April 2, 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 Performance of Energy Imbalance Market

Dear Secretary Bose:

The Department of Market Monitoring hereby submits its fourth 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 February 13 – March 16, 2015.[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 Independent
System Operator Corporation

California ISO

Report on Energy Imbalance Market Issues and Performance

April 2, 2015

Department of Market Monitoring

Executive Summary

This report represents the fourth report by the Department of Market Monitoring (DMM) pursuant to the Commission's December 1, 2014, Order on the ISO's Energy Imbalance Market (EIM). The report covers the same period as the ISO's fourth report issued pursuant to the Commission's December 1 Order (November 2014 through March 16, 2015). Key findings include the following:

- 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 constraint relaxations improved notably in the PacifiCorp West area, particularly in in the 5-minute market. This improvement appears to be attributable in large part to two factors. First, the ISO implemented software enhancements in early February that now allow additional transfers into PacifiCorp from the ISO over California Oregon Intertie (COI) in the 5-minute market. Second, in March, PacifiCorp also began making available additional capacity in the EIM from units that are also providing regulation.

- Even without the price discovery provisions currently in effect, average EIM prices in PacifiCorp West since mid-February in both the 15-minute and 5-minute markets would have been about equal to bilateral market price indices that were used to set prices in the PacifiCorp areas prior to EIM implementation.

- In PacifiCorp East, the frequency of constraint relaxations declined relative to the period covered in the ISO's last report. However, without price discovery provisions in place under the Commission December 1 Order, EIM prices in this area have continued to average about twice as high as bilateral market price indices used to set prices in PacifiCorp East prior to EIM implementation. With these provisions, EIM prices have been kept about equal to these bilateral market price indices.

- While the energy bids offered into the EIM appears to be sufficient to meet demand during most hours, the portion of this supply available for dispatch on a 15-minute and 5-minute basis is still sometimes insufficient to meet the demand for imbalance energy as projected by the market software. In many cases, these insufficiencies appear to be largely attributable to the various factors cited in the ISO's reports rather than more fundamental market or system conditions.

- Undispatched bids for incremental energy from participating gas and coal resources in PacifiCorp East averaged about 7.7 percent of the total load during February, compared to about 5.8 percent during peak-hours and 5.3 percent during off-peak hours in January. This may reflect an increase in supply that may have played a role in helping to reduce the number of intervals the power balance constraint was relaxed in February in PacifiCorp East.

- However, the amount of gas and coal supply bid into the EIM in PacifiCorp East remains notably lower than in PacifiCorp West. In PacifiCorp West, undispatched bids for incremental energy from participating gas and coal averaged about 20 percent during peak and 33 percent during off-peak hours during February.

- The amount of gas and coal supply bid into the EIM that is dispatchable on a 15-minute basis in PacifiCorp East was also notably low in many hours and was consistently lower than in PacifiCorp

West. DMM recommends 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.

- As previously noted, software enhancements implemented by the ISO in early February now allow additional transfers into PacifiCorp from the ISO over the COI in the 5-minute market. These transfers are now limited to roughly 11 MW during peak hours and roughly 110 MW during off-peak hours, compared to essentially 0 MW over the over the first three months of EIM. Analysis of historical data in Section 6 shows that this additional 5-minute capacity could significantly reduce the need for power balance relaxations in the 5-minute market, particularly in PacifiCorp West.

- The ISO's March 26 report also indicates that the ISO is prepared to implement a software enhancement in the EIM that is currently in place in the ISO real-time market that would mitigate the impacts of excessive load biasing in the pricing run.[1] Analysis in Section 6 of this report indicates this software enhancement could mitigate the impacts of over biasing in the pricing run during about 50 percent of all intervals in which the power balance constraint has been relaxed in the scheduling run.

- The ISO has indicated it plans to implement this new software feature in the EIM after the price discovery features currently in place expires. DMM is recommending that the ISO begin to report on the portion of intervals in which power balance relaxations would be mitigated by the load bias limiter feature after expiration of the price discovery measures currently in place.

- 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.

