Challenges and Opportunities for Wind on Power Systems

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RENEWABLE NORTHWEST PROJECT
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Renewable Northwest Project (RNP)

Non Profit Renewable Resource Advocacy Organization

Promoting renewable energy in Oregon, Washington, Idaho and Montana through:

- Policies (laws, regulations, and utility business practices)
- Responsible siting
- Retail markets.

Members

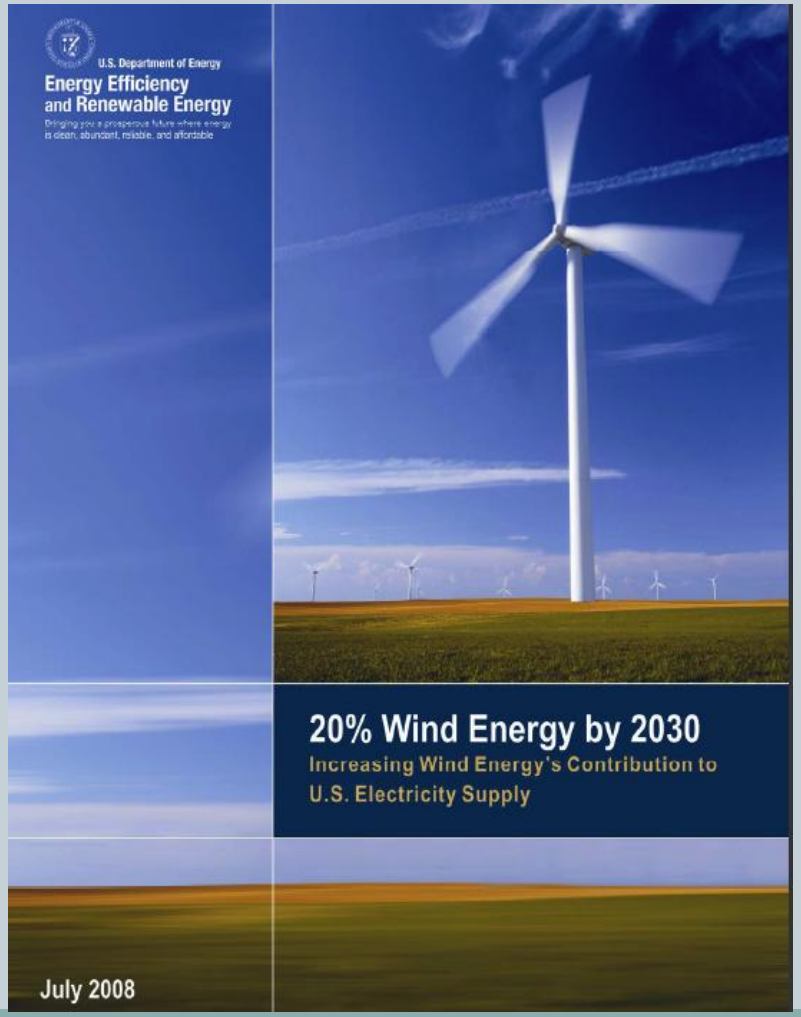
Businesses, non-profits, educational institutions

