Stitching seams with different threads: US versus EU electricity markets

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Outline

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  - Salient characteristics of US ISO/RTO markets,
- Resistance is useless:
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- Seams between RTOs.
- High level view of EU electricity markets:
  - US versus EU seams management.
  - Implications for renewables in EU.

High level view of US electricity markets.

- Majority of US electric energy now served in “organized” markets.
- Operated by Independent System Operators/Regional Transmission Organizations (ISOs/RTOs).
- Bilateral trade between utilities/regions in “old” world supplemented through additional centralized trading options:
  - Bilateral trade options include across seams between ISO/RTO markets.

Salient characteristics of ISO/RTO markets.

- Centralized *day-ahead* (DA) market operated by ISO/RTO with unit commitment and locational pricing:
  - Day-ahead market is ostensibly a *forward* market, not a spot market,
  - But "make-whole" payments to compensate for some commitment costs (and other issues) mix in some "physical delivery" aspects.
- DA market considers both energy and ancillary services.

Salient characteristics of ISO/RTO markets.

- Centralized *real-time* (RT) market operating by ISO with locational pricing:
  - The "spot" market, settled on deviations from day-ahead positions,
  - Explicitly designed to match, where possible, design of day-ahead market,
  - Generators can participate in both day-ahead and real-time, but real-time involves physical dispatch,
  - Arbitrage facilitated between day-ahead and real-time to further match DA and RT,
  - Short-term unit commitment in some markets.

Salient characteristics of ISO/RTO markets.

- Additional “reliability” practices of ISO/RTO such as emergency protocols under scarcity,
- Financial transmission rights auction operated by ISO/RTO,
- Capacity markets operated by some ISOs/RTOs that arrange for capacity to be available in three years’ time:
  - Capacity not differentiated between energy and reserves/ancillary services.

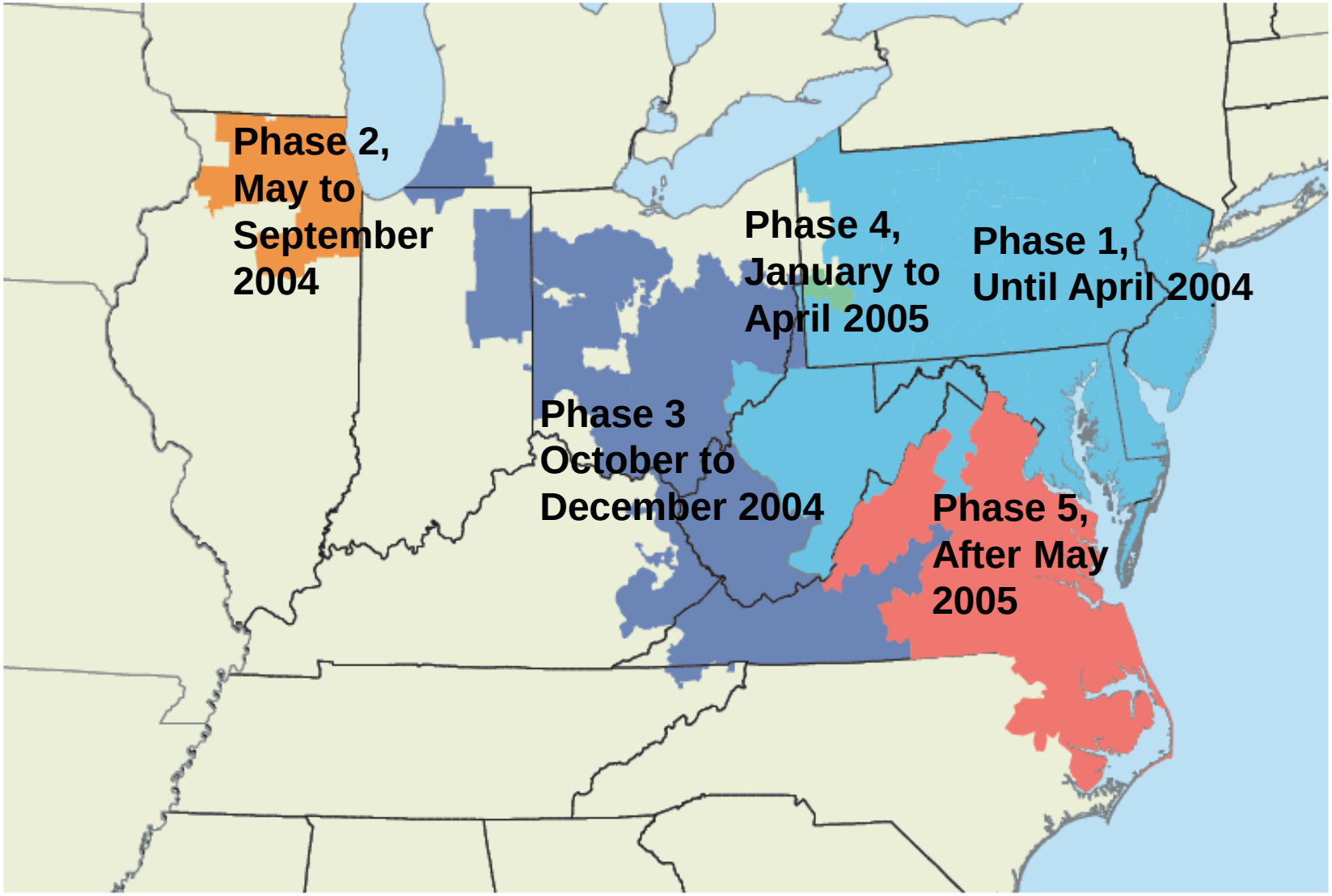
Salient characteristics of ISO/RTO markets.

