

Review of EIM Operation

Scott Harvey

Infocast: California Energy Summit

San Francisco, California

April 17, 2015



Critical thinking at the critical time™

TOPICS

- The California ISO EIM
- EIM Design Challenges
- EIM Transfer Capacity and Benefits
- Load Balance Violations and EIM Pricing

THE CALIFORNIA ISO EIM

Activation of the California ISO and PacifiCorp EIM on November 1, 2014 was an important step in the evolution of western power markets.

- The expanded regional dispatch will allow the EIM participants to reduce rate payer costs and better maintain reliability while accommodating higher levels of intermittent resource output.
- The eventual participation of the Nevada Companies, Puget Sound Energy and Arizona Public Service should lead to even larger rate payer benefits.

THE CALIFORNIA ISO EIM

The California ISO EIM design in which the California ISO coordinates inter-balancing area interchange on a 15- and 5 minute basis, while the EIM balancing authority areas continue to carry out their responsibilities, follows the designs initially implemented by MISO and SPP.

- MISO multi-balancing area operation April 1, 2005 to January 9, 2009;
- SPP multi-balancing area operation February 1, 2007 to March 1, 2014.

EIM DESIGN CHALLENGES

The design in which the individual balancing area authorities continue to carry out balancing area functions while the market operator coordinates a real-time dispatch among the balancing areas has substantial advantages in terms of allowing gradual transitions and reducing implementation risks.

- This design also creates operational challenges, such as the division of dispatchable resources between those available to the EIM dispatch and those available to the balancing area authority.
- This was the case for MISO and SPP, just as it has been for the California ISO.

EIM DESIGN CHALLENGES

When the MISO began operations in April 2005, the MISO coordinated day-ahead and real-time energy markets but reserves and regulation continued to be managed by the responsible balancing authority.

- Like the California ISO EIM, the initial MISO operating design accommodated reserve sharing groups that extended beyond the MISO.
- During this period, the MISO faced challenges similar to the California ISO with binding ramp constraints in its real-time dispatch causing potential power balance violations, which the MISO sought to address without raising rate payer costs by committing more generation than was really needed given the resources available to the balancing area authorities.

EIM DESIGN CHALLENGES

In seeking approval from FERC for its ARC procedure in 2006, Joe Gardner, the MISO director of system wide operations, observed:

“One typical situation involves a substantial curtailment of imports in response to a TLR procedure, either called by the Midwest ISO or a different Reliability Coordinator, which can in a matter of a few minutes create a large demand-supply gap that exceeds the capability of the on-line Resources responding to the UDS signal.”¹

1. Affidavit of Joe Gardner, June 5, 2006 Docket ER06-1099-000 p. 4

EIM DESIGN CHALLENGES

The difficulty of cost effectively balancing load and generation on a 5 minute basis without access to additional ramp capability caused the MISO to file its ARC procedure (adequate ramp capability) on June 5, 2006 in Docket ER06-1099-000.

- This procedure was approved by FERC ¹ and implemented on March 20, 2007.
- The MISO 2007 State of the Market Report contains a long list of ARC activation events and the cause. ²

1. See 118 FERC ¶61,009 January 5, 2007.

2. Potomac Economics, 2007 State of the Market Report for the Midwest ISO, pp. 59-61

EIM DESIGN CHALLENGES

SPP faced similar challenges with ramp constraints creating an inability to balance load and generation during the period when it coordinated a multi-balancing authority area real-time dispatch.

Table II.15 Market Ramp Rate Violations

Month	% of Intervals with Market Ramp Rate Violations in 2007	% of Intervals with Market Ramp Rate Violations in 2008	% of Intervals with Market Ramp Rate Violations in 2009
January	NA	1.24%	0.63%
February	1.30%	0.81%	0.29%
March	1.10%	0.95%	0.36%
April	0.94%	0.53%	0.44%
May	0.90%	0.86%	1.00%
June	0.82%	0.72%	0.49%
July	0.71%	0.26%	0.03%
August	0.44%	0.31%	0.13%
September	0.66%	0.59%	0.19%
October	1.24%	0.77%	0.41%
November	1.50%	0.66%	0.55%
December	1.01%	0.60%	0.39%
Average*	0.96%	0.69%	0.41%

* Average is weighted by the number of days in each month

EIM DESIGN CHALLENGES

These challenges were in part due to the limited proportion of the dispatchable capacity that was made available by the balancing area authorities to the SPP EIM real-time dispatch.

