PJM's Challenge—Scarcity Pricing in the Context of Least Cost, Security Constrained Dispatch

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- Scarcity?
  - Scarcity exists when supply is less than, or equal to, demand where demand includes a level of operating reserves.
- Scarcity Pricing?
- Why is it important?

Table 3, Vol. I Total net revenue and 20-year, levelized fixed cost for new entry CT, CC and CP generators: Economic dispatch assumed

	CT		CC		CP	
	Economic Dispatch Net Revenue	20-Year Levelized Fixed Cost	Economic Dispatch Net Revenue	20-Year Levelized Fixed Cost	Economic Dispatch Net Revenue	20-Year Levelized Fixed Cost
1999	$74,537	$72,207	$100,700	$93,549	$118,021	$208,247
2000	$30,946	$72,207	$47,592	$93,549	$134,563	$208,247
2001	$63,462	$72,207	$86,670	$93,549	$129,271	$208,247
2002	$28,260	$72,207	$52,272	$93,549	$112,131	$208,247
2003	$10,565	$72,207	$35,591	$93,549	$169,510	$208,247
2004	$8,543	$72,207	$35,785	$93,549	$133,125	$208,247
2005	$10,437	$72,207	$40,817	$93,549	$228,430	$208,247
2006	$14,948	$80,315	$49,529	$99,230	$182,461	$267,792
Avg	$30,212	$73,221	$56,120	$94,259	$150,939	$215,690

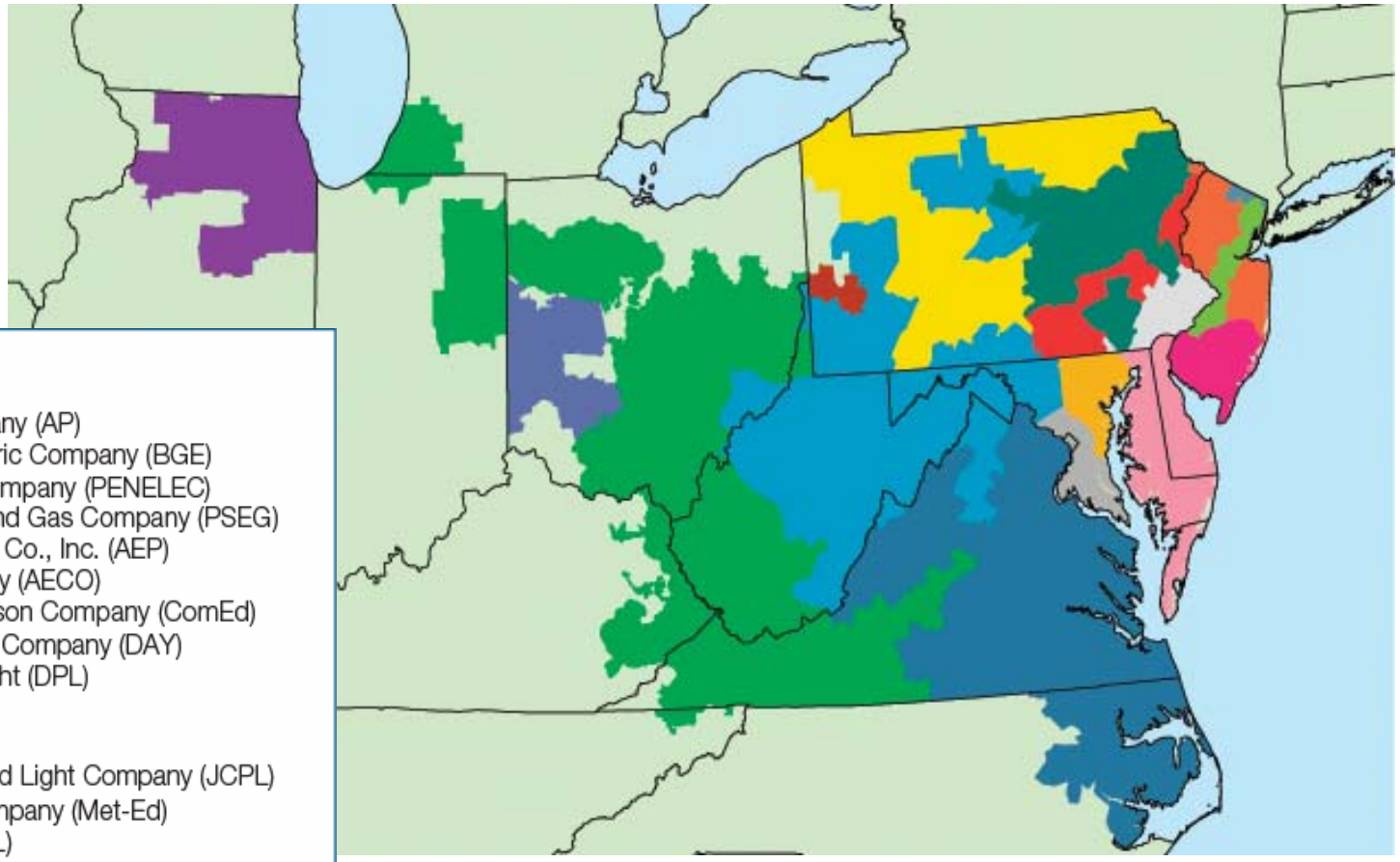
- Why is it a challenge for RTOs?
  - Administrative tools needed to maintain reliability
    - Limited demand response in real time
    - Supply must equal demand at all times
    - Many of the tools force demand to equal supply:
      - Voltage reductions
      - Load dump
      - Active load management
    - Other tool provide more supply:
      - Loading maximum emergency generation
      - Emergency purchases
      - Recalling energy

- Why is it a challenge for RTOs?
  - Administrative tools needed to maintain reliability
    - These tools tend to suppress market prices in times of scarcity

- Why is it a challenge for RTOs?
  - Mitigation of market power
    - Market rules designed to promote competitive outcomes
    - Under FERC standards prices are reasonable when they are the result of a competitive market, or barring a competitive market, on a market with sufficient mitigation to allow a competitive outcome.