[1] See Category 5 (Load Forecast Accuracy, Issue 1 (Load forecast biasing), which notes under the column labeled *Remedial Action and Status* that "CAISO will be implementing software functionality to limit erroneous excessive load bias, similar to logic used for CAISO operator bias of load. This feature corrects operator bias of load forecast that exceeds available ramp." See the ISO's *Energy Imbalance Market Pricing Waiver Report February 13 – March 16*, March 26, 2015, p. 31: http://www.caiso.com/Documents/Mar26_2015_EIM_InformationalRpt_Feb13-Mar16_2015_ER15-402.pdf.

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.[2]

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.[3]

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.[4] The Commission also directed the ISO to file detailed informational reports at 30-day intervals during the 90-day waiver period, 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.

This represents DMM's fourth report pursuant to the Commission's December 1 Order. The ISO filed its fourth report pursuant to the December 1 Order on March 26.[5] The ISO's report covered market performance through March 16, 2015.

The ISO's reports identified a wide range of factors contributing to the need to relax software constraints and trigger the special price discovery features, along with steps to be taken by the ISO and PacifiCorp to address these issues. These steps include a range of software improvements and tools,

[2] http://www.caiso.com/Documents/Nov13_2014_PetitionWaiver_EIM_ER15-402.pdf

[3] 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.

[4] http://www.caiso.com/Documents/Dec1_2014_OrderGrantingWaiver_EIMPricingParameters_ER15-402.pdf

[5] http://www.caiso.com/Documents/Mar26_2015_EIM_InformationalRpt_Feb13-Mar16_2015_ER15-402.pdf

enhanced processes and procedures, and increased operational training and experience. DMM does not have the resources to monitor or assess the progress or impact of these specific steps. However, DMM has developed a range of metrics and analysis to provide insights into the ultimate effectiveness of these efforts on EIM market performance.

This report provides estimates of average prices in the PacifiCorp West and PacifiCorp East areas after November 14 if the same pricing parameters used in the ISO real-time market were used for all constraints relaxed in the EIM. As noted in our first two reports, DMM believes this will provide a valuable quantitative measure of EIM market performance and progress made as the result of various steps being taken by the ISO and PacifiCorp to improve market performance.

This report also provides a comparison of EIM prices to bilateral market price indices that were used to set prices in the PacifiCorp areas prior to EIM implementation. Prior to EIM implementation, DMM identified this bilateral price index to stakeholders and regulators as a benchmark DMM would use to assess the competitiveness and overall performance of the EIM.

2 Energy imbalance market prices

During most intervals, prices in the EIM have been 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 had to be relaxed for the market software to balance modeled supply and demand.

- Figure 2.1 and Figure 2.3 show the frequency of constraint relaxations in the 15-minute market by day in PacifiCorp East and PacifiCorp West, respectively, from January 1, 2015 through March 16, 2015. As shown in these figures, four different constraints have been relaxed in the 15-minute market: Power balance constraint shortages (red bar) occur when the power balance constraint that matches generation and load is relaxed when load exceeds the available generation. The penalty price for power balance relaxation due to energy shortage within EIM balancing authority areas is set at $1,100/MW in the scheduling run. In the pricing run, the penalty price normally assigned to relaxations of this constraint would be consistent with the offer cap of $1,000/MW. The pricing parameter when this constraint is relaxed has been set to $0 in the EIM when the price discovery mechanism has been implemented.

- The light blue bars in Figure 2.1 and Figure 2.3 show the number of intervals when power balance constraint shortages occurred due to reasons that the ISO determined would have triggered price correction even if price discovery provisions were not in place.[6]

- Power balance constraint excess (green bar) occurs when the power balance constraint that matches generation and load is relaxed because generation exceeds load. The penalty price for excess generation related to the power balance constraint is set at -$155/MW in the scheduling run and is normally set at the offer floor of -$150/MW in the pricing run. The pricing parameter when this constraint is relaxed has been set to $0 in the EIM when the price discovery mechanism has been implemented. The figures show the count of intervals where power balance excess occurred in terms of a negative number, since these violations reduce overall prices.

