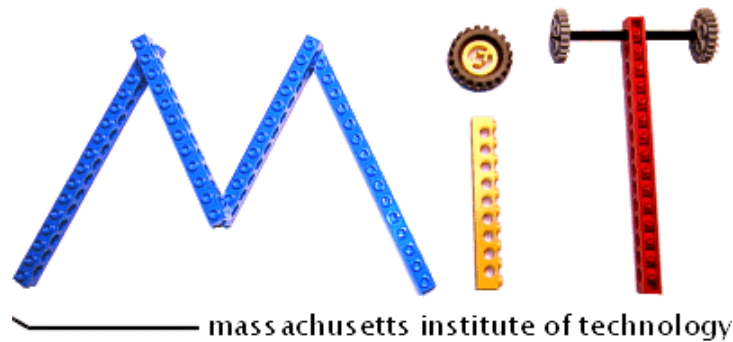


# INDEPENDENT SYSTEM OPERATORS (VI + Access Rules vs. ISO vs. ITS0)

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# ALTERNATIVE SYSTEM OPERATOR MODELS

- System operator (SO) is vertically integrated utility (G+T)
  - Functional separation of SO and TO from generation, marketing and distribution combined with information transfer rules
  - Transparent “unbiased” open access terms and conditions (tariff conditions) for transmission network interconnection, delivery, ancillary services, balancing
  - Transparent “unbiased” system operating protocols for scheduling dispatch, congestion management, and emergencies
  - Open transparent “unbiased” transmission planning process
  - → Operate and plan the transmission network as if there is no vertical integration
  - Typically implemented with a (physical and financial) bilateral contract system plus cost-based ancillary services and balancing
  - Regulator (and network users) responsible for monitoring violations of SO and TO access rules and general market monitoring and market power mitigation
  - Example: Vertically integrated utilities in the U.S. operating under FERC Orders 888/889/890 and related interconnection and functional separation orders