Integrating Wind on Power Systems

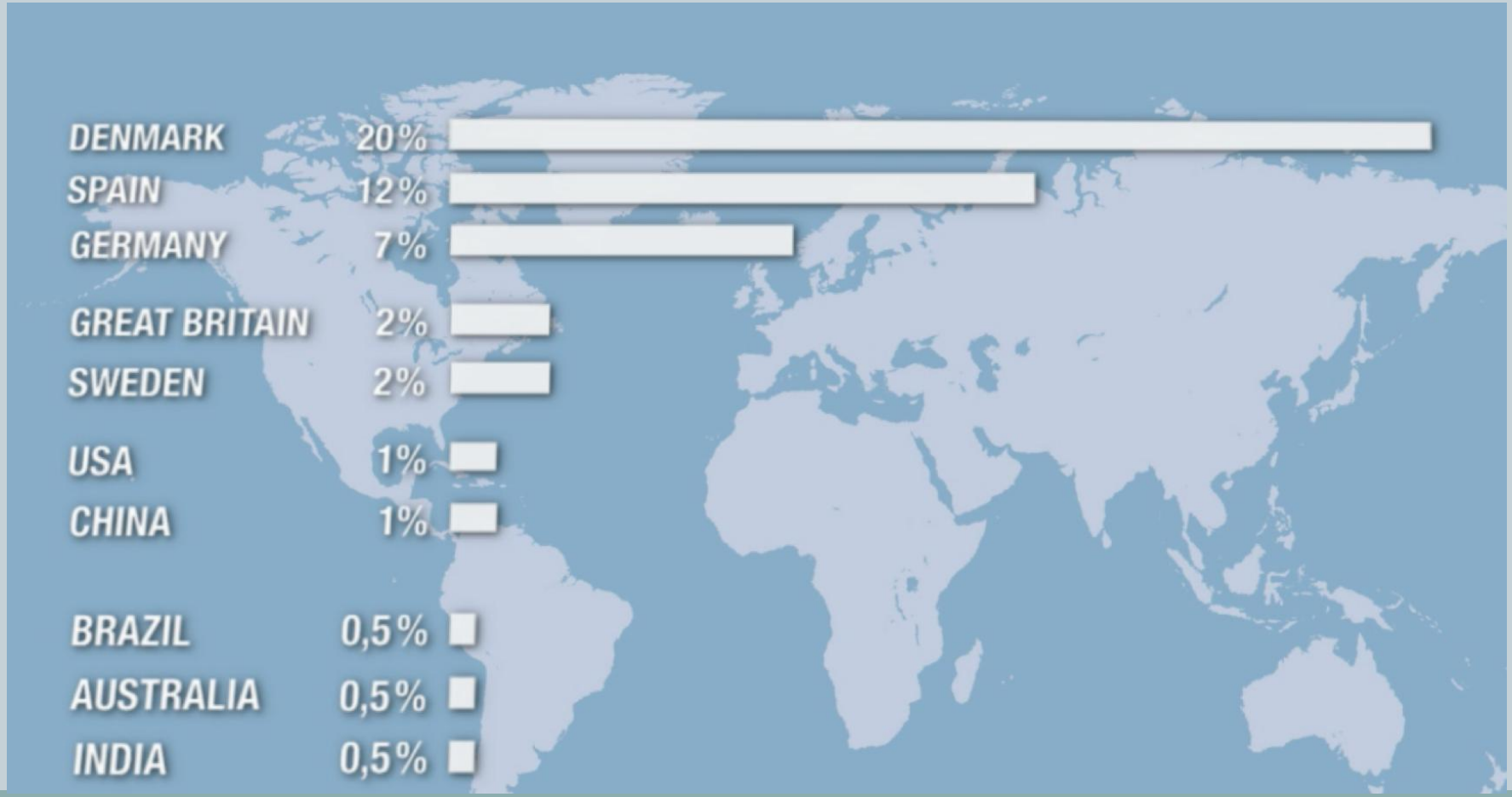
- Wind generation is inherently variable and not entirely predictable.
  - ***Wind integration refers to changes in power system operations that allow wind energy to be most efficiently used to reliably meet demand for power.***

Can it Be Done?

