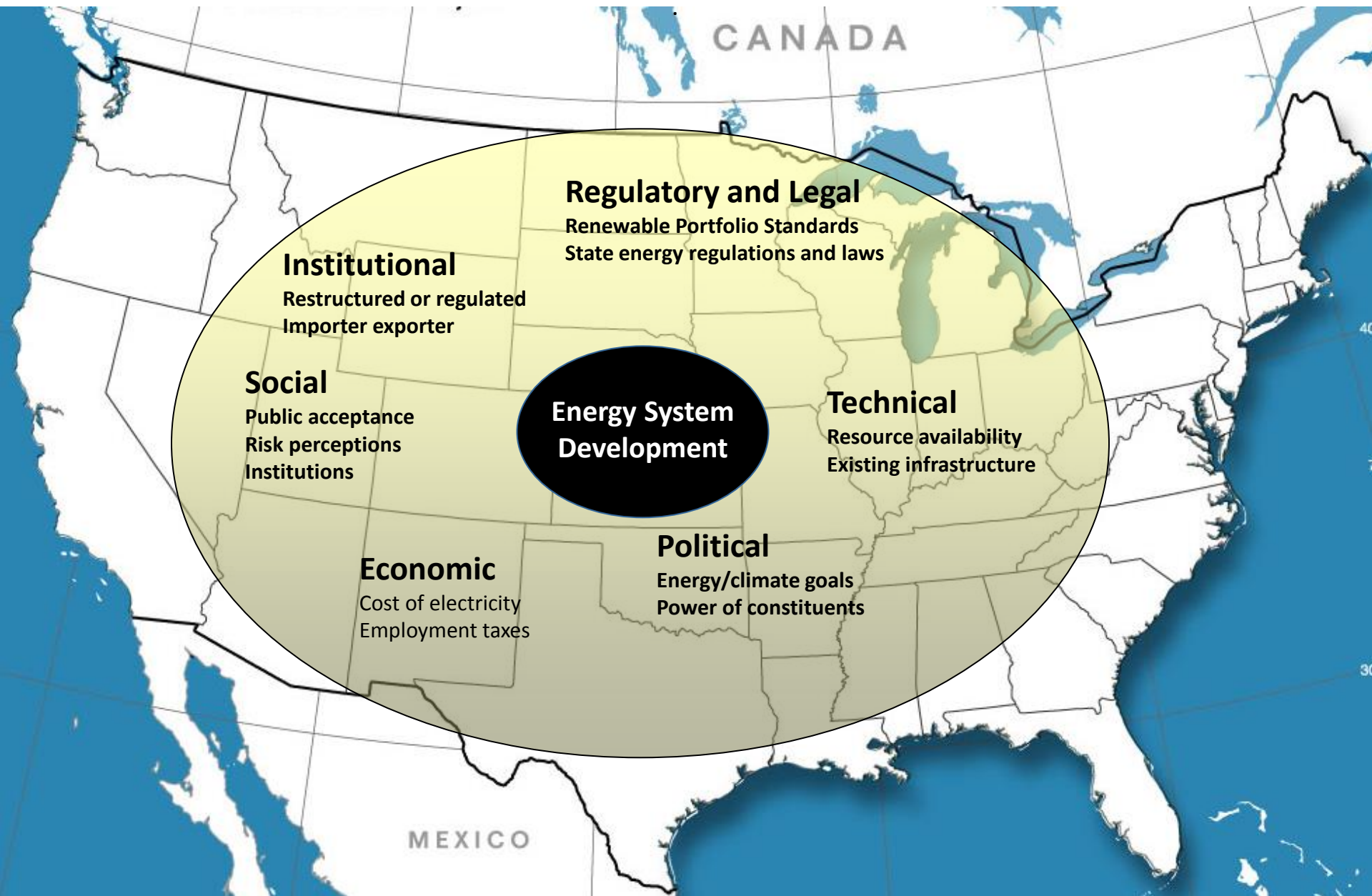




# Talk Outline

- 1) Smart Grid (or grid) Modernisation and Stakeholder Perspectives
- 2) Socio-Technical Considerations for Smart Grid in Asia and the U.S.
- 3) Example: Critical stakeholder and wind power integration into the smart(er) grid



CANADA

### **Regulatory and Legal**

Renewable Portfolio Standards  
State energy regulations and laws

### **Institutional**

Restructured or regulated  
Importer exporter

### **Social**

Public acceptance  
Risk perceptions  
Institutions

## **Energy System Development**

### **Technical**

Resource availability  
Existing infrastructure

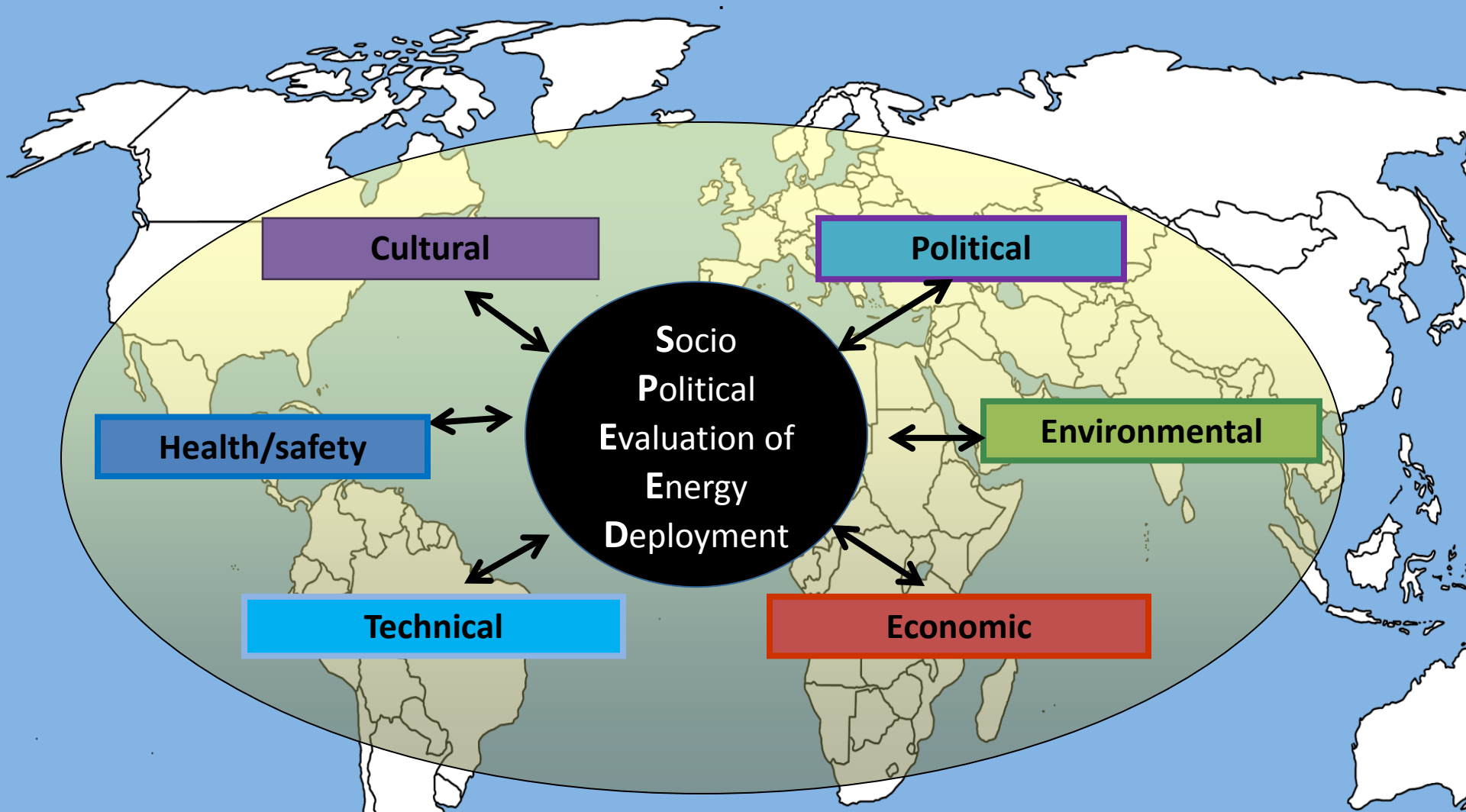
### **Political**

Energy/climate goals  
Power of constituents

### **Economic**

Cost of electricity  
Employment taxes

MEXICO



Stephens, JC, EJ Wilson, TR Peterson. 2008. "Socio-Political Evaluation of Energy Deployment (SPEED): An Integrated Research Framework Analyzing Energy Technology Deployment" *Technological Forecasting and Social Change*. 75: 1224–1246

Stephens, JC, EJ Wilson, TR Peterson, Smart Grid: Promoting System Innovation in Complex Multi-jurisdictional Socio-Political Contexts, *UCLA Law Review*, Volume 61, Issue 6, July 2014