- Traditional bilateral contracting between market participants.
- Exchanges that facilitate longer-term contracting:
  - Chicago Board of Trade,
  - Intercontinental Exchange.

Resistance is useless

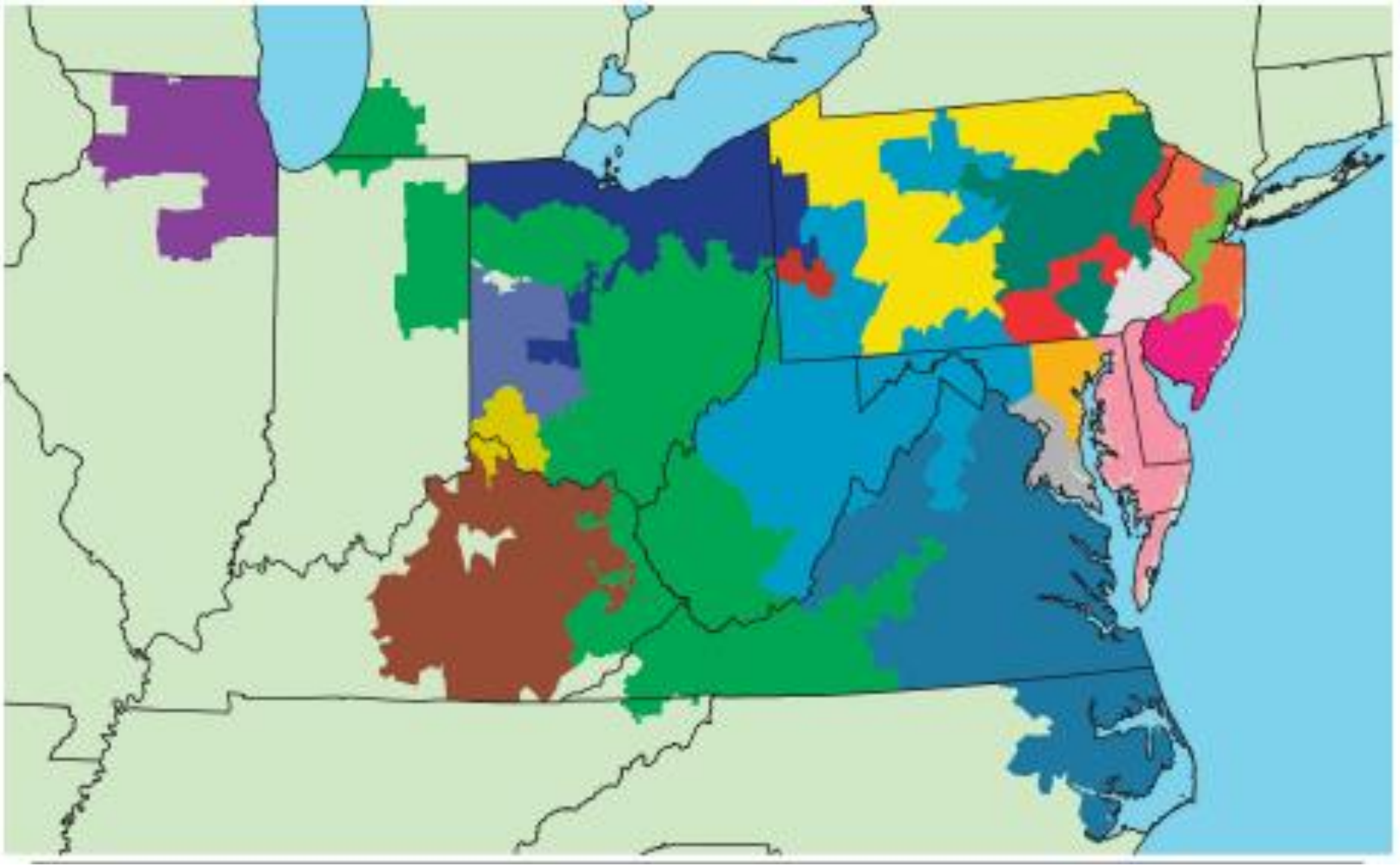
- Remainder of US, particularly in West outside of California, served by more traditional vertically-integrated models:
  - But organized markets grown geographically over years.
- "Seams" between inside organized market and outside organized market has typically been "stitched" through growth of organized market.