Table II.14 Dispatchable Range of Capacity Made Available to the EIS Market by Month

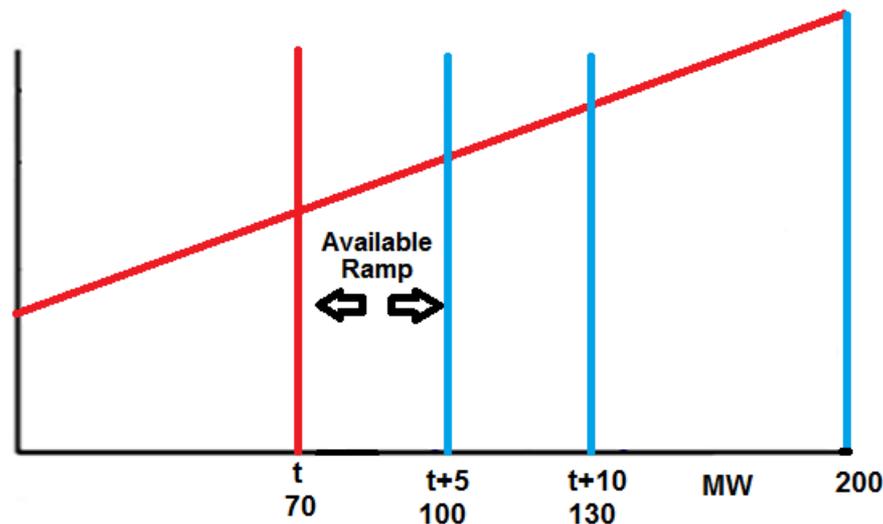
Month	Percent of Capacity Dispatchable in 2007	Percent of Capacity Dispatchable in 2008	Percent of Capacity Dispatchable in 2009
January	NA	46%	45%
February	50%	47%	44%
March	47%	48%	46%
April	47%	47%	43%
May	46%	46%	44%
June	47%	49%	45%
July	48%	50%	45%
August	49%	48%	46%
September	46%	46%	43%
October	46%	43%	41%
November	46%	44%	41%
December	47%	45%	42%
Average*	47%	46%	44%

* Average is weighted by the number of days in each month

EIM DESIGN CHALLENGES

It is important to understand that temporary load balance violations in the 5 minute dispatch due to ramp constraints do not indicate a lack of capacity. A resource can be ramp constrained in a particular 5 minute dispatch interval but have lots of dispatchable capacity available for subsequent intervals.

Ramp Limited Unit

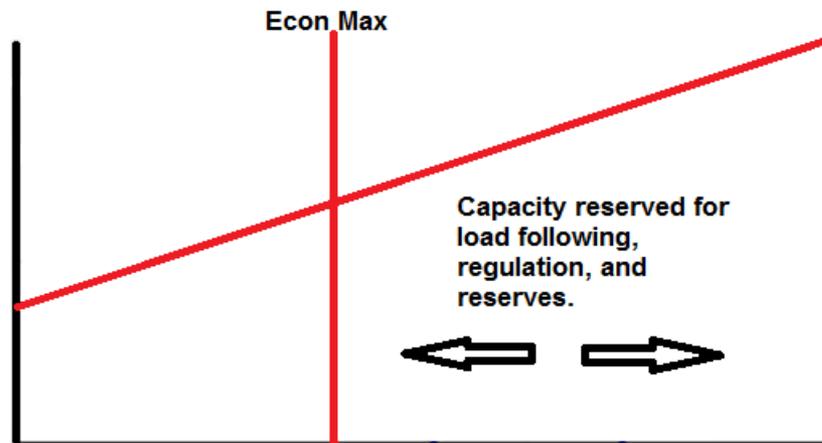


200 megawatt capacity
30 megawatt ramp rate

EIM DESIGN CHALLENGES

Load balance violations in the 5 minute dispatch also do not necessarily reflect a lack of ramp capability to balance load and generation, they may arise because not all of the available ramp capability is visible to the dispatch software.