# Smart Grid (R)Evolution

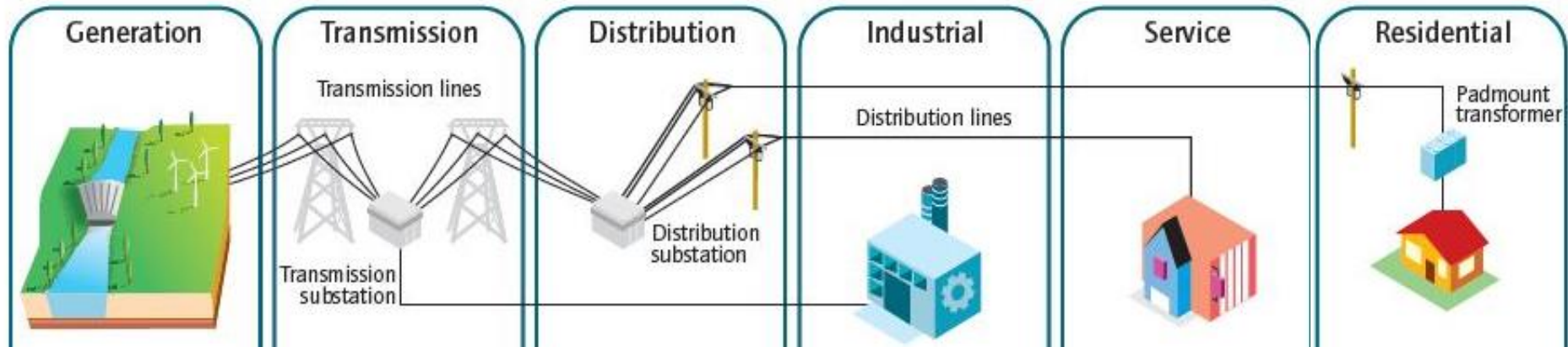
Electric Power Struggles

JENNIE C. STEPHENS  
ELIZABETH J. WILSON  
TARLA RAI PETERSON

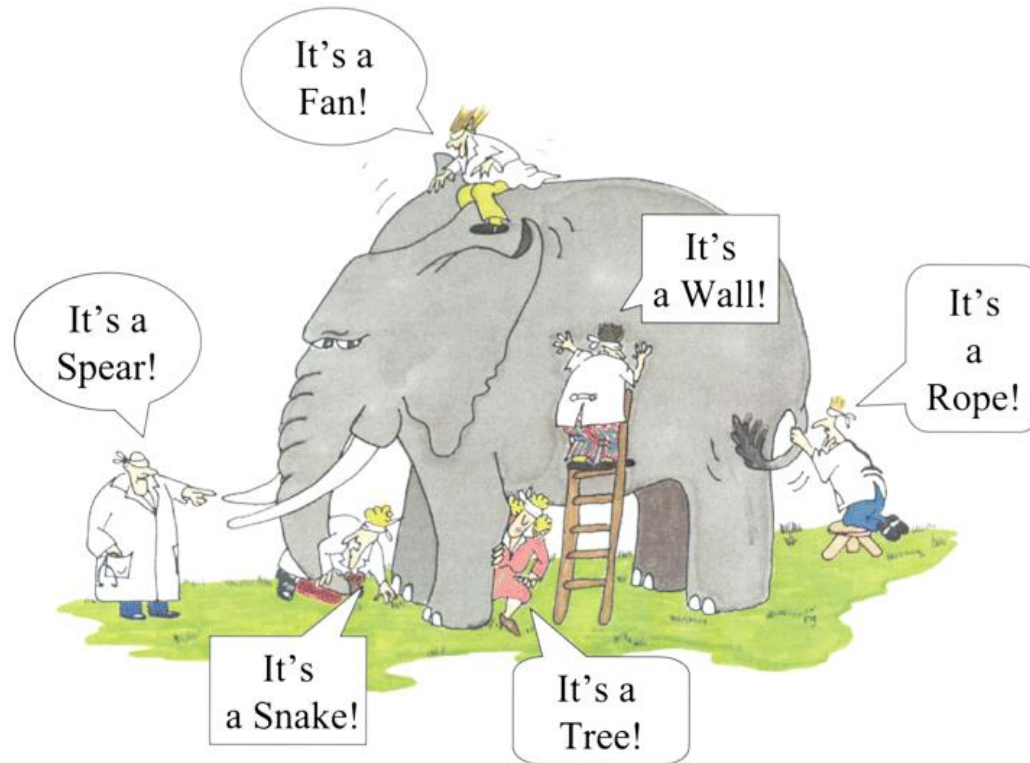
- Narrow focus of engineers and economists
- Smart grid term so broad that multiple types of changes are justified under the umbrella
- Smart grid for WHAT purpose? Incremental or Radical Change?
- Multiple opportunities for broader civic engagement in energy system change

Cambridge University Press, 2015  
Forward by Michael Dworkin

# The Electric Grid



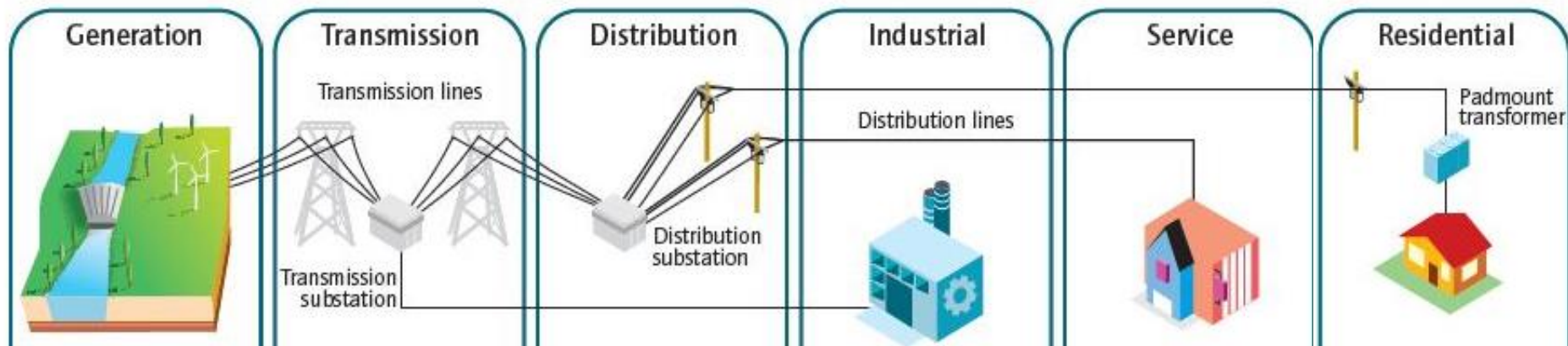
# What is smart grid?



G. Renee Guzlas, artist

Source: [http://www.nature.com/ki/journal/v62/n5/fig\\_tab/4493262f1.html](http://www.nature.com/ki/journal/v62/n5/fig_tab/4493262f1.html)

# The Smart Grid



Information and Communications Technology Integration

Renewable Energy and Distributed Generation Integration

Demand Response, Price Controls

Advanced metering infrastructure

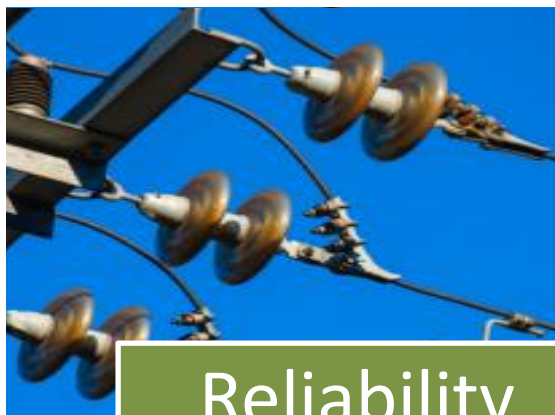
Consumer Interface tools, load appliances







