

Transmission and wind

Willett Kempton

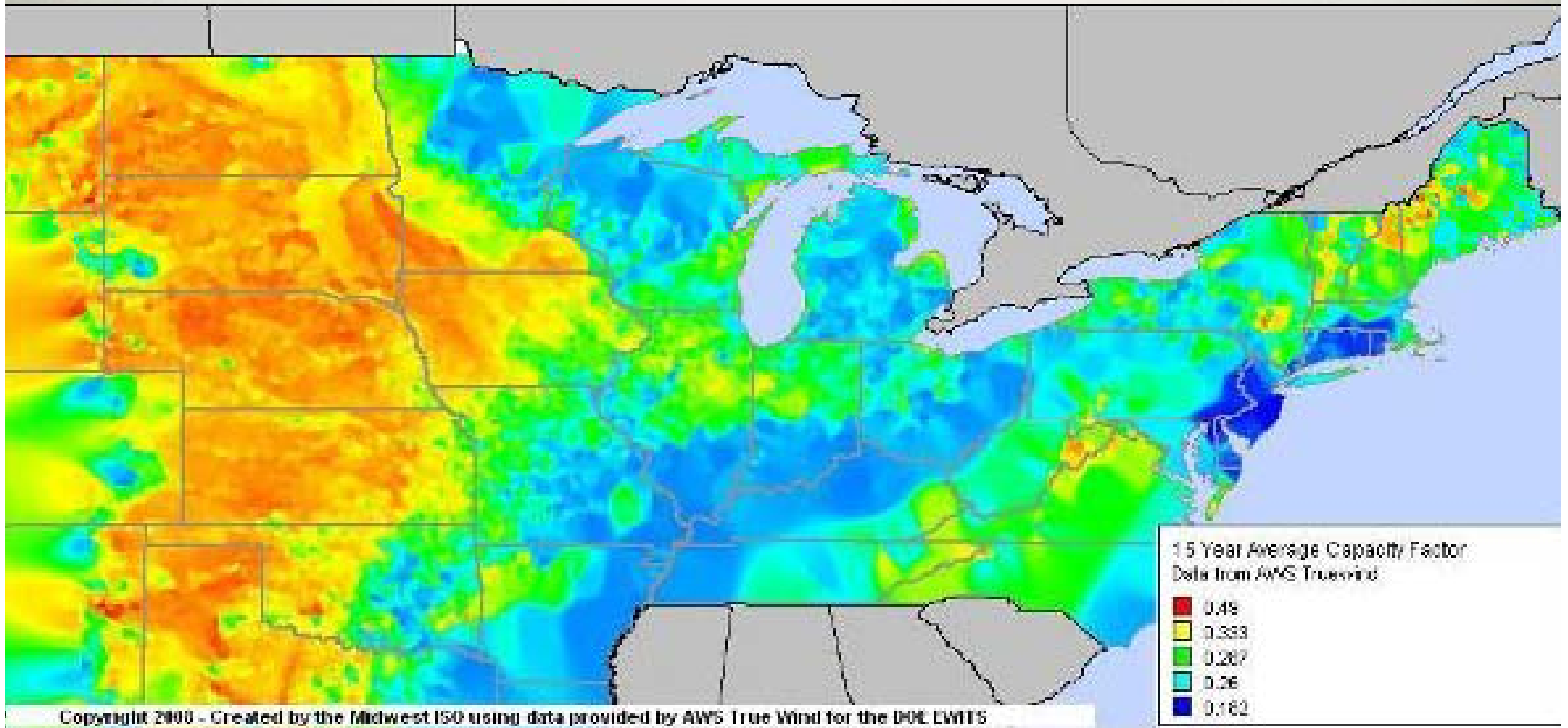
Center for Carbon-free Power Integration
College of Earth, Ocean, and Environment
University of Delaware

