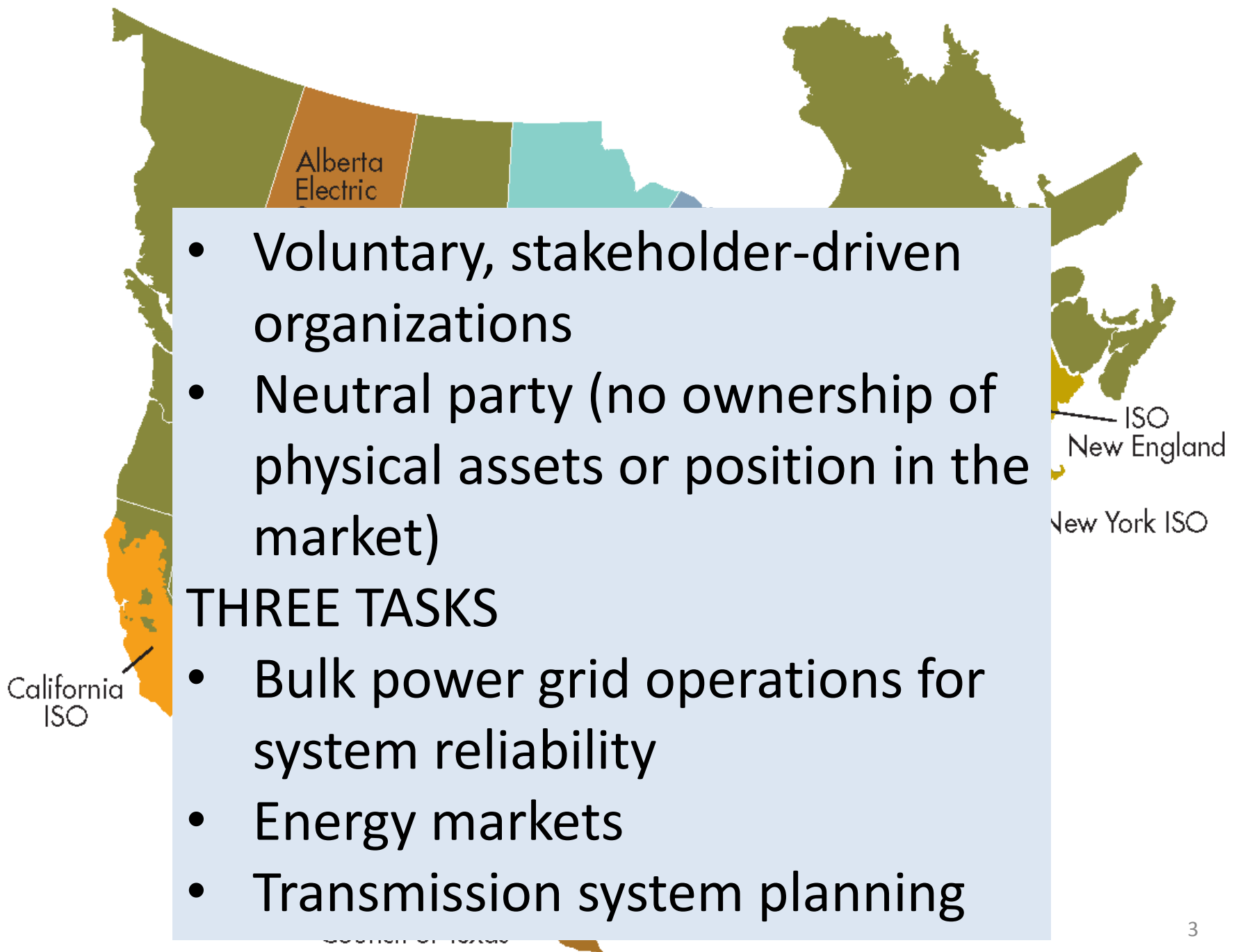


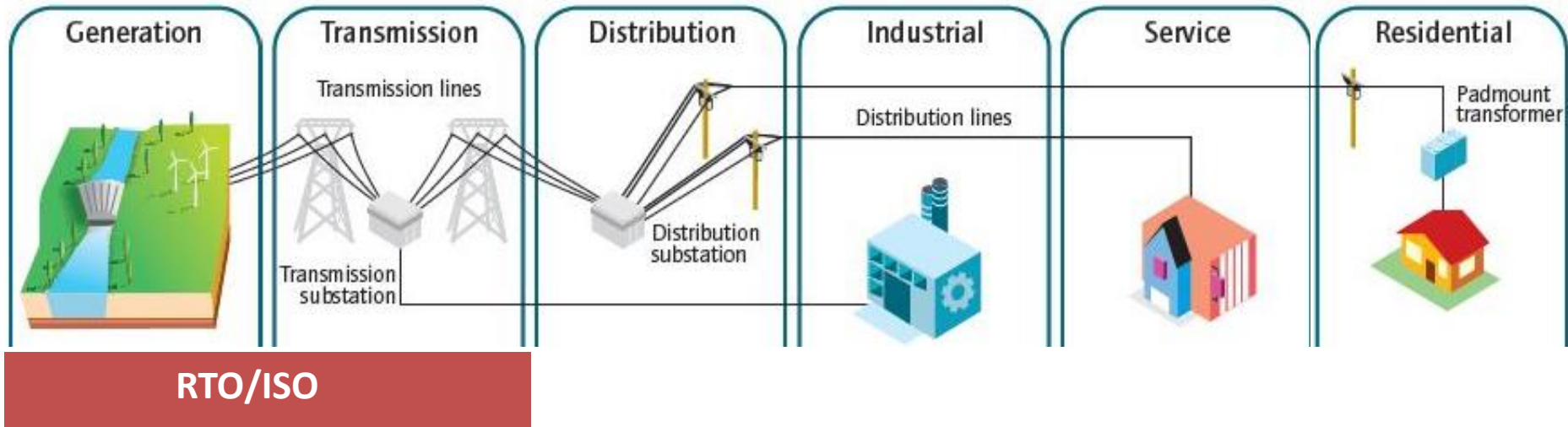


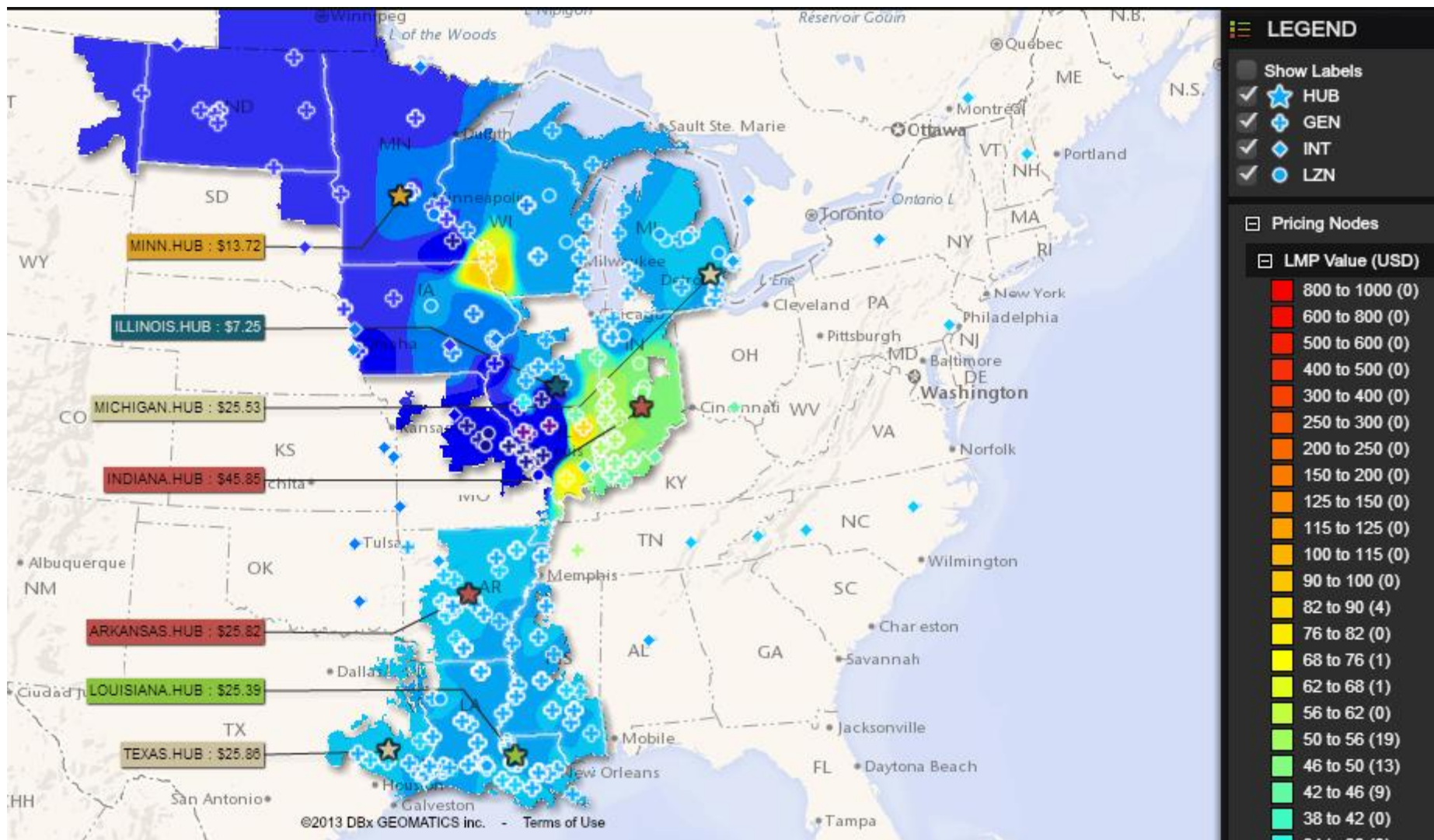
“We have a couple things we do at the ISO level... all we really are is the air traffic controller of what we call the bulk power supply, which is a lot more voltage than you have going to your house... These are kind of like the superhighways of electricity.”

