Monitoring Analytics

Three Pivotal Supplier Test Discussion

FERC Litigation Staff Meeting

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Monitoring Analytics

The Independent Market Monitor for PJM

Monitoring Analytics

- Market monitoring is required by Federal Power Act
  - Associated FERC Orders
- Role of competition under the FPA
  - Mechanism to regulate prices
  - Competitive outcome = just and reasonable
- Relevant model of competition is not laissez faire
- Competitive outcomes are not automatic
- Detailed rules required – like other markets/exchanges

- 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 - parameters

  - 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

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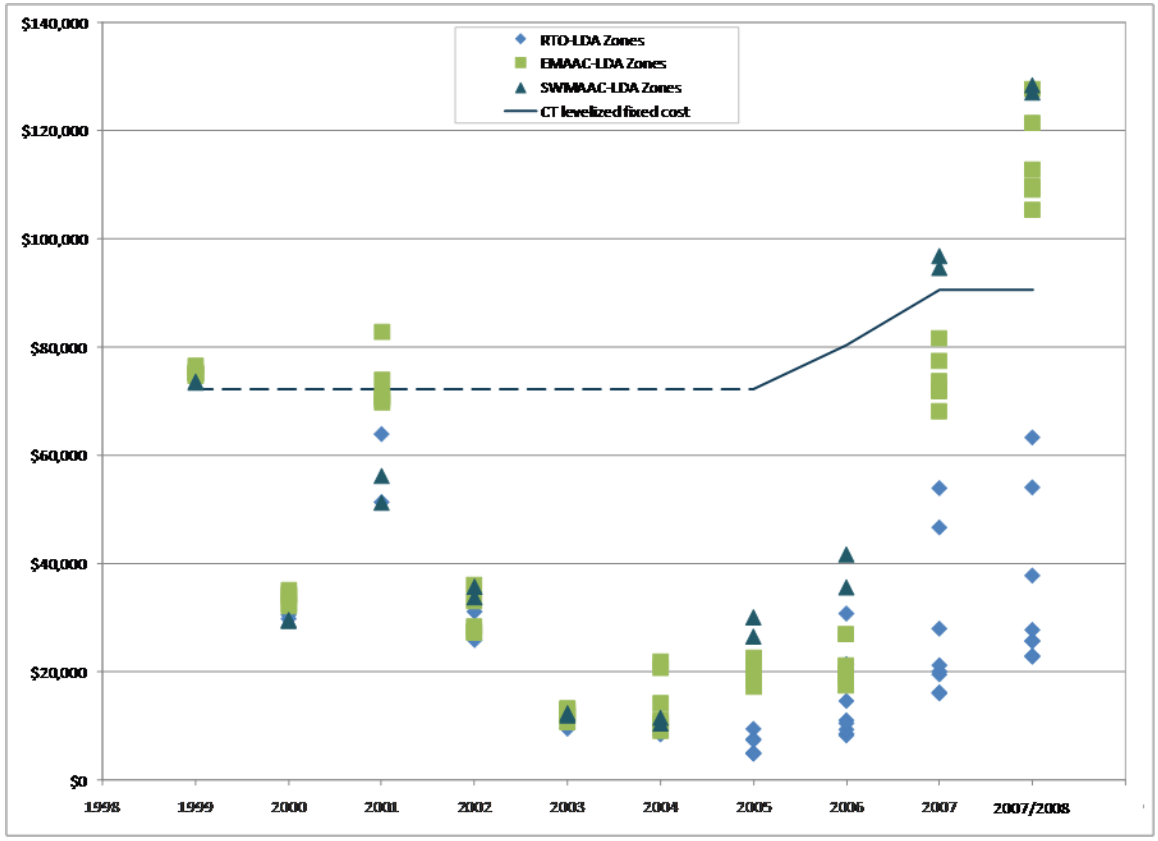
- Goal is sustainable, competitive market design
  - Competitive markets that result in investment incentives
  - Sustainable market design cannot rely upon market power
- PJM markets are complete
  - Day ahead and real time energy markets
  - Capacity market
  - Ancillary services markets
- PJM markets are revenue adequate
- PJM markets provide investment incentives
  - Locational marginal prices
  - Locational RPM

- Scarcity revenues are captured in the RPM design
  - RPM revenues are a substitute for the scarcity revenues that would result in an all-energy market
- Scarcity revenues in the energy market are an offset to the scarcity revenues in the capacity markets
- PJM has clearly defined, FERC approved scarcity pricing rules.
- Local market power mitigation is not applied during scarcity conditions.

CT Net Revenue from All Markets and Fixed Costs



MW added under RPM: 2007 – 2011 RPM auctions

	UCAP (MW)
Total internal capacity @ 31-May-07	154,967.6
New generation	3,139.2
Reactivated units	**796.8**
Generation capmods	1,713.5
DR mods	**2,117.2**
Reclassification of Duquesne units	(3,009.5)
Net EFORd effect	**157.9**
Total internal capacity changes	4,915.1
Total internal capacity @ 01-Jun-11	159,882.7
Reclassification of Duquesne units	**3,009.5**
Adjusted internal capacity @ 01-Jun-11	162,892.2
Net exchange (imports-exports) @ 01-Jun-11	2,480.7
ALM/ILR @ 01-Jun-11	**370.0**
Postponed/withdrawn retirements/deactivations @ 01-Jun-11	1,790.8
Total MW added under RPM @ 01-Jun-11	12,566.1

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- The three pivotal supplier test is applied in the PJM Day-Ahead Energy Market.
- The three pivotal supplier test is applied in the PJM Real-Time Energy Market.
- The three pivotal supplier test is applied in the PJM RPM (capacity) Market.

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- Derived from FERC's Delivered Price Test
  - 107 FERC ¶ 61,018 (2004) (AEP Order)
  - Market power screens
  - Market power tests
- Definition of the relevant market – supply available at 1.05 times clearing price
- Metrics
  - HHI test
  - Market share test
  - Pivotal supplier test

Consistent with FERC Methodology

- FERC considers a supplier to have market power if the FERC screens are failed for any one of the identified demand conditions.
  - Screens and tests
- FERC approach is historical
  - Relies on data samples from representative periods
- FERC approach requires the application of judgment
- FERC outcome is a decision that applies for three years
  - Relies upon mitigation rules in organized markets
- TPS is applied in real time using a market definition based on PJM's actual dispatch logic
- TPS is for local markets only

Three Pivotal Supplier Test

- Definition of competitive local market structure
- Replaces offer capping of all units for local markets created by constraints
- Real-time analysis of market structure
- Offer caps based on cost data from each unit

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- In an LMP-based market, constraints create smaller, local markets with different structural characteristics than the aggregate market.
- In a local market, all units do not have an equivalent ability to compete.
- The ability to compete is a function of:
  - Unit offer price or cost
  - Unit impact on the constrained facility.
- The local market includes only resources that can deliver relief to specific constraints at a competitive price within a defined time.
- Same logic for locational RPM market design.

Distribution factors

- Consider two units with the same 100 MW capacity and identical energy offers of $150 at a time when the PJM LMP is $100.
- Unit A is located electrically close to the constrained facility and has a distribution factor of 90 percent, while unit B is electrically distant with a 5 percent distribution factor.
- Unit A is able to provide (100 MW * (-0.90)) = -90 MW of relief at an effective cost of ($100 - $150)/(-0.90) = $55.56 per MW
- Unit B can provide (100 MW * (-0.05)) = -5 MW of relief at an effective cost of ($100 - $150)/(-0.05) = $1000

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- TPS is a dynamic, real-time application that measures market structure based on PJM's market logic and rules
- Pivotal means that the output of the defined suppliers is necessary to clear the market
- Three pivotal suppliers means that the output of three suppliers is necessary to clear the market

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- Demand
  - Incremental, effective MW
  - Requirement for constraint relief
  - MW measured at constraint
- Supply
  - Incremental, effective MW
  - Operationally available
  - Unit MW reflecting distribution factor to constraint
- Market definition
  - Supply available at less than or equal to 1.50 times clearing price

Context of TPS Test Results

- TPS test is triggered in real time whenever PJM's Unit Dispatch System (UDS) dispatch software detects the need to provide incremental relief for a transmission constraint.
- The universe of real-time TPS tests is all intervals in which PJM's UDS software identifies the need to provide incremental relief for a transmission constraint.

Units Subject to Offer Capping

- Only offline units are subject to offer capping
- In the majority of cases, the relevant supply curve consists of units which are already operating
- Such units (already operating) are not subject to offer capping, regardless of the TPS test result

Use of actual dispatch and operational parameters

- The application of TPS test uses PJM's actual dispatch of units to solve a constraint.
- Detailed unit characteristics are explicitly accounted for:
  - distribution factors;
  - operational status;
  - fuel type;
  - start and notification time;
  - minimum run time;
  - steam units' ramp rates;
  - economic maximum and economic minimum limits.

