

**EPRI**

ELECTRIC POWER  
RESEARCH INSTITUTE

# Integrating Wind Generation in the Bulk Electricity System

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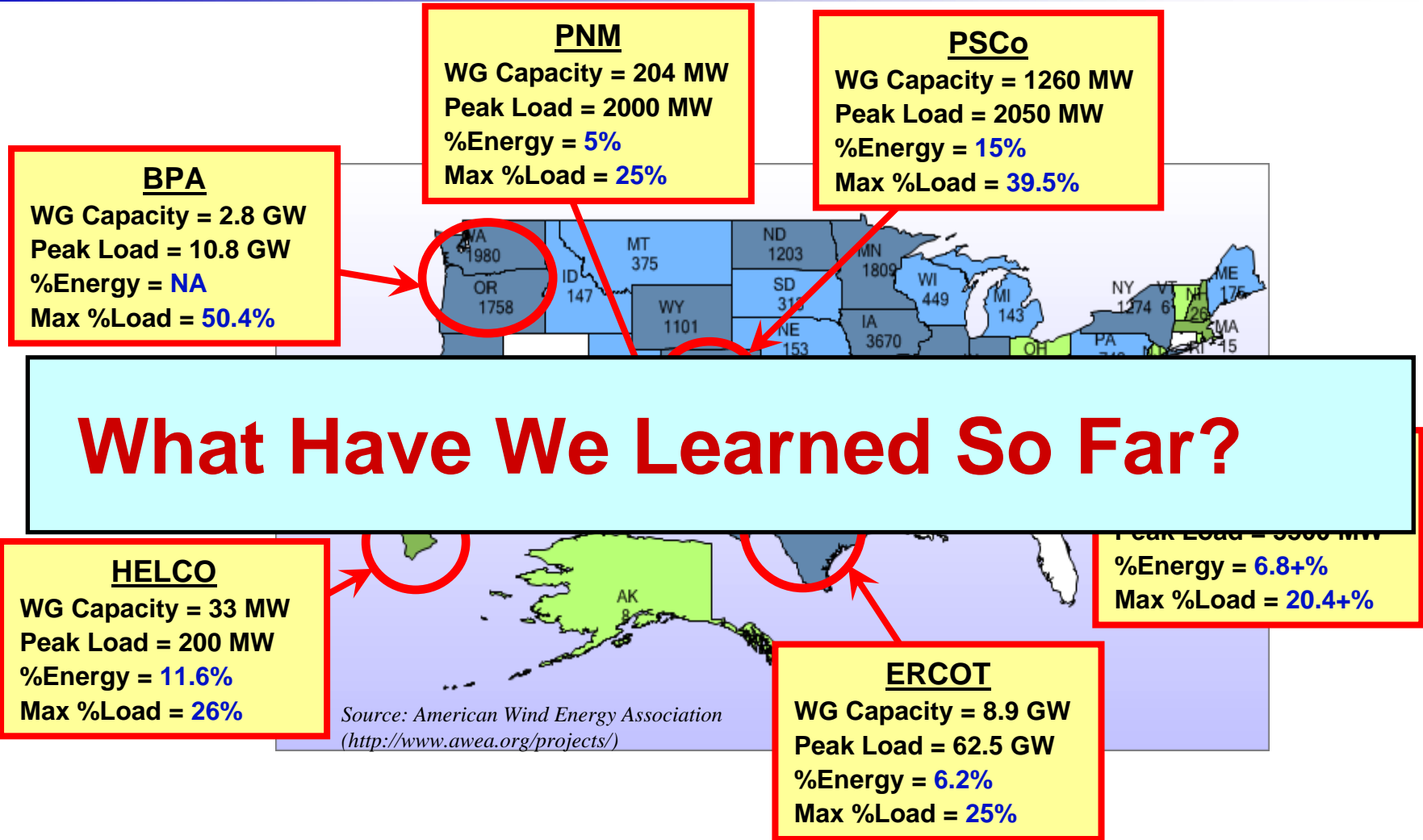
NARUC Committee on Energy Resources and  
the Environment, Winter Meeting 2011

