Offshore Wind Energy:

Status, Issues, & Comparisons With U.S. On-Land Development Potential in Coastal Areas

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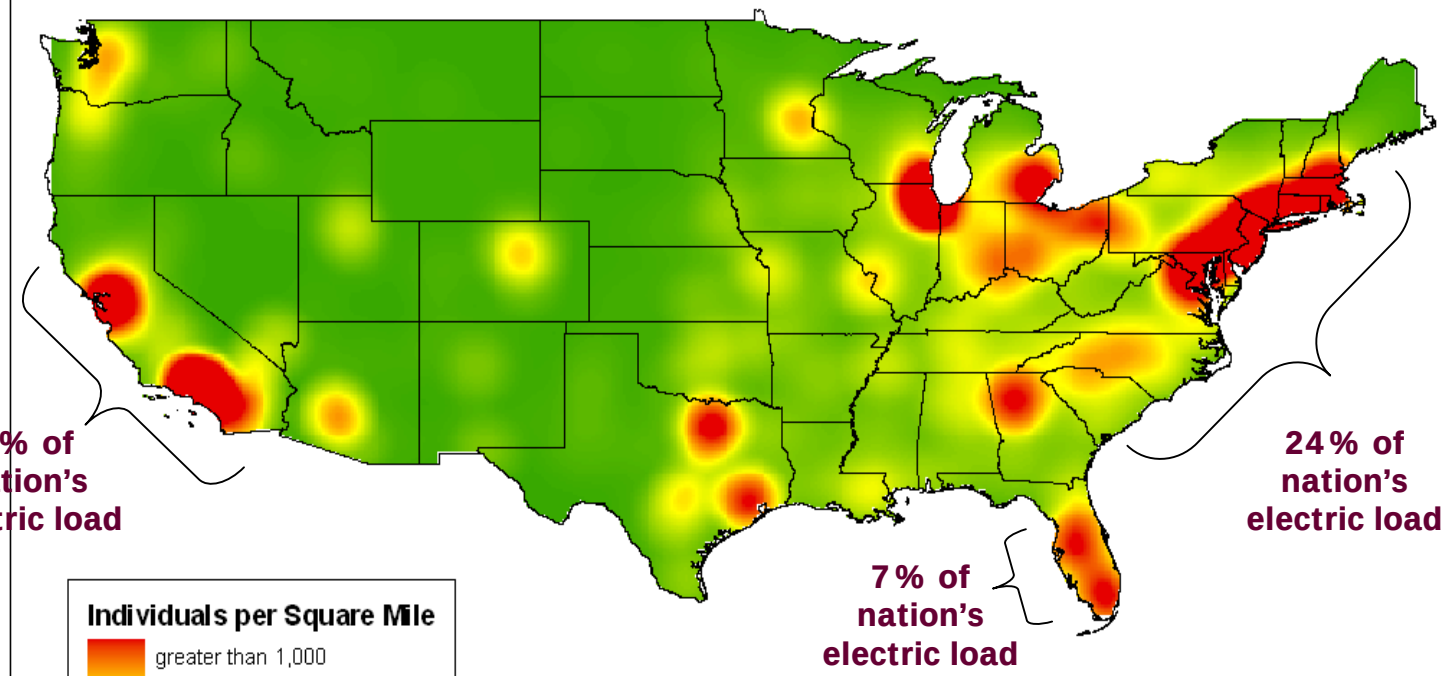
Stanford University, April 26, 2004

Population Density of the Counterminous United States



Over half the population lives in coastal counties

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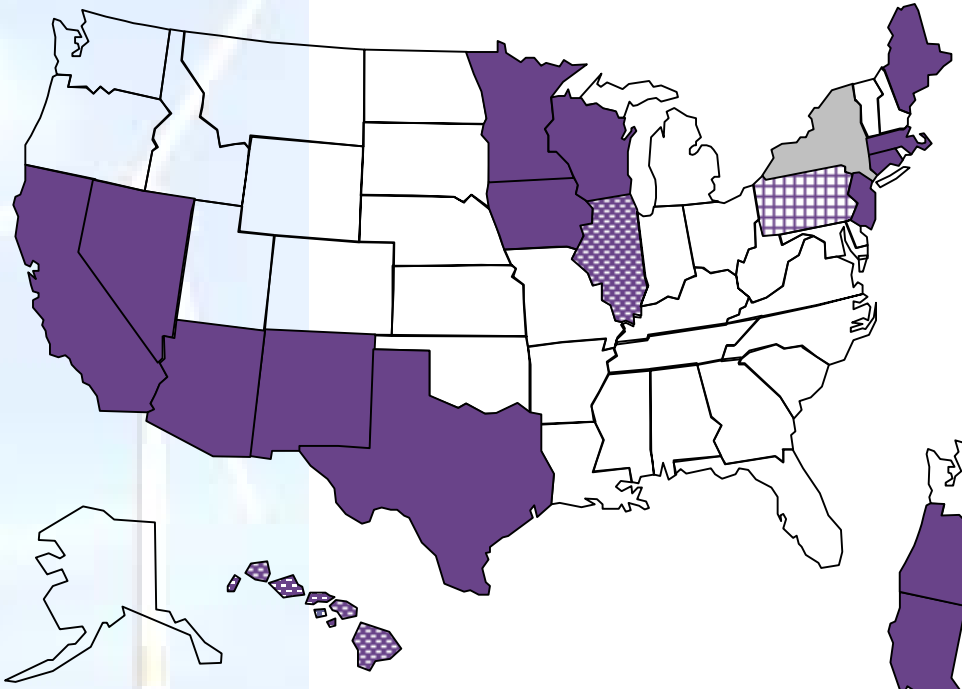
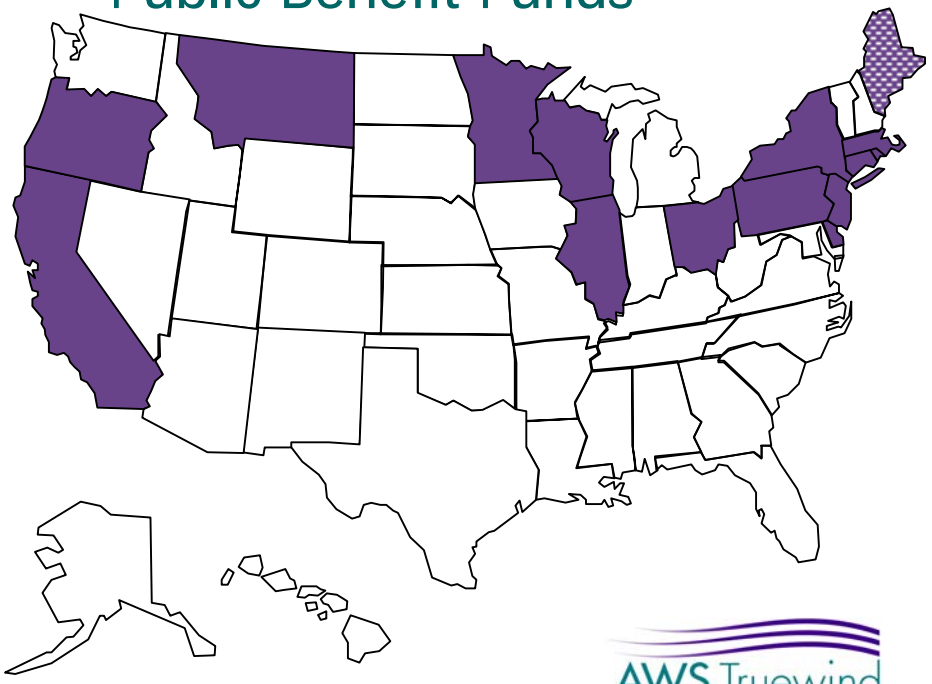
State Incentives



Renewables Portfolio Standards

Public Benefit Funds



Can enough wind be built on land in the Northeast?

http://www.dsireusa.org

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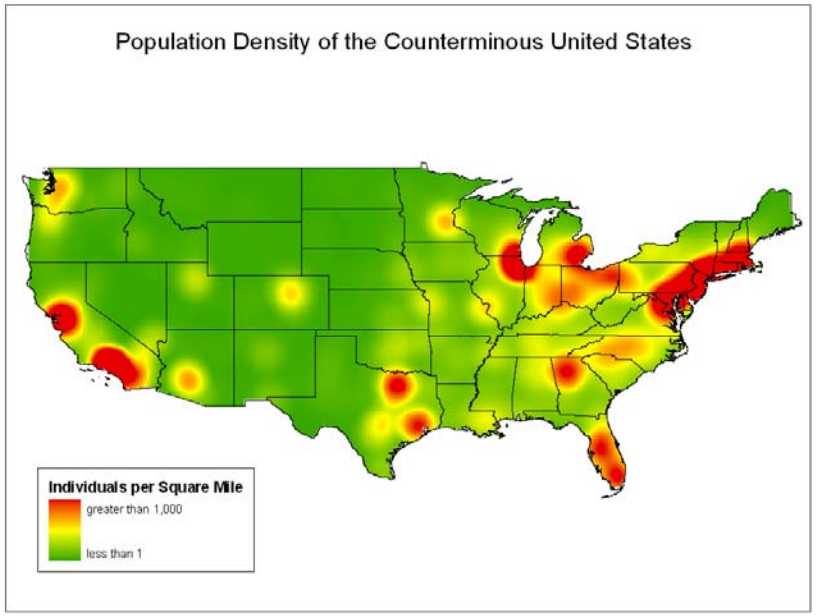
Why Go Offshore?