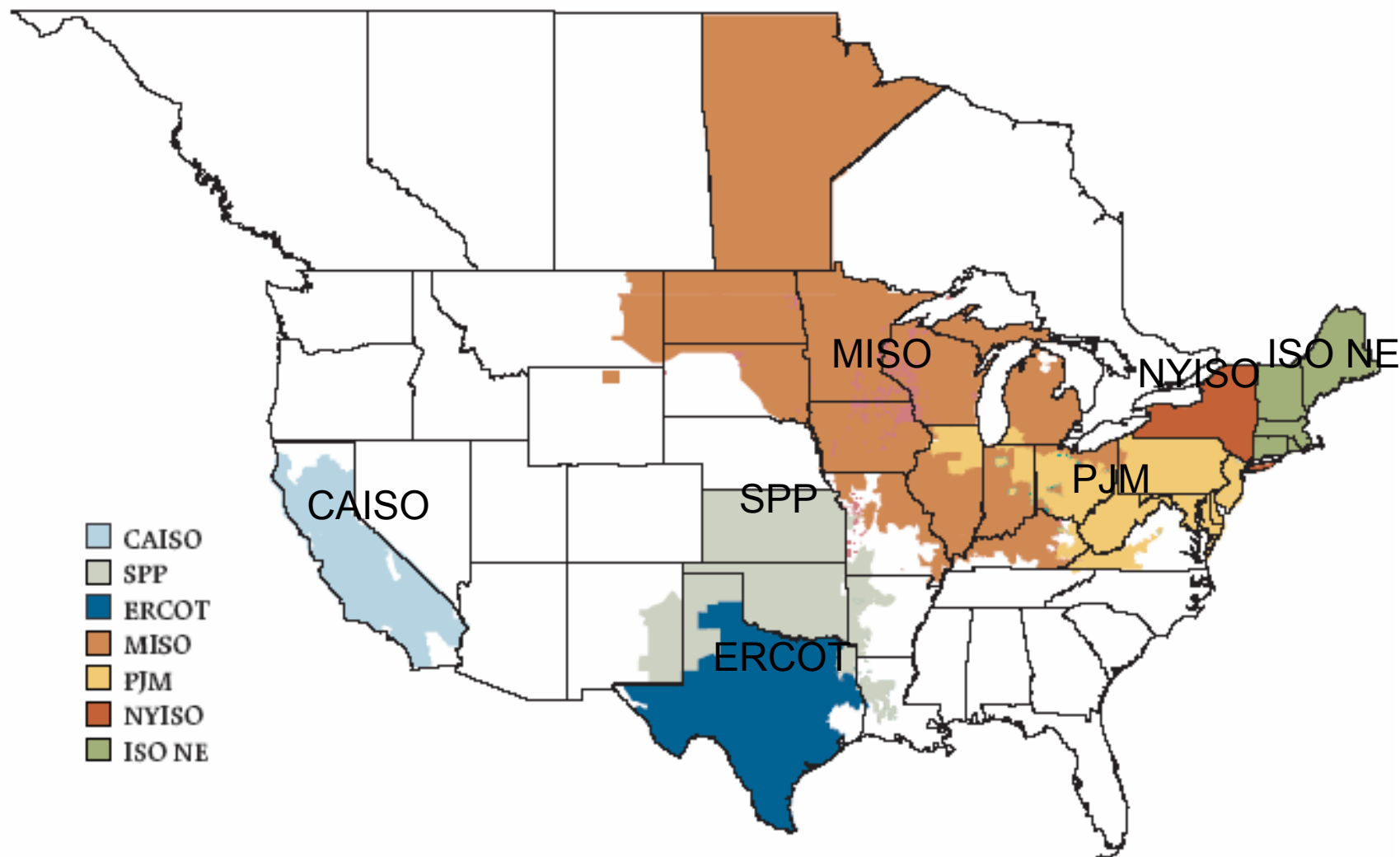
# ALTERNATIVE SYSTEM OPERATOR MODELS

- Transco (ITSO) Model
  - Ownership separation of TO/SO from generation, marketing, retail supply to eliminate potential conflicts of interest
  - SO and TO functions are under common ownership/control
  - SO/TO are regulated (ideally with PBR)
  - SO/TO may be privately-owned or state-owned though ownership affects incentives and behavior
  - Corporate governance arrangements consistent with independence from affiliated market participants
  - Transparent network access, operating rules, pricing and investment planning (regulated tariff rules and terms)
  - Horizontal integration of transmission facilities to create large enough SO/TO to span regional market areas
  - Typically combined with transparent organized public markets for energy, network support services and congestion management that are used by the ITSO to fulfill responsibilities
  - Examples: National Grid in England and Wales, Red Electrica in Spain, TenneT in the Netherlands (almost)

# ALTERNATIVE SYSTEM OPERATOR MODELS

- Separate ISO without ownership of T or G
  - Independent of all market participants, transmission and distribution owners – owns control room and communications facilities
  - Responsible for all aspects of reliable and economical system operations and interconnection and may cover facilities of multiple transmission network owners (some vertically integrated)
  - Independent board of directors: Private, state-owned, not-for-profit
  - Stakeholder committees to review procedures and comment on them
  - Transparent open access network rules, prices and operating protocols (regulated tariff)
  - Wide variations in “depth” of ISO functions but a trend toward deeper functional responsibility over time
  - Increasing responsibility for integrated planning of transmission investments
  - Typically integrated with operation of organized wholesale markets for energy, frequency regulation and operating reserves, balancing that it uses to operate the network (scheduling, dispatch, congestion management, etc.) economically and reliably
  - Examples: PJM, ISO-New England, AESO in Alberta, National Grid in Scotland

## ISO/RTOs in the United States 2006



Source: State of the Markets Report 2004, FERC Office of Market Oversight and Investigations (2005, page 53).