Efficiency



Reliability



Affordability



Resilience

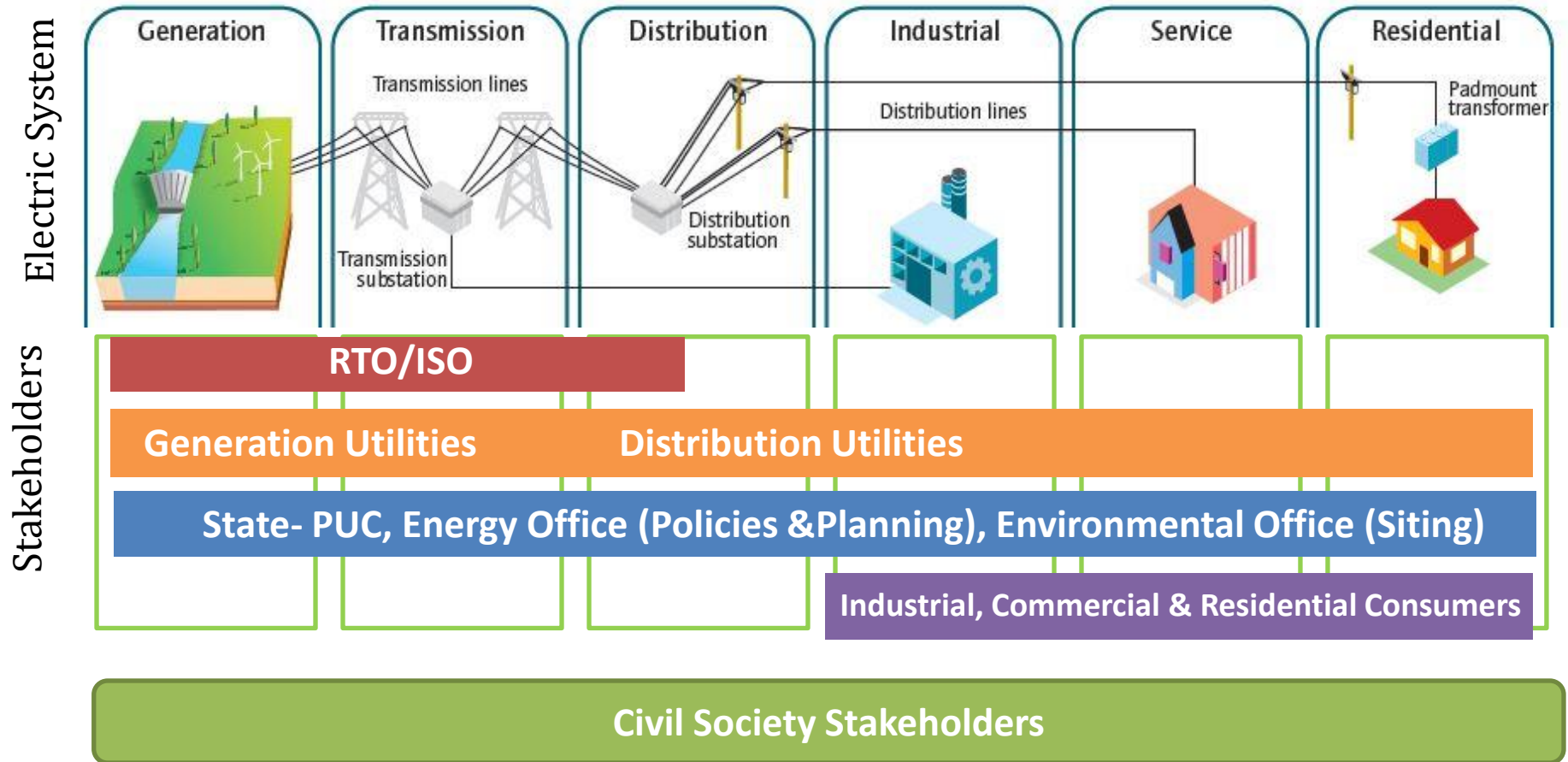


Security



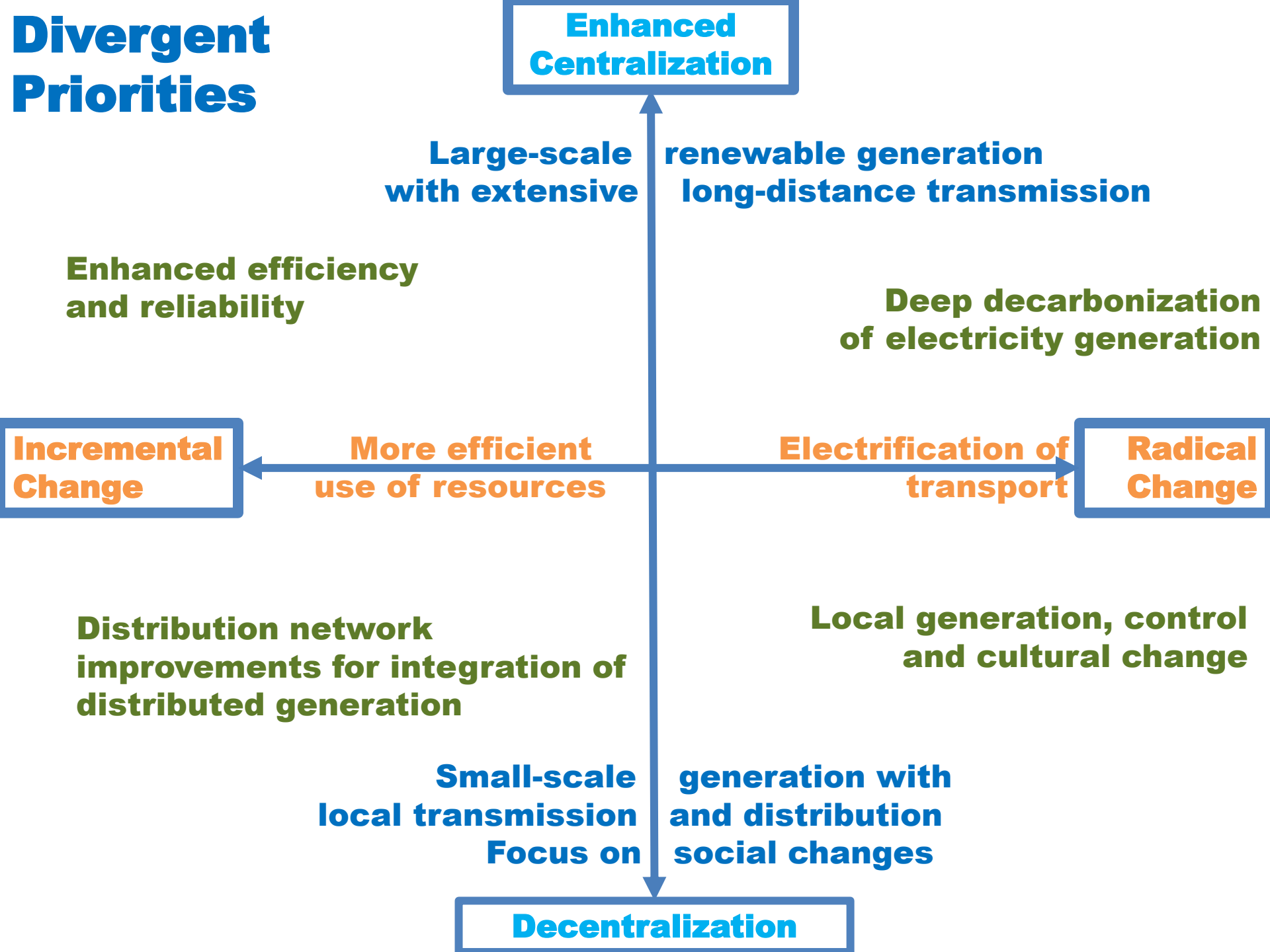
Sustainability

# Key Actors in Smart Grid Development



# Where you sit is where you stand

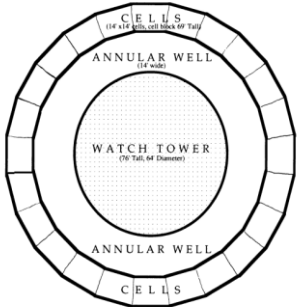
Key Actors	Priorities & Perspectives
Consumers	Reliability, low-rates, reduced environmental impact – but sense of limited influence
Government (National, Regional, State, Local)	Jurisdictionally complex regulation
Private Sector	Accountable to shareholders
Electric Utilities	Maintaining reliable service, responding to consumers and regulators
Technology companies	Innovative & entrepreneurial
Environmental advocates	Low carbon shift & renewable energy, local land use
Energy system researchers	Technologically optimistic – tend to assume minimal social change







IRREGULAR TIMES

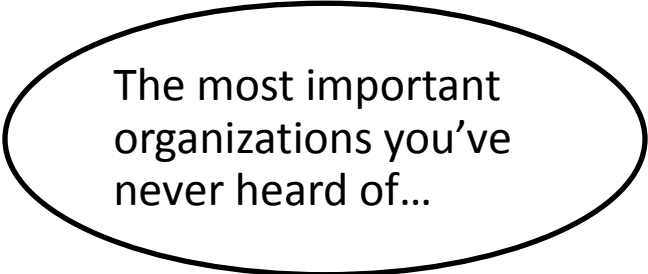


<http://irregulartimes.com>

# Alienated citizens - Panopticon



# What are Regional Transmission Organizations?



The most important  
organizations you've  
never heard of...



“We have a couple things we do at the ISO level... all we really are is the air traffic controller of what we call the bulk power supply, which is a lot more voltage than you have going to your house... These are kind of like the superhighways of electricity.”