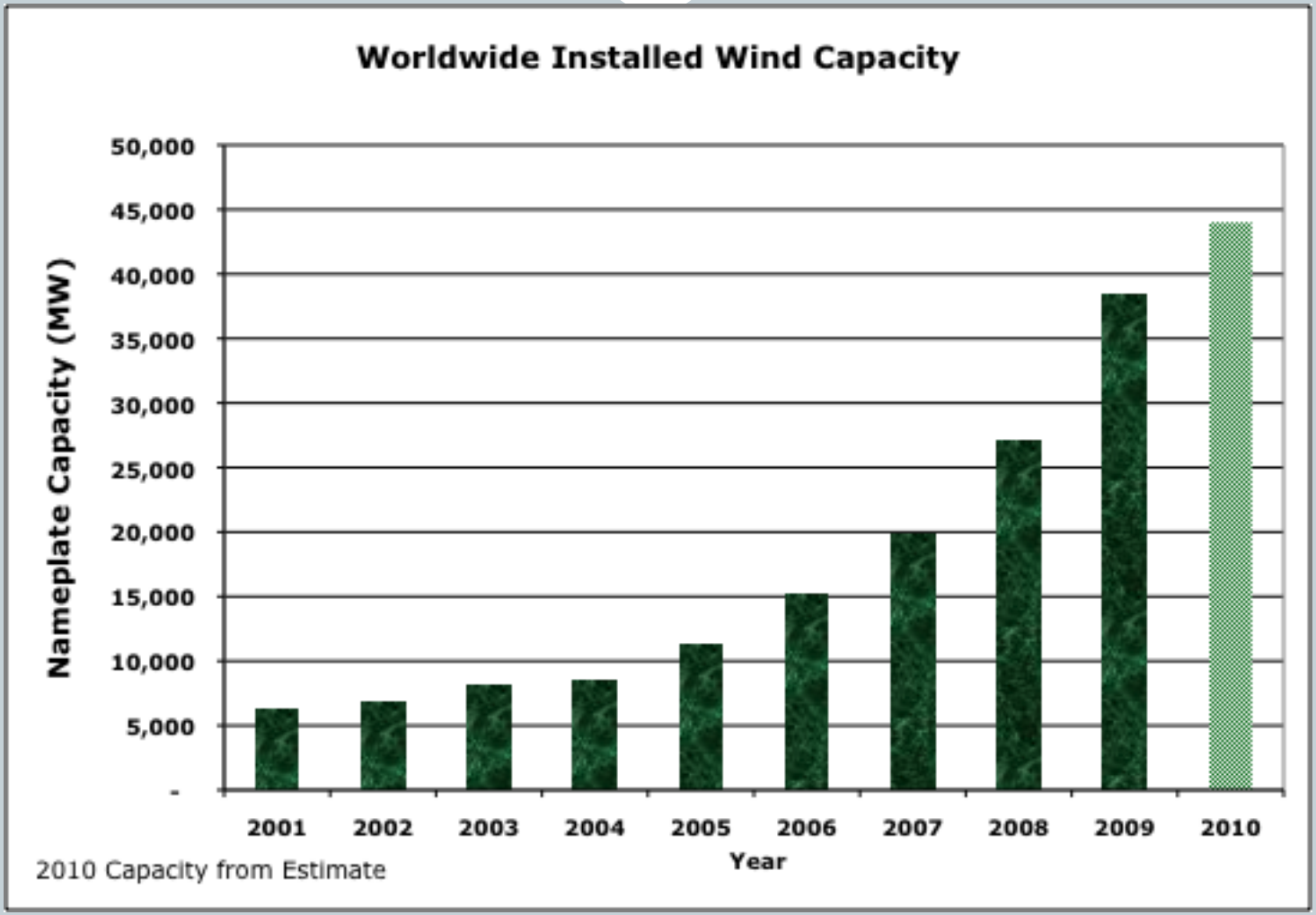
- Yes!
  - Studies indicate wind can serve anywhere from 20% (US DOE) to 41% (Eir Grid) of electrical energy demand.
  - Denmark currently generates 20% of its electric energy from wind and targets 50% in ten years.
  - Germany has more than 25,000 MW of wind, 7 % of demand.
  - Spain has about 20,000 MW of wind, 12% of demand.



