



California Independent System Operator Corporation

June 12, 2015

The Honorable Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

**Re: California Independent System Operator Corporation
Docket No. ER15-402
Independent Assessment – Department of Market Monitoring
Report on Energy Imbalance Market Issues and Performance**

Dear Secretary Bose:

The Department of Market Monitoring hereby submits its independent assessment on the causes and solutions identified by the California Independent System Operator Corporation in its report on the performance of the Energy Imbalance Market for the month of April, 2015.¹

Please contact the undersigned with any questions.

Respectfully submitted,

By: /s/ Anna A. McKenna
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¹ The CAISO submits this report pursuant to *California Independent System Operator Corp.*, 149 FERC ¶ 61,194 (2014).



California ISO

California Independent
System Operator Corporation

California ISO

Report on energy imbalance market
issues and performance

June 12, 2015

Department of Market Monitoring

Executive Summary

Pursuant to the Commission’s March 16, 2015, Order on the ISO’s Energy Imbalance Market (EIM), the ISO filed a report on June 3, 2015 covering the period from April 1-30, 2015 (June 3 Report).¹ This report provides a review by the Department of Market Monitoring (DMM) of the information and period covered in the ISO’s June 3 Report. Key findings include the following:

- Performance of the EIM during April remained similar to performance during March. During most intervals, prices in the EIM have continued to be highly competitive and have been set by bids closely reflective of the marginal operating cost of the highest cost resource dispatched to balance loads and generation. However, during a relatively small portion of intervals, energy or flexible ramping constraints have still had to be relaxed for the market software to balance modeled supply and demand.
- The frequency of intervals in which the power balance constraints have been relaxed in the 15-minute market remained at about 1.5 percent in PacifiCorp East and about 0.2 percent in PacifiCorp West.
- In the 5-minute market, the power balance constraint was relaxed about 2.5 percent of intervals in PacifiCorp East compared to about 1.9 percent of intervals in March. In PacifiCorp West the power balance constraint was relaxed about 0.8 percent of 5-minute intervals during April compared to about 0.7 percent of 5-minute intervals in March.
- In PacifiCorp East, without the price discovery provisions currently in effect, average EIM prices in the 15-minute and 5-minute markets during April would have exceeded bilateral market price indices that were used to set prices prior to EIM implementation by about 70 percent and 80 percent, respectively.
- In PacifiCorp West, without price discovery provisions in place, EIM prices in the 15-minute market during April would have been about 23 percent higher than these bilateral market price indices, while prices in the 5-minute market would have been about 9 percent higher than bilateral prices.
- With price discovery provisions, EIM prices in both PacifiCorp areas have been kept about equal to the bilateral market price indices that were used to set prices prior to EIM implementation.
- Bidding in the EIM continues to be highly competitive, with bids for most capacity slightly below or above default energy bids used in market power mitigation. When bids are mitigated due to market power mitigation provisions, these procedures generally result in modest reductions in bid prices.
- On March 30, the ISO implemented an automated tool that set the flexible ramping constraint requirements. DMM has analyzed the performance of the new method of setting flexible ramping constraint requirements and is recommending significant modifications in how flexible ramping constraint requirements are set in both the IDO and EIM areas.

¹ *Energy Imbalance Market Pricing Waiver Report, April 1 – April 30, 2015*, ISO Market Quality and Renewable Integration, June 3, 2015, http://www.caiso.com/Documents/Jun3_2015_April2015_EnergyImbalanceMarketPriceWaiverReport_ER15-402.pdf

The ISO's June 3 report included several new informational updates, as summarized below.²

- **Load bias limiter.** The ISO's April 24 report noted that the ISO was prepared to implement a software enhancement known as the *load bias limiter* in the EIM that is currently in place in the ISO real-time market and that it plans to implement this new software feature in the EIM after the price discovery features currently in place expires. The ISO's June 3 report notes that the ISO implemented this feature for EIM on March 20, 2015,³ and also provides a detailed description of this feature.⁴ Additional discussion of this feature is provided in pages 13 to 15 of this report.
- **Multi-stage generating unit modeling improvements.** During April and May "the CAISO implemented numerous market software fixes to handle transitions between configurations [of resources modeled as multi-stage generating units] as well as during startup and shutdown. The CAISO has also added additional business logic in the software to protect against invalid Dispatch Operating Target instructions."⁵
- **Interruptible industrial loads.** The ISO's June 3 reports notes that on April 1 the ISO removed large "non-conforming Industrial Loads" (which may be curtailed) from the PACE BAA area load, and that PacifiCorp started submitting industrial load base schedules for these loads. The report notes that PacifiCorp has been submitted price sensitive economic bids to the EIM software for these interruptible loads since mid-May 2015.⁶
- **Rate of change constraints.** Prior ISO reports have noted that the CAISO, PacifiCorp and BPA are involved in ongoing discussions on how to improve the dynamic transfer capacity on the California Interchange (COI) between PacifiCorp and the ISO in the 5-minute EIM market. The ISO's June 3 reports notes that work continues on testing two methodologies or approaches to identify which methodology is superior and acceptable to BPA as an alternative to the method currently in place. The June 3 report notes that first methodology was deployed mid May 2015, and that the ISO, PacifiCorp and BPA are committed and continue to discuss on weekly calls the effectiveness of this approach, as well as potential better alternatives.⁷
- **Available supply during interval of insufficient market bids.** Attachment C of the June 3 report includes a more detailed explanation of the analysis each interval of infeasibility to determine whether it was infeasible due to actual supply insufficiency by calculating the degree to which the infeasibility was in excess of PacifiCorp's available capacity to balance its system. The report provides additional discussion of the data used in the analysis and caveats about the analysis.⁸ This additional information addresses a recommendation by DMM that additional information on this analysis be included in the ISO's report.

² Since the ISO's monthly reports are composed primarily of information in prior reports, DMM has recommended that the ISO provide a redlined version of each report and/or a summary of key additional information in each report so that this new information is more readily apparent.

³ June 3 Report, pp. 27-28.

⁴ June 3 Report, pp. 79-81.

⁵ June 3 Report, pp. 19.

⁶ June 3 Report, pp. 28.

⁷ June 3 Report, pp. 31.

⁸ June 3 Report, pp. 34.

1 Background

On November 13, 2014, the ISO requested a 90-day waiver of two tariff provisions for establishing the price of energy in the Energy Imbalance Market (EIM) during intervals when, due to a lack of sufficient supply from capacity bid into the market, the ISO's market software must resort to relaxing transmission or system energy balance constraints in order to reach a market solution.⁹

Under these conditions, the waiver would allow prices to be set by a special *price discovery* process designed to let prices reflect the highest cost supply dispatched to meet demand, rather than based on penalty pricing parameters such as the \$1,000/MW price otherwise applied to the amount by which the power balance constraint relaxed. To effectuate this price discovery feature, the ISO has also set the penalty price for the flexible ramping constraint to \$0 in the pricing run of the EIM software. This allows energy prices to be set based on the highest cost supply needed to meet demand when the price discovery mechanism is triggered without any additional impact from the penalty price assigned to the flexible ramping constraint in the scheduling run.¹⁰

The ISO's November 13 waiver request was submitted as a means of mitigating high prices that the ISO believes resulted from a variety of factors which prevented the market software from producing prices reflective of actual supply and demand conditions. The ISO explained that these high prices are not always indicative of actual physical conditions on the system, and instead reflect factors such as (1) challenges in providing timely and complete data to ensure system visibility under the new procedures, (2) limitations on the resources available to PacifiCorp for use in the EIM, and (3) several forced outages of large EIM participating resources.

On December 1, the Federal Energy Regulatory Commission (FERC) issued an order granting the ISO's petition for waiver of these provisions for 90 days, effective November 14, 2014, as requested.¹¹ The Commission also directed the ISO to file detailed informational reports at 30-day intervals, providing detailed supporting data demonstrating progress towards identifying and eliminating the problems giving rise to the waiver petition. FERC indicated that these reports should include independent assessments from the Department of Market Monitoring on the causes and the solutions identified by the ISO. The Commission indicated that the first report be filed 30 days from the effective date of the tariff waiver, December 15, 2014.