Growth of PJM



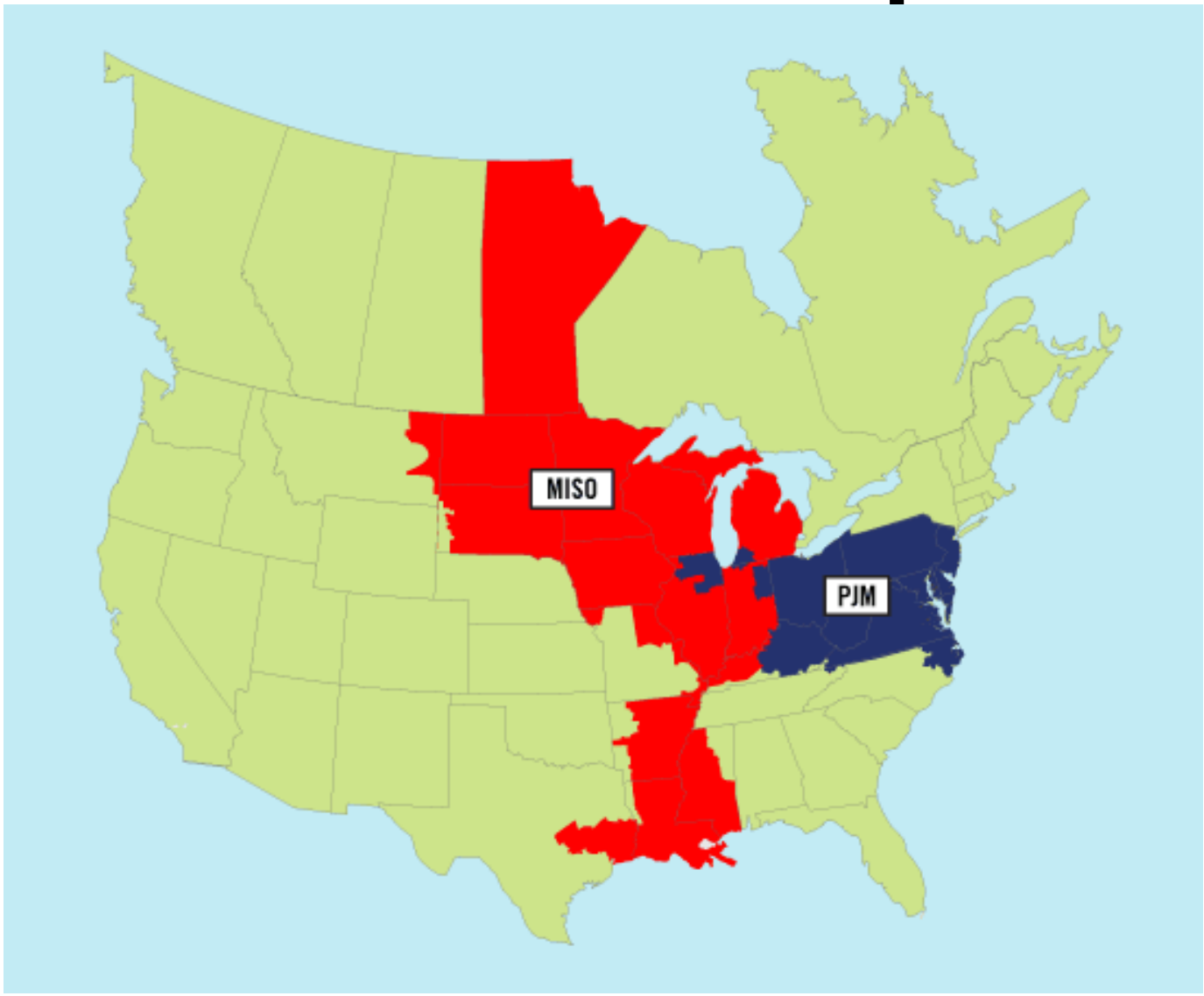
Source: PJM 2006 State of the Market Report, pages 344-345.

