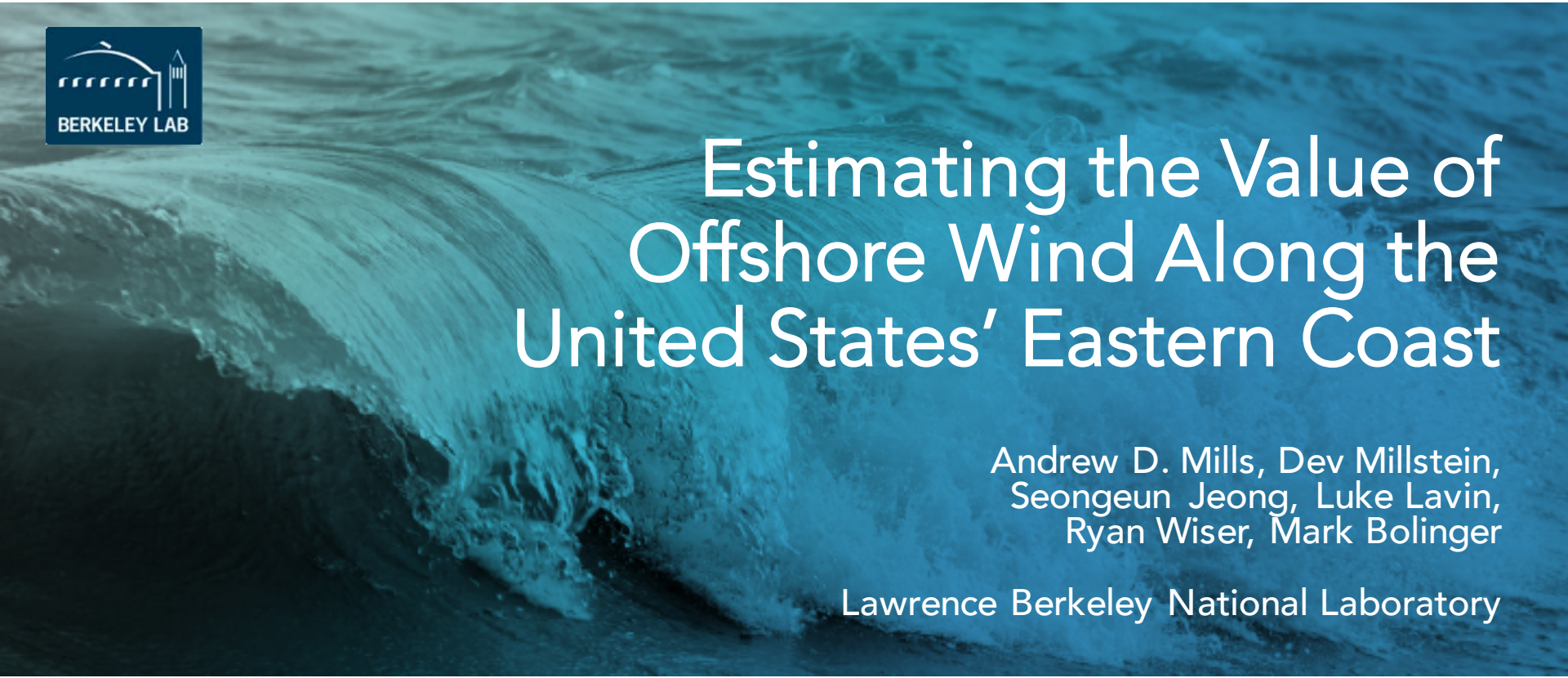

Estimating the Value of Offshore Wind Along the United States' Eastern Coast

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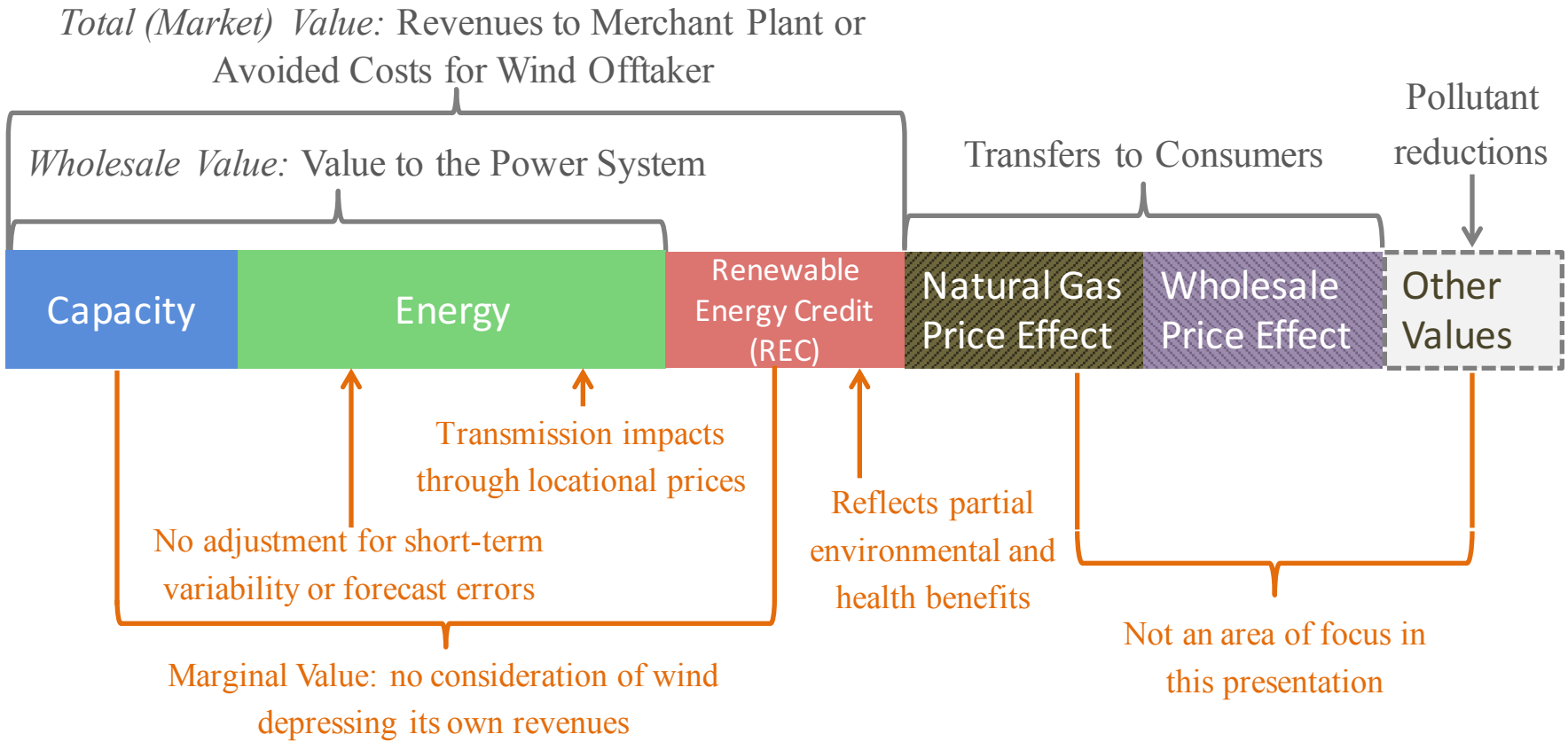
What economic value does offshore wind provide?

- Context:
  - Costs vary by technology, but so does value provided
  - Auctions demonstrate cost declines in offshore wind
  - How can we assess the value at specific locations with unique temporal profiles of wind resources?
- Who wants to know?
  - Wind developers, purchasers, and energy system decision-makers
  - Researchers: To find necessary cost targets and guide early-stage research strategies