On March 16, 2015, FERC extended the waiver for an additional 90 days and, in addition, extended the reporting requirements. The ISO filed a report pursuant to the March 16 Order covering EIM performance in April on June 3, 2015.¹² This represents DMM's report corresponding to the information and period covered in the ISO's June 3 Report.

⁹ http://www.caiso.com/Documents/Nov13_2014_PetitionWaiver_EIM_ER15-402.pdf

¹⁰ The penalty price for the flexible ramping constraint was \$247/MW until January 14, 2015. As of January 15, 2015, the ISO tariff specifies that the parameter for the flexible ramping constraint will be set to \$60.

¹¹ http://www.caiso.com/Documents/Dec1_2014_OrderGrantingWaiver_EIMPricingParameters_ER15-402.pdf

¹² *Energy Imbalance Market Pricing Waiver Report, April 1 – April 30, 2015*, ISO Market Quality and Renewable Integration, June 3, 2015: http://www.caiso.com/Documents/Jun3_2015_April2015_EnergyImbalanceMarketPriceWaiverReport_ER15-402.pdf.

2 Energy imbalance market prices

Figure 2.1 and Figure 2.3 show the average daily frequency of constraint relaxations in the 15-minute market by month in PacifiCorp East and PacifiCorp West, respectively. Figure 2.5 and Figure 2.7 provide a similar summary for the 5-minute market in these two areas. A detailed description of various types of constraint relaxation in these figures has been provided in prior reports.¹³

Figure 2.2 and Figure 2.4 show average monthly prices in the 15-minute market *with* and *without* the special price discovery mechanism being applied to mitigate prices in PacifiCorp East and PacifiCorp West, respectively. Figure 2.6 and Figure 2.8 provide the same monthly price summary for the 5-minute market. These figures also include monthly average bilateral market prices that were used to determine balancing energy charges prior to EIM implementation in PacifiCorp East and PacifiCorp West, respectively. Table 2.1 shows results of this analysis for the month of April.

A detailed description of the methodology used to calculate these counterfactual prices that would result without price discovery has been provided in prior reports.¹⁴ The ISO's June 3 Report notes that the ISO implemented the load bias limiter feature for EIM on March 20, so that data in the ISO's report now exclude intervals since March 20 when the power balance constraint was relaxed in the scheduling run, but this software feature would have been triggered if price discovery was not in effect. DMM has also adjusted its analysis to be consistent with the data in the ISO report.¹⁵ However, Section 4 of this report provides additional detail on the impact of the load bias limiter feature on prices if price discovery was not in effect.

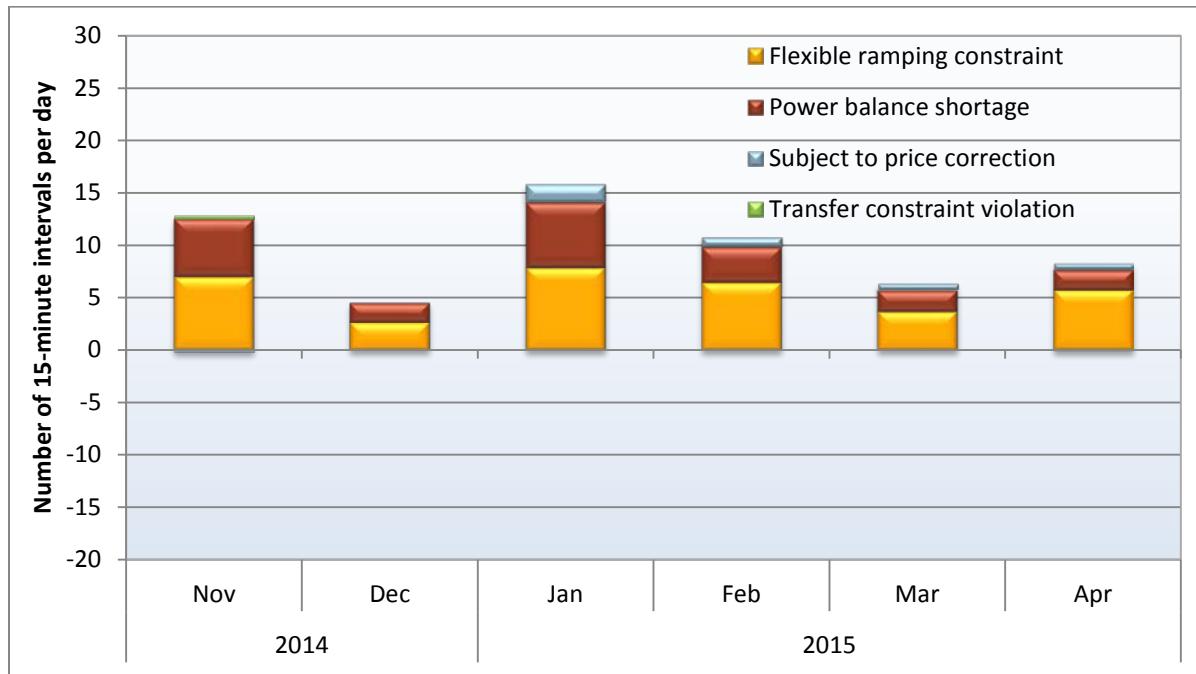
As shown in these figures, the price discovery mechanism approved under the Commission's December 1, 2014 order has effectively mitigated the impact of constraint relaxation on market prices. As shown in Table 2.1, without price discovery, prices in PacifiCorp East during April would continue to be 70 to 80 percent higher than bilateral prices in the 15-minute and 5-minute markets, respectively. In PacifiCorp West, prices in April would have been 23 percent higher than bilateral market prices in the 15-minute market and 9 percent higher in the 5-minute markets.

¹³ *Report on Energy Imbalance Market Issues and Performance*, Department of Market Monitoring, April 2, 2015, p.5.
http://www.caiso.com/Documents/Apr2_2015_DMM_AssessmentPerformance_EIM-Feb13-Mar16_2015_ER15-402.pdf.

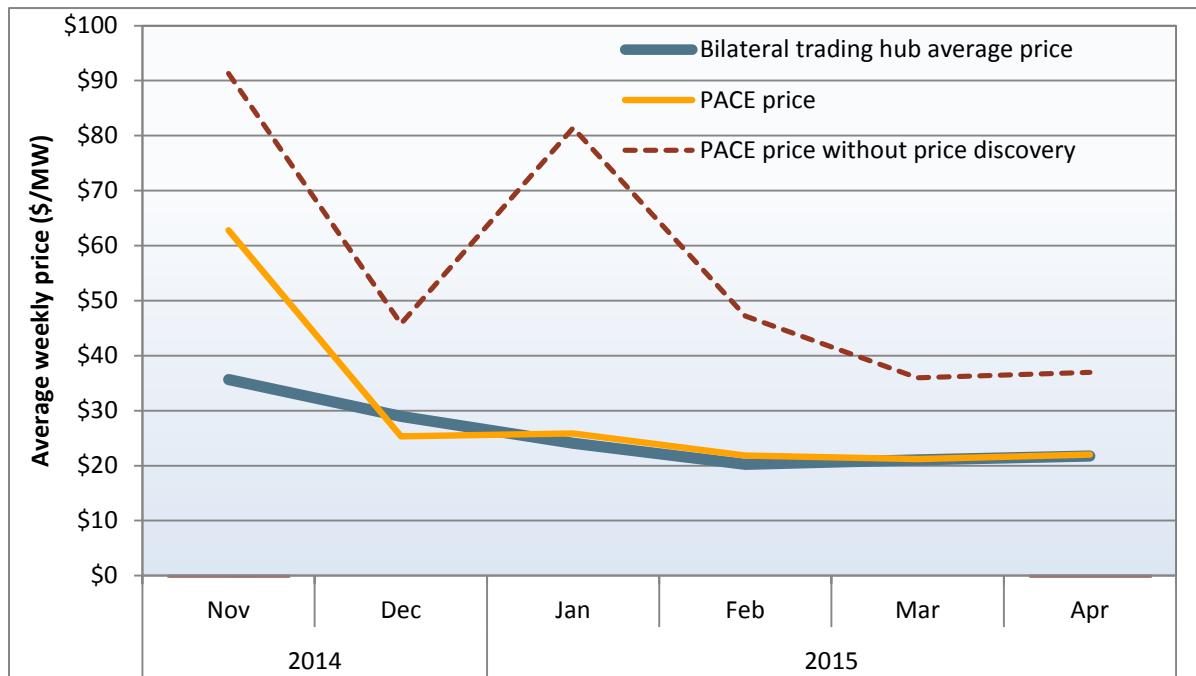
¹⁴ *Report on Energy Imbalance Market Issues and Performance*, Department of Market Monitoring, April 2, 2015, p.6.
http://www.caiso.com/Documents/Apr2_2015_DMM_AssessmentPerformance_EIM-Feb13-Mar16_2015_ER15-402.pdf.