Dispatch Limited Unit with Unused Ramp



200 megawatt capacity
30 megawatt ramp rate

EIM DESIGN CHALLENGES

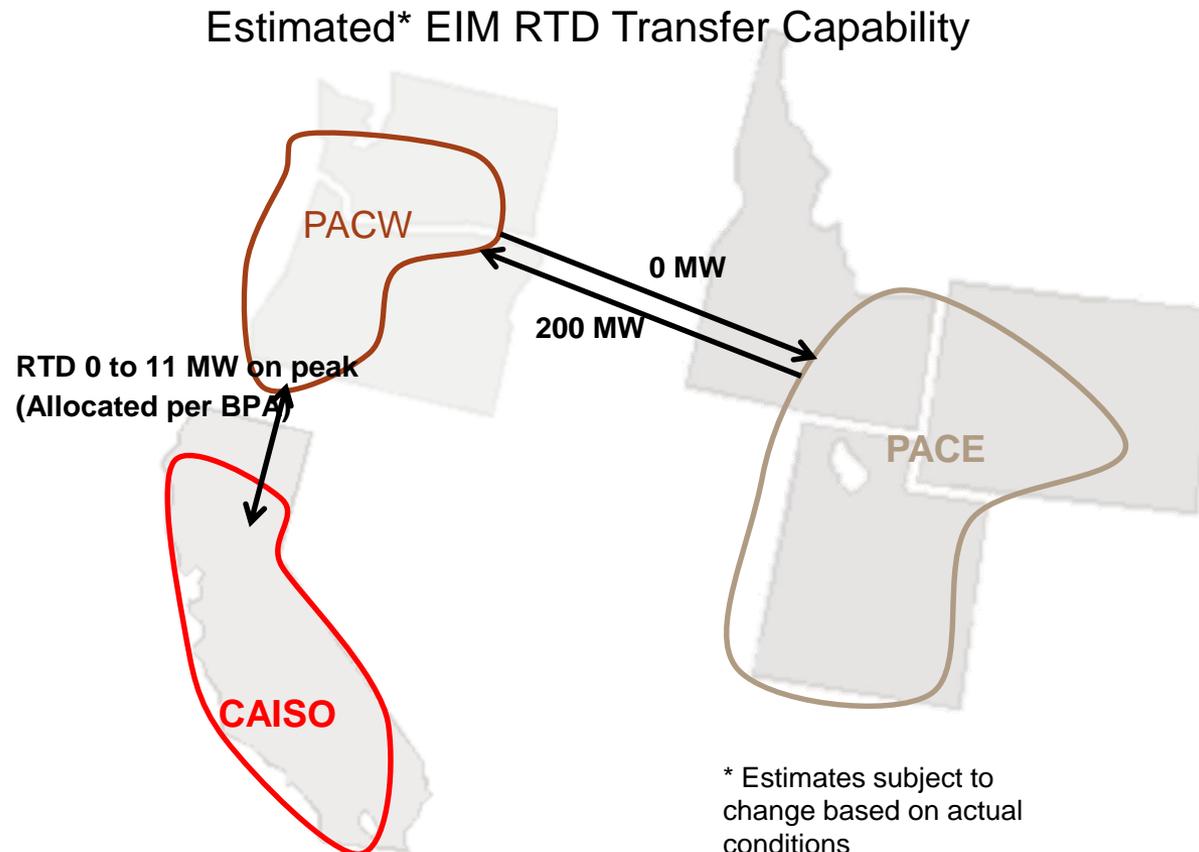
The California ISO proposes to better manage the division of ramp capability between the EIM dispatch and the balancing authority area by: ¹

- Making more resources and capacity visible to the dispatch software, while limiting the circumstances in which the capacity reserved by the balancing authority area can be dispatched to balance load and generation in the 5 minute dispatch;
- This is a useful step in evolving the EIM design to more fully realize the potential benefits from operating an multi-balancing area energy imbalance market in the west;
- It should be anticipated that as the California ISO and the EIM participants gain experience with the design, additional improvements will be identified, just as was the case in eastern EIM Designs.

