

March 22, 2016

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 January 1, 2016 through January 31, 2016.¹

Please contact the undersigned with any questions.

Respectfully submitted,

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¹ The CAISO submits this report pursuant to *California Independent System Operator Corp.*, 149 FERC ¶ 61,194 (2014).

California ISO

Report on energy imbalance market issues and performance: PacifiCorp balancing authority areas

March 18, 2016

Prepared by: 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 March 7, 2016 covering the period from January 1 through January 31, 2016 (January Report) for the PacifiCorp balancing areas.¹ The red line portion of the ISO's January report shows that it contains updated graphs and figures from the ISO's December report.

This report provides a review by the Department of Market Monitoring (DMM) of EIM performance during the period covered in the ISO's January report. Key findings of DMM's review of EIM performance in the PacifiCorp balancing areas during January 2016 include the following:

- Overall market performance improved and remained very good in both PacifiCorp areas during January. The percentage of intervals when either the flexible ramping constraint or energy power balance constraint was relaxed to allow the market software to balance modeled supply and demand dropped and was relatively low during January.
- The frequency of intervals in which the power balance constraint was relaxed was highest in the 5-minute market PacifiCorp West. In this area, the power balance constraint was relaxed during 1.2 percent of 5-minute intervals, so that prices without price discovery in effect would have been about \$10/MWh higher than prices with price discovery.
- Prices used to settle load deviations in PacifiCorp East was about \$21.50/MWh during January, while prices in PacifiCorp West averaged about \$22.50/MWh. The load settlement price is calculated as an average of prices in the 15-minute and the 5-minute markets, weighted by forecast load imbalance in each respective market. Average settlement prices in both areas tracked closely with bilateral trading hub prices, and were below the average price for the PG&E load aggregation area in the ISO during January. DMM uses PG&E as a benchmark for competitiveness of the PacifiCorp areas, as this is the region where much of the energy transfer between PacifiCorp and the ISO occurs.
- In both PacifiCorp areas, the percentage of intervals when the flexible ramping constraint was relaxed in the 15-minute market – but price discovery provisions were not triggered due to relaxation of the energy power balance constraint – continued to decrease during January to less than 1 percent of intervals.² The additional \$60/MWh that occurs during these intervals increased overall monthly averages by less than \$0.50/MWh in both areas. This is a significant change from November where prices in PacifiCorp East were relaxed during 16 percent of intervals, which resulted in a price impact greater than \$9/MWh. As noted in prior reports, DMM attributes much of this improvement in performance to a reduction in generator outages and the additional transfer capacity that was added when EIM was implemented in the NV Energy area in December 2015.
- In PacifiCorp West, the power balance constraint was relaxed in 1.2 percent of 5-minute intervals during January, compared to 2.4 percent of 5-minute intervals the prior month. Prices in EIM continued to be mitigated by special price discovery provisions that prevent prices from being set by

¹ The ISO's January Report was filed at FERC on March 7 and posted in the ISO website on March 8, 2016, http://www.caiso.com/Documents/Mar7_2016_January2016_EIMPriceWaiverReport_ER15-402.pdf.

² When price discovery provisions are triggered by relaxation of the energy power balance constraint, the penalty price for the flexible ramping constraint is changed from \$60/MWh to \$0/MWh in the pricing run, so that the shadow price of this constraint is \$0/MWh.

the \$1,000/MWh penalty price for energy power balance shortages that would otherwise be utilized to set final market prices. Prices in the 5-minute market in PacifiCorp West would have been about \$10/MWh higher than prices had price discovery provisions not been in place. Even so, the effect of this on settlements prices was limited because of the higher weight of the 15-minute prices (about 80 percent) compared to 5-minute prices (about 20 percent).

- If price discovery provisions had not been in place in January, the load bias limiter feature would have only been triggered in less than 4 percent of 5-minute intervals in PacifiCorp West when the power balance constraint was relaxed. When triggered, the load bias limiter would have the same effect as the price discovery feature triggered by power balance constraint shortages, and would cause prices to be set by the last economic bid dispatched rather than the \$1,000/MWh penalty price for energy power balance shortages. This would have decreased prices in the PacifiCorp West 5-minute market by about 1 percent. Because of the low number of power balance constraint shortages in the other PacifiCorp EIM markets, the load bias limiter would have had a minimal impact on market prices.

The remainder of this report is organized as follows. This summary section highlights key findings and trends occurring in January 2016. Section 1 provides a description of prices in the market and impacts from the power balance and flexible ramping market constraints. Section 2 provides information regarding the flexible ramping constraint. Section 3 provides details on the impact of the load bias limiter.

1 Energy imbalance market prices

Figure 1.1 shows weekly average prices used for settlement of loads in PacifiCorp East, PacifiCorp West, and the Pacific Gas & Electric (PG&E) area (Northern California) prices, along with the range of bilateral trading hub prices DMM uses as an additional benchmark for EIM prices.

On January 5 and January 31, high system marginal energy costs, primarily driven by power balance constraint relaxations in the ISO, drove average settlement prices in the PacifiCorp East and PG&E areas above the bilateral trading hub price range.³ Still, weekly prices in both PacifiCorp areas tracked closely to representative bilateral trading hub prices during January.

The average monthly settlement price in PacifiCorp East was about \$21.50/MWh, about 2 to 4 percent below the bilateral price range. Alternatively, the PacifiCorp West settlement price was about \$22.50/MWh, about 1 to 3 percent above the bilateral price range. Prices during January in both PacifiCorp areas remained significantly below the PG&E area settlement price.

The load settlement price in Figure 1.1 is an average of prices in the 15-minute market and the 5-minute market, weighted by forecast load imbalance in each respective market.⁴ Prices in the 15-minute market are weighted by the imbalance between base loads and forecast load in the 15-minute market. The 5-minute prices are weighted by the difference between forecast load in the 15-minute market and forecast load in the 5-minute market. These load settlement prices track closely with 15-minute market prices since load settlement prices are weighted more heavily on prices in the 15-minute market and less heavily on prices in the 5-minute market. Data in Figure 1.1 begin in November, since this represents a period after the ISO made some corrections to their methodology for calculating EIM load settlement prices.

The bilateral trading hub price range in Figure 1.1 is calculated as the range between prices from the ICE and Powerdex indices. For each index, prices are calculated using weighted daily averages of four major western trading hubs (California Oregon Border, Mid-Columbia, Palo Verde, and Four Corners) and include both peak and off-peak prices.⁵ The PG&E load aggregation area price is used to compare with both PacifiCorp regions because much of the energy transfer between PacifiCorp and the ISO occurs via tie points in Northern California.

³ Data in Figure 1.1 for the week starting January 24 includes data from January 31, rather than a seven day average.

⁴ Business Process Manual Configuration Guide: Real-Time Price Pre-calculation, Settlements and Billing, October 29, 2015: https://bpmcm.caiso.com/BPM%20Document%20Library/Settlements%20and%20Billing/Configuration%20Guides/Pre-Calcs/BPM%20-%20CG%20PC%20Real%20Time%20Price_5.9.doc.

⁵ Prior to EIM implementation, DMM identified this to stakeholders and regulators as a benchmark DMM would use to assess the competitiveness and overall performance of EIM.