70%



# The Electric Grid



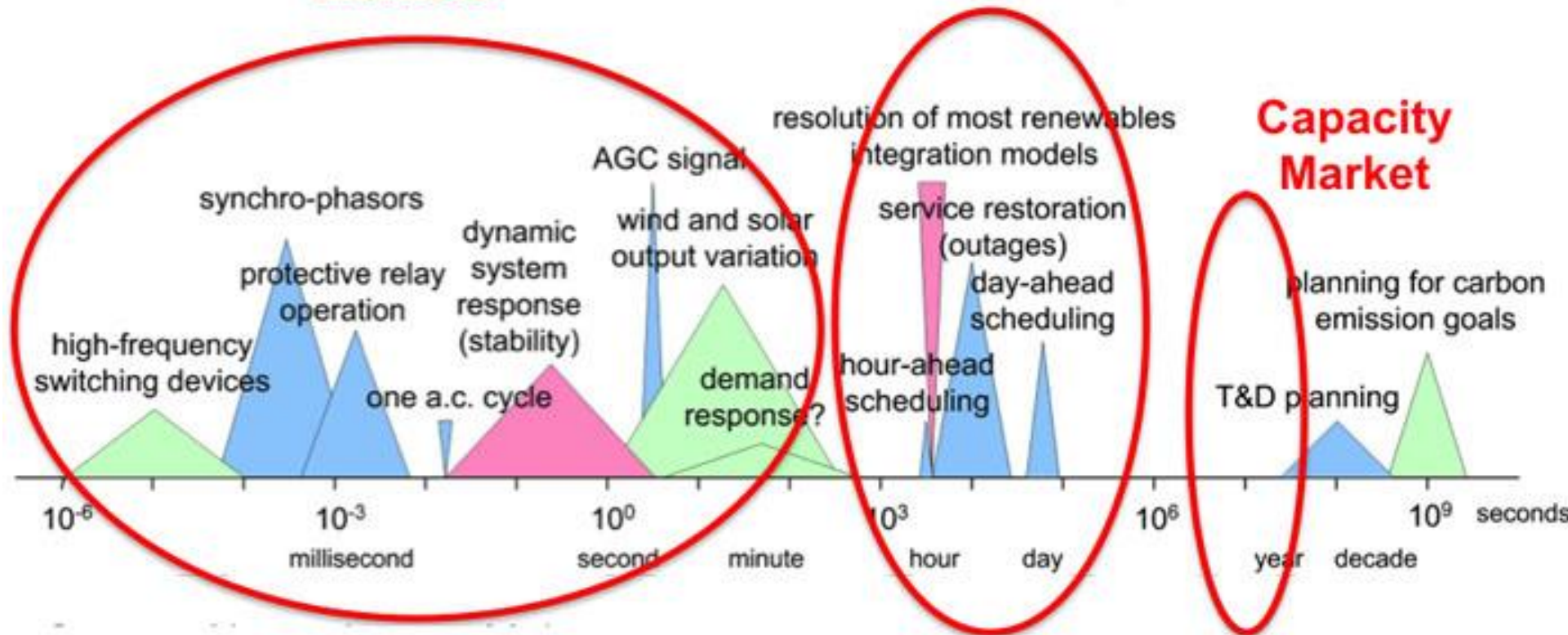




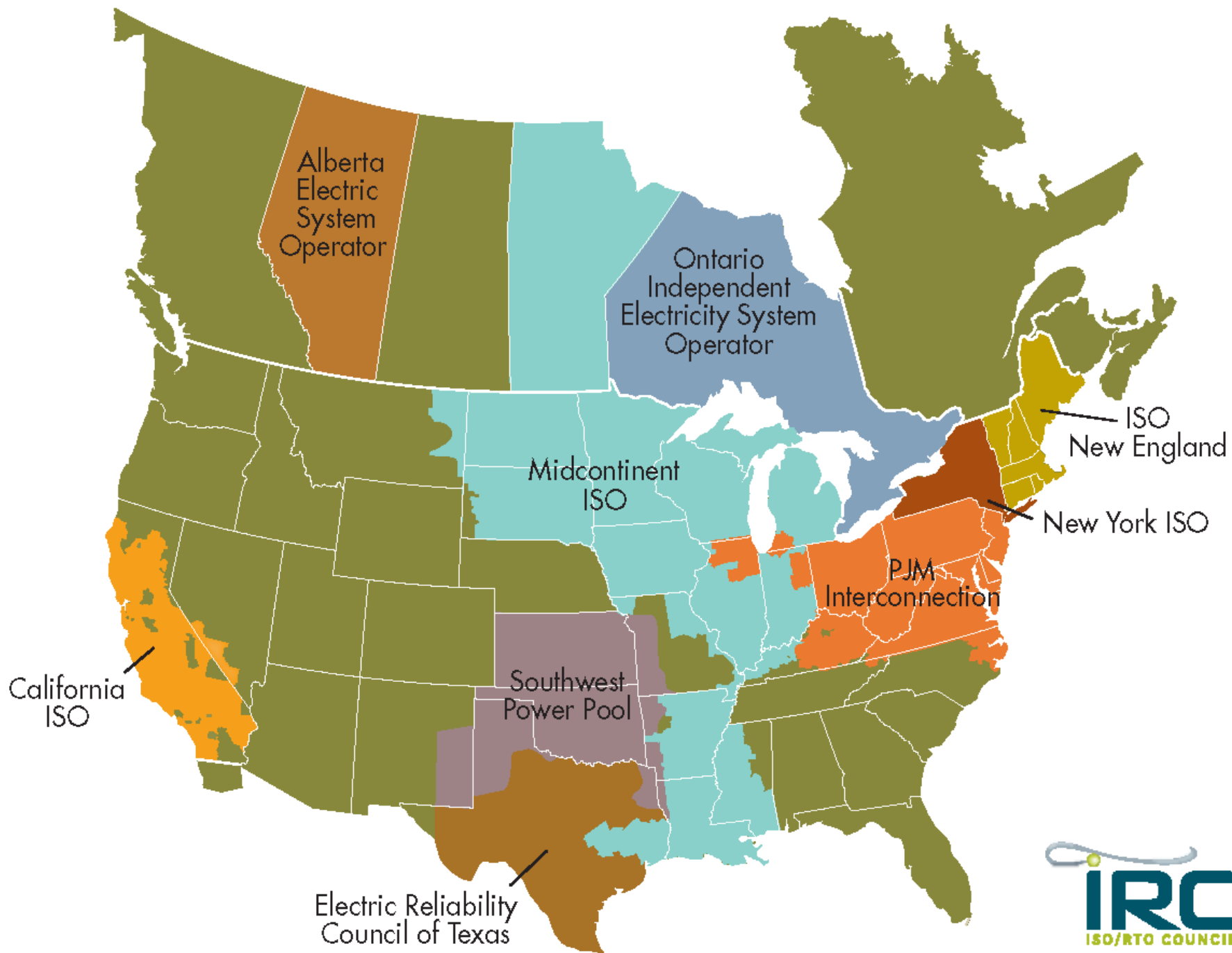
## Ancillary Services Markets

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

## Capacity Market



Regional Transmission Organization	Jurisdiction	Customers	Generation capacity	Miles of HV Transmission Line (km)
PJM	Multi-state	61 million	183,000 MW	63,000 (101,000)
ISO-NE	Multi-state	14 million	32,000 MW	8,000 (13,000)
MISO	Multi-state	48 million	205,759 MW	65,000 (104,000)
SPP	Multi-state	15 million	77,366 MW	48,000 (77,000)
ERCOT	Single state	23 million	84,000 MW	40,500 (65,000)
CA-ISO	Single state	30 million	59,000 MW	25,900 (41,000)
NYISO	Single state	19.5 million	37,925 MW	11,005 (18,000)





# NSF PROJECT: Decision Making within RTOs

## *Review of documents and observation of meetings*

### Stakeholder Meetings

Stakeholder meetings provide Members with the opportunity for communication and interaction. The purpose of stakeholder meetings is to foster collaboration, not legislation. The two types of meetings are [stakeholder groups](#) and [symposiums and forums](#).



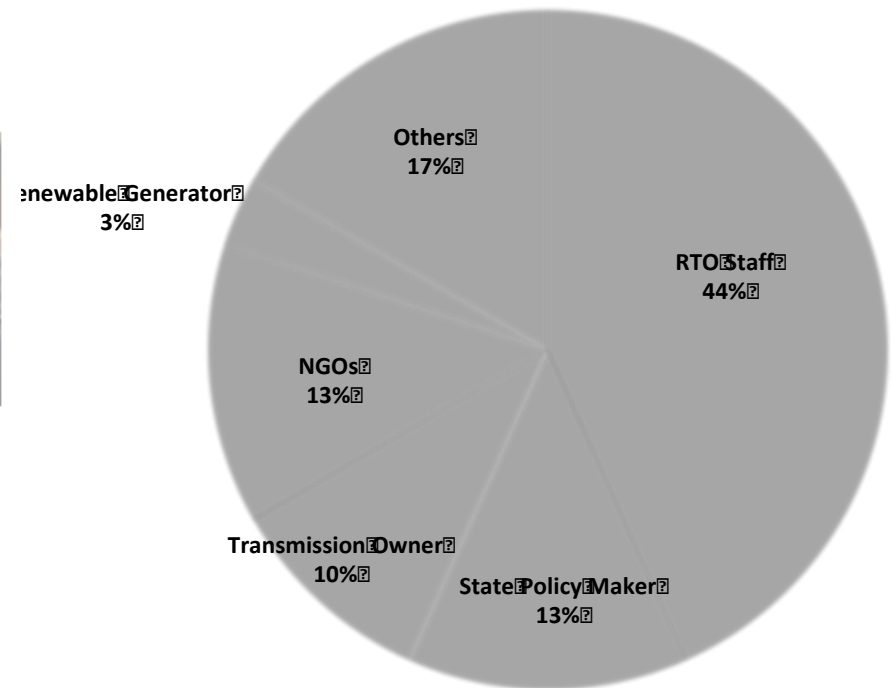
#### Stakeholder Groups

- [eData/eDataFeed Stakeholder Group](#)
- [PJM Online Tools Refresh](#)
- [General Session](#)
- [Inter-Regional Planning Stakeholder Advisory Committee - MISO](#)

#### Symposiums and Forums



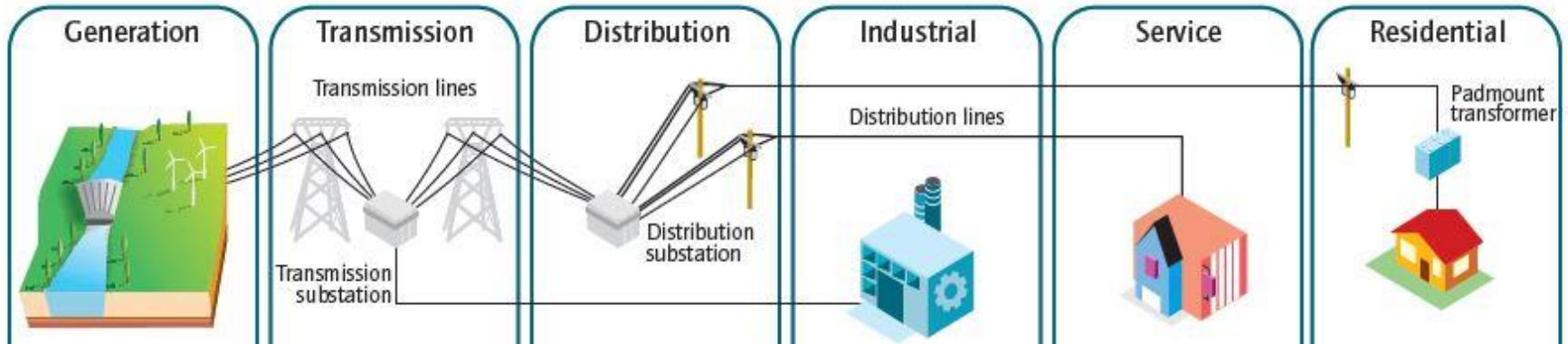
## *Semi-structured interviews with stakeholders*