Energy and Environment Study Institute

17 July 2009

Outline

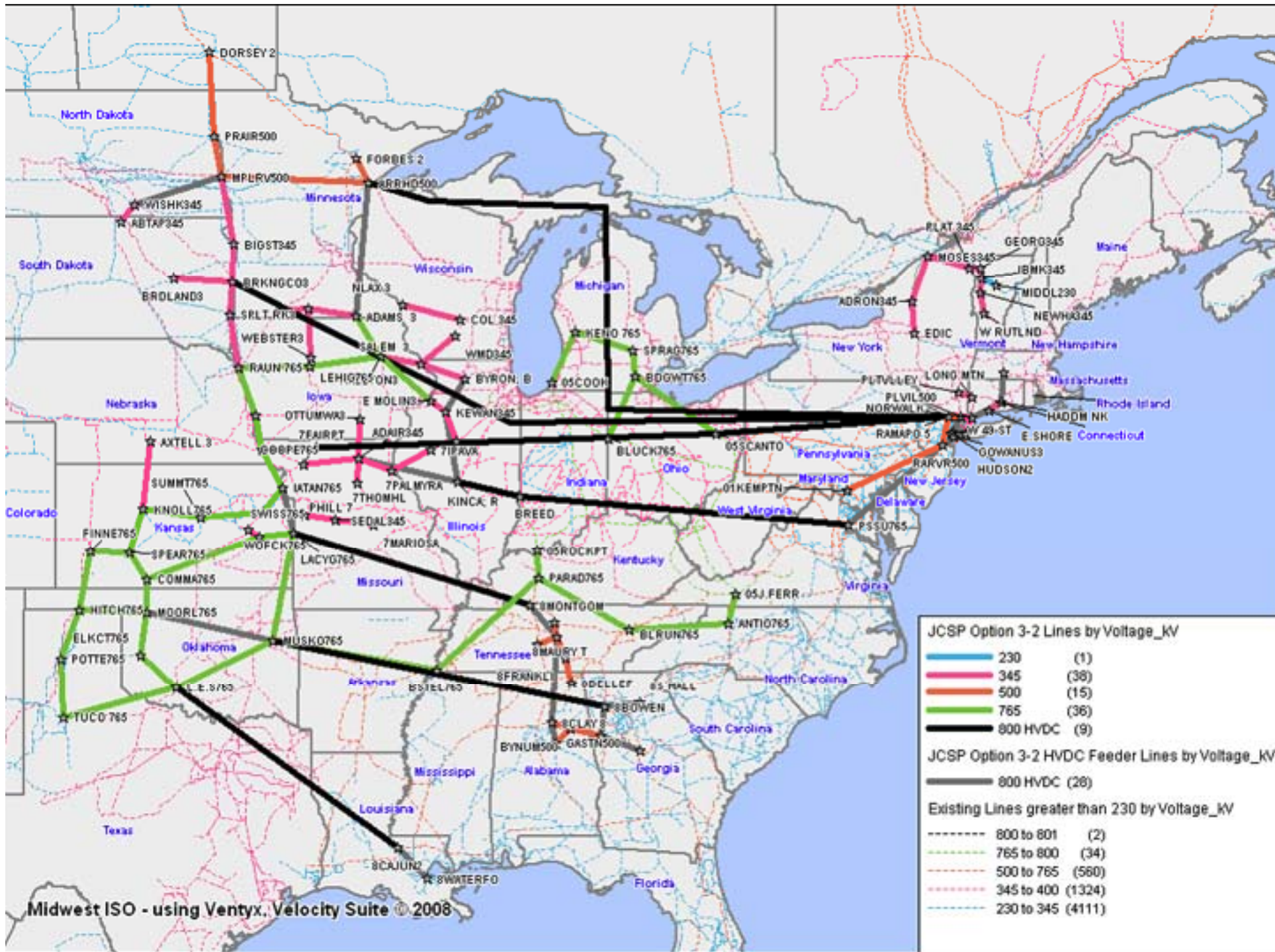
- Midwest ISO study
- Large-scale transmission
- Where are the wind resources
- Is there enough to matter?
- Suppose we were smart about locating transmission?



MISO Joint Coordinated System Plan

Great Plains Wind

- Very large wind resource
- But distant from population and load centers
- Solution from MISO System Plan is to build transmission





Massachusetts



Rhode Island



Delaware



Maine



Maryland



New Hampshire



New Jersey



New York



Vermont



Virginia

May 4, 2009

The Honorable Harry Reid
Majority Leader
U.S. Senate
Washington, DC 20510

The Honorable Mitch McConnell
Minority Leader
U.S. Senate
Washington, DC 20510

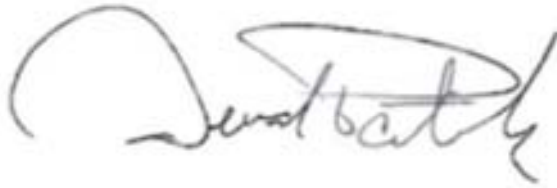
The Honorable Nancy Pelosi
Speaker
U.S. House of Representatives
Washington, DC 20515

The Honorable John Boehner
Minority Leader
U.S. House of Representatives
Washington, DC 20515

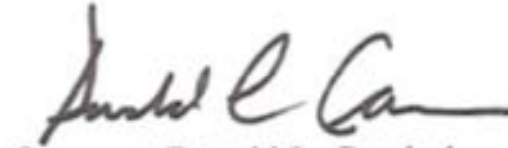
Dear Senator Reid, Senator McConnell, Speaker Pelosi, Representative Boehner,

As Governors from Northeast and Mid-Atlantic states, we applaud your support for renewable energy and its role in enhancing clean energy job creation, increasing our energy security and

