Analysis of High Real-Time Energy Prices in the Midwest ISO

January 1 – June 30, 2010

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Overview

- We were asked to investigate the underlying causes of relatively high prices and evaluate the causes these prices.
- We performed an analysis of all high-price events in the Midwest ISO between January 1 and June 30, 2010.
- The first class of events we analyzed were high system-wide prices.
  - ✓ Each event is a period characterized by a System Marginal Price ("SMP") greater than $175 per MWh during each 5-minute interval.
  - ✓ There were 224 such events in the studied period, lasting on average 1.45 intervals. The longest event lasted 6 intervals.
- The second class of events were relatively high prices at specific location caused by congestion. This events were identified by:
  - ✓ An LMP greater than $175 per MWh *and* a congestion component equal to at least $50 per MWh.
  - ✓ There were 1,228 such events in the studied period, lasting on average 6 intervals. The longest constraint-specific locational price spike lasted 132 intervals.
- The balance of this presentation shows when these events occurred and the primary causes of the events.

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System-Wide High Prices

- The first figure shows the number of system-wide pricing events that occurred in each month, along with the types of shortages that occurred during the event.
- The figure shows that the number of events ranged from 15 to 24 in the six months studied, but the percent of intervals affected were very small because the events are all very short.
  - ✓ In 5 of the 6 months, the share of intervals that were high-priced was less than 0.6 percent.
- The figure also shows that in nearly all of the high-priced intervals (94 percent), the market was short of one or more classes of ancillary services.
  - ✓ The value of the forgone ancillary service is included in the ASM prices and the energy prices so it is not surprising that most of the high prices are associated with once or more shortages of reserves or regulation.
  - ✓ In general, the system will go into shortage in the lowest value reserve first, making trade-offs that will maintain higher-value reserves. Hence the system will generally go short of spinning reserves, then regulation, then overall operating reserves.
  - ✓ Hence, the system is short of only spinning reserves in 72 percent of the high-priced intervals during the study period.

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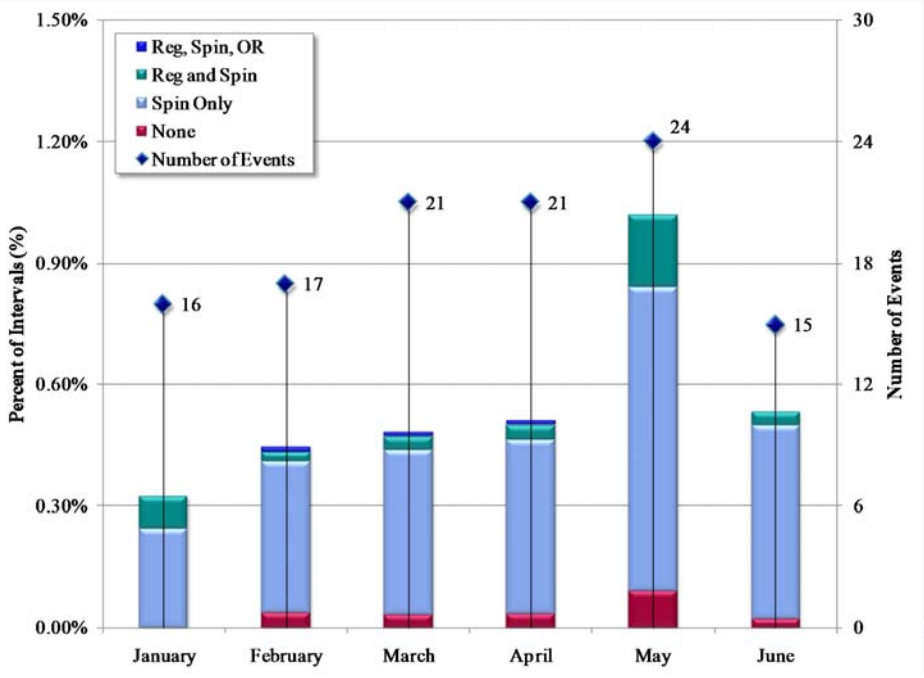
High-Priced SMP Events



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Causes of High System Marginal Prices

- The next figure identifies the primary causes of high SMPs during the study period.
  - ✓ The figure shows the share of the high-priced intervals in each month that each factor contributed to causing.
- In all cases, the system is limited in its ability to ramp the necessary supply to satisfy both energy and ASM requirements.
  - ✓ In some cases, the system can ramp sufficiently but only at a cost that is higher than the spinning reserves' value so the system will not procure the entire requirement.
  - ✓ In general, the causes shown in the figure are factors that demand ramp from the system and, thus, contribute to the shortage and associated high price.
  - ✓ When these factors produce a ramp demand leading into the shortage greater than 300 MW, we classify the factor as a contributor to the shortage.