*48 interviews in PJM/MISO /CAISO to date*

# Key Actors in RTO Decision Making

Electric System



Stakeholders

RTO/ISO

Generation Utilities

Distribution Utilities

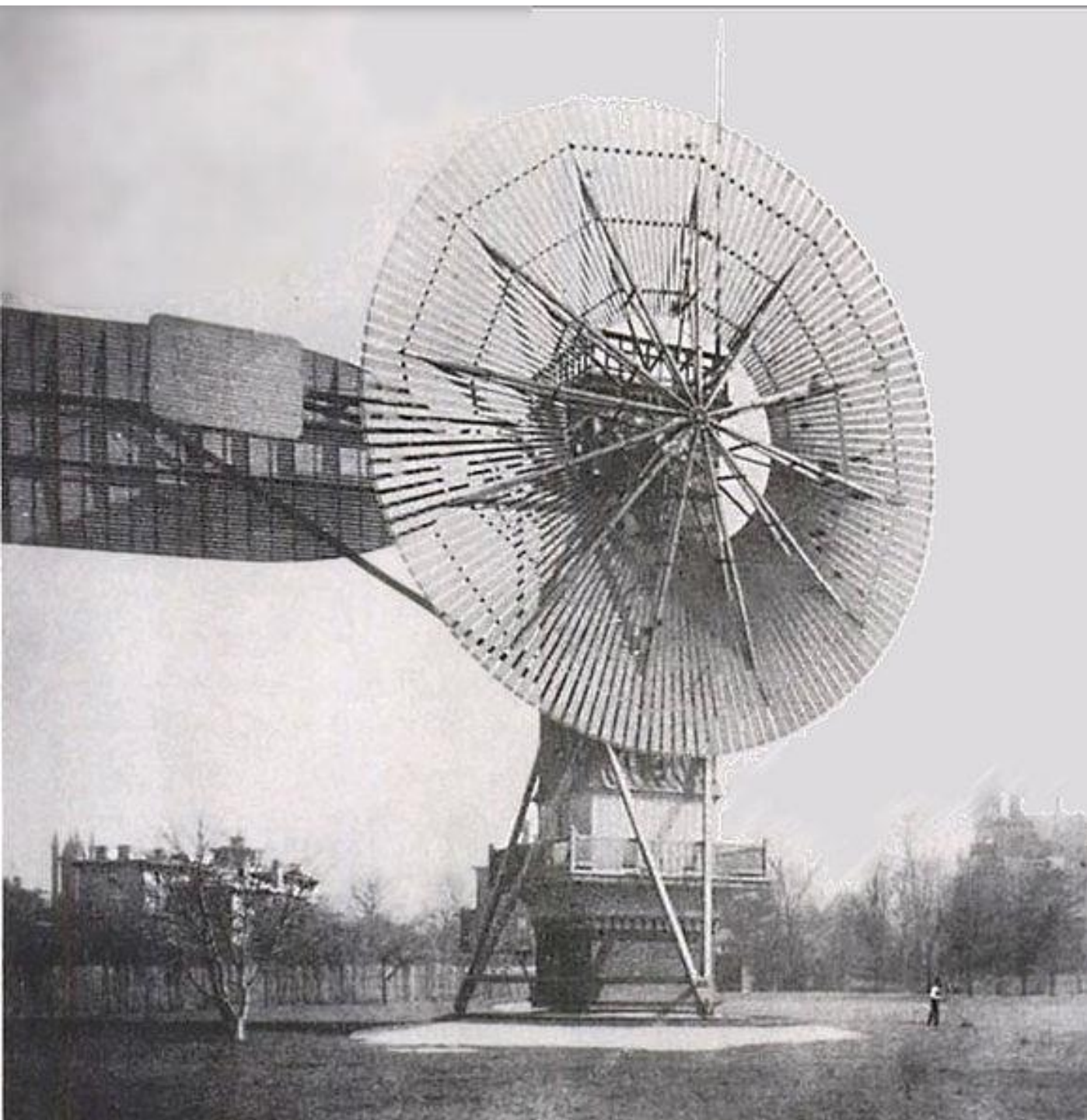
State- PUC, Energy Office (Policies & Planning), Environmental Office (Siting)