The flexible ramping constraint shortages (yellow) occur when there is insufficient ramping capacity in the 15-minute market to meet the capacity requirement. This requirement has been set at about 25 to 40 MW for each of the PacifiCorp areas. The penalty price for shortages of the flexible ramping constraint would normally be set in the pricing run to $247/MW prior to January 15, and $60/MW thereafter. However, the penalty price for the flexible ramping constraint has been set to $0/MW in the pricing run since the price discovery provisions were implemented in December 2014. This constraint is enforced in the binding 15-minute market but not in the binding 5-minute market. Figure 2.2 and Figure 2.4 show average daily prices in the 15-minute market *with* and *without* the special price discovery

[6] Section 35.4 of the ISO tariff provides the CAISO authority to correct prices if it detects an invalid market solution or prices due to issues such as data input failure, occurrence of hardware or software failure, or a result that is inconsistent with the ISO tariff.

As noted in the ISO's February 19 report, Figure 16 through Figure 23 of the ISO's report exclude intervals in which power balance constraint was relaxed due to factors that would have been subject to price correction if price discovery provisions had not been applied (p.44). The ISO determined that prices resulting under price discovery during these intervals were equivalent to prices that would result from price correction, so that no further price adjustment was appropriate. DMM has included data on the frequency of these intervals to provide market transparency.

mechanism being applied to mitigate prices in PacifiCorp East and PacifiCorp West, respectively. These figures also provide a comparison of EIM prices to bilateral market price indices that were used to set prices in the PacifiCorp areas prior to EIM implementation.[7] For this analysis, the estimated EIM price without price discovery is calculated as follows:

- When the power balance constraint was relaxed for a shortage of energy, it is assumed prices would be $1,000/MW minus estimated losses of about 3 percent on average.
- When the EIM transfer constraint was relaxed for a shortage of energy, it is assumed prices would be $1,000/MW minus estimated losses of about 3 percent on average.
- When only the flexible ramping constraint was relaxed due to a shortage of 15-minute ramping, it is assumed shadow prices for this constraint would be $247/MW before January 15 and $60/MW thereafter,[8] and that this shadow price would be reflected in the price for the EIM area.
- When the power balance constraint needed to be relaxed in market software for an excess of energy, it is assumed prices would be -$150/MW plus estimated losses of about 1 percent.
- When relaxations of penalty parameters occurred due to conditions that would trigger price correction, prices were not adjusted (see light blue bars in Figure 2.1 and Figure 2.3). This is because there was an underlying error that caused the price discovery provisions to be triggered. The ISO determined that prices resulting under price discovery during these intervals were equivalent to prices that would result from price correction, so that no further price adjustment was appropriate.

This methodology differs for the estimates of counterfactual price in the ISO's reports in at least one key respect. DMM's analysis estimates prices without application of any special price discovery provisions in EIM. The ISO's analysis only incorporates the effects of price discovery provisions implemented by the ISO following approval of the ISO's November 13 waiver request.

Specifically, the ISO analysis reflects the fact that shortly prior to full EIM implementation on November 1, the ISO amended the EIM business practice manual (BPM) so that price discovery was triggered if a constraint was relaxed during an interval when the EIM balancing area had failed to pass the flexible ramping requirement test.[9] DMM includes these events in its counterfactual prices without price discovery, the ISO does not.

[7] The bilateral market index represents a daily average of peak and off-peak prices for four major Western trading hubs representative of the PacifiCorp East and West areas (California Oregon Border, Mid-Columbia, Palo Verde and Four Corners). Prior to EIM implementation, DMM identified this bilateral price index to stakeholders and regulators as a benchmark DMM would use to assess the competitiveness and overall performance of the EIM.

[8] The penalty price associated with procurement shortfalls was set to $247 before January 15, 2015. Beginning January 15, 2015, the penalty price is now set to $60. For more information, see: http://www.caiso.com/Documents/Dec18_2014_OrderAcceptingFlexibleRampingConstraintParameterAmendment_ER15-50.pdf.

[9] See pp. 10-11 of *Energy Imbalance Market Pricing Waiver Report*, December 1 - 31, 2014, January 15, 2015, http://www.caiso.com/Documents/Jan15_2015_EnergyImbalanceMarket_REPORT_ER15-402.pdf.