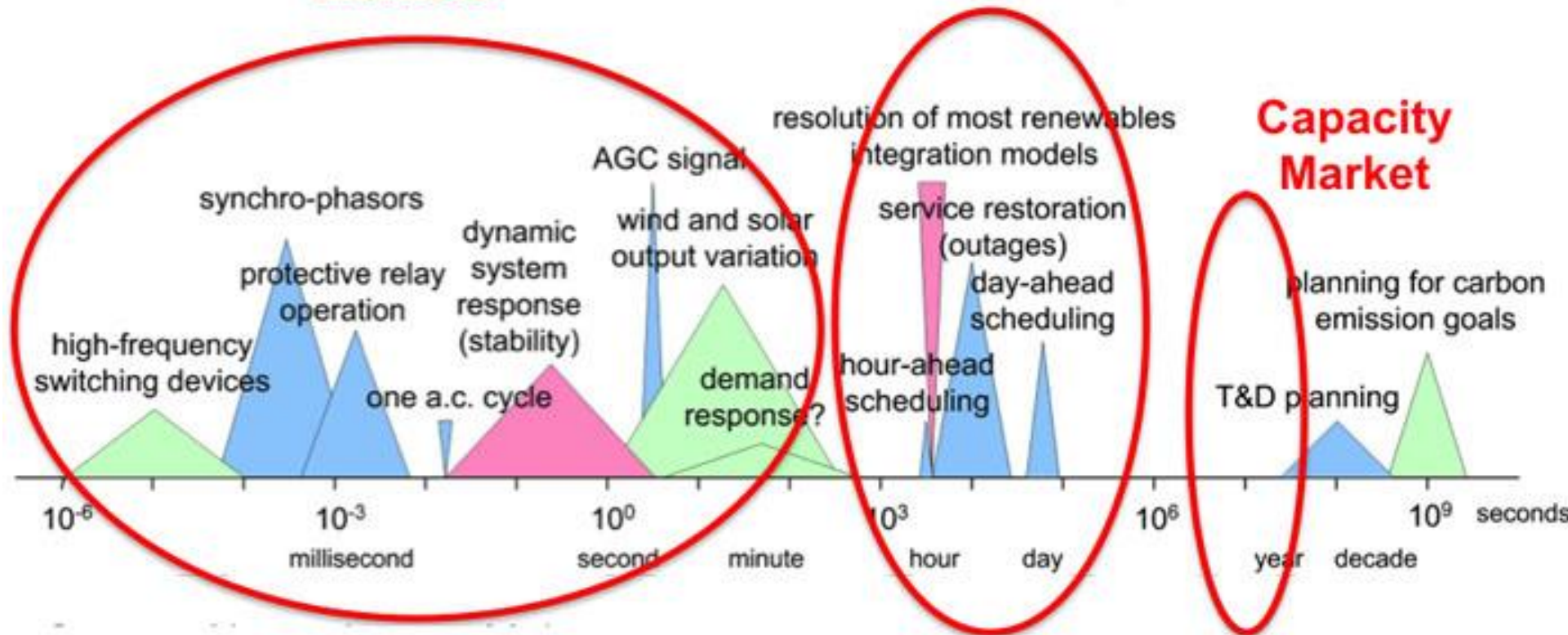
70%

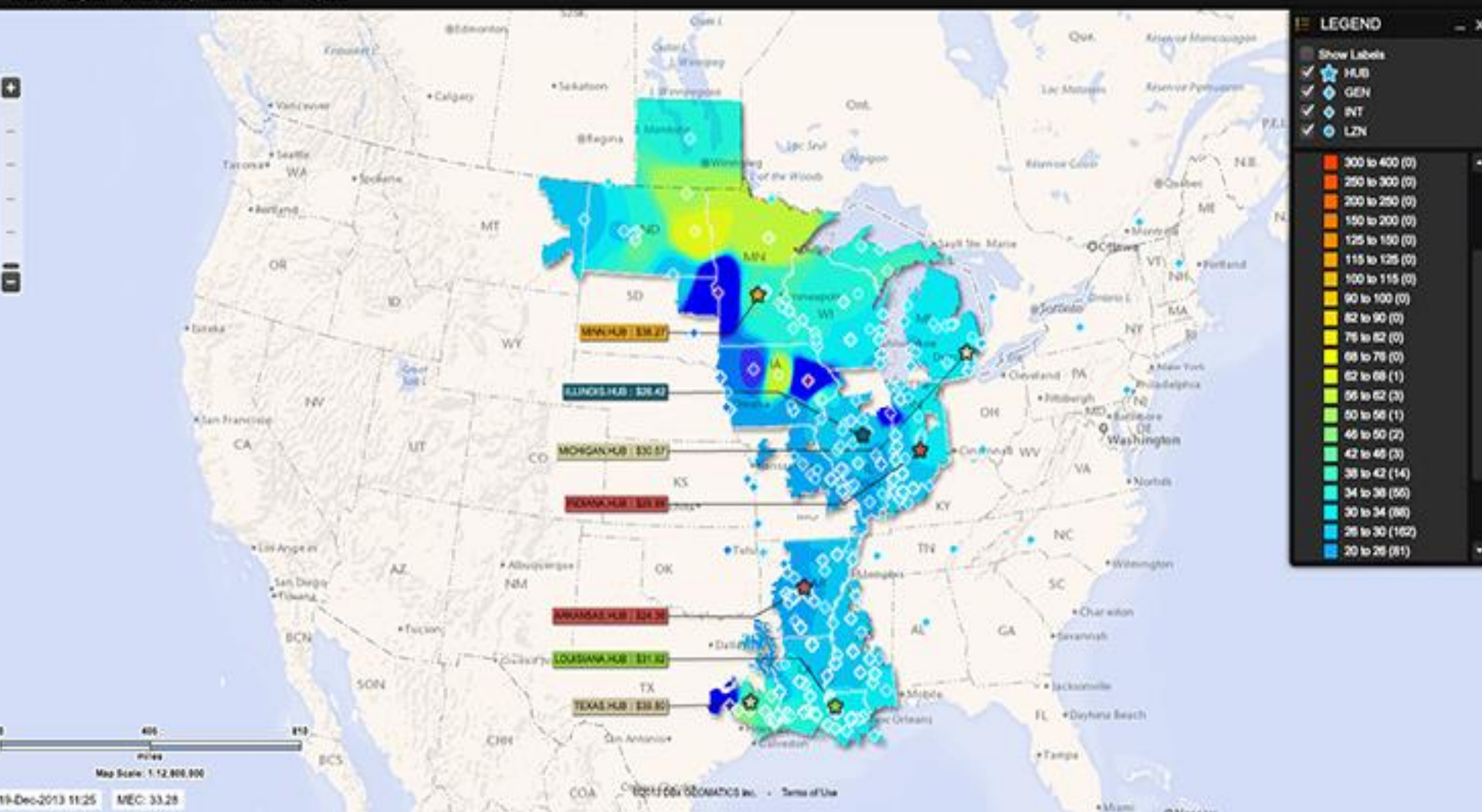


## Ancillary Services Markets

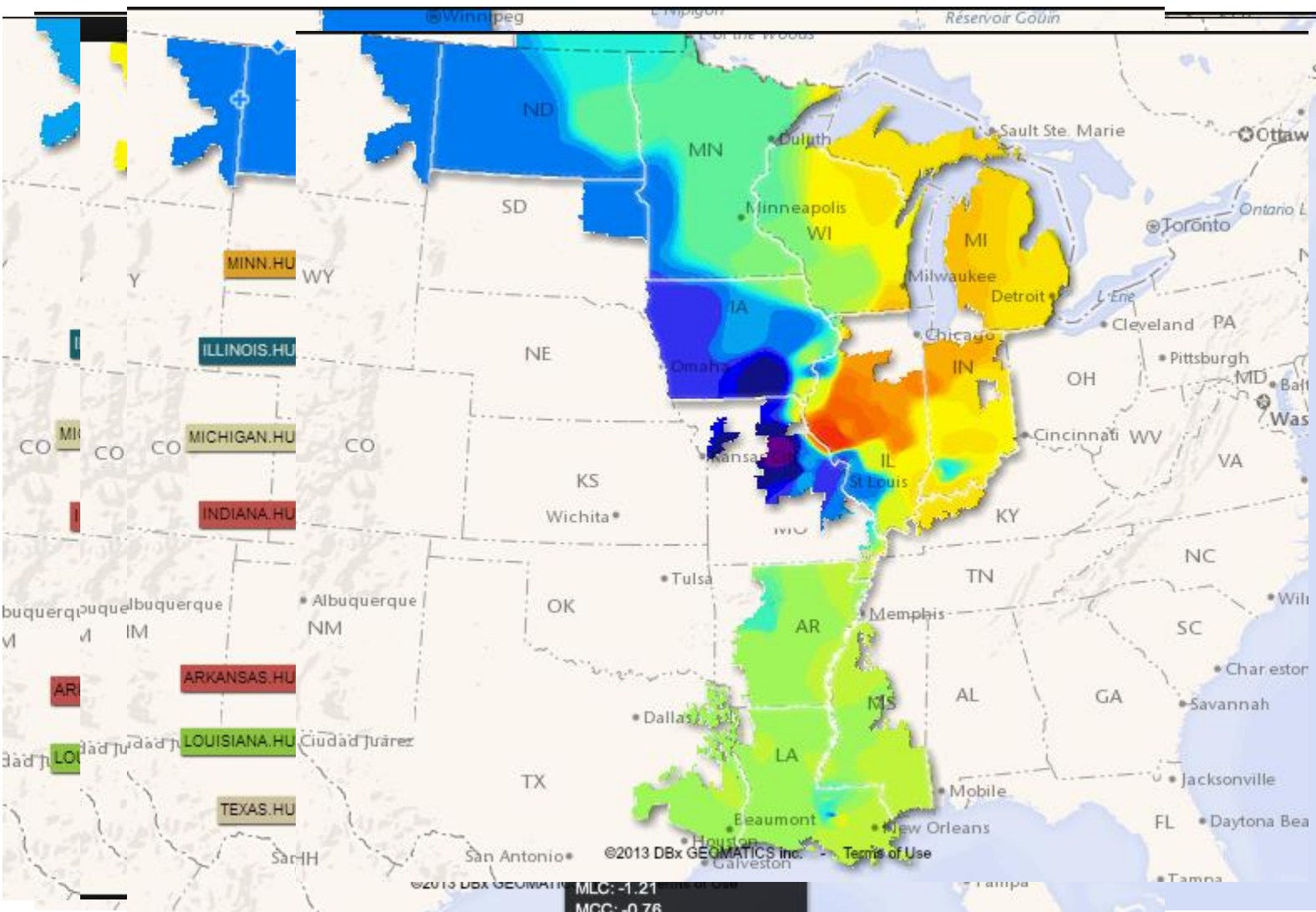
## Energy Markets (Day Ahead and Real-Time)