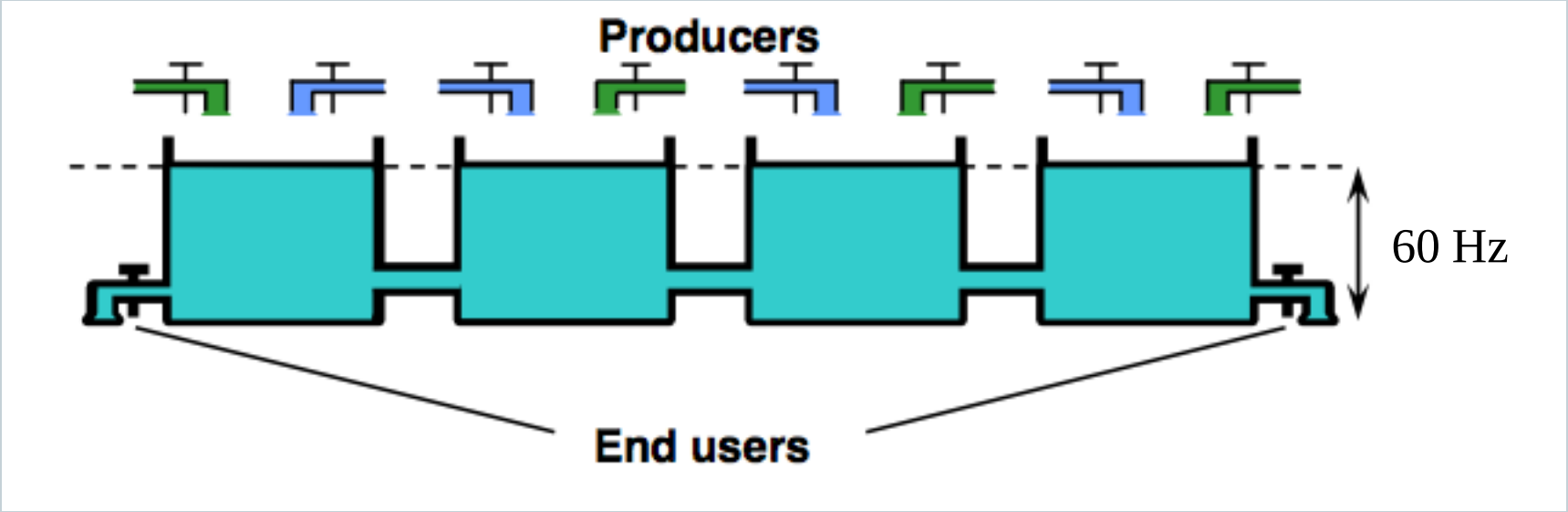
Top Wind Countries by Penetration Rates



Wind is Fastest Growing Resource

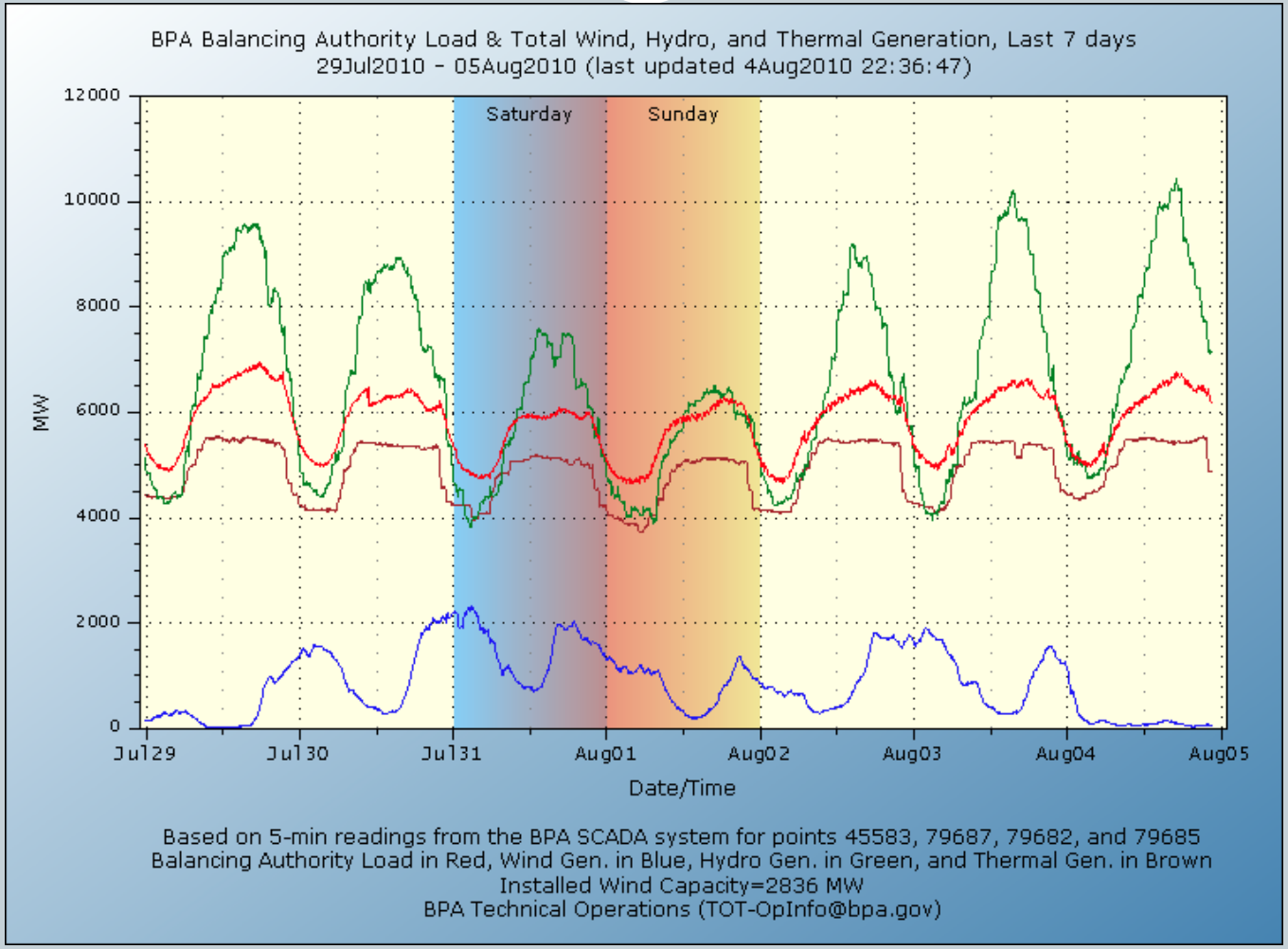