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

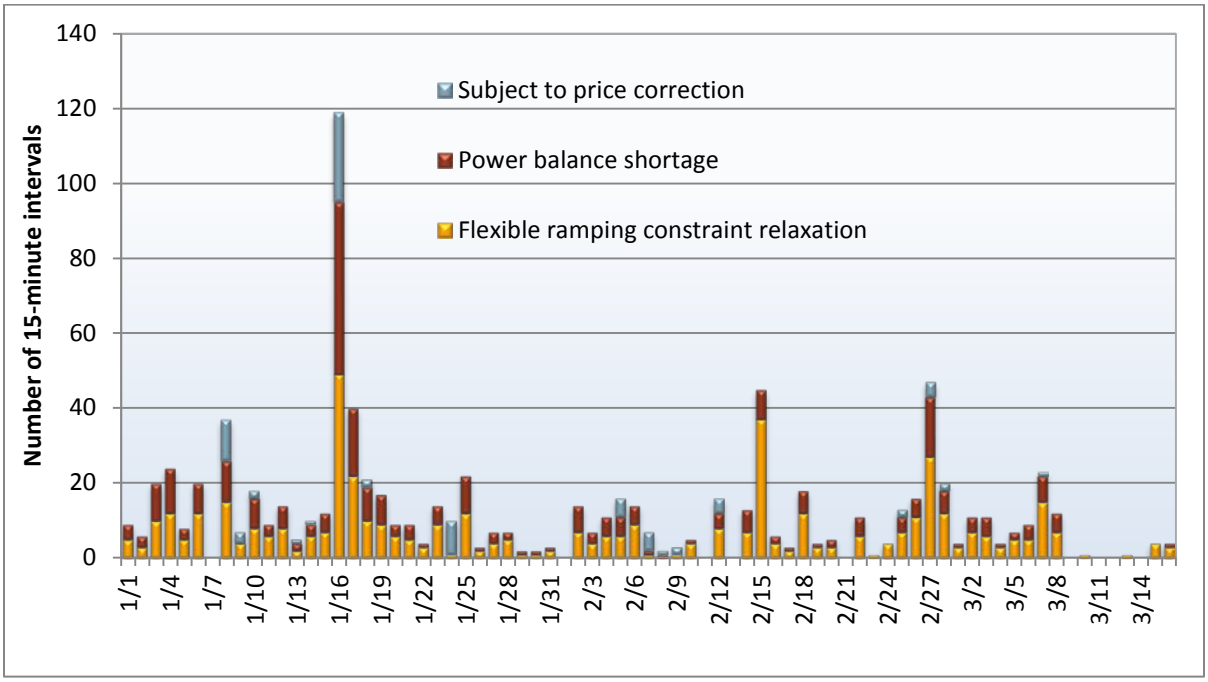


Figure 2.2 Average daily prices with and without price discovery
PacifiCorp East - 15-minute market

