Market Monitoring in PJM

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Market Monitor

- **Market Monitoring Function**
- PJM Markets
- Approach to Market Analysis
- Market Design, Market Monitoring and Competition

- Monitor **compliance with rules**, standards, procedures and practices of PJM.
- Monitor **actual or potential design flaws** in rules, standards, procedures and practices of PJM.
- Monitor **structural problems** in the PJM market that may inhibit a robust and competitive market.
- Monitor the potential of Market Participants to **exercise market power**.

Develop/modify market rules to:

- **Facilitate competition**
- **Limit returns to market power**
- Provide **incentives to competitive behavior**
- Make **exercise of market power more difficult**
- **Stop exercises of market power** before significant impact

- **Discussion of issues** with relevant Market Participants; informal resolution of issues.
- **Make formal referrals to FERC** regarding the behavior by relevant Market Participants.
- **Recommend modifications to rules**, standards, procedures and practices of PJM.
  - **Make recommendations** to PJM Committees or to PJM Board.
  - **Make regulatory filings** to address market issues and seek remedial measures.
- **Evaluate additional enforcement mechanisms**.

- MMU has no authority to modify prices ex post
- MMU has no authority to make ad hoc adjustments in day-to-day market activities
- MMU has no authority to require changes in market participant behavior

- Goal: Independent from Market Participants
  - Independent System Operator
  - ISO/RTO has no financial stake in market outcomes
  - ISO/RTO has independent Board
  - MMU is independent from market participants
  - Market Monitoring Plan is not subject to modification by PJM members.
  - Amendment to PJM's Open Access Transmission Tariff subject to FERC approval

- Goal: Independent from ISO/RTO

- Goal: MMU Accountability

Clear and transparent definitions required in Market Monitoring Plan

- Market monitoring is a FERC required function
- Market monitoring plan is approved by FERC as part of the PJM tariff
- Clear definition of independence/reporting/accountability
  - Roles of FERC, the PJM Board and PJM management
- Clear definition of MMU budget approval process
  - Roles of FERC, the PJM Board and PJM management
- Clear definition of MMU obligation/ability to prepare reports
  - For FERC
  - For PJM Board
  - For PJM Members
  - For Authorized Government Agencies

- Independent Internal Market Monitoring
  - MMU also monitors PJM
  - Role of PJM in ensuring efficient market outcomes
  - Operating reserves issues
    - Operator decisions
    - Impact on prices
  - Actions when market is tight
    - DSM resources
    - Trigger for actions

- Independent Internal Market Monitoring - Adequate resources are critical
  - Staff resources
  - IS resources
  - Hardware resources
  - Data resources (external/internal)
  - External resources

- Diverse staff expertise
  - Economics/Engineering
  - Generation
  - Transmission
  - Power markets
  - Database/IT
- Build understanding of detailed market structure: macro/micro
- Build understanding of physical infrastructure
- Build understanding of operations
- Build in MMU data access/storage to RTO data designs
- Confidentiality protocols
- Complaint protocols

- Ex parte rules
- California Order re expedited tariff modifications
- Policy Statement on Market Monitoring
  - May 27, 2005
- MMU referrals to FERC
  - Process
- Enforcement
  - FERC has enforcement authority
  - FERC approved tariffs include market rules
  - Violation of RTO market rules
  - Violation of FERC behavioral rules

- Interaction with market participants is critical to understanding real markets

- Interaction with state Commissions is critical to understanding retail/wholesale interaction issues

- Interaction with RTO staff is critical to understanding real markets

- Coordination with FERC is essential to efficient monitoring and mitigation

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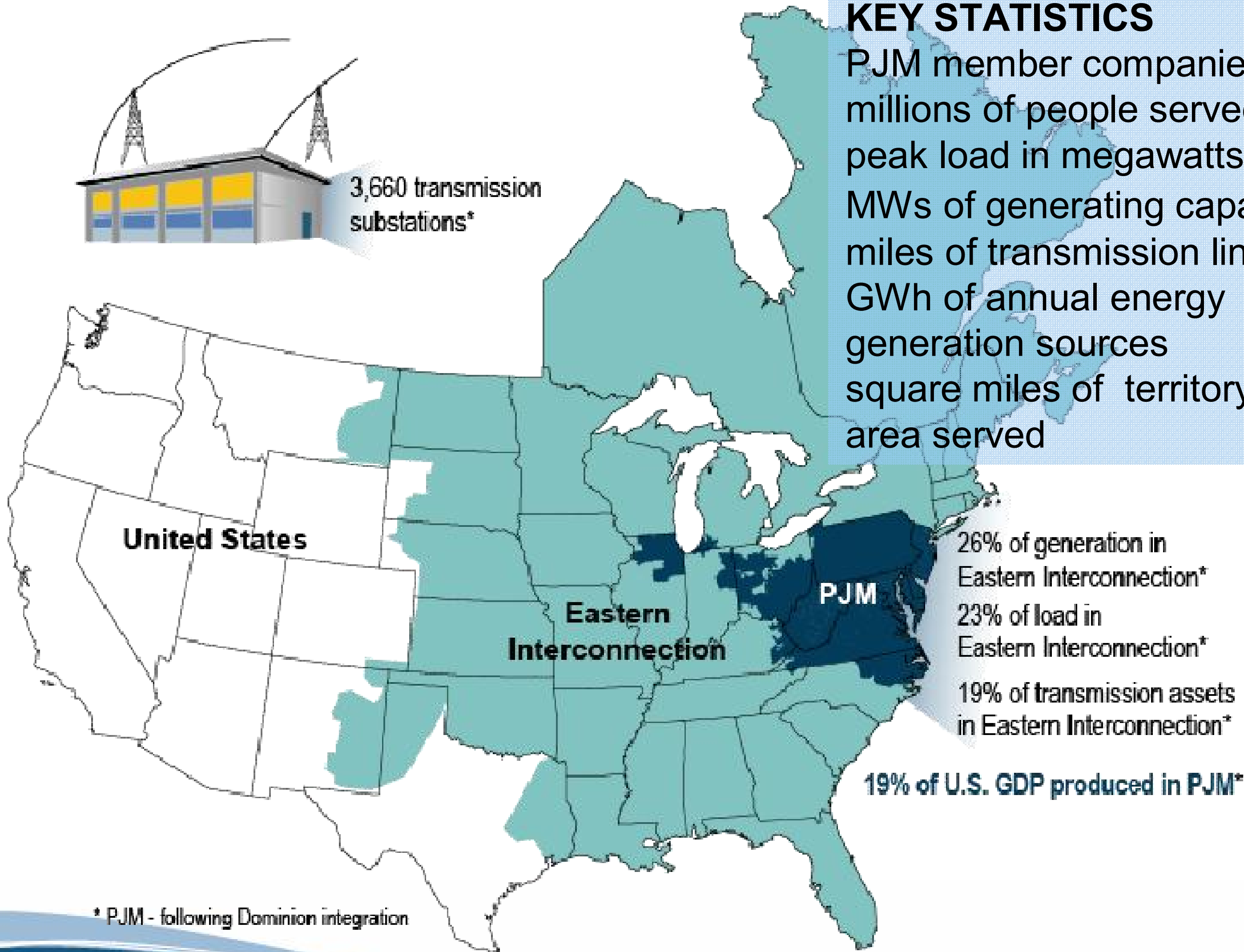
PJM as Part of the Eastern Interconnection