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- A generation owner is pivotal when output of its units required to meet demand
- RSI = (Total supply – $supply_1$) / (Total demand)
- If RSI < 1.0, owner is pivotal
- Generation owners are jointly pivotal when output of owners' units required to meet demand
- RSI = (Total supply – $supply_{1,2,3}$) / (Total demand)
- If RSI < 1.0, owners are jointly pivotal

Details: Three Pivotal Supplier Test

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- Incrementally *Available* supply (S_i) is measured as incremental effective MW of supply:

$$MW \bullet DFAX$$

Example: 100 MW 15 minute start CT with a DFAX of .05 to the constraint would contribute 5 MW to Incrementally available MW relative to the constraint.

- With one constraint, LMP at any given bus j is given by:

$$LMP_j = SMP + \lambda_i \times DFAX_{ij}$$

- If LMP = the offer (Offer) of the marginal unit that cleared the constraint:

$$\lambda_i = \frac{Offer_c - SMP}{DFAX_{ic}} = P_c$$

- For purposes of the test, this defines the shadow price (the clearing price) at the point of intersection between incrementally available supply and the amount of relief needed.

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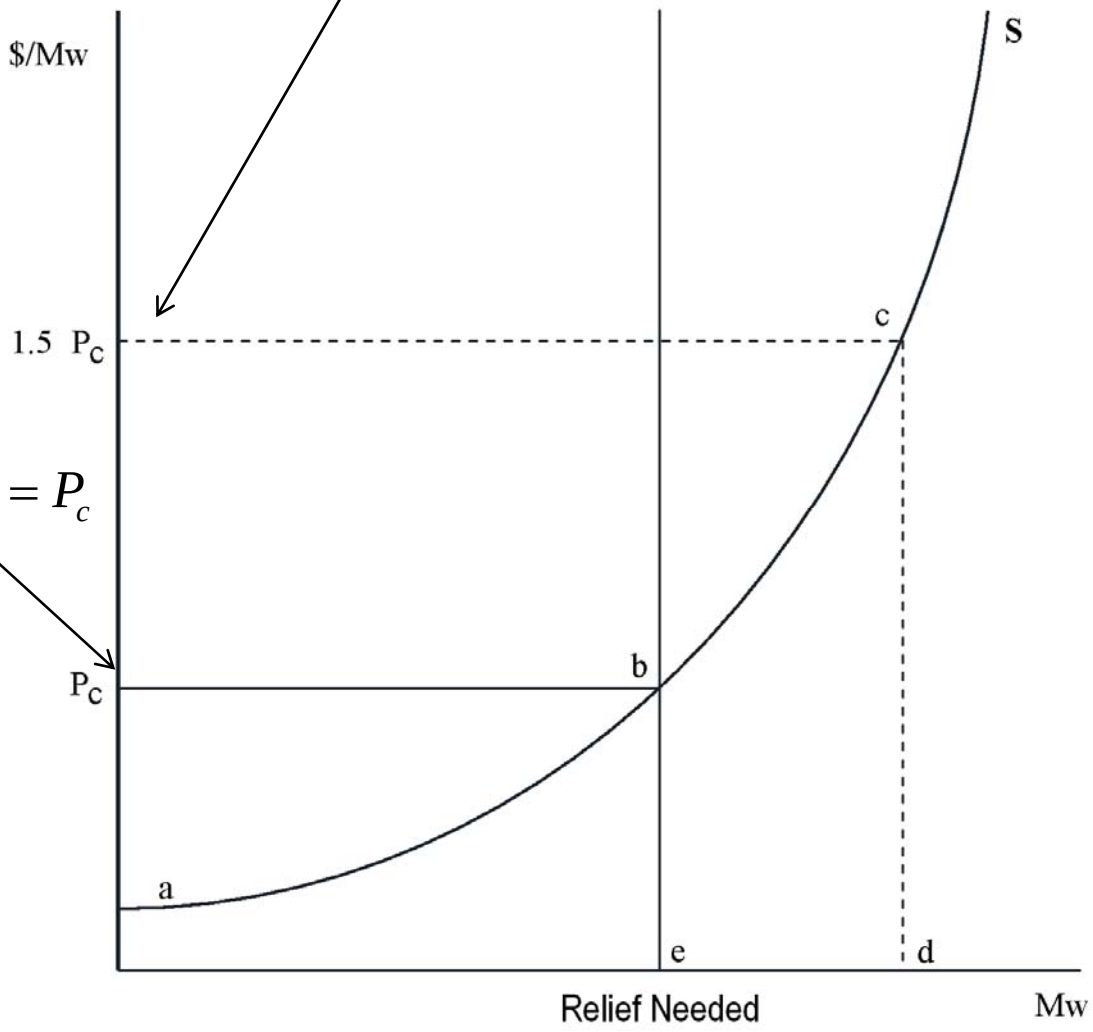
$$1.5 \times \lambda_i = 1.5 \times \left(\frac{Offer_c - SMP}{DFAX_{ic}}\right) = 1.5 \times P_c$$

$$\lambda_i = \frac{Offer_c - SMP}{DFAX_{ic}} = P_c$$



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- Incrementally available and *effective* supply from Supplier j:

$$S_j = MW_j(Offer_j) \times DFAX_{ij}$$

- Where

$$1.5 \times \lambda_i \geq \left(\frac{Offer_j - SMP}{DFAX_{ij}}\right)$$

- or

$$SMP + 1.5 \times \lambda_i \times DFAX_{ij} \geq Offer_j$$

TPS – Total Effective Supply

- Where S_i is the effective supply of supplier I
- Total incremental, effective supply for suppliers i=1 to n:

$$S = \sum_{i=1}^{n} S_i$$

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- Each effective supplier is ranked, from largest to smallest relevant effective supply, relative to the constraint for which it is being tested.
- In the first iteration of the test, the two largest suppliers are combined with the third largest supplier, and this combined supply is subtracted from total relevant effective supply.
- The result, effective supply from all other suppliers, is divided by the total relief required (D).

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- Where j defines the supplier being tested in combination with the two largest suppliers (initially the third largest supplier with j=3):
- Where this ratio (RSI3) is less than or equal to one, the three participant portfolios of effective and relevant supply tested fail the TPS test

$$RSI3_j = \frac{\sum_{i=1}^{n} (S_i) - \sum_{i=1}^{2} (S_i) - S_j}{D}$$

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- In each iteration, when RSI is less than 1.0, it indicates that the tested supplier, in combination with the two largest suppliers, has failed the test.
- Iterations of the test continue until the combination of the two largest suppliers and a supplier j achieve a result of RSI3 greater than 1.0.
- When the result of this process is that RSI3j is greater than 1.0, the remaining suppliers will pass the test.

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- If a supplier fails the TPS test for a constraint, units that are part of a supplier's effective supply with respect to the constraint can have their offers capped at cost + 10% (or cost plus relevant adders for frequently mitigated units and associated units).

- Offer caps are applied only if the supplier's relevant units are offered at greater than cost + 10% and are dispatched to contribute to the relief of the constraint

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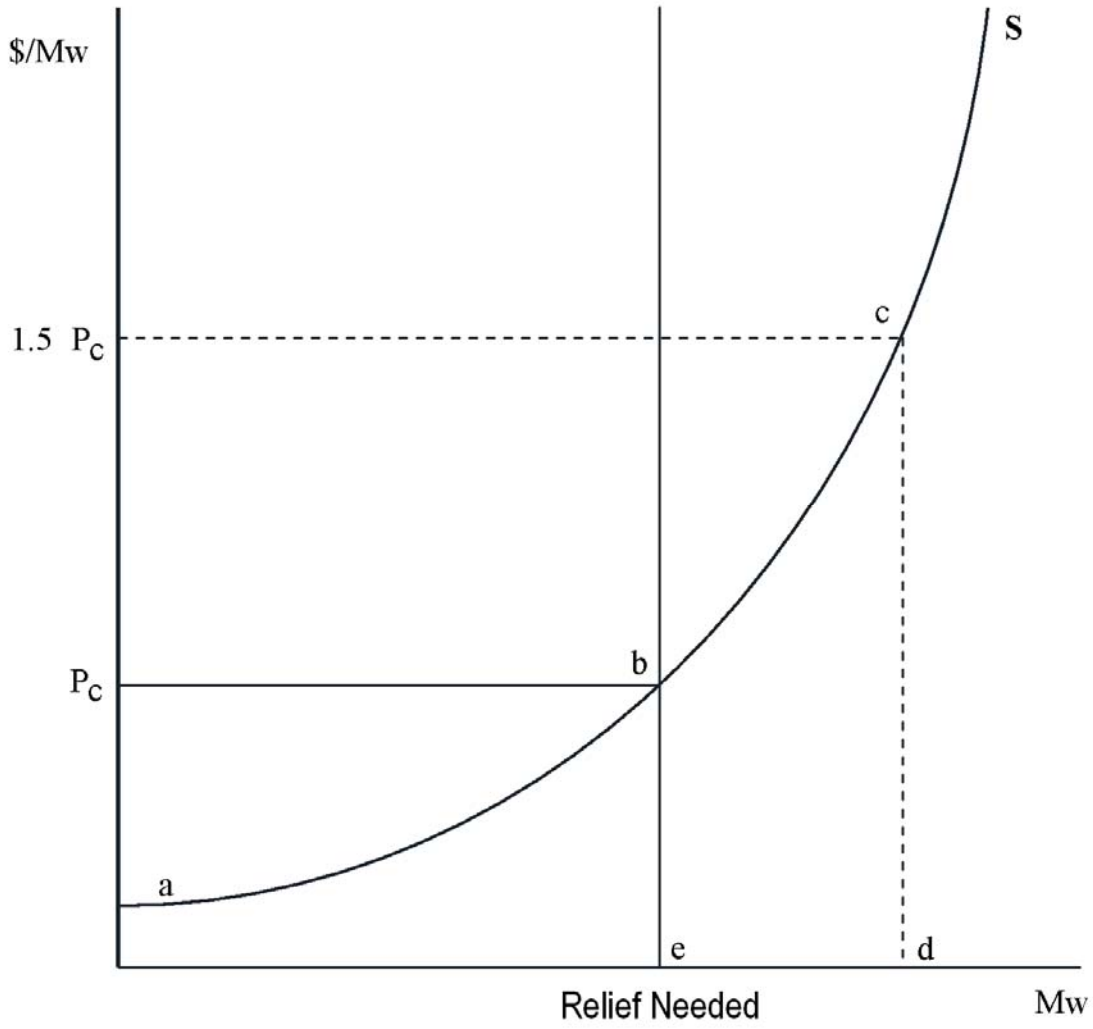

