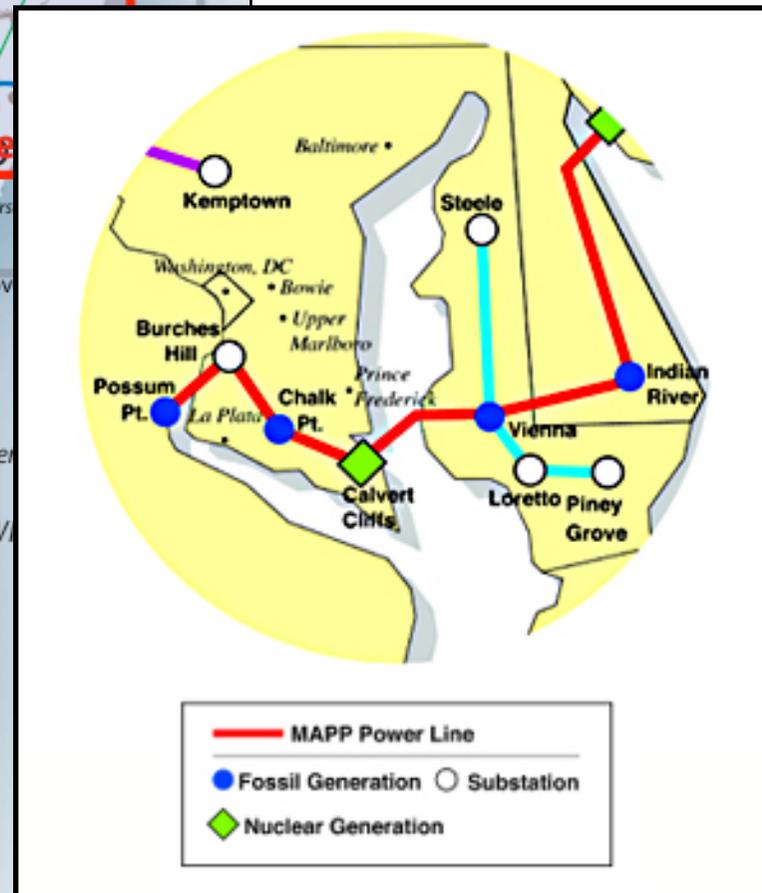
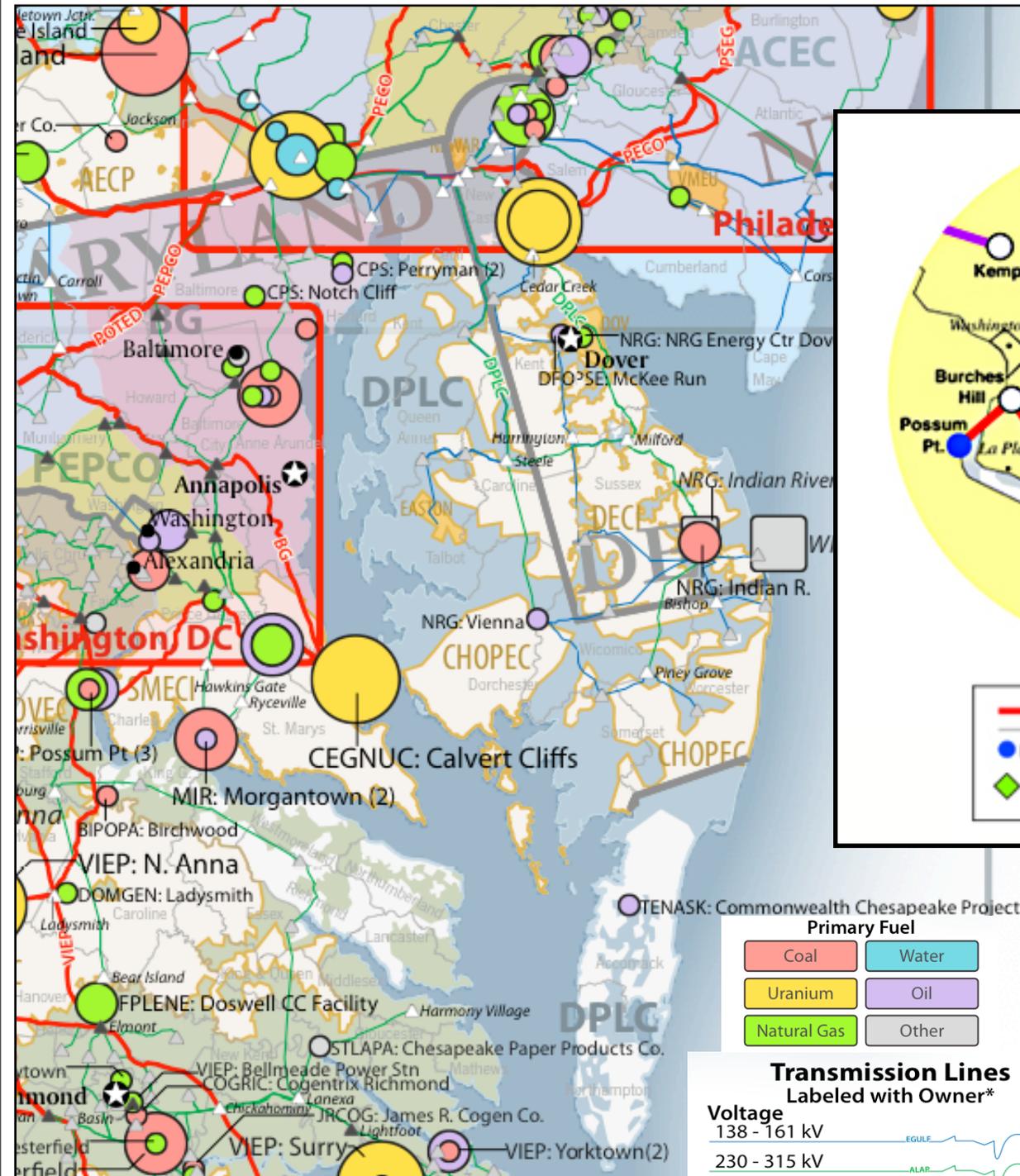


PHI is proposing a 230 mile, 500 kV high-voltage transmission line originating in Northern Virginia, crossing Maryland, traveling up the