- No windy lands near many load centers
- Transmission barriers on land for long distances
- Strong winds reside offshore; good load matching too



- Offshore wind can help satisfy RPS and SBC initiatives and still be cost-competitive with other renewables

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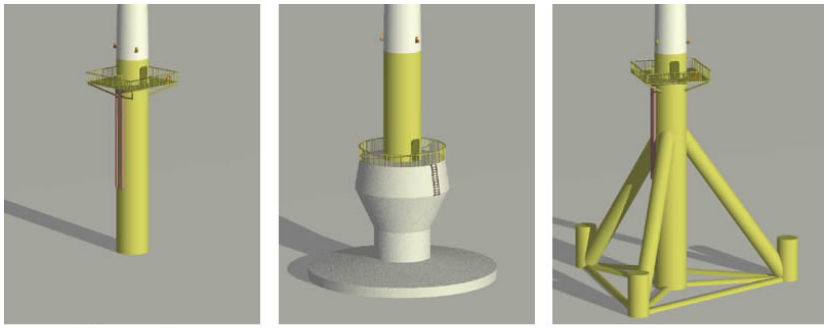
Offshore Components

- Tower heights >200 ft (60 m)
- Turbines rated 2 - 5 MW
- Spaced 1/3 to ½ mile apart
- Rotor diameters 250-350 ft
- Foundations
- Substation & marine cable
- Port facilities



Nysted Project, Denmark

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Key Design/Siting Factors

- Water Depth
- Extreme Wind/Waves
- Seabottom Geology
- Distance to Transmission
- Installation Equipment

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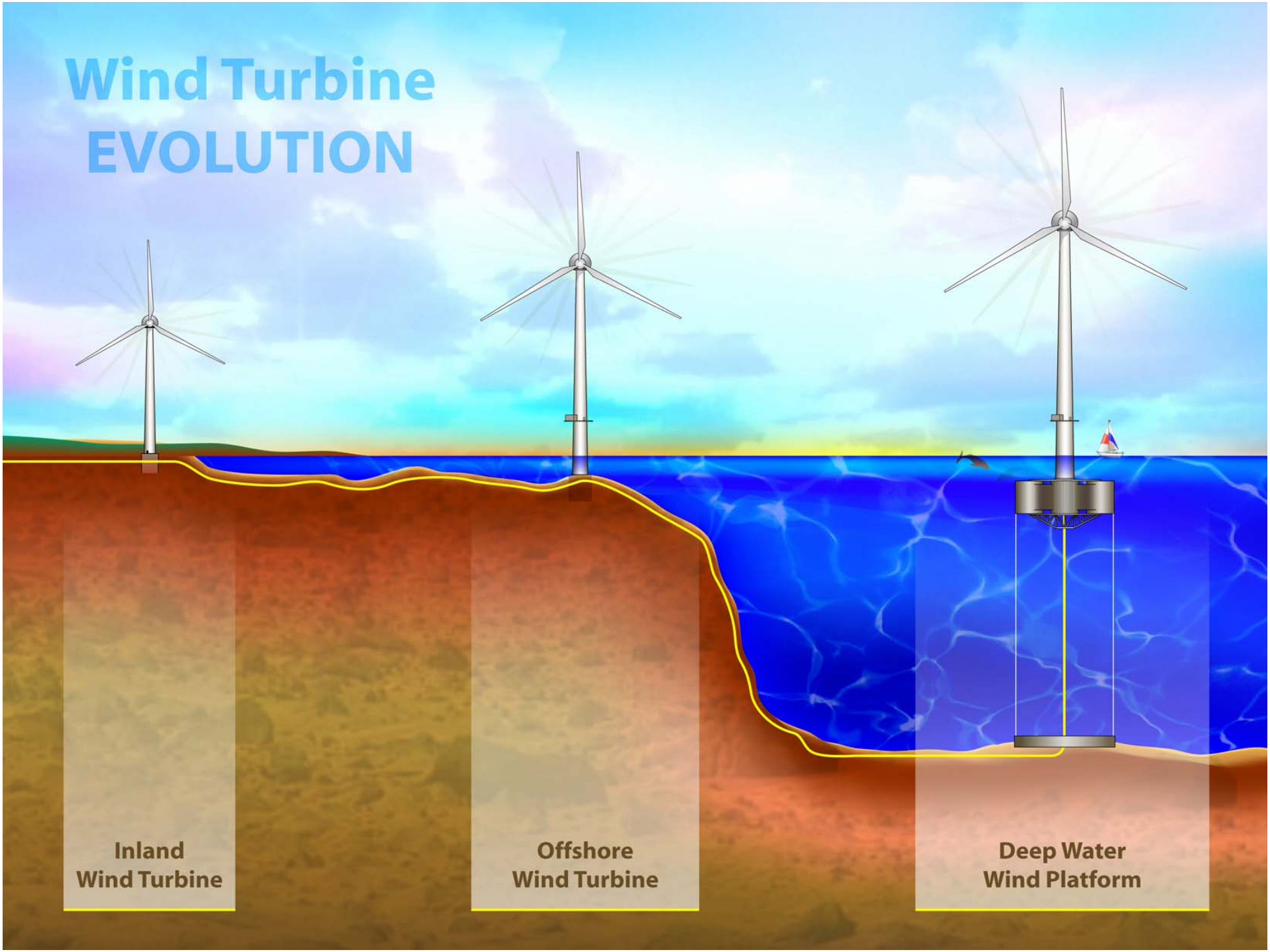
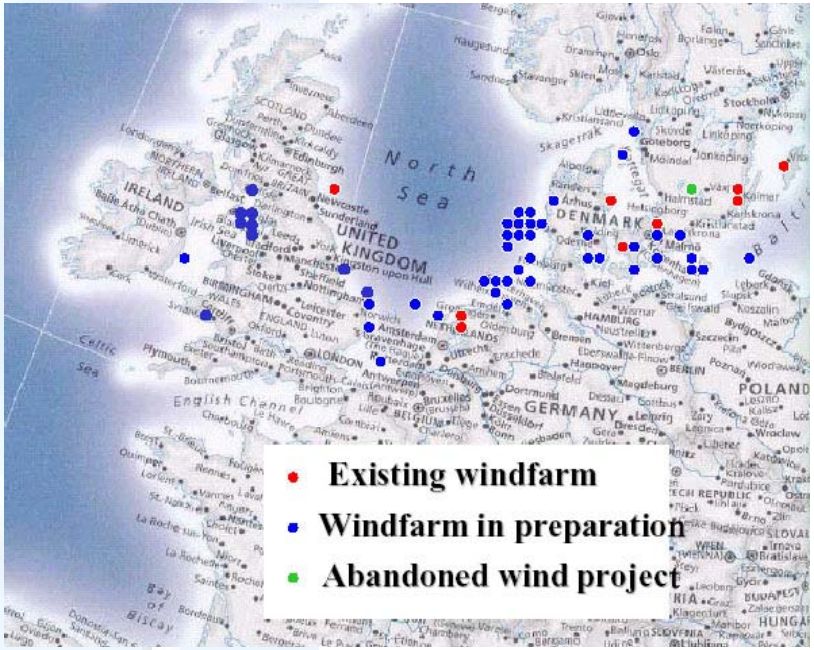

Wind Turbine
EVOLUTION
Inland
Wind Turbine
Offshore
Wind Turbine
Deep Water
Wind Platform

Why Europe is Pursuing Offshore Wind

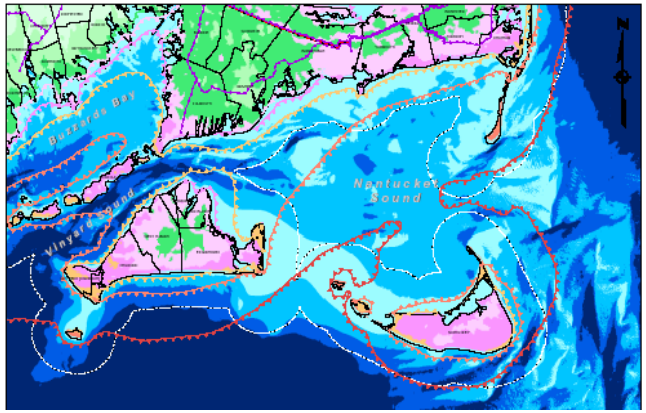


- **Strong, aggressive government policies promoting green energy**
- **Shrinking opportunities on land**
- **Widespread acceptance / familiarity with land-based wind projects**
- **Shallow waters well offshore**

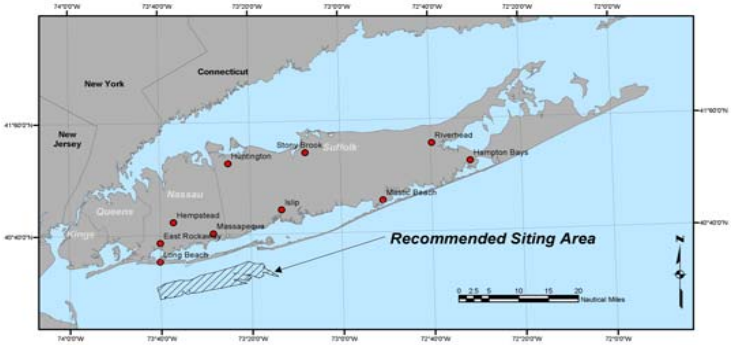
160 MW Horns Rev Project, Denmark

U.S. in Contrast

- Only two serious pending projects
- Independent pioneers
- Almost no wind projects on nearby land
- Fickle renewable energy support