- Why is it a challenge for RTOs?
  - Mitigation of market power
    - Market mitigation rules can fail to differentiate between market power and scarcity signals.
    - An issue in every market:
      - Conduct and Impact
      - Out of merit-based “Direct Mitigation”

The Challenge of Scarcity Pricing: PJM's footprint and its zones



Legend

- Allegheny Power Company (AP)
- Baltimore Gas and Electric Company (BGE)
- Pennsylvania Electric Company (PENELEC)
- Public Service Electric and Gas Company (PSEG)
- American Electric Power Co., Inc. (AEP)
- Atlantic Electric Company (AECO)
- The Commonwealth Edison Company (ComEd)
- Dayton Power and Light Company (DAY)
- Delmarva Power and Light (DPL)
- Dominion
- Duquesne Light (DLCO)
- Jersey Central Power and Light Company (JCPL)
- Metropolitan Edison Company (Met-Ed)
- PPL Electric Utilities (PPL)
- PECO Energy (PECO)
- Potomac Electric Power Company (PEPCO)
- Rockland Electric Company (RECO)

- 3 pivotal supplier test
  - More precise market mitigation
    - Market structure test
    - Behavior test
    - Impact test

- Modification of Frequently Mitigated Units rules
  - Local area scarcity rule
  - Provides an adder to unit cost offers if the unit qualifies

Table 2-5 Annual offer-capping statistics: Calendar years 2002 to 2006

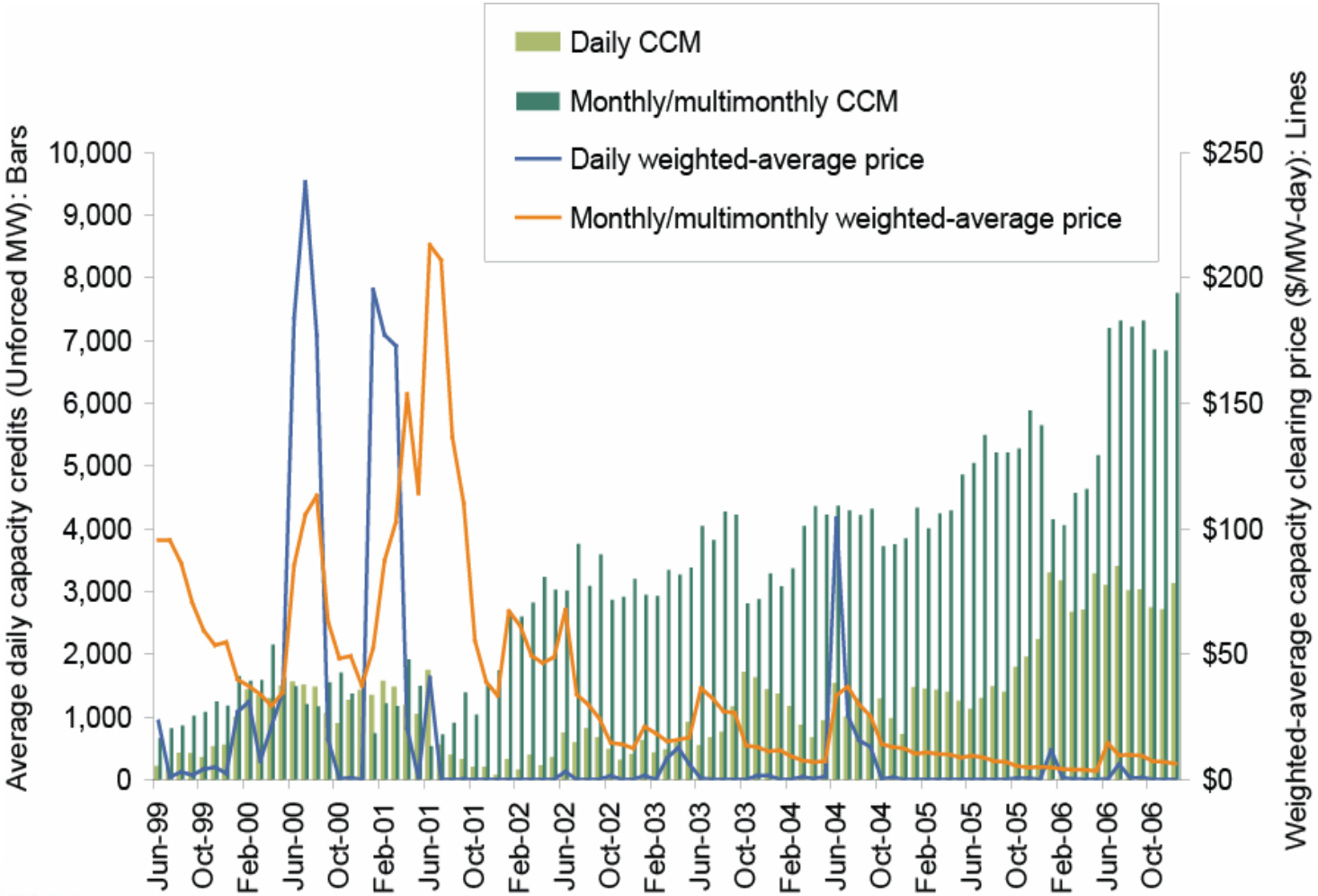
	Real Time		Day Ahead	
	Unit Hours Capped	MW Capped	Unit Hours Capped	MW Capped
2002	1.6%	0.3%	0.7%	0.1%
2003	1.1%	0.3%	0.4%	0.2%
2004	1.3%	0.4%	0.6%	0.2%
2005	1.8%	0.4%	0.2%	0.1%
2006	1.0%	0.2%	0.4%	0.1%

Table 2-8 Three pivotal supplier test details for regional constraints: March 1, to December 31, 2006

Constraint	Period	Average Constraint Relief (MW)	Average Effective Supply (MW)	Average Number Owners	Average Number Owners Passing	Average Number Owners Failing
5004/5005 Interface	Peak	110	397	17	14	3
	Off Peak	107	376	17	14	3
Bedington - Black Oak	Peak	57	220	12	9	3
	Off Peak	63	239	12	9	2
Kammer	Peak	83	285	17	13	4
	Off Peak	77	301	15	12	3
AP South	Peak	101	271	16	10	6
	Off Peak	97	306	15	9	6
West	Peak	138	829	17	17	0
	Off Peak	140	739	16	15	1

- RPM
  - Overhauled capacity market
  - Geographic price signals

Figure 5-6 PJM Daily and Monthly/Multimonthly CCM performance: June 1999 to December 2006



- Scarcity Pricing Rules
  - Triggers: emergency energy request events; maximum emergency generation events; manual load dump events; and voltage reduction events.
  - Based on the implementation of one or more of these emergency actions over an area consisting of two or more contiguous zones with 5 percent or greater positive distribution factor (“dfax”) relative to concurrently binding 500 kV or greater transmission constraints.
  - Effect: Price goes to the highest offer of a unit running for PJM within the zone.

- The two days with potential scarcity pricing event hours in 2005 were July 26 and July 27.
- voltage reduction and maximum emergency generation loaded.

- July 26, 2005
  - Ten 500 kV or greater transmission constraints
  - Mid-Atlantic Region, BGE and PEPCO, had a maximum emergency generation loaded action concurrently in effect for approximately two hours (1636 through 1830).