KEY STATISTICS	
PJM member companies	390+
millions of people served	51
peak load in megawatts	135,000
MWs of generating capacity	163,806
miles of transmission lines	56,070
GWh of annual energy	700,000
generation sources	1,200
square miles of territory	164,260
area served	13 states + DC



* PJM - following Dominion integration

RTO/ISO Peak Loads

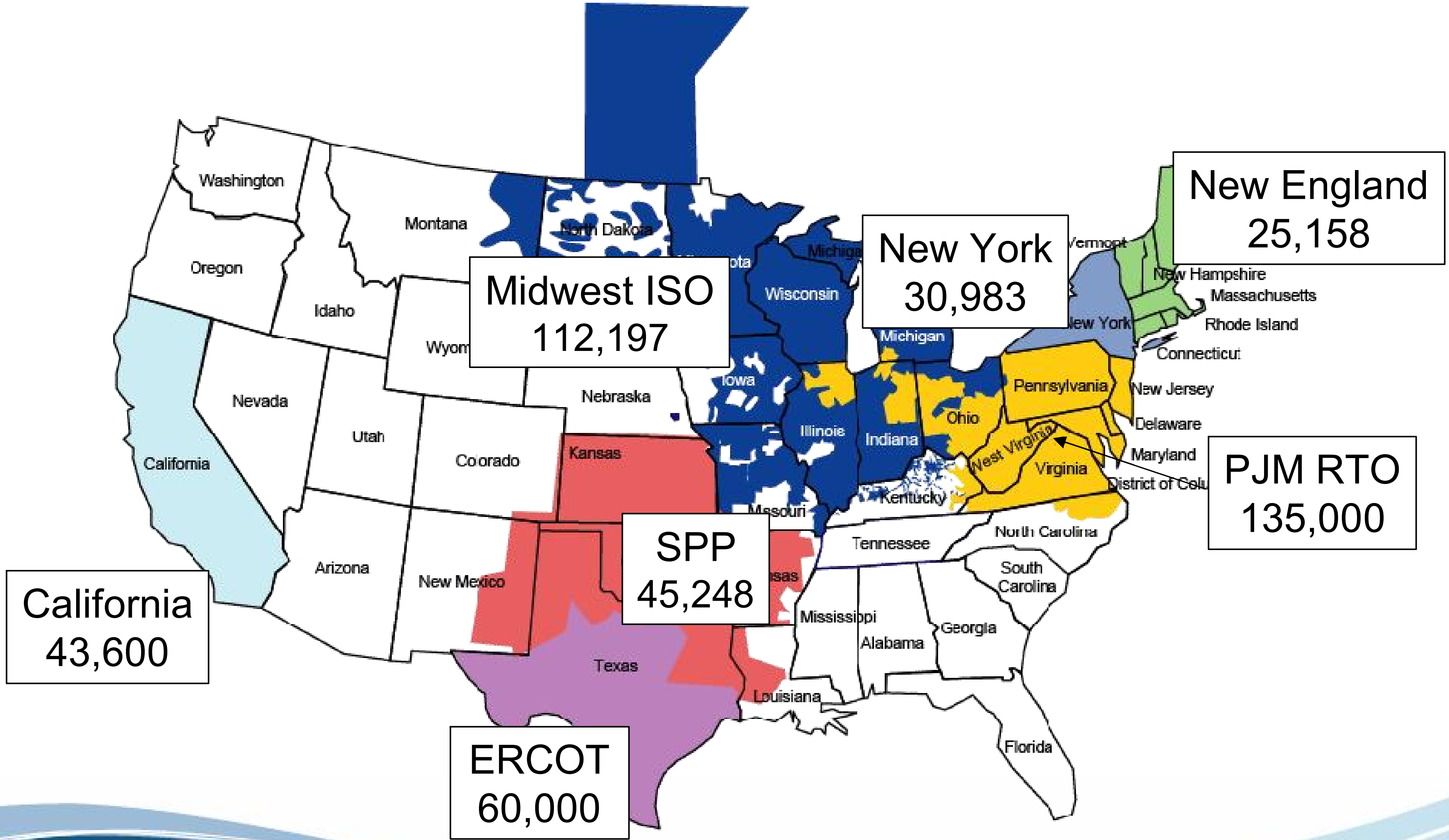


Figure 3-4 - PJM capacity (By fuel source): At December 31, 2005

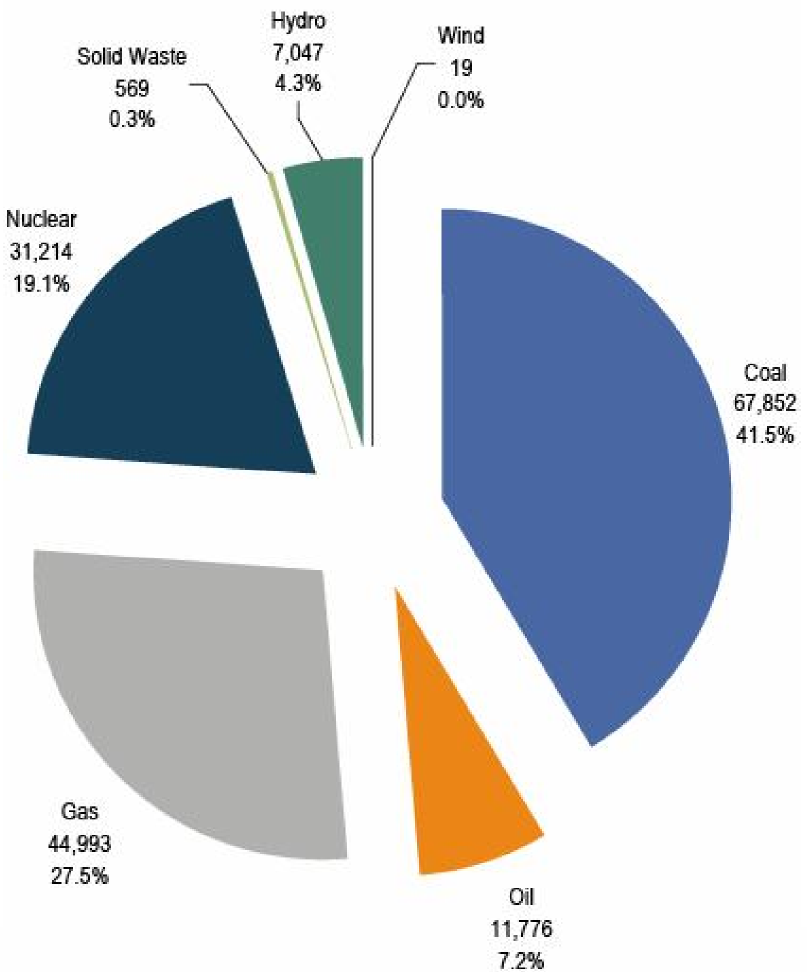
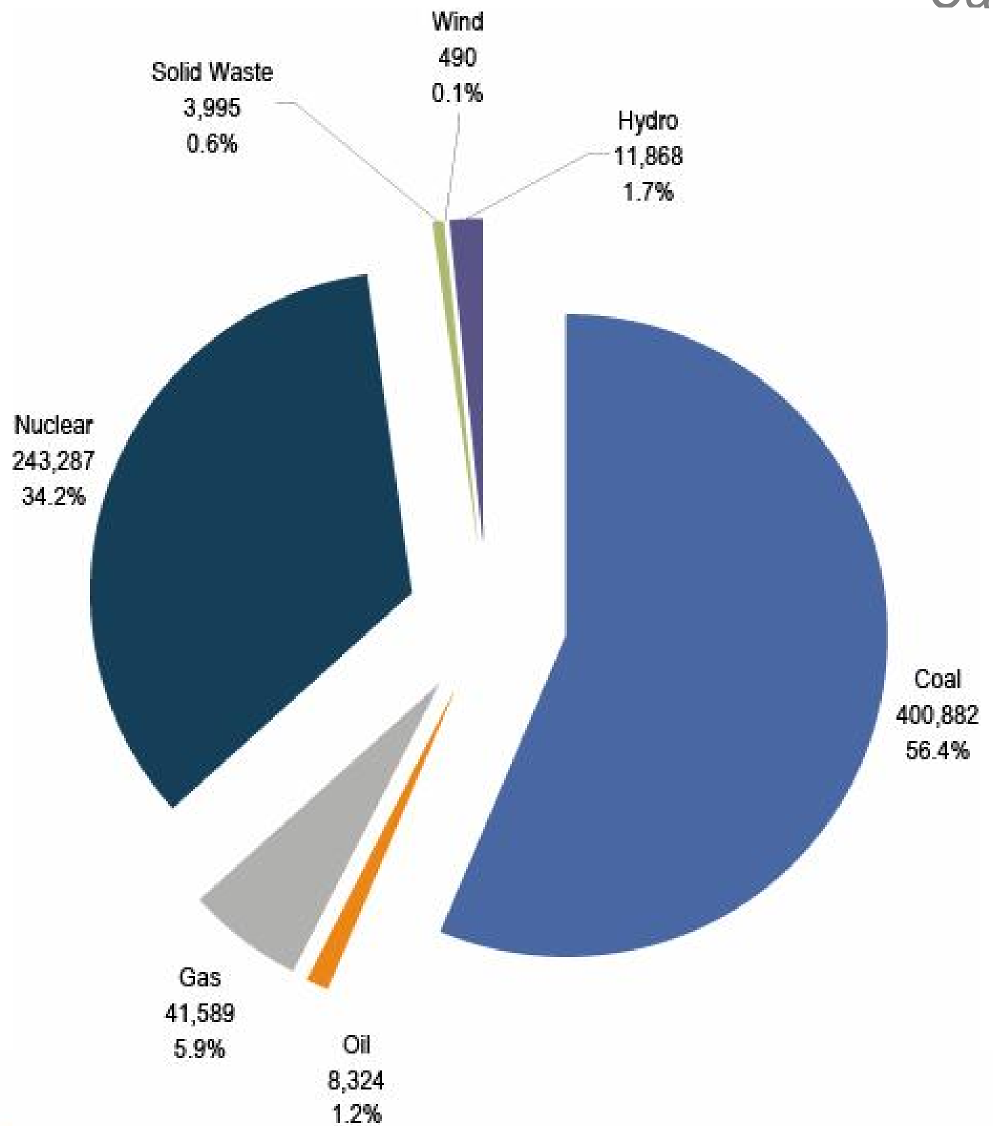


Figure 3-5 - PJM generation [By fuel source (In GWh)]: Calendar year 2005



- Energy Markets
  - Day Ahead
  - Real Time (Balancing)
- Capacity Credits Markets
  - Daily
  - Long-Term
- Financial Transmission Rights Market
  - ARR/FTR
  - Annual/Balance of period/Monthly
  - Auction Options
- Ancillary Services
  - Regulation Market
  - Spinning Reserve Market
  - Black Start Service
  - Reactive Service

Related Wholesale Electricity Markets

- Futures Market
  - NYMEX PJM West Hub Contract
- Forward Markets
  - OTC Bilateral Contracts
  - Bilateral Contracts

- Market Monitoring Function
- PJM Markets
- **Approach to Market Analysis**
- Market Design, Market Monitoring and Competition

- Approach to market analysis
  - Structure
    - Concentration
    - Pivotal suppliers
  - Conduct/Behavior
    - Economic withholding
    - Physical withholding
  - Performance
    - System markup
    - Net revenue
  - Definition of the market
    - Relevant competitors

- Structure/conduct/performance
  - Structural measures
    - Concentration of ownership: HHI
    - Individual company Market Share: MS
    - Pivotal supplier(s): RSI
  - Conduct/behavior measures
    - Markup (unit): (P – C)/P
    - Offer behavior
  - Performance measures
    - Markup (clearing price)
    - Net revenue

- Ability to increase/decrease market clearing price above/below competitive price level
  - Market structure permits participant behavior with an impact on market performance

- Competitive price level is the short run marginal cost of unit setting market clearing price
  - Risk
  - Opportunity costs
  - Scarcity pricing

- Structure – Aggregate Market
  - Market shares
  - Concentration
  - Pivotal suppliers
- Structure – Local Markets
  - Pivotal suppliers
  - Three pivotal supplier test
  - Definition of the market