## Independent System Operators and Organized Wholesale Markets 2006

System Operator	Generating Capacity (MW)
ISO-New England (RTO)	31,000
New York ISO	37,000
PJM (expanded) (RTO)	164,000
Midwest ISO (MISO)	130,000
California ISO	52,000
ERCOT (Texas)	78,000
Southwest Power Pool (RTO) <a href="#">[1]</a>	60,000
	_____
ISO/RTO Total	552,000
	_____
Total U.S. Generating Capacity	970,000

[\[1\]](#) Organized markets being developed

# BASIC ATTRIBUTES OF U.S. ISOs

- Independent System Operator (ISO)
  - Non-profit entity (effectively) that does not own transmission assets
  - Independent boards plus stakeholder committees
  - Responsible for operating the network reliably and economically
  - Manages FERC Open Access Transmission Tariff, OASIS, generator interconnection rules
  - Manages voluntary wholesale spot markets for energy and ancillary services
  - Manages requests for transmission service, allocation of scarce transmission capacity and network expansions
  - Transparent Regional Transmission Expansion Planning process
  - Market monitoring and mitigation programs
  - Coordination with neighboring control areas, including imports/exports (cross-border trade)
- Regulated Incumbent Transmission Owners (TOs)
  - Functional separation rules if TO is vertically integrated
  - T Maintenance in conjunction with ISO
  - Opportunities/obligations for new regulated and merchant T projects
  - Regulated projects must go through ISO planning process

# ISOs OPERATE AND USE WHOLESALE MARKETS FOR OPERATIONS

- Security constrained bid-based dispatch using state-estimator network model
  - Day-ahead hourly markets
  - Real-time market (adjustments, imbalances, 5-minutes)
  - Self-scheduling permitted subject to imbalance and congestions charges
- Resulting LMPs calculated at each bus
  - Marginal cost of congestion
  - Marginal cost of losses (NE, NY, and now PJM)
  - Internalizes network externalities into prices
  - Allocates scarce transmission capacity efficiently
- Market-based provision of frequency regulation and operating reserves integrated with day-ahead and real-time energy markets



# ISO OPERATE GENERATING CAPACITY MARKETS

- Generating capacity (reserve) obligations imposed on retail suppliers (e.g. 18% forward reserve margin) and/or “capacity markets” and capacity payments
  - New England and PJM
  - “Reserve Capacity demand curve” in New York
  - California will have capacity obligation/payment system
  - MISO considering capacity obligation/payment system
  - Texas will continue to rely on “energy only” markets

**Table 8: RTO Market Characteristics in 2006**

Services Provided	■ Existing	□ Projected	◆ Cost-Based			● Other	
	ISO-NE	NYISO	PJM	MISO	SPP	ERCOT	CAISO
Bilateral transactions	■	■	■	■	■	■	■
Active online physical trading	■		■	■		■	■
Active online financial trading	■	■	■	■			■
Real-time energy market	■	■ <sup>1</sup>	■	■	■ <sup>2</sup>	■	■
Locational energy price	■	■	■	■	■	■	■
Hourly energy price	■	■	■	■	■	■	■
Congestion price	■	■	■	■	■	■	■
Losses price	■	■	□ <sup>07</sup> <sup>3</sup>	■	■ <sup>4</sup>	■	■ <sup>5</sup>
Day-ahead energy market	■	■ <sup>1</sup>	■	■		□ <sup>09</sup>	□ <sup>08</sup>
Locational energy price	■	■	■	■		□ <sup>09</sup>	□ <sup>08</sup>
Hourly energy price	■	■	■	■		□ <sup>09</sup> <sup>6</sup>	□ <sup>08</sup>
Congestion price	■	■	■	■		□ <sup>09</sup>	■ <sup>7</sup>
Losses price	■	■	□ <sup>07</sup> <sup>3</sup>	■			□ <sup>08</sup>
Ancillary services market	■	■	■	□ <sup>08</sup>	◆	■	■
Regulation service market	■	■	◆ <sup>8</sup>	◆ <sup>10</sup>	◆	■	■
Operating reserves market	■	■	■ <sup>9</sup>	◆ <sup>10</sup>	◆	■	■
Reactive power market	● <sup>11</sup>	● <sup>12</sup>	◆	◆	◆	◆	◆
Black start market		◆	◆	◆	◆	● <sup>13</sup>	◆
Financial transmission rights	■	■	■	■		■	■ <sup>7</sup>
Capacity market	■ <sup>14</sup>	■	■			● <sup>15</sup>	◆ <sup>16</sup>
Regional transmission scheduling	■	■	■	■	■	■	■
Regional economic dispatch	■	■	■	■	■	■ <sup>17</sup>	■ <sup>17</sup>
Regional transmission planning	■	■	■	■	■	■	■
Regional interconnection process	■	■	■	■	■	■	■
Independent market monitor	■	■	■	■	■	■	■
Mitigation	■	■	■	■	■		■