1. See Comments of the California ISO, Dockets ER15-861-000 and EL15-53-000 April 23, 2015.

TRANSFER LIMITS

The California ISO has faced greater challenges than MISO and SPP in balancing load and generation within the EIM on a five minute basis because of the limited transfer capability between the EIM regions that has been available for use in a five minute time frame.



TRANSFER LIMITS

While MISO and SPP were able to dispatch generation within their footprint to balance load and generation subject to actual pre and post contingency flows over the impacted transmission elements, the California ISO and PacifiCorp:

- Had less than a megawatt of transfer capability available in RTD between PacifiCorp West and the CAISO on-peak until February 4 and only up to around 11 megawatts since February 4;¹
- Have no transfer capability available in RTD between PacifiCorp West into PacifiCorp East once exports from PacifiCorp East are reduced to zero.

1. See California ISO, Department of Market Monitoring, Report on Energy Imbalance Market Issues and Performance, April 2, 2015 pp 2, 9.

TRANSFER LIMITS

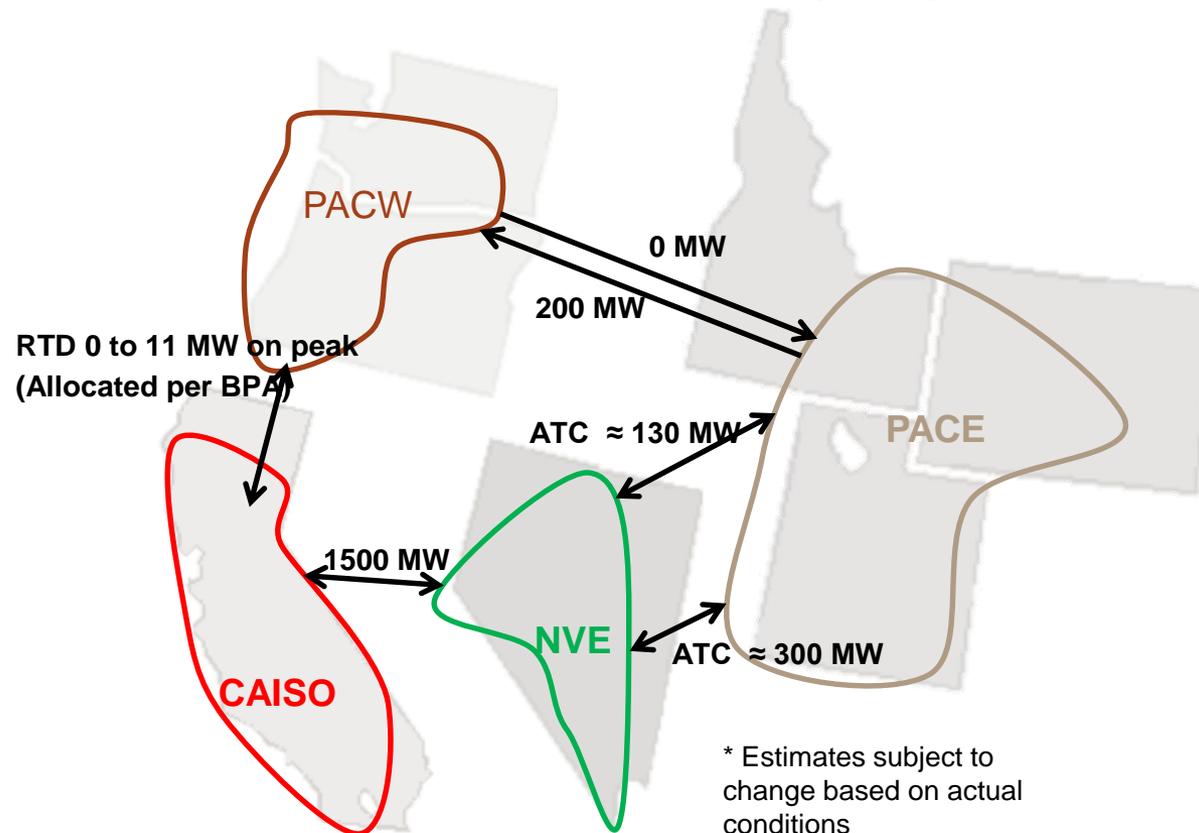
While a substantial portion of the EIM benefits can be realized by the coordinated 15 minute dispatch, additional benefits can be realized by adjusting interchange on a five minute basis, particularly those associated with balancing unpredictable variations in intermittent resource output.