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Causes of High System Marginal Prices

- The most prevalent cause of high prices are sharp movements in actual load. Load increases contributed to more than one quarter of the high-priced intervals.
  - ✓ In 40 percent of these intervals (10 percent of all high-priced intervals), non-conforming load was a major cause of the movement in actual load.
- Sudden reductions in NSI contributed to 15 percent of the high-priced intervals.
  - ✓ NSI volatility has improved from the early days of the market because the MISO has adjusted its criteria for accepting substantial changes in physical imports/exports.
- The next two factors shown in the figure relate to the operation of the system.
  - ✓ The most significant operational factor was the "offset", which operators use to adjust the system-wide load that the real-time market is serving.
    - – The operators' use of the offset contributed to the ramp shortage in 23 percent of the high-priced intervals.
    - – It is difficult to determine how many, but some offsets that increase the ramp demand on the system are justifiable if they prevent a larger shortage later.
  - ✓ The second operational factor relates to the short-term load forecast used to determine the real-time market load. In 9 percent of the intervals, the real-time market load increased much faster than the actual load, suggesting a poor forecast.
    - – The Midwest ISO has been working to improve its STLF.

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Causes of High System Marginal Prices

- The next two factors relate to the conduct of suppliers in the Midwest ISO.
  - ✓ Reductions in supply can cause the system to have to ramp to replace the supply.
    - – Reductions on total generation through outages, deratings, or decommitment contributed to the high-prices in 10 percent of the high-priced intervals.
  - ✓ The second factor related to supplier behavior relates to potential economic withholding, which is measured by the "output gap" metric.
    - – The figure shows that the output gap only contributed to the high prices in May and June, and was significant in less than 1 percent of the high-priced intervals.
- The final two factors relate to spinning reserves that are "stranded" by transmission constraints.
  - ✓ The Midwest ISO designates a unit to be stranded when it is behind a significant binding constraint, which causes the unit to lose its ability to provide reserves.
  - ✓ Normally, this does not affect prices significantly because the reserves can be shifted to other units at little cost.
  - ✓ However, our analysis indicates that spinning reserves that were really stranded caused the spinning reserve shortage in 9 percent of the high-priced intervals.
  - ✓ In an additional 3 percent of intervals, spinning reserves that were designated as stranded by the Midwest ISO but were not physically affecting a constraint were a significant cause of a spinning reserve shortage.

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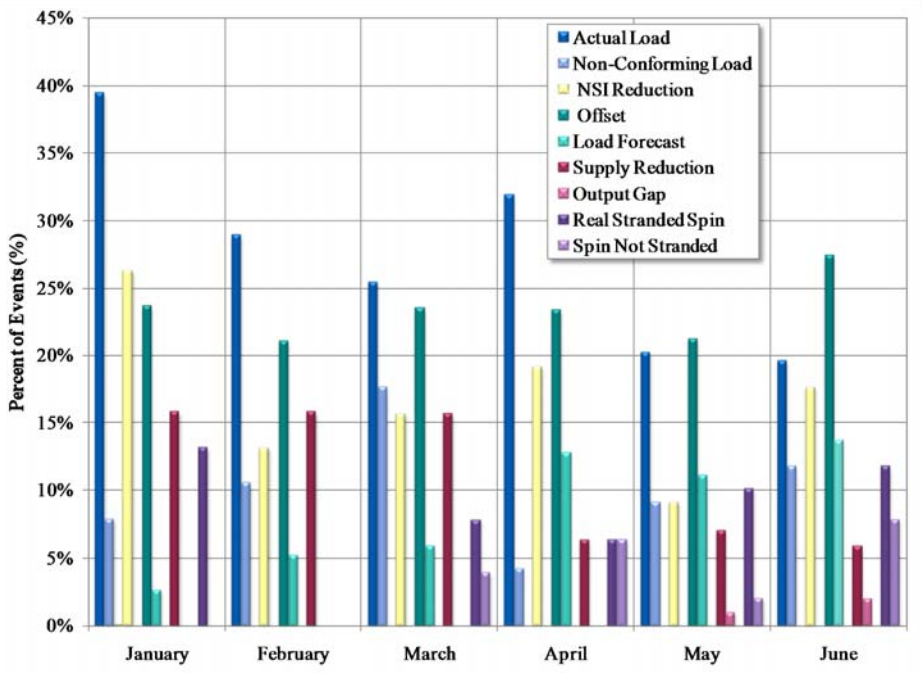
Causes of High System Marginal Prices



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High-Priced Congestion Events

- The following figure shows similar analyses for intervals exhibiting high locational prices caused by congestion. The first figure shows the number of such intervals.
- There were almost 1300 events covering almost 16000 intervals (each event lasted approximately one hour on average).
  - ✓ Unlike the prior analysis of relatively high SMPs, high locational prices due to congestion were relatively frequent (roughly one third of all intervals).
- We determine the extent to which each of the following factors was a significant contributor to the high-priced congestion:
  - ✓ Short-term planned outage;
  - ✓ Short-term forced outage;
  - ✓ Offline peaking resources that are economic;
  - ✓ Potential economic withholding; and
  - ✓ Over-production.
- We identified a factor as significant if it resulted in a reduction in flow relief over the applicable constraint equal to 30 percent or more of the constraint limit.
- The last figure below shows the share of high-priced intervals in each month that were cause in whole or in part by one or more of the factors listed above.