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Units Eligible for Mitigation - Results

- The results indicate that a very small proportion of the units failing TPS are eligible for mitigation.
- Units actually mitigated are a subset of the units that both fail the TPS and are eligible for mitigation.
- Most available constraint relief is from units that are currently operating.
- Units that fail the TPS are mitigated only when they are the least cost solution to the constraint and they are brought on to relieve the constraint.

Units Eligible for Mitigation - Results

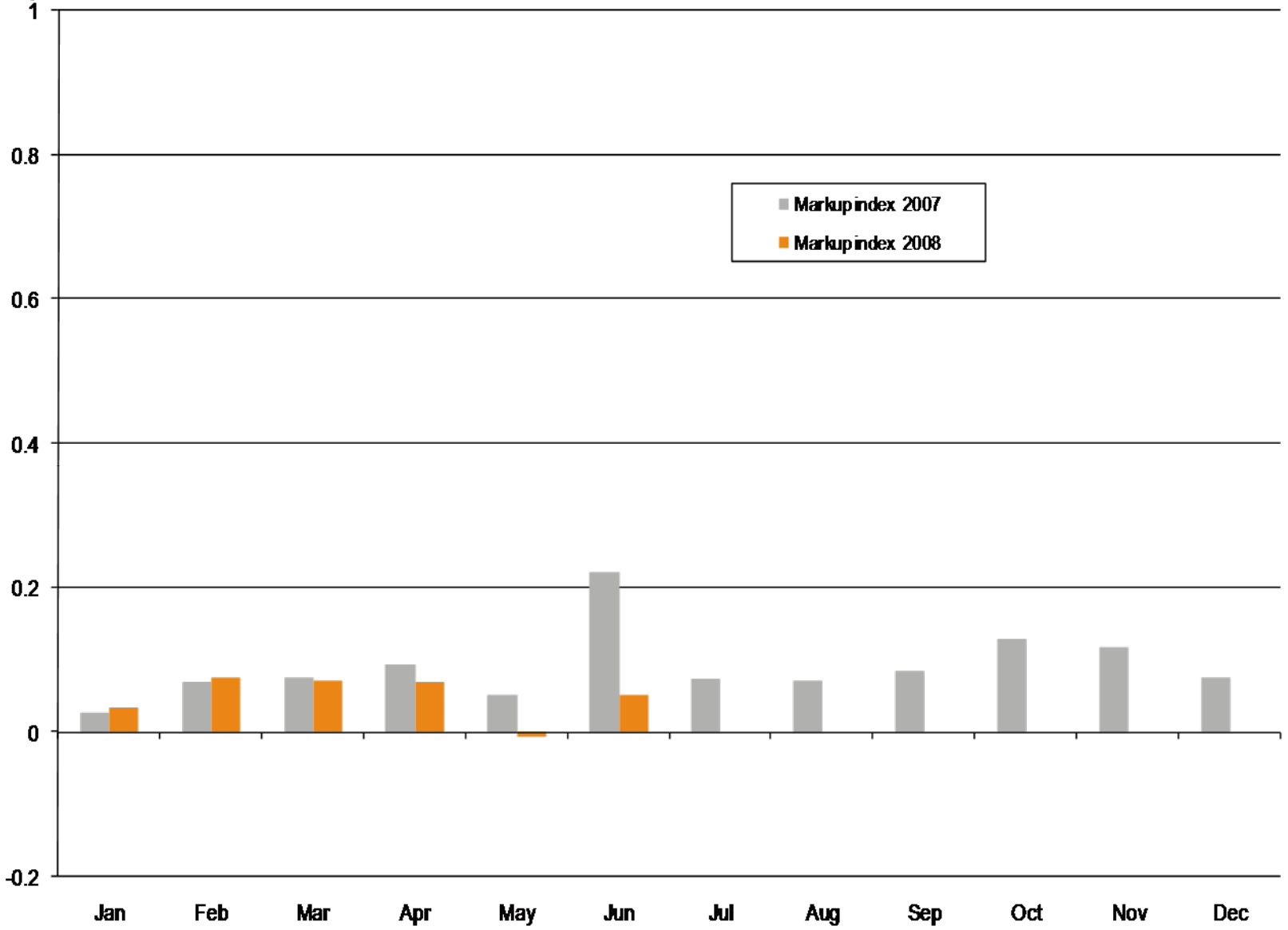
Constraint	Period	Average Number Units	Average Number of Units Eligible for Mitigation	Average Percent of Units Eligible for Mitigation
5004/5005 Interface	Peak	409.9	2.6	1.1%
	Off Peak	354.0	1.3	0.4%
Bedington - Black Oak	Peak	250.7	1.8	0.8%
	Off Peak	228.1	1.2	0.5%
AP South	Peak	373.3	5.6	1.8%
	Off Peak	336.4	4.2	1.1%
Western	Peak	427.2	0.3	0.1%
	Off Peak	401.5	0.5	0.1%
Central	Peak	448.7	0.7	0.3%
	Off Peak	458.4	0.0	0.0%
Eastern	Peak	257.8	10.6	6.5%
	Off Peak	292.0	42.0	14.4%

- Costs of over mitigation
- Costs of under mitigation
- Suggestions that the TPS test may result in “excessive” mitigation or “false positive” results, but this is not clearly defined.
- Small number of tests which may result in mitigation.
- The results of the three pivotal supplier test are based on actual, underlying market dynamics as faced by dispatchers in real time.

Components of PJM annual, load-weighted, average LMP: January 2008 through July 2008

Element	Contribution to LMP	Percent
Coal	$37.30	47.5%
Gas	$17.97	22.9%
Oil	$4.37	5.6%
Wind	$0.00	0.0%
SO2	$3.21	4.1%
VOM	$2.87	3.7%
Markup	$6.34	8.1%
Constrained off	$3.36	4.3%
NOx	$0.84	1.1%
NA	$2.23	2.8%

Load-weighted unit markup index: 2007 to July 2008



Effect of removing offer capping from PJM area 2006 marginal units on monthly load-weighted average Maryland LMP

Affected area	Month	Load-weighted LMP	Load-weighted LMP without capping	Load-weighted net LMP effect of no capping	Percent change in LMP	Total dollar effect of removing capping (1000s)
MD	January	$64.66	$65.32	$0.66	1.02%	$4,138
MD	February	$65.95	$66.37	$0.42	0.64%	$2,501
MD	March	$64.81	$64.84	$0.03	0.04%	$159
MD	April	$52.92	$53.04	$0.12	0.23%	$596
MD	May	$60.28	$61.13	$0.85	1.41%	$4,596
MD	June	$59.54	$60.07	$0.54	0.90%	$3,368
MD	July	$82.88	$86.26	$3.39	4.09%	$25,881
MD	August	$104.00	$108.87	$4.87	4.68%	$36,809
MD	September	$38.48	$38.60	$0.12	0.30%	$629
MD	October	$43.24	$43.84	$0.59	1.38%	$3,184
MD	November	$51.01	$51.27	$0.26	0.52%	$1,421
MD	December	$50.00	$50.09	$0.08	0.17%	$517
MD	Annual	$63.44	$64.60	$1.16	1.83%	$83,800

Table 2-38 Comparison of exempt and non-exempt markup component: January and February of 2008

	Units Marginal	Markup Component
Non-exempt units	427	$6.62
Exempt units	28	$1.44

Comparison of exempt and non-exempt markup component: January 2008 through July 2008

	Units Marginal	Markup Component
Non-exempt units	664	$5.55
Exempt units	42	$0.80

Comparison of exempt and non-exempt markup component effect on Maryland load-weighted hourly average LMP by location of marginal unit: Calendar year 2006