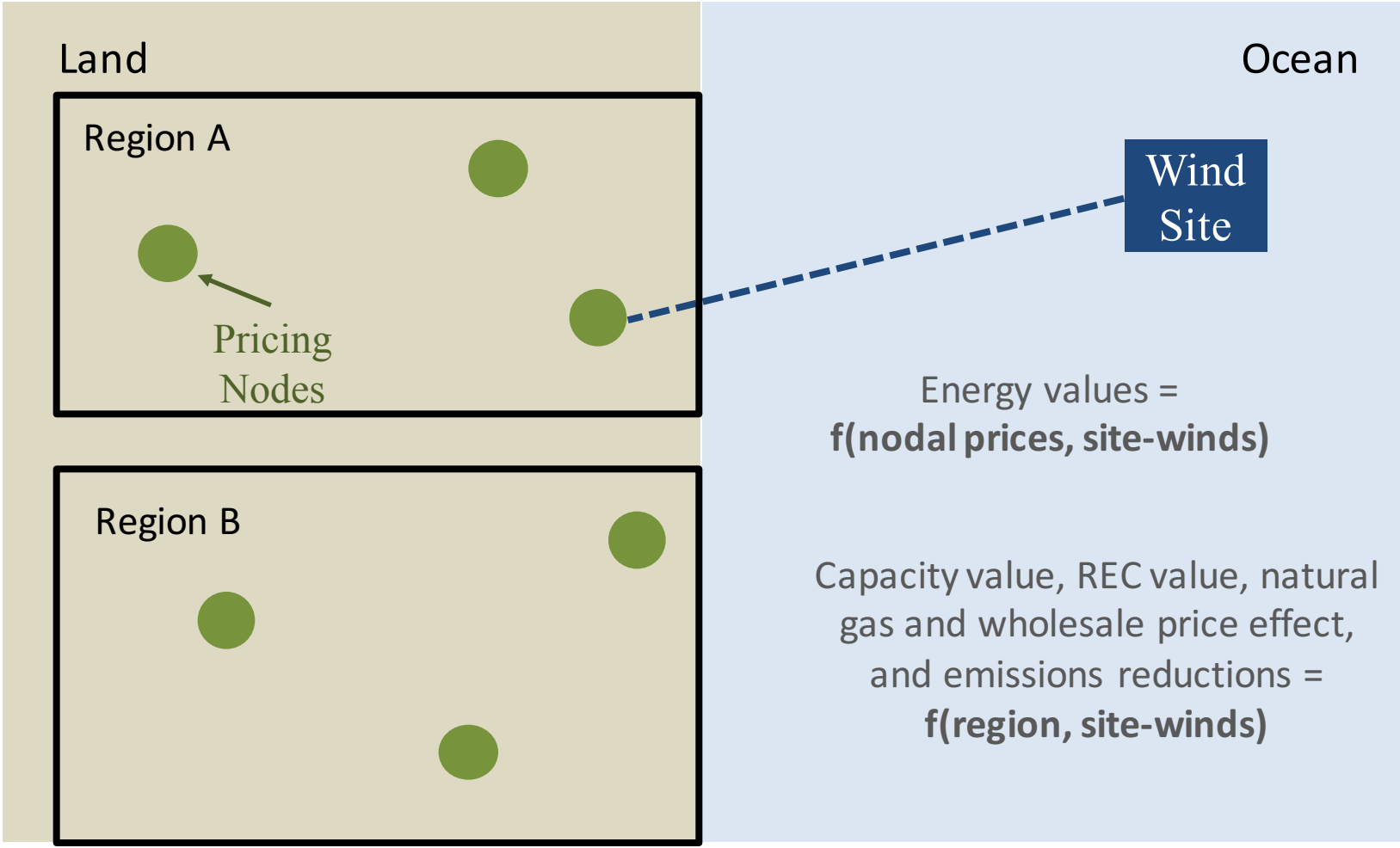
Outline

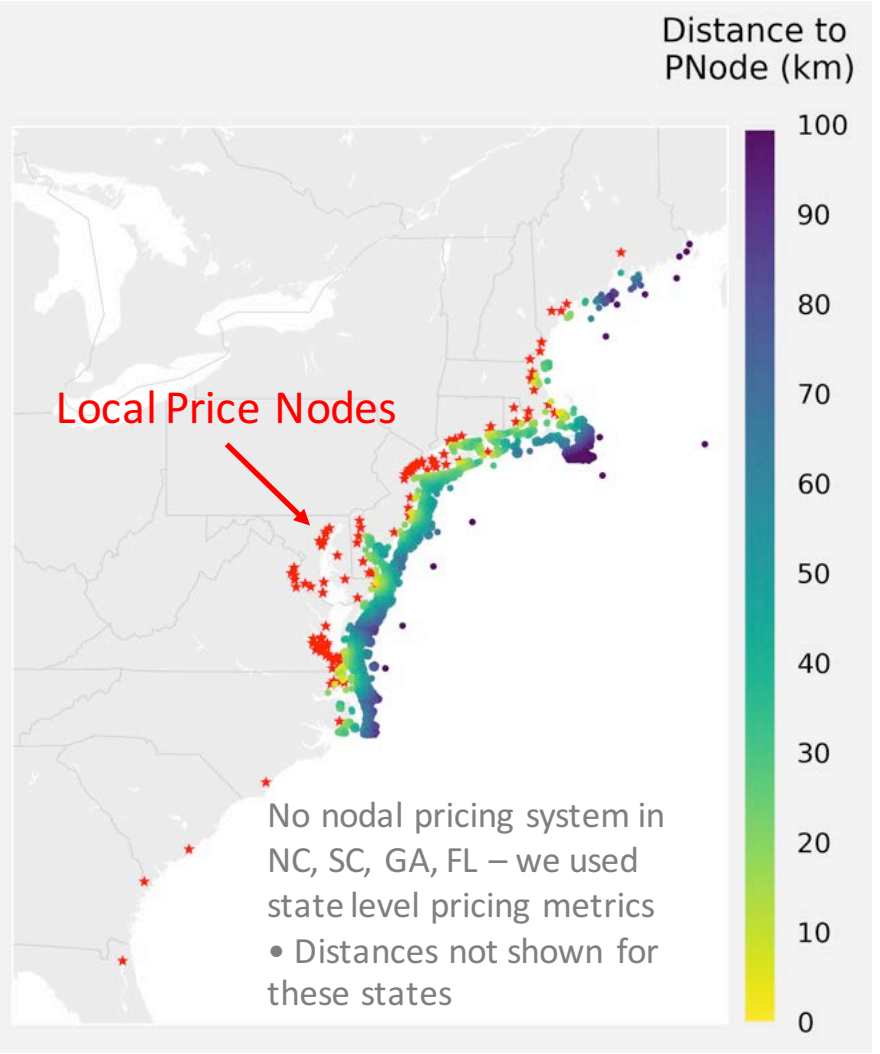
1. Types of value streams and associated methods
2. Value on the east coast
3. Context for value on the west coast
4. Conclusions

BENEFICIARIES



LIMITATIONS


Land
Ocean
Region A
Wind Site
Pricing Nodes
Energy values = f(nodal prices, site-winds)
Region B
Capacity value, REC value, natural gas and wholesale price effect, and emissions reductions = f(region, site-winds)