¹⁵ As in the ISO report, data on the frequency of constraint relaxation exclude intervals since March 20 when the power balance constraint was relaxed in the scheduling run, but this software feature would have been triggered if price discovery was not in effect. Also, when estimating prices without price discovery, it is assumed that when the load bias limited would have been triggered, the resulting price would have been equal to the actual price that resulted with price discovery in effect.

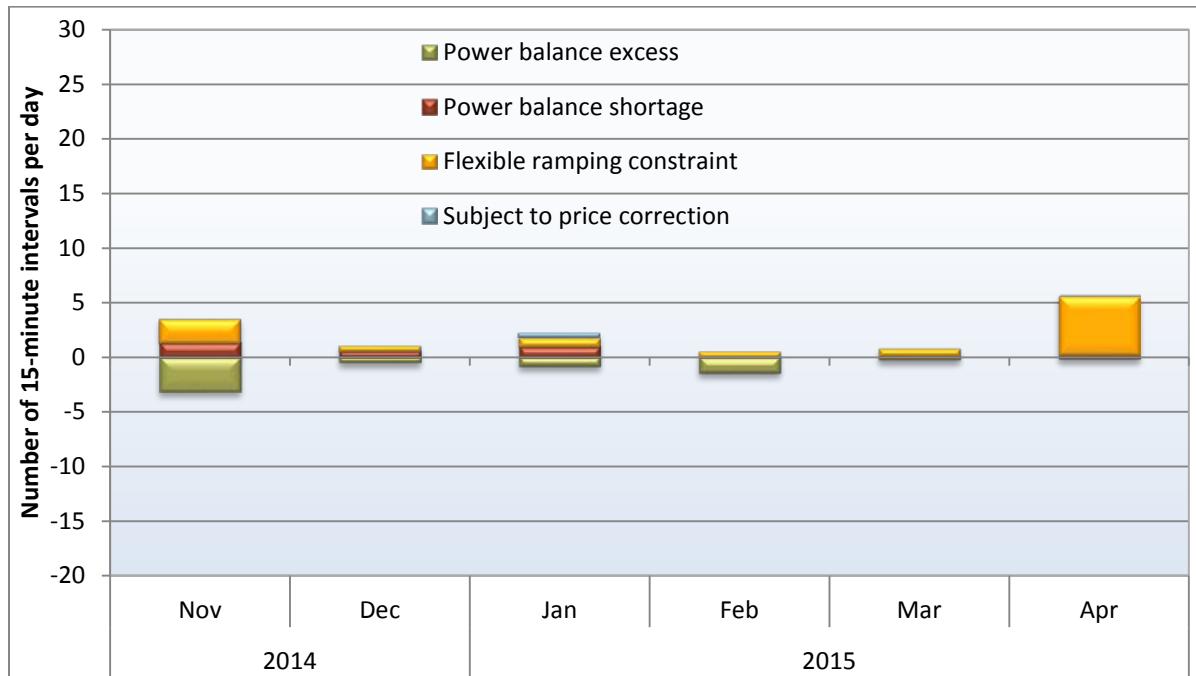
**Figure 2.1 Frequency of constraint relaxation
PacifiCorp East - 15-minute market**



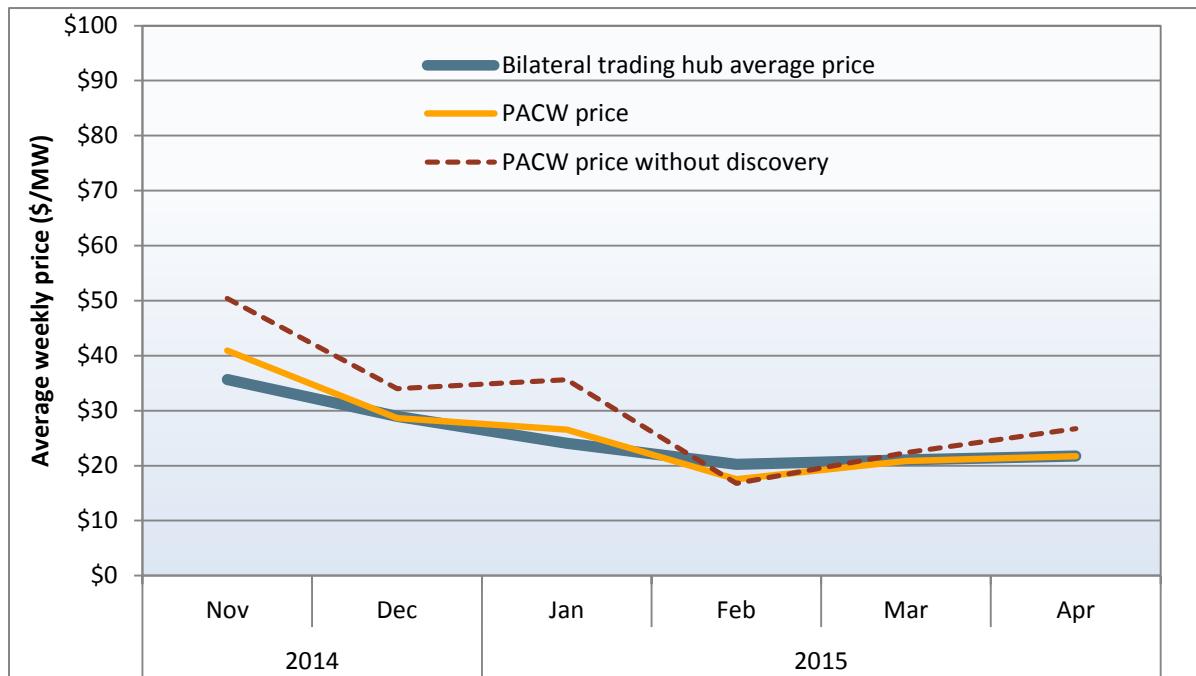
**Figure 2.2 Average daily prices with and without price discovery
PacifiCorp East - 15-minute market**