Sincerely,



Governor Deval Patrick
Massachusetts



Governor Donald L. Carcieri
Rhode Island



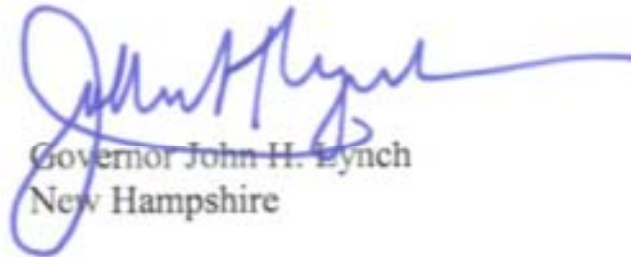
Governor Jack Markell
Delaware



Governor John Baldacci
Maine



Governor Martin O'Malley
Maryland



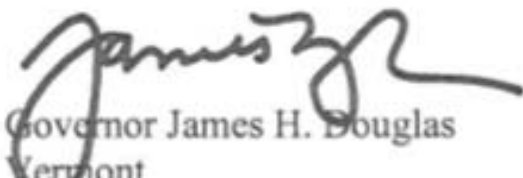
Governor John H. Lynch
New Hampshire



Governor Jon S. Corzine
New Jersey



Governor David A. Paterson
New York



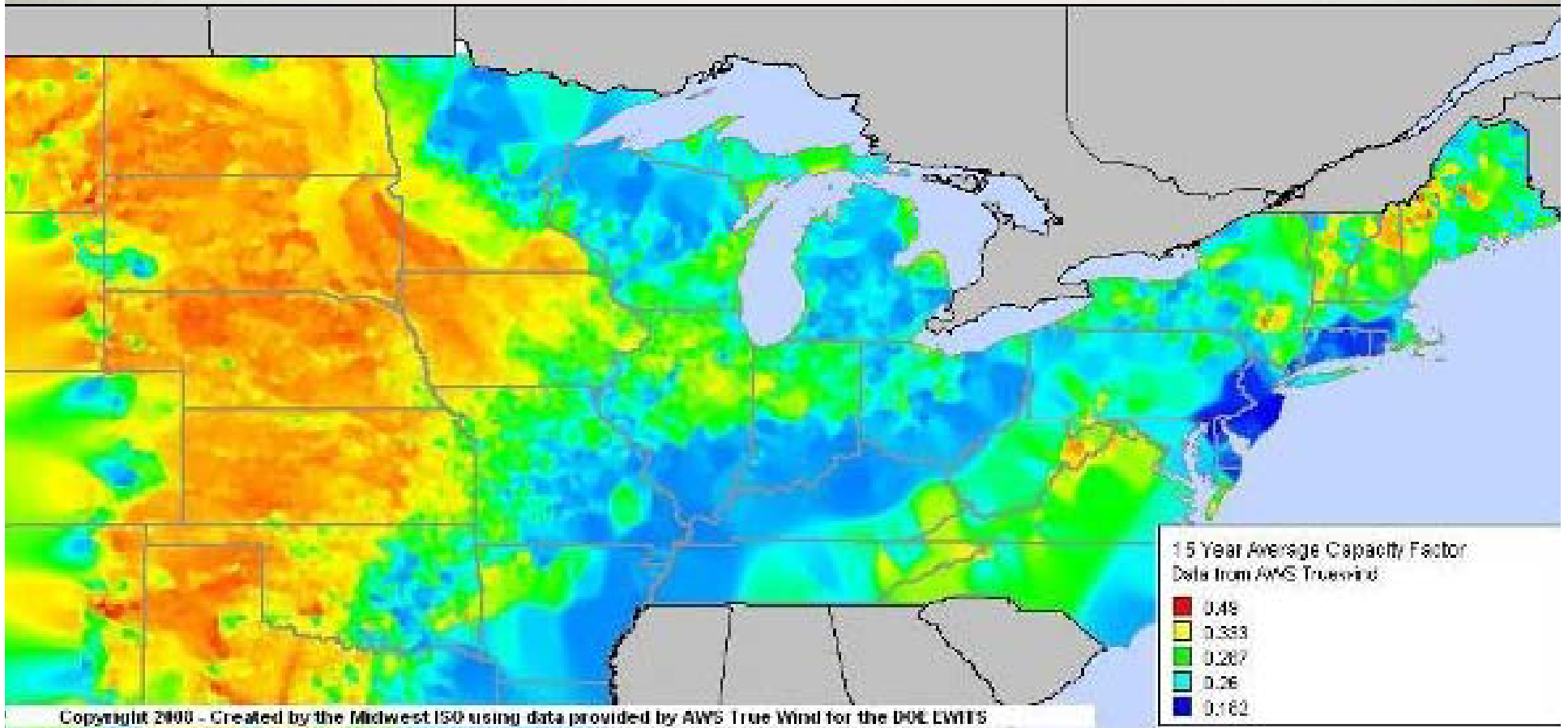
Governor James H. Douglas
Vermont



Governor Timothy M. Kaine
Virginia

Governors' Letter

- "... the waters adjacent to the East Coast hold potential for developing some of the most robust wind energy resources in the world"
- "... offshore wind installation costs currently exceed those of onshore installations, these resources are much closer to our load centers..."
- "... research and development efforts ... promise to make offshore wind competitive with Midwest wind farms on a delivered cost of power basis."



MISO Joint Coordinated System Plan

Wind power beyond the coast?

- Scientific evidence for the Governors' claim of large wind resource offshore?
- No airport meteorological towers
- Many wind maps stop at the coast
- How to measure?
 - (Met buoys and satellite-QuikScat)