The Balancing Challenge

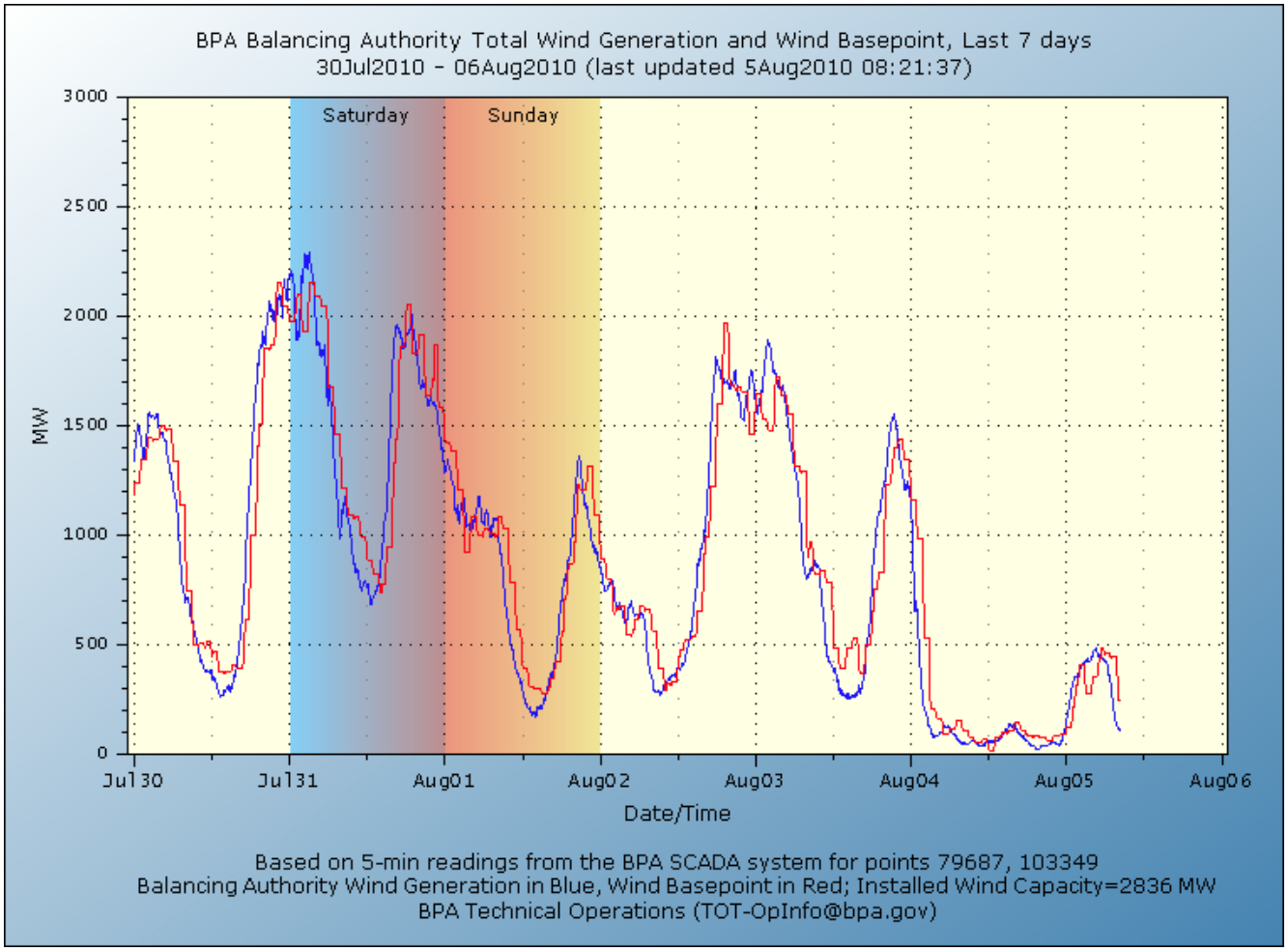


Adapted from *The Nordic Electricity Market*, Anders Houmøller, 2010.