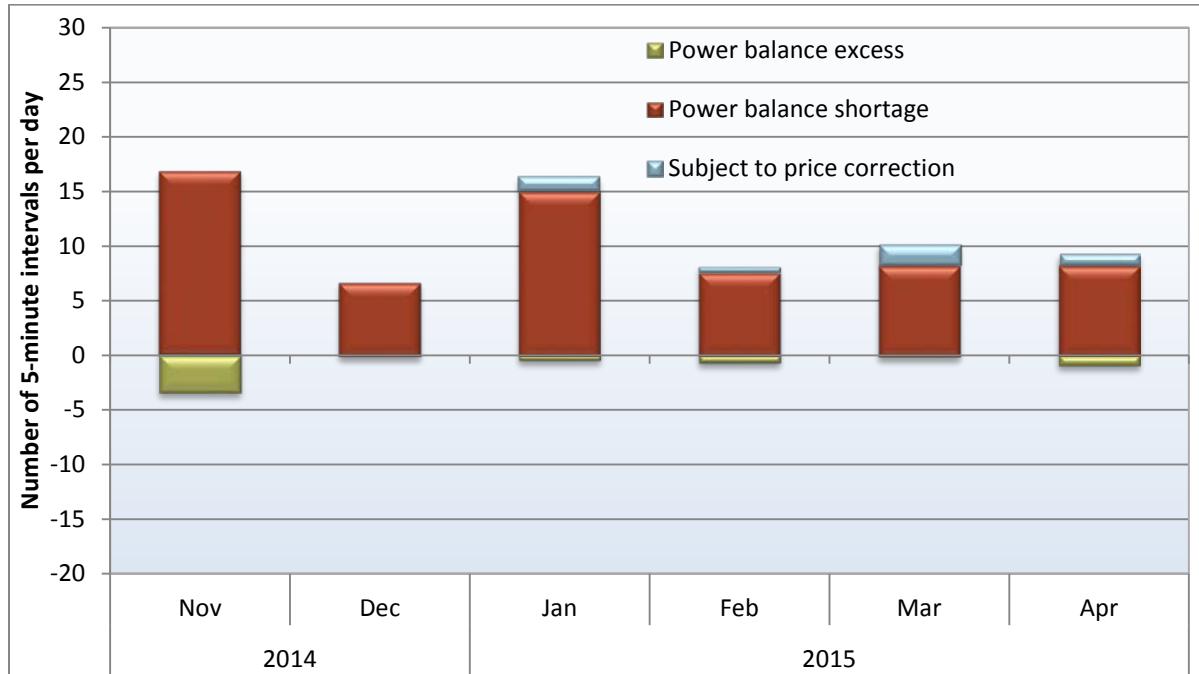
**Figure 2.3 Frequency of constraint relaxation
PacifiCorp West - 15-minute market**



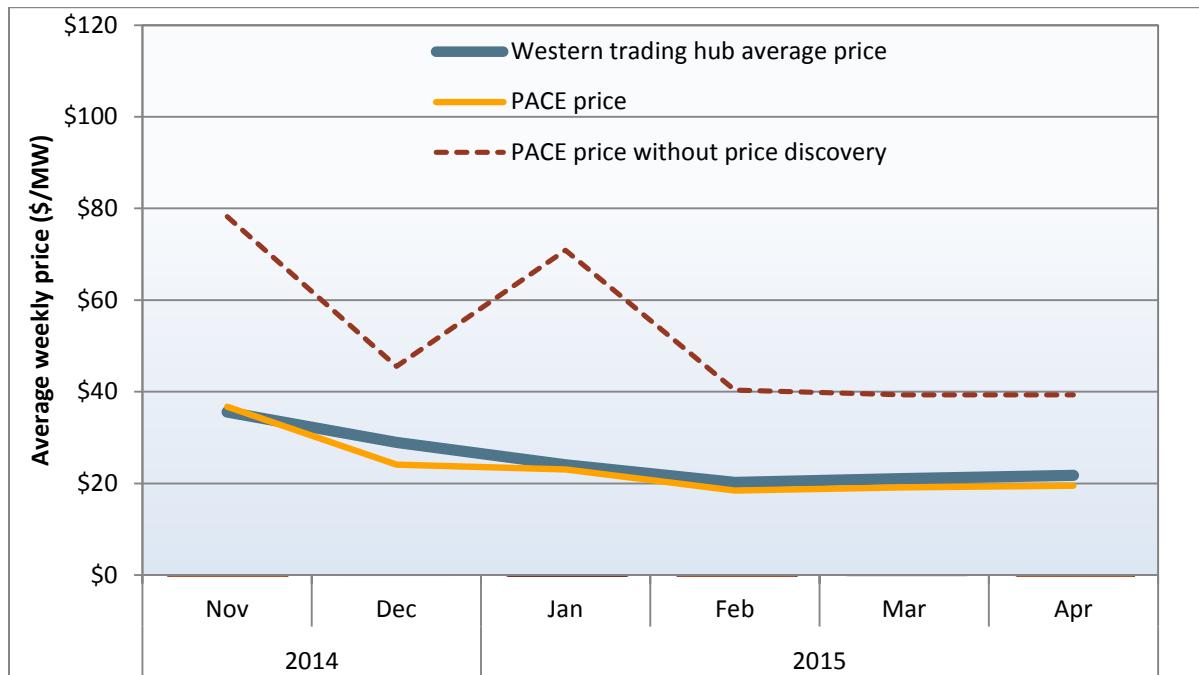
**Figure 2.4 Average daily prices with and without price discovery
PacifiCorp West - 15-minute market**



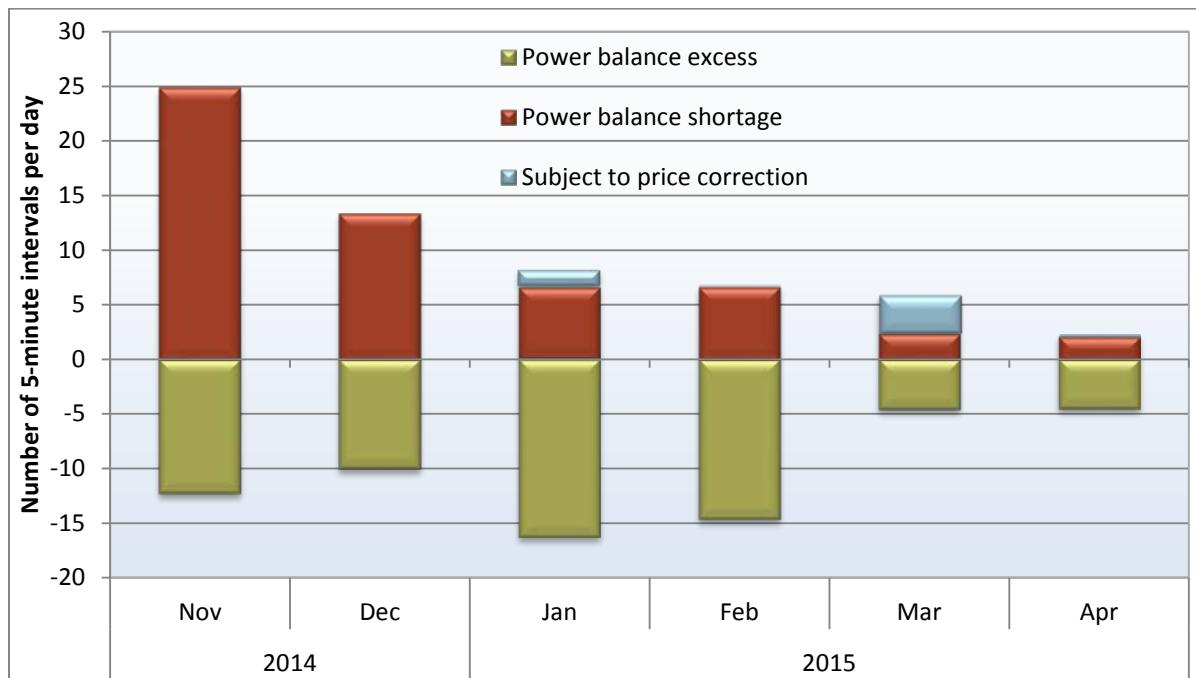
**Figure 2.5 Frequency of constraint relaxation
Pacificorp East – 5-minute market**