QuikSCAT

Met. buoy

VS

Image credit: NASA

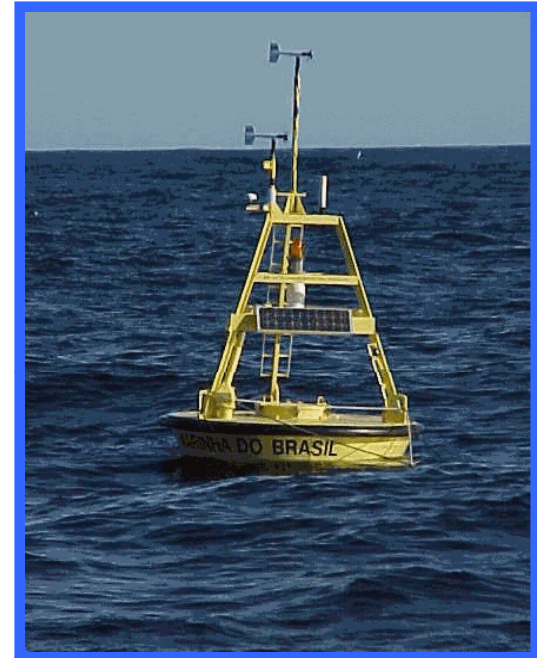
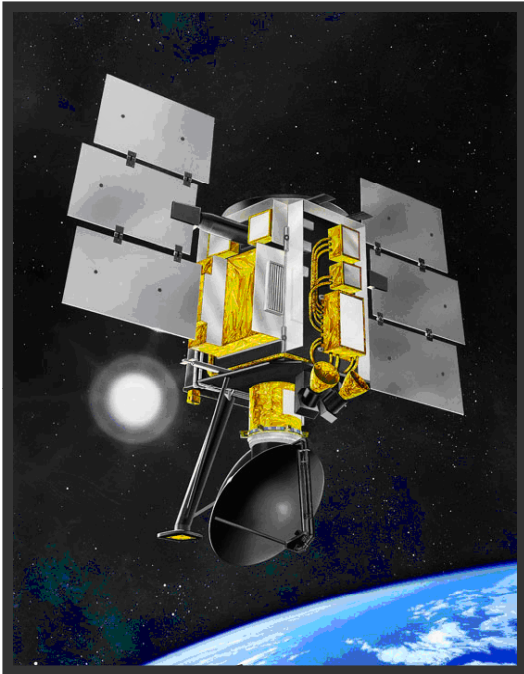
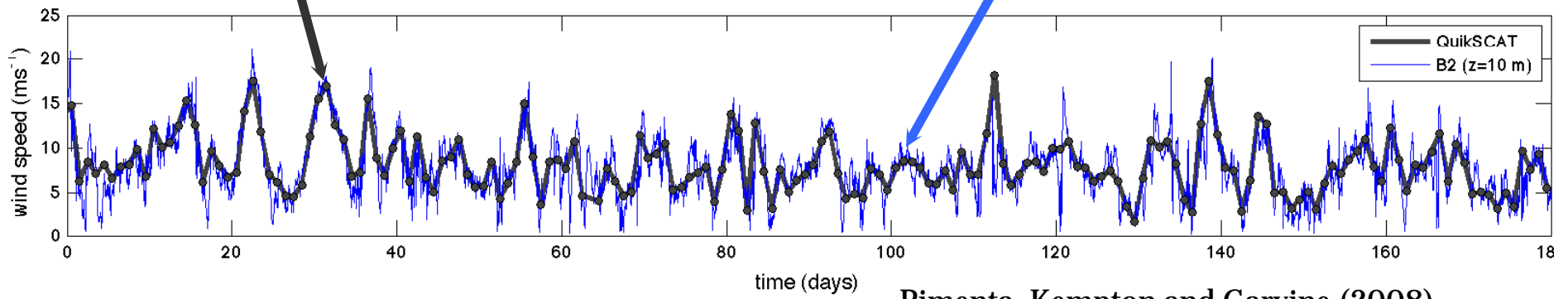
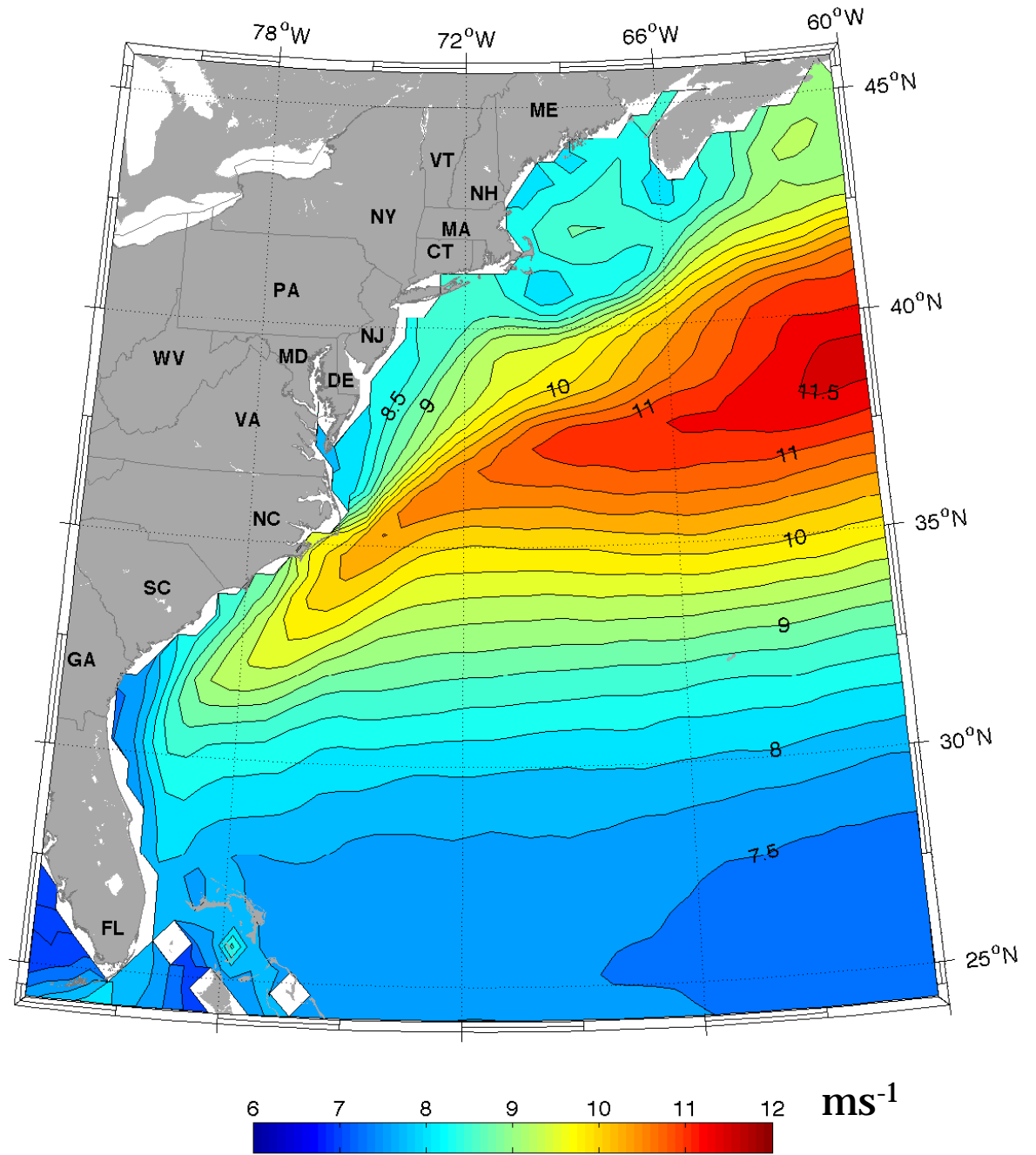
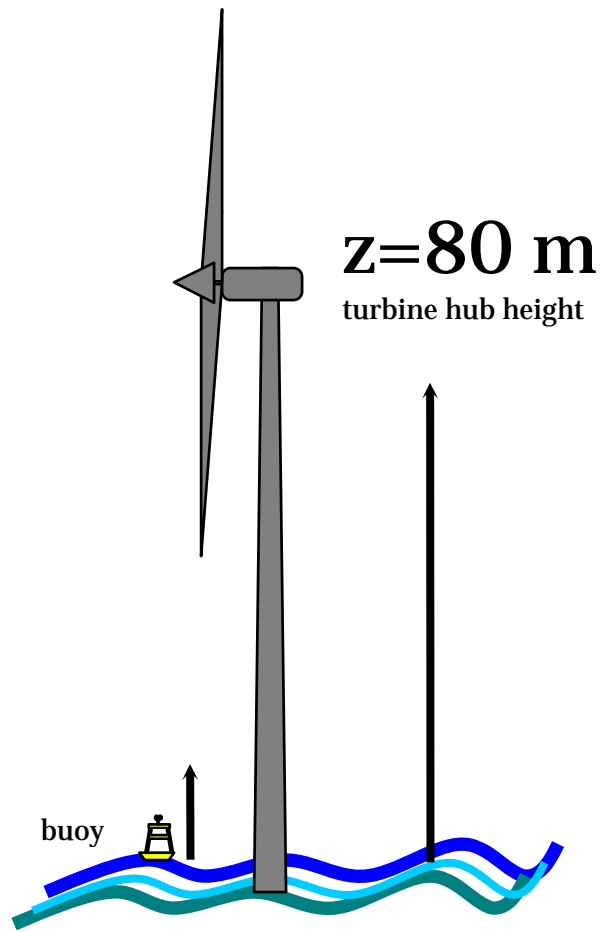