# Overview

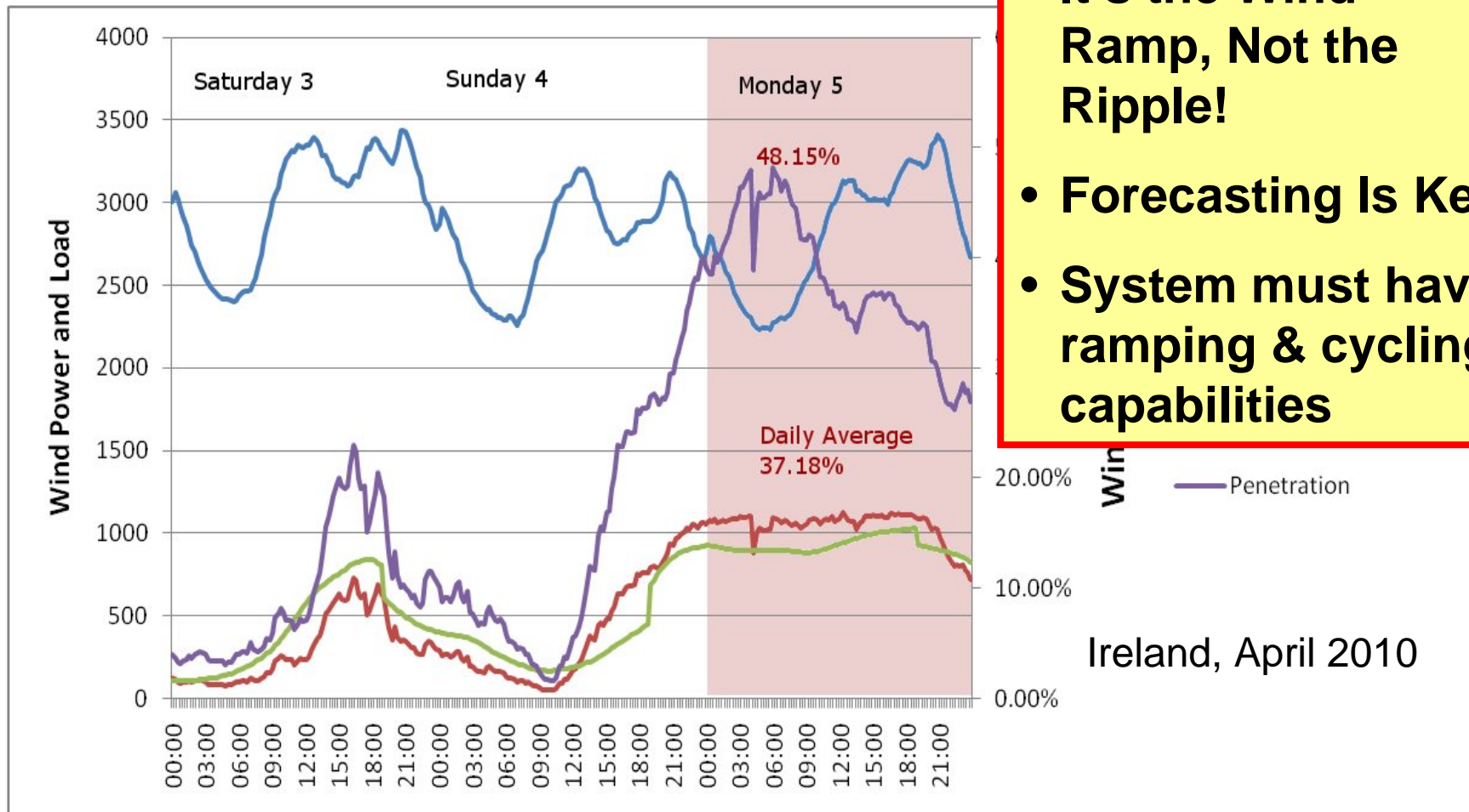
- Challenges for integrating wind
  - Variability and Uncertainty
  - Stability and Reliability
- How do these impact on system?
- What have we seen thus far?
- What can we do to reduce the impacts?