Industrial, Commercial & Residential Consumers

FERC

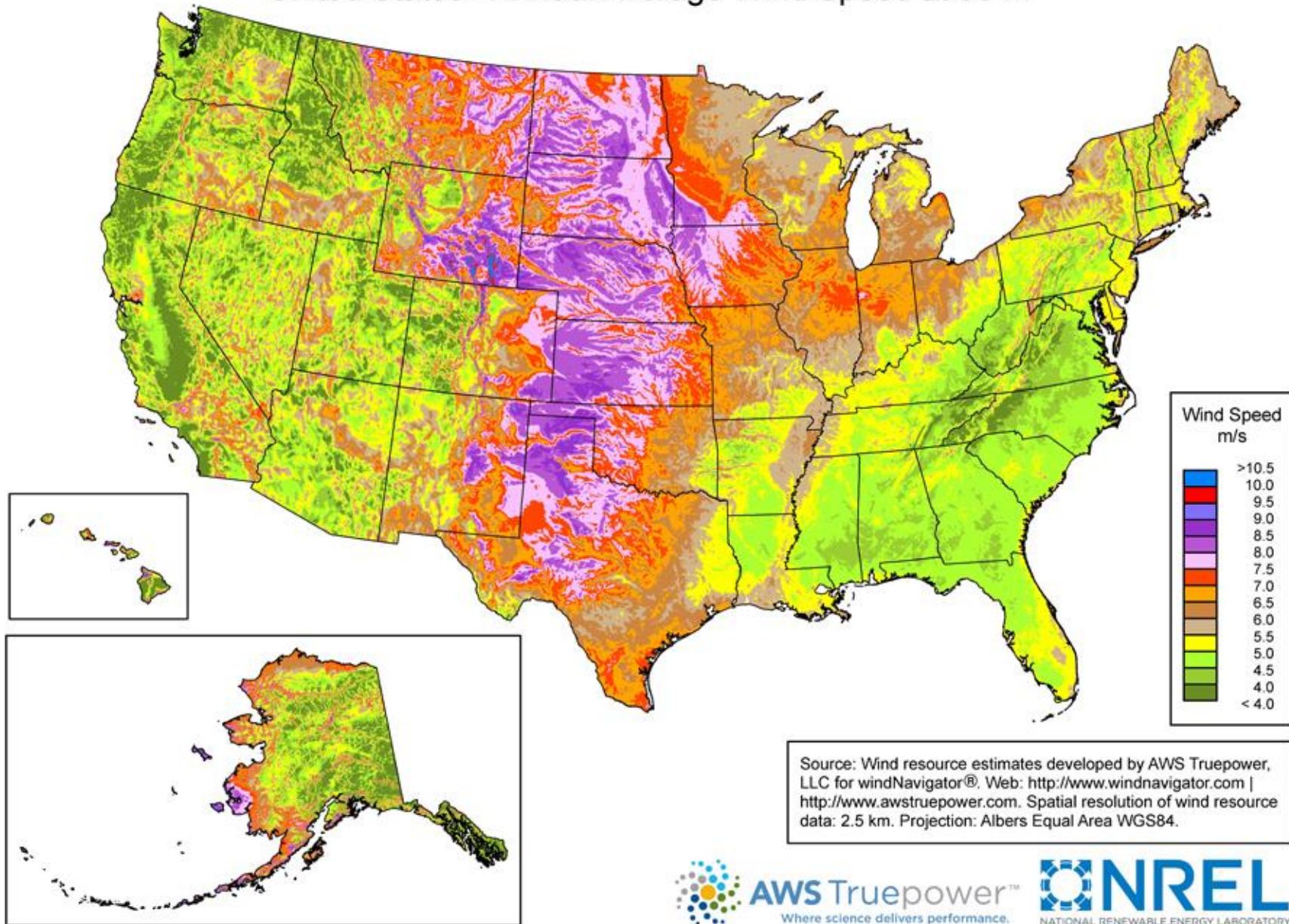
Federal and State Courts

Civil Society Stakeholders

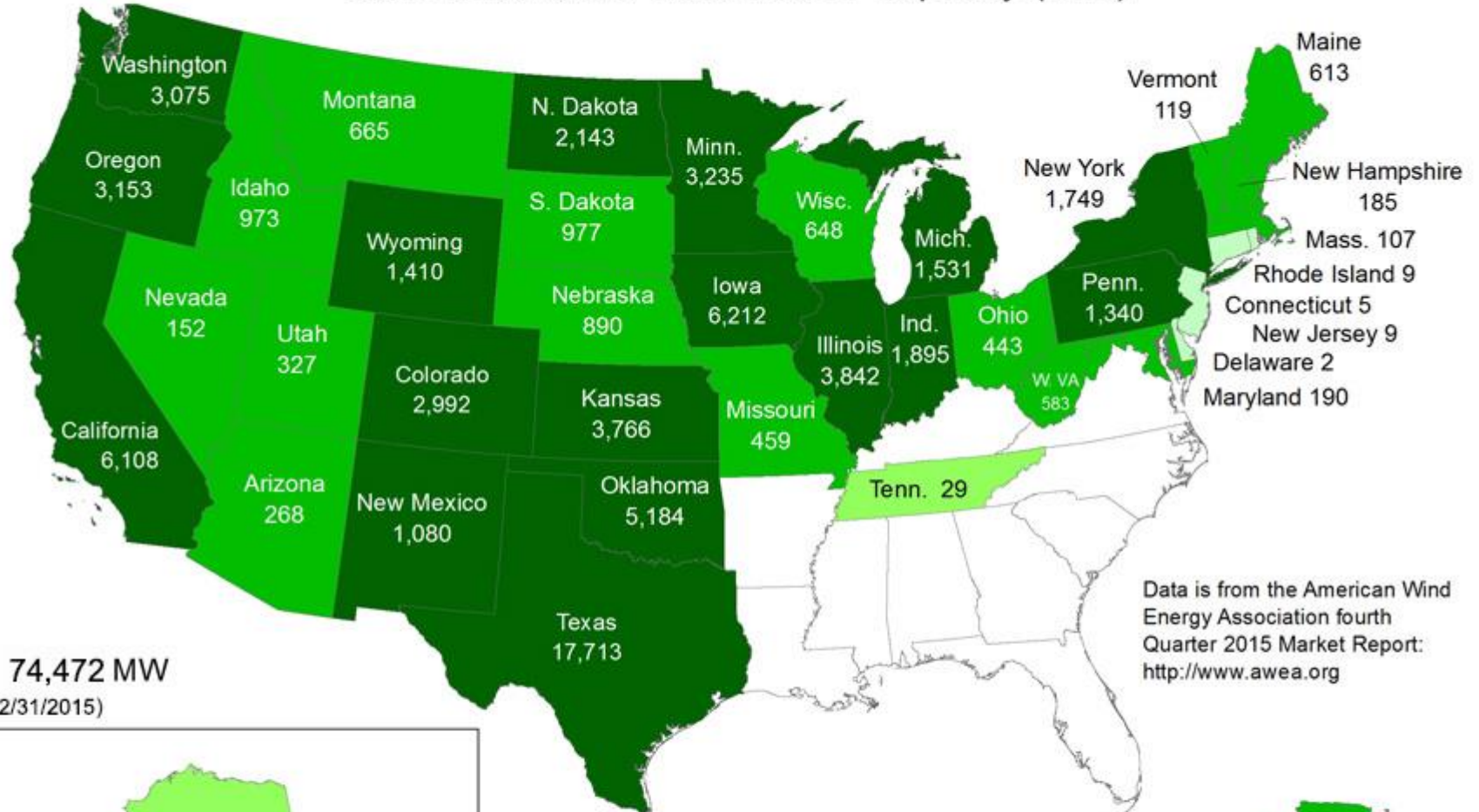




## United States - Annual Average Wind Speed at 80 m



# Current Installed Wind Power Capacity (MW)

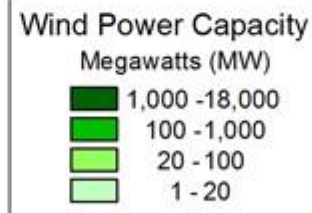


**Total: 74,472 MW**  
(As of 12/31/2015)

Data is from the American Wind Energy Association fourth Quarter 2015 Market Report:  
<http://www.awea.org>



**Puerto Rico - 125**



U.S. Department of Energy



02-FEB-2016 1.1.38





“We have the gift of lots of wind, but it doesn’t seem the transmission lines are in the right place. [...]

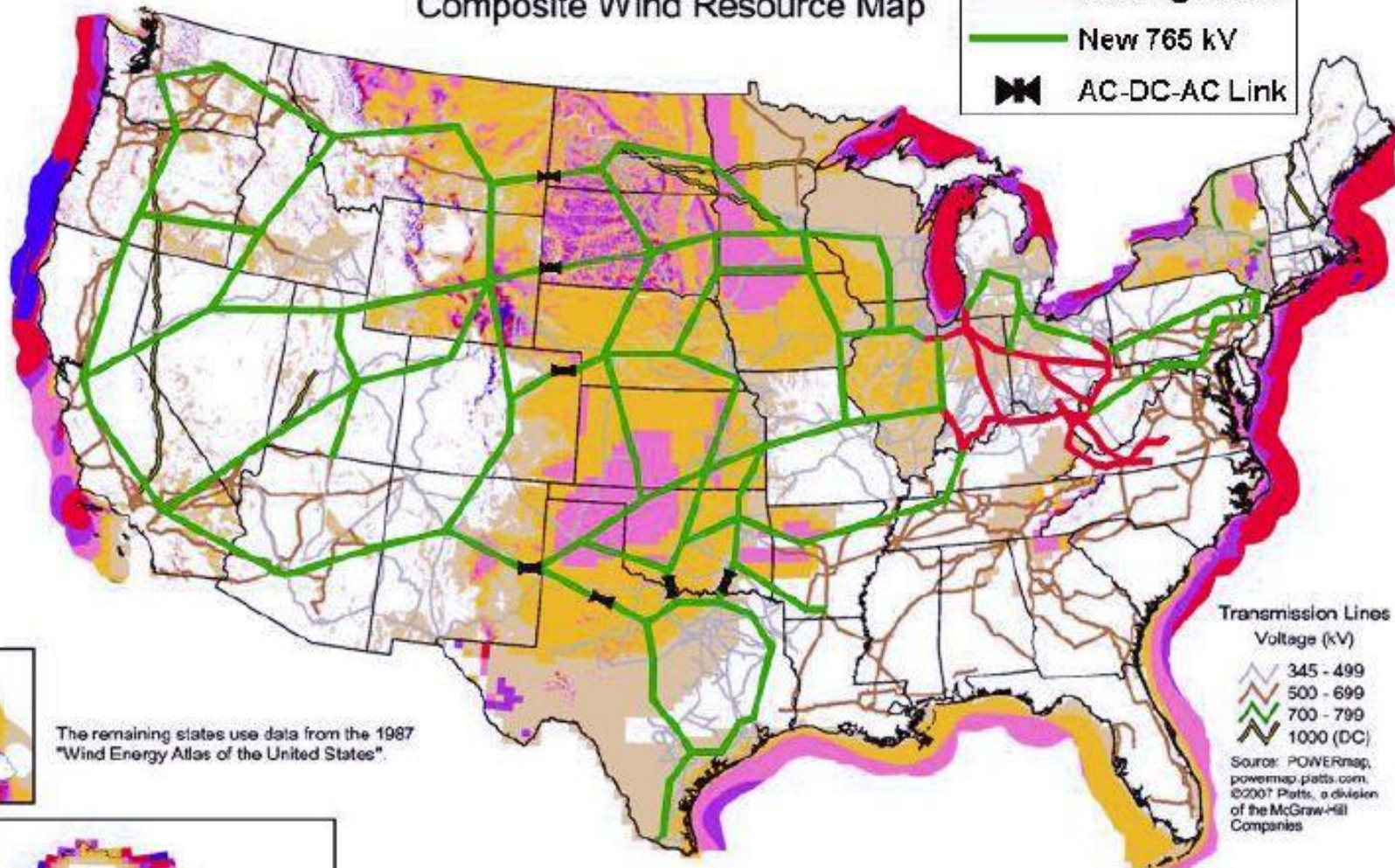
‘How do you get the wind from here to there without it being too expensive for the wrong people?’ “

--*MISO Stakeholder*

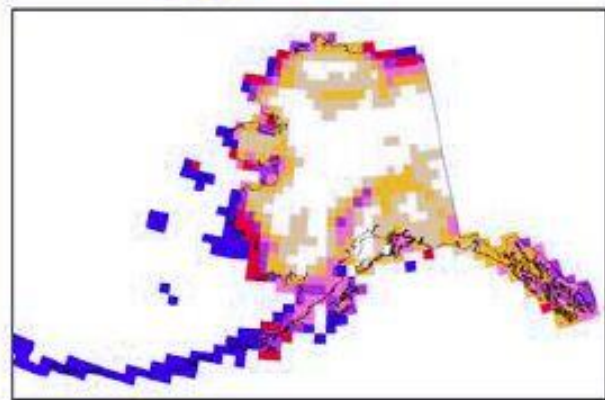


# Composite Wind Resource Map

- Existing 765 kV
- New 765 kV
- ⌘ AC-DC-AC Link



The remaining states use data from the 1987 "Wind Energy Atlas of the United States".



## Transmission Lines Voltage (kV)

- 345 - 499
- 500 - 699
- 700 - 799
- 1000 (DC)

Source: POWERmap,  
powermap.platts.com,  
©2007 Platts, a division  
of the McGraw-Hill  
Companies

## Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m $W/m^2$	Wind Speed <sup>a</sup> at 50 m m/s	Wind Speed <sup>a</sup> at 50 m mph
2	Marginal	200 - 300	5.6 - 6.4	12.5 - 14.3
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	800 - 1600	8.8 - 11.1	19.7 - 24.8

<sup>a</sup> Wind speeds are based on a Weibull k value of 2.0

U.S. Department of Energy  
National Renewable Energy Laboratory



“We could sit down with crayons and write on a map a few lines that would make all kinds of sense to make stuff move around. Then we would take 20 years to figure out who pays for it.”