Cape Wind Associates



Long Island Power Authority

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Land vs Offshore Potential In Coastal Areas

- Compare amount of windy areas in coastal states and offshore
- Assume higher threshold wind resource for offshore projects
- Assume maximum water depths for offshore projects in near-term
- Contrast public with private lands

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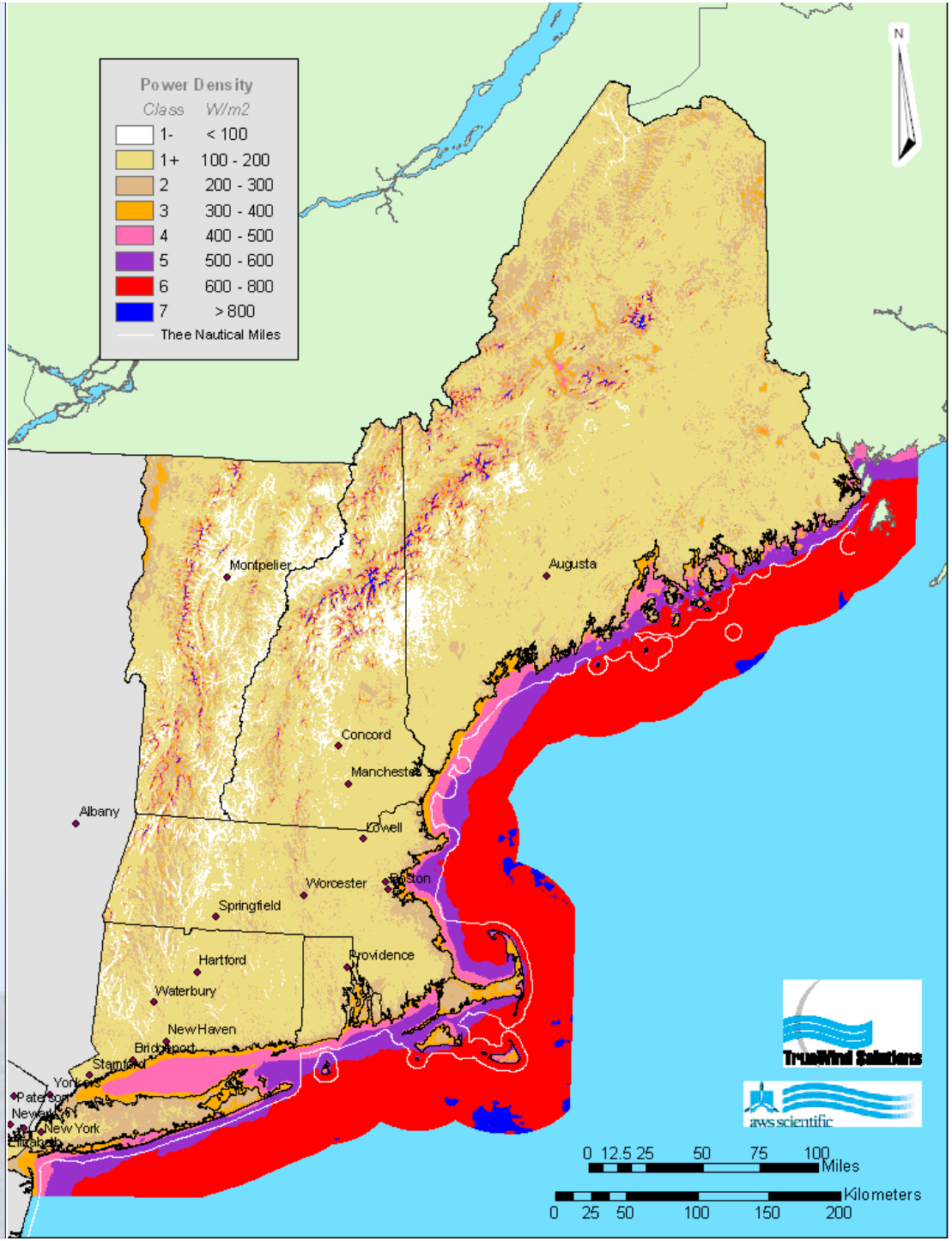
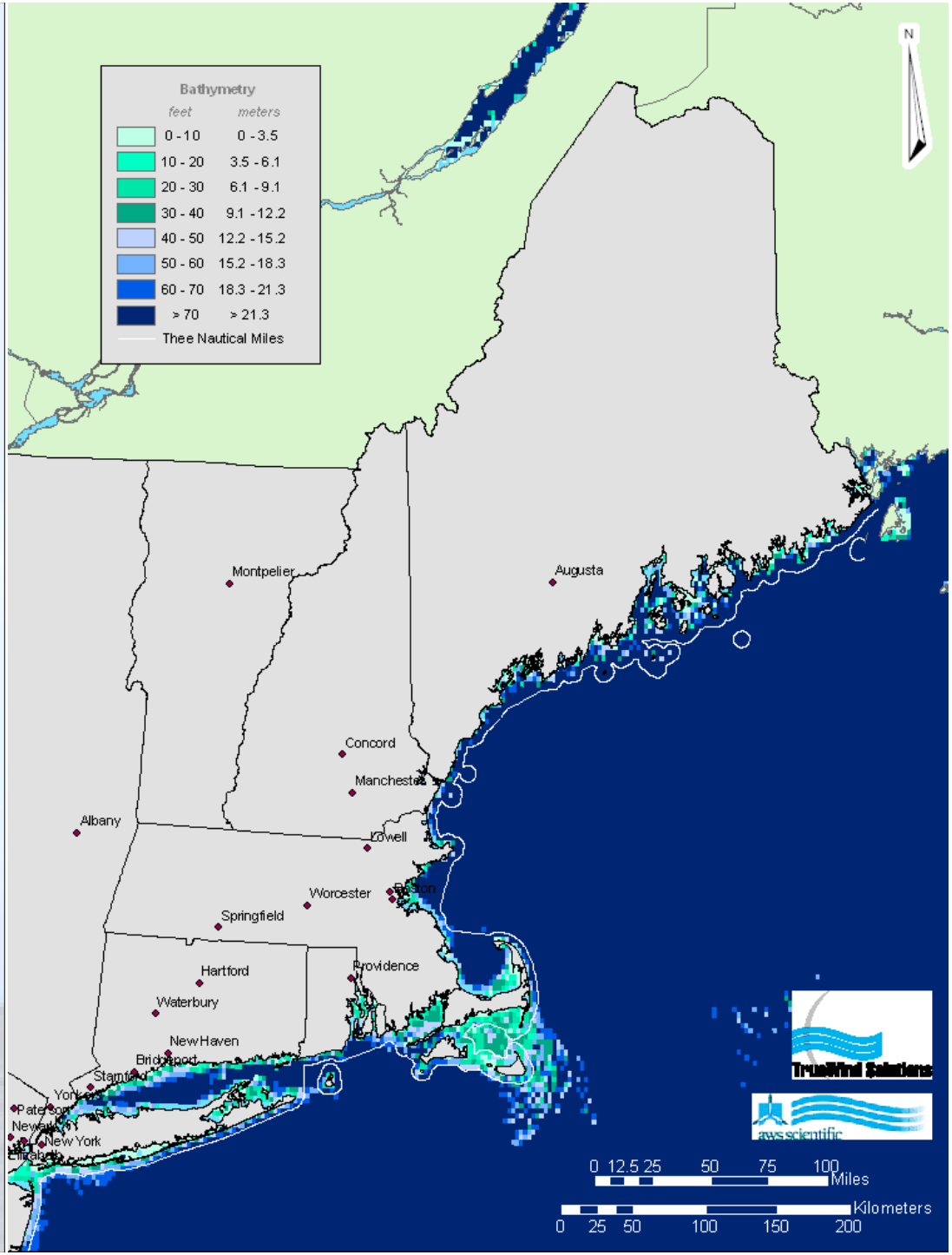
New England Wind Power Class Map

- Commercial Land Wind Projects Require Class 4+ Wind Class
- Offshore Wind Projects Require Class 5+ Due to Higher Construction Costs