- Realizing these additional EIM benefits will be aided by having more inter-balancing area transfer capability available in RTD.

TRANSFER LIMITS

The California ISO's ability to balance load and generation within the EIM on a five minute basis will be improved with the participation of the Nevada companies and the increased real-time transfer capability into PACE.

Estimated* EIM RTD Transfer Capability



TRANSFER LIMITS

In the longer run, a major source of cost reductions as the EIM footprint expands will be the ability to better utilize the existing transmission system by dispatching generation based on the actual pre and post contingency transmission limits.

Kentucky and Wisconsin Flowgates

	511 Hours with Zero Hour-Ahead AFC Flowgate 2198 Fall 2003¹	TLR Level 3 and 4 9 Kentucky Flowgates July-October 2003²	198 Wisconsin TLR Level 3 – 5 June-November 2003³
Real-time capacity available and unused on limiting element	23%	9.31%	11.407%

¹ Direct Testimony of Ron McNamara, December 29, 2003, p. 16.

² Direct Testimony of Ron McNamara, December 29, 2003, pp. 13-14.

³ MISO, The Benefits and Costs of Wisconsin Utilities Participating in Midwest ISO Energy Markets, March 26, 2004.

POWER BALANCE VIOLATIONS

The power balance constraint for PacifiCorp west was apparently violated in the EIM five minute dispatch (RTD) during 2.8% of all intervals during January, 2% during February,¹ and .6% during March 2015.

The power balance constraint for PacifiCorp east was apparently violated during 5.3% of all five minute dispatch intervals in January, 2% during February,² and 2% during March 2015.

While we should expect further reductions in the frequency of these power balance violations with continued improvements in training, refinements in operating policy, elimination of software bugs and data transfer issues, it is not realistic to expect that their frequency will drop close to zero.

1. See California ISO, Department of Market Monitoring, "Report on Energy Imbalance Market Issues and Performance," April 2, 2015, p. 18.
2. See California ISO, Department of Market Monitoring, "Report on Energy Imbalance Market Issues and Performance," April 2, 2015, p. 18.

POWER BALANCE VIOLATIONS

The New York ISO has had potential load balance violations in the real-time dispatch under SMD 2 operation since 2005. ¹

In 2010, the NYISO made some data public on the past frequency of real-time regulation shortages:²

2006 1.79% of all intervals

2007 1.24% of all intervals

2008 1.02% of all intervals

2009 .91% of all intervals

These data cover all causes of regulation shortages but real-time regulation shortages are almost always a result of ramp constraints leading to potential load balance violations.

1. SMD Software was implemented in February 2005.

2. New York ISO, Shaun Johnson, "Enhanced Shortage Pricing," Market Issues Working Group, June 21, 2010 pp. 30-31.

POWER BALANCE VIOLATIONS

The MISO also encounters binding ramp constraints in its real-time dispatch, even after implementing a single balancing authority area in January 2009.

- An analysis of price spikes during uncongested intervals found that there were price spikes during 1.6% of these intervals over the period March 1, 2010 through December 8, 2011.¹
- Another analysis of spinning reserve shortages found 915 intervals out of 113,863 (.8%) over the period August 1, 2010 to August 31, 2011 when the spinning reserve constraint was relaxed,² in most cases the spin relaxation was likely a result of ramp constraints creating potential load balance violations.

1. MISO, Stakeholder 5th technical Workshop, Ramp Capability in MISO Markets, April 14, 2012, pp. 45-47

2. MISO, Market Subcommittee, "Spinning Reserve Demand Curve –Construct, January 6, 2012

POWER BALANCE VIOLATIONS

Power balance violations in the five minute time frame are visible in the California ISO, the EIM, the MISO and NYISO because they are reflected in prices.

- The same inability to balance load and generation with on-dispatch resources within a five minute time frame can be present in an ISO sending out 15 minute dispatch signals, but it will not be reflected in prices.
- The same inability to balance load and generation with on dispatch resources within a five minute time frame can be present in a system operator sending out manual dispatch instructions but it would not be reflected in prices and the manual dispatch might not even account for ramp constraints.