*--CAISO Stakeholder*

# Powerline

The First Battle of America's Energy War

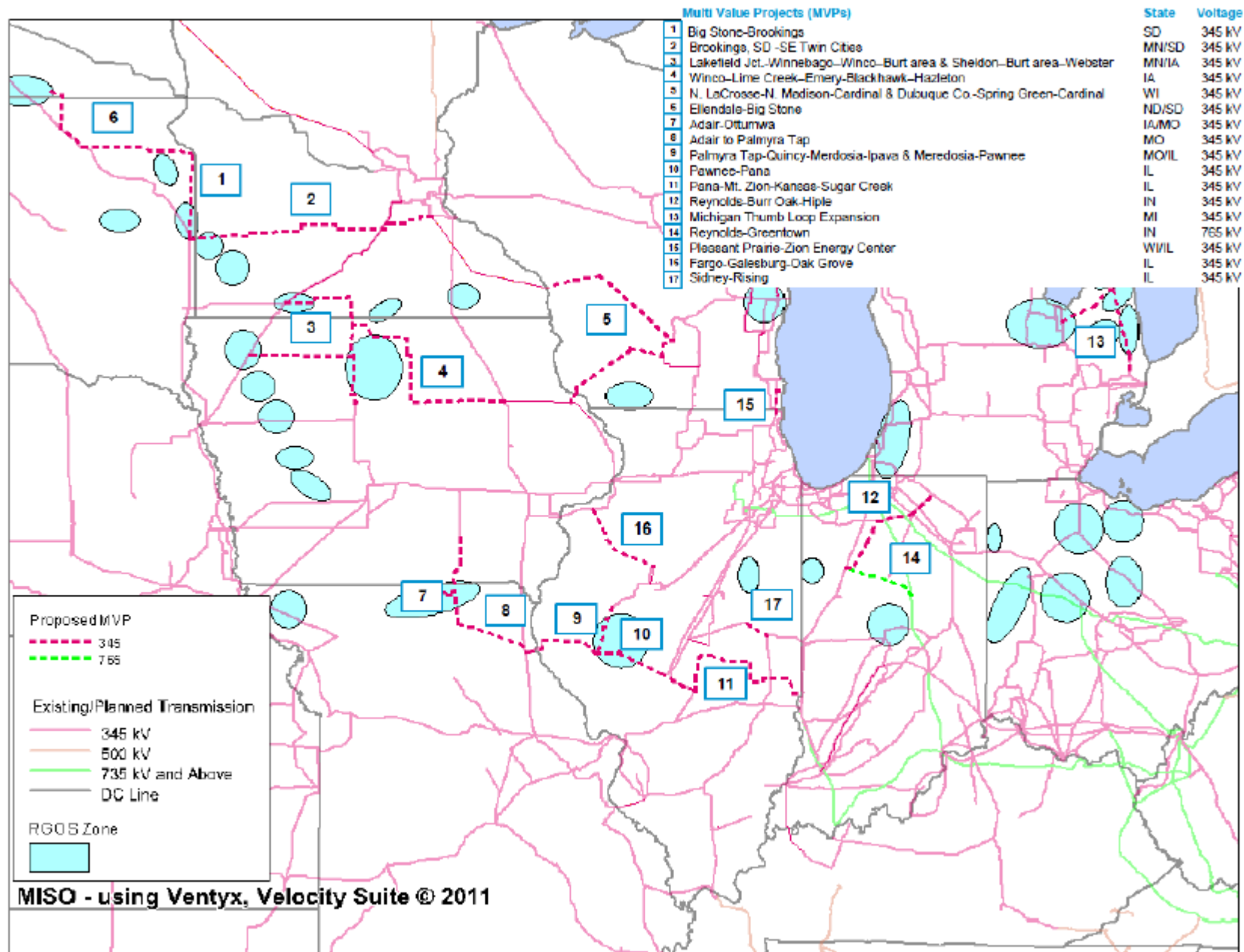
PAUL WELLSTONE and BARRY M. CASPER

Foreword by Tom Harkin





# MVP Portfolio

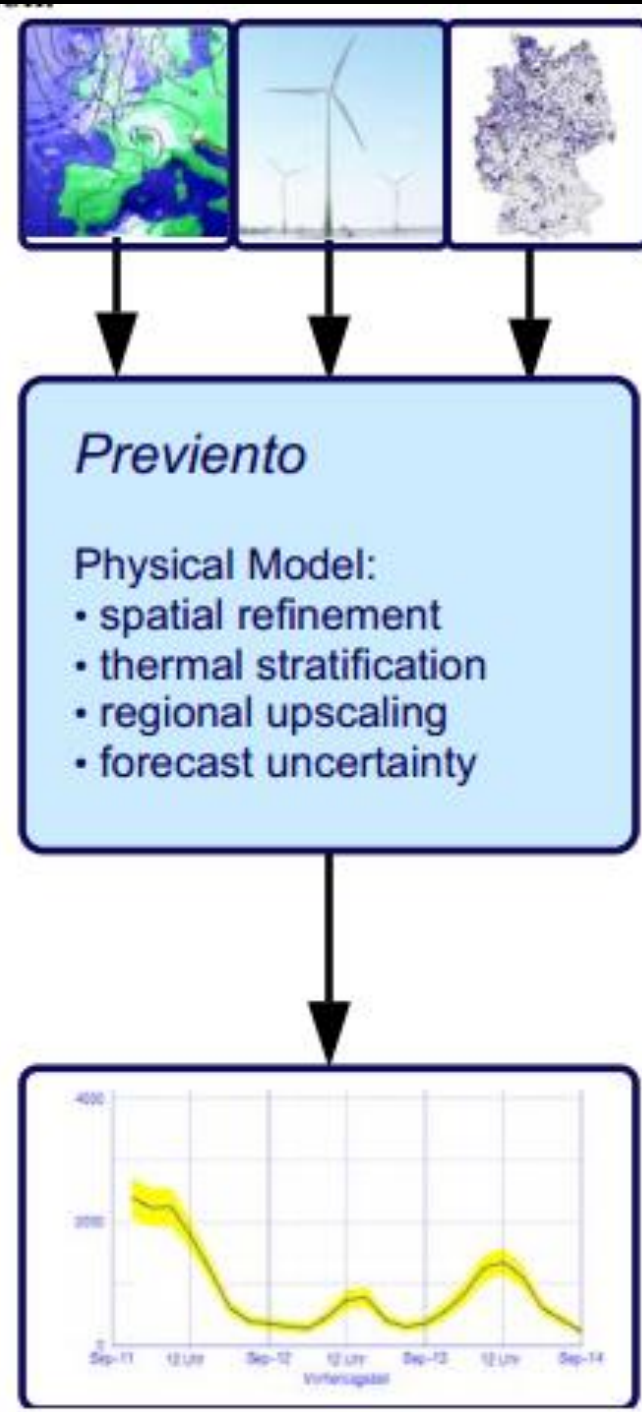


**Cost Allocation**

**=**

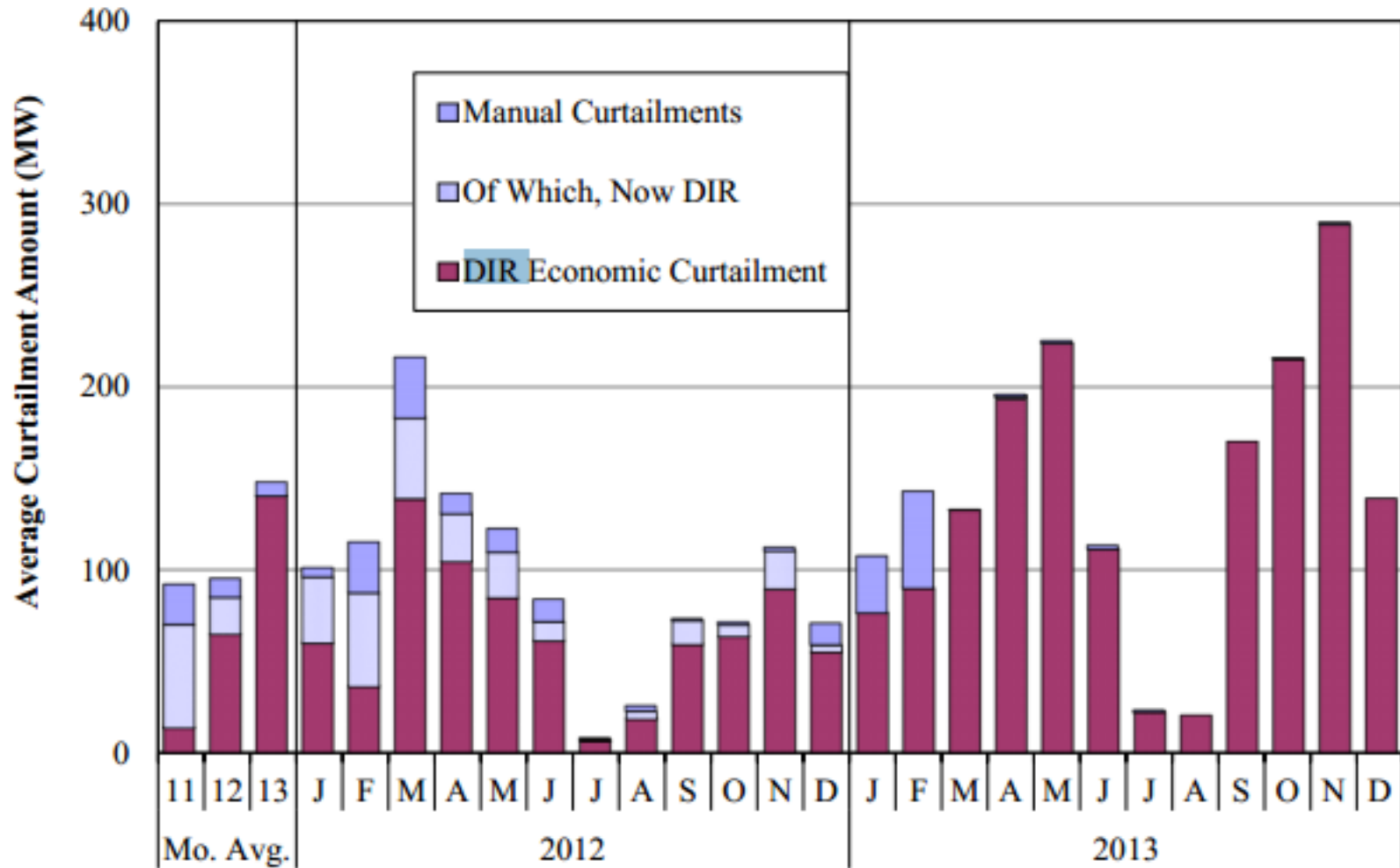
**Blood Sport**

# Regional Transmission Orga





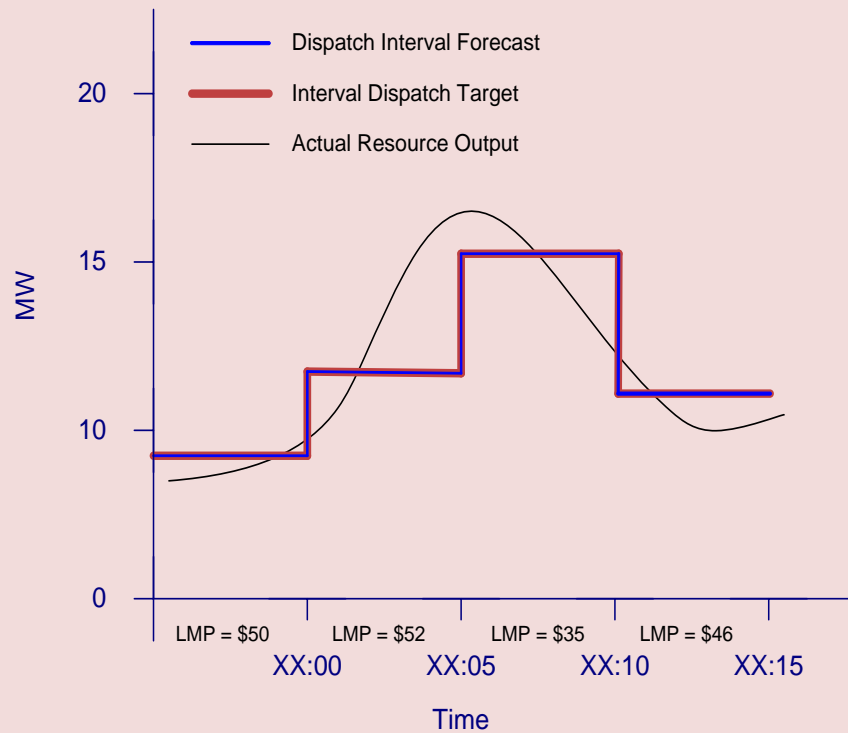
**Figure A53: Wind Curtailments**  
2012–2013