Image credit: Brazilian Navy



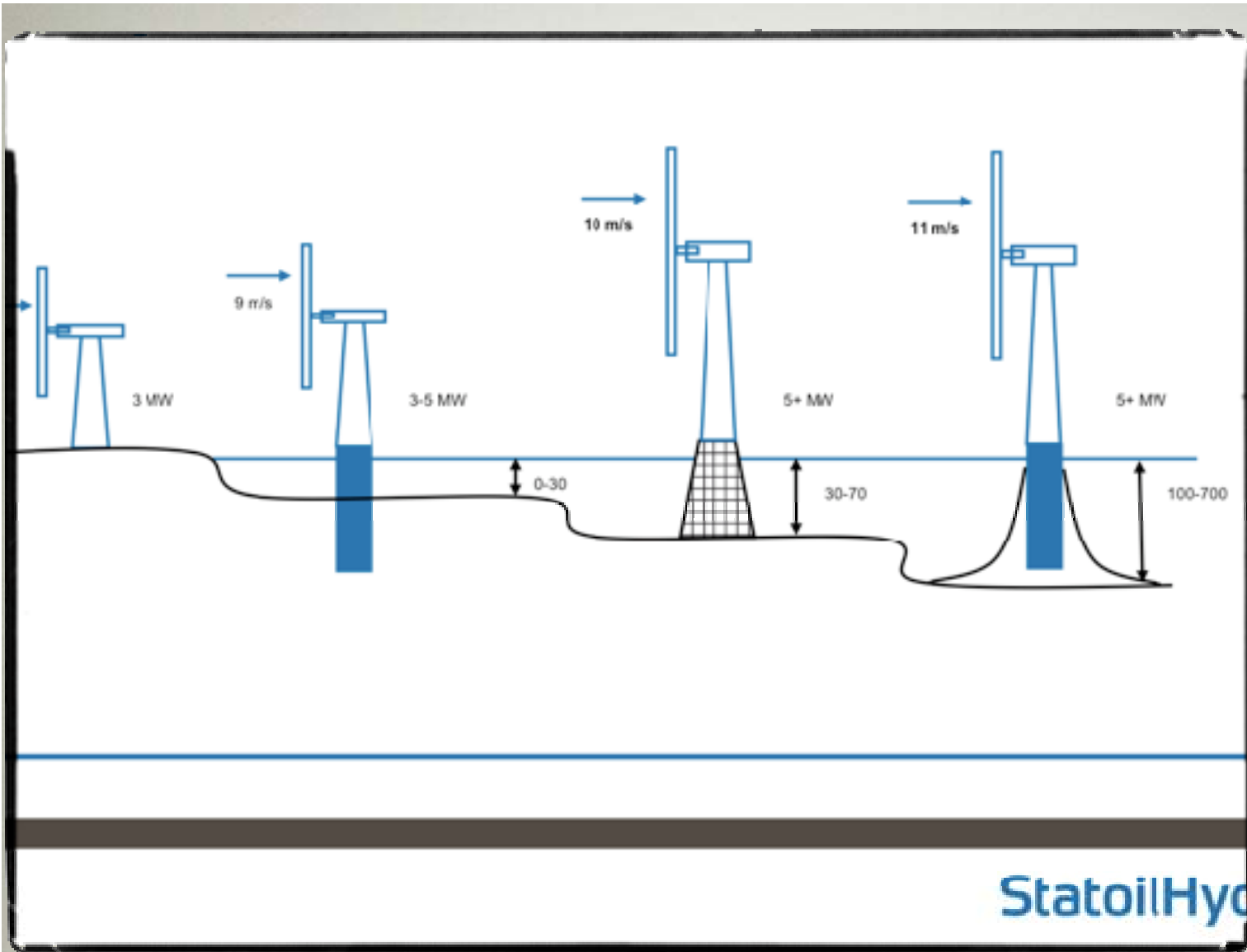
Pimenta, Kempton and Garvine (2008)