Source: FERC 2006 State of the Markets Report

# ISO NEW ENGLAND MARKET PRICE COMPONENTS

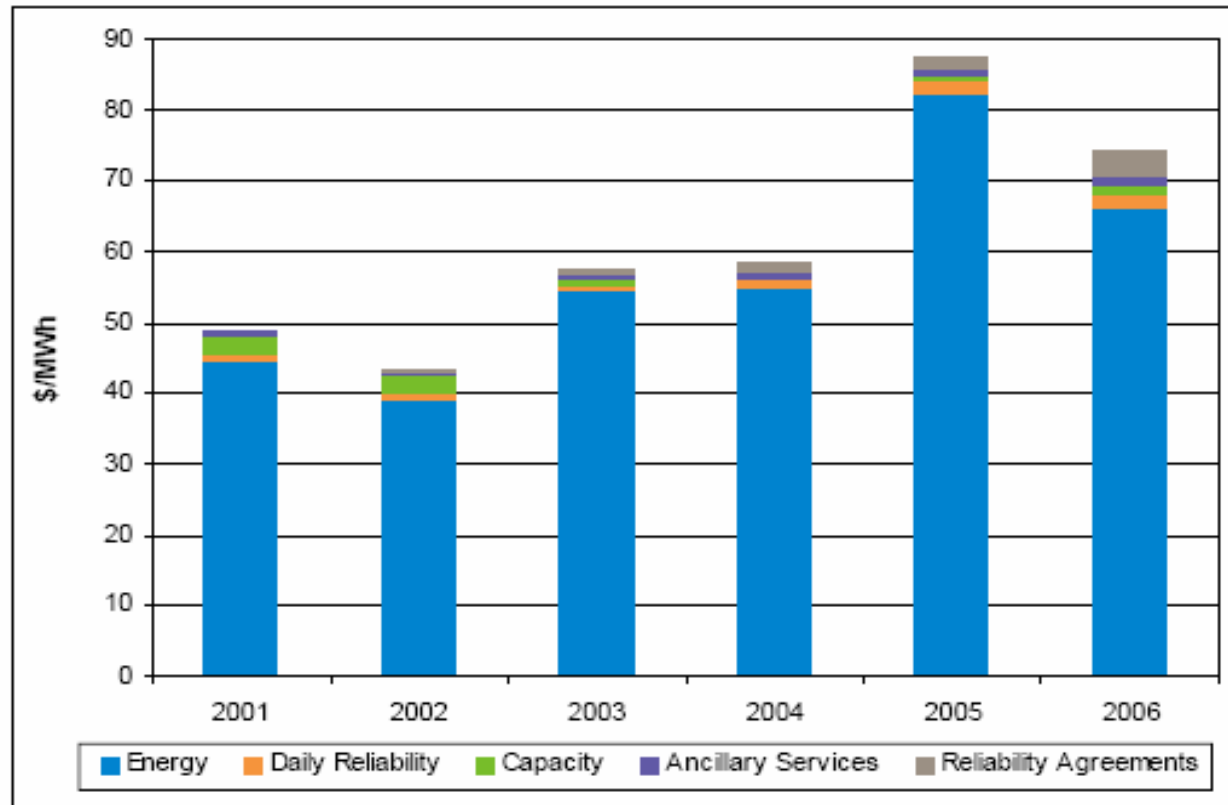


Figure 1-2: All-in wholesale electric energy cost metric for 2001 to 2006.

ISO-NE (2007)