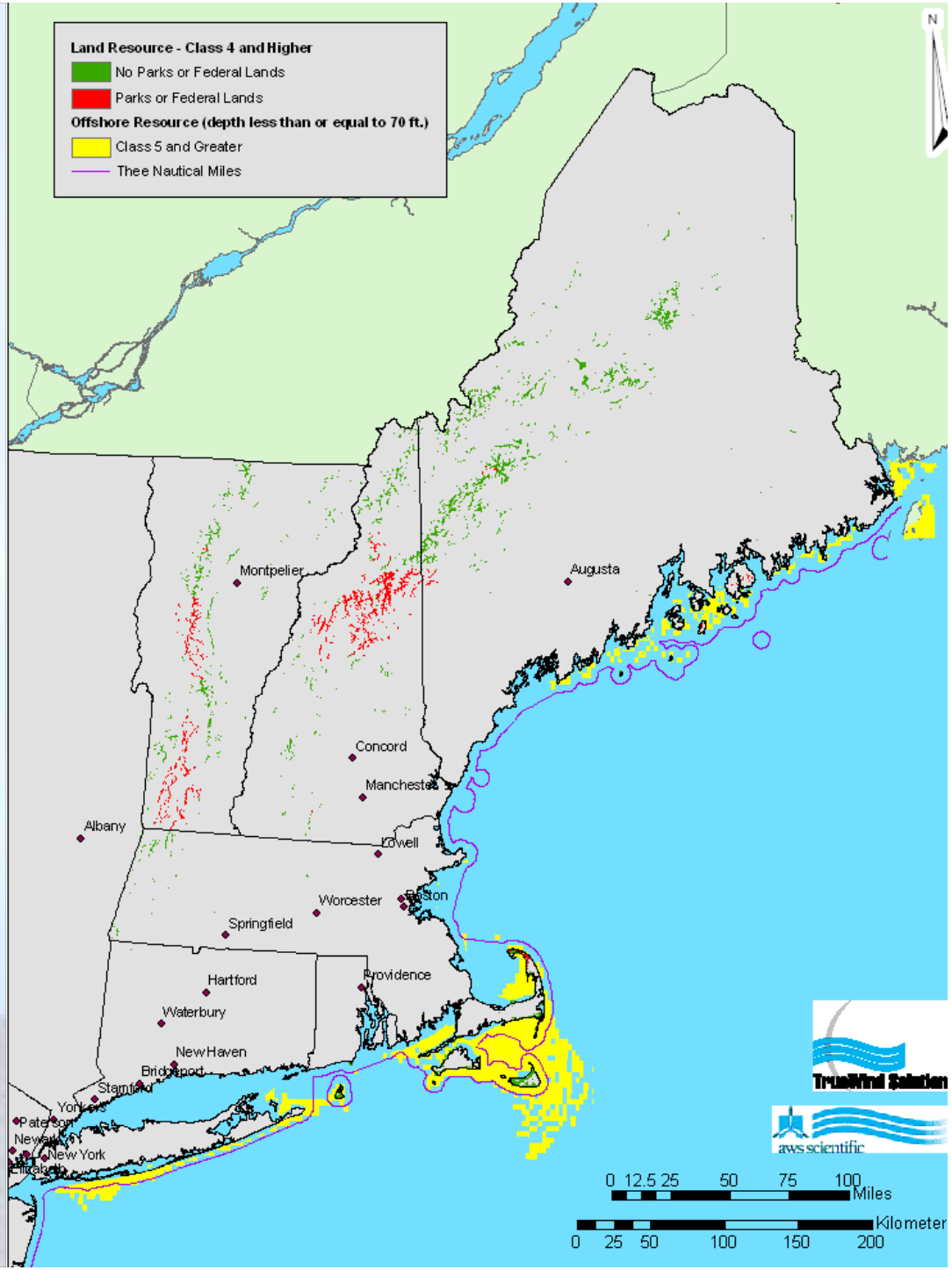
New England Water Depths

- Most Offshore Projects Have Been Built in Waters <50 ft Deep
- Some New Offshore Projects Are In Waters Up to 75 ft Deep
- Deep-Water Foundation Designs Are Under Development



New England Windy Areas

- Windy Lands (Class 4+) With and Without Parks/Govt. Forests
- 28% of windy lands are in parks/govt. forests
- Windy Waters (Class 5+) with depths <70 ft
- 40% of windy waters beyond 3-mile limit



Mid-Atlantic Wind Power Class Map

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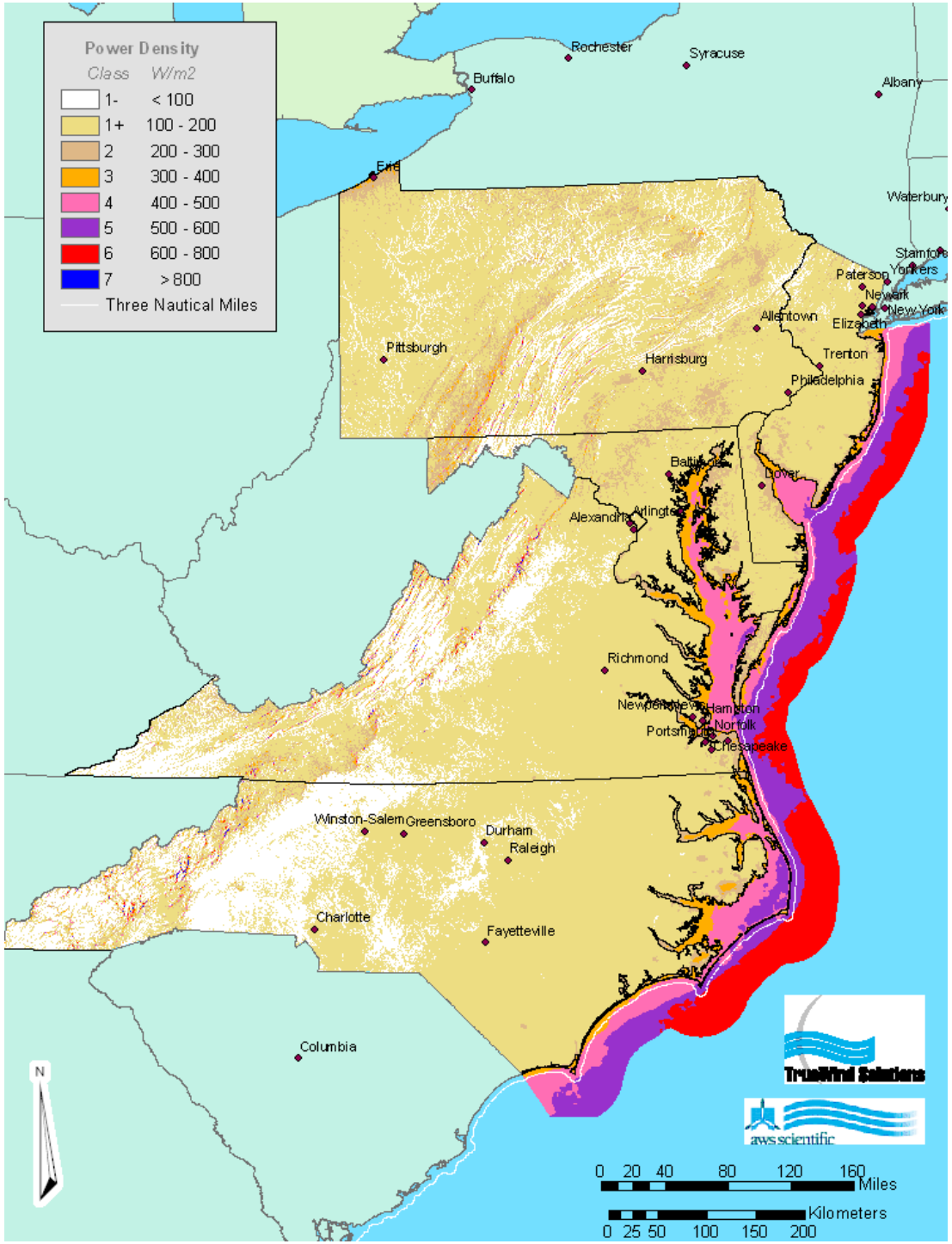