- July 27, 2005
  - Eleven 500 kV or greater transmission constraint
  - BGE, PEPCO, PSEG, PECO, JCPL and eastern PPL comprise a contiguous subset of the Mid-Atlantic Region and Dominion
  - Max emergency generation loaded and voltage redductions: 3.5 to 4.5 hours

- No events met the criteria in 2006

Figure 2-1 Average PJM aggregate supply curves: Summers 2005 and 2006

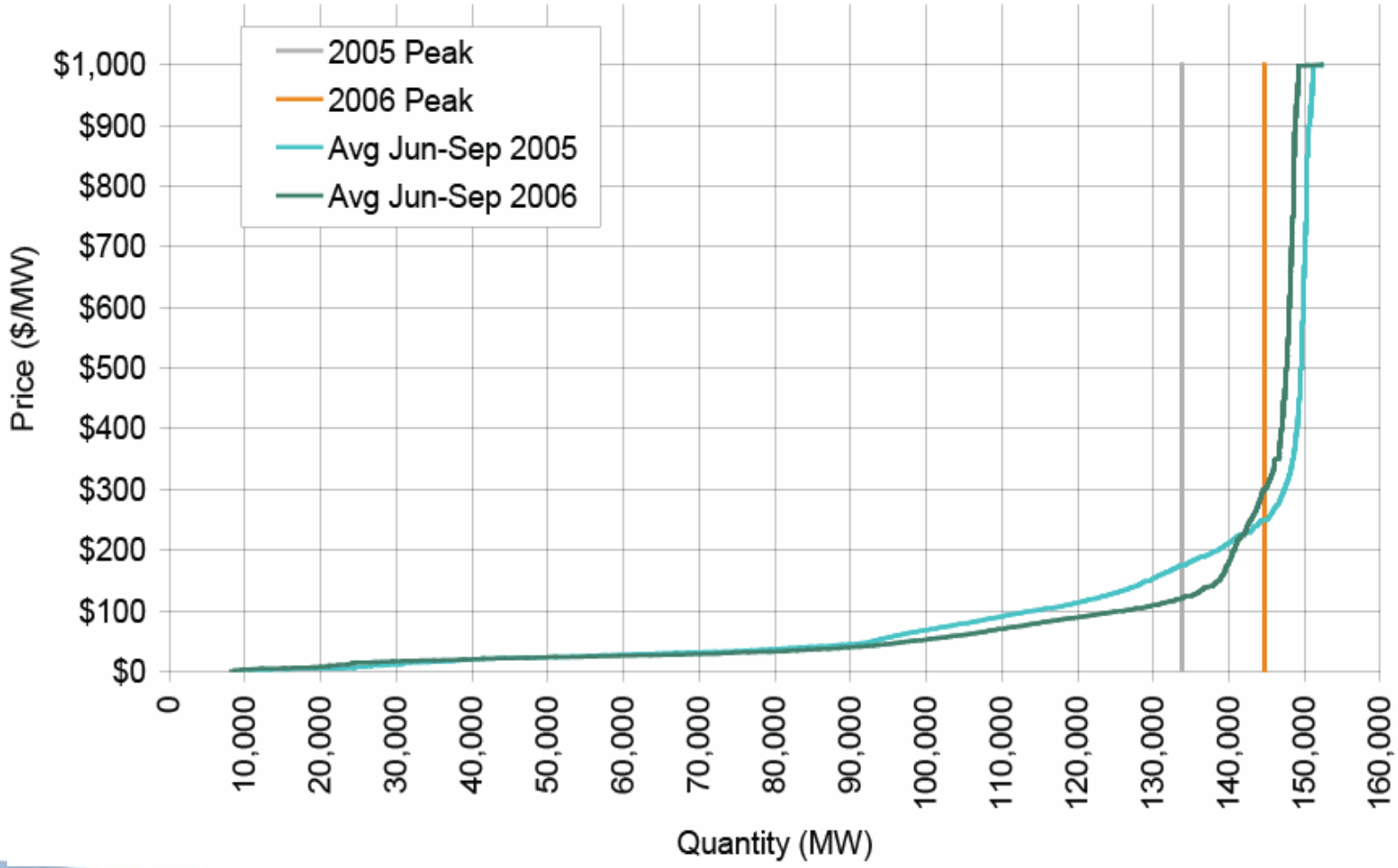


Table 2-2 Actual PJM footprint summer peak loads: 1999 to 2006

Year	Date	EPT Hour Ending	PJM Load (MW)	Difference (MW)
1999	06-Jul-99	1400	59,365	NA
2000	26-Jun-00	1600	56,727	(2,638)
2001	09-Aug-01	1500	54,015	(2,712)
2002	14-Aug-02	1600	63,762	9,747
2003	22-Aug-03	1600	61,500	(2,262)
2004	03-Aug-04	1700	77,887	16,387
2005	26-Jul-05	1600	133,763	55,876
2006	02-Aug-06	1700	144,644	10,881

Figure 2-2 PJM summer peak-load comparison: Wednesday, August 2, 2006, and Tuesday, July 26, 2005