# Increasing Understanding – Trial by Fire!



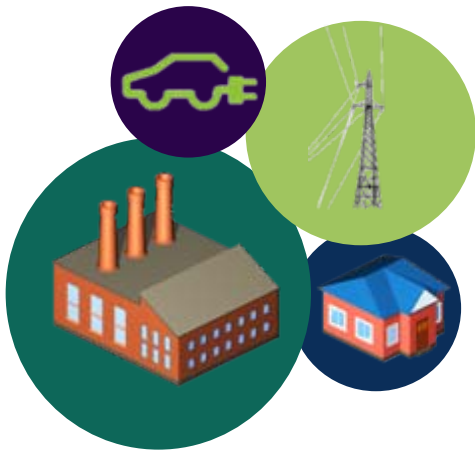
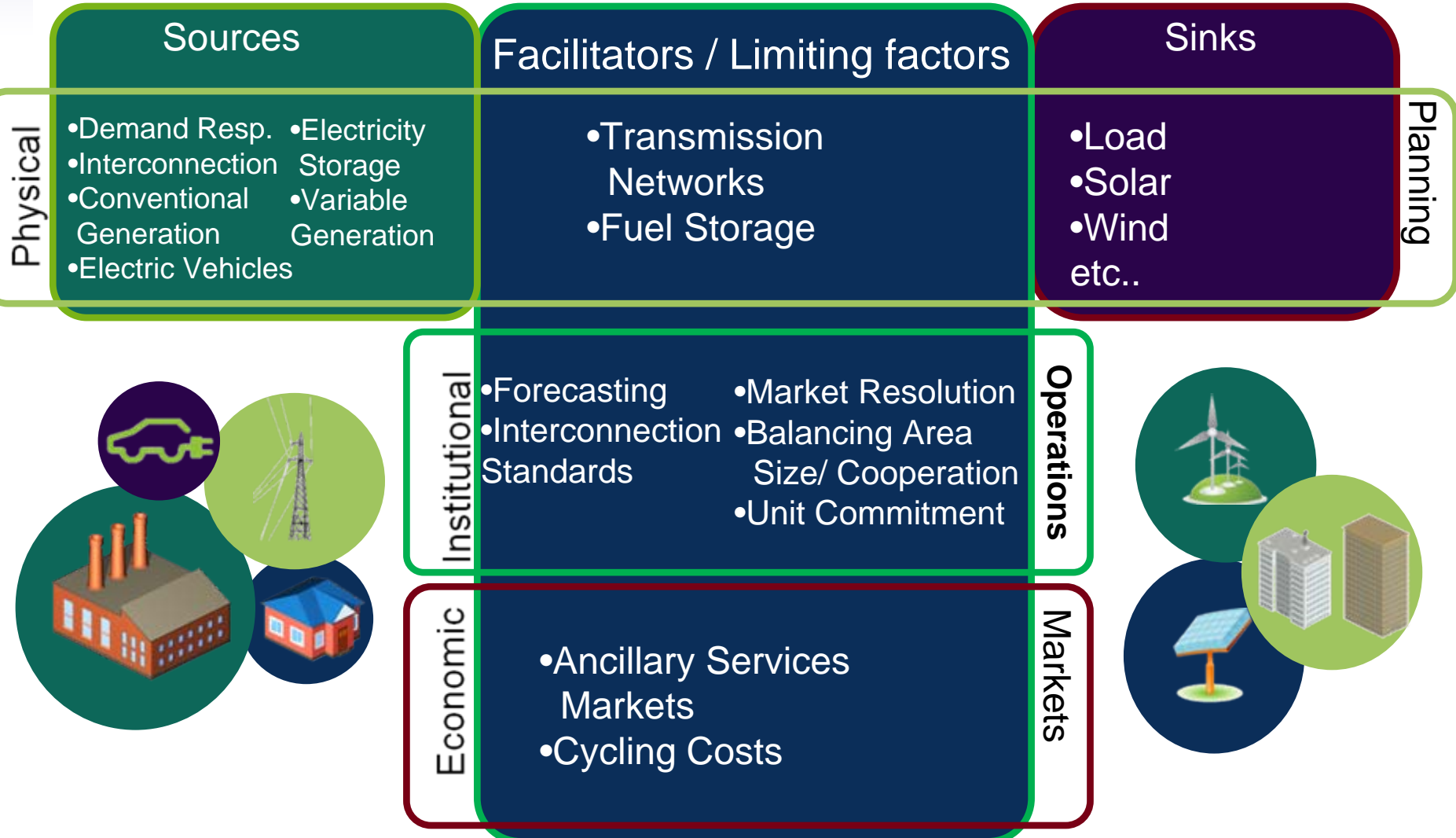
# Wind & PV Variability/Uncertainty Increases the Need for System Flexibility



Source: Constructed from EIRGRID online data ([www.eirgrid.com](http://www.eirgrid.com)).