Figure 2-3 - PJM hourly Energy Market HHI: Calendar years 2004 and 2005

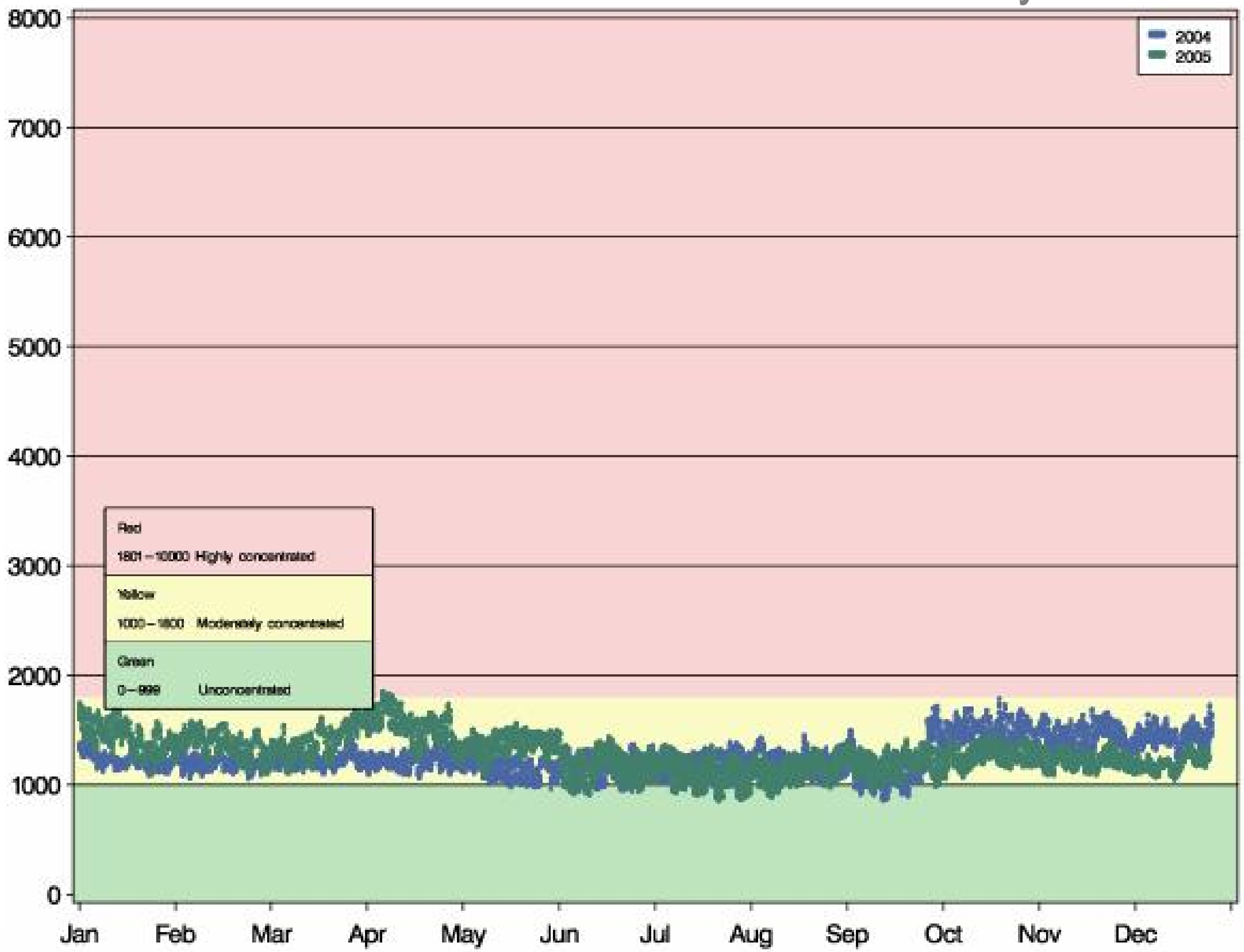
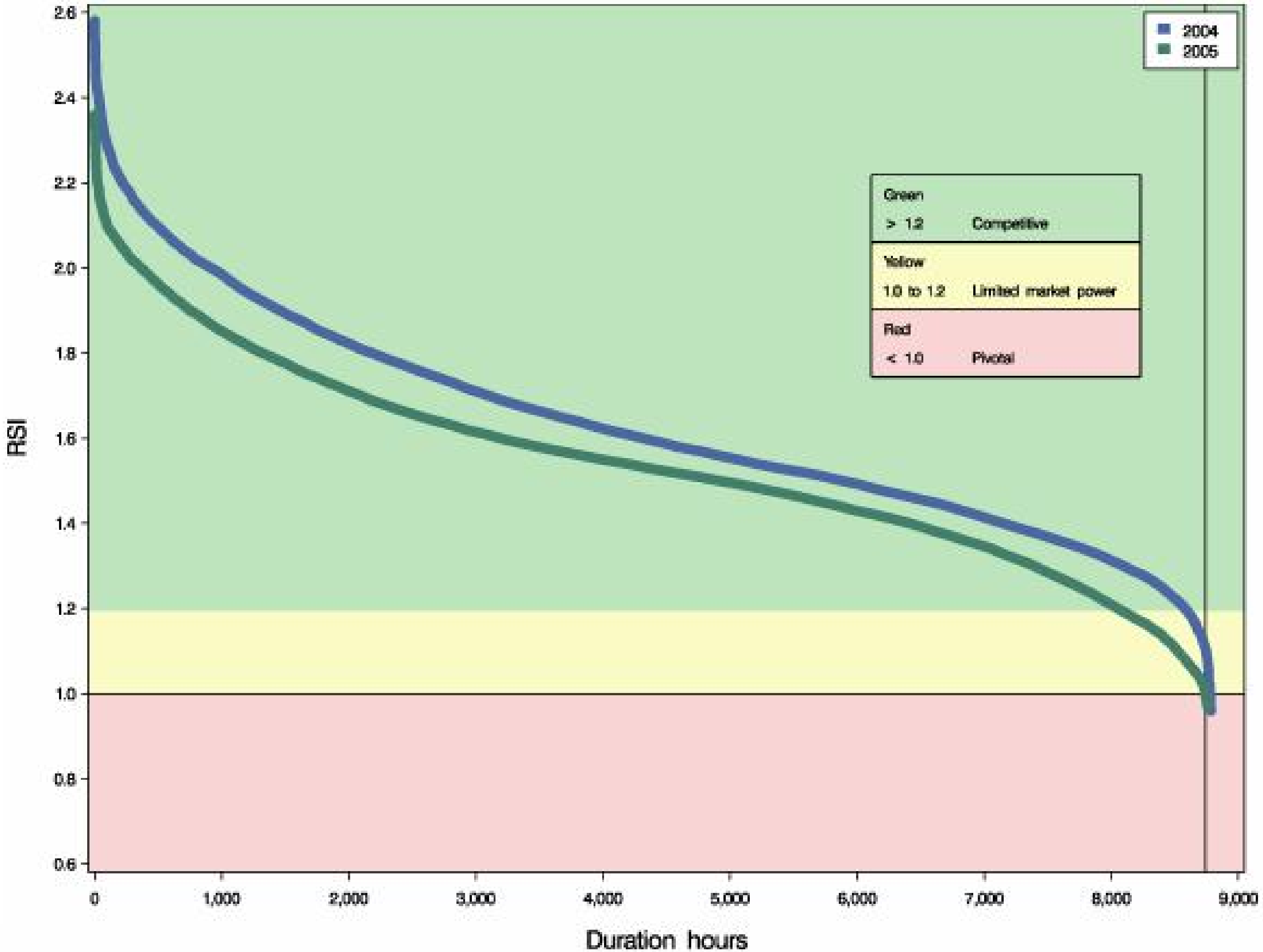


Figure 2-4 - PJM RSI duration curve: Calendar years 2004 and 2005



- Conduct/Behavior
  - Offer behavior
  - Mark up
  - Operating parameters
  - Outage behavior

Figure 2-10 - Average markup index of marginal units (By type of fuel): Calendar years 2001 to 2005

