# Discussion on Energy Imbalance Market Pricing: Ramp Constraints and Load Balance Penalties in Electricity Markets

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# TOPICS

- Power Balance Violations
- New York ISO
- MISO
- Conclusions

# POWER BALANCE VIOLATIONS EIM

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

Ramp constraint power balance violations in California ISO occurred in .6% of all five minute real-time dispatch intervals in 2012, .4% in 2013, and ranged from .2% to around 2% over the months in 2014. [1]

- These kind of power balance violations in the real-time dispatch are not unique to the CAISO or EIM.
- The New York ISO and MISO have potential power balance violations due to ramp constraints in their five minute real-time dispatch and this has been the case for many years.
- The MISO also had difficulties with power balance violations due to ramp constraints during the early years of MISO operation (2005-2009), when it was coordinating a real-time dispatch across distinct balancing authority areas.

1. See California ISO, Department of Market Monitoring,2013 Annual Report on Market Issues & Performance, p. 85 and Q4 2014 Report on Market Issues and Performance, March 3, 2015 pp. 32-33.

# POWER BALANCE VIOLATIONS NEW YORK ISO

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

The MISO also encounters binding ramp constraints in its real-time dispatch.

- 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 MISO

The MISO faced even greater challenges with binding ramp constraints in its real-time dispatch causing potential power balance violations prior to 2009 when it coordinated a five minute dispatch across distinct balancing authority areas within its footprint (i.e. as the California ISO does today within the EIM).

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

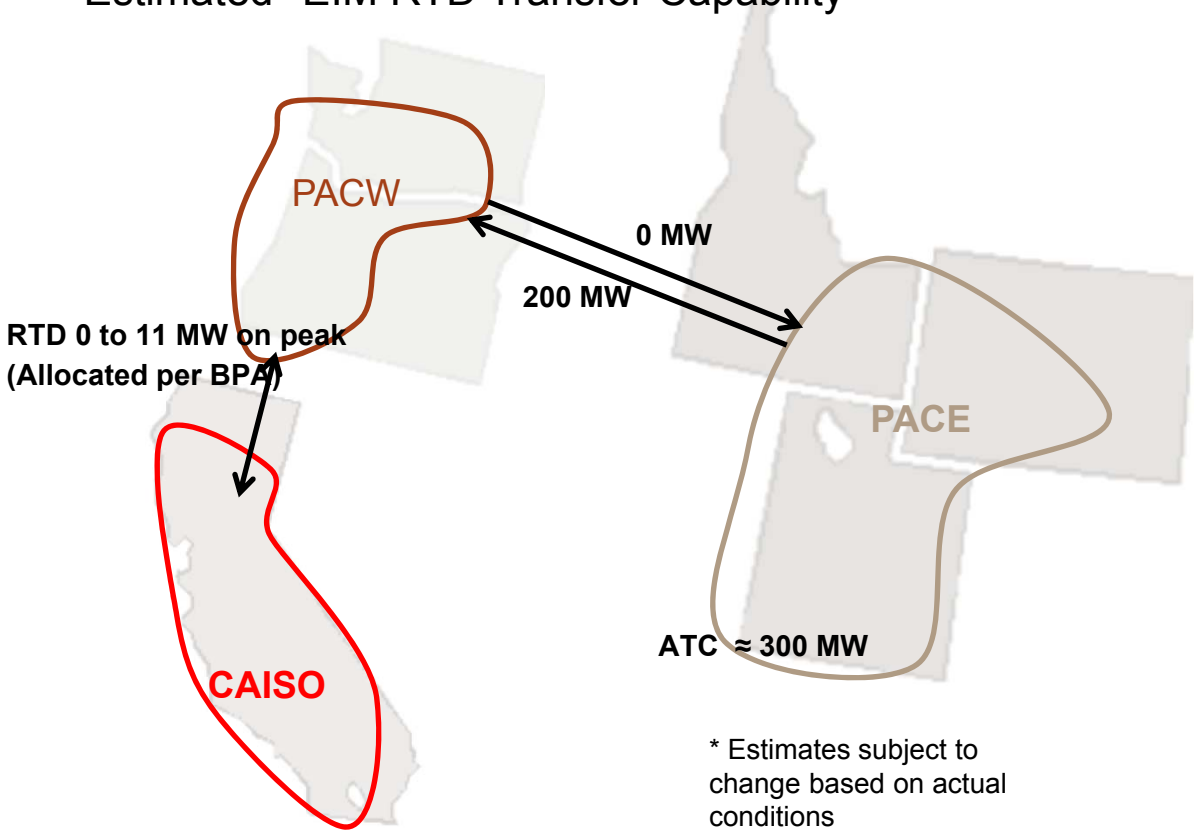
> "One typical situation involves a substantial curtailment of imports in response to a TLR procedure, either called by the Midwest ISO or a different Reliability Coordinator, which can in a matter of a few minutes create a large demand-supply gap that exceeds the capability of the on-line Resources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