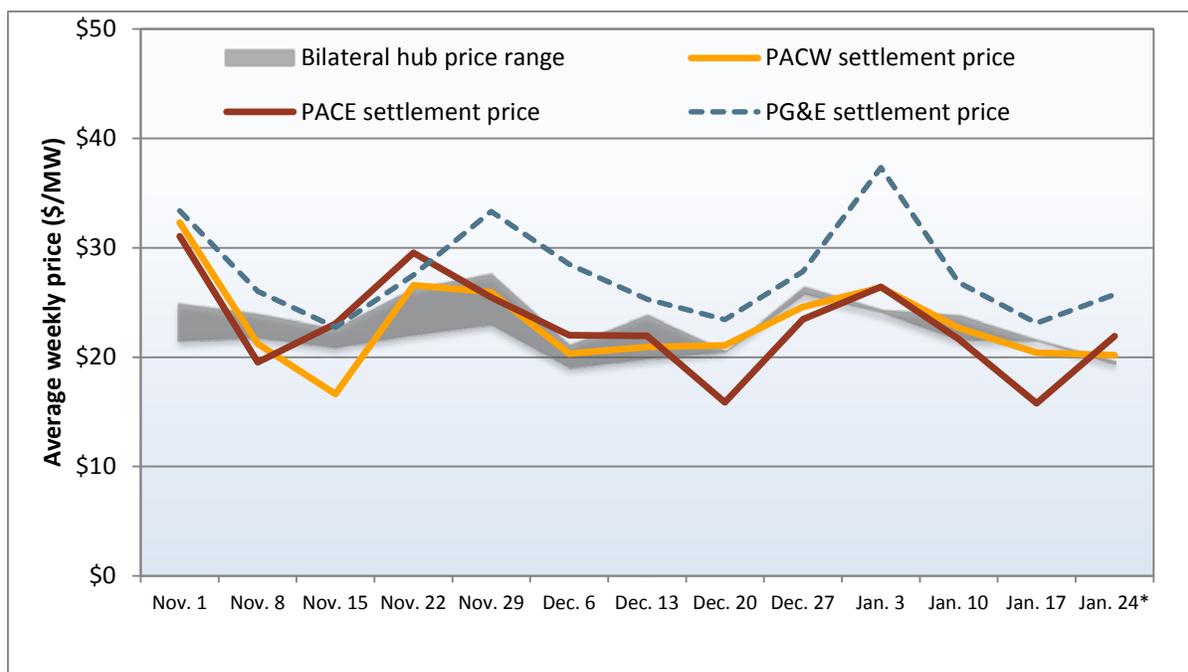
Figure 1.1 Settlement and bilateral trading hub prices – PacifiCorp East and West

Figure 1.2 and Figure 1.4 show the average daily frequency of constraint relaxations in the 15-minute market by month in PacifiCorp East and PacifiCorp West, respectively. Figure 1.6 and Figure 1.8 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.⁶

Figure 1.3 and Figure 1.5 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.⁷ Figure 1.7 and Figure 1.9 provide the same monthly price summary for the 5-minute market. All four figures also include monthly averages of firm bilateral trading hub market prices for comparison to EIM market prices.

Figure 1.2 through Figure 1.5 show that the flexible ramping constraint was relaxed very infrequently in January in both PacifiCorp areas. As a result, prices in the PacifiCorp areas in the 15-minute market were very close to the bilateral trading hub range. This is in sharp contrast to market outcomes in PacifiCorp East during October and November, when 15-minute market prices were significantly larger

⁶ 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.

⁷ A detailed description of the methodology used to calculate these counterfactual prices that would result without price discovery was provided on p. 6 of the April 2 report from DMM (link below). 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 excludes 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. DMM has also adjusted its analysis to be consistent with the data in the ISO report. http://www.caiso.com/Documents/Apr2_2015_DMM_AssessmentPerformance_EIM-Feb13-Mar16_2015_ER15-402.pdf.

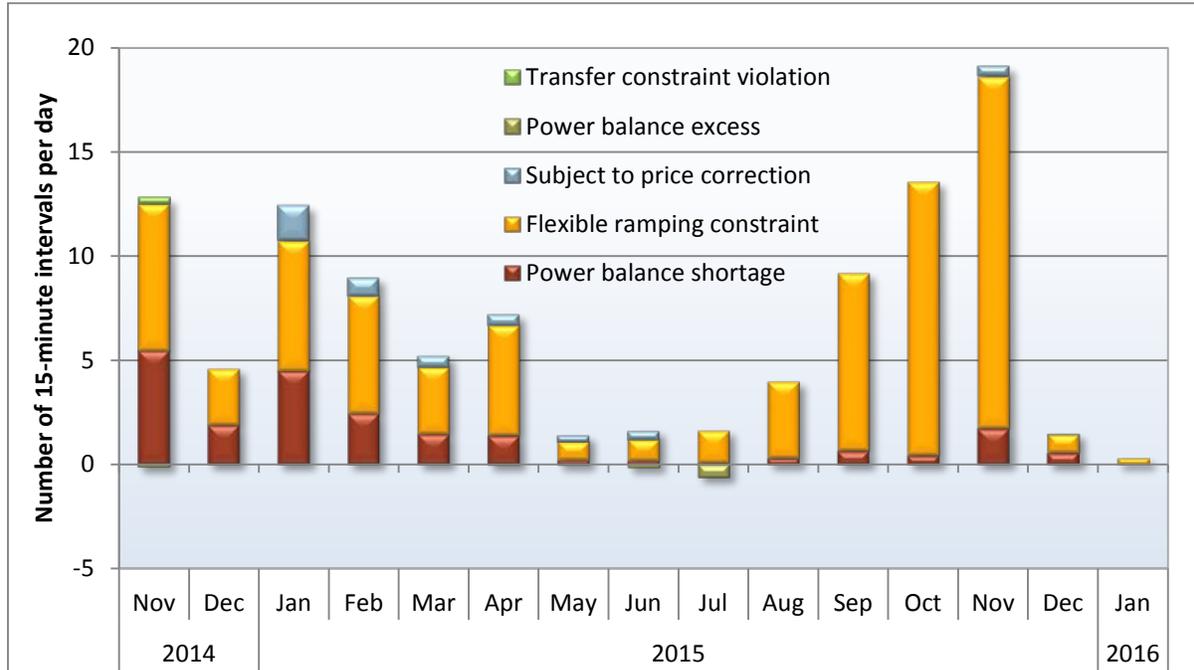
than the bilateral trading hub price range due to frequent relaxations of the flexible ramping constraint. These figures also show that during January the power balance constraint was relaxed very infrequently in the 15-minute market in both PacifiCorp areas, and thus prices without the price discovery mechanism nearly matched prices with price discovery.

Figure 1.9 shows that the price discovery mechanism approved under the Commission’s December 1, 2014 Order had a significant impact in terms of mitigating the impact of power balance constraint relaxation on 5-minute market prices in PacifiCorp West during January 2016. Without the price discovery mechanism, 5-minute market prices in PacifiCorp West would have been about 54 percent higher. During January, prices with and without price discovery were very similar in the 5-minute and 15-minute markets for PacifiCorp East as well as the 15-minute market for PacifiCorp West because of the relatively low number of power balance constraint relaxations in these markets during the month.

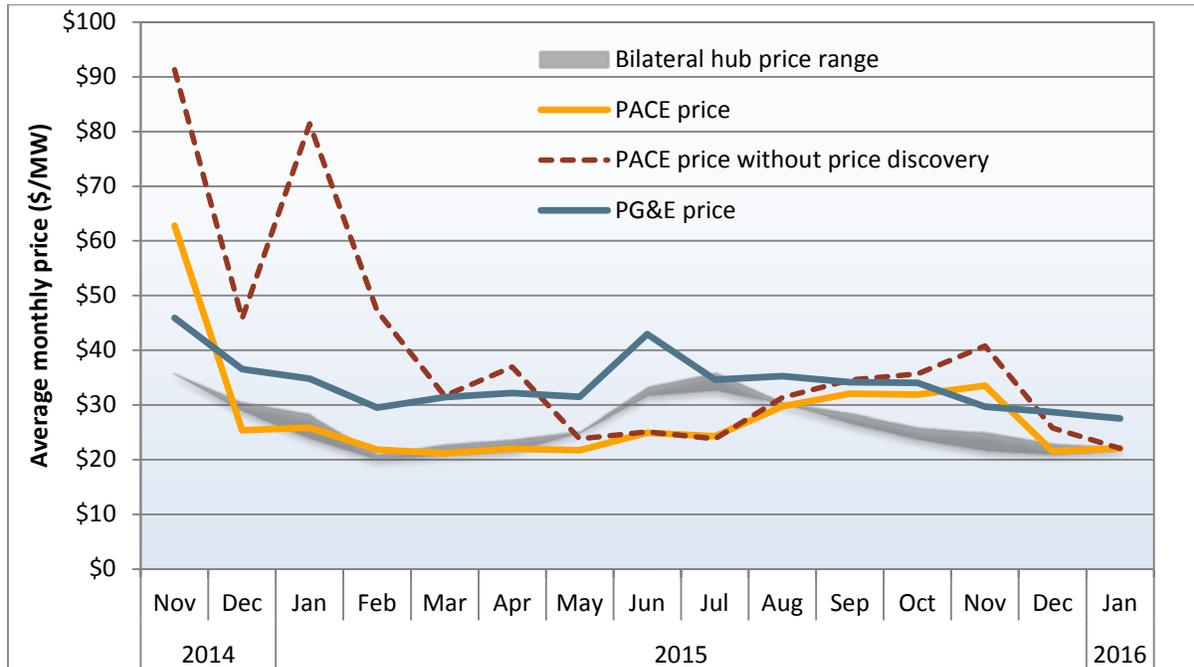
Table 1.1 Average prices in EIM and bilateral markets (January 2016)