POWER BALANCE VIOLATIONS

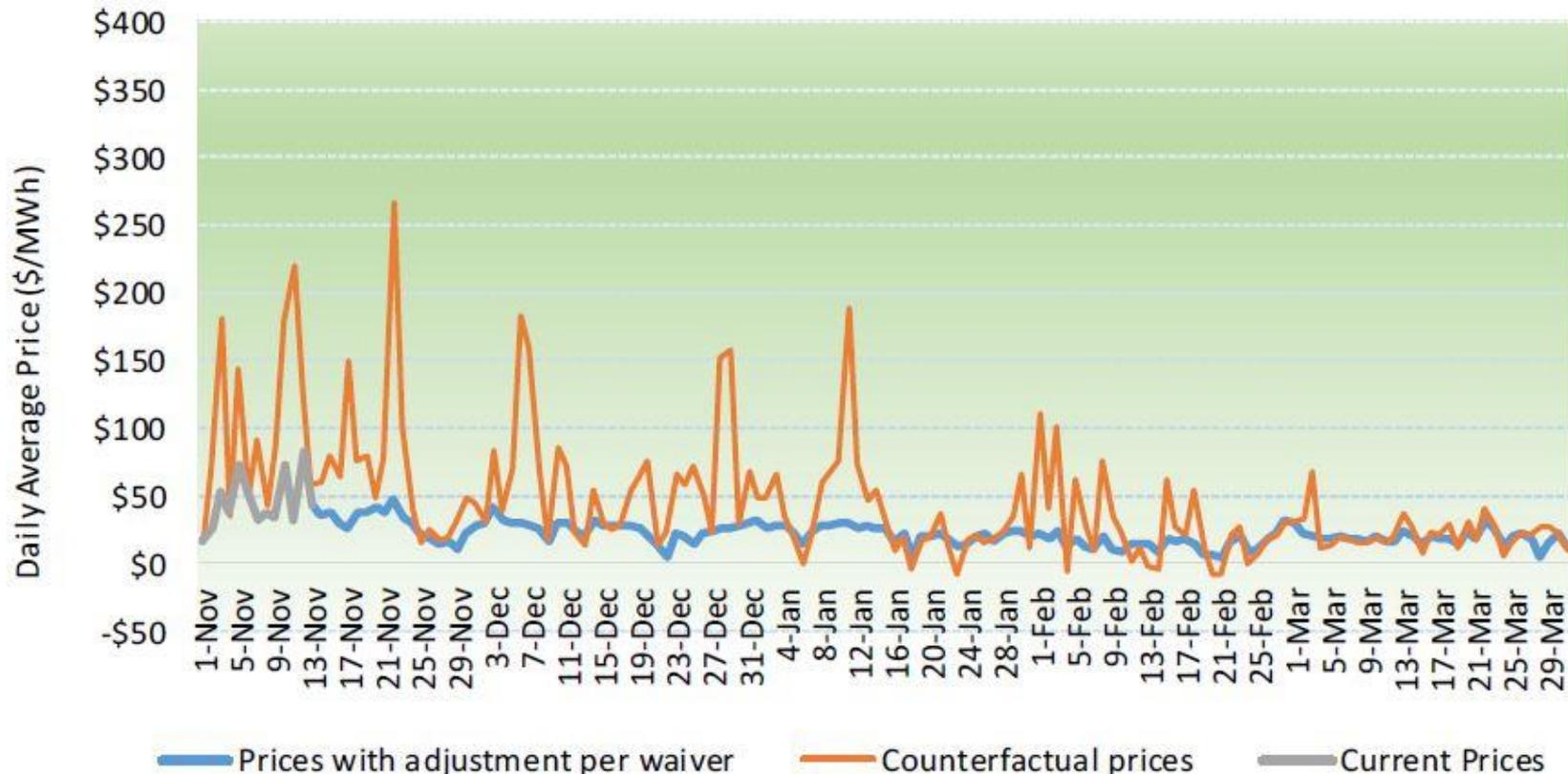
Whether operating in market or non-market framework, it is important that the cost of the actions taken to avoid a ramp induced power balance violation in the real-time dispatch is reasonably related to the operational significance of the violation.