QuikSCAT wind speed 1999-2008



How much power?

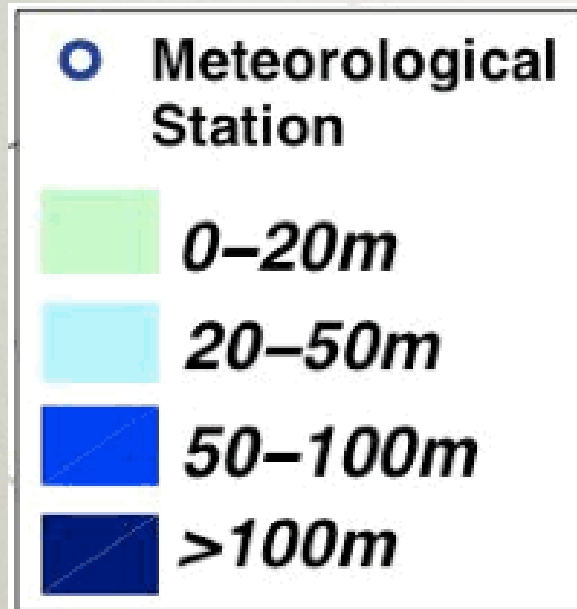
- Water Depth
- Exclusions (shipping lanes, bird flyways)
- Remaining area gives MW output
- Compare to load: electric, cars (assuming plug-ins), heating
- refs:
 - Dhanju, Whitaker & Kempton 2008
 - Kempton, Archer, et al *Geophysical Research Letters* 2007



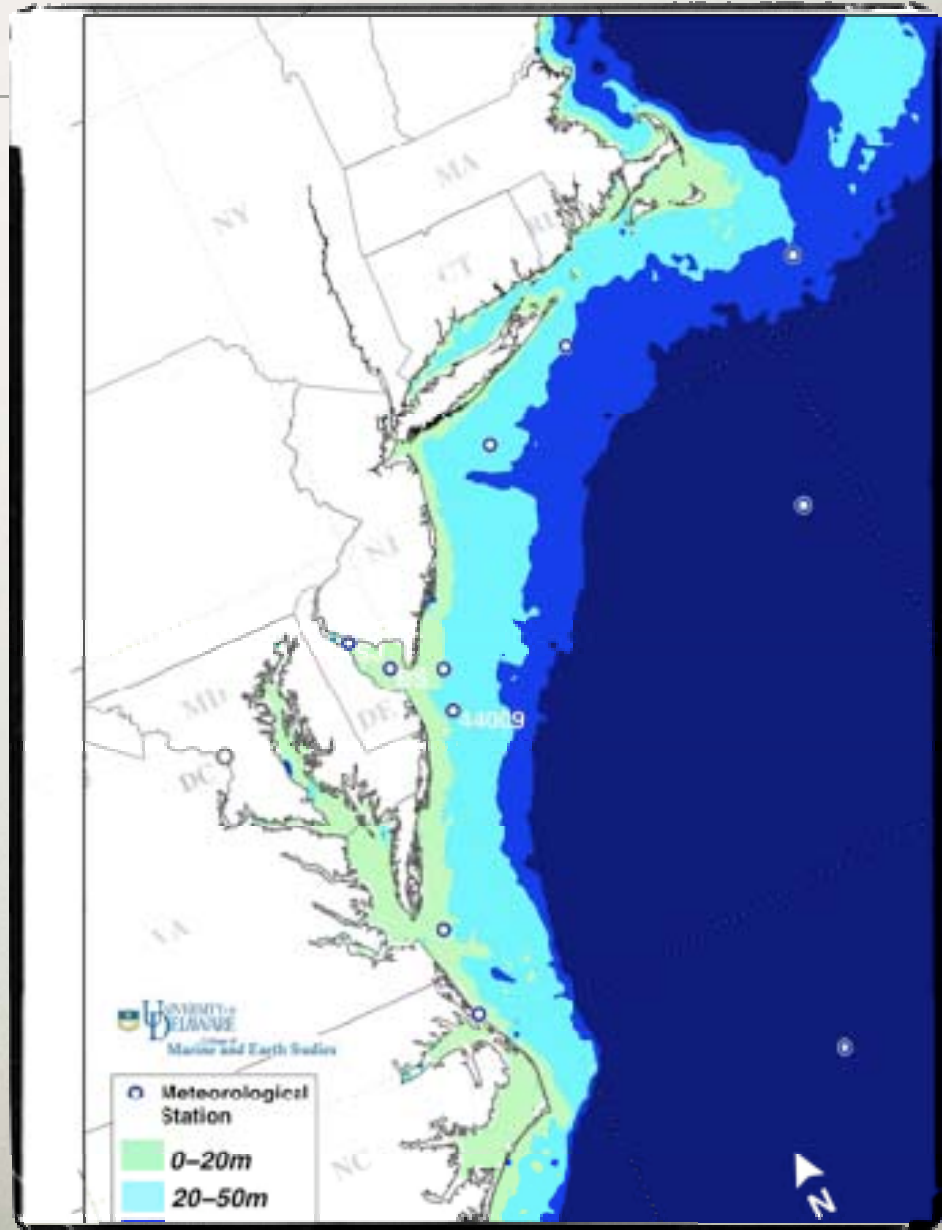
Tower enables depth range,
thus resource