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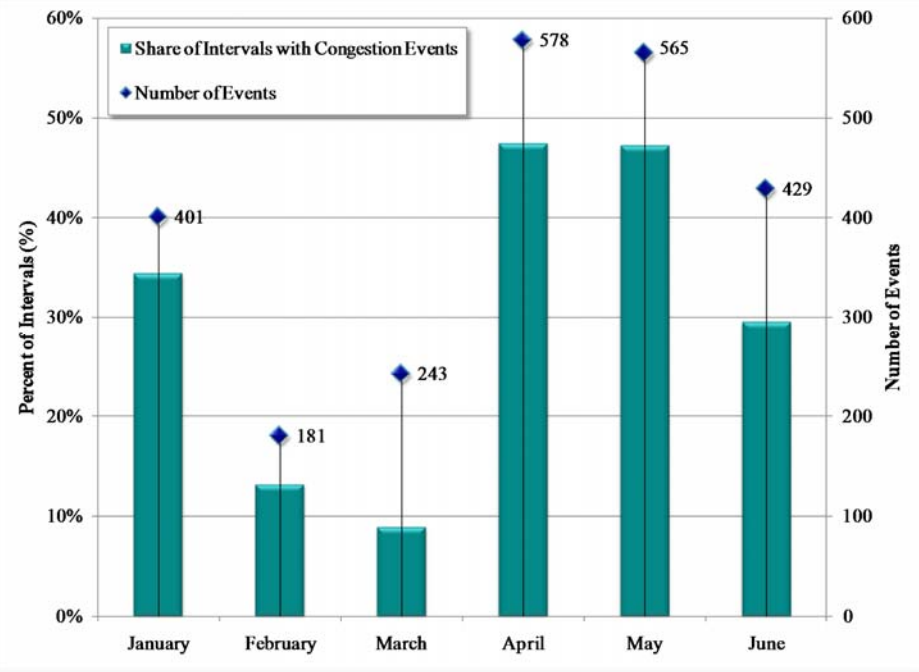
High-Priced Congestion Events



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Constraint-Specific Results

- The following figure shows that short-term planned and unplanned outages contribute to a relatively small share of the high locational prices (less than 5 percent in total).
  - ✓ However, outages can be the primary cause of some congestion, which explains the higher shares in some months (as high as 14 percent in June).
- The figure also shows that in some cases (5 percent of the intervals), economic peaking resources were available that could have helped manage the congestion.
  - ✓ In this analysis, a peaking resource is considered economic if its energy offer is less than the high-priced LMP. This does not mean it would have been economic to commit, which would depend on the duration of the high prices.
  - ✓ It is difficult for operators to determine whether a peaking unit should be committed economically, which is why we have recommend that the Midwest ISO develop a "look-ahead" tool to assist in making this determination.
- The final causes we evaluated are related to participants' conduct.
  - ✓ The figure shows that the congestion caused in part by potential economic withholding and over-production was 4.5 percent and 2 percent, respectively.
  - ✓ In general, participants' offers were not a major contributor to instances of high-priced congestion, although the effects were large in some specific cases. The automated mitigation addresses cases that satisfy the conduct and impact tests.
- The vast majority of the high-priced congestion was caused by the natural dispatch of the system in real time.

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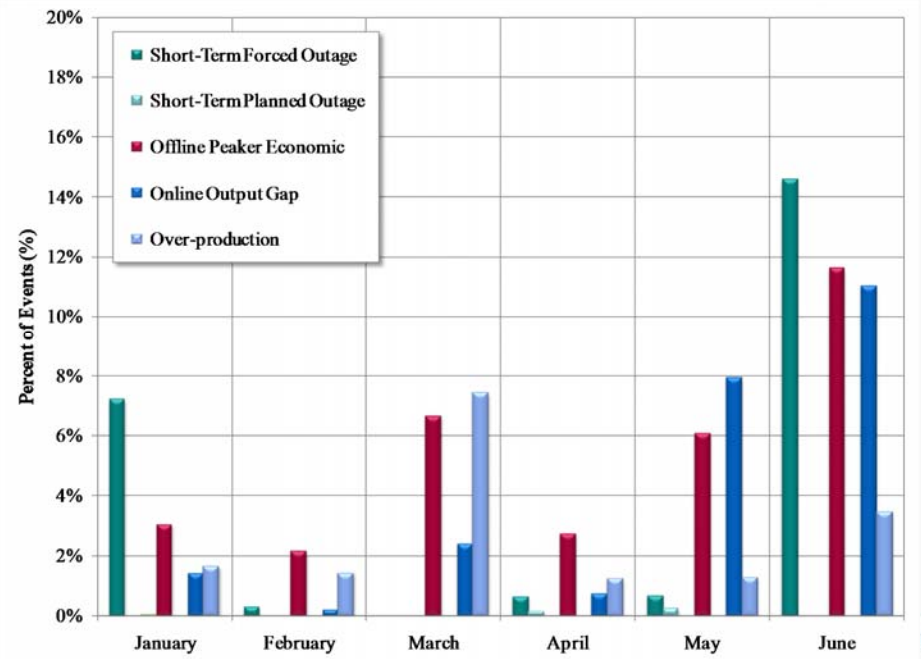
Causes of High Congestion Prices



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