Delmarva Peninsula and terminating in southern New Jersey. In addition to this line, significant 230 kV lines that support Maryland, Delaware and New Jersey would be added.



Generation & Transmission Infrastructure

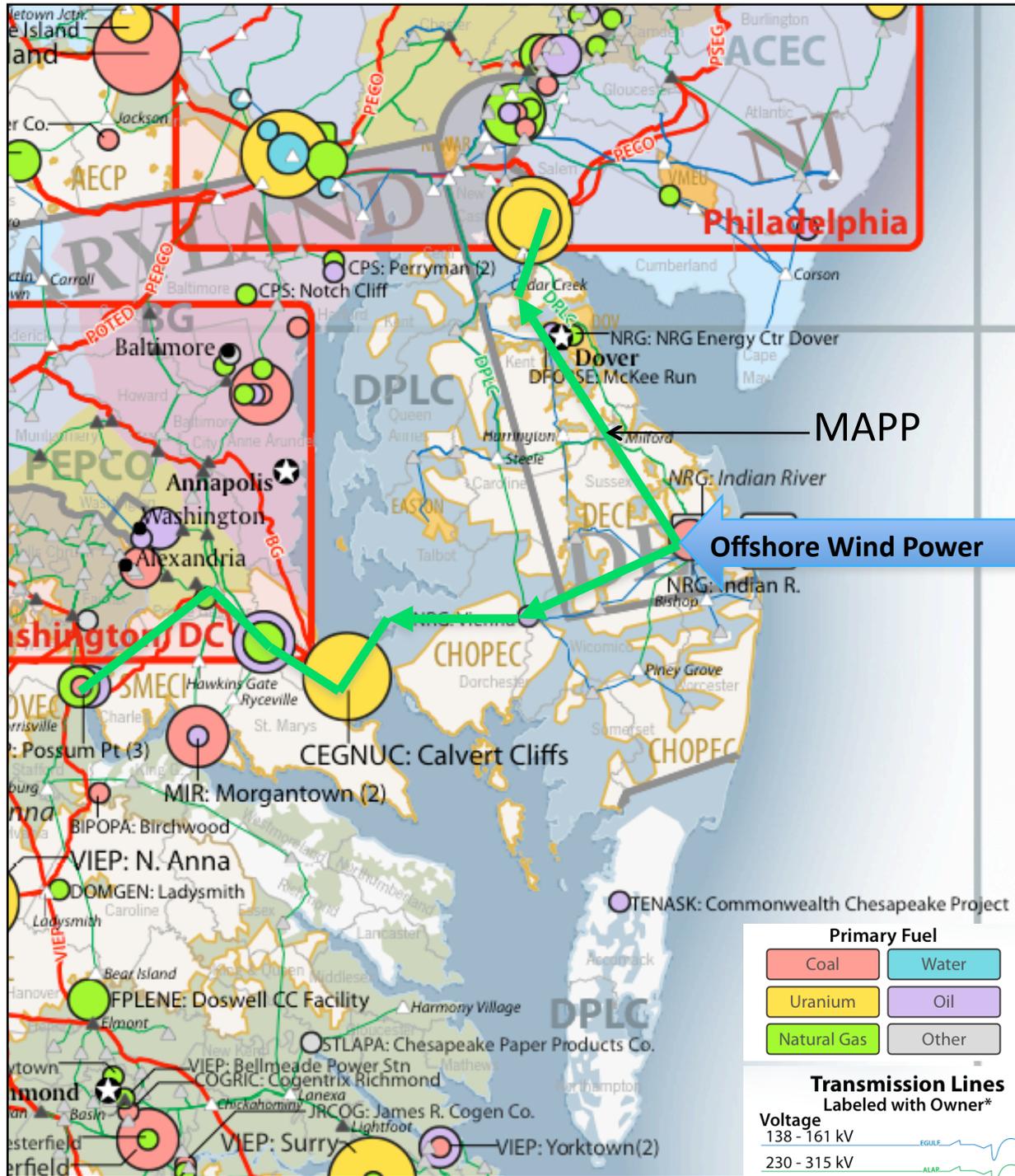
MAPP Transmission Project



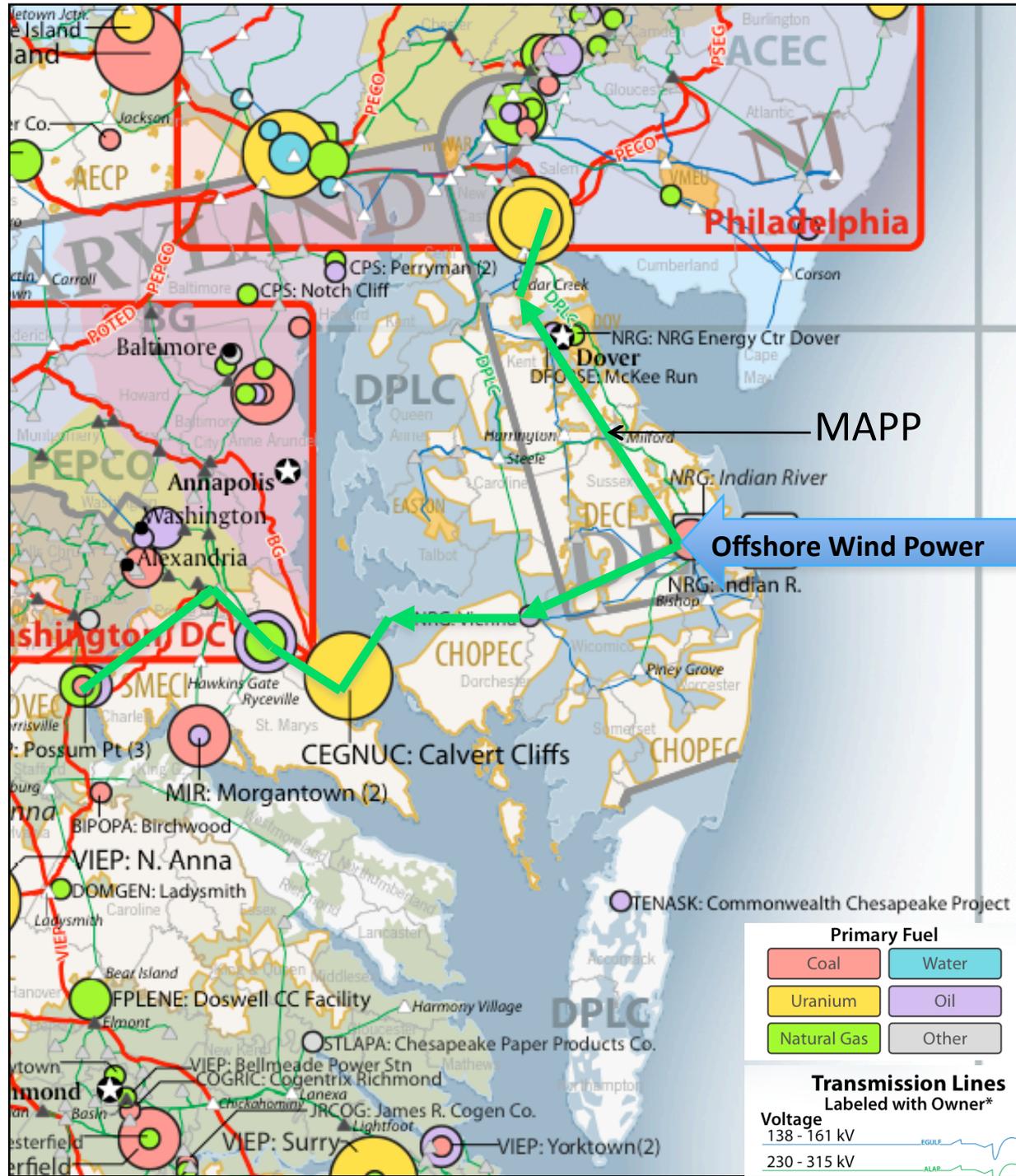
- Existing transmission is constrained in Delmarva and MAPP will create linkages with MD, DC and VA across Chesapeake.