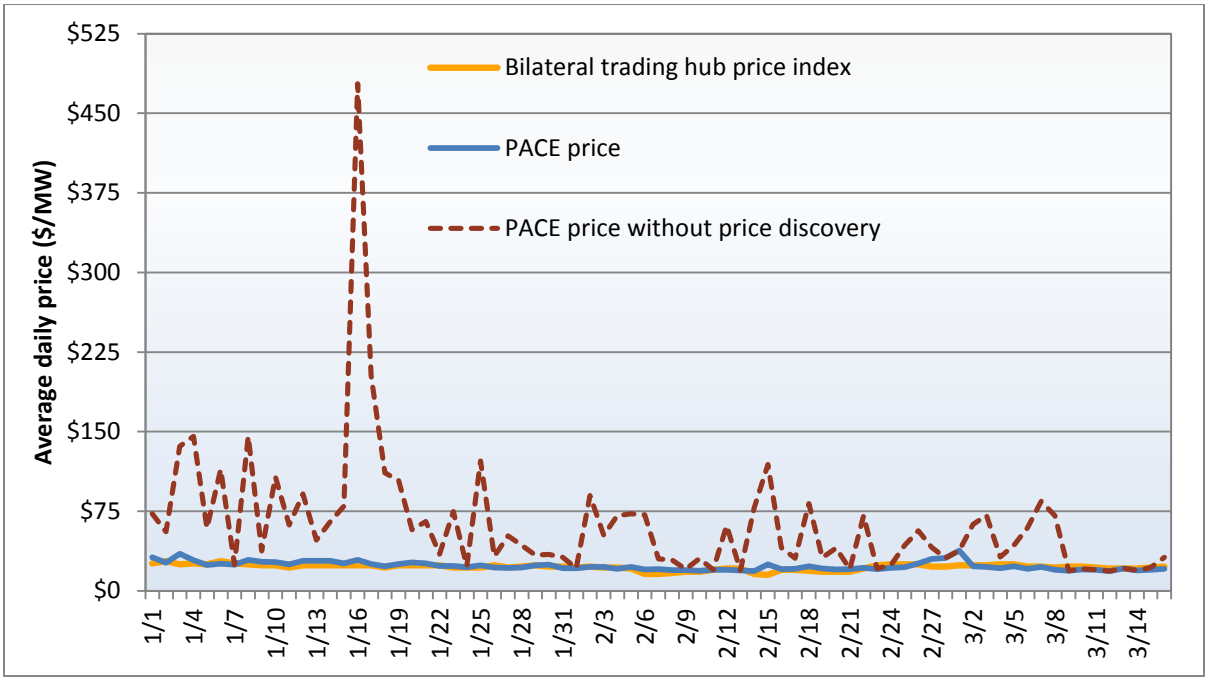


Figure 2.3 Frequency of constraint relaxation
PacifiCorp West - 15-minute market

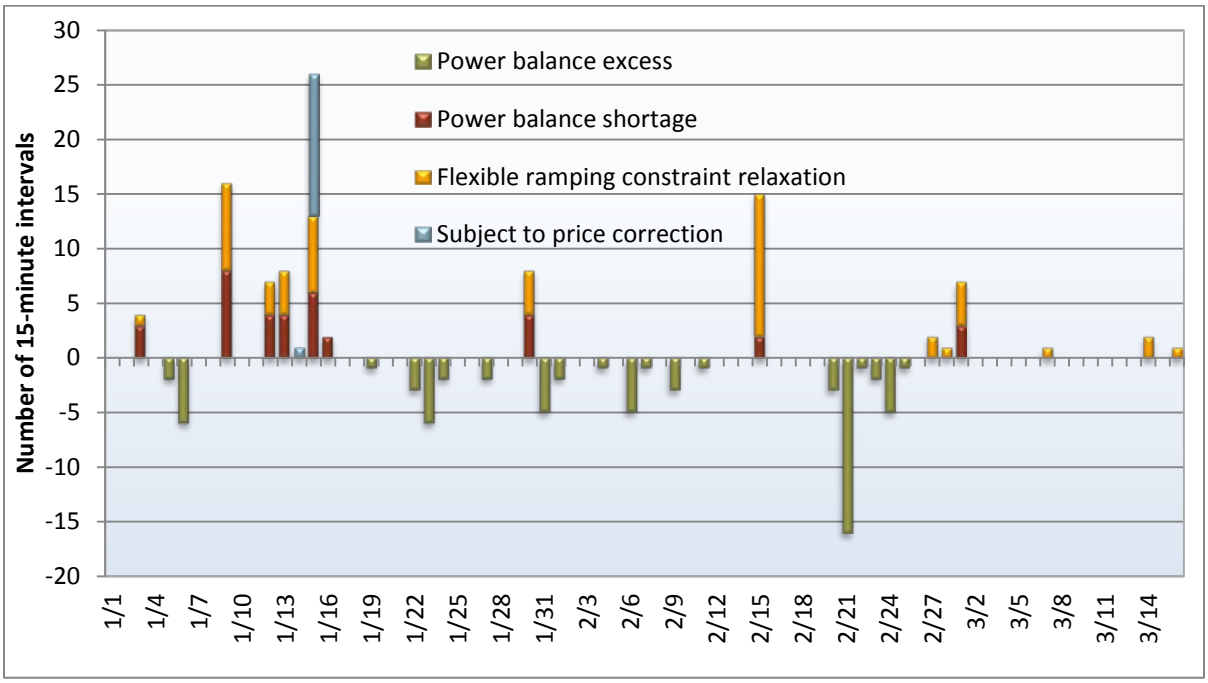
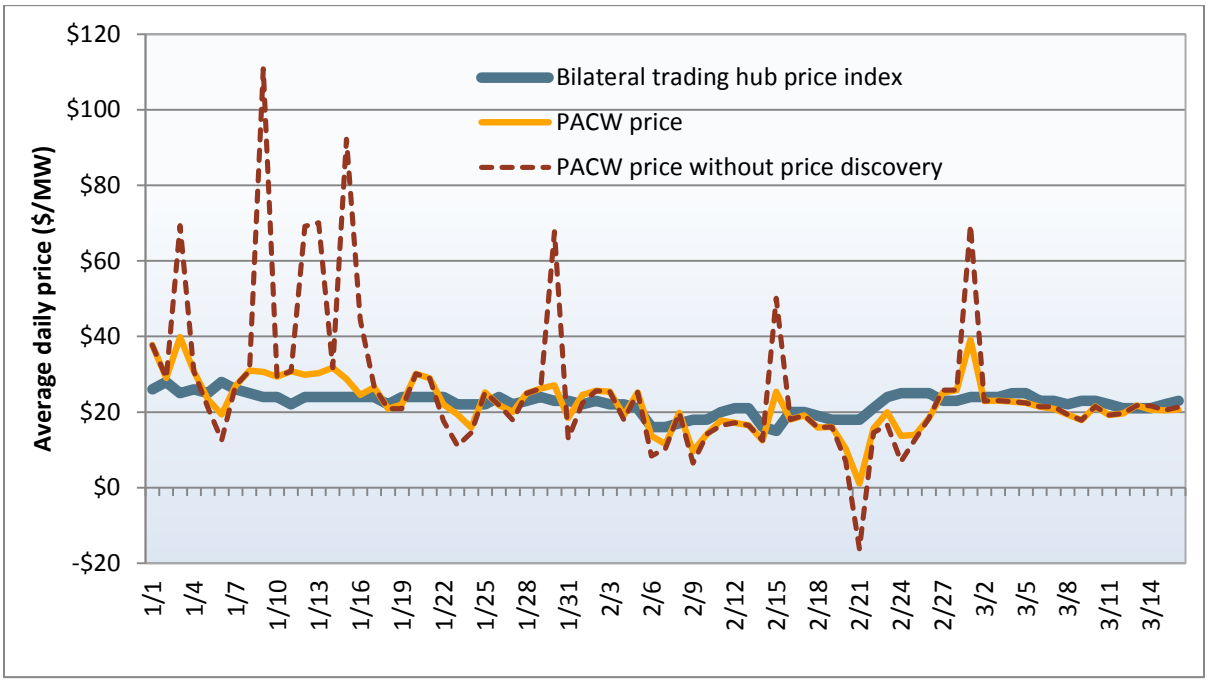