## Capacity Market









**LEGEND**

Show Labels

- ☒ HUB
- ☒ GEN
- ☒ INT
- ☒ LZN

☐ Pricing Nodes

☐ LMP Value (USD)

800 to 1000	(0)
600 to 800	(0)
500 to 600	(0)
400 to 500	(0)
300 to 400	(0)
250 to 300	(0)
200 to 250	(0)
150 to 200	(0)
125 to 150	(1)
115 to 125	(0)
100 to 115	(0)
90 to 100	(0)
82 to 90	(0)
76 to 82	(0)
68 to 76	(0)
62 to 68	(0)
56 to 62	(1)
50 to 56	(2)
46 to 50	(0)
34 to 38	(0)

MLC: -1.21  
MCC: -0.76

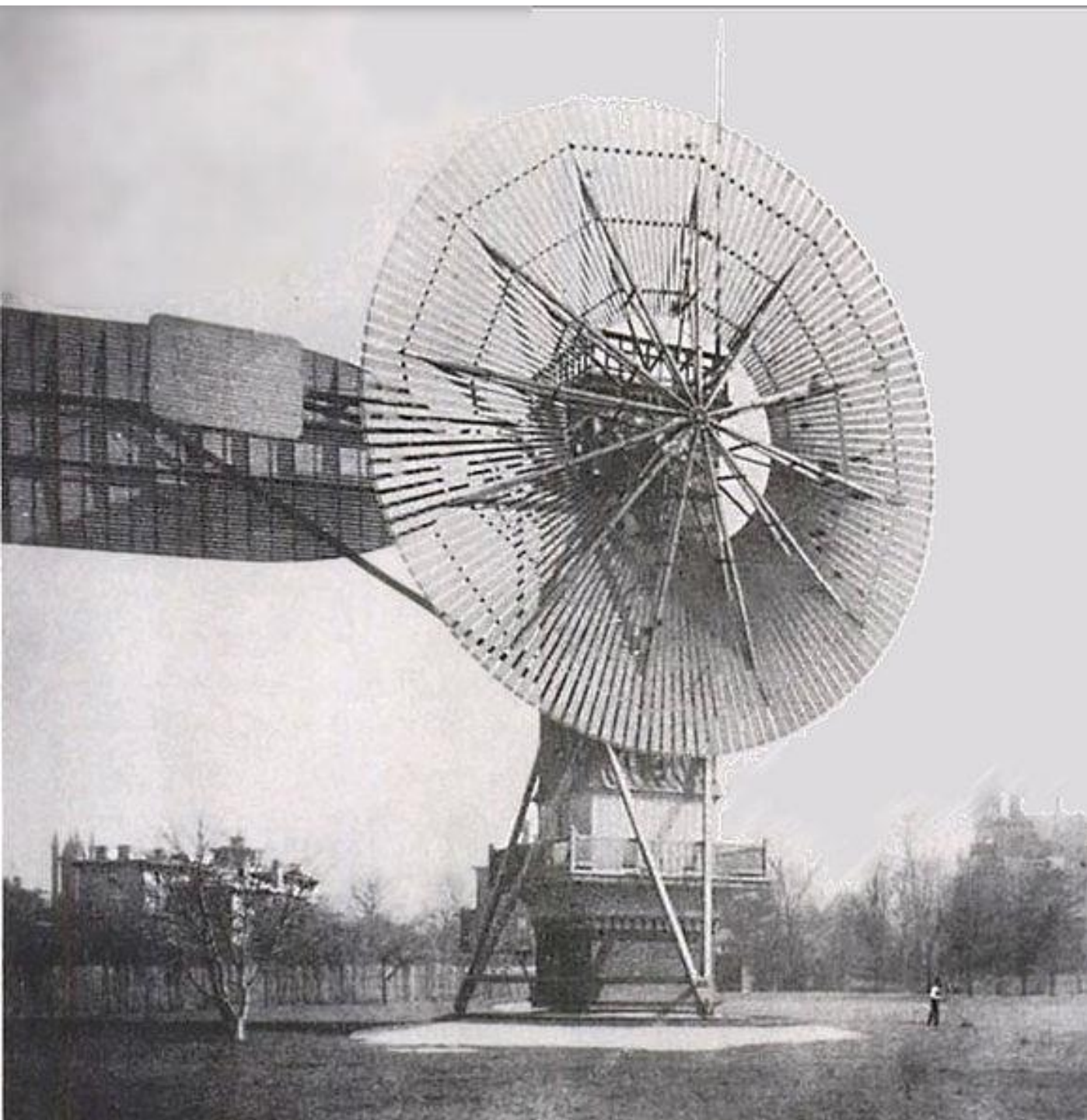
Regional Transmission Organization	Jurisdiction	Customers	Generation capacity	Miles of Transmission Lines
ISO-NE	Multi-state	14 million	32,000 MW	8,130
MISO	Multi-state	48 million	205,759 MW	65,250
ERCOT	Single state	23 million	84,000 MW	40,530
CA-ISO	Single state	30 million	59,000 MW	25,865
NYISO	Single state	19.5 million	37,925 MW	11,005

*“They say ‘smart grid’, that implies that it’s a dumb grid now. I think it's very, very smart right now. And if anyone doesn't believe that, I have to just walk over to our control room and see what's going on.”*