Land-based, monopile,
jacket, spar buoy

Extend to Mid-Atlantic



- Examine resource of entire Mid-Atlantic
- Vs. load



Needs

	GW_{avg}
Electricity	73
Cars	29
Heating	83
total	185

Needs vs. Resource

	GW_{avg}
Electricity	73
Cars	29
Heating	83
total	185

m	Excl	GW_a
0-20	0.46	60
20-50	0.40	117
50-100	0.10	153
Total		330

All of electricity, cars and heating uses 2/3 of the wind resource, dropping regional CO₂ by 68%.

Drill, Baby, drill?

- Just how much oil in Atlantic OCS?
- Compare delivered energy
 - Offshore wind 330,000 MW_a
 - OCS oil 18,000 MW_a (during 20 years)
- Wind > 16 times oil !

from: Kempton et al Geophysical Research Letters 2007

Reduce oil imports?

- One electric car draws 400 W_a ($.4 \text{ kW}_a$)
- Mid-Atlantic cars draw $29,000 \text{ MW}_a$
- Atlantic OCS oil could run 30% of Mid-Atlantic cars for 20 years
- Offshore wind would run 100% of those cars.... forever

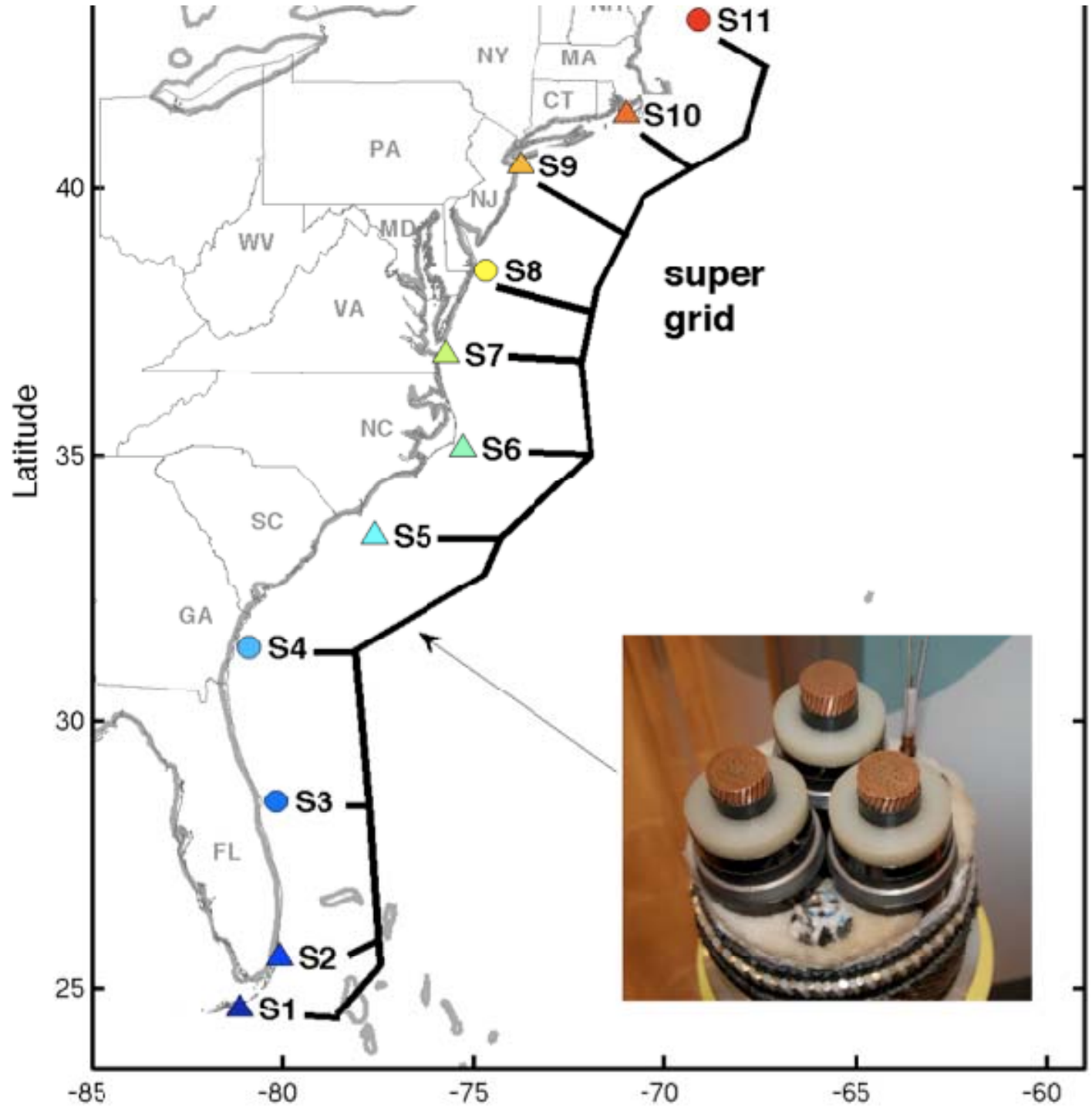
Governors' Letter

- "If transmission is to be addressed in energy legislation ... "
- "For offshore wind, this means a new offshore wind transmission backbone to facilitate..."
- "... interconnection of offshore renewable energy resources to major load centers along the East Coast."