	Bilateral trading hub price range		Average EIM price	EIM price without price discovery
	Low	High		
<i>PacifiCorp East</i>				
15-minute market (FMM)	\$21.85	\$22.28	\$22.09	\$22.09
5-minute market (RTD)	\$21.85	\$22.28	\$21.59	\$21.80
<i>PacifiCorp West</i>				
15-minute market (FMM)	\$21.85	\$22.28	\$23.31	\$24.54
5-minute market (RTD)	\$21.85	\$22.28	\$19.86	\$30.68

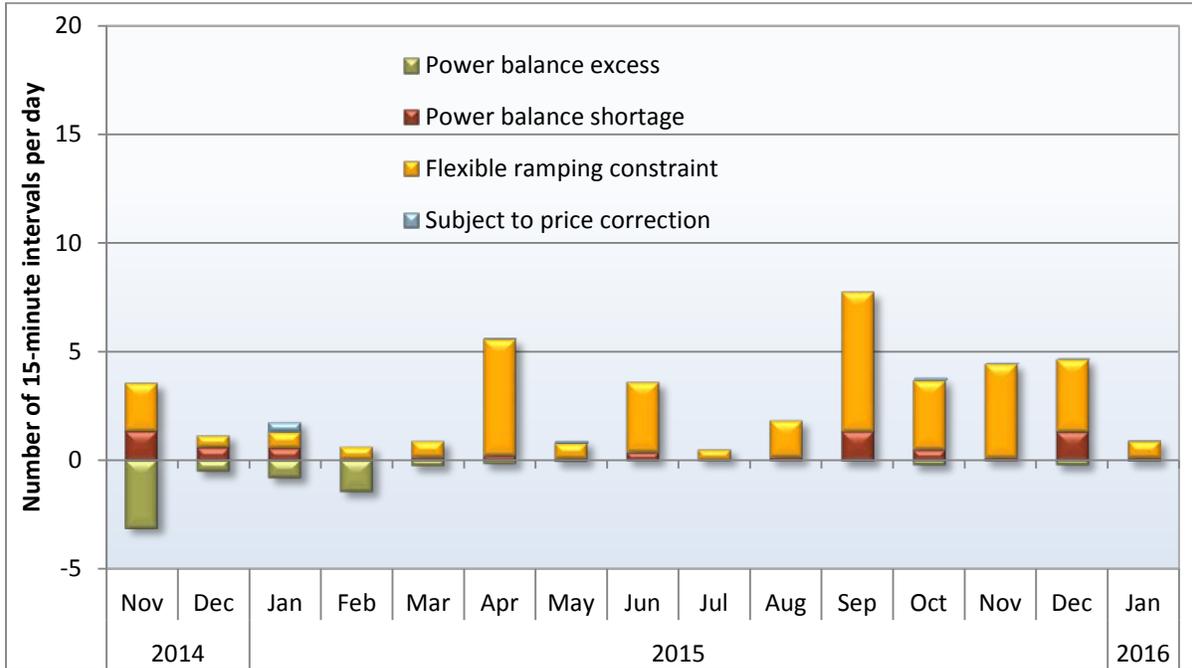
**Figure 1.2 Frequency of constraint relaxation
PacifiCorp East – 15-minute market**



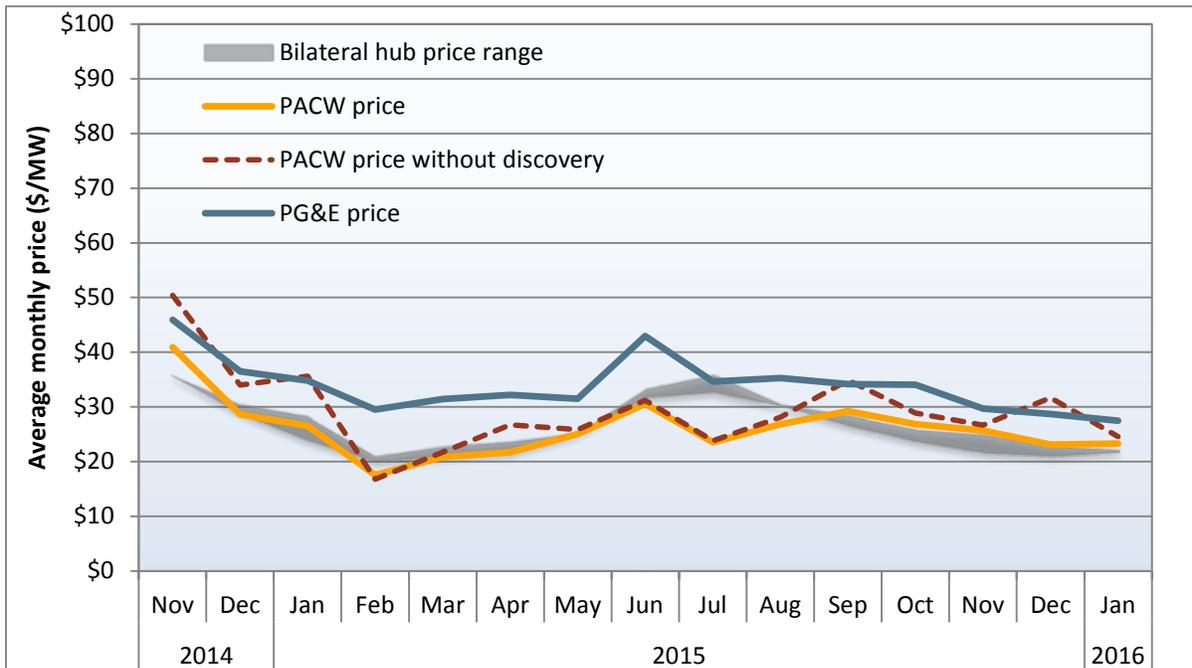
**Figure 1.3 Average monthly prices with and without price discovery
PacifiCorp East – 15-minute market**