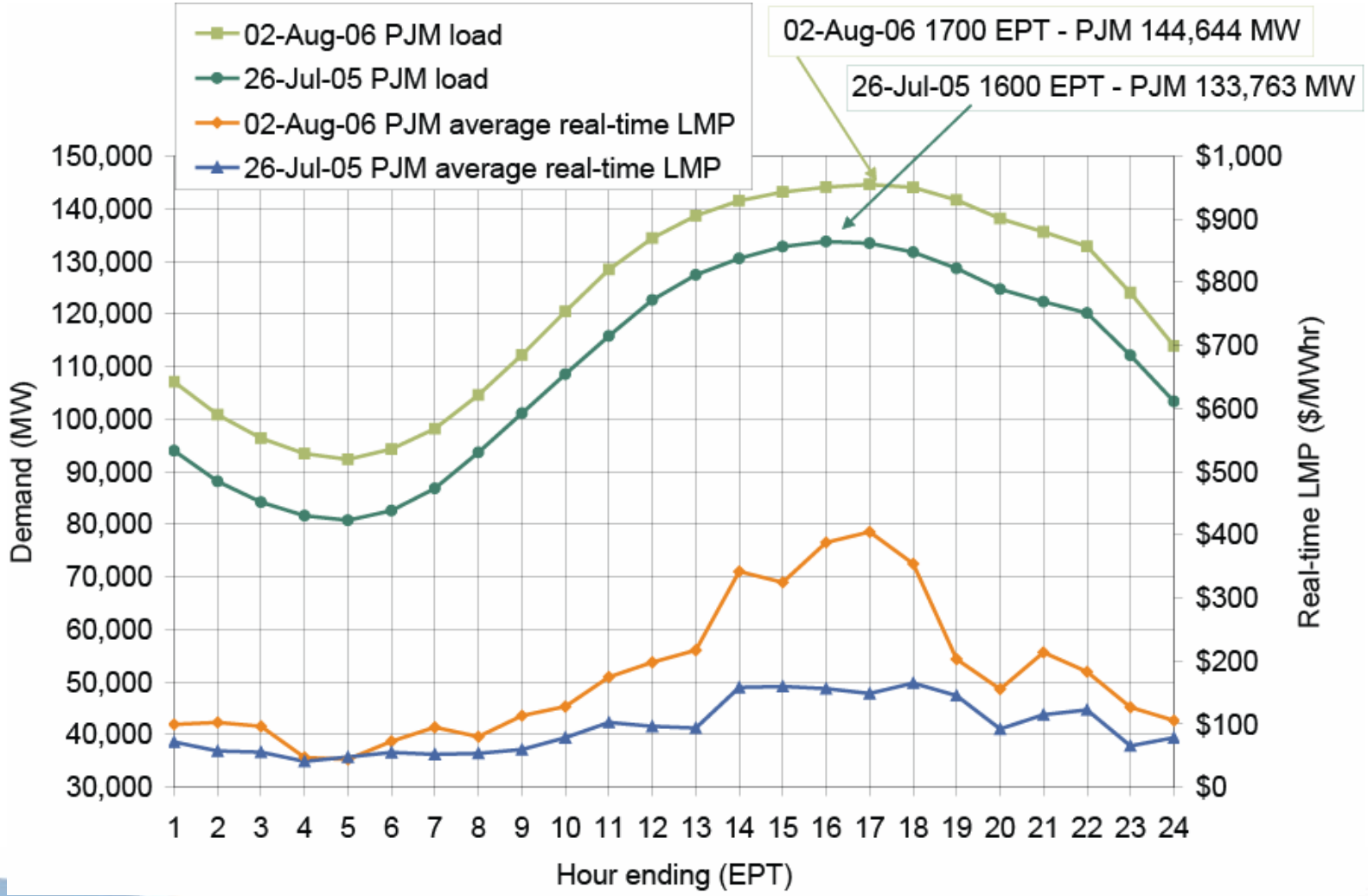
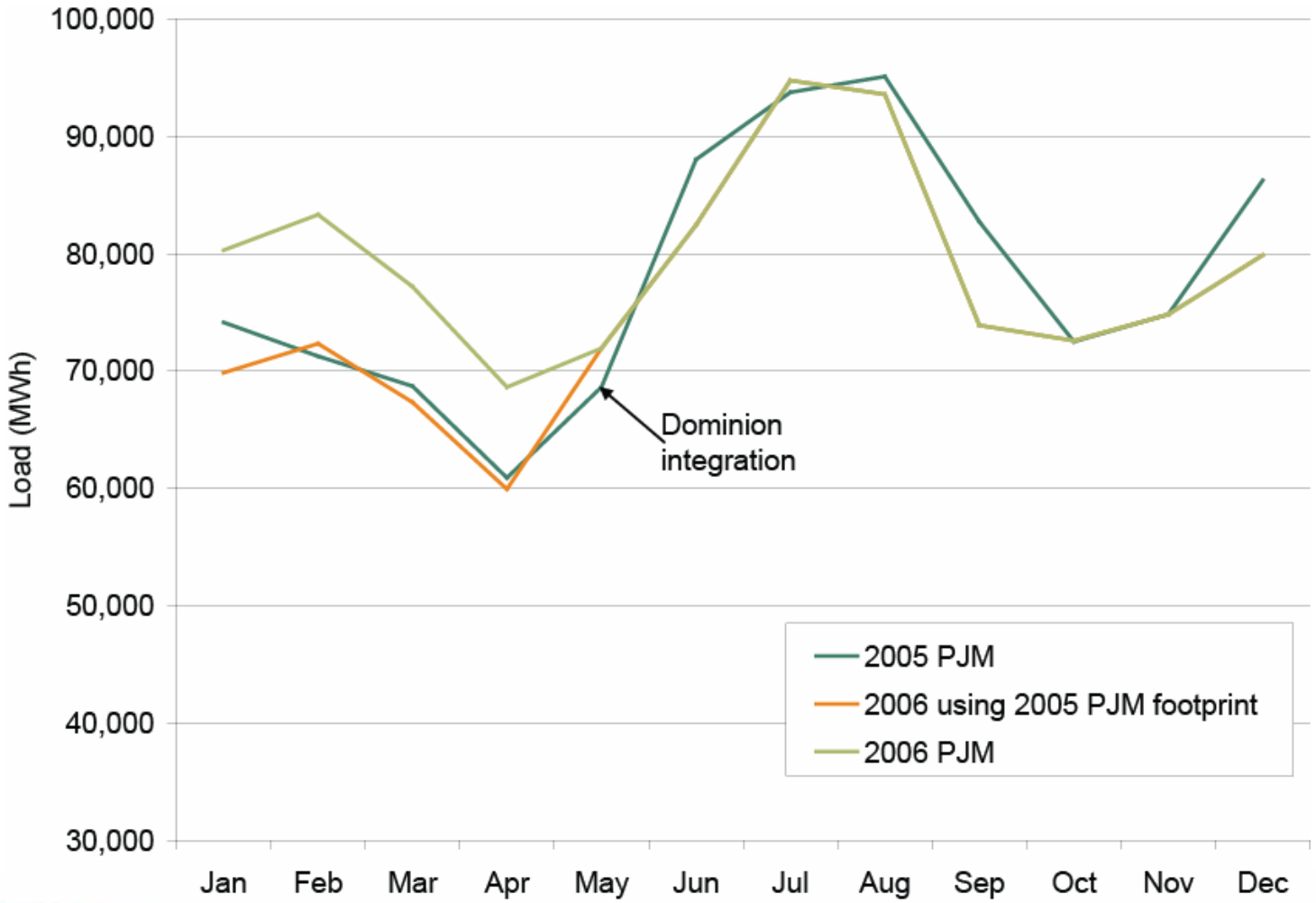