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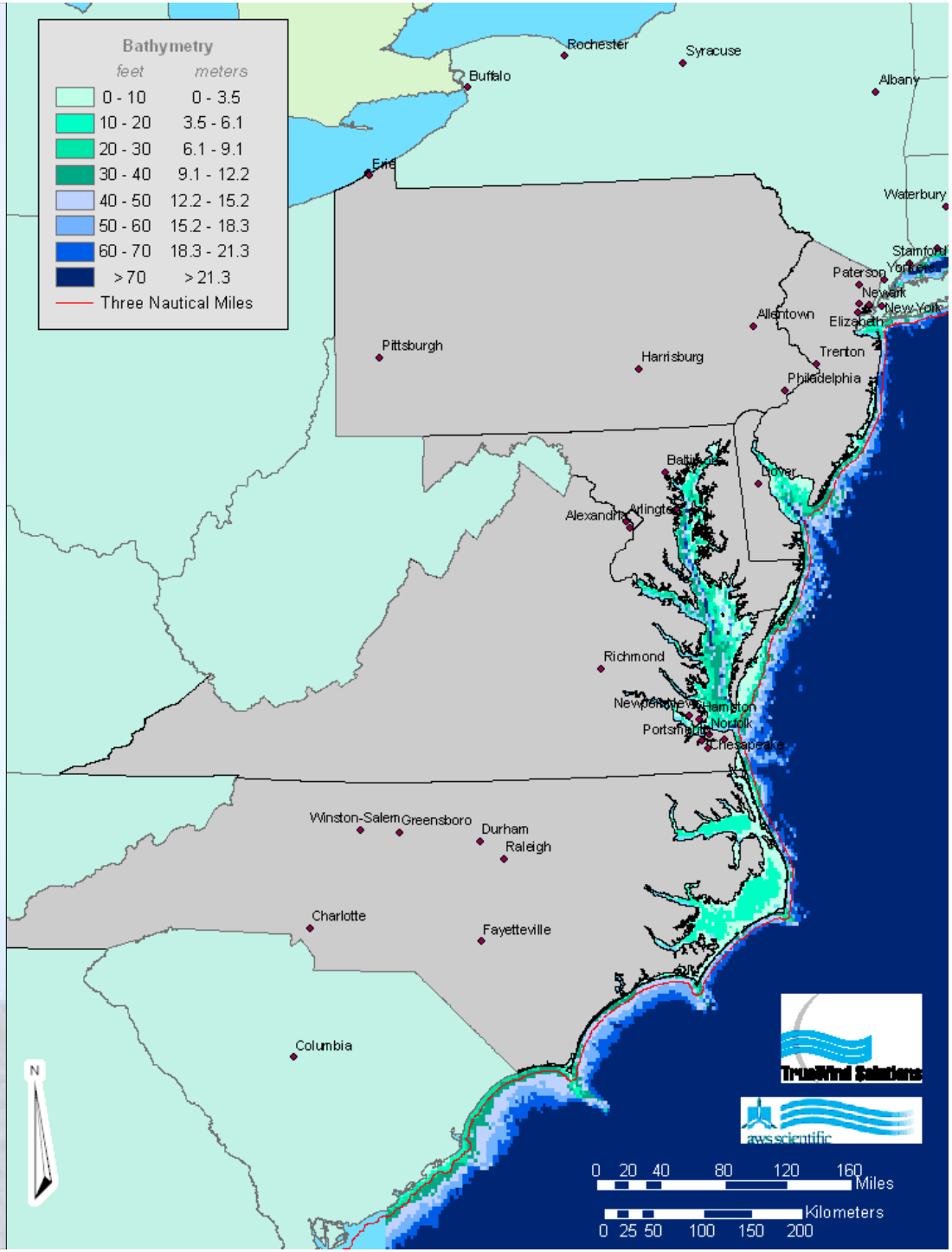
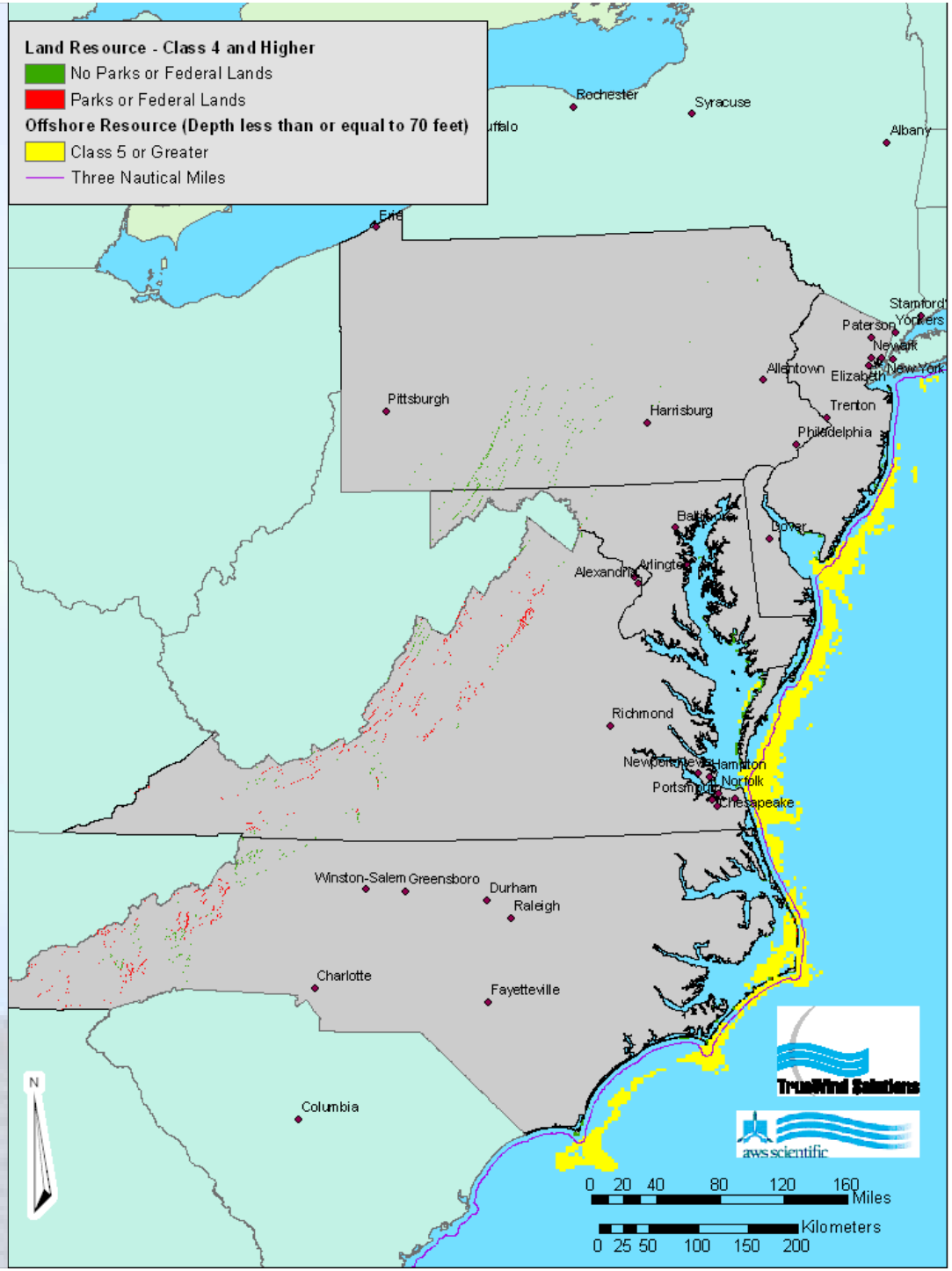
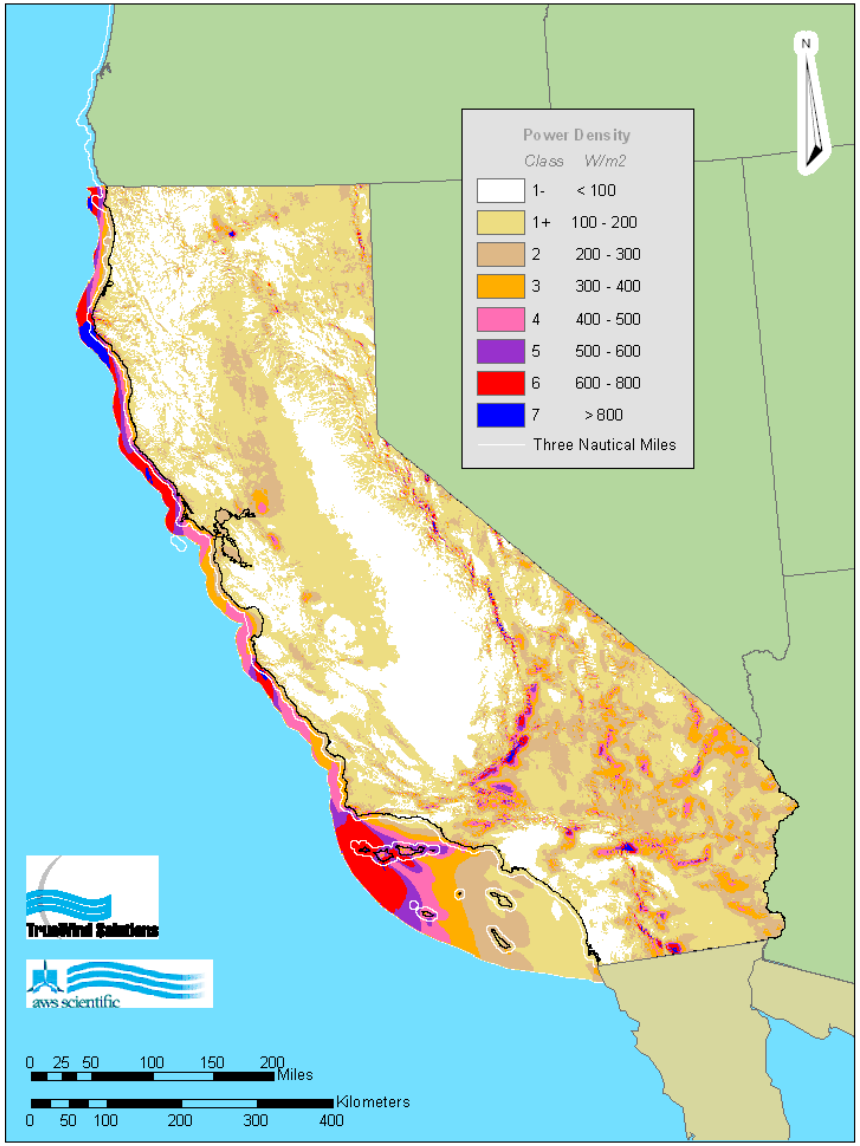