PJM today



Source: 2016 State of the Market Report for PJM, figure 1.

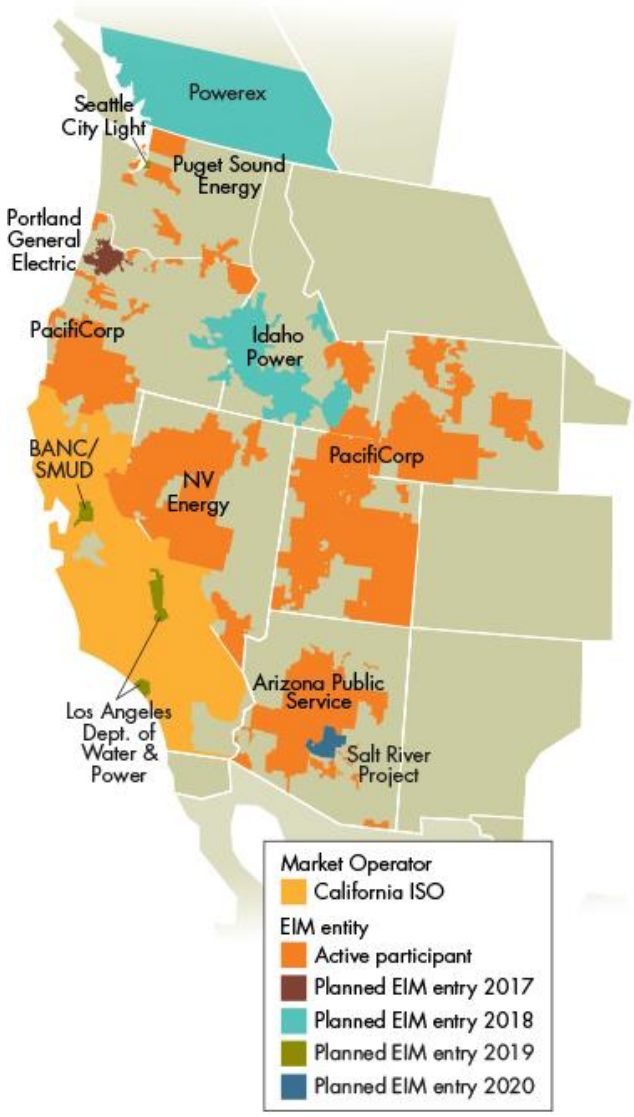
PJM and MISO footprints.