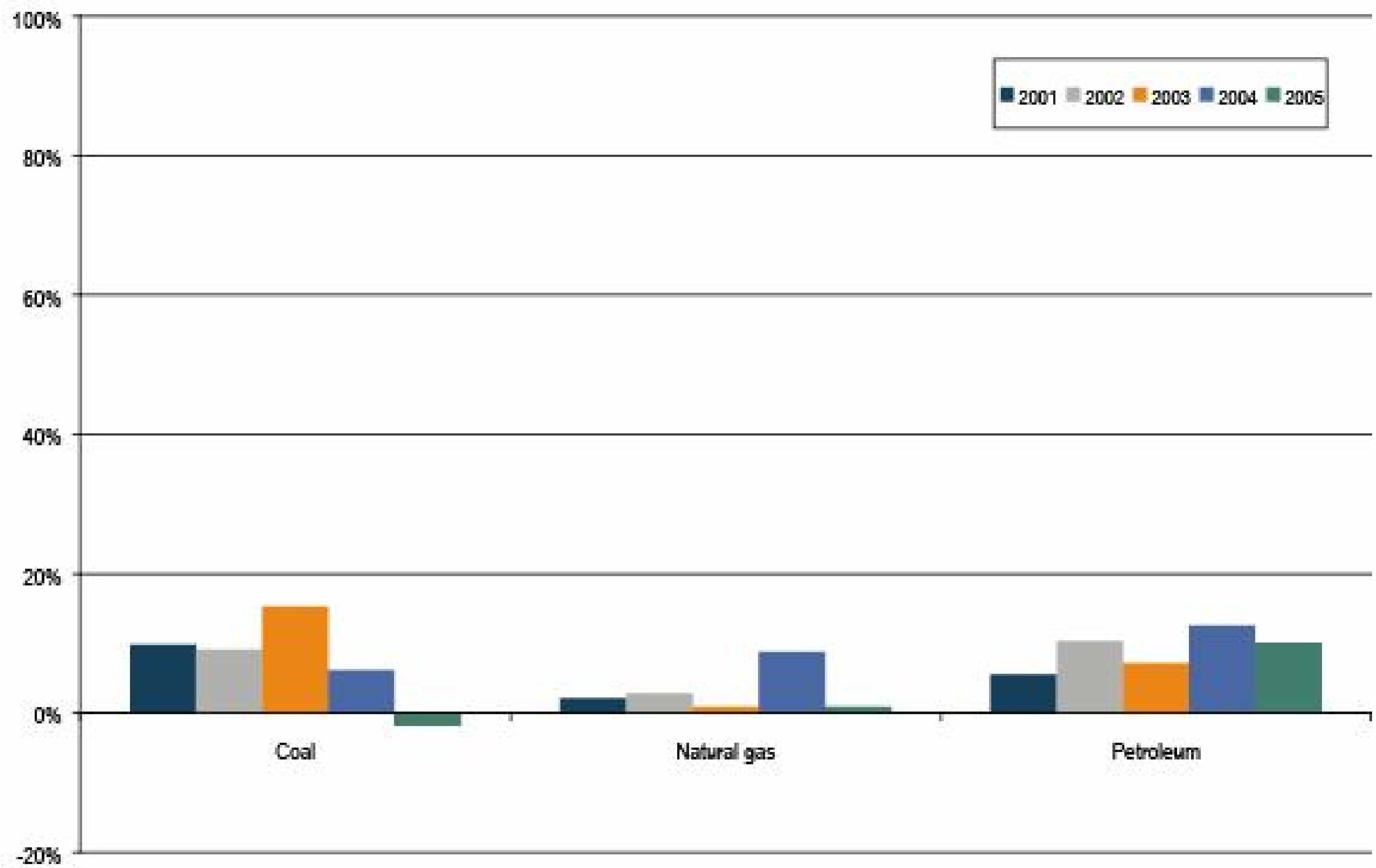


Table 2-20 - Annual offer-capping statistics: Calendar years 2001 to 2005

	Real Time		Day Ahead	
	Unit Hours Capped	MW Capped	Unit Hours Capped	MW Capped
2001	2.8%	1.0%	2.8%	0.7%
2002	1.6%	0.3%	0.7%	0.1%
2003	1.1%	0.3%	0.4%	0.2%
2004	1.3%	0.4%	0.6%	0.2%
2005	1.8%	0.4%	0.2%	0.1%

- Performance
  - Market markup
  - Net revenue
  - Prices
  - Operating reserves payments/charges

Figure 2-8 - Load-weighted, average monthly markup indices: Calendar year 2005

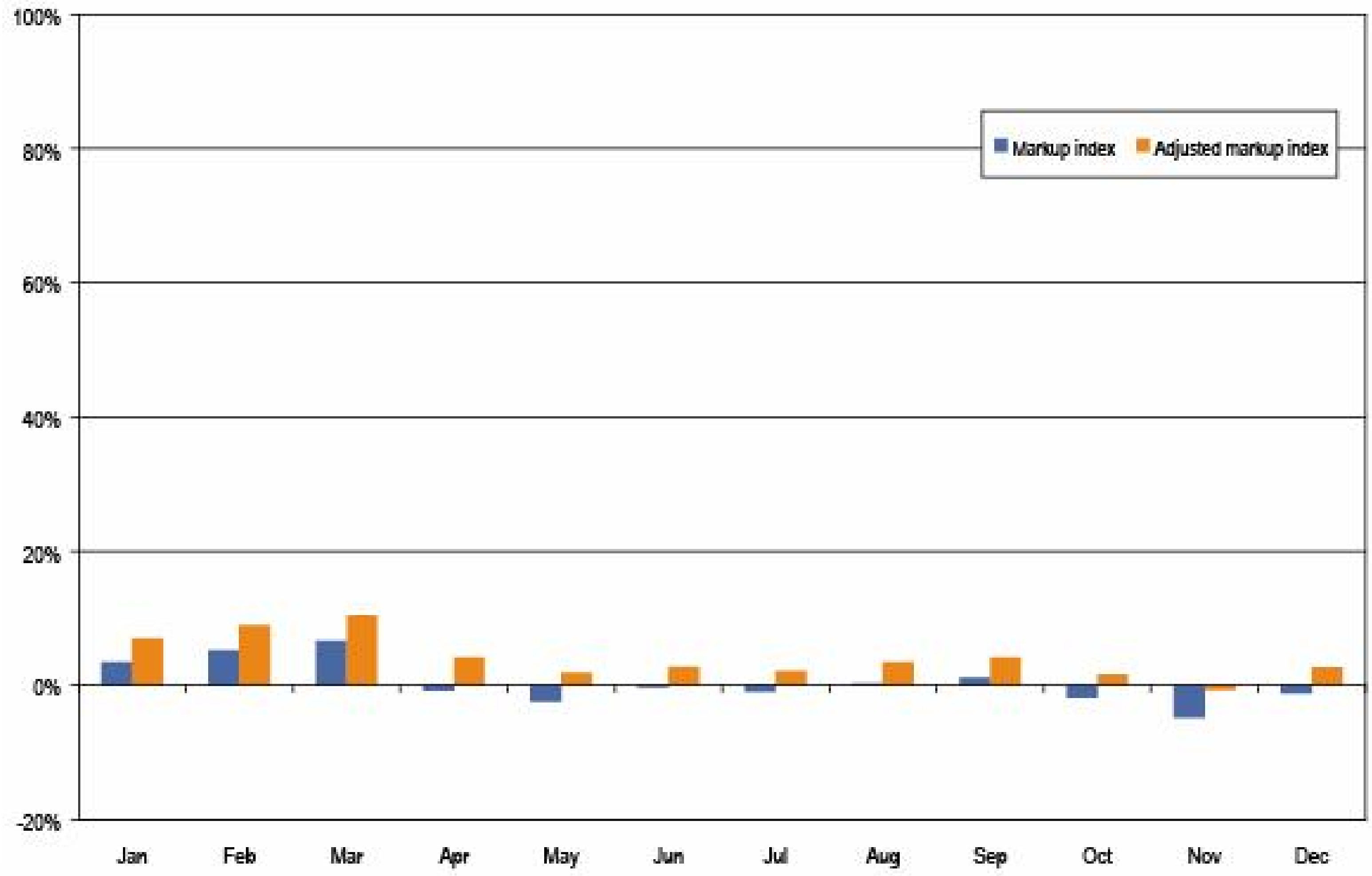


Table 3-12 - CT 20-year levelized fixed cost vs. net revenue (Dollars per installed MW-year)