- In a market framework it is also important to reflect the cost of the actions it would be economic to take to avoid power balance violations in market prices to provide an appropriate price signal for long-run changes in supply and resource mix and for appropriate actions by price responsible load in the short-run.

POWER BALANCE VIOLATIONS

The use of a \$1000 penalty price for power balance violations in the EIM would materially impact 5 minute prices (RTD) in PacifiCorp East as illustrated by the counterfactual prices.

Figure 7: Daily average of five-minute market prices in PAC West.

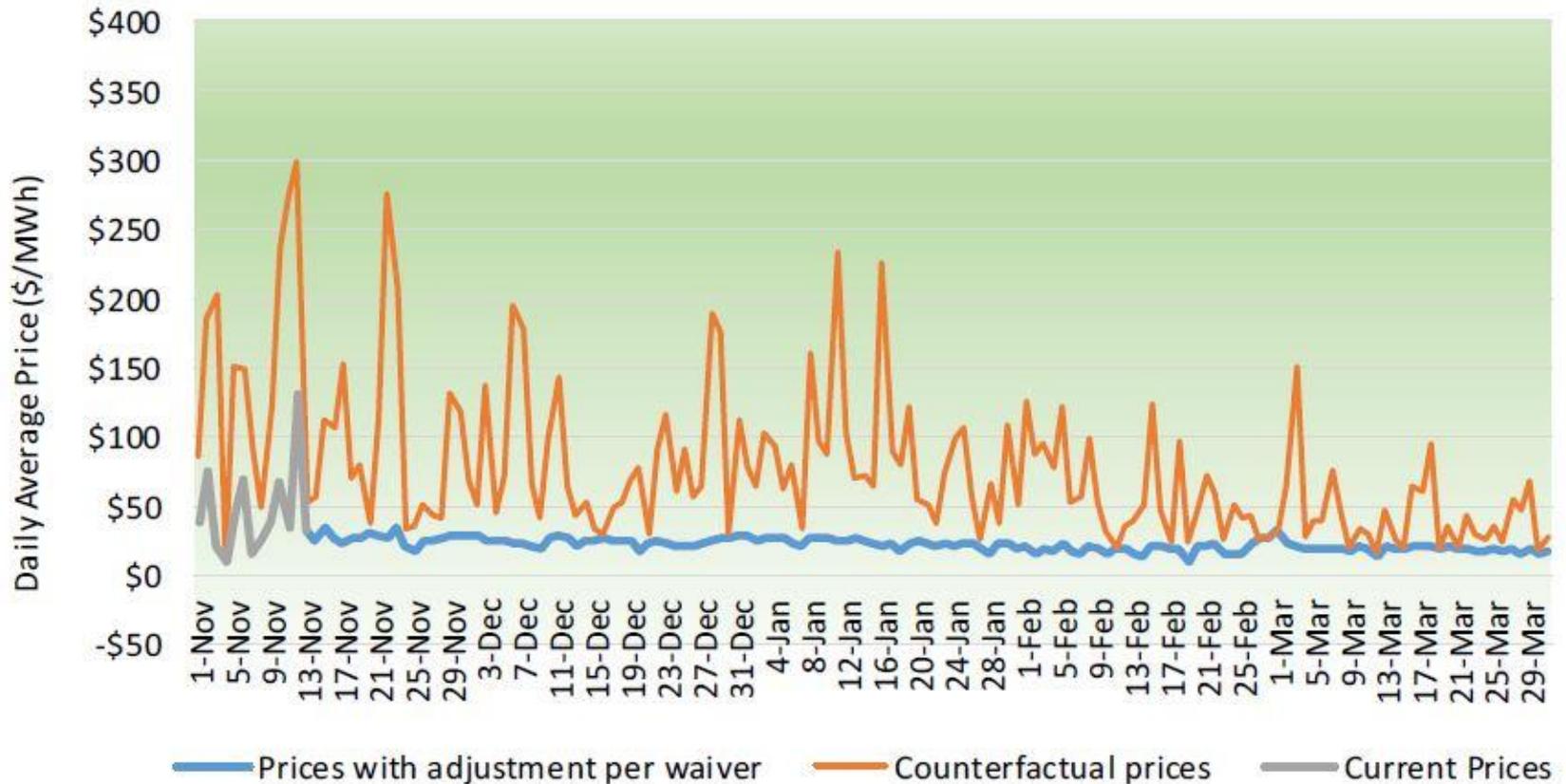


Source: California ISO, Energy Imbalance Market Pricing Waiver Report, April 24, 2015, p.60.