Source: www.miso-pjm.com

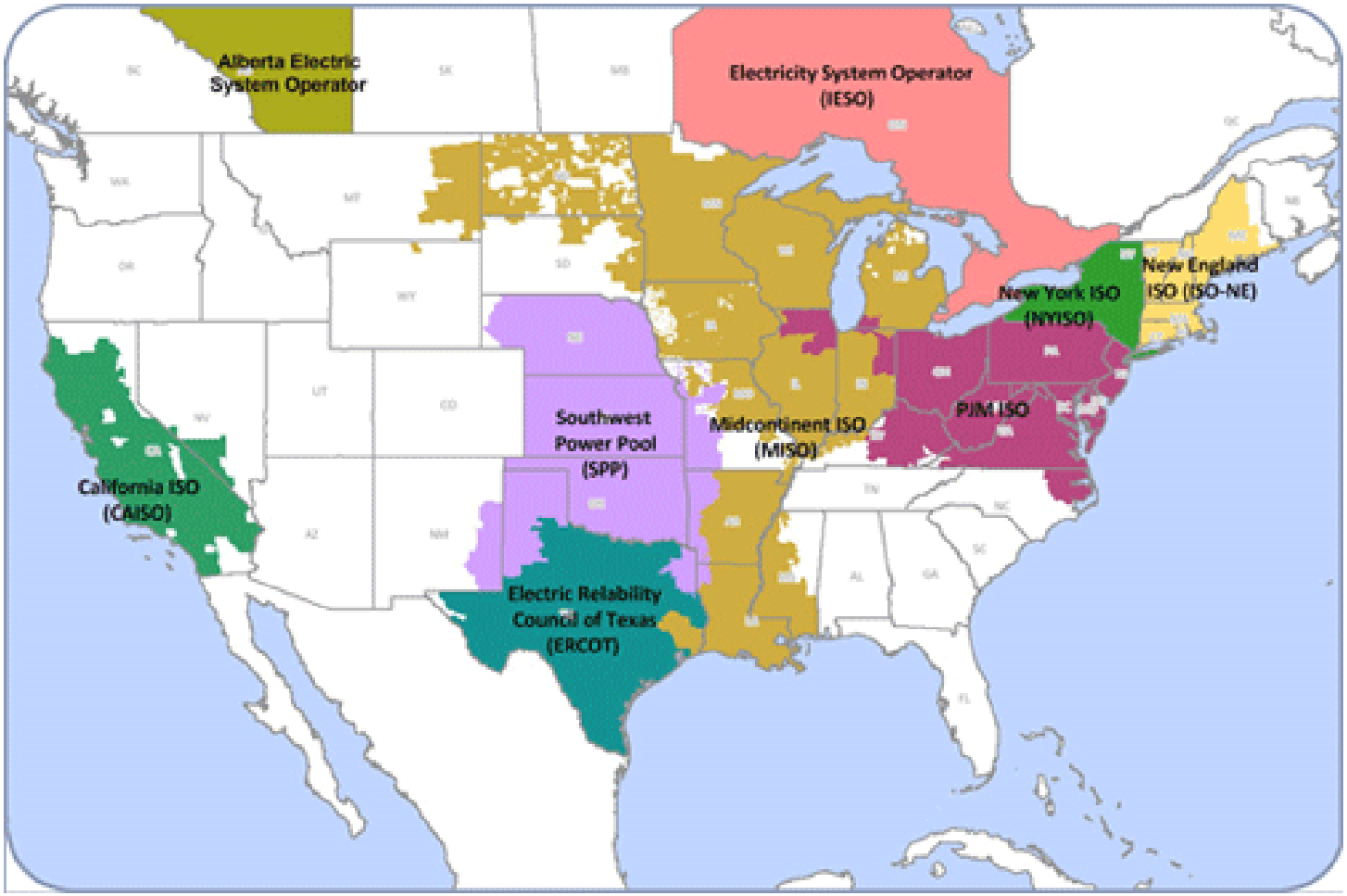
Growth of Western Energy Imbalance Market

- California ISO has operated DA and RT nodal markets in California since 2009:
  - Also supported bilateral (hourly and longer term) trading with entities in other states.
- Expanded geographical scope of RT market in 2014 with Energy Imbalance Market.