# Sufficient Flexibility will ease Integration

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Source: E. Lannoye, University College Dublin ERC

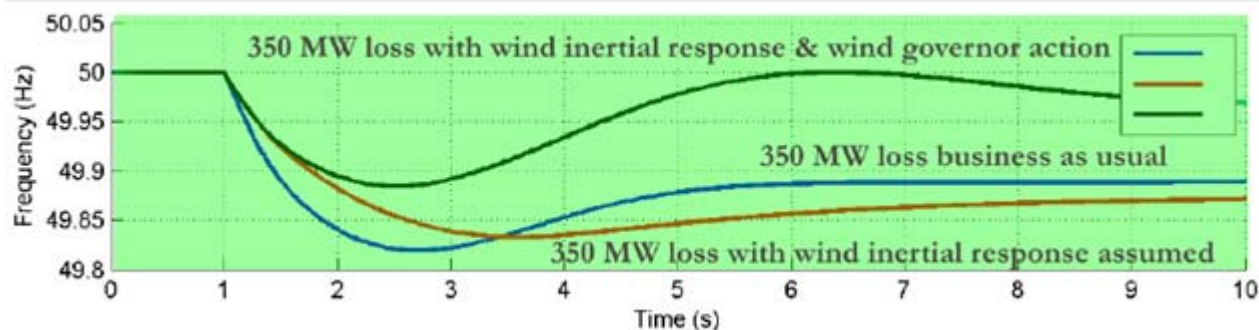
# Balancing variability and uncertainty

- Integration costs can be reduced by:
  - Better operational methods
  - Increased coordination between area
  - Standards for interconnection of wind
  - Planning methods to ensure flexibility
  - Flexible resources: gas is key resource
- Flexibility is key to balancing variability
  - Every system is starting from a different place
  - No one answer for integrations costs / needs: suite of institutional and physical capacity measures needed



# Frequency stability and wind

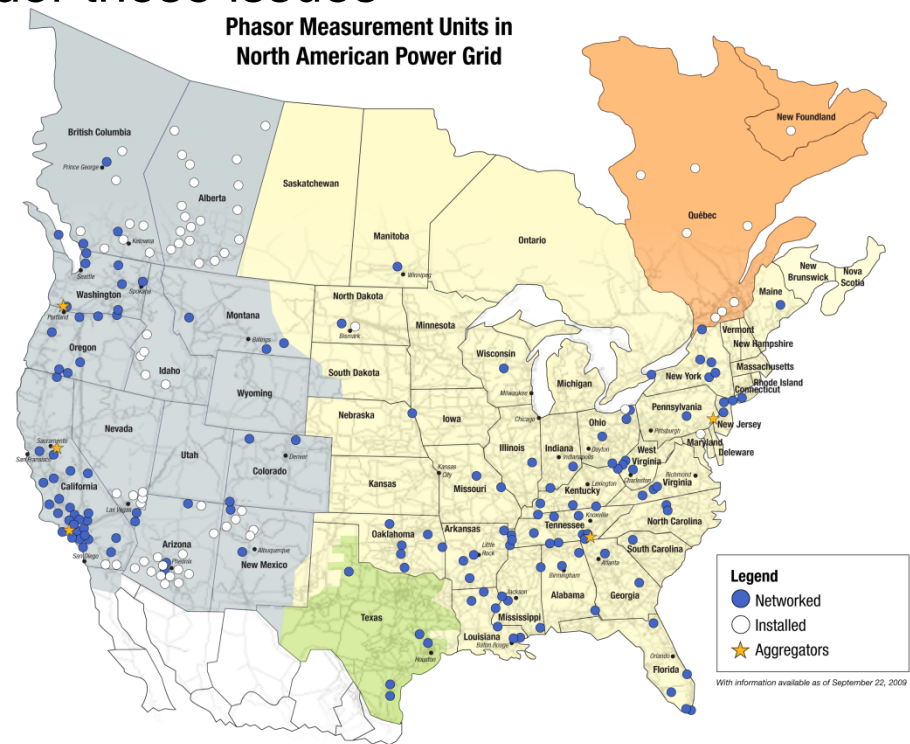
- Frequency response: How a system responds to faults
  - Wind may reduce the ability to respond
  - FERC LBNL report, Jan 2011



- Possibility for power electronics to provide this from wind
- Metrics / standards to ensure stability

# Other integration issues

- Other areas relating to stability will also be impacted:
  - Voltage, Reactive power, fault response
  - Standards and codes to consider these issues
- Grid modernization will aid integration
  - Sensors
  - Power Electronics
  - Communication
  - Situational Awareness