Unit Type	Zone	Marginal Units	Markup Component	Percent contribution to total mark-up component of hourly average LMP	Dollar impact of markup component on zone (1000s)
Non-Exempt Units	MD	667	$0.97	44.4%	$69,797
Exempt Units Not In MD	MD	26	$0.49	22.3%	$35,063
Exempt Units In MD	MD	17	$0.73	33.4%	$52,492
Total		710	$2.18	100.0%	$157,352

Passing the test: Market Power Event

- An example of one of several recent events (Wednesday of this week):

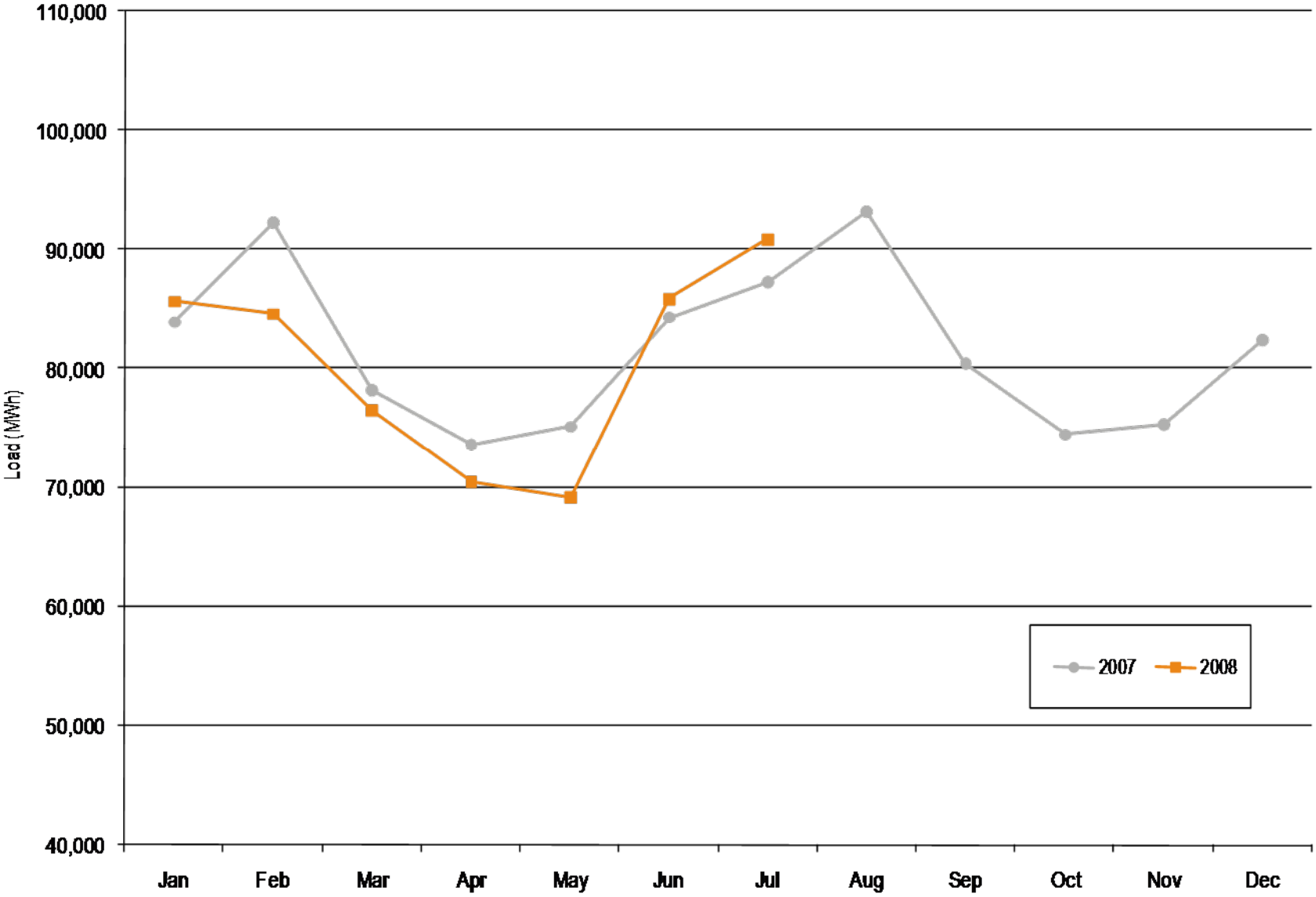
SCHEDULE_ID	LPA_DATE	STATUS	DES_MW	UDS_LMP	MARGINAL_COST	marginal	BUS LMP	CONGCOMP	LOSSCOMP	SE MW
1	28Oct2008:11:14:00	econ	24	432.64	288.68	1	360.85	199.8	3.9	3.2

	Segment	MW	Price
COST	1	19	$288.68
PRICE	1	19	$360.85

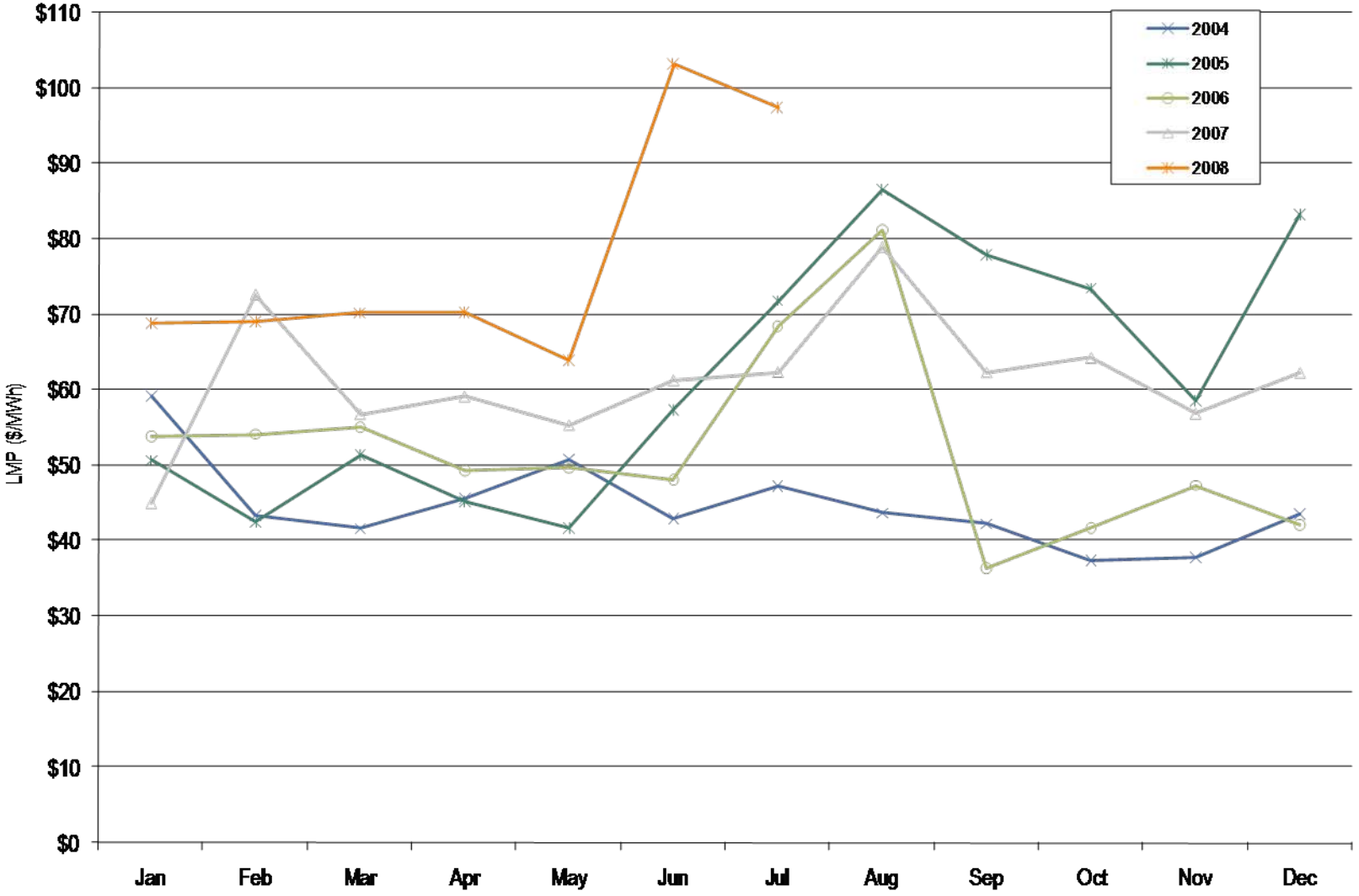
- Unit passed the TPS test, was marginal on price and had an impact on prices in PEPCO ($473), BC ($378) and DOM ($301).

- Does the use of a single price-based offer curve by generators each day make it unlikely that a generation owner could exercise market power when an owner has a non-competitive test result for only a few intervals.
- There are a number of daily strategies for exercising market power in such a case, absent offer capping.
  - Repeated game
    - Observable patterns in hourly load, LMP and congestion
    - Exempt unit behavior
  - High offer; self scheduling
  - Intraday strategies (tail blocks, min and max)
- In addition, it is possible to pass the test and exercise market power.