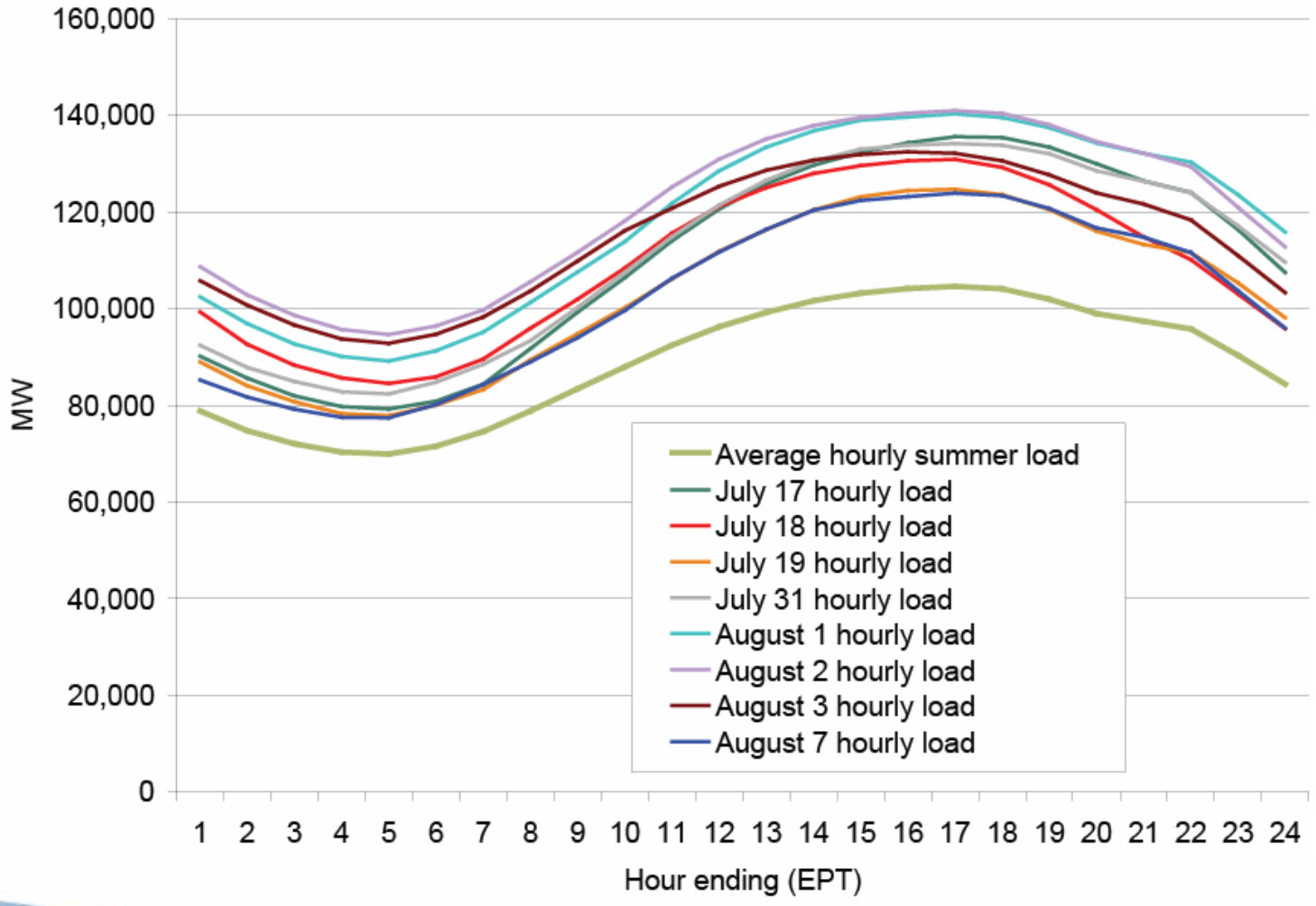
Figure 2-8 PJM average real-time load: Calendar years 2005 to 2006



- High Load
  - When hourly demand, including the day-ahead operating reserve target, equals 90 percent or more of total, within-hour supply in the absence of non market administrative intervention.
  - Administrative interventions added to demand (ALM) or subtracted from supply (Emergency Generation loaded)

- Scarcity
  - When hourly demand, including the day-ahead operating reserve target is greater than, or equal to, within-hour supply in the absence of non market administrative intervention.
  - Administrative interventions added to demand (ALM) or subtracted from supply (Emergency Generation loaded)

Figure 3-4 High-load day hourly load and average hourly load: Summer 2006



- Active Load Management (ALM)
  - August 2 and 3
- Max Emergency Generation Alert
  - July 17-18, July 31, August 1-3