- This line provides us with an opportunity to stimulate our renewable energy generation.

Reconfiguring MAPP

- Total capacity of Delmarva Peninsula Offshore Wind resource is 87,000 MW, with average output just under 29,000 MW.

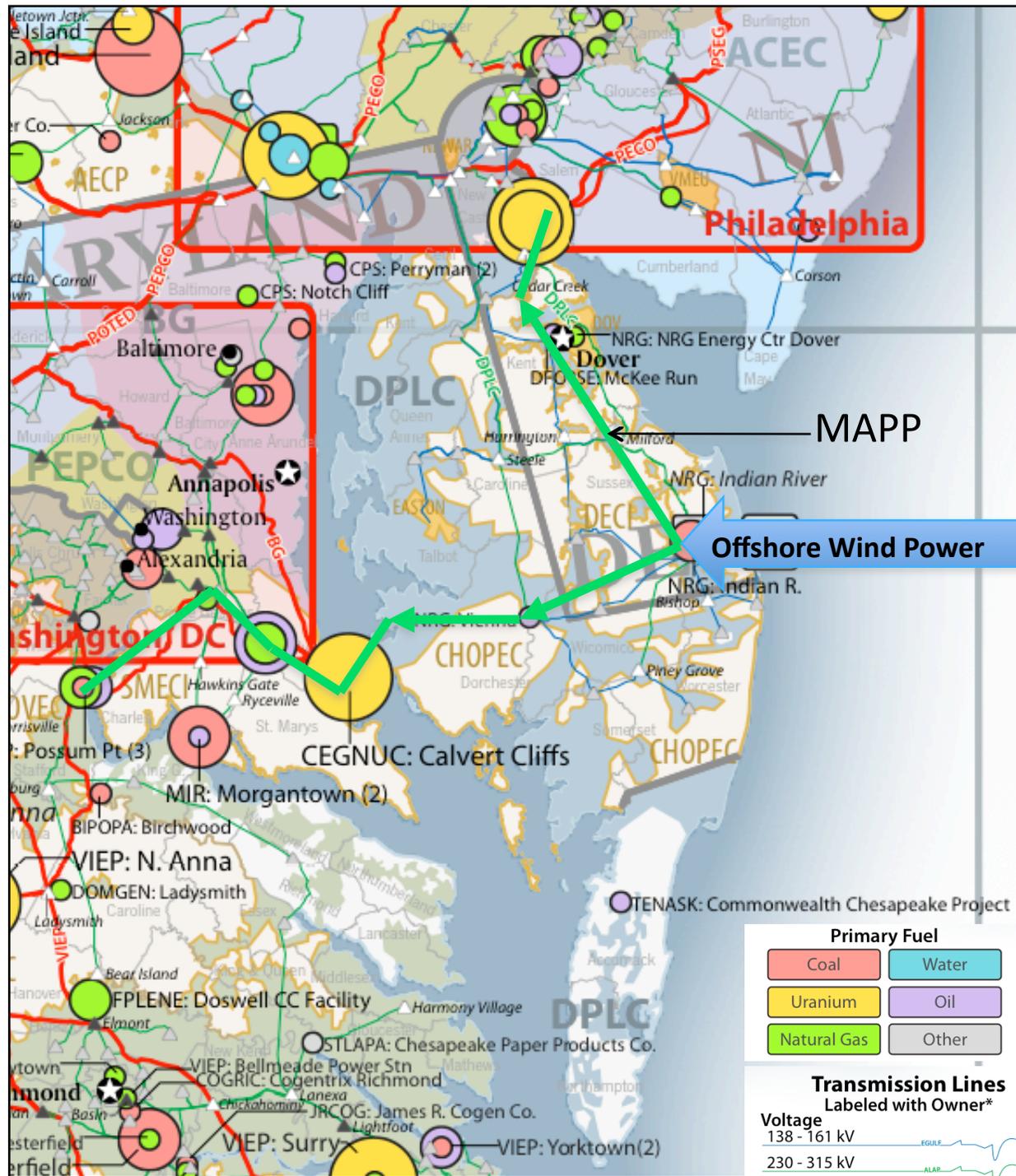


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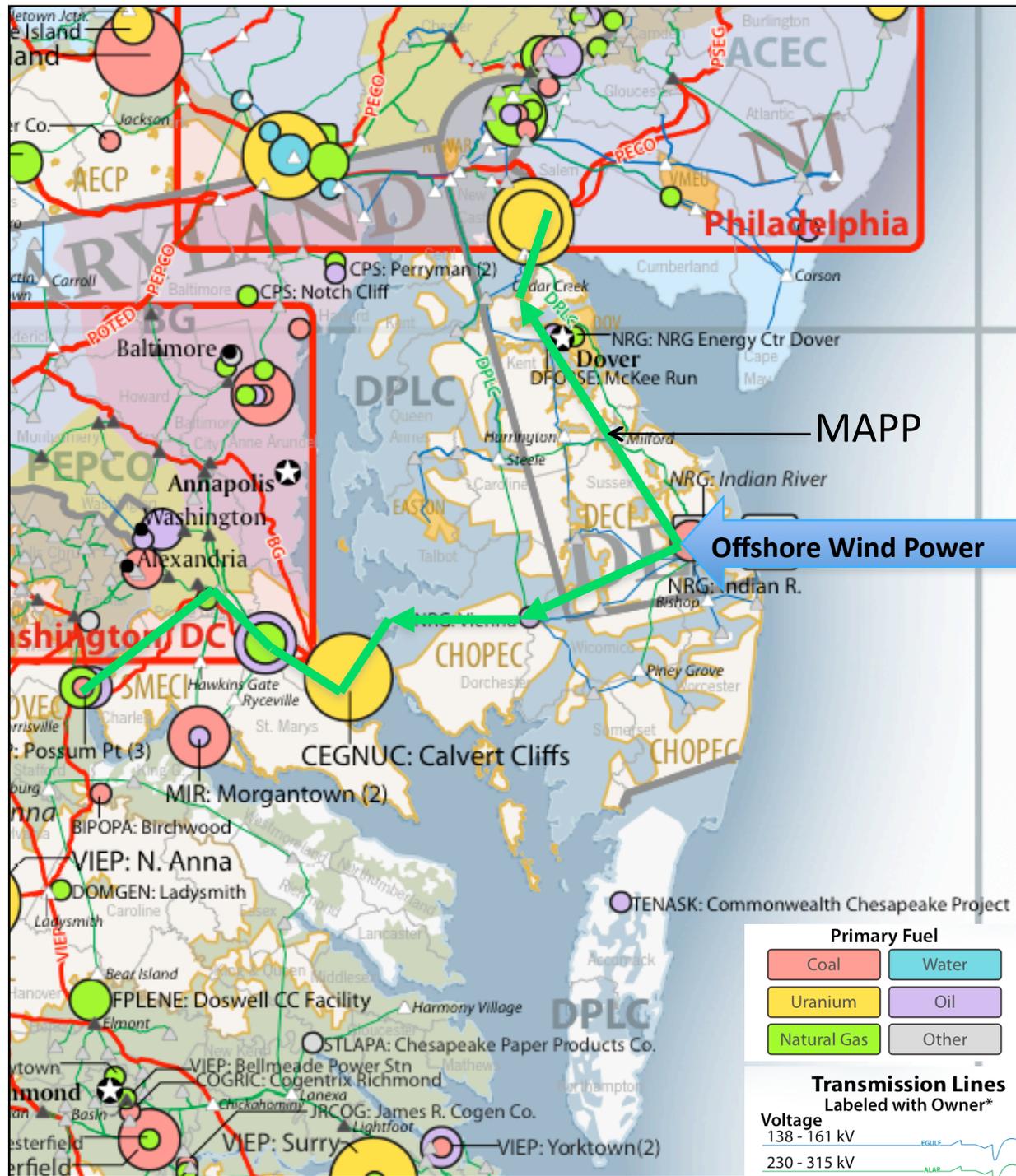
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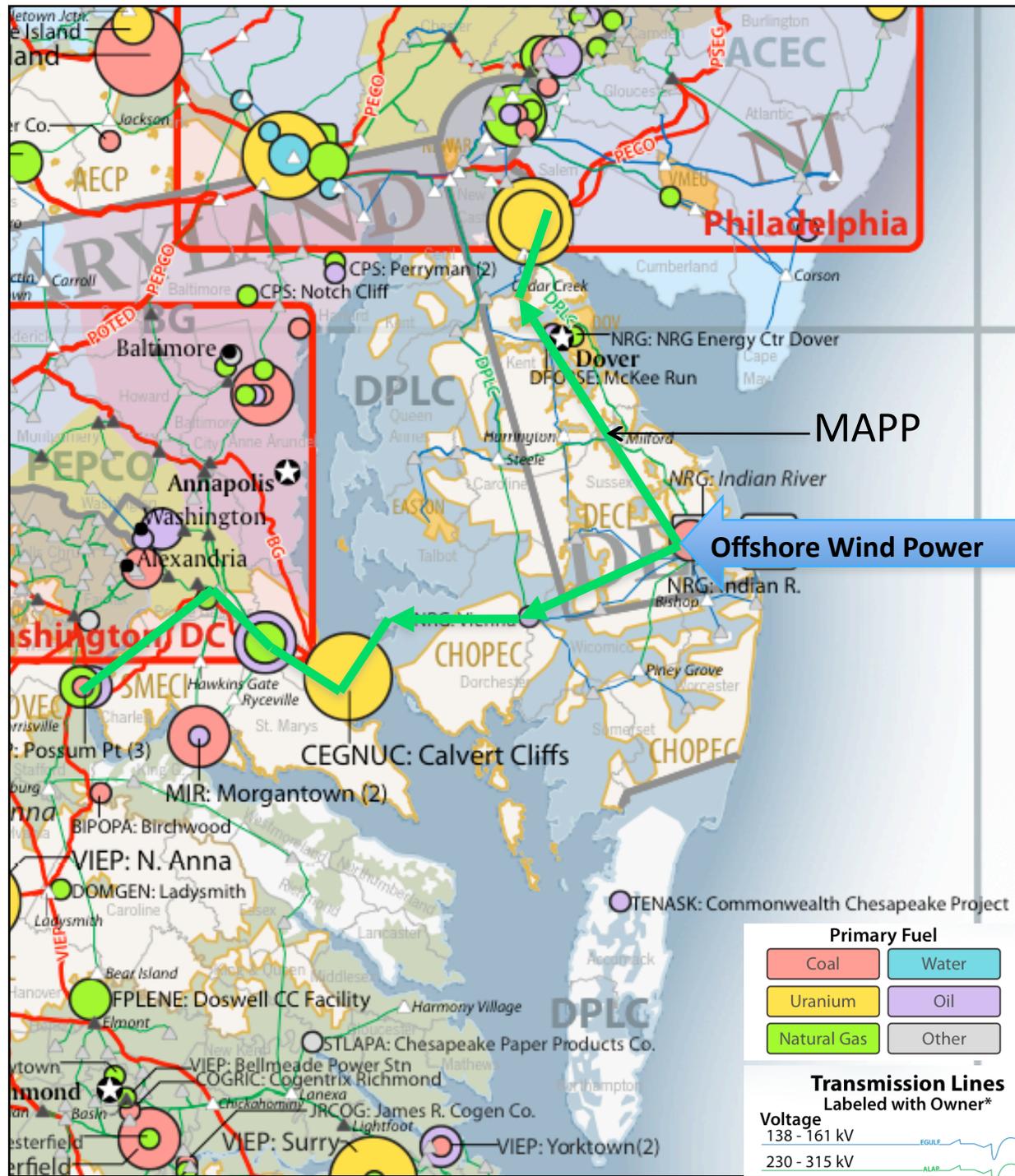
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- Electric load growth is about 2% per year. If we assume retirements average average 3%/year, MD, DC & VA would require 1,035 MW new output added per year.