**Figure 2.6 Average daily prices with and without price discovery
Pacificorp East – 5-minute market**



**Figure 2.7 Frequency of constraint relaxation
Pacificorp West 5-minute market**



**Figure 2.8 Average daily prices with and without price discovery
Pacificorp West – 5-minute market**

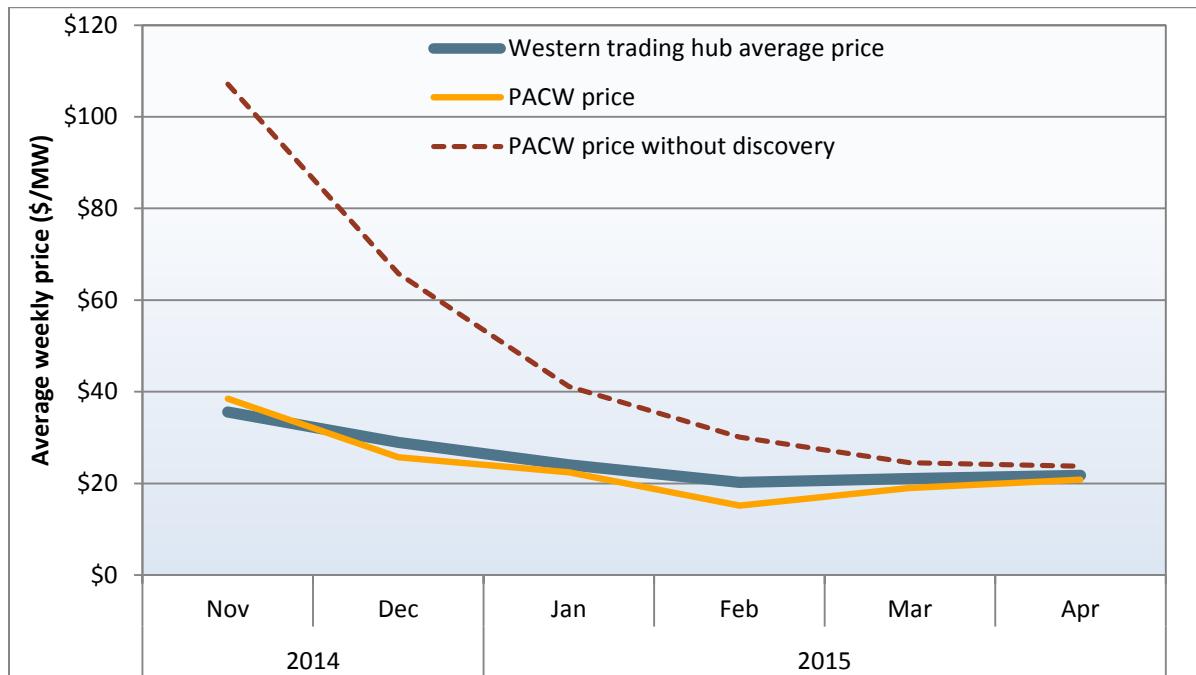


Table 2.1 Average prices in EIM and bilateral markets (April 2015)

	Western trading hub average price	Average EIM price	EIM price without price discovery
<i>PacifiCorp East</i>			
15-minute market (FMM)	\$21.77	\$22.00	\$36.98
5-minute market (RTD)	\$21.77	\$19.51	\$39.34
<i>PacifiCorp West</i>			
15-minute market (FMM)	\$21.77	\$21.71	\$26.72
5-minute market (RTD)	\$21.77	\$20.84	\$23.77

3 Market software constraint relaxation

EIM performance has been driven primarily by the need to periodically relax several key constraints in the EIM market model. This section provides summary information on the frequency of the constraint violations in the EIM by calendar month for each market. Figure 3.1 and Figure 3.2 summarize the percent of intervals in which the power balance and flexible ramping constraints have been relaxed by month in PacifiCorp East and PacifiCorp West, respectively.¹⁶

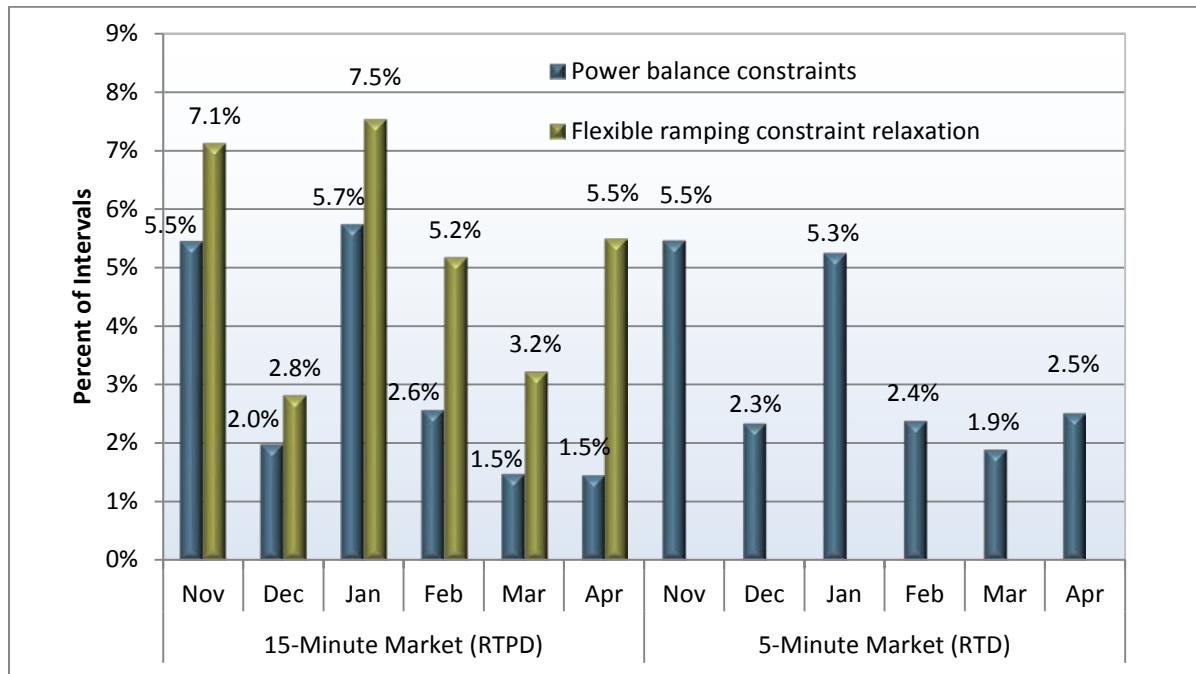
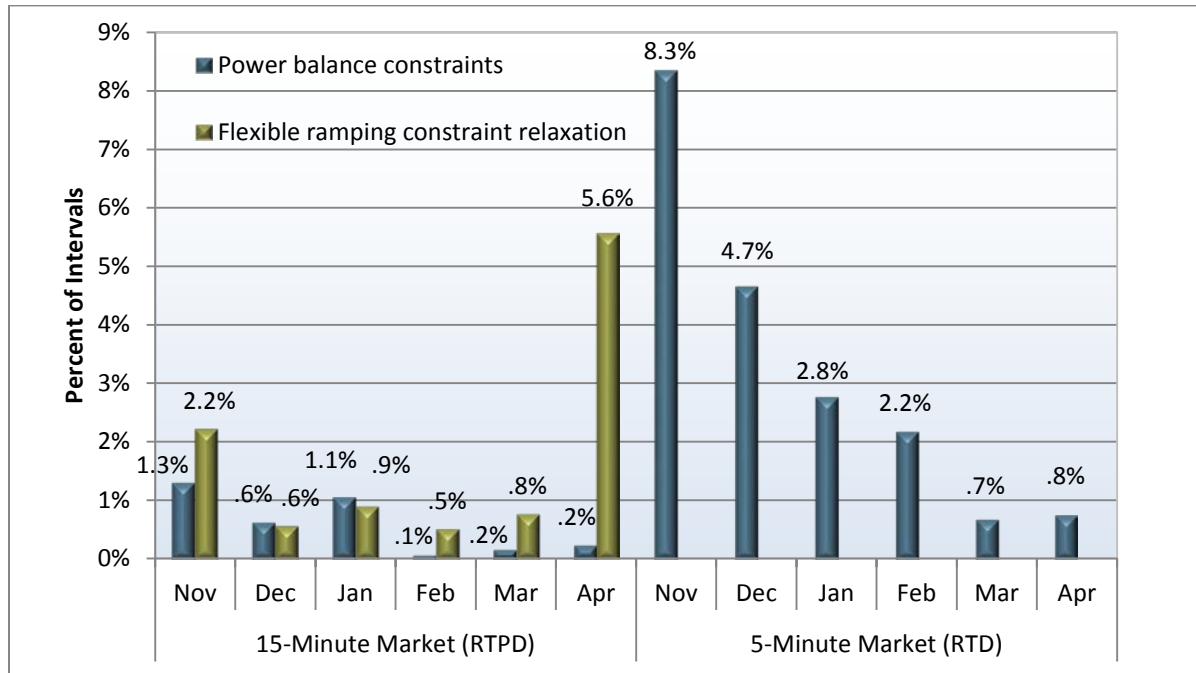
As shown in Figure 3.1, in PacifiCorp East the frequency of intervals in which the power balance constraint have been relaxed in the 15-minute market remained at about 1.5 percent of intervals, while the frequency of power balance constraint relaxation in the 5-minute market increased from about 1.9 percent to about 2.5 percent of intervals.