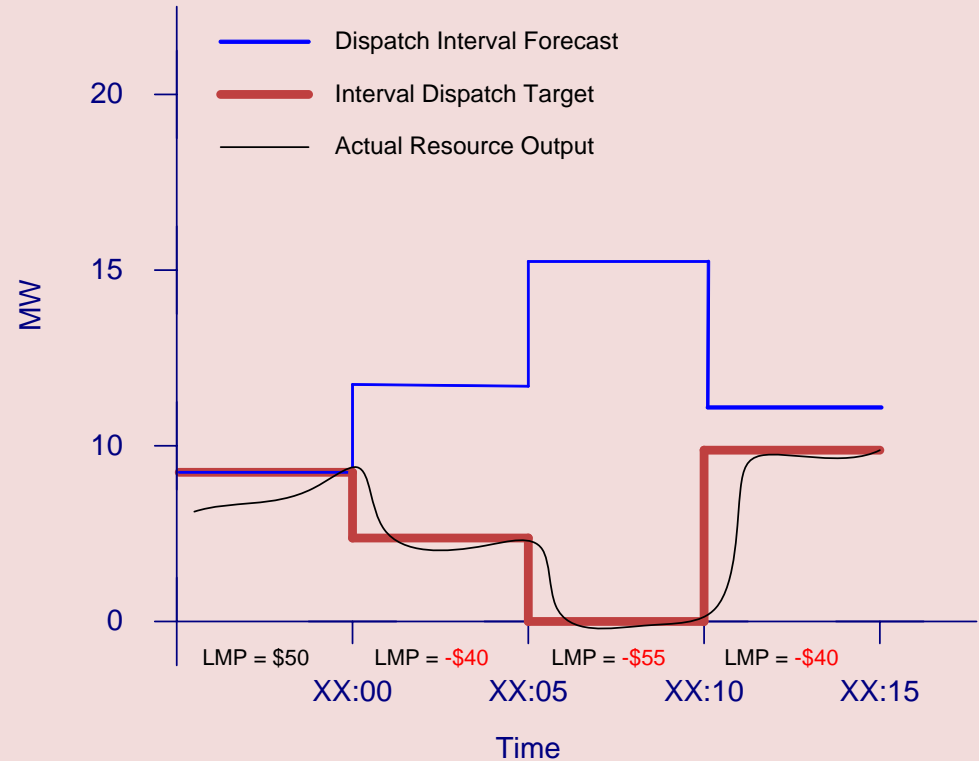
*Figure A54: Wind Generation Volatility*



# Dispatchable Intermittent Resources (DIR)



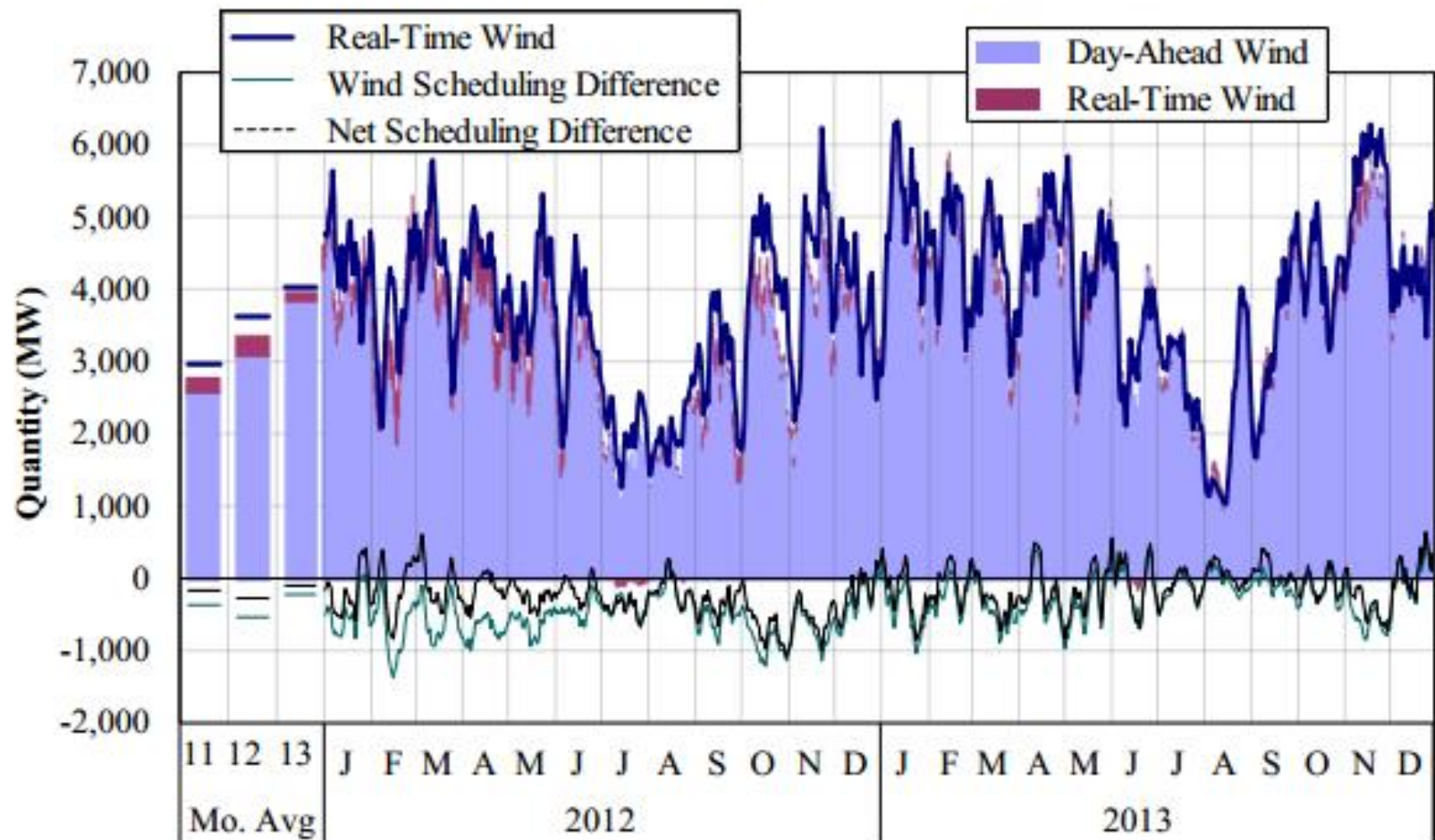
Unconstrained



Nearby Congestion

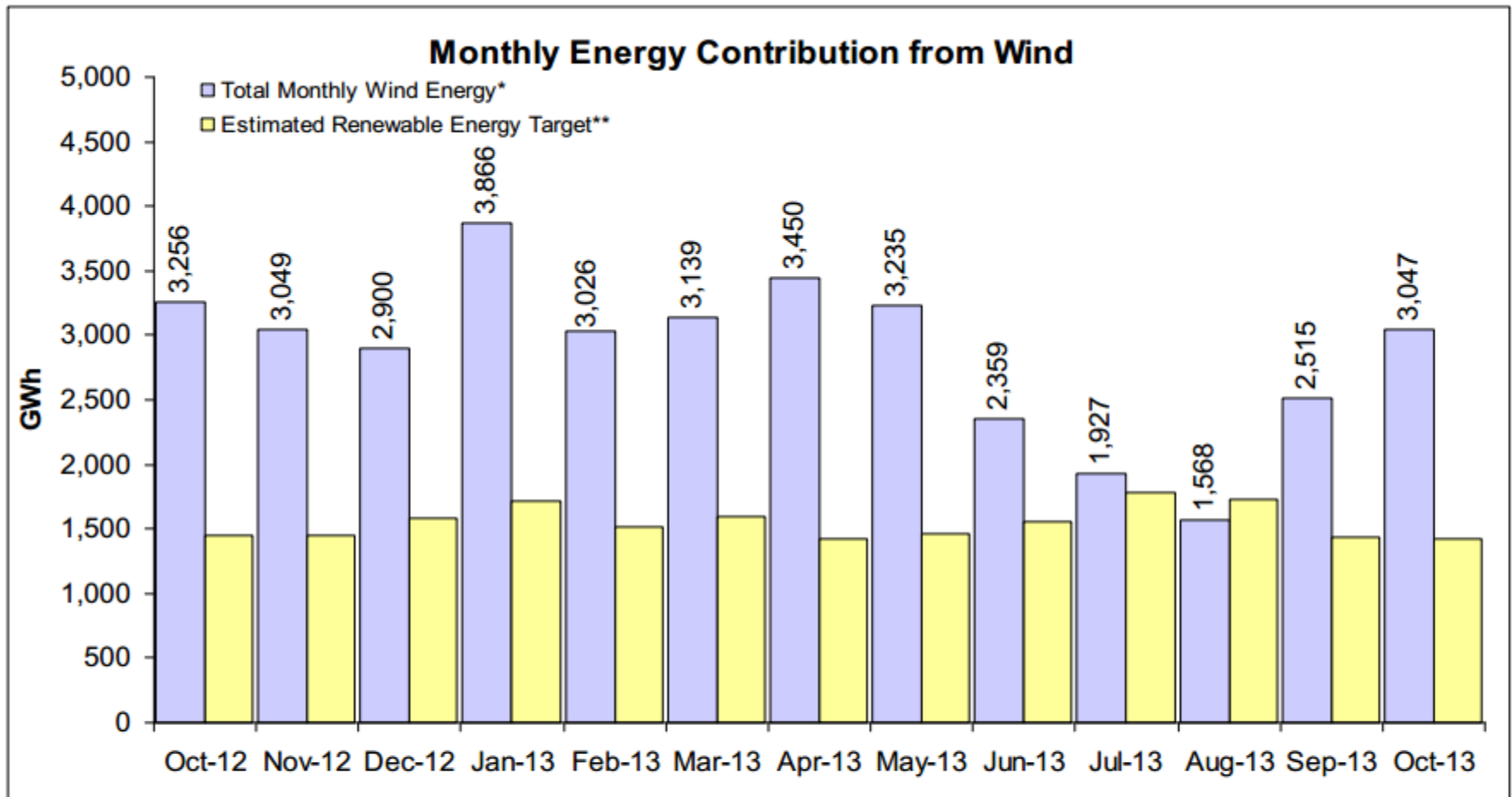


**Figure A51: Day-Ahead Scheduling Versus Real-Time Wind Generation  
2012–2013**



*Figure A52: Seasonal Wind Generation Capacity Factors by Load Hour Percentile*

# 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.



*"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



**Rules Matter**

*(A lot)*

# Smart Grid (R)Evolution

Electric Power Struggles

JENNIE C. STEPHENS  
ELIZABETH J. WILSON  
TARLA RAI PETERSON

AMERICAN  
CASEBOOK  
SERIES

## ENERGY LAW AND POLICY



Lincoln L. Davies, Alexandra B. Klass,  
Hari M. Osofsky, Joseph P. Tomain,  
& Elizabeth J. Wilson

# Decision-Making in Regional Transmission Organizations

Co-conspirators: Natalie Nelson Marsh, David Solan, Stephanie Lenhart (Boise State)

Seth Blumsack and Nicholas Johnson (Penn State), Benjamin Stafford (UMN)

Acknowledgement: NSF #SES-1261867

[illegible]



# Stakeholder Classes

## **PJM (5)**

- Transmission Owners
- Generation Owners
- Electricity Distributors
- End Use Sectors
- Others