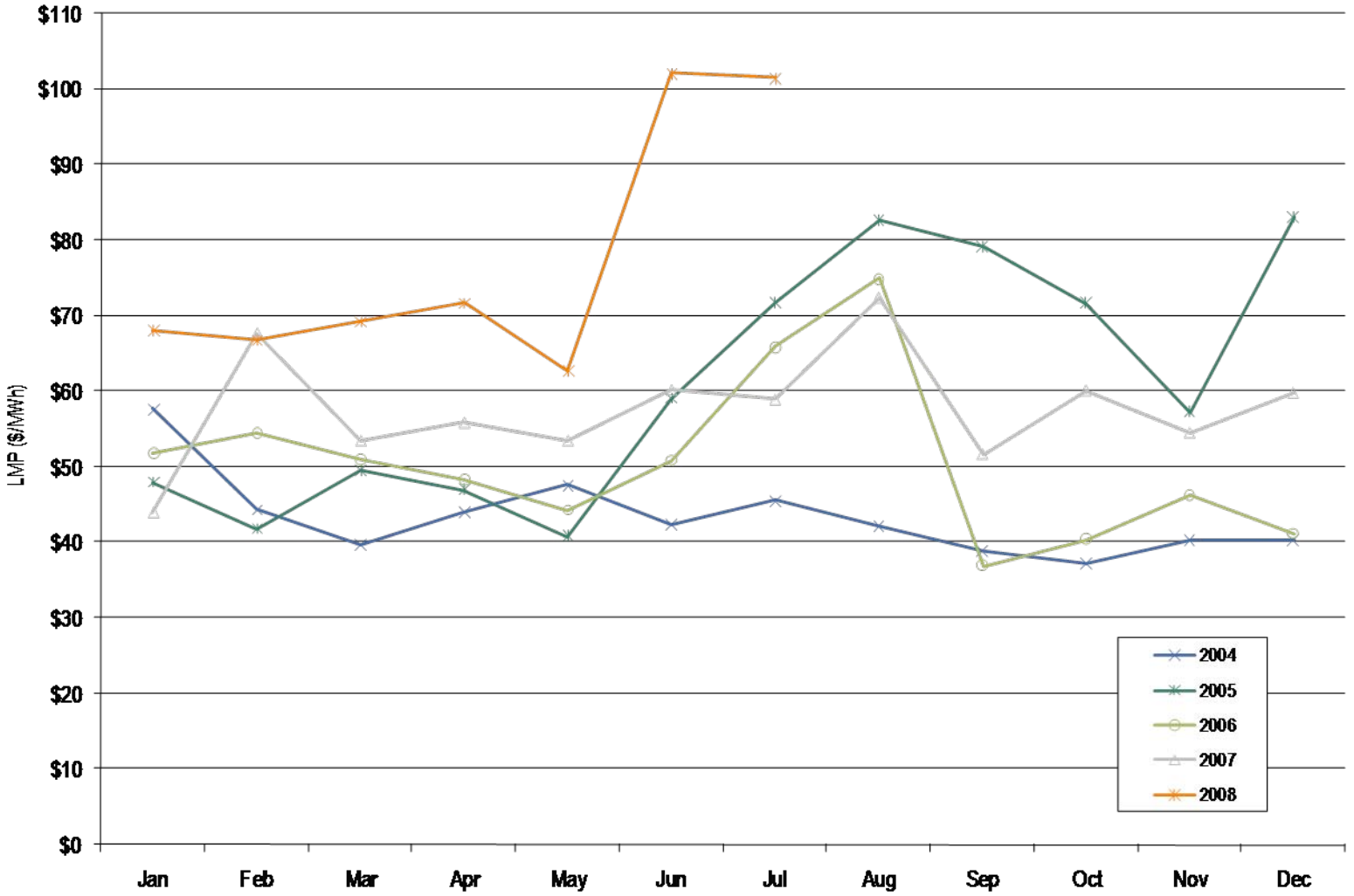
PJM monthly average real-time load: 2007 to July 2008



PJM monthly load-weighted, average real-time LMP: 2004 to July 2008



PJM monthly load-weighted, average day-ahead LMP: 2004 to July 2008



TPS – Examples

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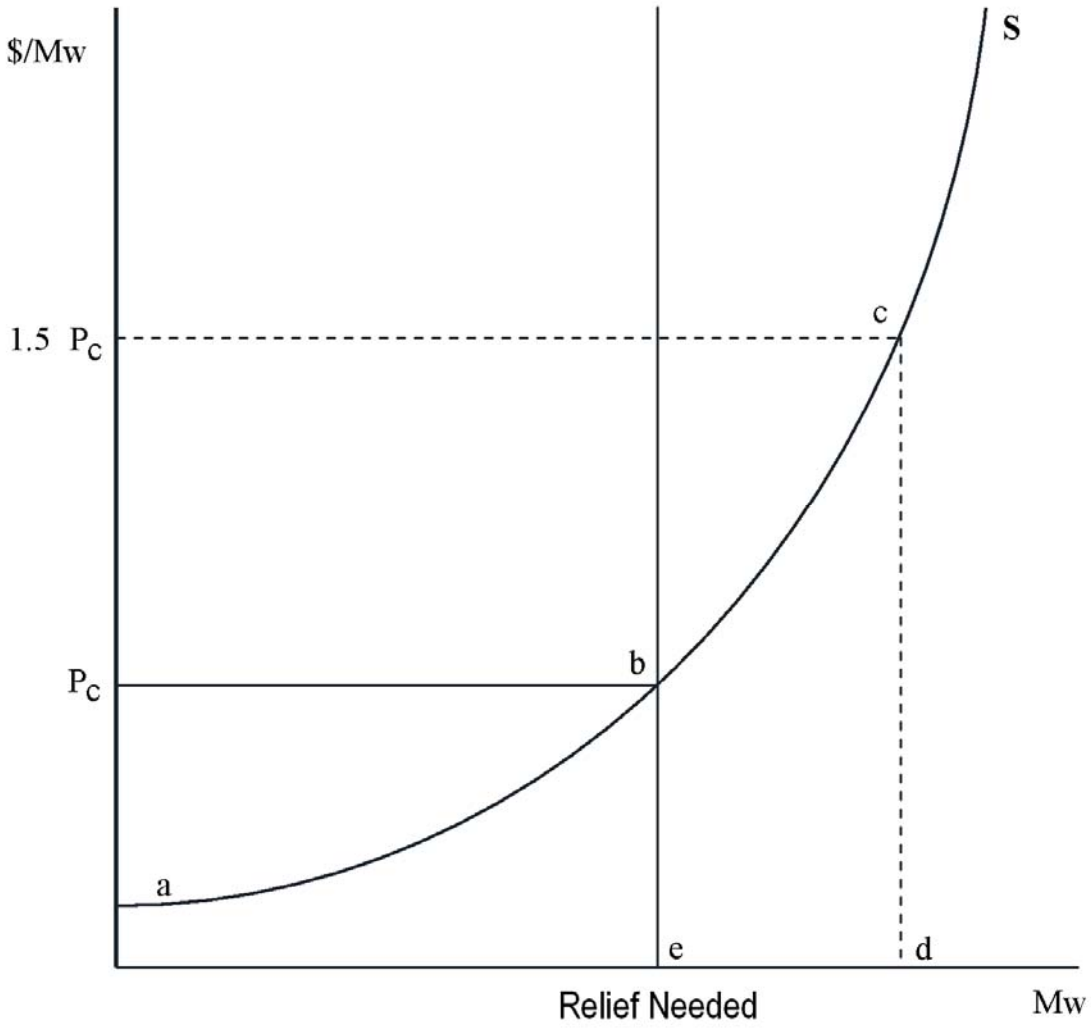

TPS – Relief Needed = 101 MW

Supplier	Effective MW	Test Score
A	40.52	0.694158416
B	35.73	0.694158416
C	20.68	0.694158416
D	20.51	0.695841584
E	20.14	0.69950495
F	13.05	0.76970297
G	7.47	0.824950495
H	2.72	0.871980198
I	2.57	0.873465347
J	1.87	0.88039604
K	0.52	0.893762376
L	0.4	0.894950495
M	0.36	0.895346535
N	0.28	0.896138614
O	0.11	0.897821782
P	0.11	0.897821782
	167.04	

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	Cost Points						
Supplier	$ 100.00	$ 110.00	$ 120.00	$ 130.00	$ 140.00	$ 150.00	Total
A	16.208	0	0	0	0	24.312	40.52
B	10.719	0	3.573	0	10.719	10.719	35.73
C	20.68	0	0	0	0	0	20.68
D	20.51	0	0	0	0	0	20.51
E	20.14	0	0	0	0	0	20.14
F	13.05	0	0	0	0	0	13.05
G	0	0	0	7.47	0	0	7.47
H	0	0	0	0	2.72	0	2.72
I	2.57	0	0	0	0	0	2.57
J	0	0	1.87	0	0	0	1.87
K	0	0	0.52	0	0	0	0.52
L	0	0	0	0.4	0	0	0.4
M	0	0	0	0	0.36	0	0.36
N	0	0	0	0	0	0.28	0.28
O	0	0	0	0	0	0.11	0.11
P	0	0	0	0	0	0.11	0.11
Cost specific supply	103.877	0	5.963	7.87	13.799	35.531	
Cumulative Supply	103.877	103.877	109.84	117.71	131.509	167.04	167.04