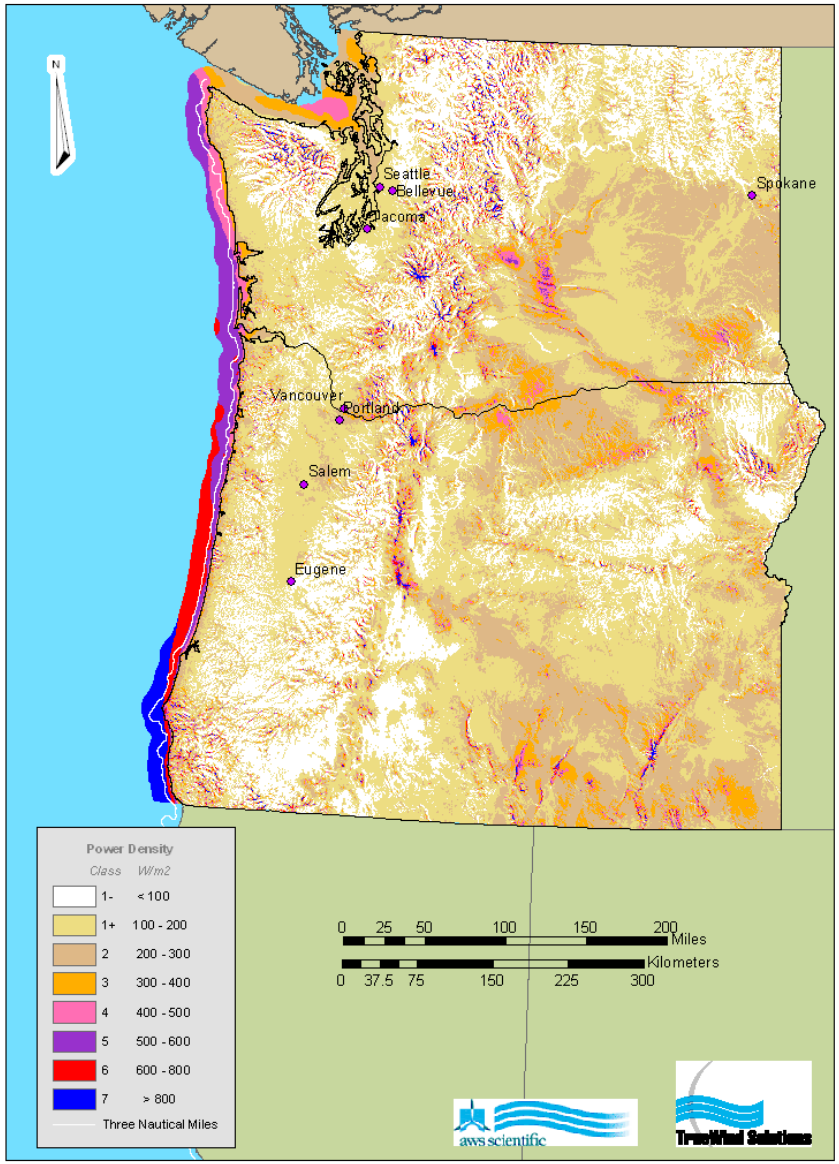
Mid-Atlantic Windy Areas

- Windy Lands (Class 4+) With and Without Parks/Govt. Forests
- 42% of windy lands are in parks/govt. forests
- Windy Waters (Class 5+) with depths <70 ft
- 80% of windy waters beyond 3-mile limit



West Coast – Wind Power Class





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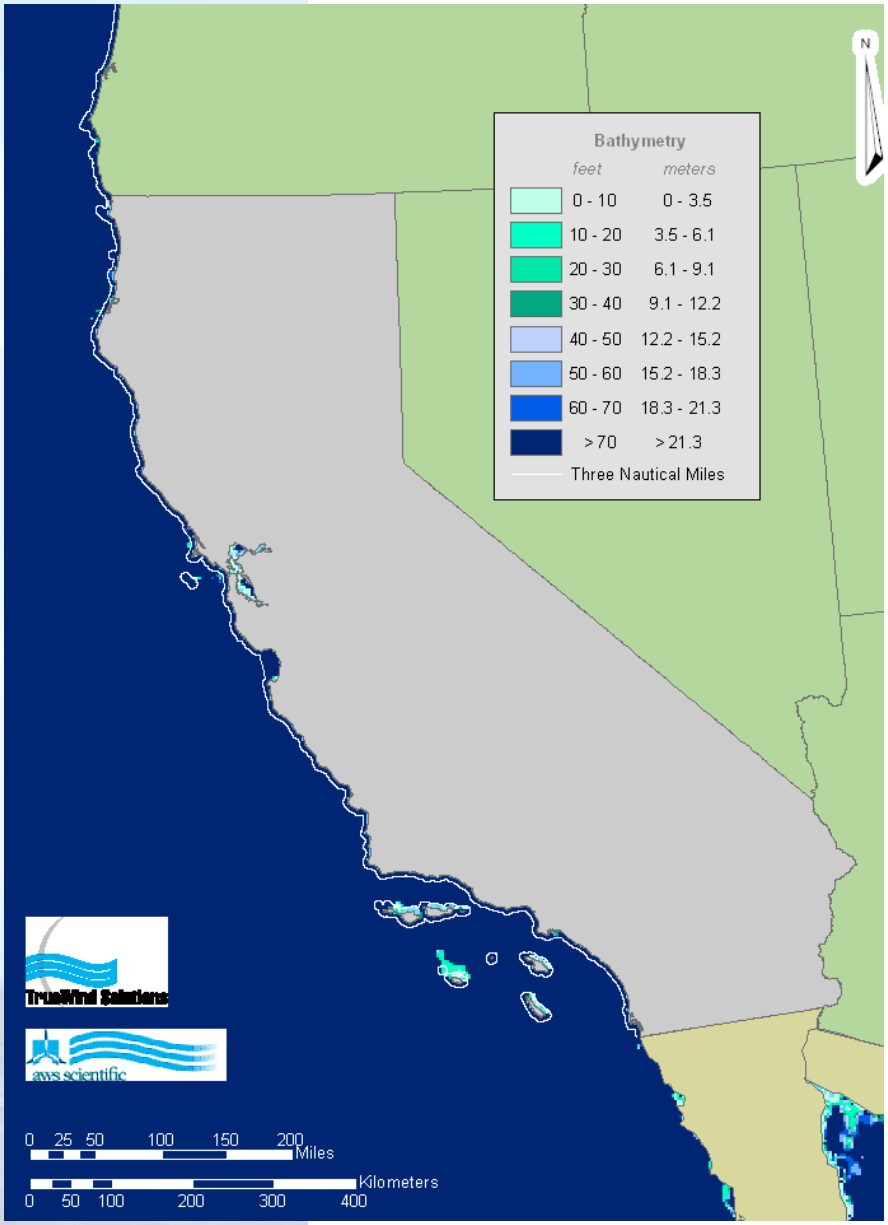