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

# POWER BALANCE VIOLATIONS EIM

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

Estimated* EIM RTD Transfer Capability




* Estimates subject to change based on actual conditions



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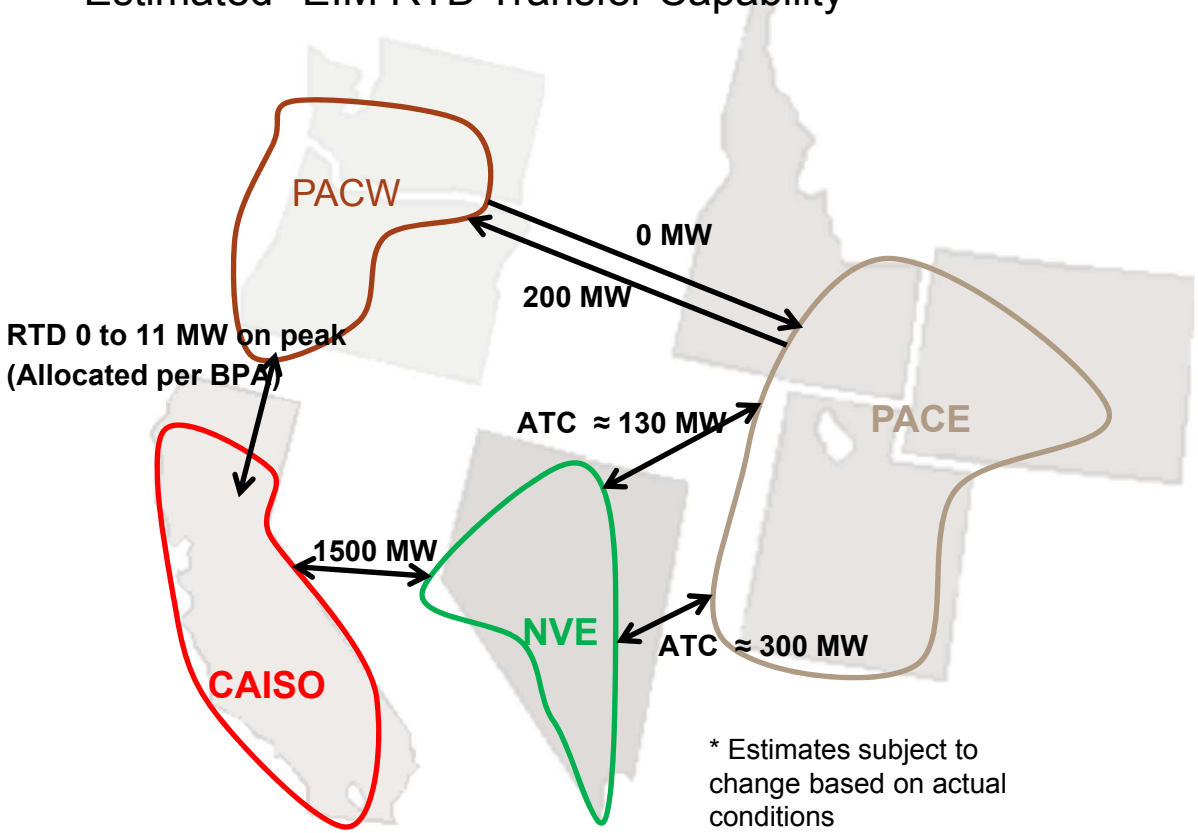
# POWER BALANCE VIOLATIONS EIM

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

Estimated* EIM RTD Transfer Capability



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# POWER BALANCE VIOLATIONS ELSEWHERE

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.

# NEW YORK ISO LOAD BALANCE PRICING

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

- 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 applies in real-time.

1. SMD 2 Software was implemented in February 2005.

# NEW YORK ISO LOAD BALANCE PRICING

The initial and current shortage prices used by the NYISO for regulation, eastern spinning reserves, total spinning reserves and total 10 minute reserves are shown below. [1]

| | 2005-2011 | 2011- |
|---|---|---|
| Regulation | | |
| < 25 MW | $250 | $80 |
| > 25 MW; < 80 | $300 | $180 |
| > 80 MW | $300 | $400 |
| Eastern Spinning Reserves | $25 | $25 |
| Total Spinning Reserves | $500 | $500 |
| Total 10 Minute Reserves | $150 | $450 |

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

Because eastern spinning reserves have a shadow price of only $25 per megawatt hour, a ramp constraint in the east would likely be solved by using capacity that would otherwise provide eastern spinning reserve, and shifting incremental spinning reserves to the west.