Figure 2.4 Average daily prices with and without price discovery
PacifiCorp West - 15-minute market



As shown in Figure 2.2 and Figure 2.4, without the price discovery provisions being applied in EIM, on days when the power balance or flexible ramping constraints need to be relaxed in more than a few intervals of the 15-minute market, average daily prices would consistently exceed the bilateral market price index reflective of prices for imbalance energy in the PacifiCorp areas prior to EIM. However, with price discovery, EIM prices track very closely with this bilateral price index.

Figure 2.5 and Figure 2.6 provide a weekly summary from the beginning of November 2014 to mid-March 2015 of the frequency of constraint relaxation, average prices with and without price discovery, and bilateral market prices for PacifiCorp East and PacifiCorp West, respectively.

Figure 2.7 and Figure 2.8 provide the same weekly summary for the 5-minute market. As shown in these figures, the need to relax the power balance constraint in the 5-minute market has also remained relatively high, particularly in the PacifiCorp East area, since EIM implementation. This reflects the fact that in the 5-minute market the supply of ramping capacity within PacifiCorp is more constrained than in the 15-minute market.

The higher frequency of power balance constraint relaxations in the 5-minute market also reflects the fact that incremental transfers into PacifiCorp from the ISO in the 5-minute market had been essentially prevented from occurring during almost all intervals until the first week of February. The dynamic transfer constraint (DTC), which constrains the extent to which transfers between PacifiCorp and the ISO scheduled in the 15-minute market can change in the 5-minute market, was set to a limit of less than 0.003 MW during most 5-minute market intervals until early February. Since early February, the dynamic transfer capability limits now allow 15-minute EIM transfer schedules on COI to be modified by about ±11MW during peak hours and about ±110 MW during off-peak hours. This appears to have helped reduce the frequency of power balance relaxations in the 5-minute market in PacifiCorp West since this change was implemented.