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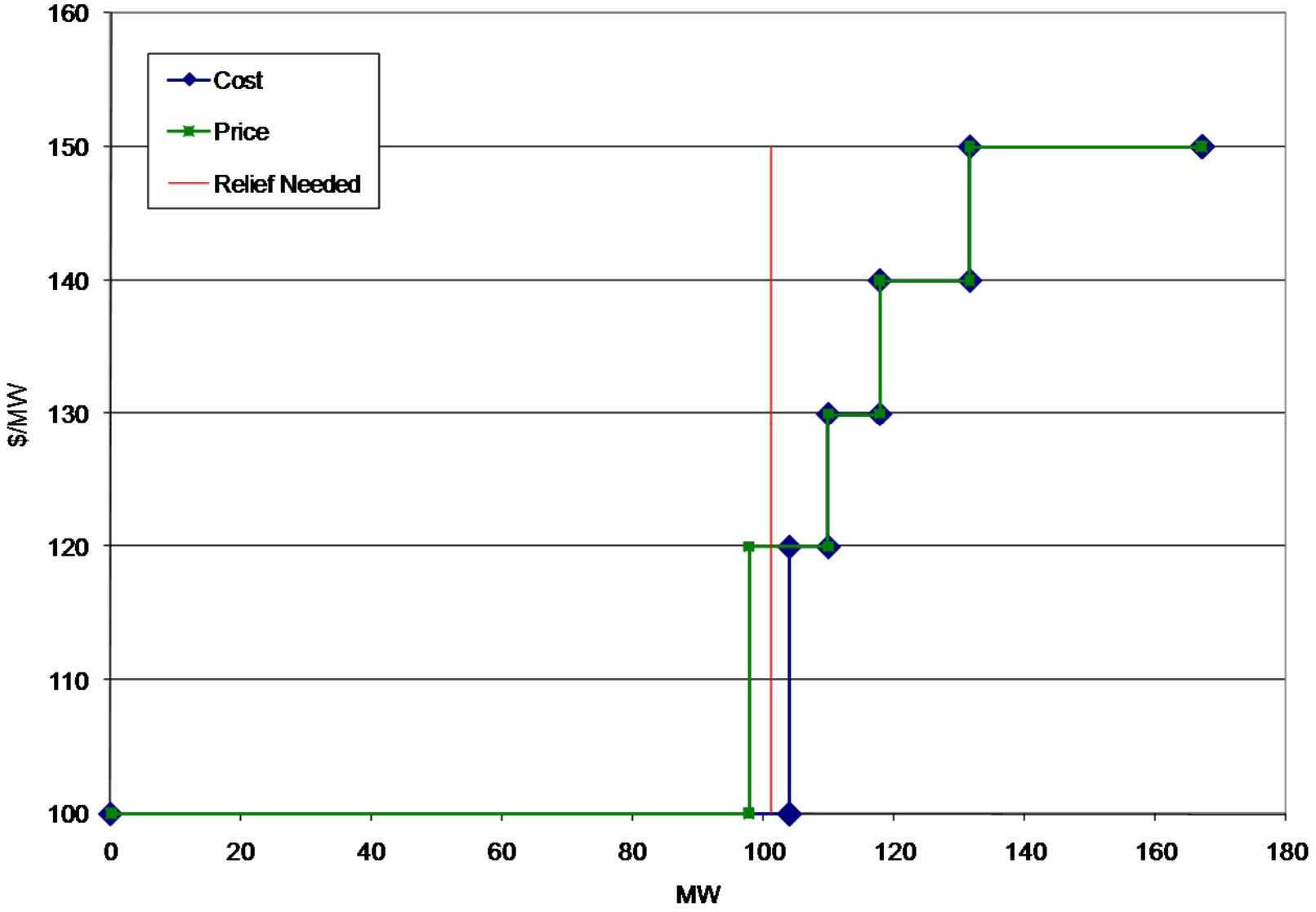
Supplier C

Supplier	Price Points $ 100.00	$ 110.00	$ 120.00	$ 130.00	$ 140.00	$ 150.00	Total
A	16.208	0	0	0	0	24.312	40.52
B	10.719	0	3.573	0	10.719	10.719	35.73
C	14.476	0	6.204	0	0	0	20.68
D	20.51	0	0	0	0	0	20.51
E	20.14	0	0	0	0	0	20.14
F	13.05	0	0	0	0	0	13.05
G	0	0	0	7.47	0	0	7.47
H	0	0	0	0	2.72	0	2.72
I	2.57	0	0	0	0	0	2.57
J	0	0	1.87	0	0	0	1.87
K	0	0	0.52	0	0	0	0.52
L	0	0	0	0.4	0	0	0.4
M	0	0	0	0	0.36	0	0.36
N	0	0	0	0	0	0.28	0.28
O	0	0	0	0	0	0.11	0.11
P	0	0	0	0	0	0.11	0.11
Cost specific supply	97.673	0	12.167	7.87	13.799	35.531	
Cumulative Supply	**97.673**	**97.673**	**109.84**	**117.71**	**131.509**	**167.04**	**167.04**

Supplier C changes the shadow price and changes LMPs



TPS – Sequential TPS Result: Same Market

Supplier	Supply	Round 1 Score (Standard TPS)	Result 1 (Standard result)	Round 2 Score (Sequential TPS)	Result 2 (Sequential)	Round 3 Score (Sequential TPS)	End State (Sequential TPS)
A	40.52	0.694	Fail		Fail		Fail
B	35.73	0.694	Fail		Fail		Fail
C	20.68	0.694	Fail	1.190	Pass		Pass
D	20.51	0.696	Fail	1.190	Pass		Pass
E	20.14	0.700	Fail	1.190	Pass	NA	Pass
F	13.05	0.770	Fail	1.477	Pass	NA	Pass
G	7.47	0.825	Fail	1.702	Pass	NA	Pass
H	2.72	0.872	Fail	1.894	Pass	NA	Pass
I	2.57	0.873	Fail	1.900	Pass	NA	Pass
J	1.87	0.880	Fail	1.928	Pass	NA	Pass
K	0.52	0.894	Fail	1.983	Pass	NA	Pass
L	0.4	0.895	Fail	1.988	Pass	NA	Pass
M	0.36	0.895	Fail	1.989	Pass	NA	Pass
N	0.28	0.896	Fail	1.993	Pass	NA	Pass
O	0.11	0.898	Fail	2.000	Pass	NA	Pass
P	0.11	0.898	Fail	2.000	Pass	NA	Pass

One Pivotal Supplier Test and Sequential One Pivotal Supplier Test

Note defined market is different

Supplier	1.05 X Defined Supply	One Pivotal Supplier Test (Step 1)	Sequential One Pivotal Supplier Test (Step 2)	Sequential One Pivotal Supplier Test (Step 3)	Sequential One Pivotal Supplier Test (Step 4)	Sequential One Pivotal Supplier Test (Step 5)	Sequential One Pivotal Supplier Test (Step 6)	Sequential One Pivotal Supplier Test (Step 7)	Sequential End State 1PS)
C	20.68	0.824							Fail
D	20.51	0.825	0.780465637						Fail
E	20.14	0.829	0.785072211	0.711					Fail
A	16.208	0.868	0.834026394	0.777	0.664				Fail
F	13.05	0.899	0.873344124	0.830	0.744	0.566			Fail
B	10.719	0.922	0.902365538	0.869	0.802	0.666	0.247		Fail
I	2.57	1.003	1.003822211	1.005	1.008	1.013	1.029	0.000	Fail
G	0	NA	NA	NA	NA	NA	NA	NA	NA
H	0	NA	NA	NA	NA	NA	NA	NA	NA
J	0	NA	NA	NA	NA	NA	NA	NA	NA
K	0	NA	NA	NA	NA	NA	NA	NA	NA
L	0	NA	NA	NA	NA	NA	NA	NA	NA
M	0	NA	NA	NA	NA	NA	NA	NA	NA
N	0	NA	NA	NA	NA	NA	NA	NA	NA
O	0	NA	NA	NA	NA	NA	NA	NA	NA
P	0	NA	NA	NA	NA	NA	NA	NA	NA
Total Supply	103.877								