As shown in Figure 3.2, in PacifiCorp West the frequency of intervals in which the power balance constraint has been relaxed in the 15-minute market remained at about 0.2 percent of intervals, while the frequency of power balance constraint relaxation in the 5-minute market increased slightly from about 0.7 percent to about 0.8 percent of intervals.

As shown in Figure 3.1 and Figure 3.2, the frequency that the flexible ramping constraint was relaxed in the 15-minute market increased significantly during April, reaching about 5.5 percent in both PacifiCorp areas. This increase may be attributable to implementation of an automated tool on March 30, 2015 that set the flexible ramping constraint requirement at higher levels in the PacifiCorp balancing areas during many intervals.

DMM has analyzed the performance of the new method of setting flexible ramping constraint requirements starting in late March and is recommending significant further modifications in how flexible ramping constraint requirements are set in both the ISO and EIM areas. We will provide updated information this issue in future reports.

¹⁶ These charts have changed slightly from previous versions in earlier reports as they now exclude relaxations during intervals where prices were corrected.

Figure 3.1 Frequency of constraint relaxation by month – PacifiCorp East (PACE)**Figure 3.2 Frequency of constraint relaxation by month – PacifiCorp West (PACW)**

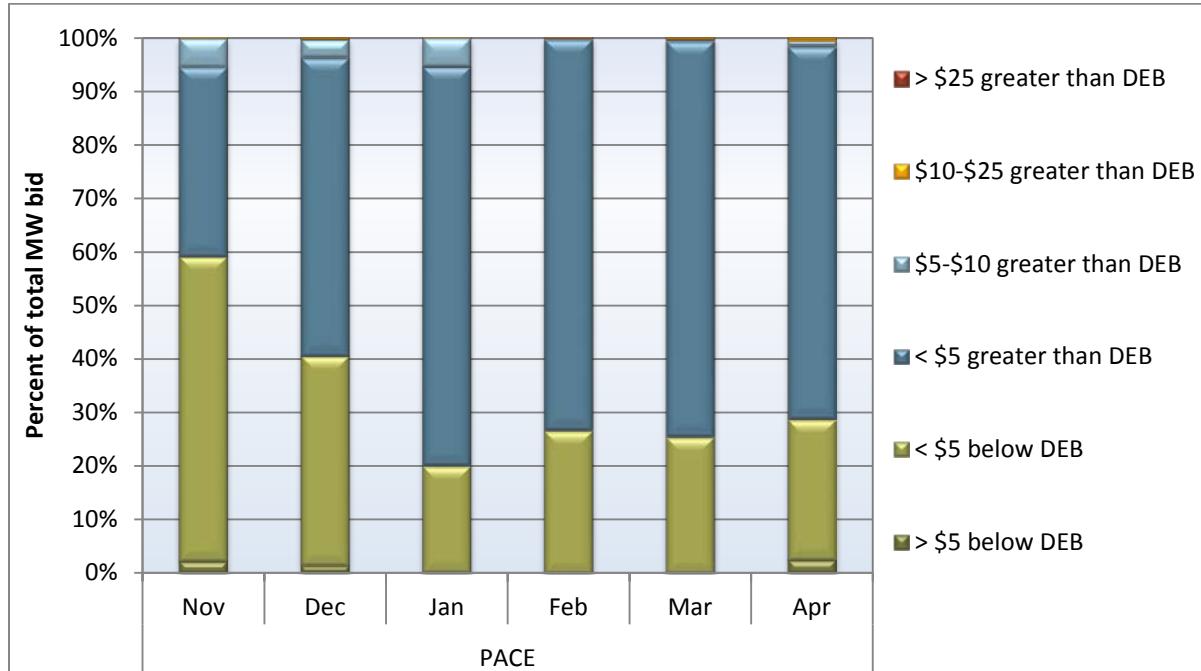
4 Market bidding and mitigation

Bidding in the EIM has been highly competitive, with bids for most capacity slightly below or above default energy bids (DEBs) used in market power mitigation. Thus, when relatively high EIM prices have occurred, these prices reflect penalty prices for software constraints rather than bid prices. In addition, when bids are mitigated due to market power mitigation provisions, these procedures generally result in modest reductions in bid prices.

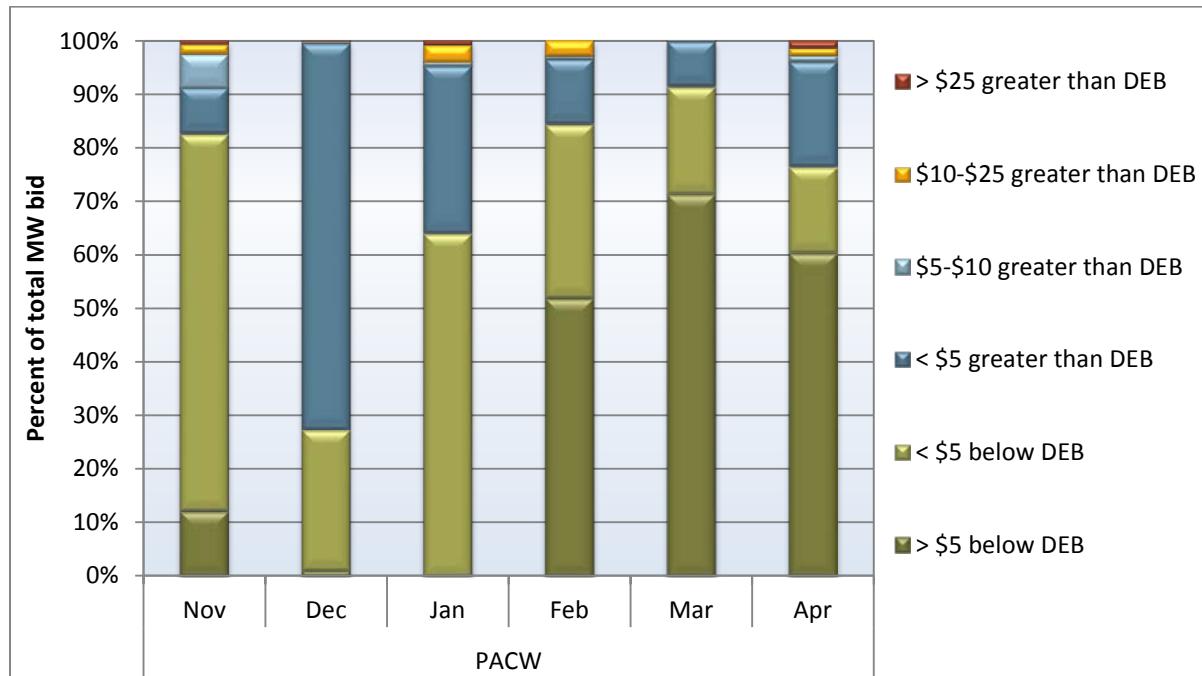
Figure 4.1 summarizes a comparison of bid prices in PacifiCorp East for thermal and hydro units compared to default energy bids used in market power mitigation. Figure 4.2 shows the same information for PacifiCorp West. These default energy bids are based on the marginal operating costs of thermal resources or opportunity cost for hydro resources with limited energy and energy storage capabilities.