Figure 3-5 Net within-hour resources: July 17 to July 19, and July 31, 2006

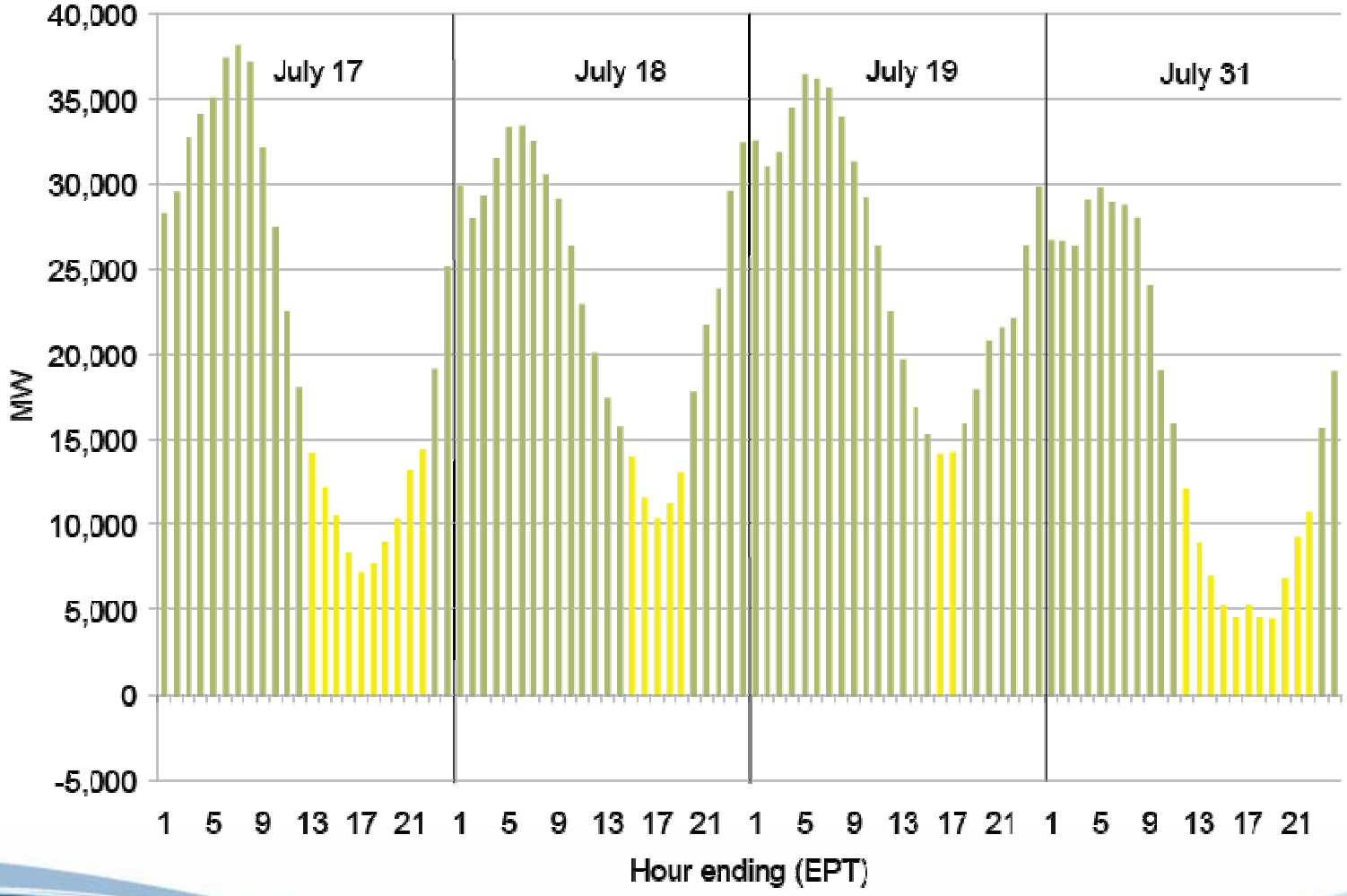
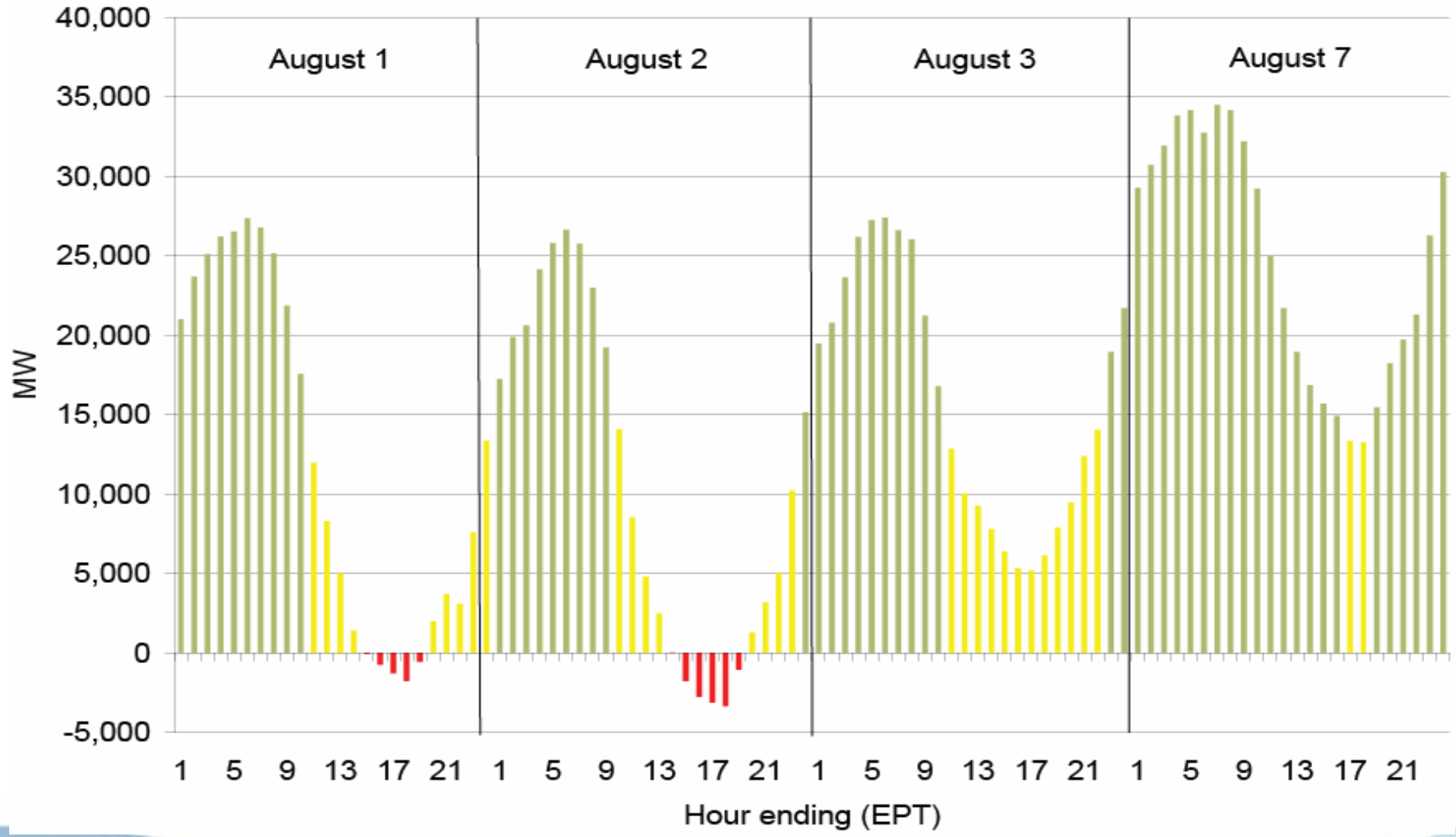


Figure 3-6 Net within-hour resources: August 1 to August 3, and August 7, 2006



Within-hour maximum emergency capacity relative to hourly demand in excess of within-hour economic resources: August 1 to August 2, 2006