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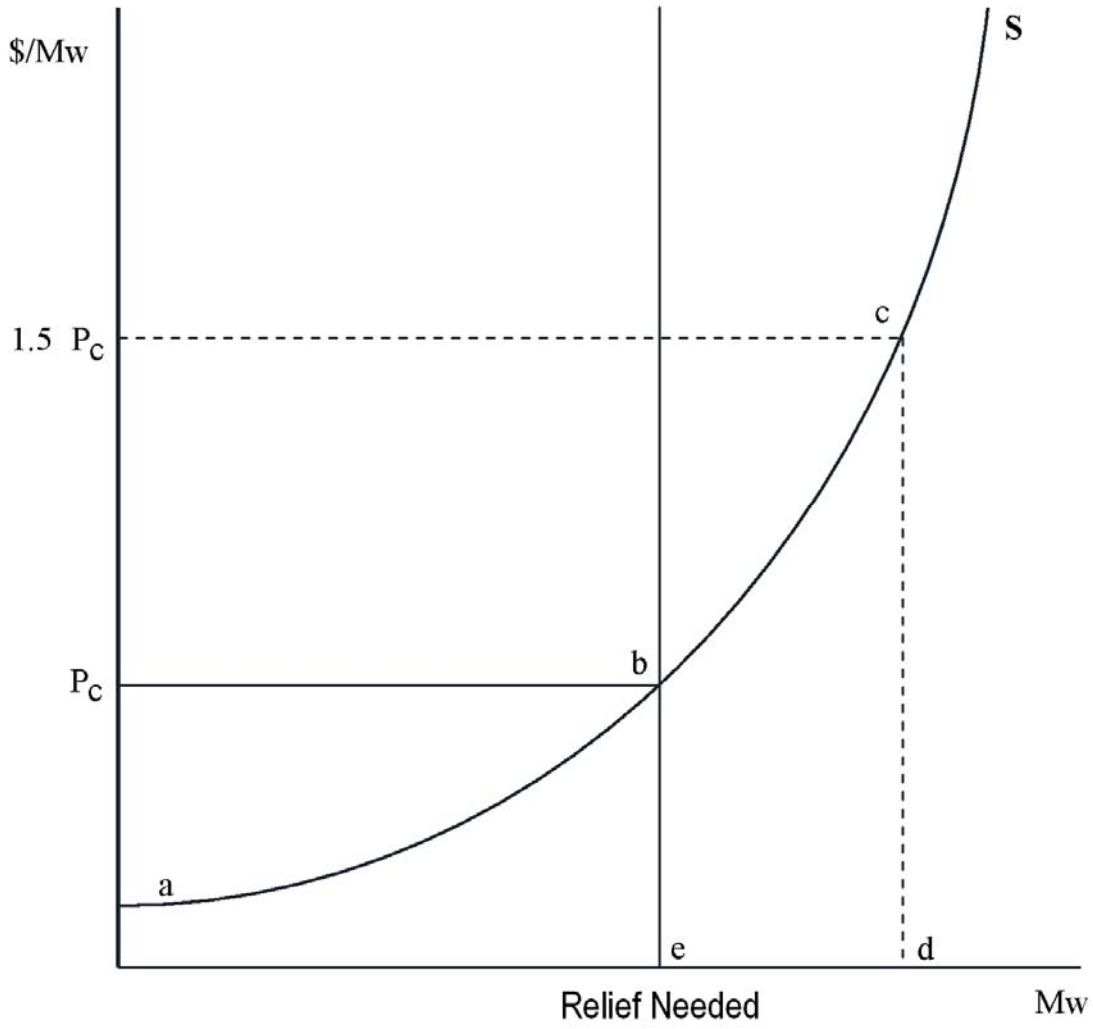
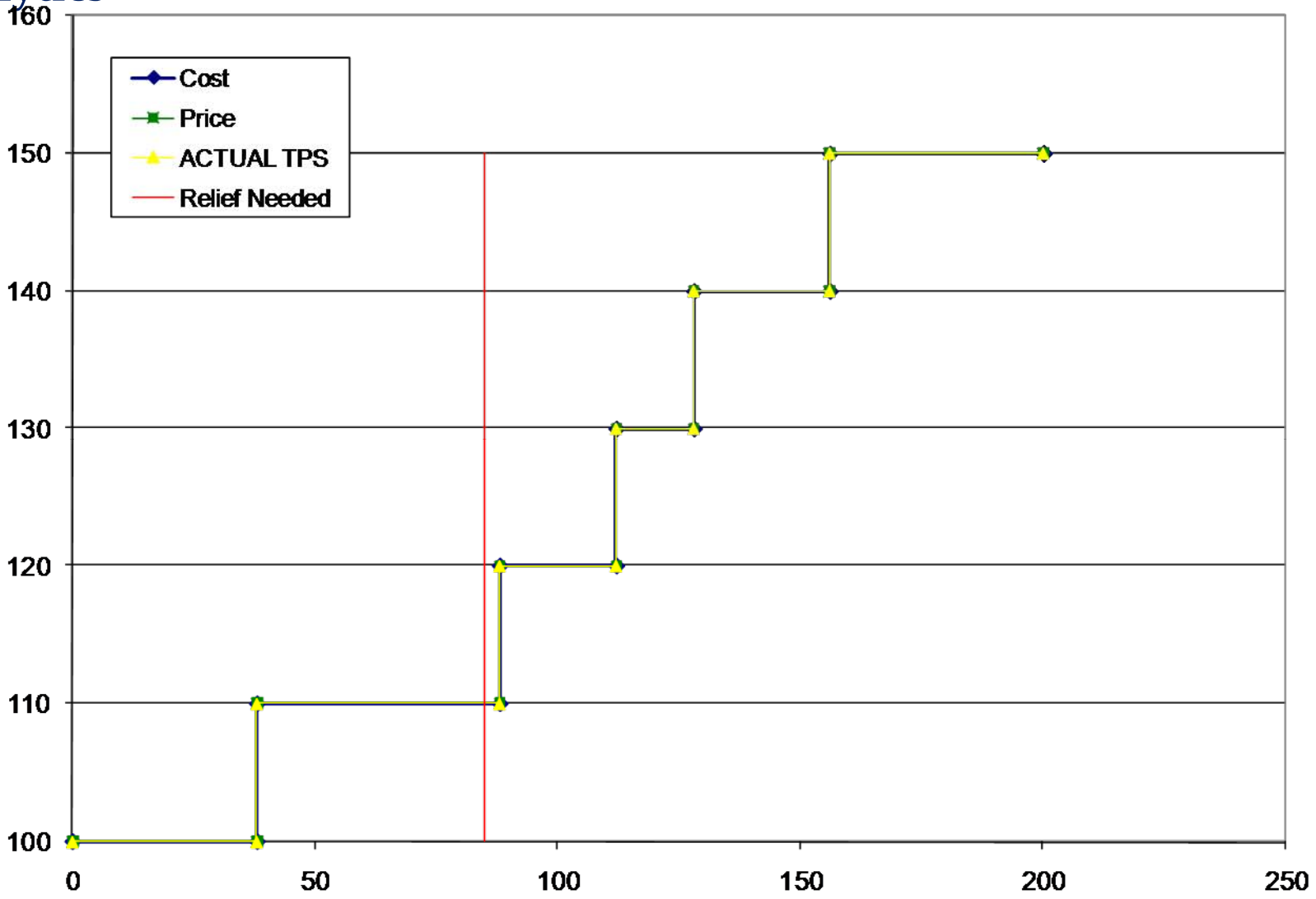


TPS - Supply


Cost
Price
ACTUAL TPS
Relief Needed
160
150
140
130
120
110
100
0
50
100
150
200
250

Monitoring Analytics

Supplier	Effective MW	Test Score
A	40	0.941176471
B	40	0.941176471
C	40	0.941176471
D	40	0.941176471
E	10	1.294117647
F	10	1.294117647
G	10	1.294117647
H	10	1.294117647
I		
J		
K		
L		
M		
N		
O		
P		
	200	
Relief needed	85	

Monitoring Analytics

	Cost Points						
Supplier	$ 100.00	$ 110.00	$ 120.00	$ 130.00	$ 140.00	$ 150.00	Total
A	0	8	0	4	4	24	40
B	4	0	12	4	8	12	40
C	0	4	4	8	16	8	40
D	24	8	8	0	0	0	40
E	10	0	0	0	0	0	10
F	0	10	0	0	0	0	10
G	0	10	0	0	0	0	10
H	0	10	0	0	0	0	10
I	0	0	0	0	0	0	0
J	0	0	0	0	0	0	0
K	0	0	0	0	0	0	0
L	0	0	0	0	0	0	0
M	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0
O	0	0	0	0	0	0	0
P	0	0	0	0	0	0	0
Cost specific supply	38	50	24	16	28	44	
Cumulative Supply	**38**	**88**	**112**	**128**	**156**	**200**	**200**