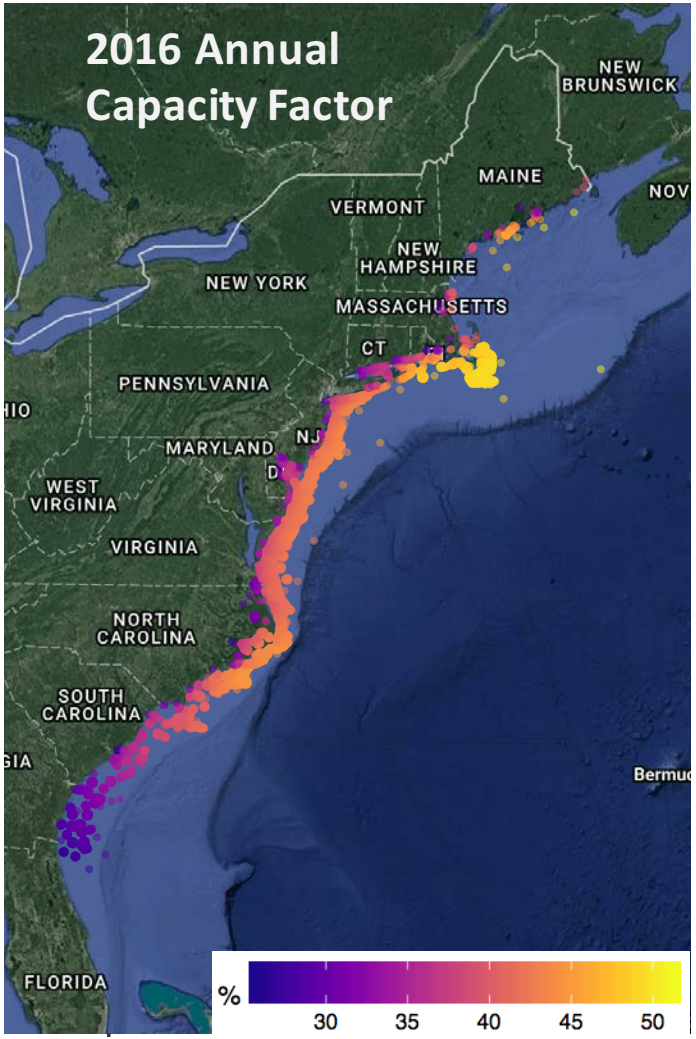

Distance to PNode (km)
100
90
80
70
60
50
40
30
20
10
0
Local Price Nodes
No nodal pricing system in NC, SC, GA, FL – we used state level pricing metrics
• Distances not shown for these states

Speed → Power

- ~6,700 sites from WIND Toolkit
- 6 MW offshore turbine power curve
- Accounted for losses:

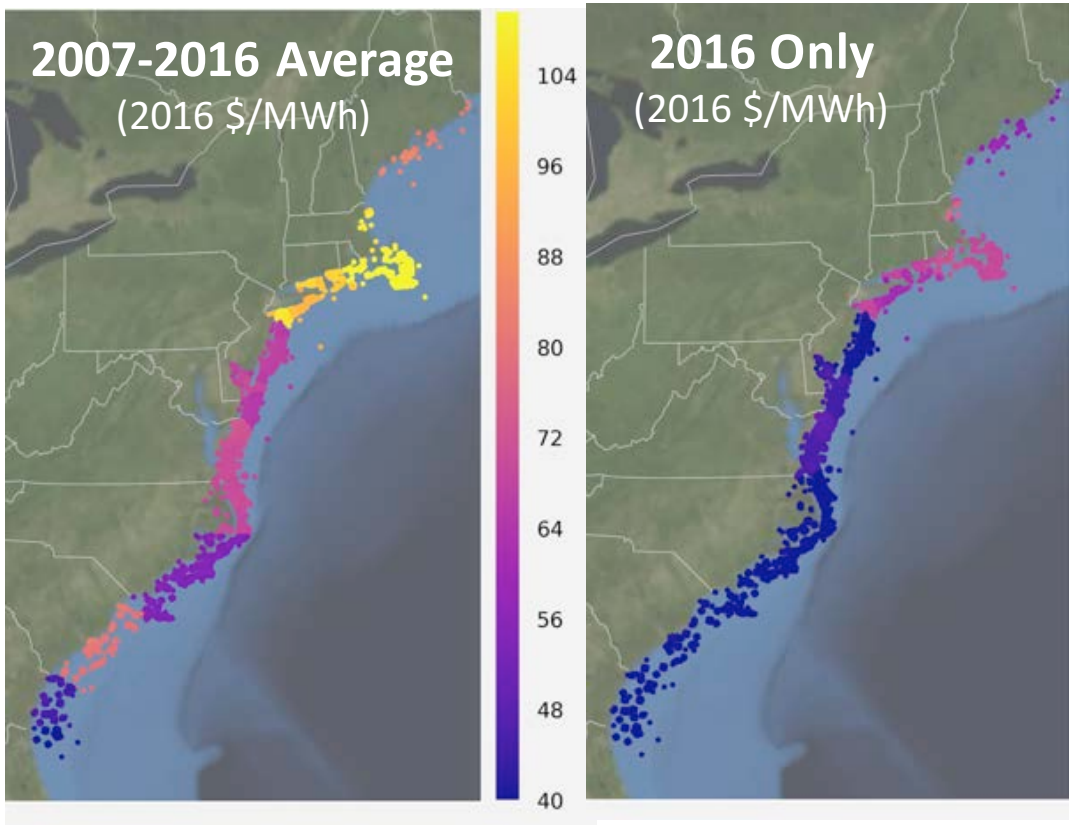
1. *Wake losses*
2. *Electrical losses*
3. *Availability*
4. *Other losses*