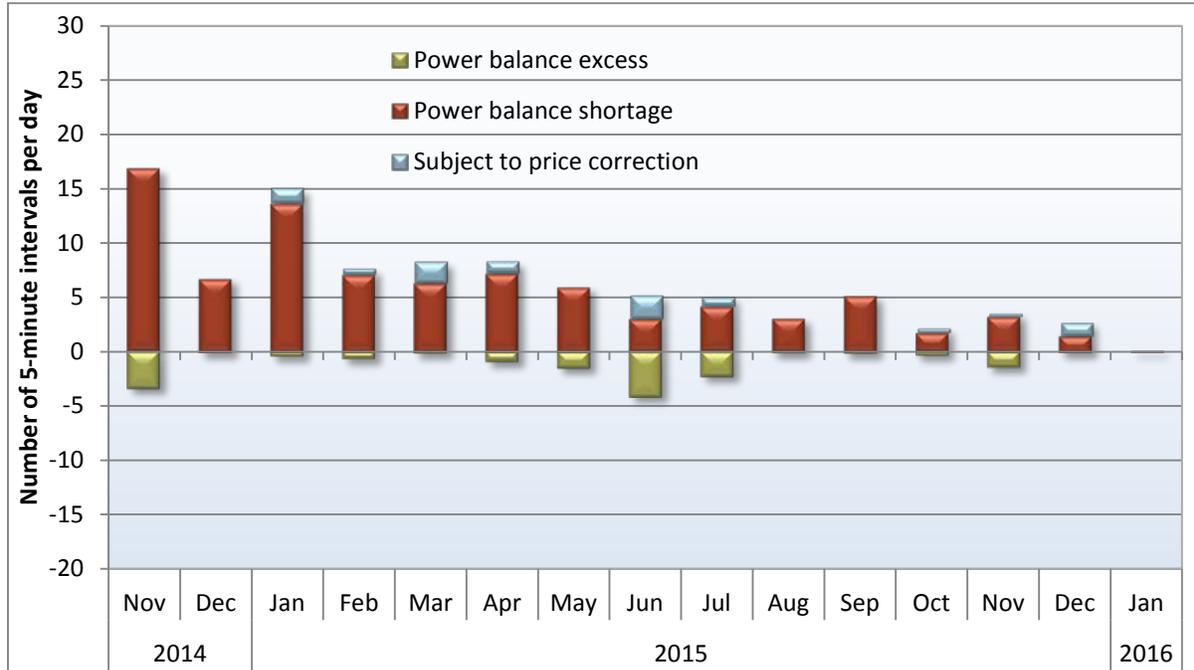
**Figure 1.4 Frequency of constraint relaxation
PacifiCorp West – 15-minute market**



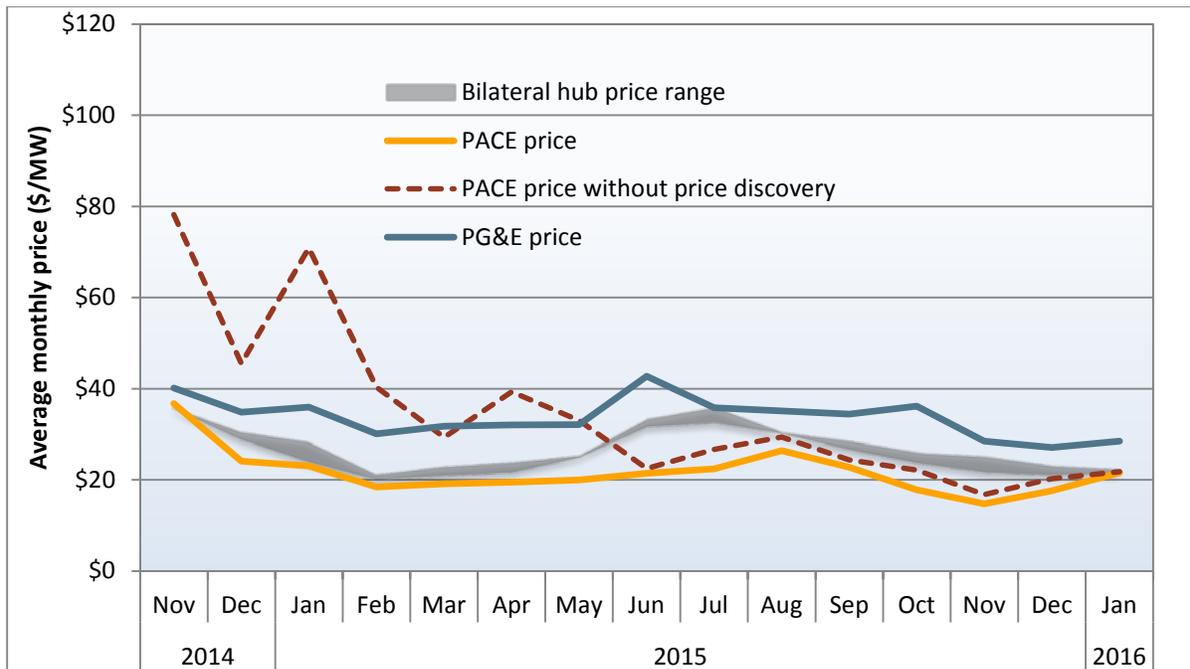
**Figure 1.5 Average monthly prices with and without price discovery
PacifiCorp West – 15-minute market**



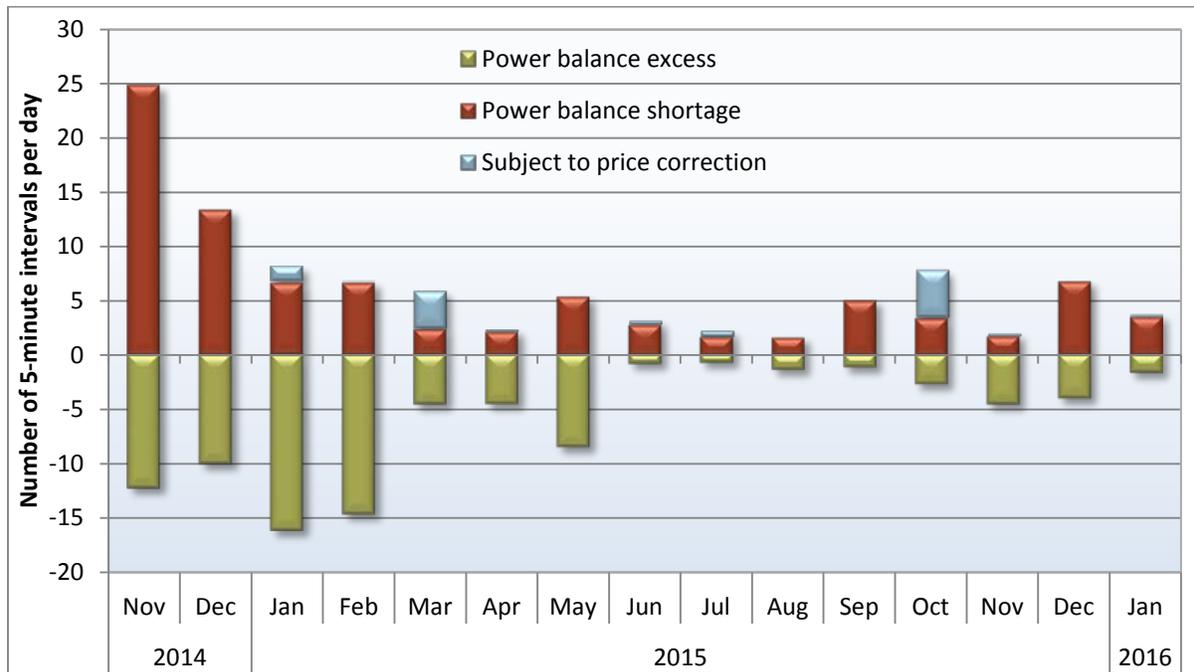
**Figure 1.6 Frequency of constraint relaxation
PacifiCorp East – 5-minute market**