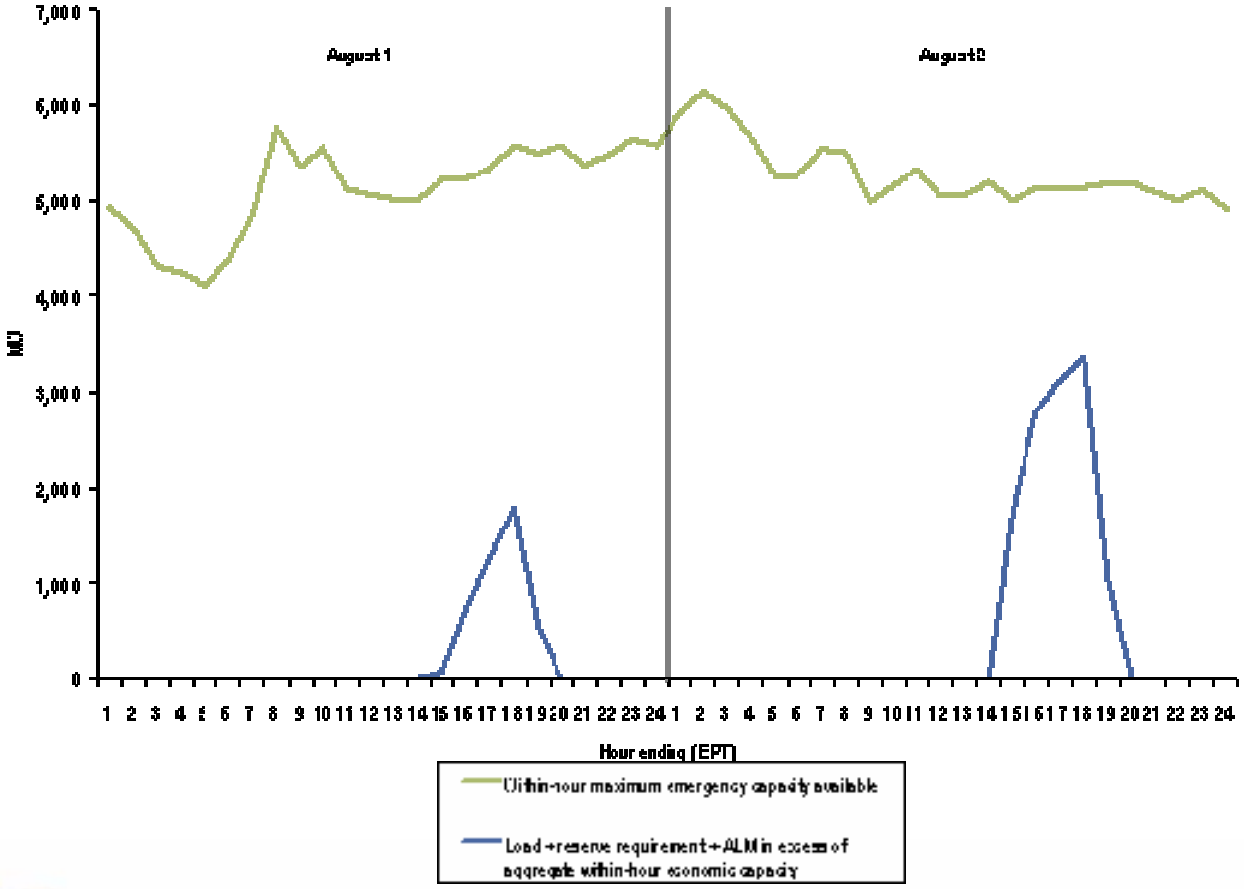


Figure 2-12 Monthly load-weighted, average LMP: Calendar years 2002 to 2006

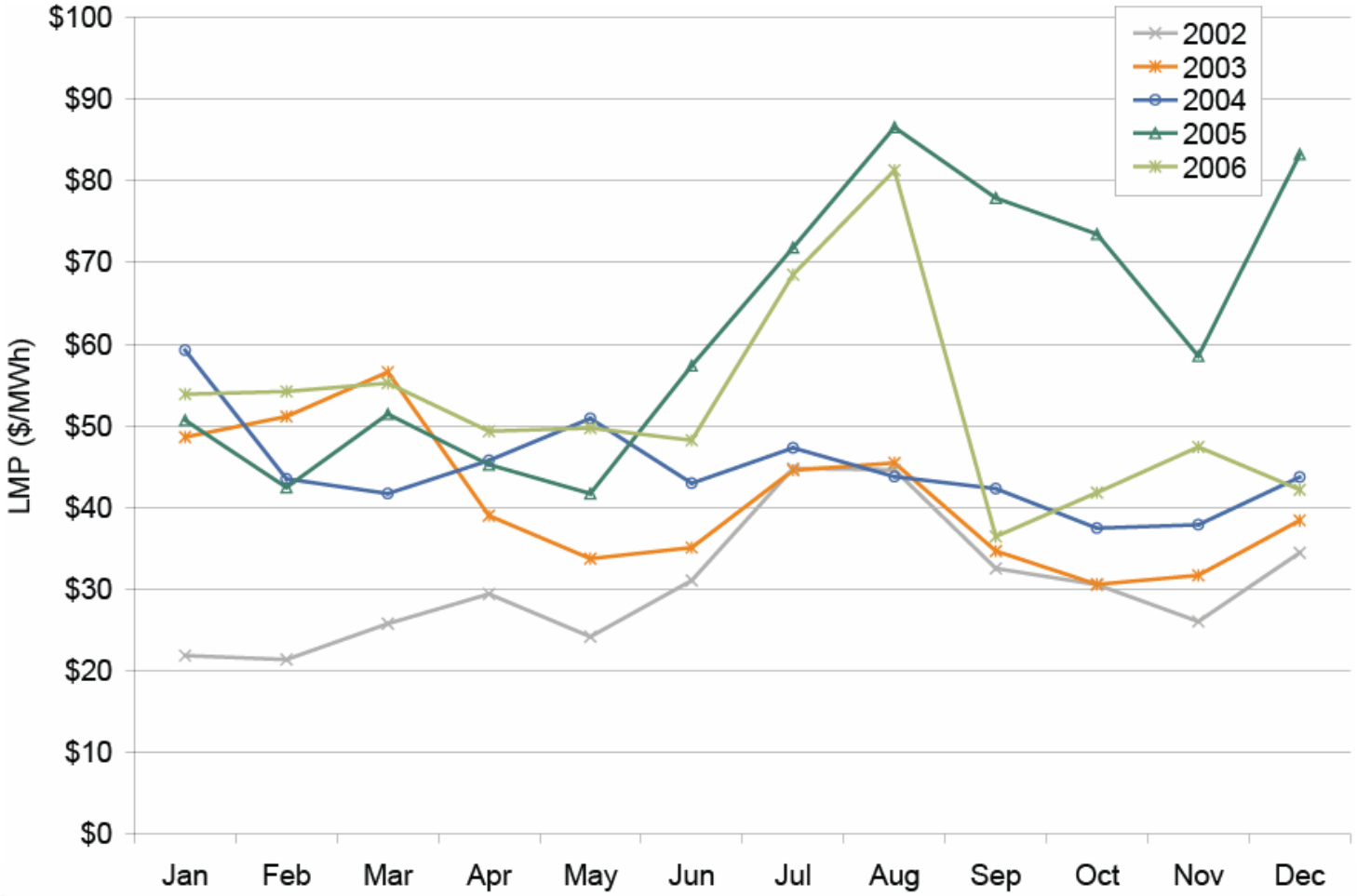


Table 2-46 PJM load-weighted, average LMP (Dollars per MWh): Calendar years 1998 to 2006