- This redispatch would raise real-time energy and spinning reserve prices in the east by $25.

# NEW YORK ISO EVOLUTION

The New York ISO did not develop its current shortage prices in a single step, but has evolved to this design as it has gained experience.

- When the New York ISO began operation in November 1999, capacity was designated to provide regulation and 10 minute reserves in a forward process (the balancing market evaluation) and this capacity was blocked off from the real-time dispatch absent operator action.
- This led to outcomes that were not consistent with New York Power Pool operating practice with many short-term price spikes due to ramp constraints.
- The first step in evolving to the current design was to implement a software feature that released blocked off capacity in response to a large change in the reference bus price or constraint shadow prices.

# NEW YORK ISO EVOLUTION

The next step was the SMD2 design implemented in February 2005 which improved on the prior design by assigning explicit shortage values to the dispatch of capacity that would otherwise have provided regulation, spinning or 10 minute reserves. [1]

- This design worked as intended but experience with this design lead to the conclusion that performance could be improved by adjusting some of the shortage values which was done in 2011. [2]
- The NYISO is currently in the process of implementing further refinements in its shortage pricing design, proposed for implementation in November 2015, pending FERC approval.[3]

1. Filed by the NYISO on Nov 26, 2003 in Docket ER04-230-000, approved by FERC Feb 11, 2004
2. Filed Dec 21, 2010 in Docket ER10-2454, implemented May 18, 2011
3. See NYISO February 18, 2015 filing in Docket ER15-1061 and New York ISO, Ethan Avallone, "Comprehensive Shortage Pricing, BIC, November 12, 2014.

# NEW YORK ISO EVOLUTION

The changes currently pending at FERC will both adjust shortage values and add an additional reserve region. [1]

| | 2005-2011 | 2011-2015 | 2015- |
|---|---|---|---|
| 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 NYISO February 18, 2015 filing in Docket ER15-10611 and New York ISO, Ethan Avallone, "Comprehensive Shortage Pricing, BIC, November 12, 2014.

# MISO LOAD BALANCE PRICING

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 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.

# MISO EVOLUTION

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.
- 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.

# MISO EVOLUTION

The MISO took over responsibility as the balancing authority within its footprint on January 6, 2009, and began coordinating ancillary service markets both day-ahead and in real-time. [1]

- In this design the MISO relaxed the spinning reserve requirement at a penalty price of $98 per megawatt hour.
- This constraint relaxation allowed capacity that would otherwise have been providing spinning reserves to balance load and generation when ramp constraints bound in the 5 minute dispatch.

This constraint relaxation occurred routinely when ramp constraints were binding in the MISO real-time dispatch, with the result that ramp constraints did not lead to power balance violations.

1. These changes were filed in Docket ER07-1372-000 on September 14, 2007.

# MISO EVOLUTION

When the spinning reserve constraint was relaxed, prices were set by the opportunity cost of spinning reserves and the incremental cost of the supply dispatched to meet load to set price, rather than applying a penalty price to determine the market price. [1]

- The MISO and its independent market monitor observed, however, that there was  not a good relationship between prices and the degree of reserve scarcity in this period.

1. MISO filing letter in Docket ER12-1185-000 March 1, 2012 p. 2. also Prepared Testimony of Kevin A Vannoy, pp.4-5.

# MISO EVOLUTION

On March 1, 2012 MISO filed in Docket ER12-1185 to implement spinning reserve shortage pricing with a penalty value of $65 of shortages of less than 10% and $98 per megawatt for shortages in excess of 10% of the target. [1]

- With implementation of these shortage values on May 1, 2012, ramp constraints are generally resolved by using capacity to meet load that would otherwise be scheduled to provide spinning reserve, with the appropriate penalty price directly reflected in energy and reserve prices.

1. Approved by FERC in a letter order on April 30, 2012 139 FERC ¶61,081.

# Conclusions

There is nothing unique about power balance violations in the time frame of the real-time 5 minute dispatch.

- These notional power balance violations occur routinely in NYISO and MISO;
- Some other ISOs and other system operators do not even enforce the power balance constraint in the dispatch on a five minute basis.
- There is no actual power balance violation even in the short-run unless regulating capacity is unable to balance load and generation.

# Conclusions

If energy and ancillary service prices are used to incent market efficiency and support reliability, shortage pricing needs to be rationally related to the degree of shortage.

- The shortage component of energy prices should not be zero when the ISO is having difficulty balancing load and generation and needs additional resources.

- The shortage component of energy prices should not be $1000 just because some capacity providing regulation is used to meet load during the interval because of ramp constraints.

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