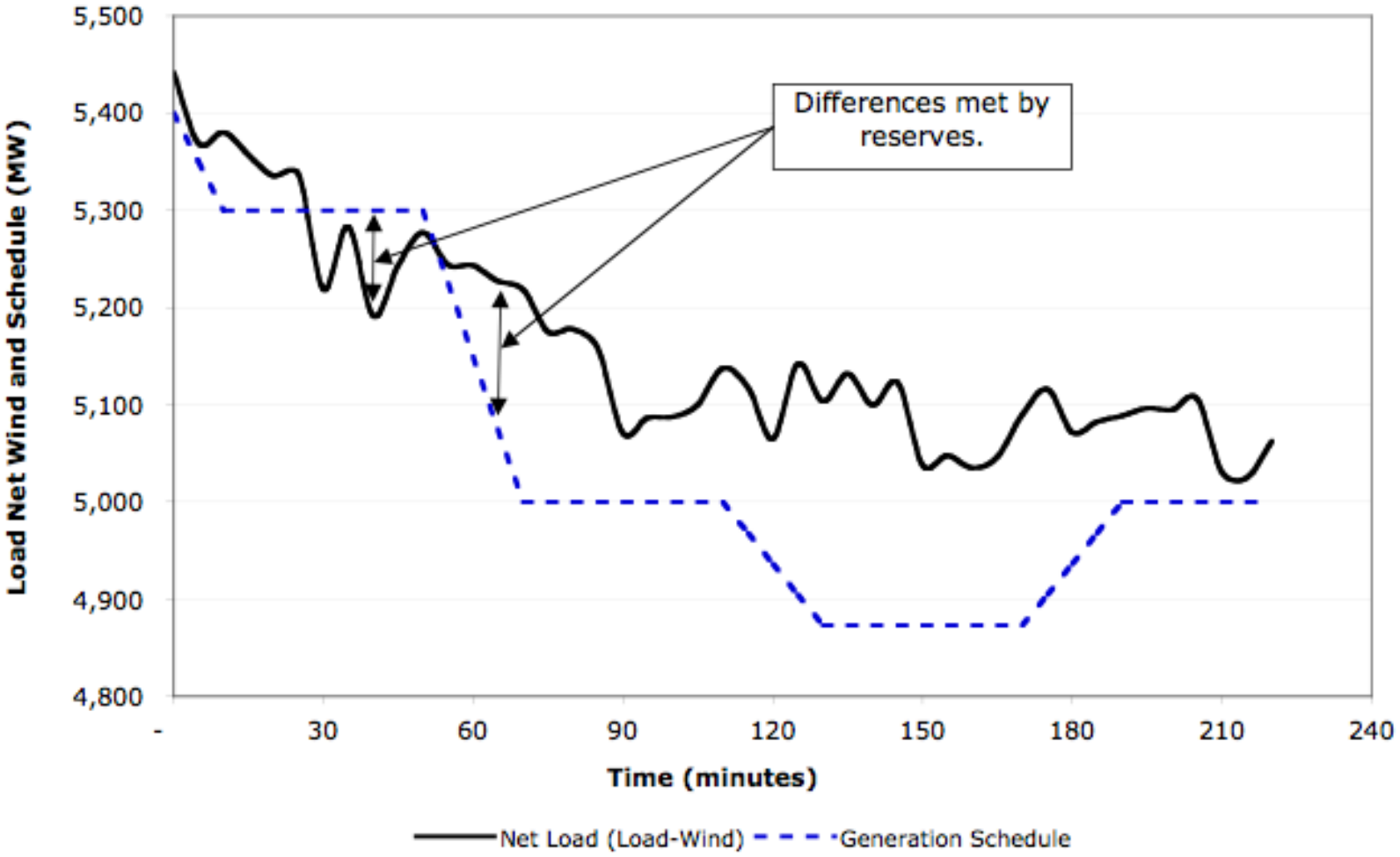
Power Plants Adjust Output to Meet Demand