Source: https://www.westerneim.com

ISOs/RTOs today.



Source: www.ferc.gov

Implications for renewables in US.

- “Organic” growth of ISO/RTO markets has resulted in large areas operating under uniform real-time pricing rules.
- Wide geographical scale of ISOs/RTOs allows for averaging of net load variability in a “single” large system.
- Widely rehearsed advantages of wide-scale balancing for renewable integration.

Implications for renewables in US.

- Temporal resolution of real-time market:
  - Update generator base-points every 5 minutes,
  - Some net load following capability for “free” due to action of real-time market,
  - Ancillary services primarily for intra-five minute variability and uncertainty.
- Wide-scale real-time markets have facilitated and will continue to facilitate integration of renewables in US markets.
- Over 15% by energy in ERCOT in 2016.

Seams.

- Possibility of further states joining organized markets.
- Participation in organized markets:
  - Entities outside of organized markets have always had options to trade with organized markets on hourly and longer timescales, but in addition,
  - Recent “Energy Imbalance Market” in California enables integration into California *real-time* market by entities outside of California, with further enhancements to come.

Seams between RTOs.

- Today have several large, adjacent RTOs:
  - Not going away, nor being supplanted,
  - Institutional barriers to further comprehensive integration of adjacent RTOs.
- What happens in seams between these existing RTOs?
  - Typical existing arrangements allow bilateral trades/schedules between markets,
  - Ongoing seams development to improve efficiency of trading in organized markets.

Seams between RTOs.

- Ongoing seams development has aimed at facilitating integration of inter-RTO trading into *real-time* market:
  - Focus on real-time is based on argument that efficient trading in all forward markets stems from efficient real-time trade.

High level view of *EU* electricity markets.

- Development of markets in several countries, with combination of day-ahead and intra-day trading:
  - Power exchange-based day-ahead and intra-day trading ignoring intra-zonal transmission constraints and separated from,
  - Balancing “market,” operated by transmission system operator to deal with “technical” issues.
- Not seen in US markets post-California crisis.

High level view of EU electricity markets.

- Finest temporal resolution of balancing market varies from 15 to 60 minutes:
  - Ancillary services typically required to cope with variation over longer duration between market adjustments than in US markets.
  - Balancing market not viewed as US-style “real-time” spot market,
  - Balancing market designs vary from country to country, but typically designed to encourage only limited trading.

High level view of EU electricity markets.

- What about seams between countries?
- As in US, bilateral trading possible.
- Several power exchanges span seams between countries for day-ahead and intra-day trading.
- Additionally, “Price coupling of regions” has recently added *day-ahead* (and eventually intra-day) pan-EU trading options through EUPHEMIA.

High level view of EU electricity markets.

- Why not real-time/balancing market seams management?
  - Obvious answer is lack of consistently designed balancing or real-time markets, reflecting historical development in each country.
- Institutional barriers to consolidating EU Transmission System Operators:
  - Analogous to situation with adjacent ISOs/RTOs in US.

US versus EU seams management.

- In both, bilateral contracting has always allowed trading across seams,
- US version of centralized seams management focuses on real-time,
- EU version of centralized seams management focuses on day-ahead and intra-day trading,
- Why the difference?
  - Are the needs of electricity markets in the US and EU really so different?

Implications for renewables in EU.

- Intra-day markets provides options in EU for trading that are absent in US:
  - Facilitates renewable integration.
- Wider-scale markets with later “gate closure” would facilitate renewable integration in EU.
- But the various balancing market designs makes wide-scale balancing difficult without significant redesign:
  - Inherent flexibility of transmission, hydro cannot be fully exploited for short time scale variations.

Conclusion

- The threads used to bind the seams in the US and EU are very different:
  - Organic growth of geographical scope of real-time market with seams managed in real-time, versus
  - Seams managed in day-ahead and intra-day.
- Renewable integration is facilitated by wide geographical scale, closer to real-time adjustment of thermal generation.
- Current EU balancing markets are not as flexible in enabling this capability as US real-time markets.

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