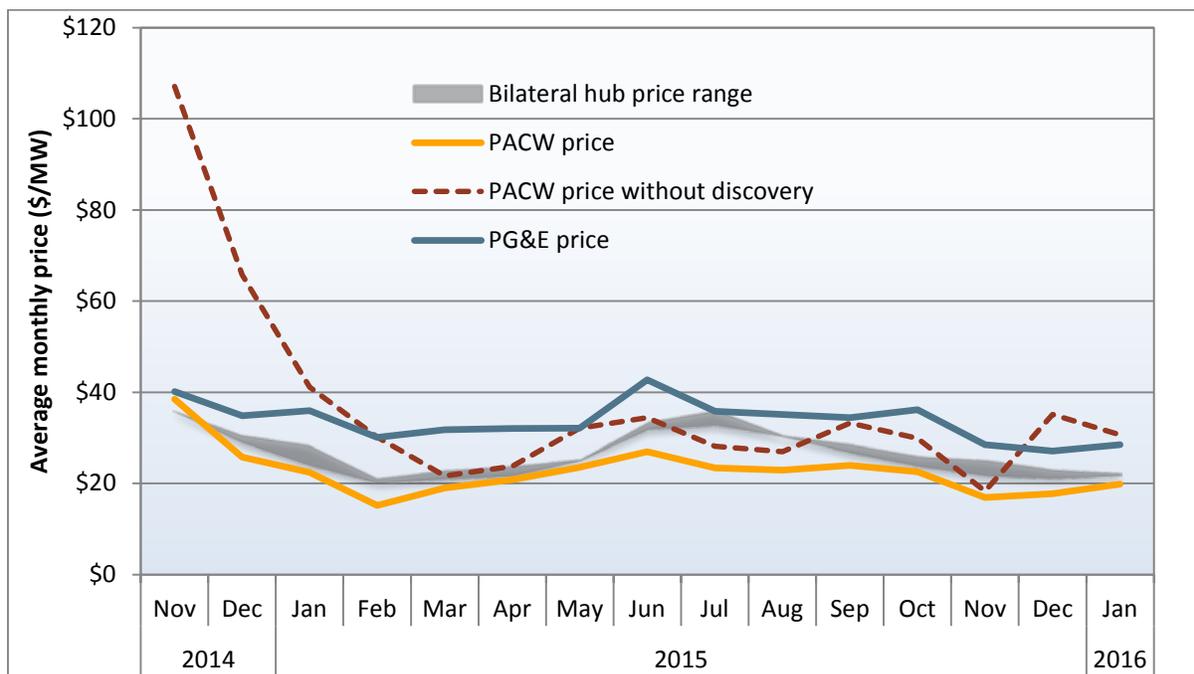
**Figure 1.7 Average monthly prices with and without price discovery
PacifiCorp East – 5-minute market**



**Figure 1.8 Frequency of constraint relaxation
PacifiCorp West – 5-minute market**



**Figure 1.9 Average monthly prices with and without price discovery
PacifiCorp West – 5-minute market**



2 Market software constraint relaxation

This section provides summary information on the frequency of the power balance and flexible ramping constraint relaxations in EIM by calendar month for each market. Figure 2.1 and Figure 2.2 summarize the percent of intervals in which the power balance and flexible ramping constraints have been relaxed, by month, in the 15-minute markets in PacifiCorp East and PacifiCorp West, respectively. Figure 2.2 and Figure 2.4 summarize the percent of intervals in which the power balance constraint has been relaxed, by month, in the 5-minute markets in PacifiCorp East and PacifiCorp West, respectively.

Figure 2.1 shows that the total number of flexible ramping constraint relaxations continued to decline during January in the 15-minute PacifiCorp East market to low levels. In this market during November, the flexible ramping constraint was relaxed during almost 18 percent of intervals, compared to less than 0.5 percent of intervals in January. When the flexible ramping constraint is relaxed a \$60/MWh penalty price is imposed, which leads to significant price increases in the 15-minute market. Figure 2.2 shows a similar trend in PacifiCorp West, where the percentage of intervals with flexible ramping constraint relaxations also decreased from 4.5 percent in November to less than 1 percent of intervals in January.

The large decline in flexible ramping constraint relaxations, which began in late November, coincided with the return of generating capacity from outage. Also, the addition of NV Energy to the EIM in December may have also helped to reduce the number of flexible ramping relaxations. The addition of NV Energy provides a significant increase in the amount of additional energy scheduled in the 15-minute market, particularly into the PacifiCorp East area. Although flexible ramping capacity cannot be directly imported from other EIM areas, additional energy imports can allow more ramping capacity from resources within an EIM area to remain unloaded and available to meet flexible ramping constraint requirements.

Figure 2.1, Figure 2.2, and Figure 2.3 show that the frequency of intervals when the power balance constraint was relaxed to allow the market software to balance modeled supply and demand declined to low levels during January, in PacifiCorp East and the 15-minute market in PacifiCorp West. The power balance constraint was not relaxed in the 15-minute PacifiCorp East market during January, and was relaxed during only 2 5-minute intervals in PacifiCorp East. The power balance constraint was only relaxed during 4 15-minute intervals in PacifiCorp West during January.

Figure 2.4 shows that the rate of power balance constraint relaxations for energy shortages also decreased in the 5-minute market in PacifiCorp West from 2.4 percent of intervals in December to 1.2 percent of intervals in January. These relaxations resulted in a more than \$10/MWh divergence between 5-minute prices with and without price discovery in PacifiCorp East during January, as discussed above.

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

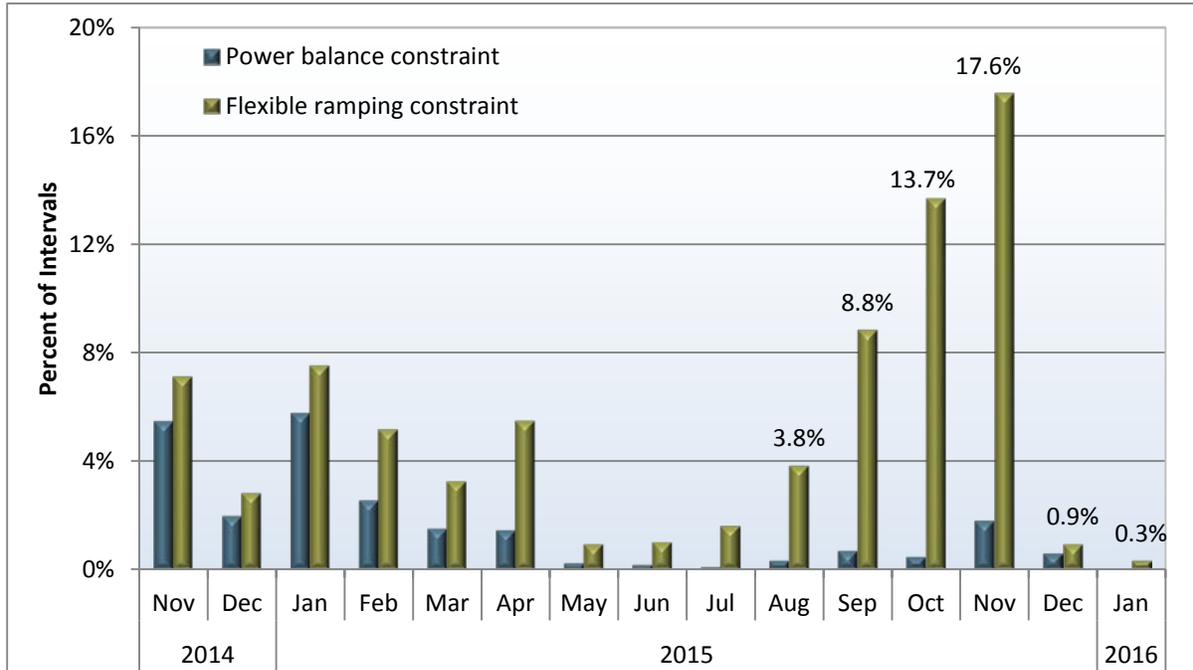


Figure 2.2 Frequency of constraint relaxation in 15-minute market – PacifiCorp West