POWER BALANCE VIOLATIONS

The impact of using a \$1000 penalty for power balance violations in RTO would have been even larger in PacifiCorp East.

Figure 8: Daily average of five-minute market prices in PAC East.



POWER BALANCE VIOLATIONS

The New York ISO has had potential load balance violations in the real-time dispatch under SMD 2 operation.

- When potential load balance violations arise, capacity that would otherwise be providing regulation, spinning reserves or possibly 10 minute reserves is dispatched to meet load.
- When ramp constraints cause the dispatch of capacity that creates a shortage of regulation, spinning reserves or 10 minute reserves, this impact is reflected in the real-time prices of regulation, reserves and energy through the relevant shortage price (for regulation, spinning reserves or 10 minute reserves).
- These shortage prices are much less than the \$1000 load balance penalty the California ISO initially applied in determining EIM real-time prices.

POWER BALANCE VIOLATIONS

The initial, current and proposed shortage prices used by the NYISO for regulation, spinning reserves and total 10 minute reserves are shown below. The changes currently pending at FERC will both adjust shortage values and add an additional reserve region.

	Initial 2005-2011	Current 2011-2015 ¹	Proposed 2015- ²
Regulation			
< 25 MW	\$250	\$80	\$25
> 25 MW; < 80	\$300	\$180	\$400
> 80 MW	\$400	\$400	\$775
Eastern Spinning Reserves	\$25	\$25	\$25
SENY Spinning Reserves	n.a.	n.a.	\$25
Total Spinning Reserves	\$500	\$500	\$775
Total 10 Minute Reserves	\$150	\$450	\$750

1. See New York ISO Market Services Tariff Sections 15.3.7 and 15.4.7

2. See NYISO February 18, 2015 filing in Docket ER15-10611 and New York ISO, Ethan Avallone, "Comprehensive Shortage Pricing, BIC, November 12, 2014. 26

POWER BALANCE VIOLATIONS

Like the New York ISO, the MISO currently manages potential power balance violations due to ramp constraints by making additional ramp capability available to the five minute dispatch.

- While the New York ISO typically does this by dispatching capacity that would otherwise be providing regulation, the MISO accomplishes this by dispatching capacity that would otherwise be providing spinning reserves.
- The MISO will dispatch up to 10% of its spinning reserves to meet load at a shortage price of \$65 per megawatt hour and will dispatch additional spinning reserves at a shortage price of \$98 per megawatt hour.¹

1. MISO Tariff, Schedule 28, sections VII and VIII. This design originated in Docket ER12-1185-000, filed March 1, 2012 and implemented May 1, 2012.

CONCLUSIONS

- The California ISO EIM design follows the designs successfully implemented by MISO and SPP to coordinate an energy dispatch among distinct balancing areas.
- Although a proven design, the EIM design has operational challenges for both the California ISO and the EIM participants that will lead over time to improvements in the basic design framework as operational experience accumulates.
- One of the areas in which the basic EIM design is likely to continue to evolve over time is in the management and pricing of short-term ramp constraints both within individual EIM balancing areas and between EIM balancing areas.

COMPASS LEXECON-FTI CONSULTING-ELECTRICITY

Joseph Cavicchi	jcavicchi@compasslexecon.com	617-520-4251
Bert Conly	bert.conly@fticonsulting.com	214-397-1604
Scott Davido	scott.davido@fticonsulting.com	832-667-5124
Scott Harvey	scott.harvey@fticonsulting.com	617-747-1864
William Hogan	William_Hogan@Harvard.edu	617-495-1317
Joseph Kalt	jkalt@compasslexecon.com	617-520-0200
Susan Pope	susan.pope@fticonsulting.com	617-747-1860
Ellen Smith	ellen.smith@fticonsulting.com	617-747-1871
Jeffrey Tranen	jtranen@compasslexecon.com	212-249-6569
Kevin Wellenius	kevin.wellenius@fticonsulting.com	207-495-2999

See papers @
<http://Impmarketdesign.com>