- Air density treated as constant

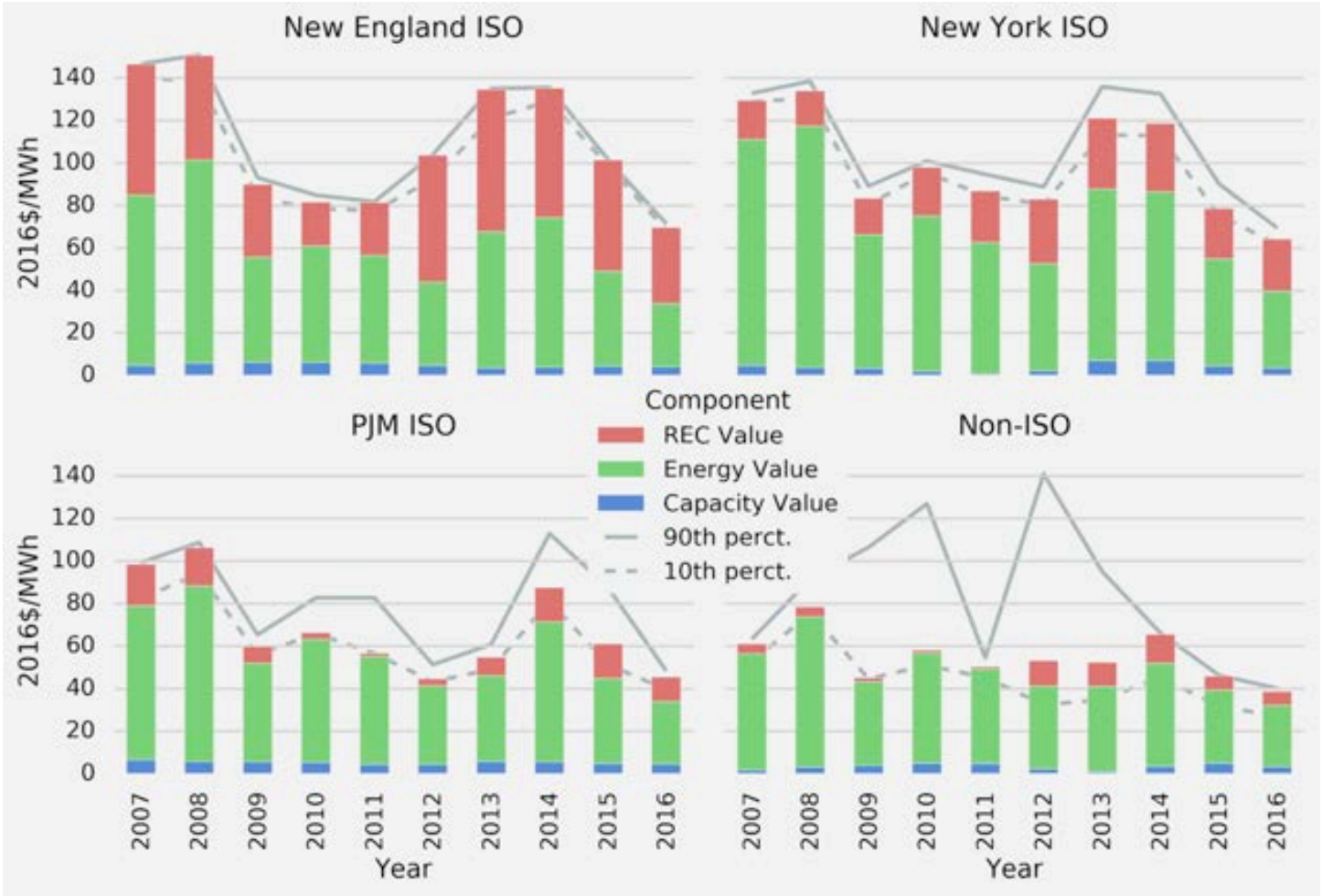


Total Energy, Capacity, and REC Value

- Highest values near NY, CT, RI, and MA
- Recent values lower than longer term average
- Values mostly sensitive to regional pricing