# EPRI/ESB Smart Grid Demonstration project

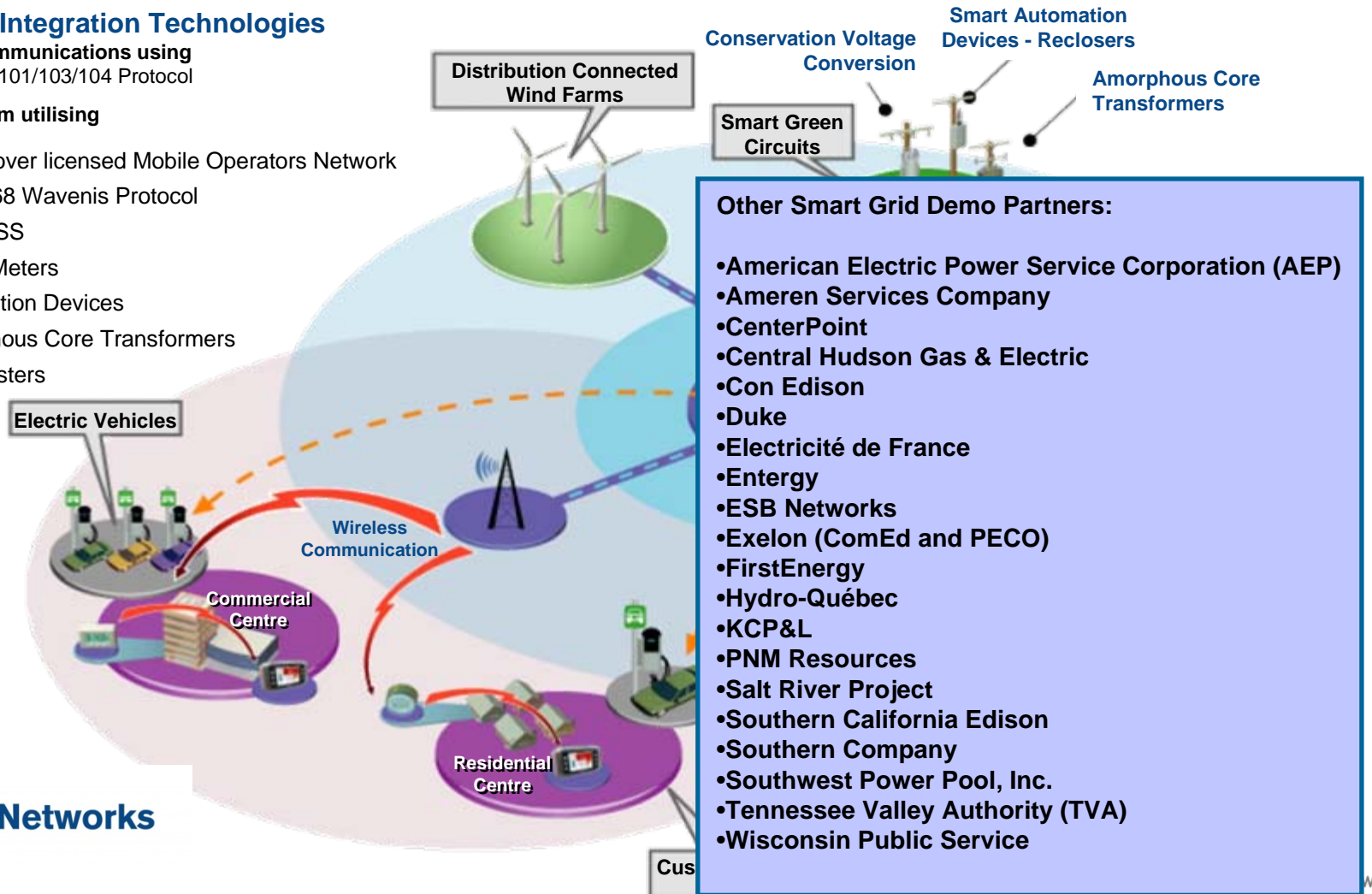
## “ESB Networks Roadmap for Smart Networks Integrating Distributed Energy Resources”

### Critical Integration Technologies

Scada Communications using  
IEC 870-5-101/103/104 Protocol

#### AMI System utilising

- GPRS over licensed Mobile Operators Network
- RF – 868 Wavenis Protocol
- Open DSS
- Smart Meters
- Automation Devices
- Amorphous Core Transformers
- LV Boosters



# What Are We Doing to Prepare for the Future?

- Numerous integration studies to define extent of needs
  - Specific BAs, state wide and interconnection wide
- Industry & standards groups
- **Collaborative R&D** → New technologies, tools, methods
  - Grid modernization
- Specific ISO/Utility Integration Initiatives

# Conclusions

- High penetrations of wind generation present system operating and planning challenges
- We are gaining critical understanding the challenges through R&D, studies, and operating experience
  - Wind generation is becoming familiar to operators
  - Operational and planning methods are being developed and put into use
- Solutions will emerge, important to
  - Ensure correct incentives are in place to maintain reliability while building sustainable, competitive system
  - Continue studies and collaborative R&D

# Together...Shaping the Future of Electricity