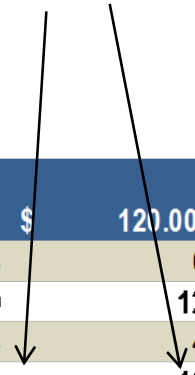
TPS – Sequential TPS

Supplier	Supply	Round 1 Score (Standard TPS)	Result 1 (Standard result)	Round 2 Score (Sequential TPS)	Result 2 (Sequential)	Round 3 Score (Sequential TPS)	End State (Sequential TPS)
A	40	0.941	Fail		Fail		Fail
B	40	0.941	Fail		Fail		Fail
C	40	0.941	Fail	6.000	Pass		Pass
D	40	0.941	Fail	6.000	Pass		Pass
E	10	1.294	Pass	6.000	Pass	NA	Pass
F	10	1.294	Pass	6.000	Pass	NA	Pass
G	10	1.294	Pass	6.000	Pass	NA	Pass
H	10	1.294	Pass	6.000	Pass	NA	Pass
I	0	1.412	Pass	8.000	Pass	NA	Pass
J	0	1.412	Pass	8.000	Pass	NA	Pass
K	0	1.412	Pass	8.000	Pass	NA	Pass
L	0	1.412	Pass	8.000	Pass	NA	Pass
M	0	1.412	Pass	8.000	Pass	NA	Pass
N	0	1.412	Pass	8.000	Pass	NA	Pass
O	0	1.412	Pass	8.000	Pass	NA	Pass
P	0	1.412	Pass	8.000	Pass	NA	Pass
Total	200						

Single Pivotal Supplier and Sequential Single Pivotal Supplier

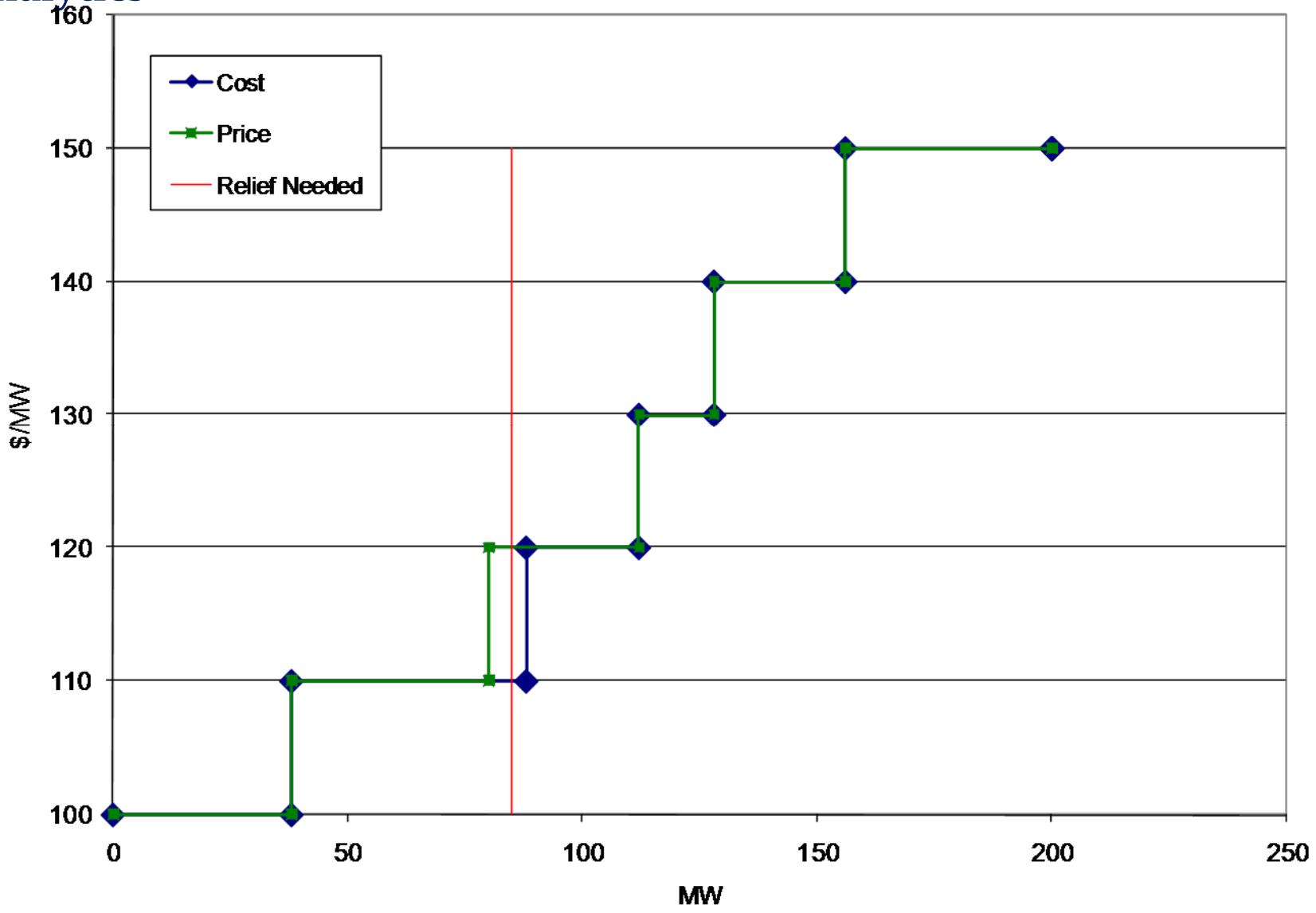
Supplier	1.05 X Defined Supply	One Pivotal Supplier Test (Step 1)	Sequential One Pivotal Supplier Test (Step 2)	Sequential One Pivotal Supplier Test (Step 3)	Sequential One Pivotal Supplier Test (Step 4)	Sequential One Pivotal Supplier Test (Step 5)	Sequential One Pivotal Supplier Test (Step 6)	Sequential One Pivotal Supplier Test (Step 7)	Sequential One Pivotal Supplier Test (Step 8)	Sequential One Pivotal Supplier Test (Step 9)	Sequential End State 1PS)
D	32	0.659									Fail
E	**10**	**0.918**	**0.867924528**								**Fail**
F	10	0.918	0.867924528	0.837							Fail
G	**10**	**0.918**	**0.867924528**	**0.837**	**0.788**						**Fail**
H	10	0.918	0.867924528	0.837	0.788	0.696					Fail
A	**8**	**0.941**	**0.905660377**	**0.884**	**0.848**	**0.783**	**0.615**				**Fail**
B	4	0.988	0.981132075	0.977	0.970	0.957	0.923	0.800			Fail
C	**4**	**0.988**	**0.981132075**	**0.977**	**0.970**	**0.957**	**0.923**	**0.800**	**0.000**		**Fail**
I	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
J	**0**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
K	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
L	**0**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
M	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
N	**0**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
O	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
P	**0**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total Supply	88										

Supplier D's Price Strategy

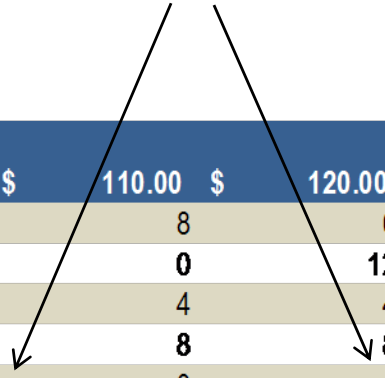


Supplier	Price Points $ 100.00	$ 110.00	$ 120.00	$ 130.00	$ 140.00	$ 150.00	Total
A	0	8	0	4	4	24	40
B	**4**	**0**	**12**	**4**	**8**	**12**	**40**
C	0	4	4	8	16	8	40
D	**24**	**0**	**16**	**0**	**0**	**0**	**40**
E	10	0	0	0	0	0	10
F	**0**	**10**	**0**	**0**	**0**	**0**	**10**
G	0	10	0	0	0	0	10
H	**0**	**10**	**0**	**0**	**0**	**0**	**10**
I	0	0	0	0	0	0	0
J	**0**	**0**	**0**	**0**	**0**	**0**	**0**
K	0	0	0	0	0	0	0
L	**0**	**0**	**0**	**0**	**0**	**0**	**0**
M	0	0	0	0	0	0	0
N	**0**	**0**	**0**	**0**	**0**	**0**	**0**
O	0	0	0	0	0	0	0
P	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Cost specific supply	38	42	32	16	28	44	
Cumulative Supply	**38**	**80**	**112**	**128**	**156**	**200**	**200**

Supplier D changes the shadow price and LMPs



Supplier E's Price Strategy



Supplier	Price Points $ 100.00	$ 110.00	$ 120.00	$ 130.00	$ 140.00	$ 150.00	Total
A	0	8	0	4	4	24	40
B	**4**	**0**	**12**	**4**	**8**	**12**	**40**
C	0	4	4	8	16	8	40
D	**24**	**8**	**8**	**0**	**0**	**0**	**40**
E	6	0	4	0	0	0	10
F	**0**	**10**	**0**	**0**	**0**	**0**	**10**
G	0	10	0	0	0	0	10
H	**0**	**10**	**0**	**0**	**0**	**0**	**10**
I	0	0	0	0	0	0	0
J	**0**	**0**	**0**	**0**	**0**	**0**	**0**
K	0	0	0	0	0	0	0
L	**0**	**0**	**0**	**0**	**0**	**0**	**0**
M	0	0	0	0	0	0	0
N	**0**	**0**	**0**	**0**	**0**	**0**	**0**
O	0	0	0	0	0	0	0
P	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Cost specific supply	34	50	28	16	28	44	
Cumulative Supply	**34**	**84**	**112**	**128**	**156**	**200**	**200**

Supplier E changes the shadow price and LMPs