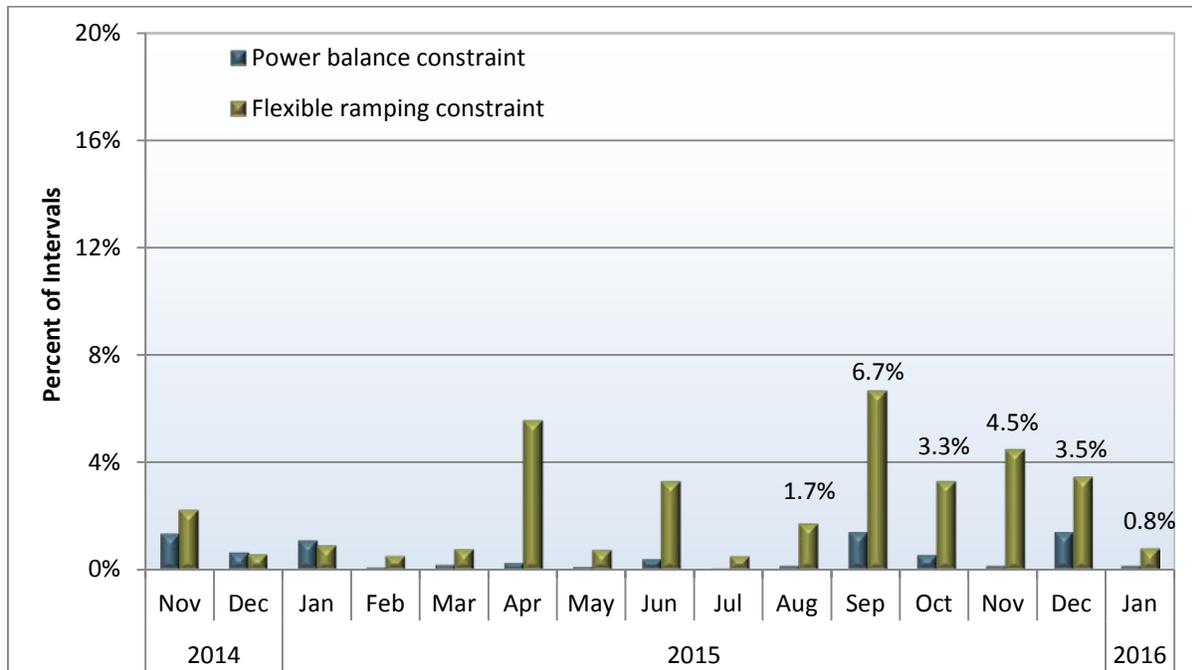


Figure 2.3 Frequency of constraint relaxation in 5-minute market – PacifiCorp East

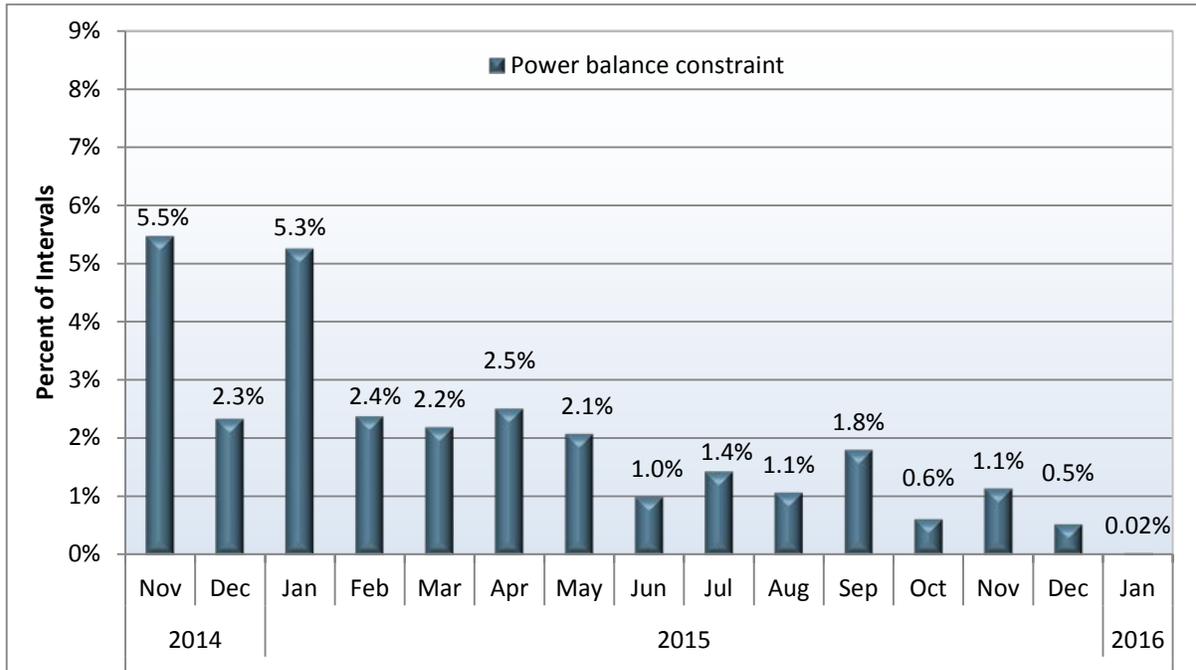
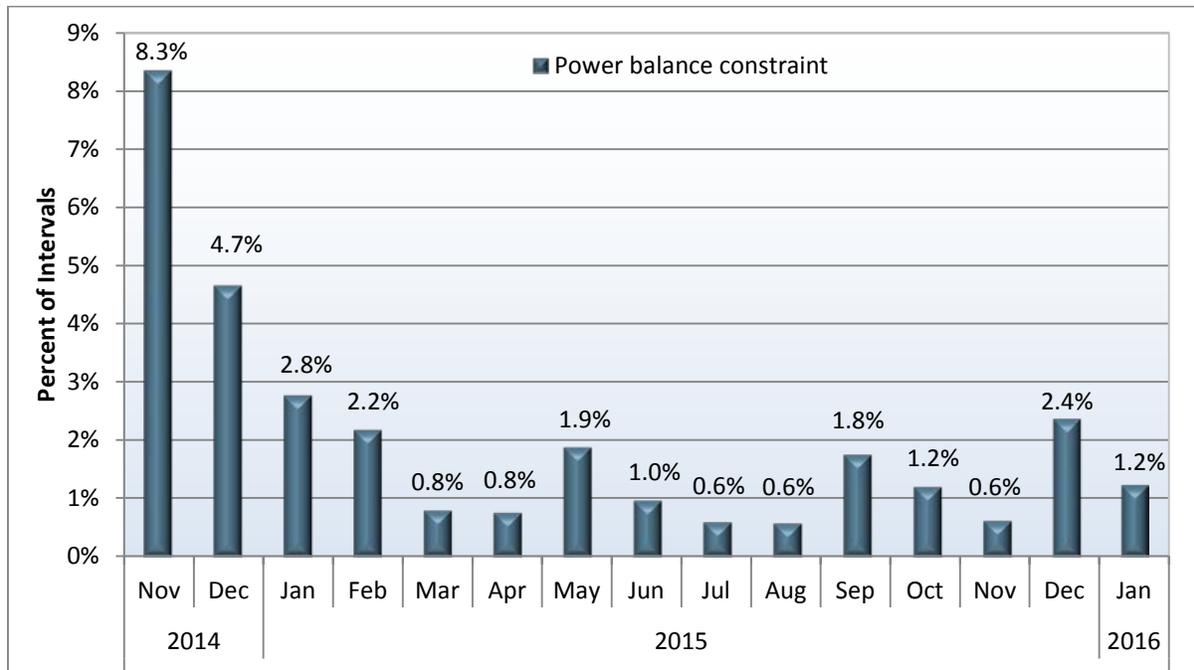


Figure 2.4 Frequency of constraint relaxation in 5-minute – PacifiCorp West



Flexible ramping capacity constraint

A detailed description of the flexible ramping constraint and a description of how the constraint impacts the market was provided in prior DMM reports on EIM market performance. In these reports DMM also discussed the relationship between the flexible ramping constraint and the flexible ramping sufficiency test. The most comprehensive discussion can be found in the EIM report covering November 2015.⁸

When the flexible ramping constraint cannot be met and must be relaxed, during intervals in which price discovery is not triggered by a relaxation of the power balance constraint, energy prices across the balancing area increase by the \$60/MWh shadow price that results for this constraint.

Table 2.1 shows that in January the percent of intervals where the flexible ramping constraint bound, but was not relaxed, increased to about 68 percent of intervals in PacifiCorp East and 57 percent of intervals in PacifiCorp West. This continues a trend of increasing requirements that began when the tool to set requirements was implemented in March 2015. This table also shows a decline in the percentage of intervals that the flexible ramping constraint was relaxed in PacifiCorp East and PacifiCorp West during January, beginning in November, which is discussed above.