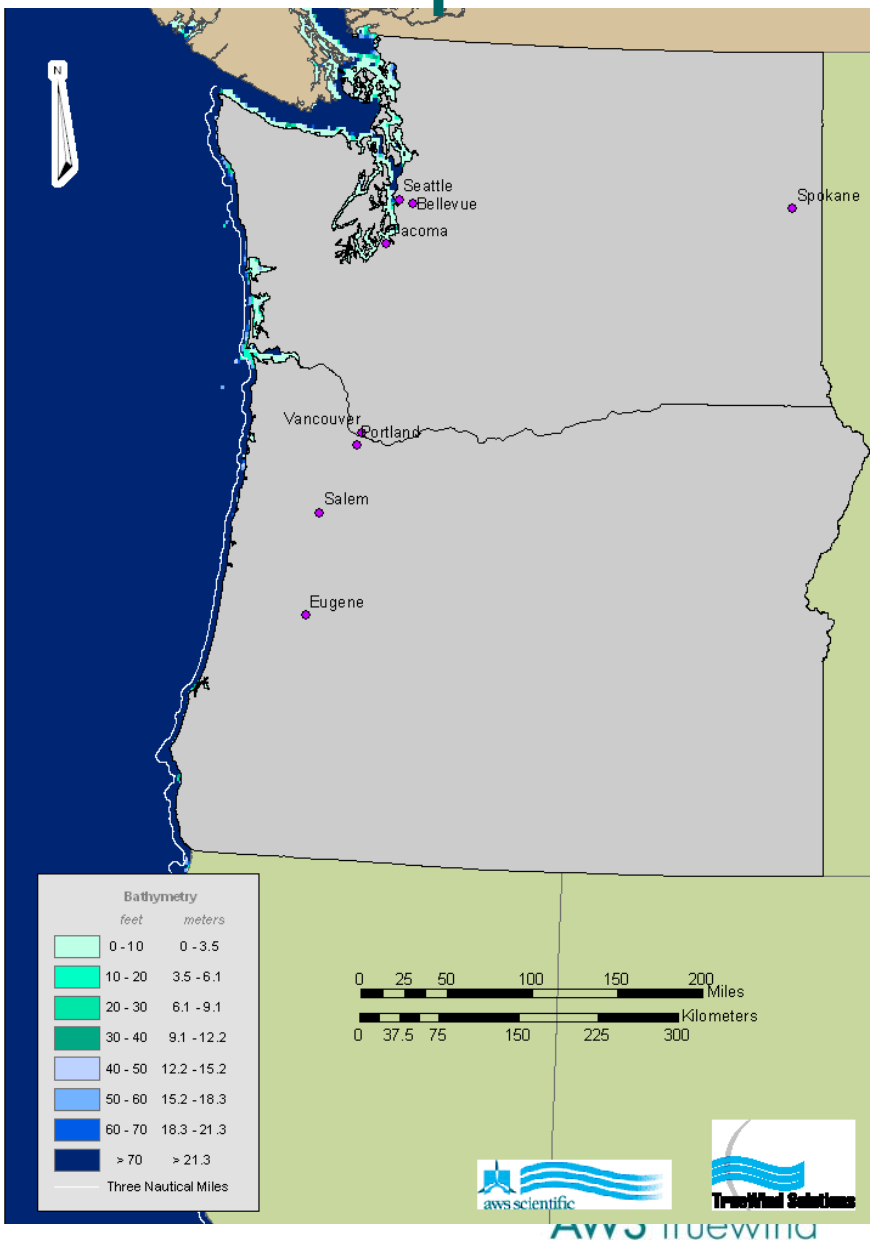

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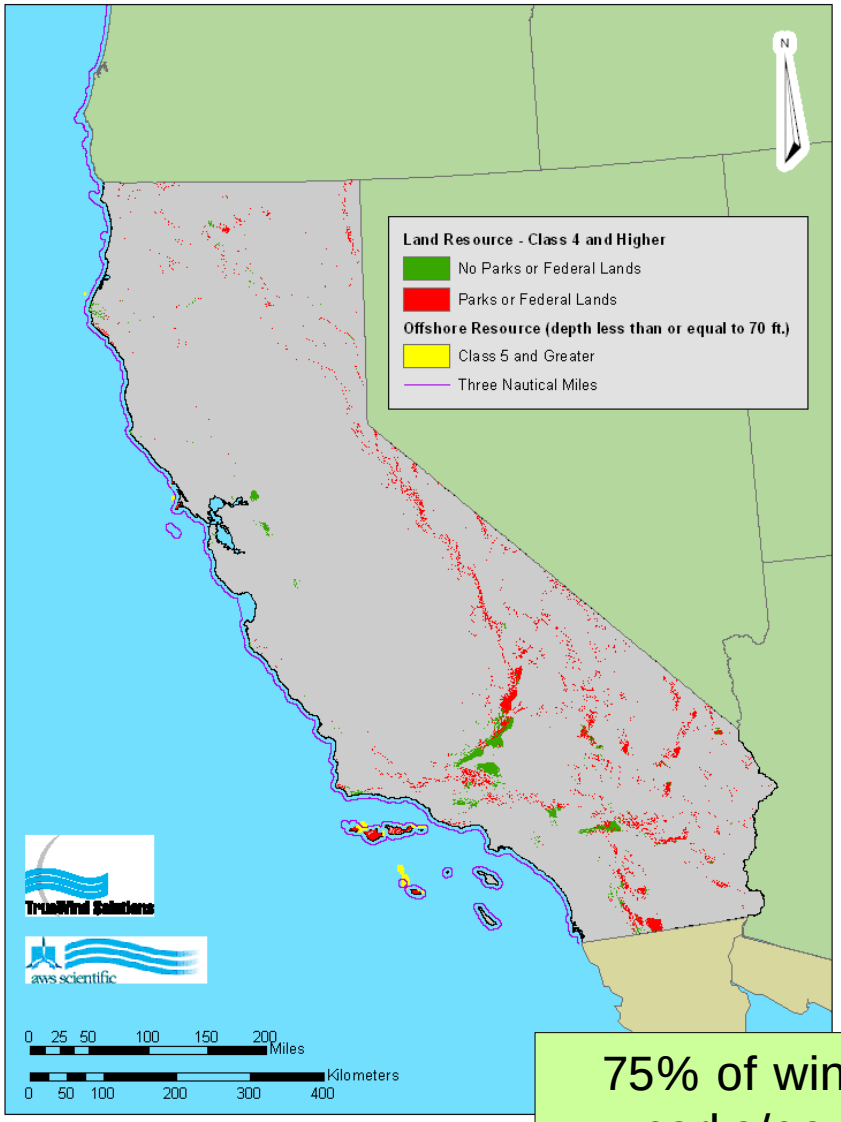
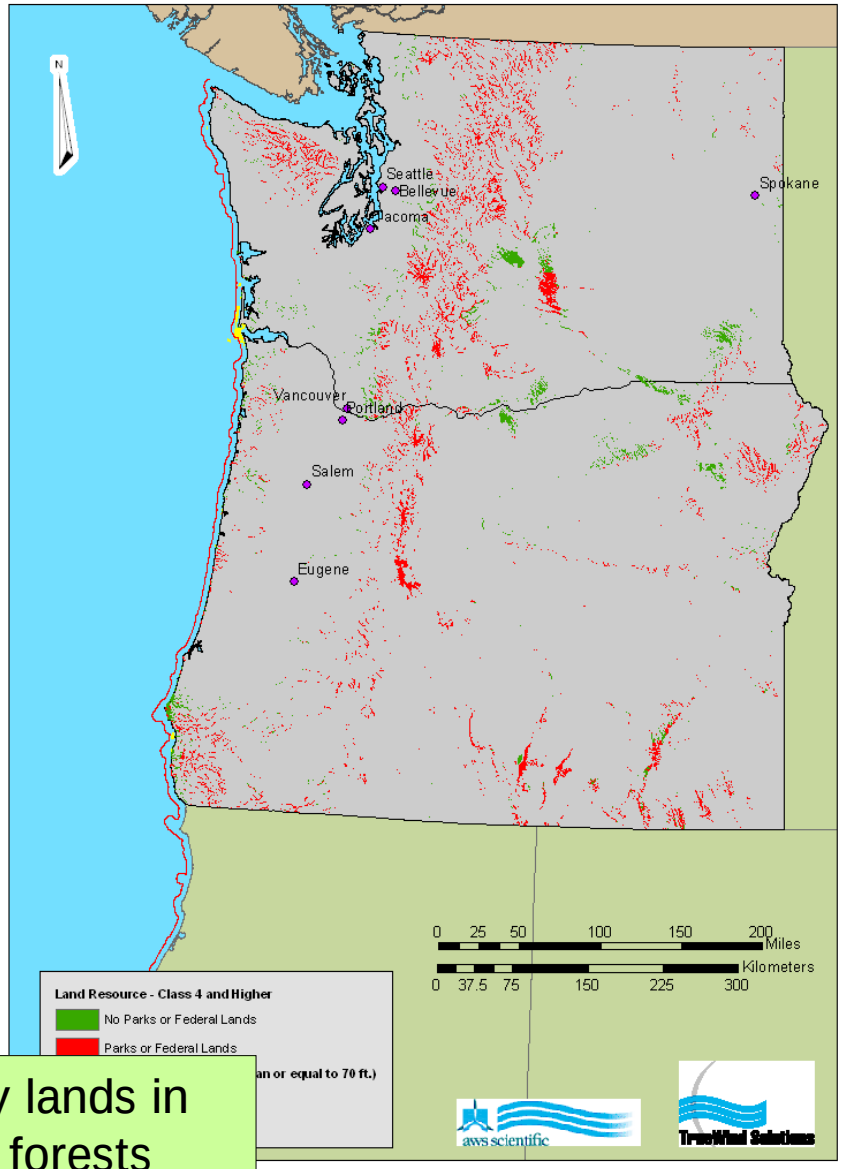
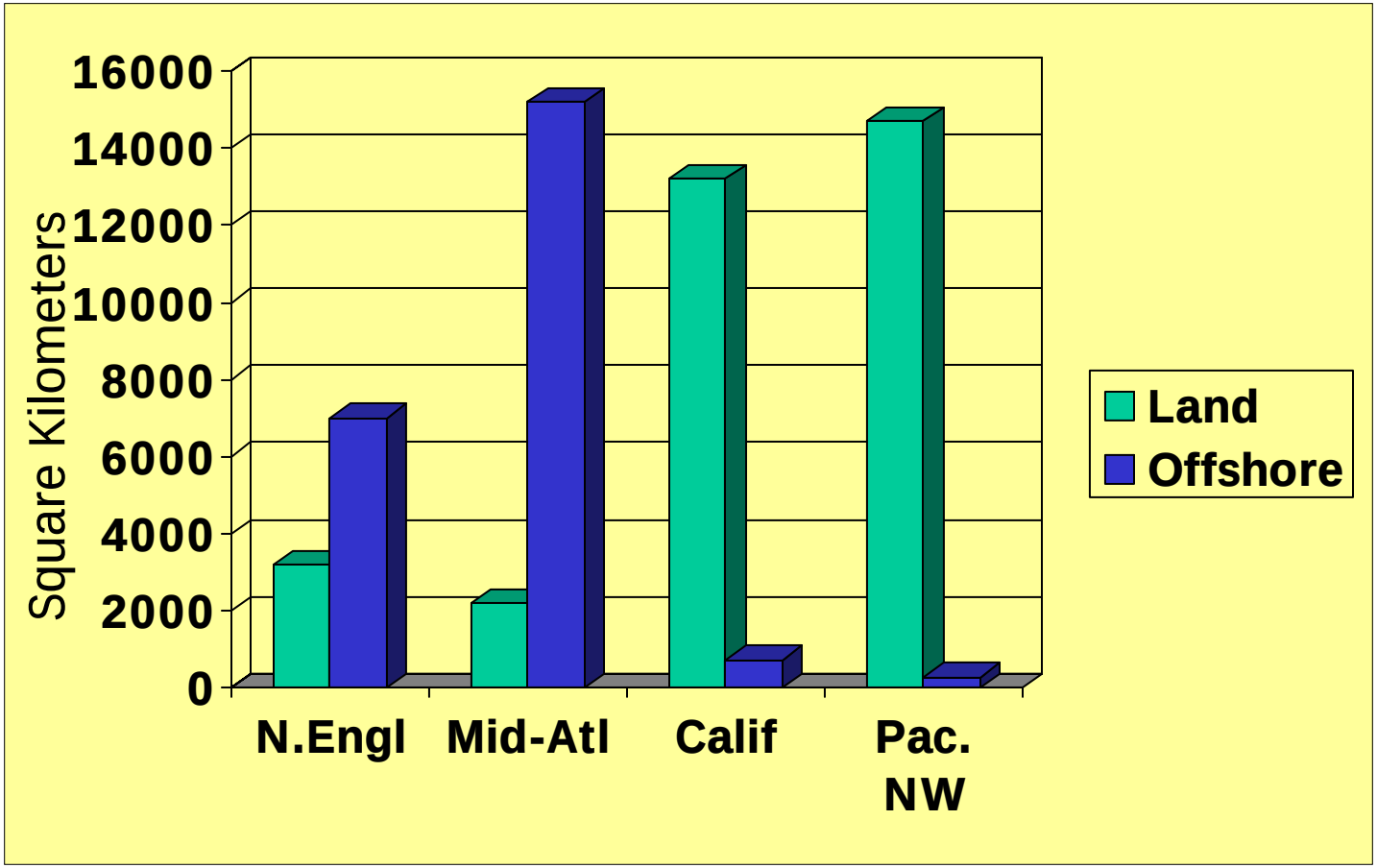