	20-Year Levelized Fixed Cost	Perfect Dispatch Net Revenue	Perfect Dispatch Percent	Economic Dispatch Net Revenue	Economic Dispatch Percent
1999	$72,207	$80,990	112%	$74,537	103%
2000	$72,207	$38,924	54%	$30,946	43%
2001	$72,207	$72,477	100%	$63,462	88%
2002	$72,207	$36,996	51%	$28,260	39%
2003	$72,207	$19,956	28%	$10,565	15%
2004	$72,207	$15,687	22%	$8,543	12%
2005	$72,207	$20,037	28%	$10,437	14%
Average	$72,207	$40,724	56%	$32,393	45%

Table 3-13 - CC 20-year levelized fixed cost vs. net revenue (Dollars per installed MW-year)

Calendar years 1999 to 2005

	20-Year Levelized Fixed Cost	Perfect Dispatch Net Revenue	Perfect Dispatch Percent	Economic Dispatch Net Revenue	Economic Dispatch Percent
1999	$93,549	$109,754	117%	$100,700	108%
2000	$93,549	$65,445	70%	$47,592	51%
2001	$93,549	$101,413	108%	$86,670	93%
2002	$93,549	$65,286	70%	$52,272	56%
2003	$93,549	$58,782	63%	$35,591	38%
2004	$93,549	$57,996	62%	$35,785	38%
2005	$93,549	$73,517	79%	$40,817	44%
Average	$93,549	$76,028	81%	$57,061	61%

Table 3-14 - CP 20-year levelized fixed cost vs. net revenue (Dollars per installed MW-year)

	20-Year Levelized Fixed Cost	Perfect Dispatch Net Revenue	Perfect Dispatch Percent	Economic Dispatch Net Revenue	Economic Dispatch Percent
1999	$208,247	$126,097	61%	$118,021	57%
2000	$208,247	$138,141	66%	$134,563	65%
2001	$208,247	$140,776	68%	$129,271	62%
2002	$208,247	$116,648	56%	$112,131	54%
2003	$208,247	$176,138	85%	$169,510	81%
2004	$208,247	$144,908	70%	$133,125	64%
2005	$208,247	$237,870	114%	$228,430	110%
Average	$208,247	$154,368	74%	$146,436	70%

Table 2-32 - PJM average hourly LMP (Dollars per MWh): Calendar years 1998 through 2005

	Locational Marginal Prices (LMPs)			Year-to-Year Changes		
	Average	Median	Standard Deviation	Average	Median	Standard Deviation
1998	$21.72	$16.60	$31.45	NA	NA	NA
1999	$28.32	$17.88	$72.42	30.4%	7.7%	130.3%
2000	$28.14	$19.11	$25.69	(0.6%)	6.9%	(64.5%)
2001	$32.38	$22.98	$45.03	15.1%	20.3%	75.3%
2002	$28.30	$21.08	$22.40	(12.6%)	(8.3%)	(50.3%)
2003	$38.27	$30.79	$24.71	35.2%	46.1%	10.3%
2004	$42.40	$38.30	$21.12	10.8%	24.4%	(14.5%)
2005	$58.08	$47.18	$35.91	37.0%	23.2%	70.0%

Table 2-34 - PJM load-weighted, average LMP (Dollars per MWh): Calendar years 1998 through 2005

	Load-Weighted, Average LMP			Year-to-Year Changes		
	Average	Median	Standard Deviation	Average	Median	Standard Deviation
1998	$24.16	$17.60	$39.29	NA	NA	NA
1999	$34.07	$19.02	$91.49	41.0%	8.1%	132.9%
2000	$30.72	$20.51	$28.38	(9.8%)	7.8%	(69.0%)
2001	$36.65	$25.08	$57.26	19.3%	22.3%	101.8%
2002	$31.58	$23.40	$26.73	(13.8%)	(6.7%)	(53.3%)
2003	$41.23	$34.95	$25.40	30.6%	49.4%	(5.0%)
2004	$44.34	$40.16	$21.25	7.5%	14.9%	(16.3%)
2005	$63.46	$52.93	$38.10	43.1%	31.8%	79.3%

Figure 2-13 - Monthly load-weighted, average LMP: Calendar years 1999 through 2005