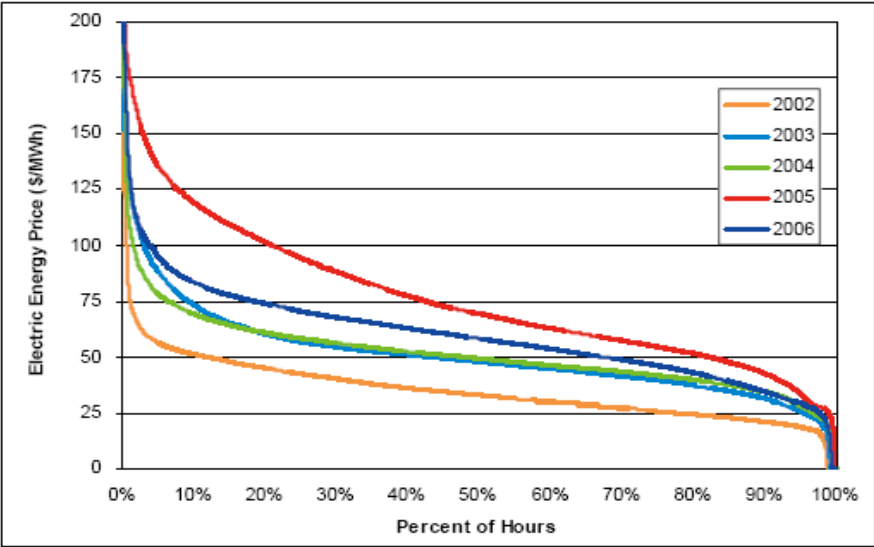


Figure 3-19: System real-time price-duration curves, prices less than \$200/MWh, 2002 to 2006.

Note: System price is the single ECP for the Interim Market period ending February 28, 2003, and load-weighted Real-Time Energy Market LMPs for March 2003 to December 2006.

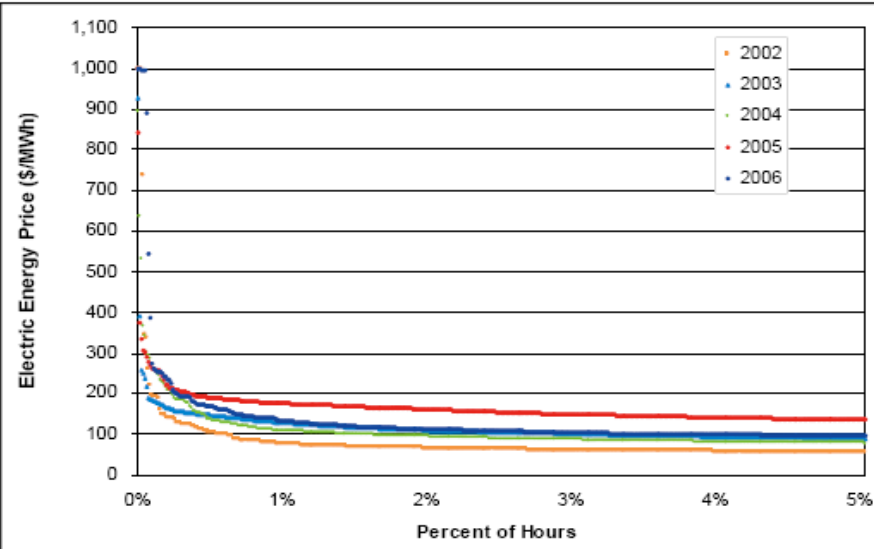


Figure 3-20: System real-time price-duration curves, prices in most expensive 5% of hours, 2002 to 2006.

ISO-NE (2007)