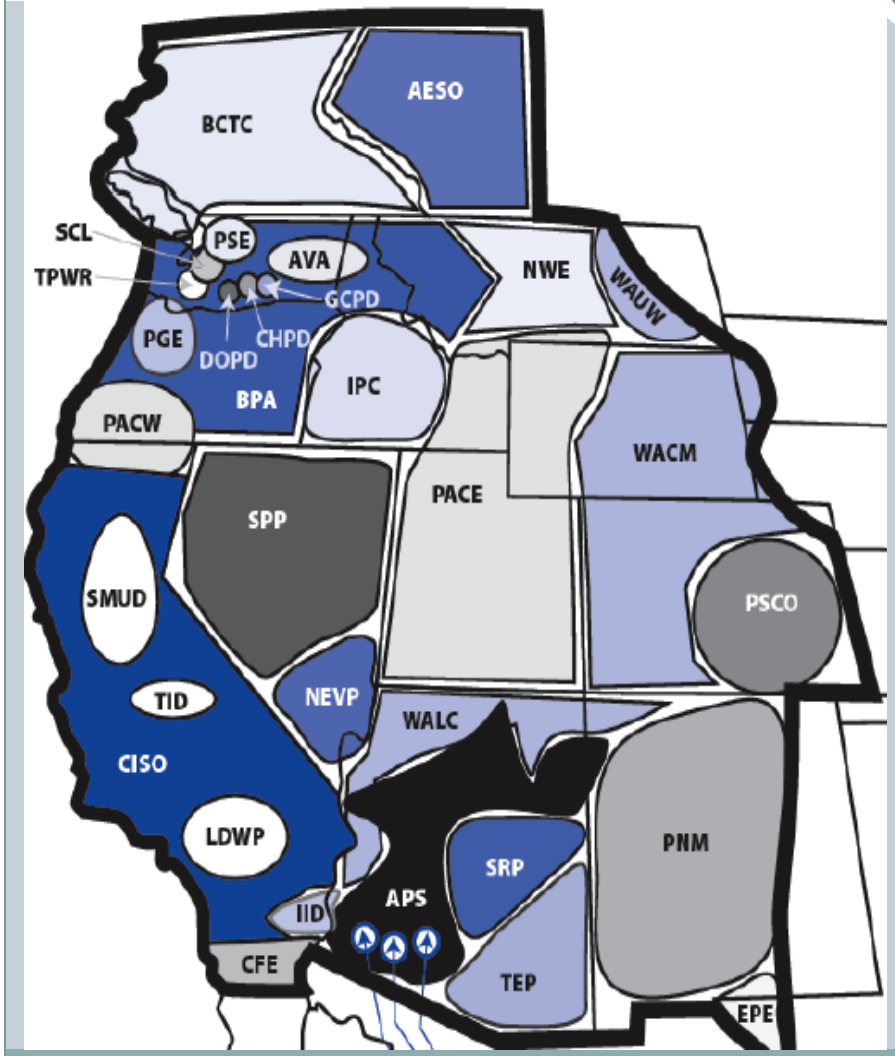
Hour-Ahead Schedule Errors



Reserve Generation Makes the Difference



Reducing the Reserve Burden



- Sharing across time and geography needed.
  - More liquid markets
  - Fewer “Balancing Areas”

What About Storage?

- Co-author of Eir Grid 41% study, Dr. Mark O'Malley: "***Storage is a fallacy!***"
  - Likely to be less expensive to actively manage wind generation.
- FDR reservoir behind Grand Coulee Dam has energy storage equivalent of 150 million electric vehicle batteries.
- Need for storage is indicated by diurnal wholesale price spreads.
  - Recent price spreads have not been high enough to justify storage.

Biggest Challenge for Wind

- The biggest challenge for power systems with high levels of wind penetration is usually:
  - ***Accommodating high levels of wind generation when demand is low.***
- This is a 180 degree turn around from power system concerns when I began my career (too little energy), and is by far the easier challenge.
- *Maybe Storage is not a fallacy?*
  - As wind becomes a larger share of the system, the value of storage rises.