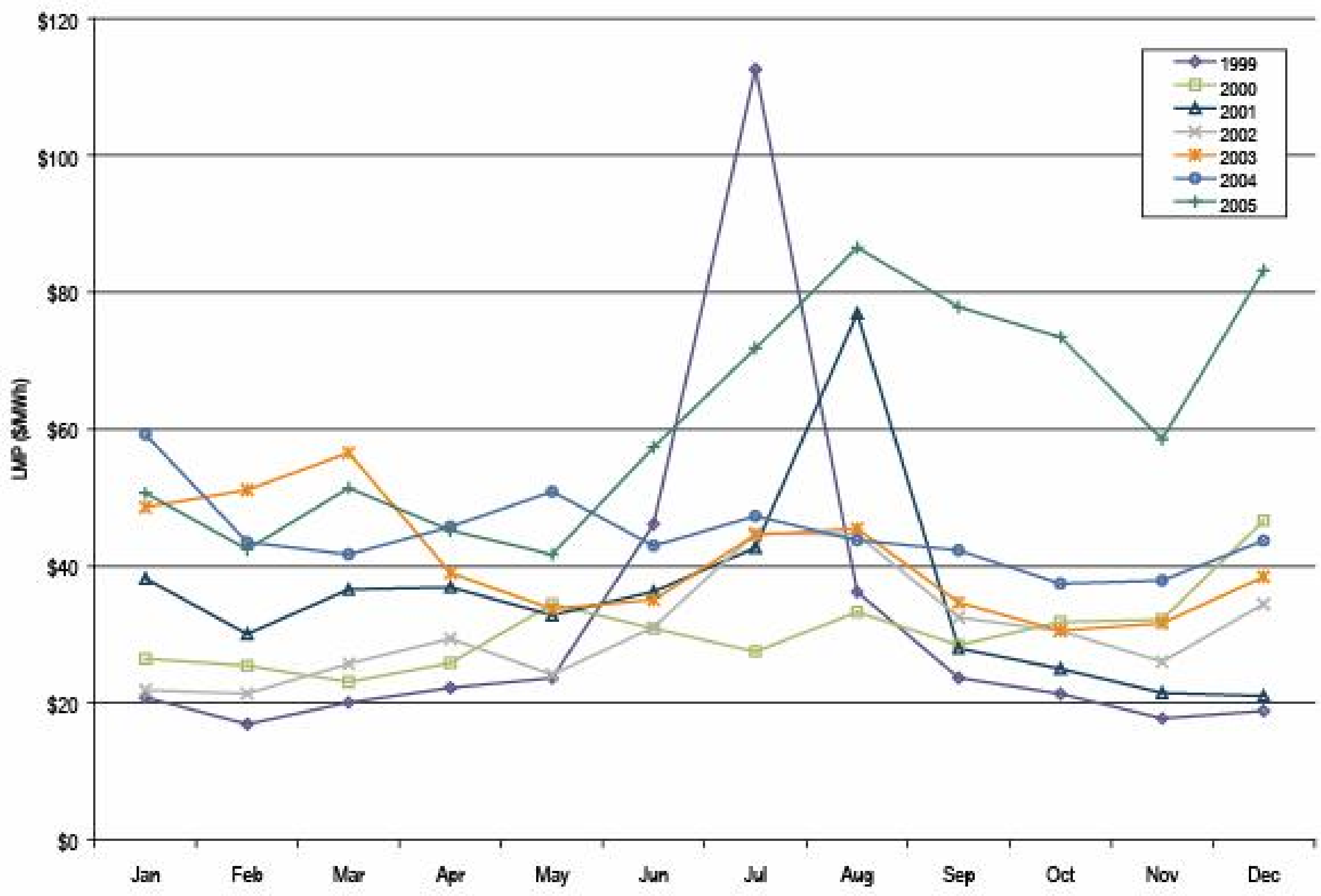


Table 2-35 - PJM fuel-cost-adjusted, load-weighted LMP (Dollars per MWh): Year-over-year method

	2004	2005	Change
Average	$44.34	$45.02	1.5%
Median	$40.16	$38.75	(3.5%)
Standard Deviation	$21.25	$25.68	20.8%

Table 2-18 - Type of fuel used by marginal units: Calendar years 2001 to 2005