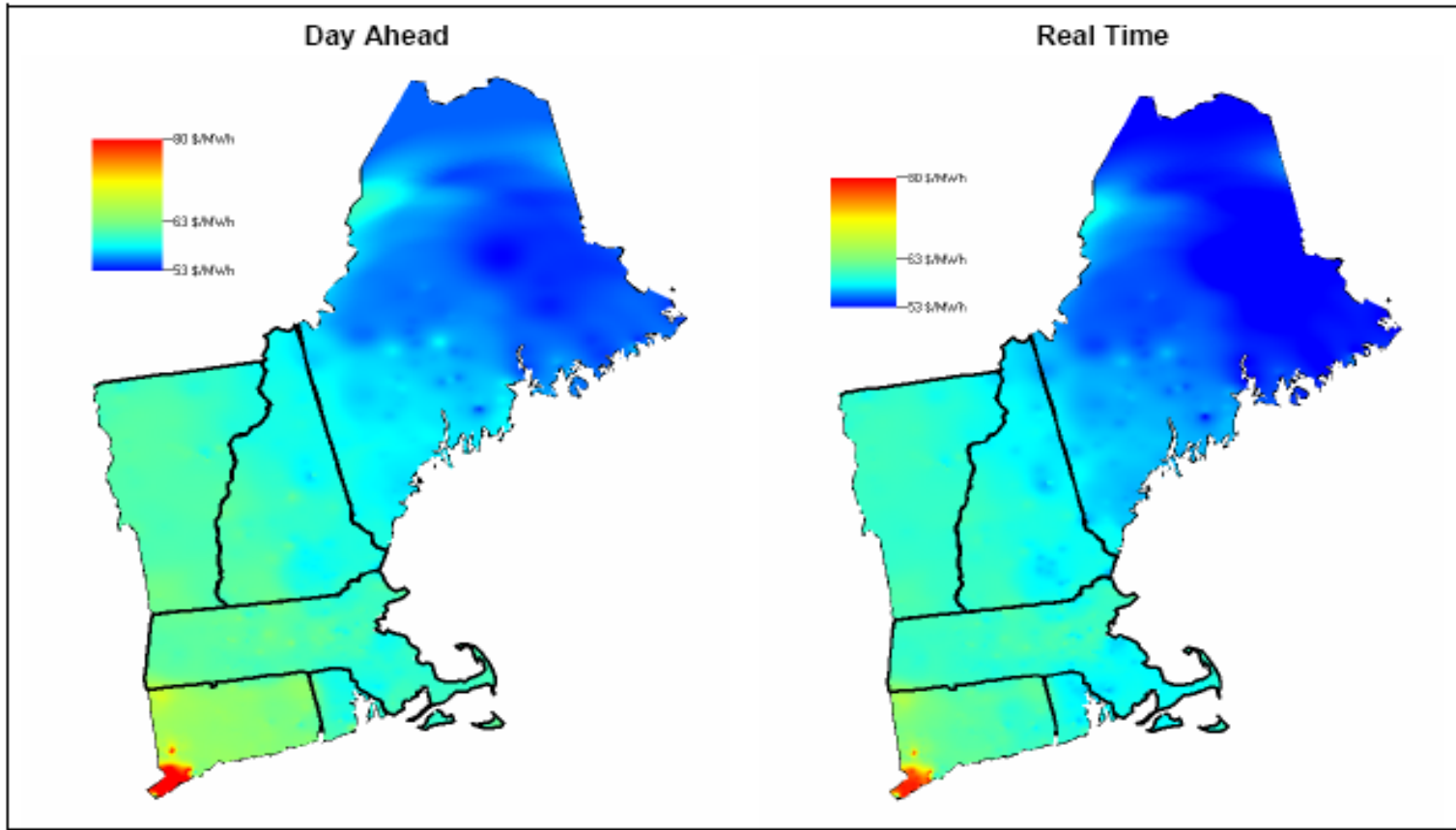


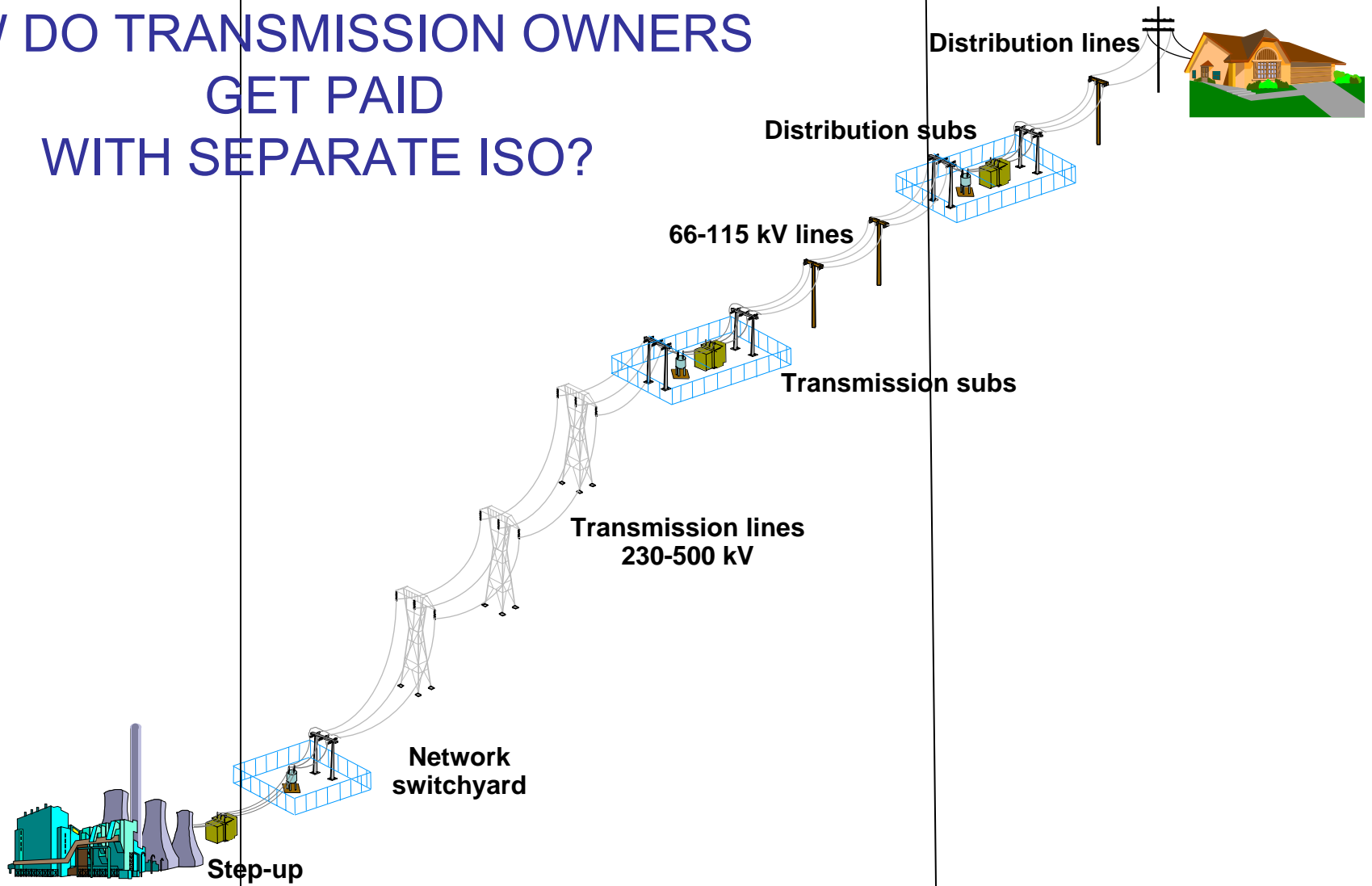
Figure 3-25: Average nodal prices, 2006, \$/MWh.

ISO-NE (2007)

# MARKET MONITORING AND MITIGATION

- Independent market monitor (big fuss in PJM at the moment)
- \$1000/MWh general bid cap on spot energy and capacity markets (lower in CA and higher in Texas)
- Local market power mitigation rules
  - Bid caps
  - RMR contracts for load pockets
  - Must-offer requirements
  - Interaction with computation of market prices
- Ex-post bid/price adjustments
- Monitoring of individual market participant behavior and market performance

# HOW DO TRANSMISSION OWNERS GET PAID WITH SEPARATE ISO?



**Generator**  
State: bundled VI gen  
FERC: unbundled gen

State: Bundled "retail" T + siting  
FERC: Unbundled "wholesale" T

Entirely State

# FERC TRANSMISSION REGULATION

- Transmission service (“wheeling”) charges
  - Network service charges
  - Integration of individual TO tariffs has evolved
    - No “pancaking” of transmission charges to generators and marketers within an ISO
    - Pricing to shippers initially based on TO’s costs at point of entry
    - Pricing to distribution companies initially based on TO costs at delivery destinations
    - Evolving to rolled-in “postage stamp” pricing with reallocation of revenues based on transmission cost shares
  - Physical and financial firm transmission rights to hedge congestion and support investment
  - Nodal pricing and congestion charges in organized ISO/RTO markets
- Interconnection charges for generators and merchant transmission projects
  - Shallow
  - Deep