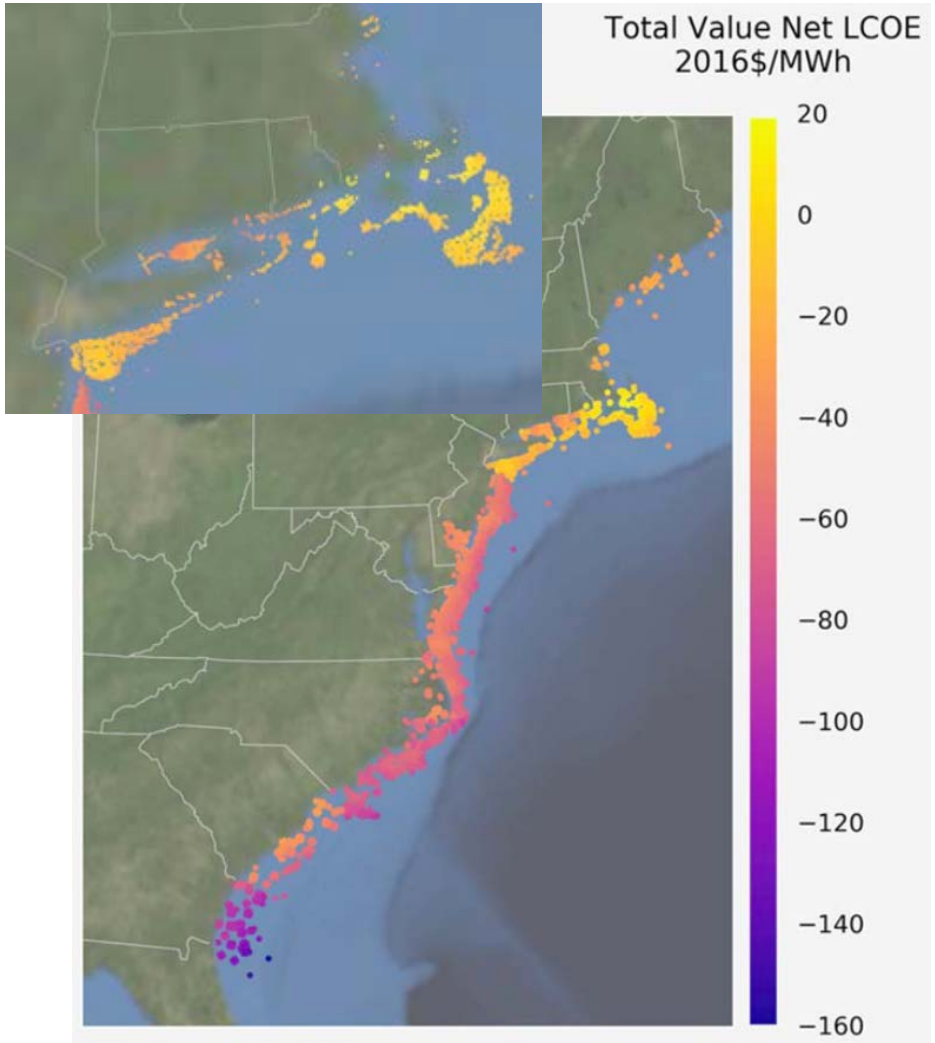


- Decline in energy and REC prices drive value decline over time
- Capacity value relatively small



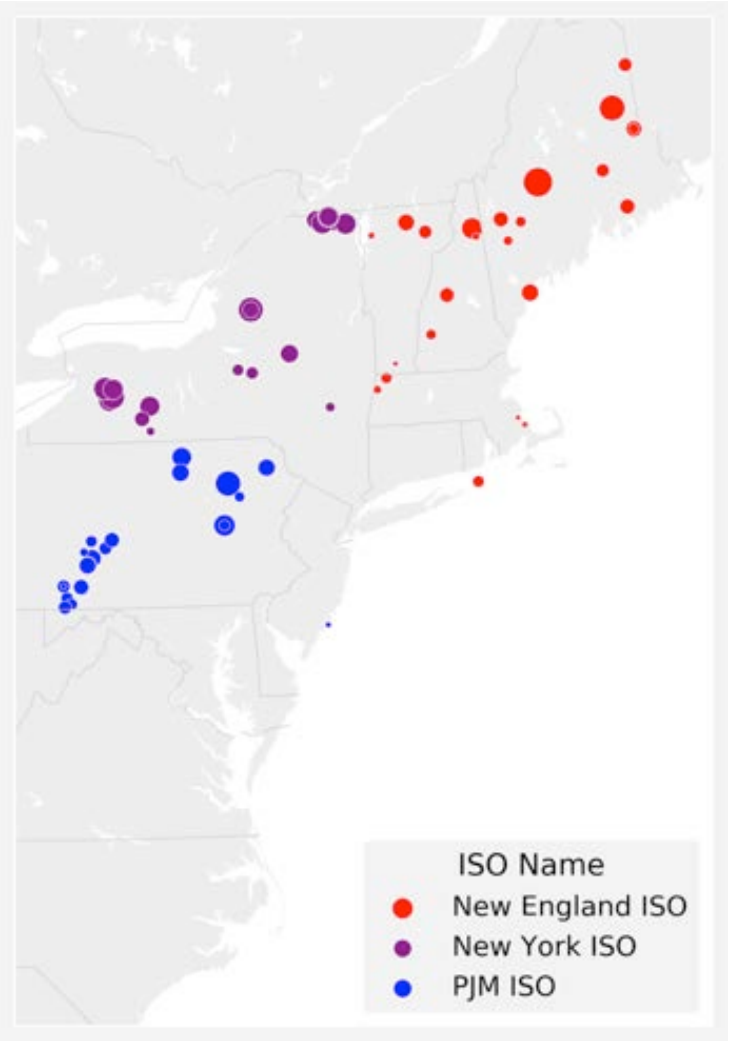
Net value measure of offshore wind (to be used only to rank sites)

- Relative ranking of sites based on difference between total market value and levelized cost of energy
- Most attractive sites are near southeastern Massachusetts and Rhode Island
- The least attractive sites are far offshore of Florida and Georgia