75% of windy lands in parks/govt. forests

Available Windy Area



*Class 4+ on Land; Class 5+ Offshore and Water Depths <70 ft; No land use exclusions

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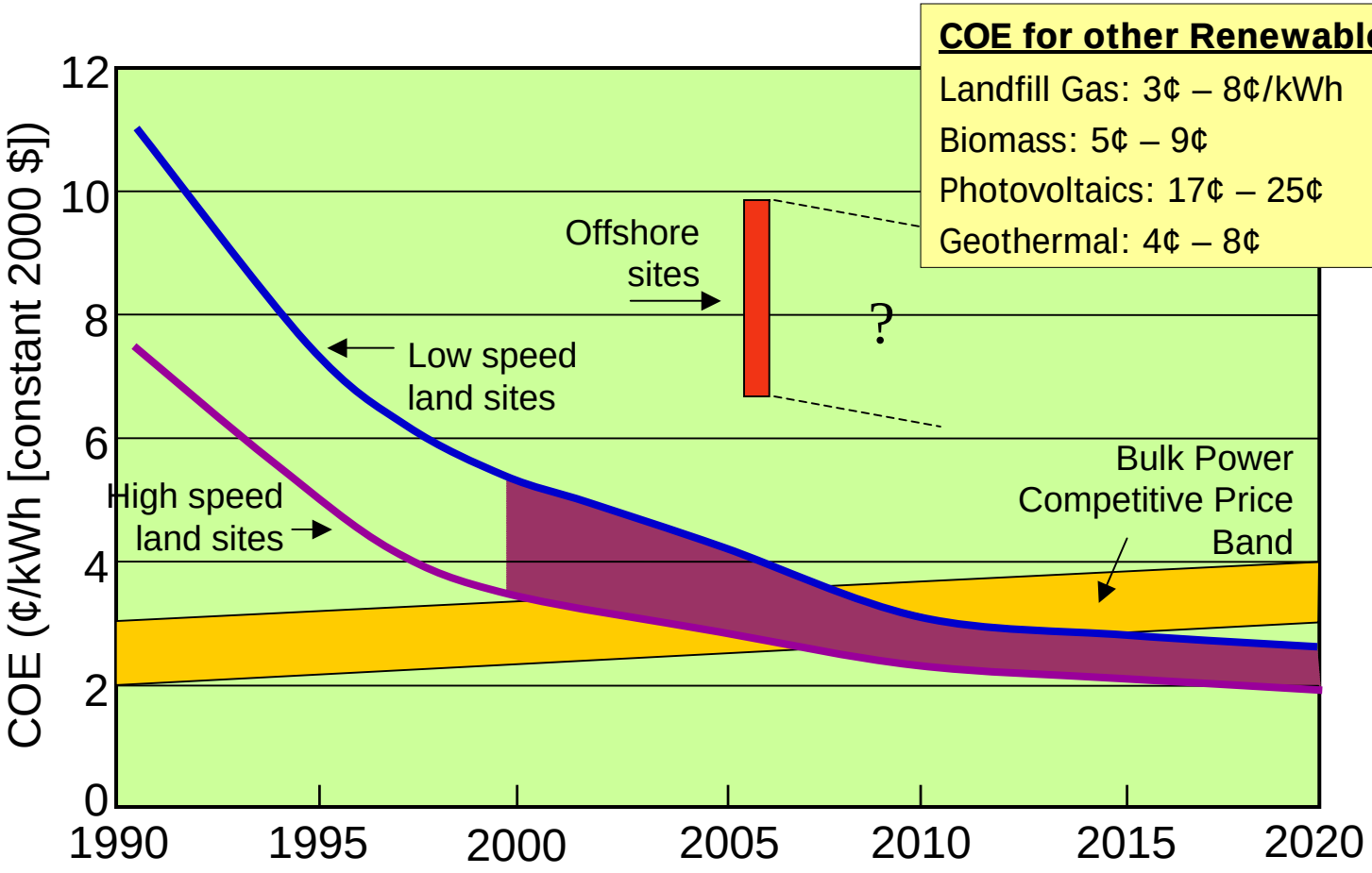
Economics of Offshore



Source: Dept. of Energy

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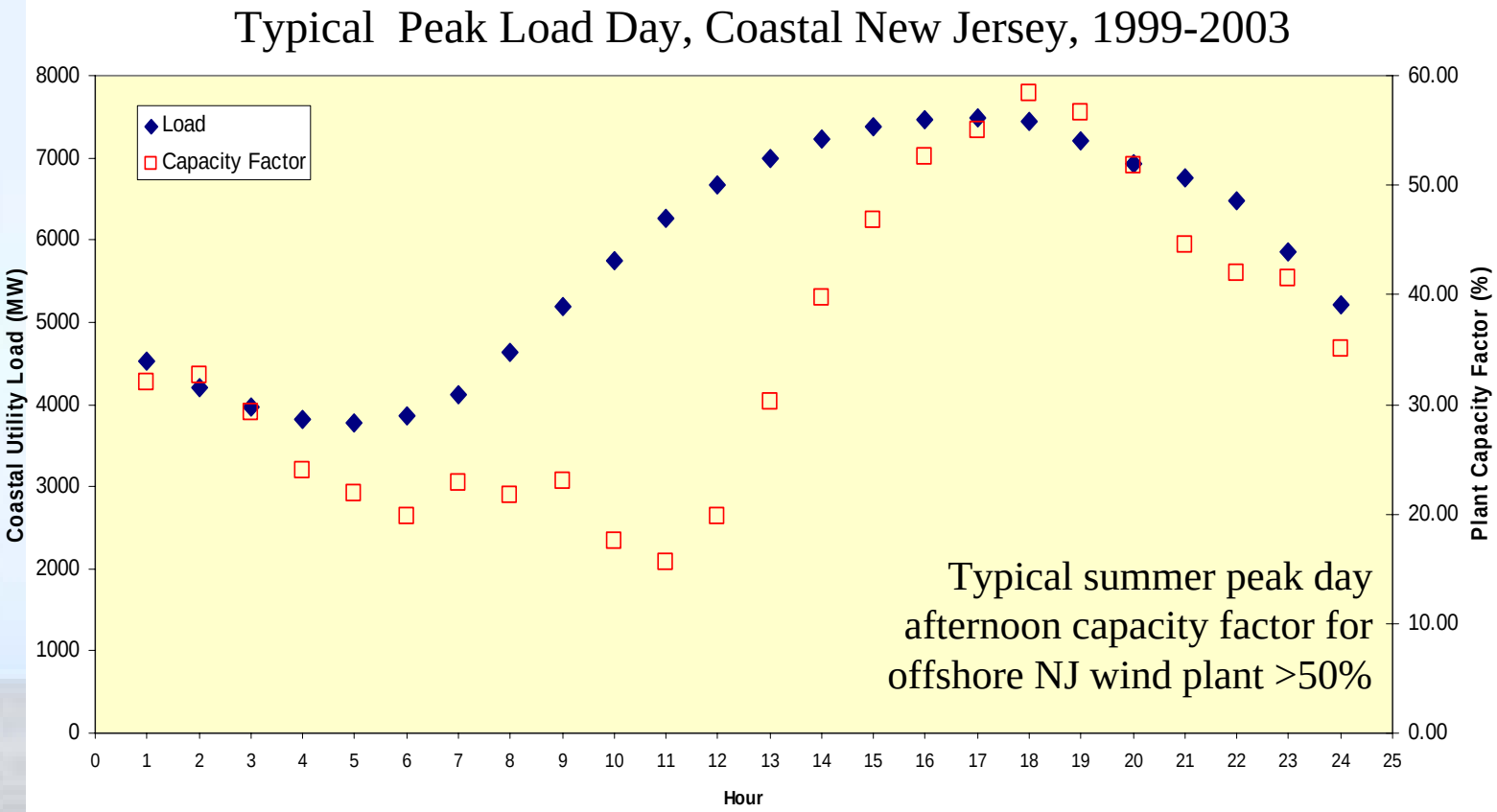
Offshore Wind Matches Peak Load Profiles



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Conclusions

- East coast has large energy appetite but relatively little windy land
- Offshore offers large wind development opportunities, for many eastern states
- Offshore can be cost-competitive with other renewables and can help wind fulfill RPS and SBC initiatives
- West coast has strong offshore wind resources but very deep water; offshore deep water foundations not yet available

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Conclusions

- Many barriers to overcome
- Need for more public familiarity with wind power, particularly in eastern US
- Include offshore wind in the visions of state and federal energy policies
- Earmark R&D funds to address offshore engineering & development issues
- Learn from European experiences and support international collaboration

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Thank You!
Questions?
Samsø Project, Denmark