# FERC TRANSMISSION SERVICE PRICING FOR TOs

- FERC applies traditional embedded cost of service pricing to each TO under ISO
  - Roll-in cost of all transmission assets  $\geq 69\text{kv}$  at original cost less  $\sum$ depreciation to form “rate base”
  - Apply ROR and depreciation rate to rate base to get target allowed annual capital service revenues
  - Pro-forma debt/equity ratio assumed
  - Add operating costs
  - Develop price per/Mw of network transmission service
  - Long periods of regulatory lag without “true-up”
  - No performance benchmarking or performance incentives --- FERC does not even collect performance data that could be used to structure a PBR system
  - “Postage stamp” pricing based on share of network peak demand

# FERC TRANSMISSION PRICING

- 2005 Energy Policy Act required FERC to develop incentives to promote transmission investment to ensure reliability and reduce wholesale power costs by reducing network congestion
- FERC has responded by offering higher “incentive” ROE for new (FERC jurisdictional) transmission investments and for joining an “independent” transmission entity
- FERC has not applied real PBR regulation aside from that implicit in regulatory lag
- The development of incentives by FERC has been confused and controversial

# GENERATOR INTERCONNECTION POLICIES

- Transmission owners must build interconnection facilities for new generators and offer them transmission service on the network consistent with reliability standards
- “Shallow” interconnection costs charged to generators requesting service
- “Deep” interconnection costs are initially charged to generator causing the need for “deep” upgrades to meet reliability standards.
- But these costs are gradually rolled into general network tariff and rebated to generators over time
  - PJM has a different system which allocates these costs to the generator(s) causing them and gives them FTRs in return.

# TRANSMISSION CONSTRUCTION PERMITS

- Primary responsibility is with the states
- FERC has “backstop” siting/permit authority for certain critical transmission corridors
- This is quite different from natural gas pipelines where FERC has most of the construction/siting authority
- In ISO/RTO areas, the ISO/RTO does system-wide transmission planning and designated transmission upgrades to be built by the affected transmission network owner
- In other areas the individual states have transmission planning authority
  - State incentives are protectionist and distorted

# STRENGTHS AND WEAKNESSES

- Functional separation of VI utilities plus regulated open access tariff conditions
  - Politically convenient
  - Ultimately any benefits of vertical integration are lost
  - Functional separation and information transfer restrictions (2003 Northeast Blackout)
  - Potential benefits of horizontal integration of TOs are not realized
  - Continued litigation over self-dealing and vertical market power problems
  - Contest between political power of incumbents and power of regulator and competition authorities
  - Requires strong regulator and competition authority
  - Functional separation evolves toward a crippled ISO
  - Ultimately incompatible with liberalized wholesale and retail markets with good performance attributes

# STRENGTHS AND WEAKNESSES

- Separate ISO
  - Politically more acceptable compared to Transco (ITSO)
  - The devil is in the details
  - ISOs with “deep functional” responsibilities that are well integrated with wholesale markets work reasonably well
  - Inefficiencies from absence of vertical integration with TO functions
    - Efficient coordination of maintenance and investment planning can be challenging
    - Interconnection process is cumbersome
  - Effective governance and regulation of ISO are also challenging, especially if not-for-profit
    - What are the incentives ?
    - Soft budget constraints if not-for-profit
    - Stakeholder process is cumbersome
    - Good PBR regulation is more difficult
  - The responsibilities of the ISO tend to expand over time to deal with these inefficiencies
    - TOs become passive owners of regulated assets that march to the ISOs orders

# STRENGTHS AND WEAKNESSES

- Transco
  - The ideal model in theory
  - Independence is structural
  - Focused business model
  - For-profit Transco is easier to regulate with PBR since objectives and incentives are clear
  - Requires well developed PBR regulatory mechanisms
  - Some functional separation required if there are unregulated lines of business (e.g. interconnections)
  - Restructuring to create regional Transco is very challenging politically
  - Existing Transco's have exhibited good performance in all dimensions

# DESIGN ISSUES FOR SEPARATE ISOs

- Geographic scope
- Functions
- Ownership form and Governance structure
- Mandatory or Voluntary TO membership
- Regulatory authority and PBR mechanisms
- Integration with wholesale markets for energy, operating reserves, and emergency protocols
- Network expansion planning responsibilities
- Integration with responsibilities and regulation of TOs