## **CAISO (6)**

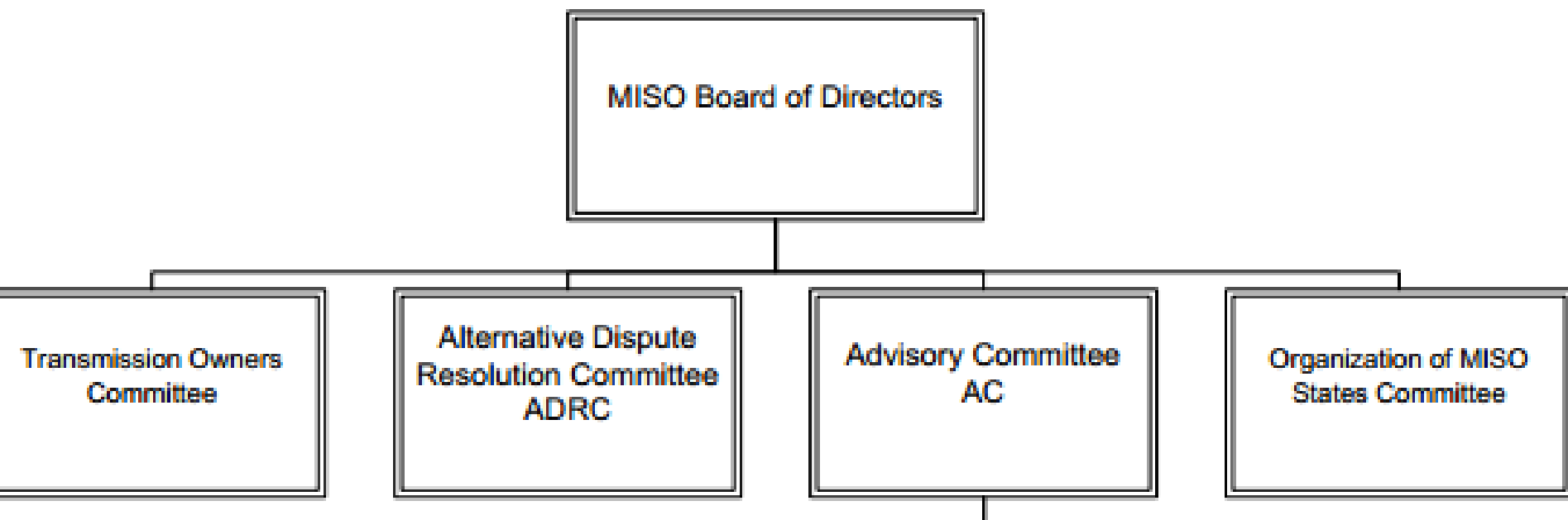
- Transmission Owners
- Generation Owners
- Transmission Dependent Utilities
- End Users & Retail Energy Providers
- Alternative Energy Providers
- Public Interest Groups
- Marketers

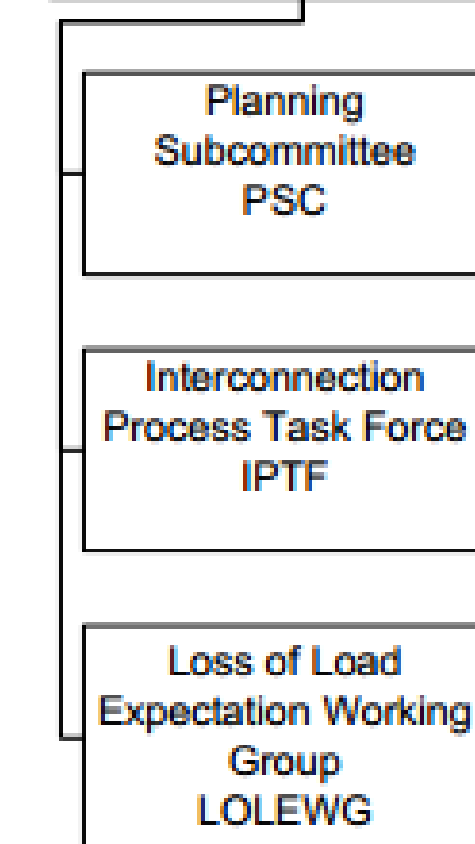
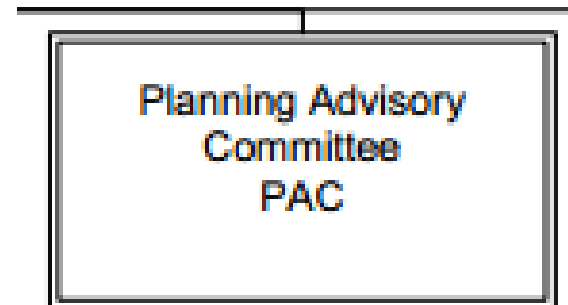
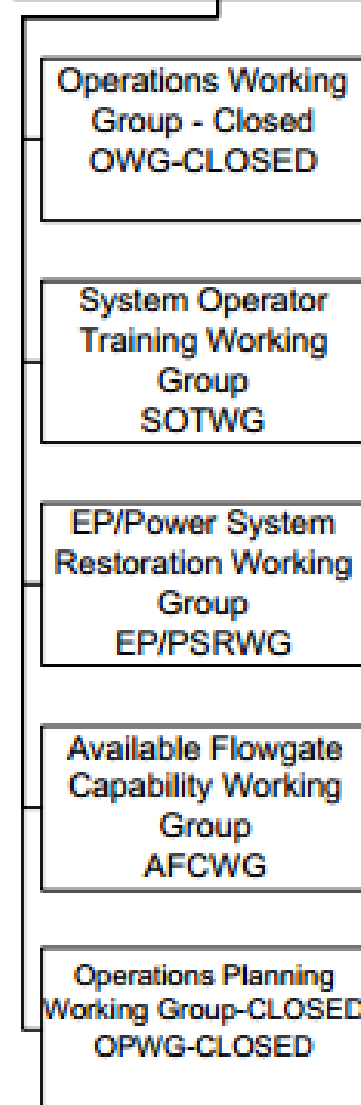
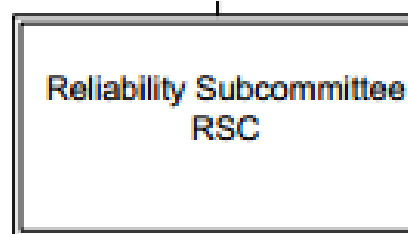
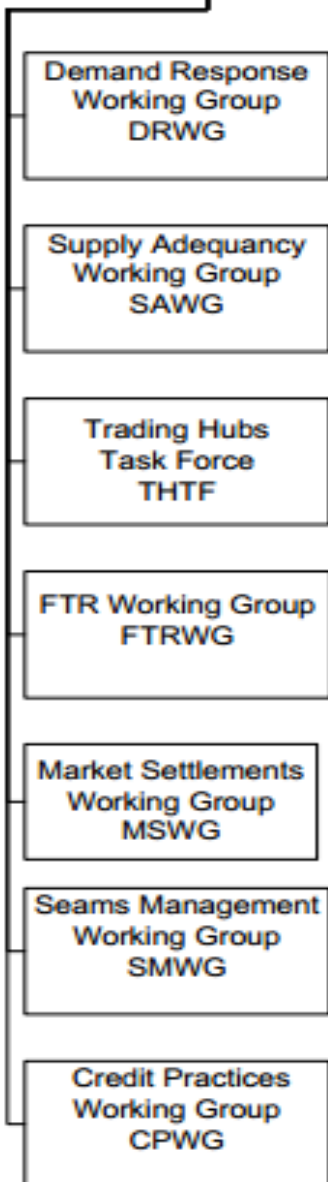
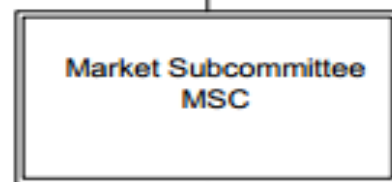
## **MISO (10)**

- Transmission Owners
- Generation Owners/Independent Power Producers
- Power Marketers
- Transmission Dependent Utilities (munis/co-ops)
- Eligible End Use Customers
- Coordinating Members
- Transmission Developers
- State Regulators (OMS)\*
- Consumer Advocates\*
- Environmental/Other\*

\* Non Paying







ROBERT'S  
RULES OF ORDER



FOLLOW  
THE  
RULES

What is a Successful Stakeholder Process?

“Well, I feel that this has  
been very successful.  
Everyone is equally dissatisfied.”

*--MISO*



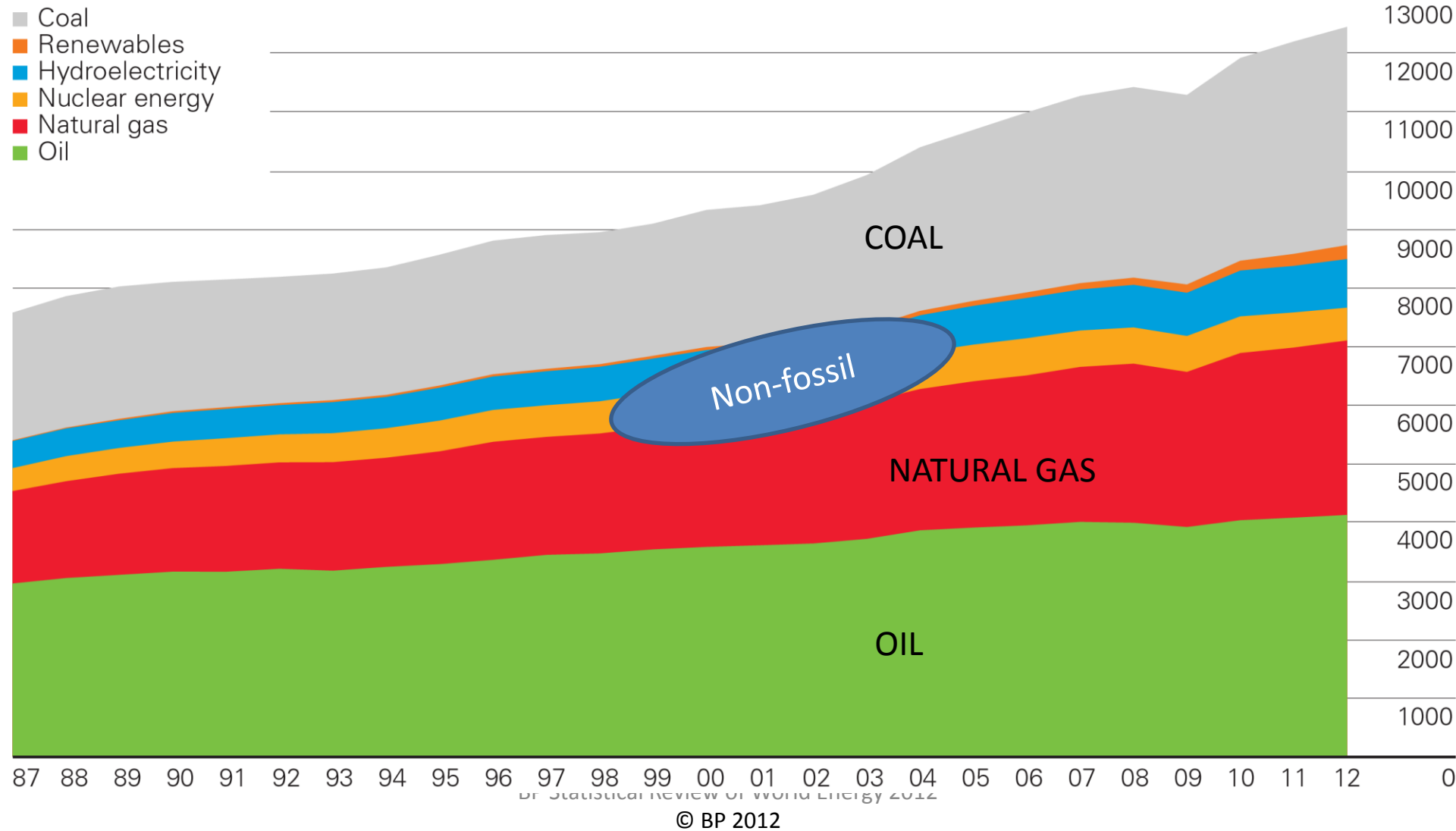
Need for Interdisciplinary Study:

[T]his is a team sport. It's a complicated world.