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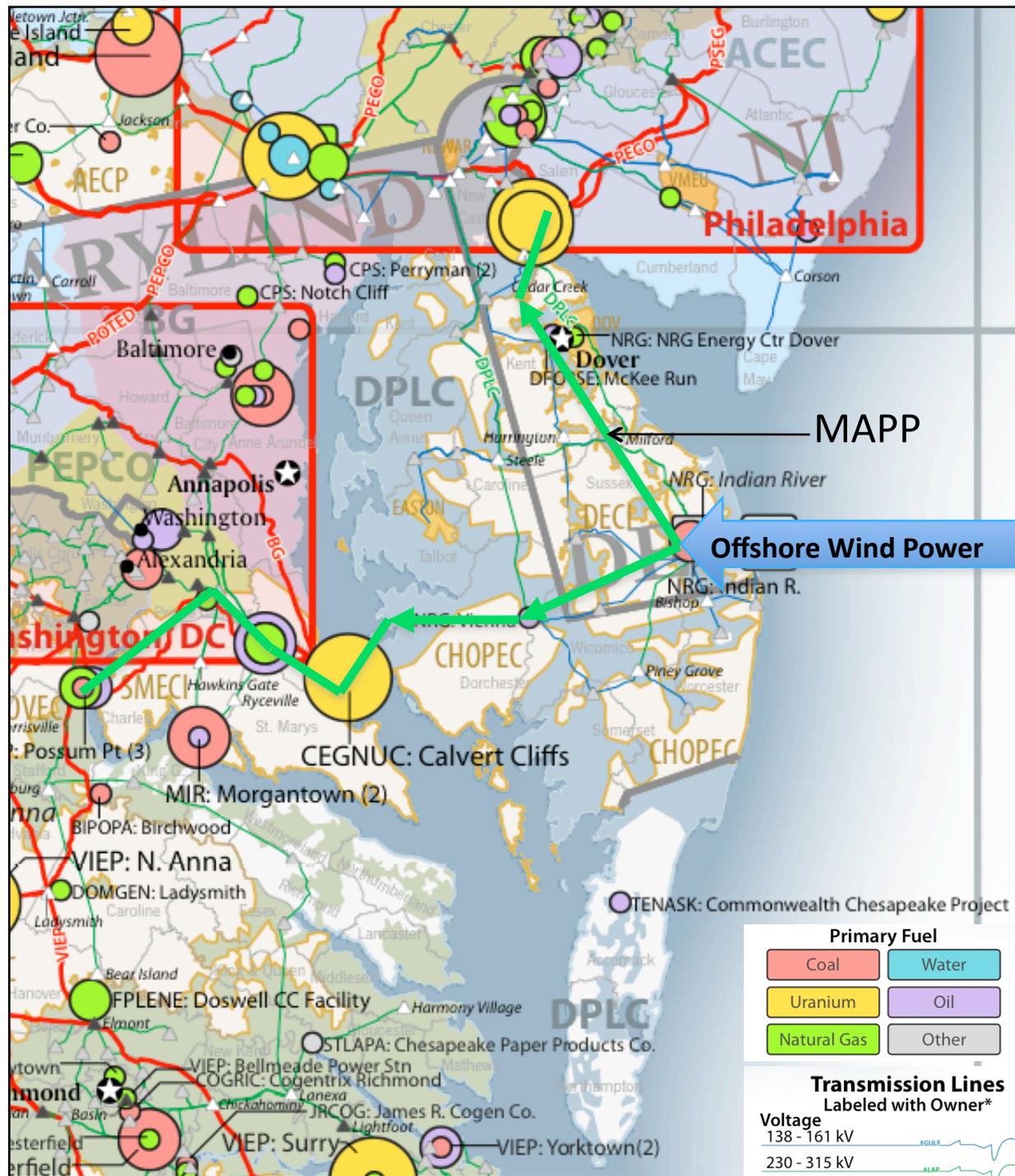
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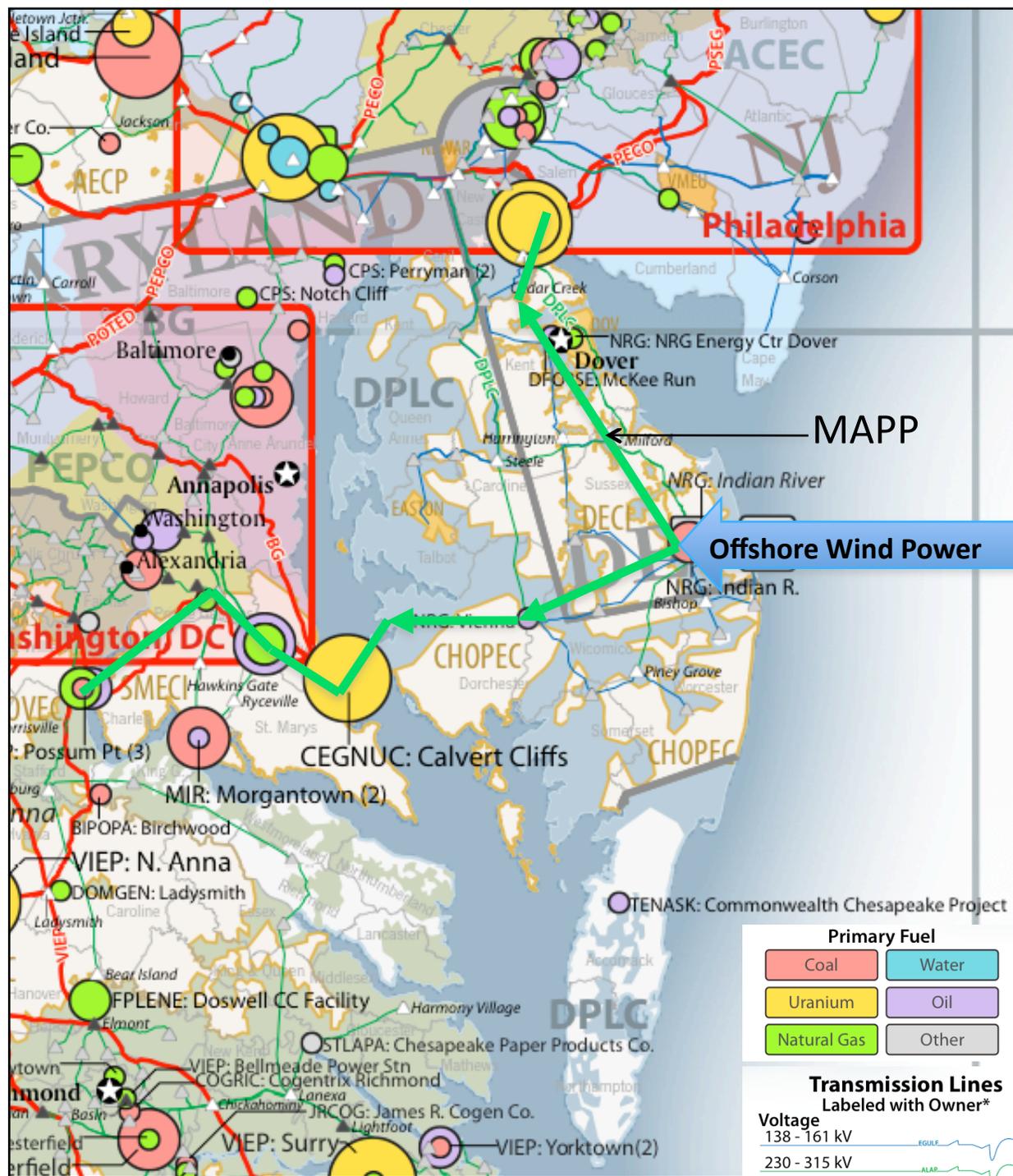
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More information

- www.ocean.udel.edu/windpower
- AWEA conference, Sept 9-10, Wilmington
 - <http://www.awea.org/events/offshorewind/>

End

- Byrne, J., Alleng, G., Hegedus, S., Hromiko, R., Salisbury, M., Schreiber, J., Walker, R. & Zhang, X. (November 2007). Determining the Potential of Solar Resources in Communities in Delaware: A case study of the City of Newark. A Renewable Energy Applications for Delaware Yearly (READY) Project. Report prepared by the Center for Energy and Environmental Policy (CEE), University of Delaware.
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