Figure 4.1 shows that the bidding pattern in PacifiCorp East in April was similar to March. However, there was an increase in the volume of bids less than \$5/MWh above the default energy bids in PacifiCorp West and a decrease in the volume of bids more than \$5/MWh below the default energy bid, as shown in Figure 4.2. Most of the bids more than \$5/MWh below the default energy bid in PacifiCorp West were between \$5 and \$10/MWh below the default energy bid.

**Figure 4.1 Comparison of market bids to default energy bids
PacifiCorp East**



**Figure 4.2 Comparison of market bids to default energy bids
PacificCorp West**



5 Other issues

Load bias limiter

The ISO's April 24, 2015 report noted that the ISO was prepared to implement a software enhancement known as the *load bias limiter* in the EIM that is currently in place in the ISO real-time market and that it plans to implement this new software feature in the EIM after the price discovery features currently in place expires. The ISO's June 3, 2015 report provides a detailed description of this feature.¹⁷ The ISO's June 3, 2015 report also notes that:

The CAISO implemented this feature for EIM on March 20, 2015. However, the feature does not currently trigger because the price waiver-based pricing requires the pricing run to establish prices based on the last economic bid when the market software relaxes the transmission or power balance constraint. For April 2015 about 44 intervals with RTD infeasibilities were covered by this functionality and, therefore, were no longer considered in the metrics of this report.¹⁸

Since data in the ISO's report now exclude intervals when this software feature would be triggered since March 20, 2015 DMM has also adjusted its analysis to be consistent with the metrics in the ISO report.

As shown in Table 5.1, although the load bias limiter would have had a significant impact in the 15-minute and 5-minute markets in February and March, during April this software feature would have not have been triggered in the 15-minute market and would have only a very limited number of times in the 5-minute market. Without price discovery in effect, the overall impact of this feature would be to lower 5-minutes prices only about 7 percent in PacifiCorp East and only about 9 percent in PacifiCorp West.

Table 5.1 Percent of power balance relaxations eliminated by load bias limiter

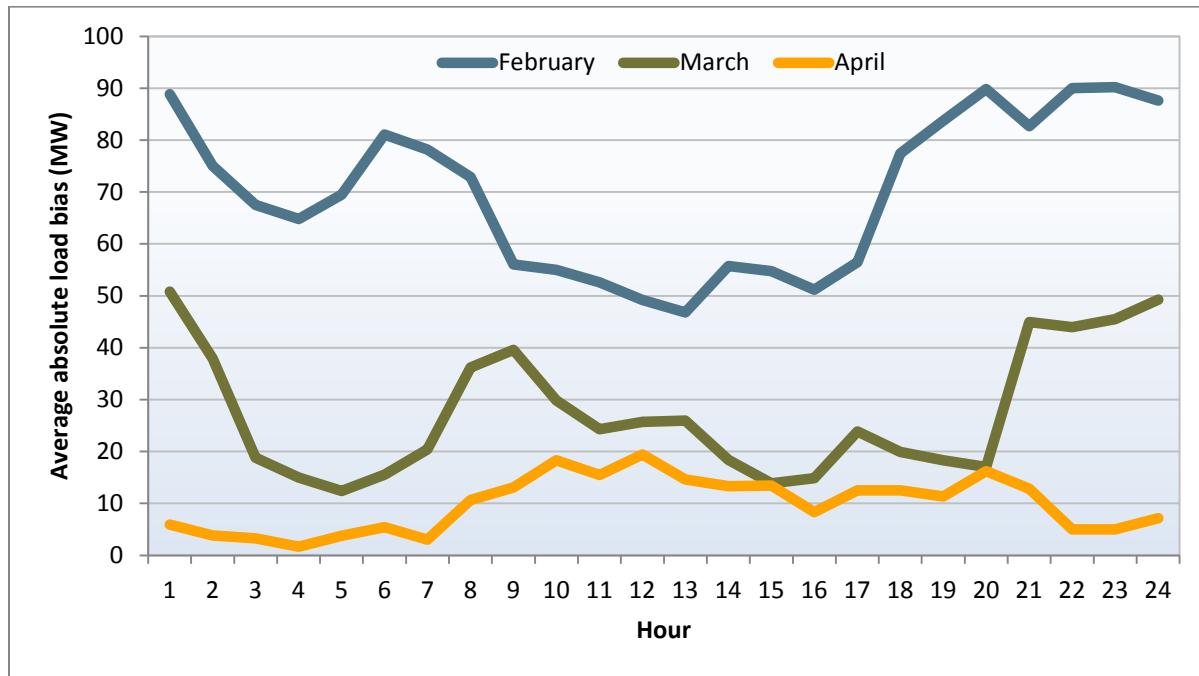
	February	March	April
PacifiCorp East			
15-minute market	53%	31%	0%
5-minute market	63%	40%	13%
PacifiCorp West			
15-minute market	50%	49%	0%
5-minute market	40%	47%	30%

The relatively low impact that the load bias limiter would have had in April compared to prior months coincides with a drop in the overall average of the load bias employed by EIM grid operators since February. This is demonstrated in the average hourly load bias for each operating hour by month provided in Figure 5.1 through Figure 5.4.

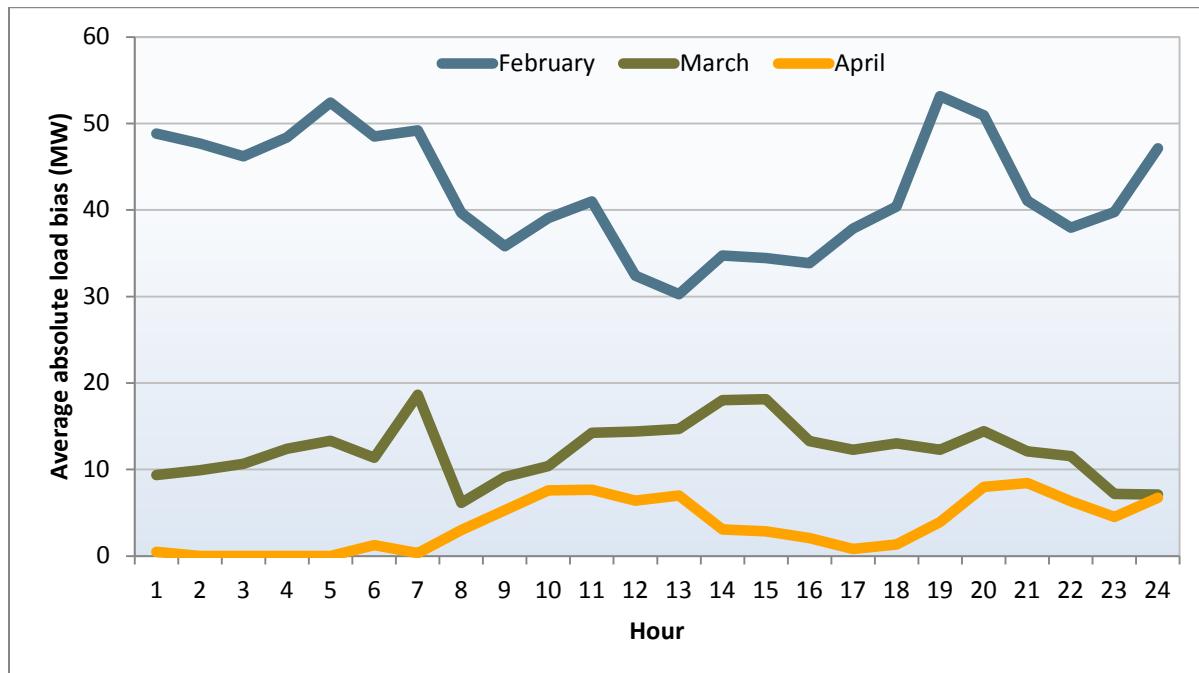
¹⁷ June 3 Report, pp. 79-81.