Fuel Type	2001	2002	2003	2004	2005
Coal	49%	55%	52%	56%	62%
Misc	0%	0%	0%	0%	0%
Natural gas	18%	23%	29%	31%	26%
Nuclear	1%	0%	1%	0%	0%
Petroleum	32%	21%	18%	12%	11%

Difference in cost: Gas-fired CT and gas-fired CT: 2004 - 2005

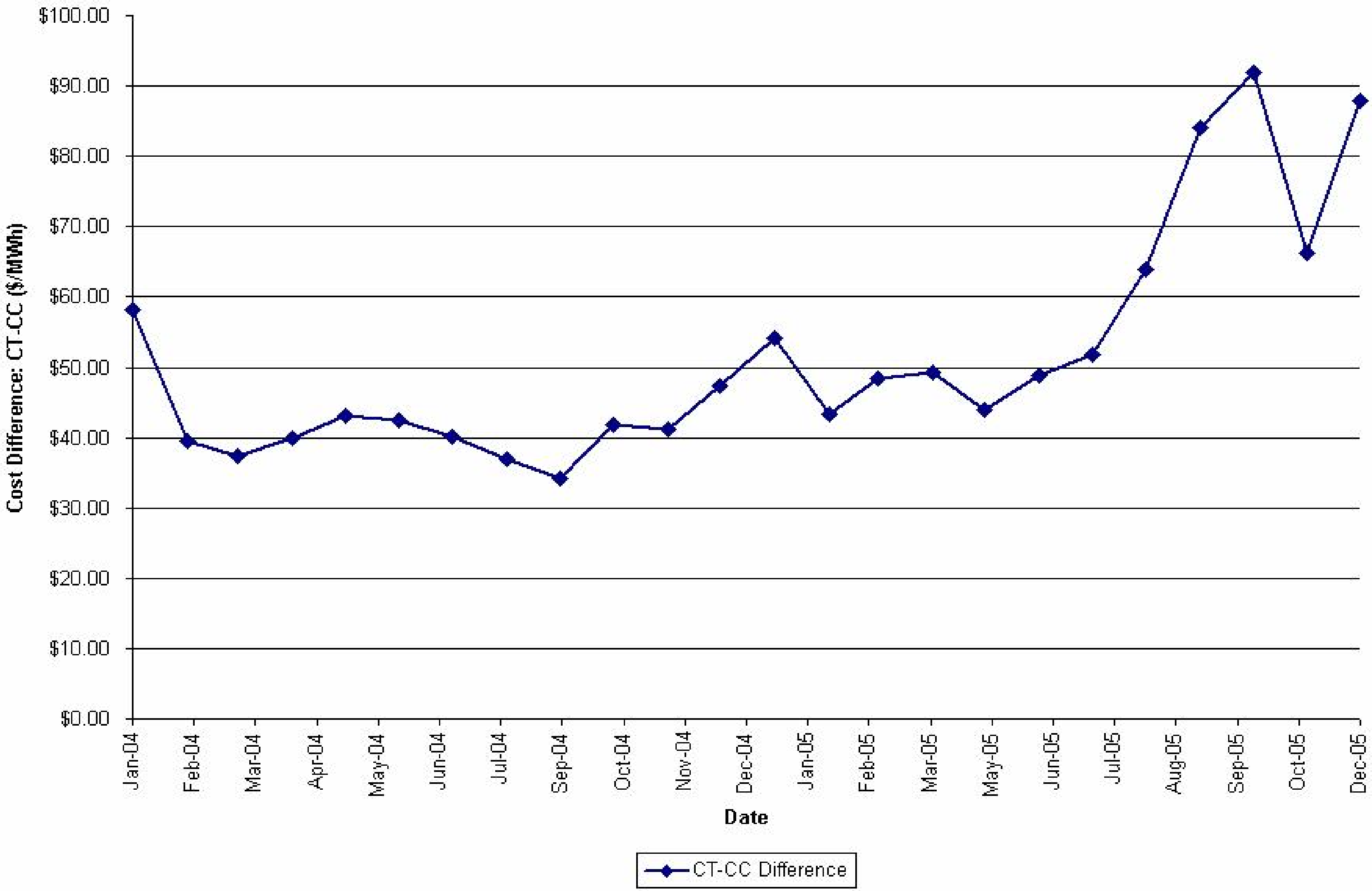
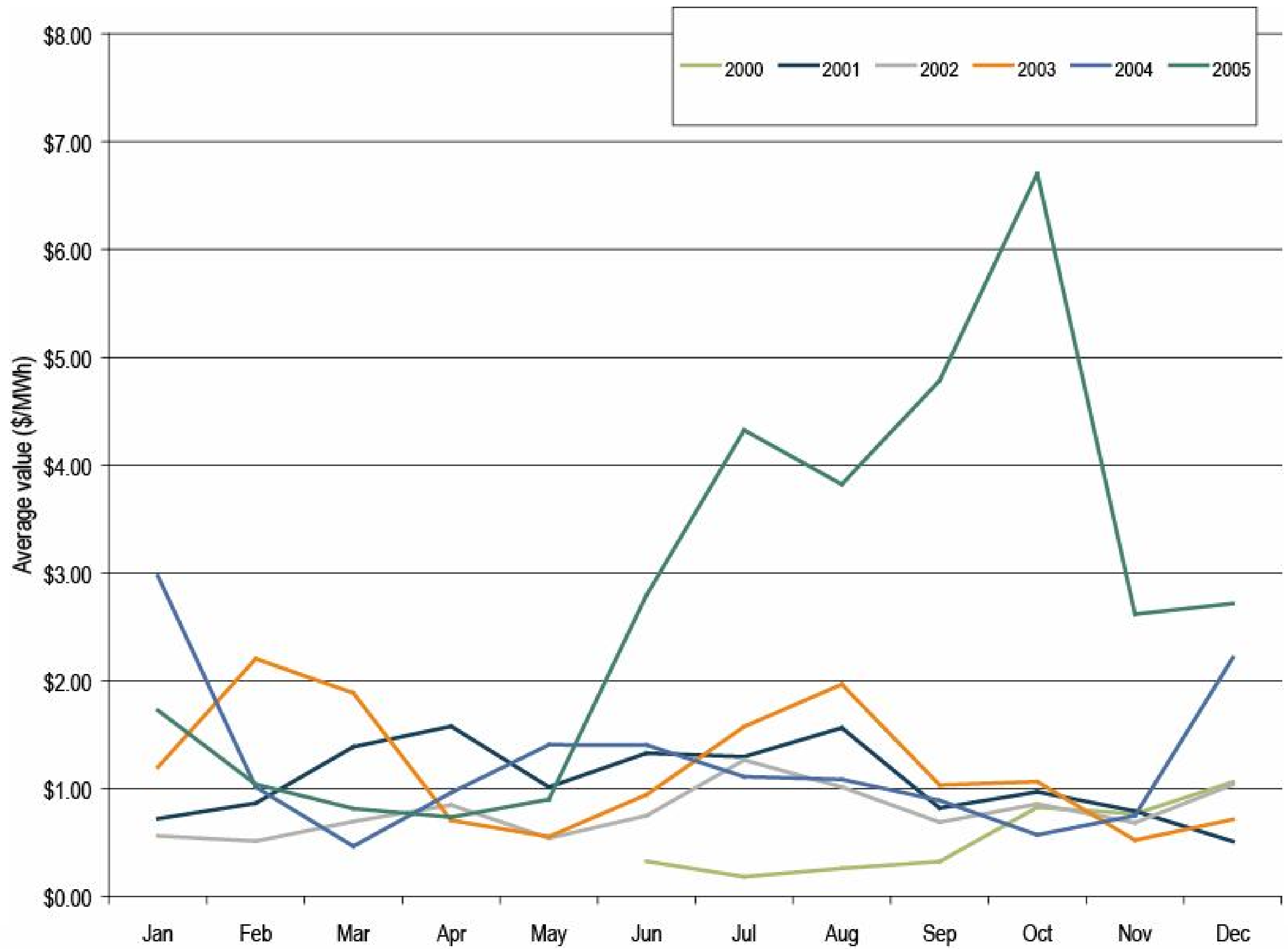