Figure 2.5 and Figure 2.6 show the incremental impact from shortages of flexible ramping capacity on average prices in the 15-minute market, as well as the percentage of intervals that the flexible ramping constraint binds and is in shortage in PacifiCorp East and PacifiCorp West, respectively. As discussed earlier, the number of intervals where the flexible ramping constraint was relaxed greatly decreased at the end of November and continued to decrease into January in PacifiCorp East. This reduction in relaxations resulted in the monthly average market price converging to nearly the 15-minute market price without flexible ramping shortages. For comparison, flexible ramping constraint shortages resulted in a more than \$9/MWh impact on prices during November and around \$8/MWh of impact during October in the same market.

Because of the small number of intervals when the flexible ramping constraint was relaxed during December and January, 15-minute market prices in PacifiCorp East and PacifiCorp West prices tracked very closely with the representative bilateral trading hub price range. This ends a trend that began in the PacifiCorp East market in August and continued through November, where the percent of intervals that the flexible ramping constraint was relaxed continually increased and caused increasing separation between market prices and the bilateral trading hub price range.

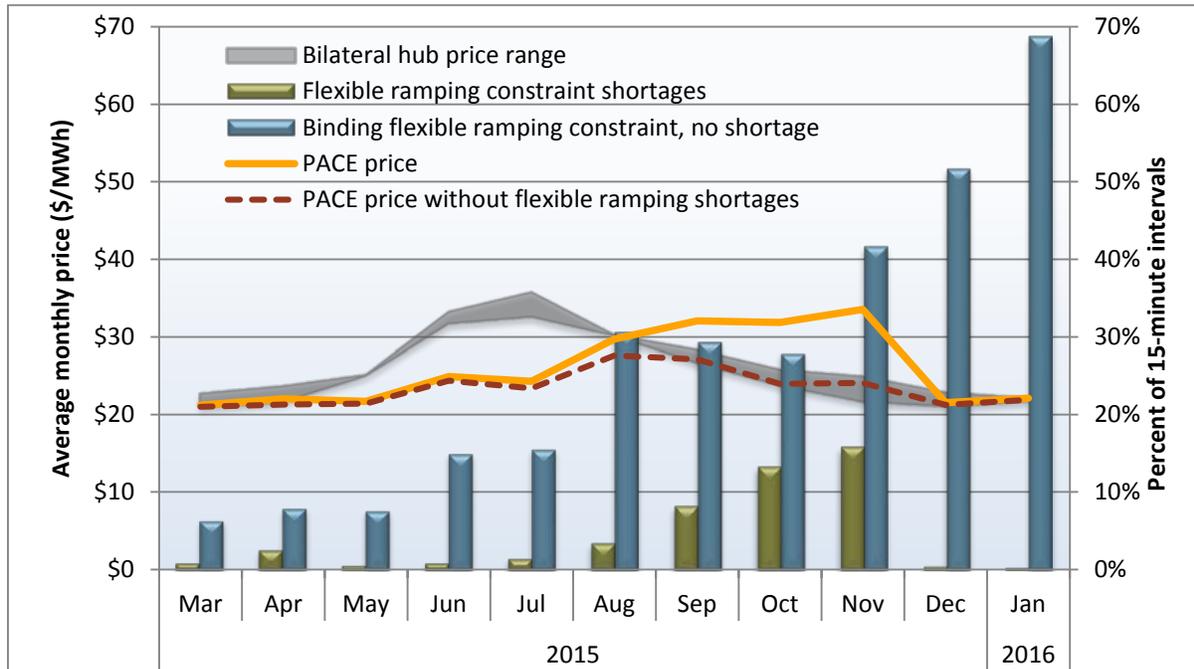
⁸ *Report on Energy Imbalance Market Issues and Performance*, Department of Market Monitoring, January 28, 2016, pp.13-19: http://www.caiso.com/Documents/Jan28_2016_Department_MarketMonitoringReport_Performance_Issues_EIM_Nov2015_ER15-402.pdf.

Table 2.1 Flexible ramping constraint requirements and market impacts⁹

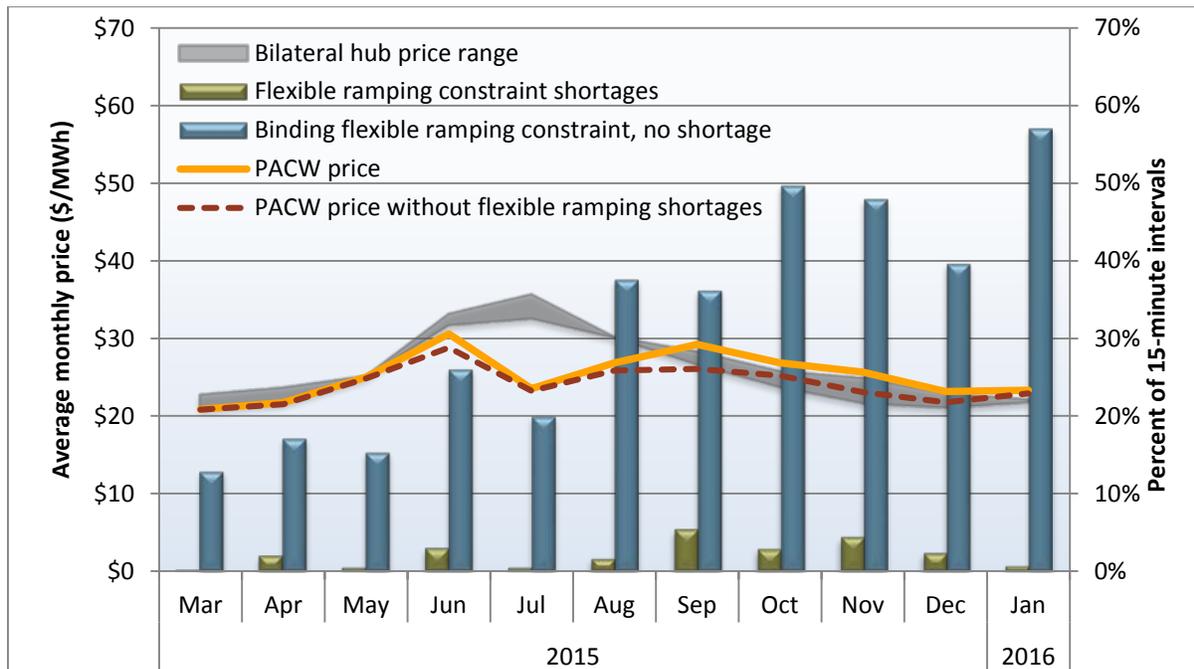
	Average flex ramp requirement (MW)	Binding flexible ramping constraint (no shortage)		Flexible ramping constraint (shortage)	
		Percent of intervals	Average shadow price	Percent of intervals	Average shadow price
<i>PacifiCorp East</i>					
2015 March	33	6.4%	\$8.92	0.9%	\$21.17
April	44	8.0%	\$7.57	2.6%	\$27.67
May	39	7.7%	\$7.68	0.6%	\$47.86
June	63	15.1%	\$9.28	0.9%	\$60.00
July	87	15.7%	\$8.91	1.5%	\$60.00
August	112	30.8%	\$11.75	3.5%	\$60.81
September	139	29.5%	\$16.20	8.2%	\$60.31
October	139	28.0%	\$16.28	13.2%	\$60.11
November	134	41.7%	\$9.17	15.8%	\$60.00
December	139	51.0%	\$7.17	0.5%	\$60.00
2016 January	139	67.6%	\$6.65	0.3%	\$60.00
<i>PacifiCorp West</i>					
2015 March	27	12.9%	\$6.09	0.2%	\$9.54
April	47	17.2%	\$8.00	2.0%	\$9.75
May	32	15.4%	\$6.95	0.5%	\$41.02
June	54	26.1%	\$10.65	2.9%	\$60.85
July	69	20.0%	\$8.78	0.5%	\$60.00
August	86	37.6%	\$9.19	1.6%	\$60.14
September	97	36.2%	\$8.22	5.3%	\$60.00
October	99	49.7%	\$10.05	2.8%	\$60.00
November	99	48.0%	\$8.30	4.3%	\$60.00
December	99	39.6%	\$5.85	2.3%	\$60.00
2016 January	99	57.0%	\$4.92	0.7%	\$60.00

⁹ The percent of intervals with flexible ramping constraint shortages in Table 2.1 reflects intervals where the constraint needed to be relaxed in the scheduling run and resulted in a positive shadow price in the pricing run, typically equal to the \$60/MWh penalty price. These intervals do not include periods when the power balance constraint was also relaxed and the penalty price for both the power balance and flexible ramping constraint were set to \$0/MWh via the price discovery mechanism.