- Focus Group participant

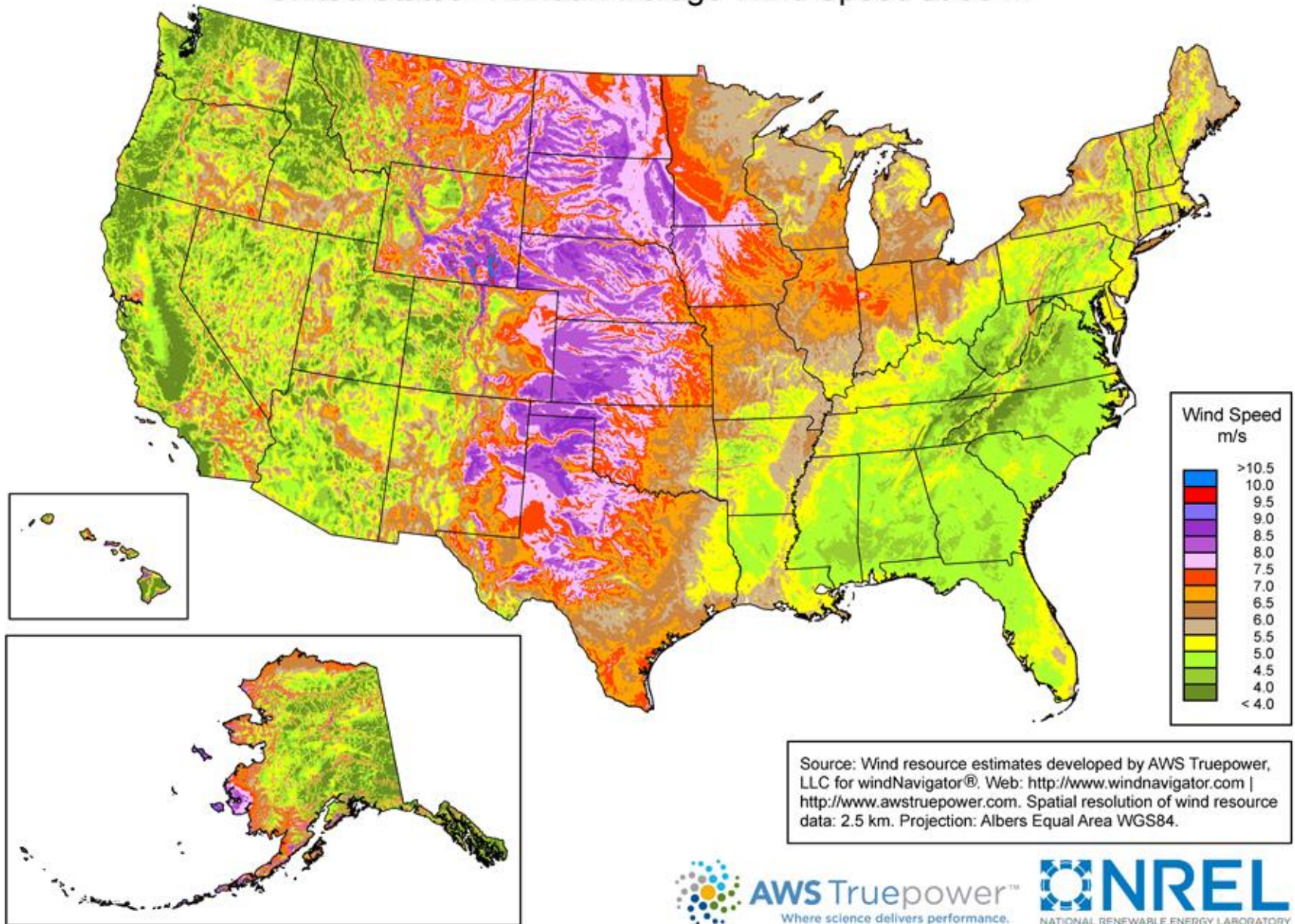




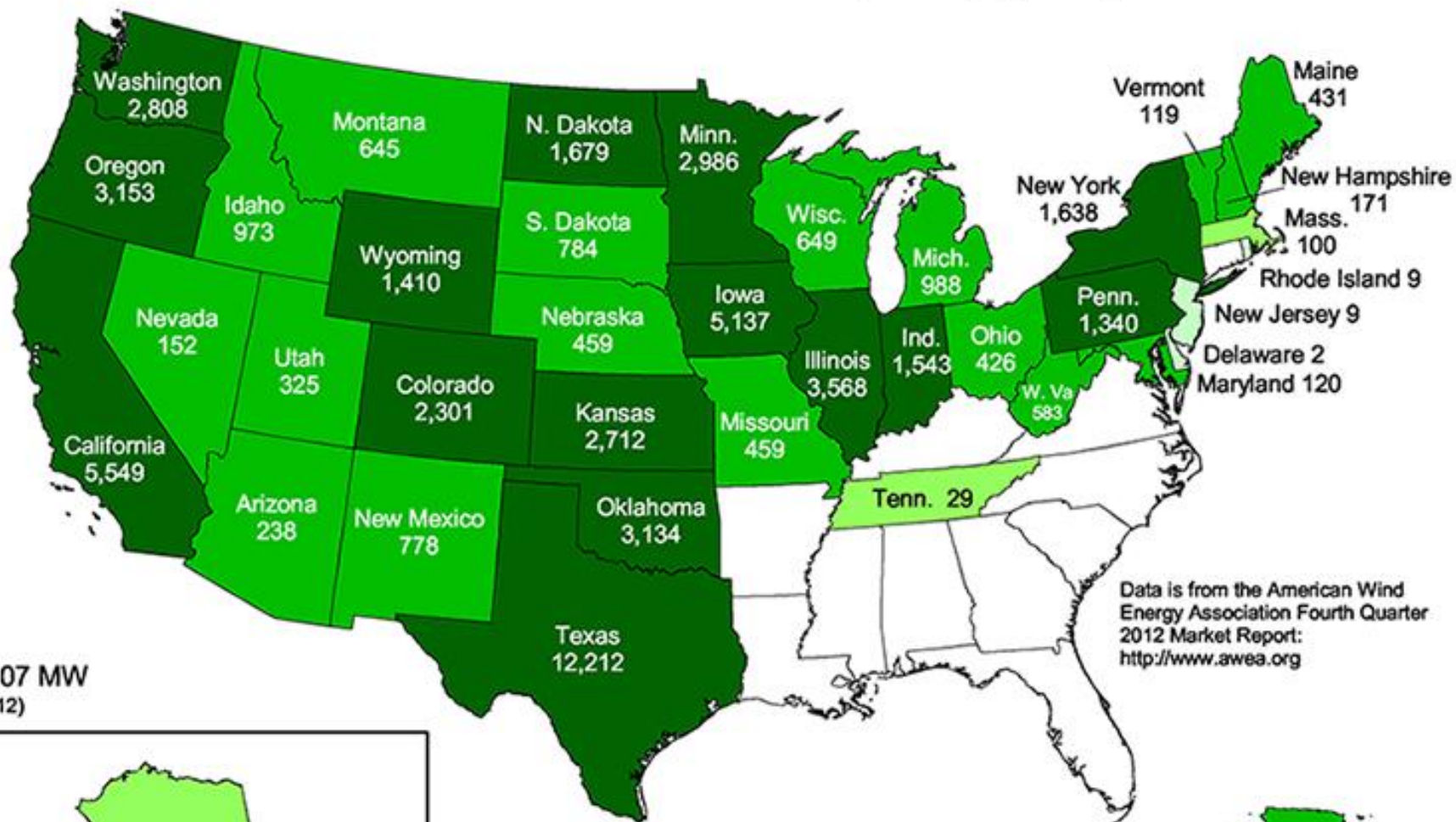




## United States - Annual Average Wind Speed at 80 m



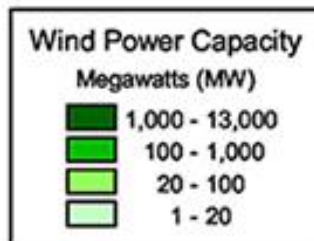
# 2012 Year End Wind Power Capacity (MW)



Data is from the American Wind Energy Association Fourth Quarter 2012 Market Report: <http://www.awea.org>

Puerto Rico - 125

Total: 60,007 MW  
(As of 12/31/2012)