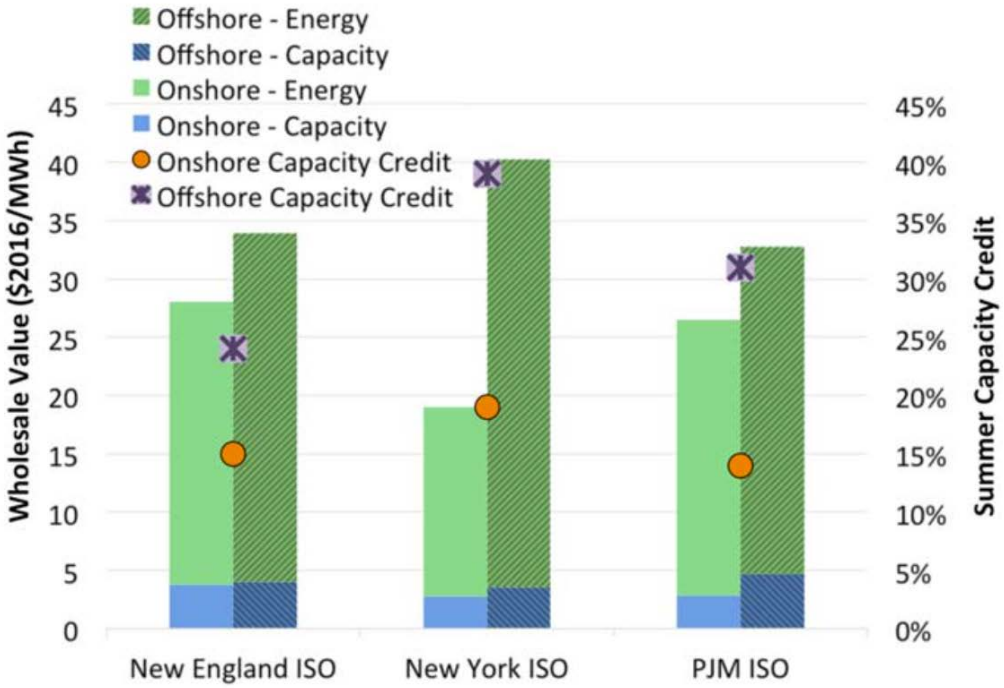
Offshore Wind vs. Onshore Wind: Energy and Capacity Value

- Onshore hourly wind production is based on the total wind production by region (ISO-NE, NYISO, and the Mid-Atlantic region of PJM)
- Energy value is based on the capacity-weighted average hourly nodal price and the aggregated hourly wind production, by region
- Capacity value based on the capacity-weighted average zonal capacity price and the capacity credit of the average wind profile



Offshore Wind More Valuable than Onshore Wind

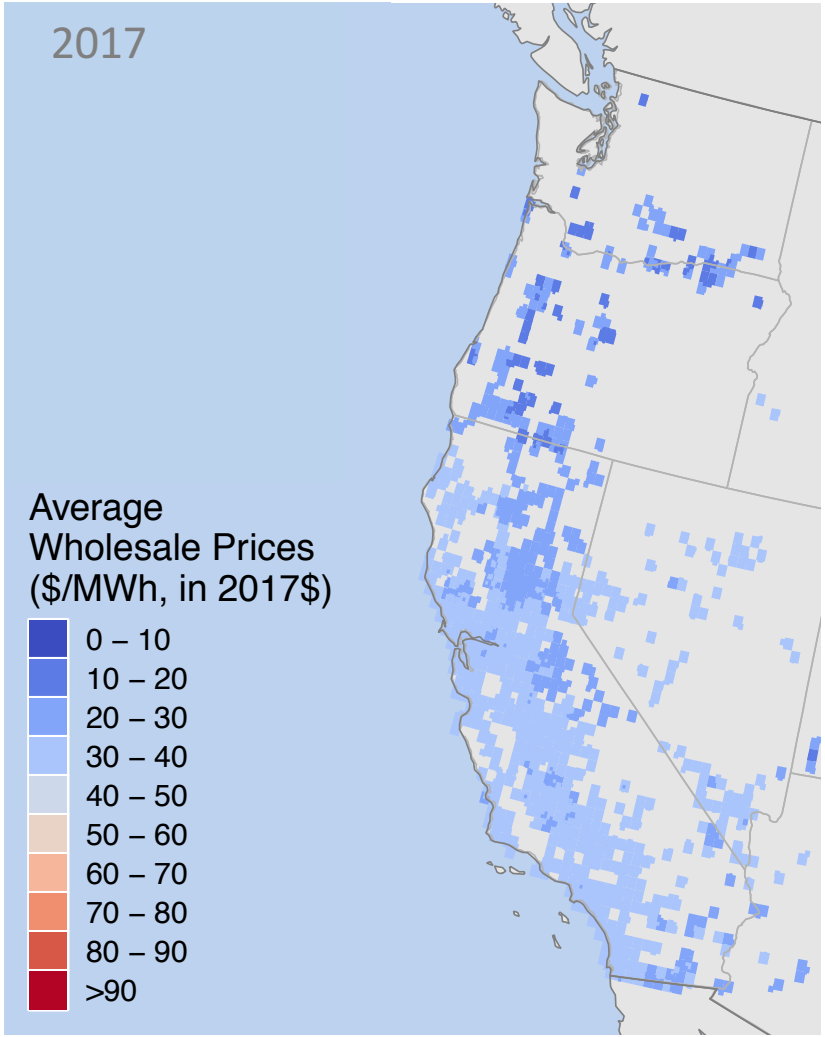
- Offshore wind is located closer to high value load than onshore wind
- Offshore wind is more closely timed to hours of high demand than onshore wind