**Figure 2.5 Impact of flexible ramping constraint relaxation
PacifiCorp East – 15-minute market**



**Figure 2.6 Impact of flexible ramping constraint relaxation
PacifiCorp West – 15-minute market**



Flexible ramping requirements

DMM believes that a factor contributing to flexible ramping constraint relaxations may be the limited number of observations used by the current methodology to set flexible ramping requirements. As discussed in DMM's last few quarterly reports, on March 30, 2015 the ISO implemented an automated procedure to set the flexible ramping requirement in both the ISO and PacifiCorp balancing areas.¹⁰ This procedure is called the balancing area ramp requirement (BARR) tool.

Because this tool calculates flexible ramping requirements based on a very limited set of historical observations, the tool returns results with a very high variability from one 15-minute interval to the next in both the ISO and EIM areas. This results in the flexible ramping requirement being set frequently at either the lower or upper thresholds imposed by the ISO on the requirement. Both DMM and other ISO staff are concerned about the limited number of observations used by the BARR tool to calculate flexible ramping requirements and the resulting high percentage of intervals when the requirement is set by the threshold. The limited number of observations used may set requirements unnecessarily high in some intervals and too low in others, when compared to the actual potential demand for ramping capacity.

The ISO implemented tighter thresholds in the second quarter of 2015 to decrease the amount of variability that the flexible requirements were set at. While this change helped reduce the volatility of flexible ramping requirements, it did not address the underlying concern about the limited size of observations that was being used by the tool. As noted in our 2015 second quarter report, DMM has recommended increasing the set of observations used to calculate the requirement – preferably by grouping surrounding intervals together – to increase the accuracy of the calculation and reduce the high level of variability due to random variations in historical data. The ISO has indicated it will seek to implement this enhancement but has taken several months to review how best to implement this change. DMM continues to recommend that the ISO expedite the implementation of this enhancement.

¹⁰ *Report on Market Issues and Performance, Q2 2015*, Department of Market Monitoring, August 17, 2015, pp. 43-46.
http://www.caiso.com/Documents/2015_SecondQuarterReport-MarketIssues_Performance-August2015.pdf.

Report on Market Issues and Performance, Q3 2015, Department of Market Monitoring, November 16, 2015, pp. 33-36.
<http://www.caiso.com/Documents/2015ThirdQuarterReport-MarketIssuesandPerformance-November2015.pdf>.

3 Load Bias Limiter

When triggered, the load bias limiter would have the same effect as the price discovery feature by causing prices to be set by the last economic bid dispatched rather than the \$1,000/MWh penalty price for energy power balance relaxations. A more detailed description of the load bias limiter was included in the DMM's April 2 report.¹¹ The ISO included discussion of the load bias limiter in its answer to the comments regarding the ISO's response to the Commission's September 24, 2015 letter requesting additional information on the ISO's August 19, 2015 filing to implement its available balancing capacity proposal in the EIM.¹²

The percentage of intervals when the energy power balance constraint was relaxed to allow the market software to balance modeled supply and demand decreased to low levels during January, particularly in PacifiCorp East and the 15-minute market in PacifiCorp West. In PacifiCorp West, even though 1.2 percent of intervals contained power balance shortages, the load bias limiter could only have resolved a small percentage of these instances.

As shown in Figure 3.1, without special price discovery provisions in effect, the load bias limiter would have only been triggered during less than 4 percent of the 5-minute intervals in PacifiCorp West when the power balance constraint was binding due to an energy shortage. The result was that the load bias limiter would have decreased average 5-minute prices in PacifiCorp West by only \$0.30/MWh, or about 1 percent, if the special price discovery provisions were not in effect.

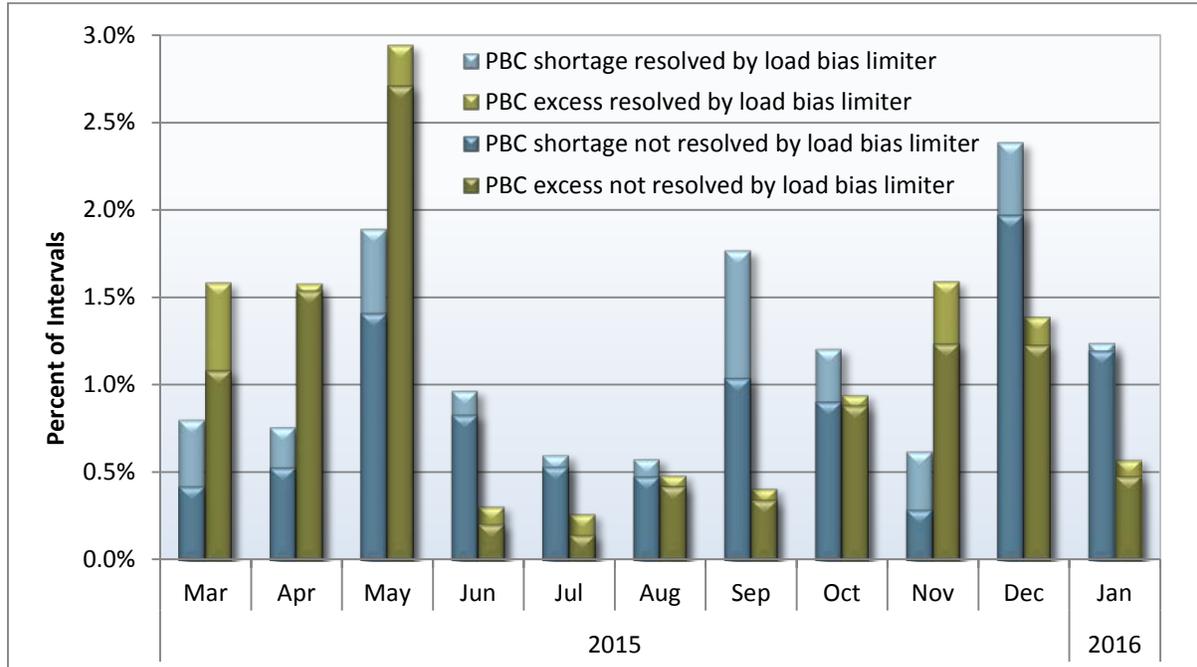
The estimates of EIM prices without price discovery in Section 1 of this report assumes that price discovery provisions are not in place, but energy prices would not be set by the \$1,000/MWh penalty price when the power balance constraint was relaxed and the criteria for triggering the load bias limiter were met.¹³ The analysis in this section reflects that on March 20, 2015 the ISO indicated that the load bias limiter would have been triggered under these criteria, if price discovery provisions were no longer in effect.

¹¹ *Report on Energy Imbalance Market Issues and Performance*, Department of Market Monitoring, April 2, 2015, pp.34-35. http://www.caiso.com/Documents/Apr2_2015_DMM_AssessmentPerformance_EIM-Feb13-Mar16_2015_ER15-402.pdf.

¹² Answer of the California Independent systems Operator Corporation to Comments, November 24, 2015, pp. 13-21. http://www.caiso.com/Documents/Nov24_2015_Answer_Comments_AvailableBalancingCapacity_ER15-861-006.pdf.

¹³ See discussion on in Section 1, page 5.

**Figure 3.1 Mitigation of power balance relaxation by load bias limiter
PacifiCorp West – 5-minute market**



CERTIFICATE OF SERVICE

I certify that I have served the foregoing document upon the parties listed on the official service list in the above-referenced proceeding, 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 22nd day of March, 2016.

Jennifer Rotz
Jennifer Rotz