Balancing at 50% Wind

- Denmark plans to supply half its demand with wind generation in ten years.
  - Wind integration is a national focus and will require more radical changes in how their system operates.
- Denmark's Risø National Laboratory Executive Director Henrik Bindslev:
  - ***The power system will change from a system where supply meets demand to a new paradigm in which demand will respond to supply.***

Advantages of Thermal Storage

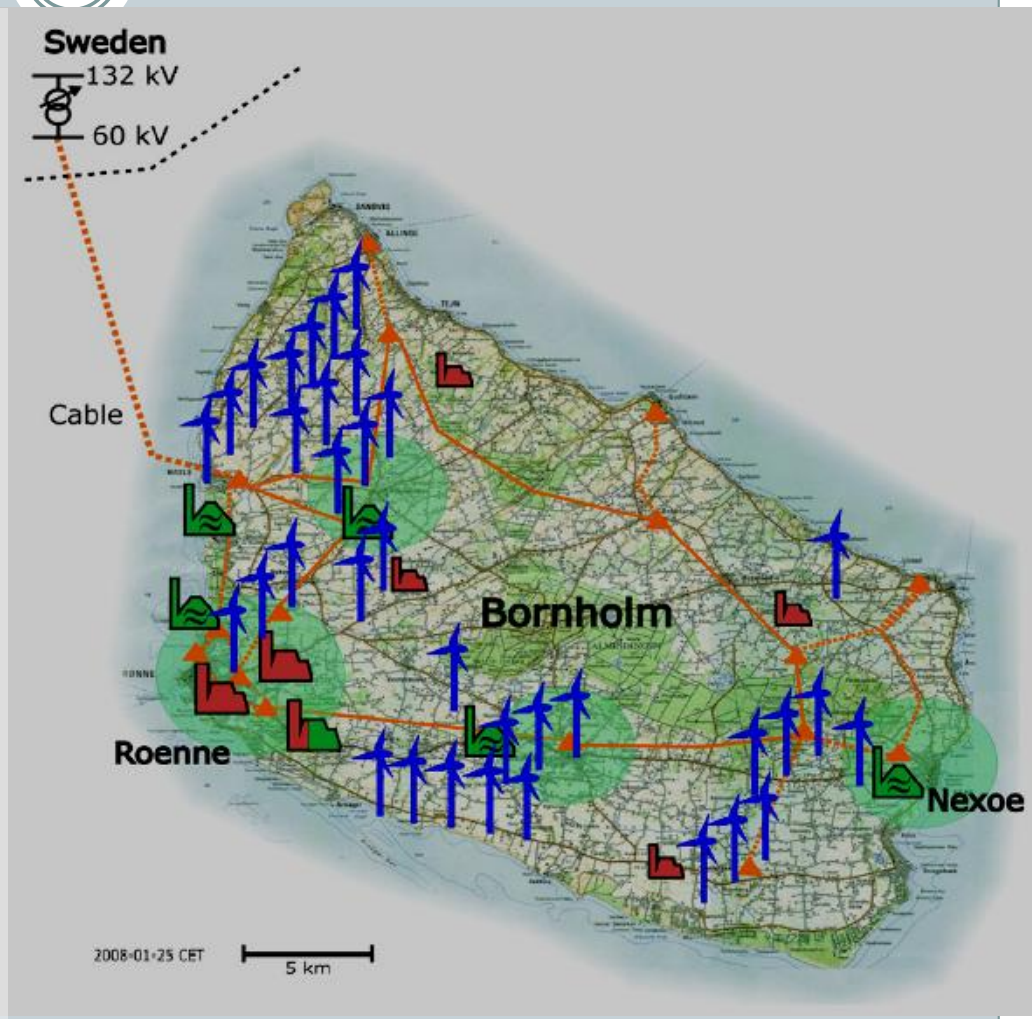
This one facility in Copenhagen has the capability of storing 2,500 MWh of thermal energy-- equivalent to 100,000 electric car batteries.

Cost of existing storage infrastructure MUCH cheaper than building new.

Lower losses, no cycling limits, low maintenance costs.

Island of Bornholm

- Danish Island off the coast of Sweden with a peak demand of about 65 MW will become the first utility-scale power system entirely fueled by renewable energy.
  - Wind
  - Solar
  - Bio fuels
  - Energy storage (thermal and EV batteries)



Victim of Our Success

- New challenges involve siting.
  - Wildlife– Eagles, Sage Grouse, Prairie Chicken
  - Radar
  - Visual Impacts

Summary

- Much larger amounts of wind can be accommodated than current levels with existing infrastructure.
  - Not counting transmission, though even that is debatable.
- Much larger amounts of wind are being handled by power systems in Europe with no changes to the power system make-up.
- Largest impediments and cost contributors relate to the structure of markets, especially in the Northwest.
- New challenges relate to siting issues are beginning to arise in a serious way.