¹⁸ June 3 Report, pp. 27-28.

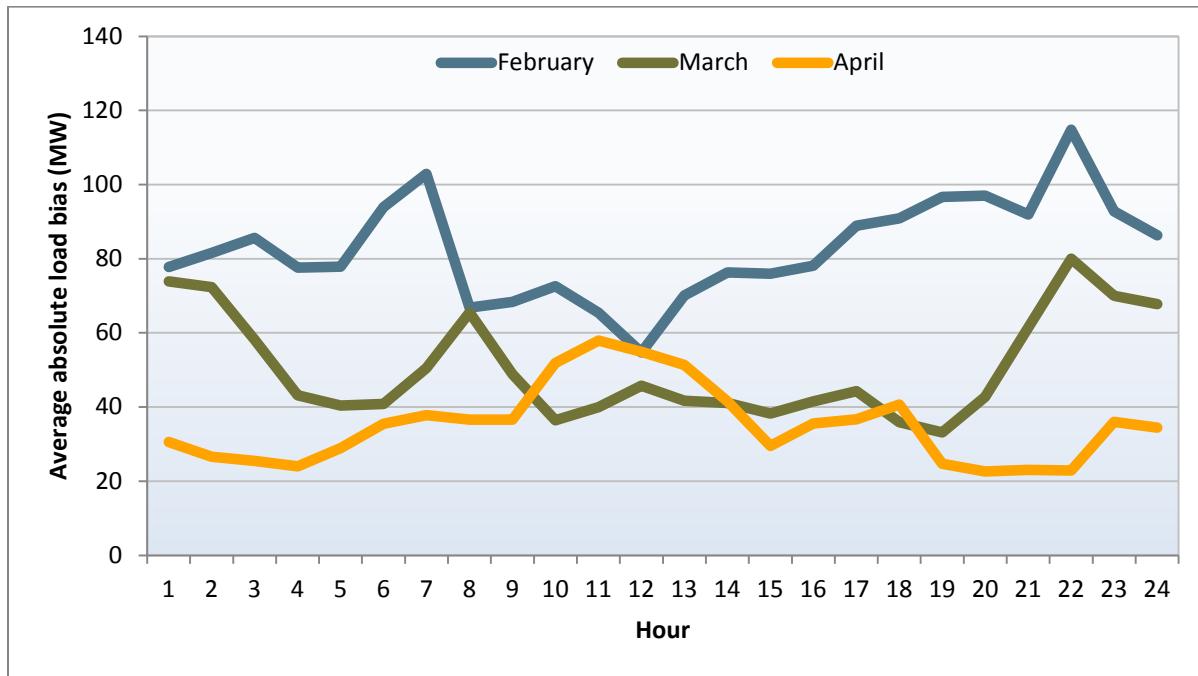
**Figure 5.1 Hourly average load bias
PacifiCorp East (15-minute market)**



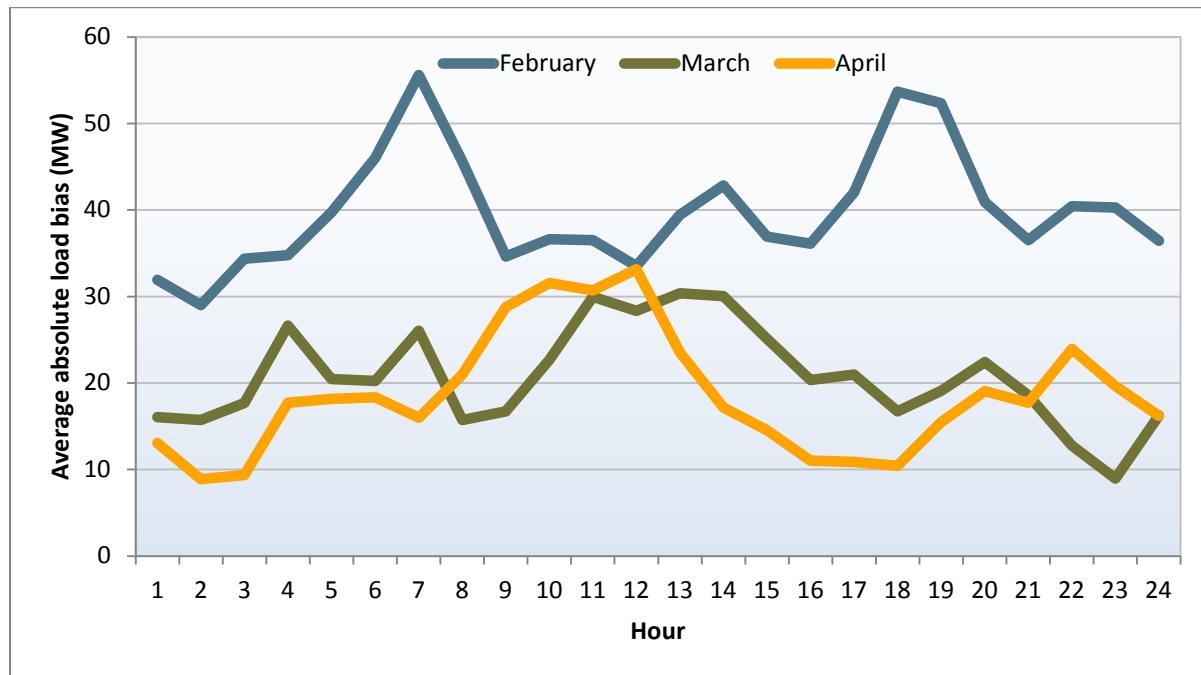
**Figure 5.2 Hourly average load bias
PacifiCorp West (15-minute market)**



**Figure 5.3 Hourly average load bias
PacificCorp East (5-minute market)**



**Figure 5.4 Hourly average load bias
PacificCorp West (5-minute market)**



Flexible ramping constraint

Until late March, the flexible ramping constraint requirement has been set at about 25 to 40 MW for each of the PacifiCorp areas. In our April 2, 2015 report, DMM recommended that the ISO consider how modifications to the flexible ramping constraint requirement might help increase the amount of supply available on a 15-minute and 5-minute basis in PacifiCorp East.¹⁹

On March 30, 2015 the ISO implemented an automated tool to set flexible ramping constraint requirements in both the ISO and EIM areas. DMM has analyzed the performance of the new method of setting flexible ramping constraint requirements and is recommending significant modifications in how flexible ramping constraints are set in both the ISO and EIM areas. We will provide updated information this issue in future reports.

Additional capacity available for manual dispatch

In Attachment C of the ISO's April 24, 2015 report, the ISO began reporting information on the amount of capacity that was available for manual dispatch by PacifiCorp but not available for dispatch by the EIM software during intervals when the power balance constraint was relaxed in the scheduling run due to an insufficiency of supply dispatchable by the market software.

Attachment C of the ISO's June 3, 2015 report includes a more detailed explanation of the analysis each interval of infeasibility to determine whether it was infeasible due to actual supply insufficiency by calculating the degree to which the infeasibility was in excess of PacifiCorp's available capacity to balance its system. The report provides additional discussion of the data used in the analysis and caveats about the analysis.²⁰

¹⁹ *Report on Energy Imbalance Market Issues and Performance*, Department of Market Monitoring, April 2, 2015, p.2. http://www.caiso.com/Documents/Apr2_2015_DMM_AssessmentPerformance_EIM-Feb13-Mar16_2015_ER15-402.pdf.

²⁰ June 3 report, pp. 34.

CERTIFICATE OF SERVICE

I hereby certify that I have served the foregoing document upon the parties listed on the official service list in the captioned proceedings, in accordance with the requirements of Rule 2010 of the Commission's Rules of Practice and Procedure (18 C.F.R. § 385.2010).

Dated at Folsom, California this 12th day of June, 2015.

/s/ Anna Pascuzzo
Anna Pascuzzo