U.S. Department of Energy



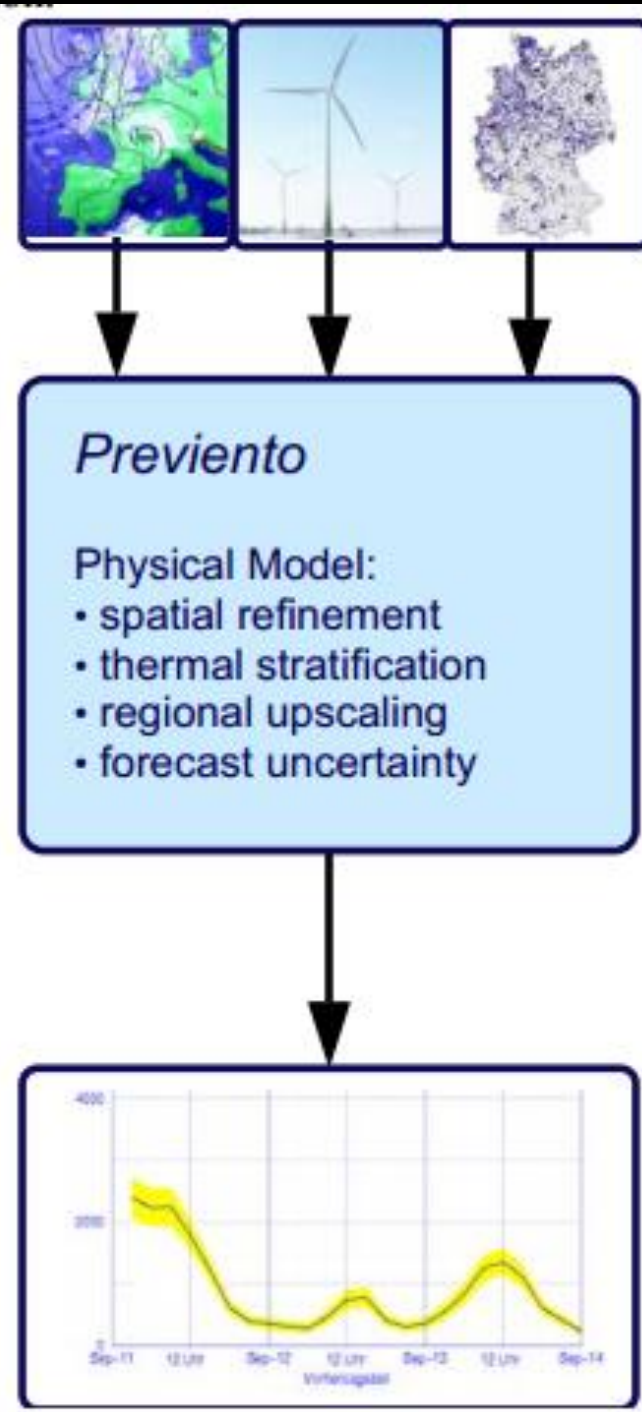
06-MAR-2013 1.1.37

# Rules Matter

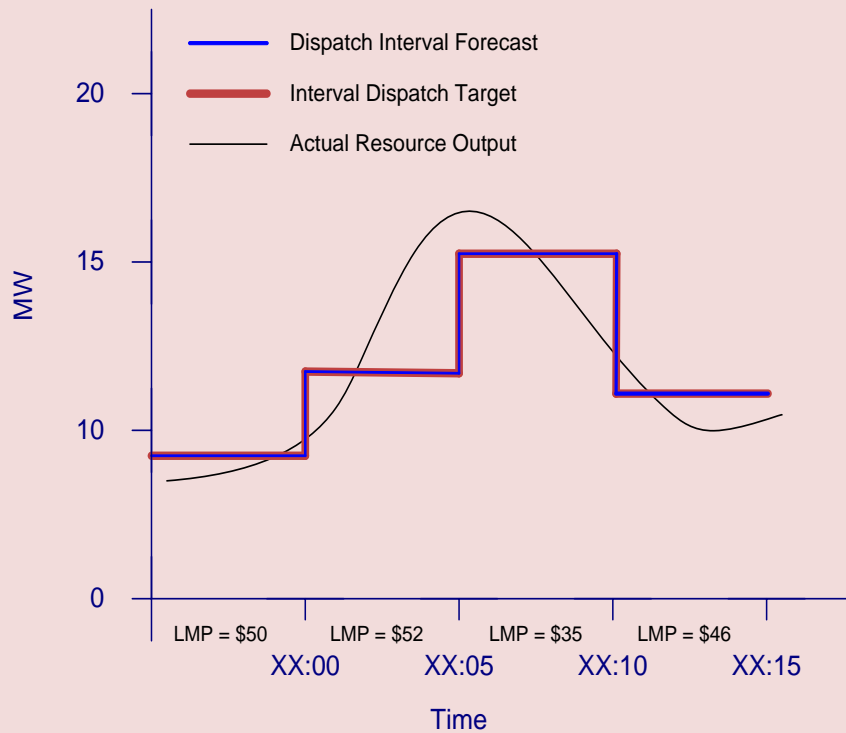
*(A lot)*



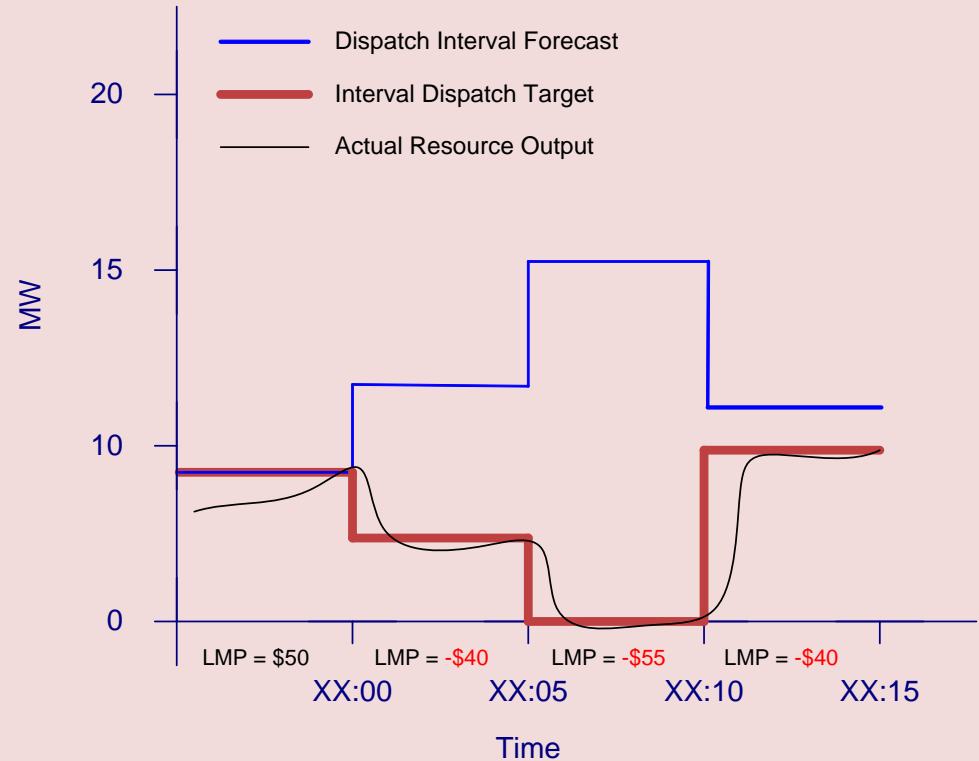
# Regional Transmission Orga



# Dispatchable Intermittent Resources (DIR)

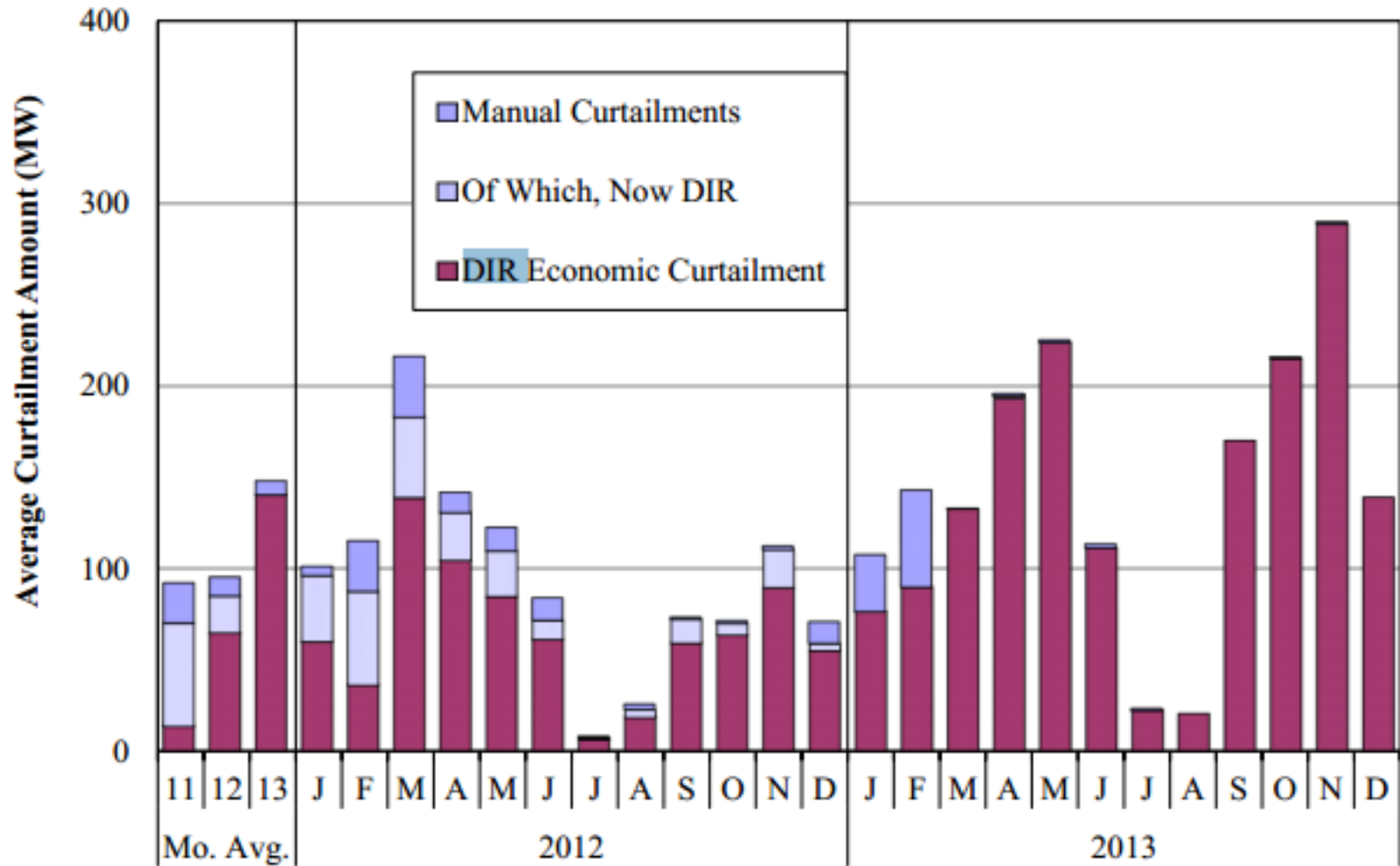


Unconstrained

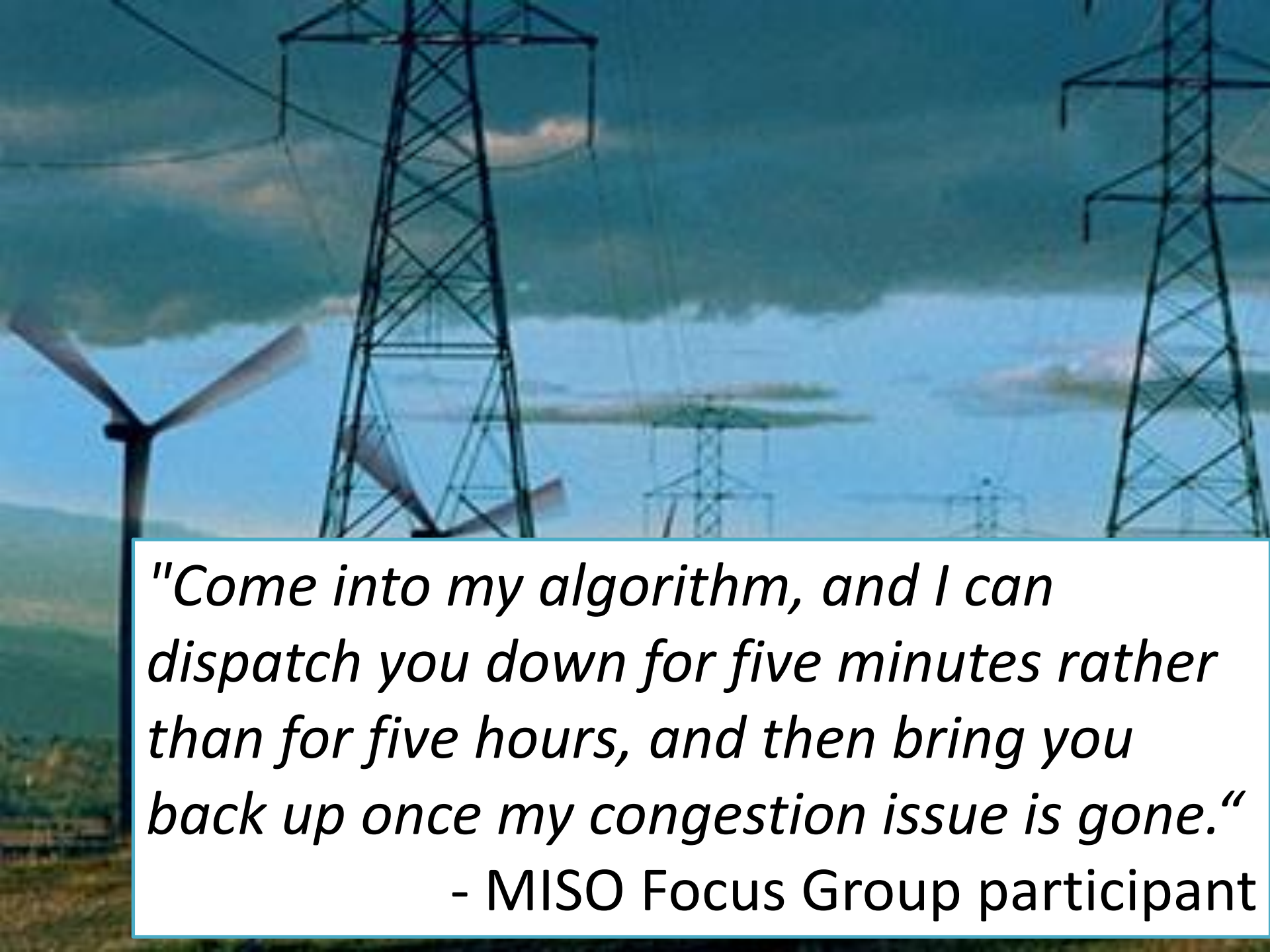


Nearby Congestion

**Figure A53: Wind Curtailments**  
2012–2013



*Figure A54: Wind Generation Volatility*

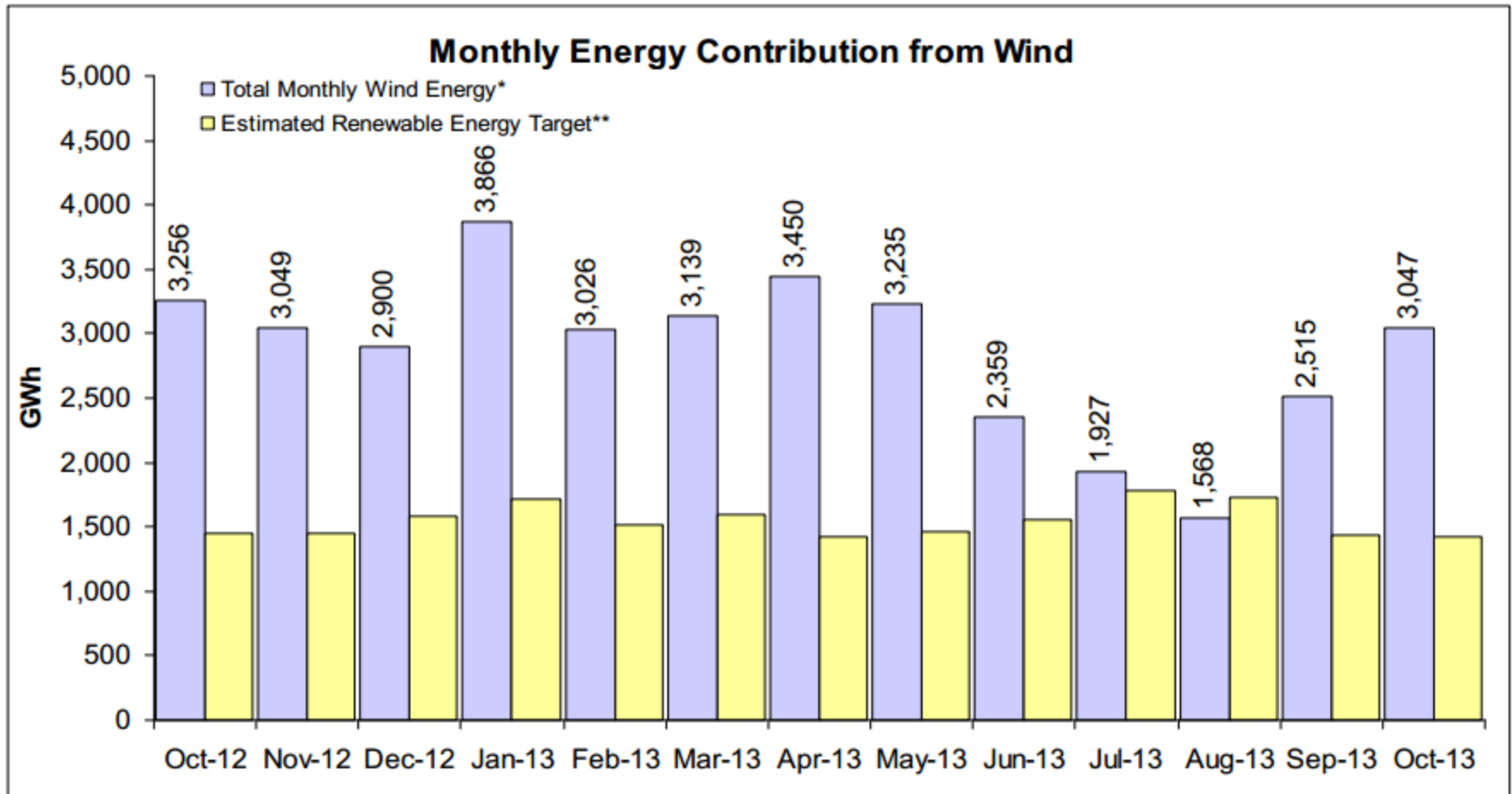


*"Come into my algorithm, and I can dispatch you down for five minutes rather than for five hours, and then bring you back up once my congestion issue is gone."*

- MISO Focus Group participant



# MISO and the RPS



RPS data extracted on October 04, 2013. Values may change due to resettlement.

\*Sum of hourly State Estimator data.

\*\*Monthly wind energy generated (light blue) compared to monthly renewable energy target (yellow bar) to satisfy approximate aggregate State RPS mandates within MISO's market footprint. While wind may be in excess today, internal projections show that current wind production may not be sufficient to meet the future needs as soon as 2014. Additional information can be found under [Stakeholder Center/Committees, Work Groups, and Task Forces/Informational Forum – Related Documents](#).

\*\* Yellow bar represents the annual renewable energy target distributed by month based on monthly capacity factor expectations of the MISO system.



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# Acknowledgements

## Smart Grid Study

**Minnesota Team:** Elizabeth Wilson (PI), Mudita Suri, Clark Koenigs, Julia Eagles, Caroline Eling, Emily Kreiter

**Clark Team:** Jennie Stephens (PI), R. Langheim

**Texas A&M Team:** Tarla Rai Peterson (PI), Adrianne Strubb

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Seth Blumsack (Penn State), Dave Solon and Natalie Marsh (Boise State), University of Minnesota

Supported by: NSF Study of Organizations (NSF SES-1261670)

ewilson@umn.edu

## Photo credits

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pubs.usgs.gov

National Geographic Stock

<http://www.nationalgeographicstock.com/ngsimages/welcome.jsf>

Wind on the Wires

[illegible]