Figure 3-11 - Monthly average balancing operating reserve rate: June 1, 2000, through December 31, 2005



- Market Based Rates tests
  - Structural definitions
  - Definition of the market
  - Fixed historical time period
  - Reliance on RTO market monitoring
- Behavioral rules
  - Conduct/behavior definitions
- RTO tariff rules (approved by FERC)
  - Market structure
  - Conduct/behavior
  - Define local market power
  - Define other specific behaviors

- State specific rules
  - Transmission right of way
  - Generation construction
  - Wholesale restructuring
  - Affiliate rules
- State specific retail programs can create challenges for market monitoring
  - Auction structure and timing
  - POLR rules
  - Affiliate rules

- Market Monitoring Function
- PJM Markets
- Approach to Market Analysis
- **Market Design, Market Monitoring and Competition**

- Market design
  - Market design critical for effective monitoring and competition
  - Good market design does not obviate need for monitoring
- Market structure
  - Aggregate, supply-side market structure conditions not adequate to ensure competition
  - Transmission constraints limit competition in unpredictable ways
  - Full demand side participation - complex regulatory interactions to create required infrastructure
- Need to define market power as clearly as possible
  - Communicate definition to participants
  - Explain specific examples as they arise
- Need to define consequences of exercising market power
  - Explain specific examples as they arise

- Each market requires distinct monitoring
  - Metrics
  - Behaviors
- Nodal energy markets
  - Increased complexity (nodal behavior)
  - Reduced complexity (no schedules; zonal issues)
  - Different potential market power mechanisms
- Day ahead markets
  - Pure financial transactions included
  - FTRs included
  - Interactions
- Ancillary services markets
  - Geographic submarkets
  - Relationship to energy markets

Subtle and complex ways to exercise market power

- Market power is generally not aggregate market issue
- Exempt units and local market power
- Operating reserves
- Bid parameters
- Retirements/mothballing
- Ramp violations
- Loop flows
- FTR/Inc/Dec
- Creation of congestion

- Energy market design
  - Bid based
  - Security constrained
  - Central economic dispatch
  - Locational pricing
- Flexible energy markets
  - Day ahead and real time markets
  - Spot market
  - Bilateral market
  - Self supply
  - Imports
  - No limits or requirements as to contract terms
- Non-firm transmission willing to pay congestion
  - Unlimited transmission service available at a low charge
  - No barrier to competition

- Only one market-based offer curve per day
  - Hourly price offer changes not permitted
  - Real time price offer changes not permitted
  - Self-scheduling option for generation
- Local market power mitigation (Exempt units by date and area.)
  - Units with local market power are offer capped for determining LMP
  - Receive greater of marginal cost plus 10% or LMP
  - Alternative methods to determine offer cap
  - Treatment of environmentally limited units
- Required daily submission of cost data by unit
- Required submission of fuel cost data

PJM Market Design Elements

- Energy market offer cap = $1,000/MWh
  - Energy market offer cap includes operating reserve payments
- Price-based start up and no load costs can be modified only biannually
- Cost-based start up and no load costs option
- Regulation market (east) offer cap = $100 plus opportunity cost
- Spinning market: Tier 2 offers are cost based
- If maximum economic output specified in day ahead offer is less than in real time, forced outage ticket
- If unit classified as Max Emergency in day ahead and not in real time, forced outage ticket
- Increment offers/decrement bids cannot create day ahead congestion greater than real time congestion

PJM Market Design Elements

- Generator interconnection process (RTEP)
- Flexible capacity markets
  - Multiple capacity markets: Daily, monthly, multi-monthly
  - Bilateral capacity markets
  - Owned or contracted generation
- Capacity markets
  - Recall option on energy output during emergencies
  - Day ahead offer requirement
  - Penalty for withholding energy (forced outage adjustment)
  - Deliverability requirements
  - Facilitate retail access
- Capacity market effective offer cap = capacity deficiency rate
- Allocation of capacity deficiency payments
- Interval capacity market
- RPM market power mitigation rules

- Transmission outage notification requirements and FTR auction
- Required notification period for transmission outages
- Required coordination of transmission outages
- Required coordination of generator outages
- Publication of offer and other data
- Demand elasticity initiatives

PJM Market Design - Examples

- Local market power mitigation rules
- One offer per day
- Aggregate offer cap = $1,000 per MWh
- Nodal virtual bids/offers
- New capacity market (RPM) design and market power mitigation rules
- Regulation market

- Local market power
  - Structure/conduct/performance
  - Local markets defined by network properties
  - Local markets can be stable and/or dynamic
  - Relevant suppliers are a function of actual market conditions
  - Real time analysis
  - Day ahead analysis
  - Three pivotal supplier analysis
- Energy market
  - Overall offer cap
  - No explicit aggregate market power rules
- Ancillary services markets
  - Structure/conduct/performance
  - Hourly offers – complex analysis