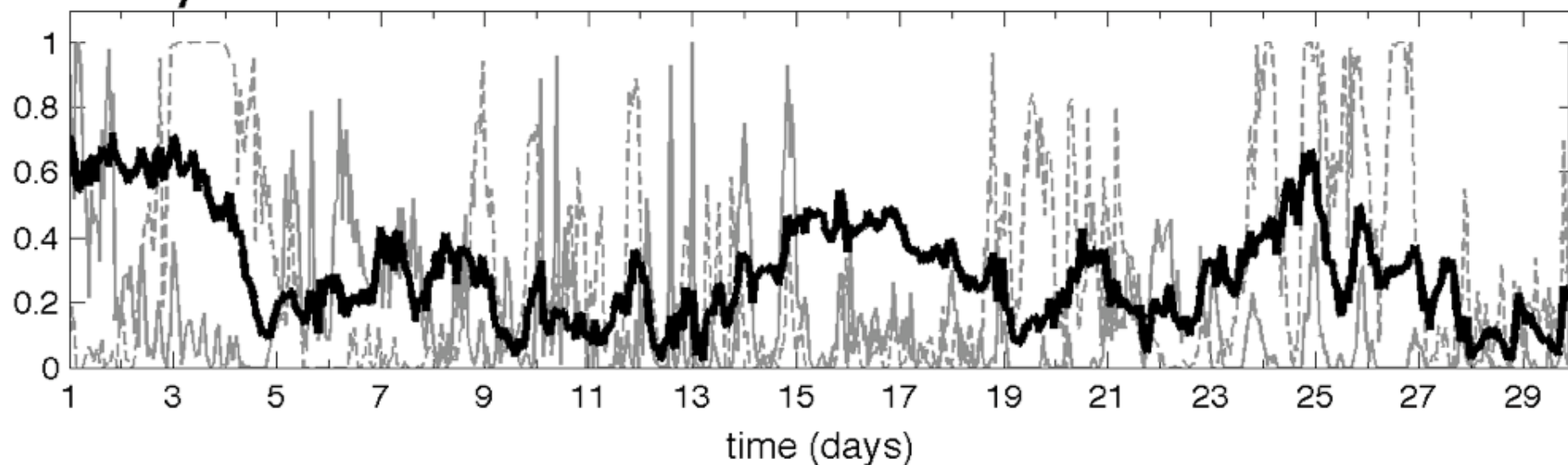
Offshore Transmission

Connect multiple wind farms to multiple state loads

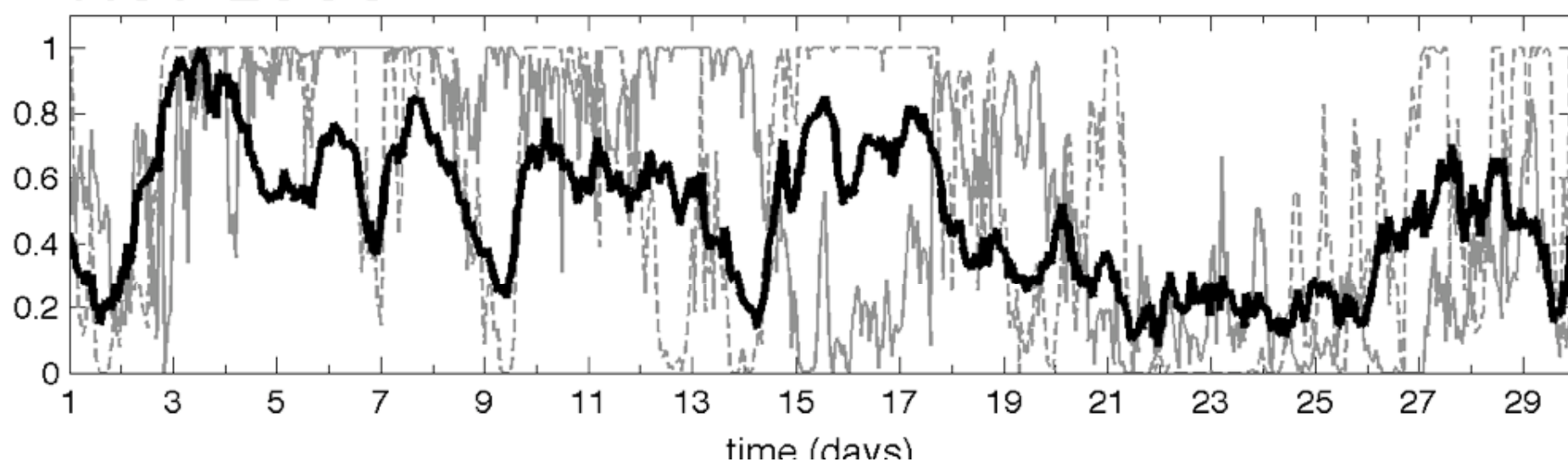
How does offshore transmission affect combined power produced?



May 1999



Nov 1999



Summary

- Enough power to run the entire East Coast
- Much more than OCS offshore oil
- Transmission can be run offshore
- Offshore wind transmission also levels power produced

END

More information:

www.carbonfree.udel.edu