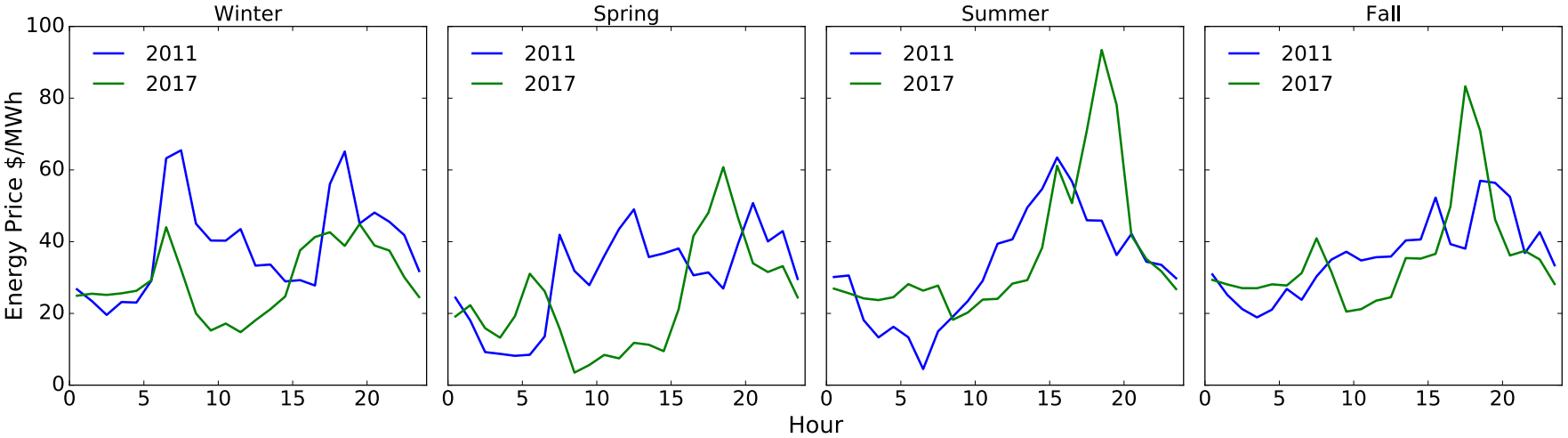
Value in 2016

West Coast Prices Show Little Regional Variation

- 2017 coastal prices are mostly in the 30 – 40 $/MWh range
- Drought years (not shown) do contain larger variation and slightly higher prices (up to 50 – 60 $/MWh)

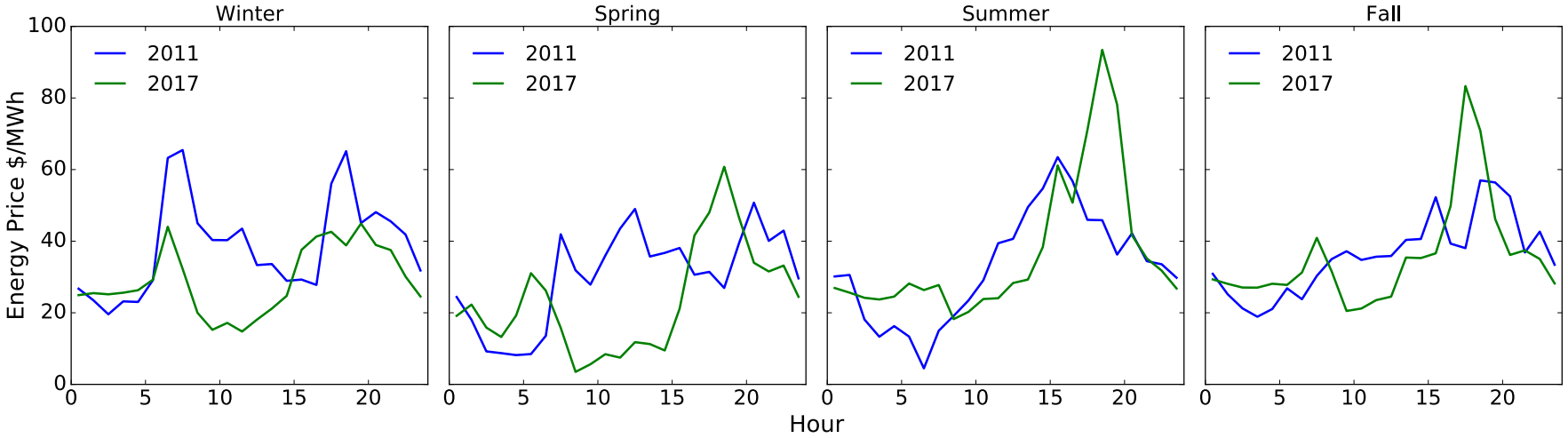


Average CAISO Energy Prices: 2011 and 2017



- Midday 2017 prices declines (vs. 2011): Increasing solar penetration
- Late afternoon 2017 prices increase (vs. 2011): Nuclear retirement and load increases
- Late afternoon price increases are due to a limited number of price spikes rather than an increase to median prices during those hours

Average CAISO Energy Prices: 2011 and 2017



- Looking forward: 2045 100% Zero-carbon energy law will cause more changes (this is an understatement)
- Opportunity for offshore wind?

Conclusions for the East Coast

- The marginal total market value of offshore wind varies significantly by project location
- The market value is highest in ISO-NE in part due to higher REC prices. The energy and capacity value is higher for NYISO, particularly for the Long Island region.
- The most attractive sites when comparing LCOE estimates with value are located near southeastern Massachusetts and Rhode Island, while the least attractive are far offshore of Florida and Georgia.
- The market value of offshore wind also varies significantly from year to year, driven primarily by changes to energy and REC prices. It is lowest in 2016.
- The energy and capacity value of offshore wind in the three ISO regions exceeds the value of onshore wind, by $6/MWh – $20/MWh in 2016.

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https://emp.lbl.gov/projects/wind

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