	Load-Weighted, Average LMP			Year-to-Year Change		
	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%
2006	$53.35	$44.40	$37.81	(15.9%)	(16.1%)	(0.8%)

Figure 2-13 Spot average fuel price comparison: Calendar years 2005 to 2006

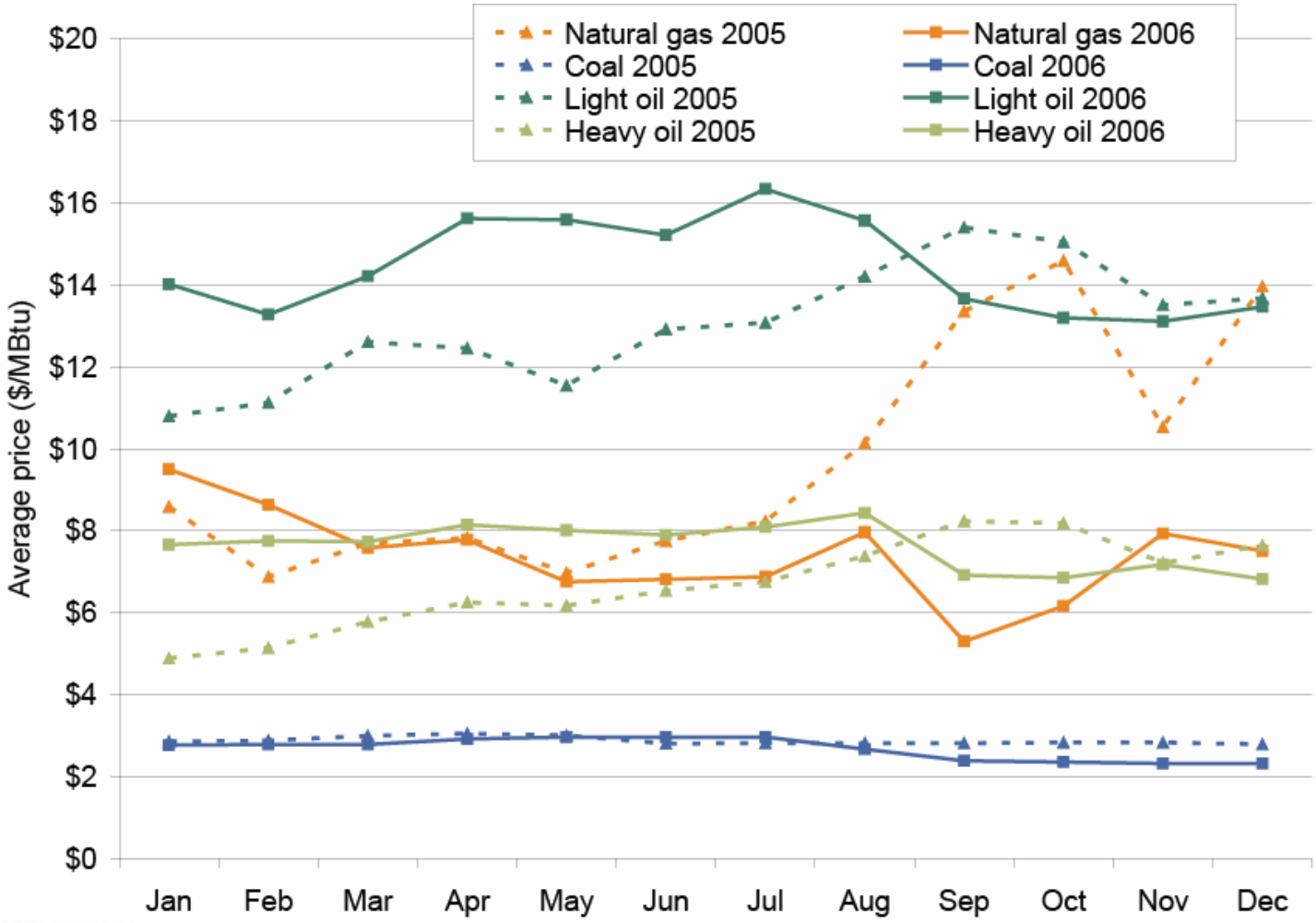


Table 2-47 PJM fuel-cost-adjusted, load-weighted LMP (Dollars per MWh): Year-over-year method

	2005 Load-Weighted LMP	2006 Fuel-Cost-Adjusted, Load-Weighted LMP	Change
Average	$63.46	$59.89	(5.6%)
Median	$52.93	$49.99	(5.5%)
Standard Deviation	$38.10	$38.34	0.6%

Table 2-50 Components of annual PJM load-weighted, average LMP: Calendar year 2006

Element	Contribution to LMP	Percent
Coal	$20.67	38.7%
Gas	$17.23	32.3%
Oil	$2.65	5.0%
Uranium	$0.00	0.0%
Wind	$0.01	0.0%
NOX	$1.53	2.9%
SO2	$5.39	10.1%
VOM	$2.67	5.0%
Markup	$1.54	2.9%
Constrained Off	$1.06	2.0%
NA	$0.59	1.1%

Table 2-36 Comparison of exempt and non-exempt markup component: Calendar year 2006

	Units Marginal	Markup Component
Non-Exempt Units	667	$0.98
Exempt Units	43	$0.56

Table 2-39 Markup contribution of exempt and non-exempt units: Calendar year 2006

	Exempt Markup Component	Non-exempt Markup Component	Total
High-Load Days	$0.11	$0.49	$0.60
Balance of Year	$0.45	$0.49	$0.94
Total	$0.56	$0.98	$1.54

- Revisiting Scarcity Pricing Rules
  - Well designed markets should not require market power abuse to achieve sustainability
    - Unlikely that market power alone could achieve sustainability and the reliable functioning of markets
  - The use of administrative steps to maintain system reliability a good proxy for regional scarcity conditions, but changes needed:
    - Every “un-priced” tool used to trigger a scarcity signal.
    - Cumulative, predetermined adders based on use of administrative steps to maintain the system during periods of relative high load.
    - Signals need to be locational
      - Adders to unit offers would allow LMP signals to continue to provide economic signals
  - Need an operational definition of local scarcity
    - Have such a mechanism largely in place due to data available from the 3 pivotal supplier test.
    - Should provide adders to offers of units in local scarcity conditions
    - Should be based on the cost of new entry, and sufficient to encourage entry.

- Scarcity pricing rules should be part of an overall market design, which allows for sustainability and reliability. Revenues integrated into RPM calculations, etc.

- Energy market prices alone not enough to sustain this market
  - Price ranges and unit characteristics define discrete markets