--MISO stakeholder

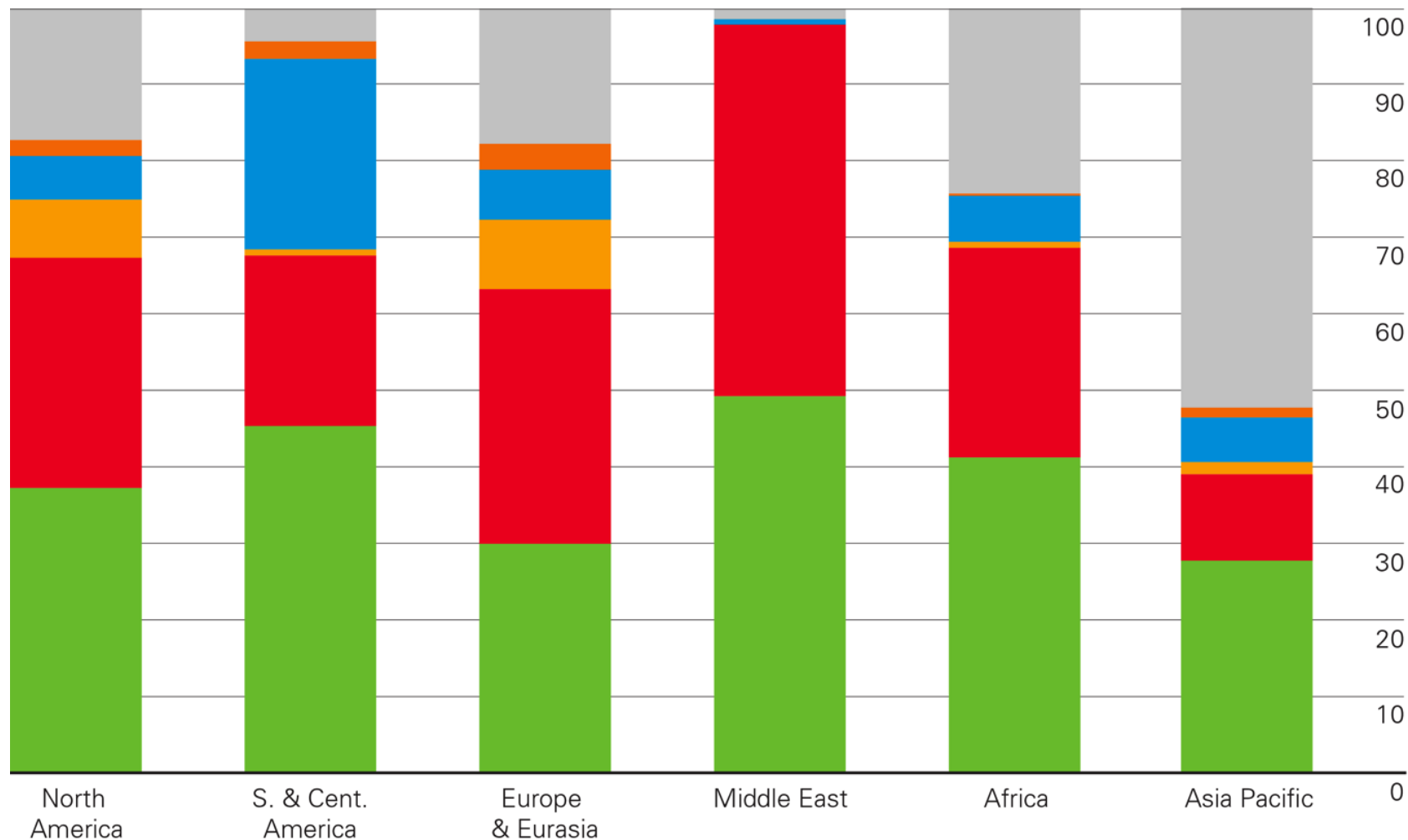
# Primary energy world consumption

## Million tonnes oil equivalent



# Primary energy regional consumption pattern 2012

## Percentage



**Table - Focus Groups Conducted in Seven States**

Stakeholder and State	RTO	Regulatory	IOU	Co-op/Muni	Tech/Acad.	Environ-mental	Consumer
MA	Holyoke	Boston	Worcester	Shrewsbury	Worcester	Boston	Boston
VT	Holyoke, MA	Montpelier	Rutland	Johnson	Burlington	San Francisco	Montpelier
NY	New York	White Plains	Liverpool	Uniondale	Albany	New York	New York
MN	St. Paul	St. Paul	Minneapolis	Maple Grove	Minneapolis	Minneapolis	St. Paul
IL	St. Paul, MN	Springfield	Oakbrook Terrace	Champaign	Urbana	Chicago	Chicago
TX	Taylor	Austin	Austin	College Station	College Station	Austin	Austin
CA	Folsom	San Francisco	San Francisco	Sacramento	Sacramento	San Francisco	San Francisco

Blue = focus groups conducted after Superstorm Sandy. Light green = focus groups conducted before Sandy.

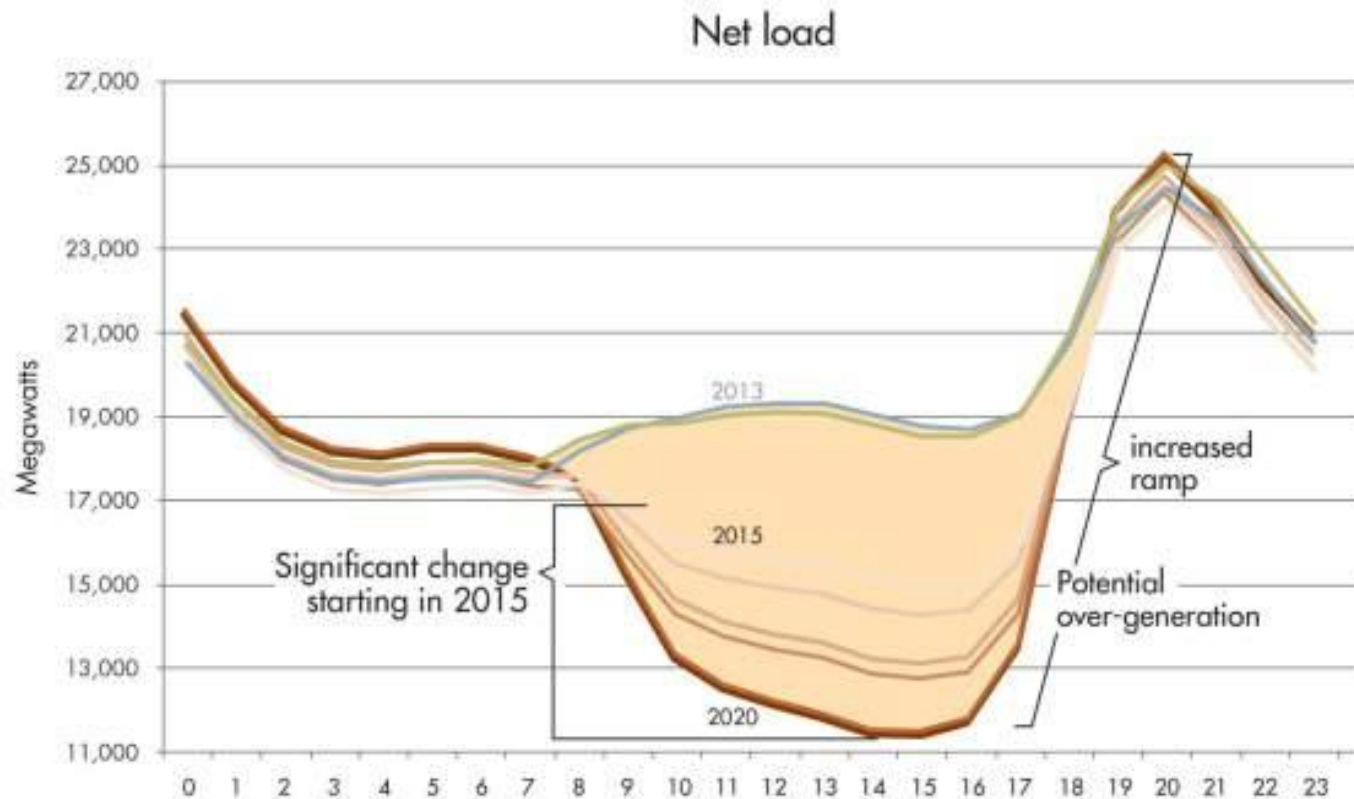


Independent System Operator	Regional Transmission Organizations
"...an organization formed at the direction or recommendation of the [FERC]..."	"...designated by the [FERC] to direct operation of the regional electric transmission grid in its area..."
"...a neutral party responsible for the management and control of the electric transmission grid in a state or region..."	"...coordinates, controls and monitors an electricity transmission grid that is larger with much higher voltages than the typical power company's distribution grid..."
"...operates an electric-transmission system that it does not own..."	"...coordinates power generation and transmission within an integrated regional market..."
"...an independent, Federally regulated entity..."	"...an independent governing body..."
"...ensure[s] the safety and reliability of the electric system..."	"...[responsible] for electric transmission grid operations, short-term electric reliability and transmission services within a multi-state region..."
"...for the purpose of providing open access to retail and wholesale markets for supply..."	"...serve as the independent operator of the regional electric market..."

Various definitions from web-based glossaries

# The FAMOUS CA ISO Duck Diagram

Growing need for flexibility starting 2015



# Texas “Wind Incident”

## February 26, 2008

- 2000 MW to 300 MW in 3 hours
- Multiple providers below scheduled production
- Load increasing
- Power frequency declines to 59.19 Hz
- Solved by a combination of demand response and diesel generators and purchasing 30 MW of power from Mexico