As shown in Figure 2.5 through Figure 2.8, the price discovery mechanism approved under the Commission's December 1 Order has effectively mitigated the impact of constraint relaxation on market prices. Table 2.1 shows average EIM prices in the 15-minute and 5-minute markets with and without application of price discovery, along with average bilateral market prices, from November 14, 2014 through March 16, 2015. As shown in Table 2.1:

- Application of the price discovery mechanism has kept average EIM prices in the 15-minute market lower than bilateral market price indices that were used to set rates in the PacifiCorp area prior to EIM by about 2 percent in PacifiCorp East and about 3 percent in PacifiCorp West.
- Prices in the 5-minute market since the price discovery mechanism has been in effect have been lower than these bilateral market price indices by about 13 percent in both PacifiCorp East and PacifiCorp West regions.

Figure 2.5 Frequency of constraint relaxation and average prices by week
PacifiCorp East - 15-minute market

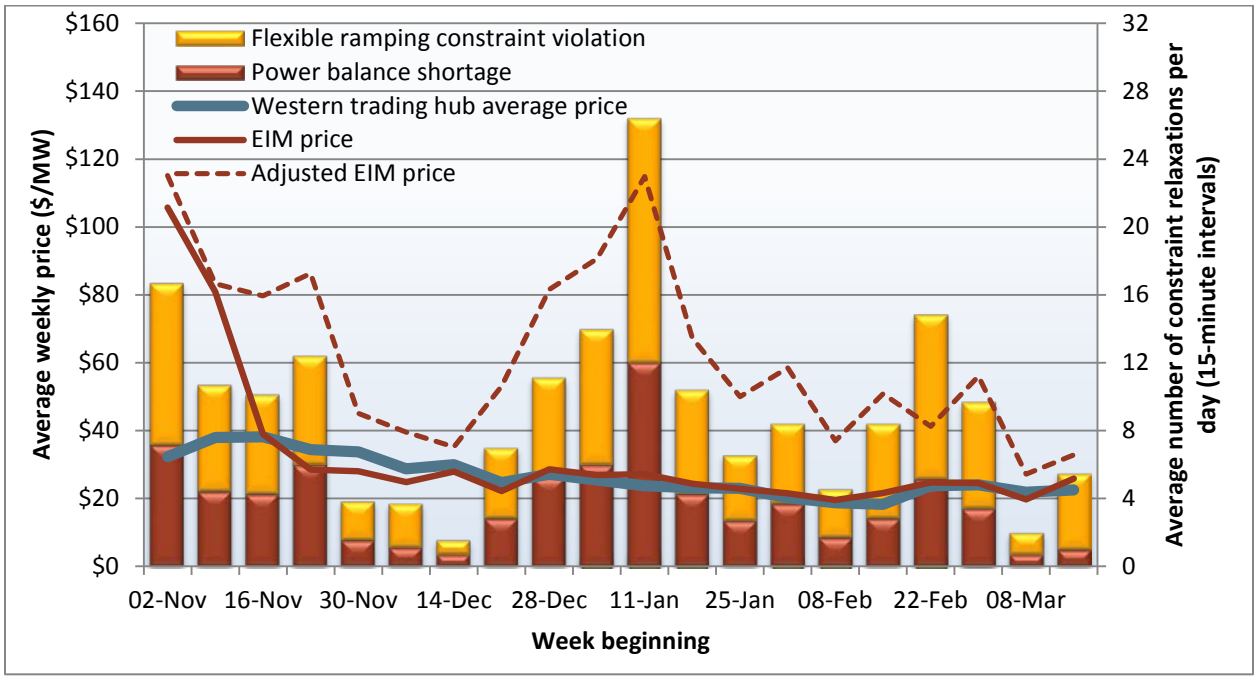


Figure 2.6 Frequency of constraint relaxation and average prices by week
PacifiCorp West - 15-minute market

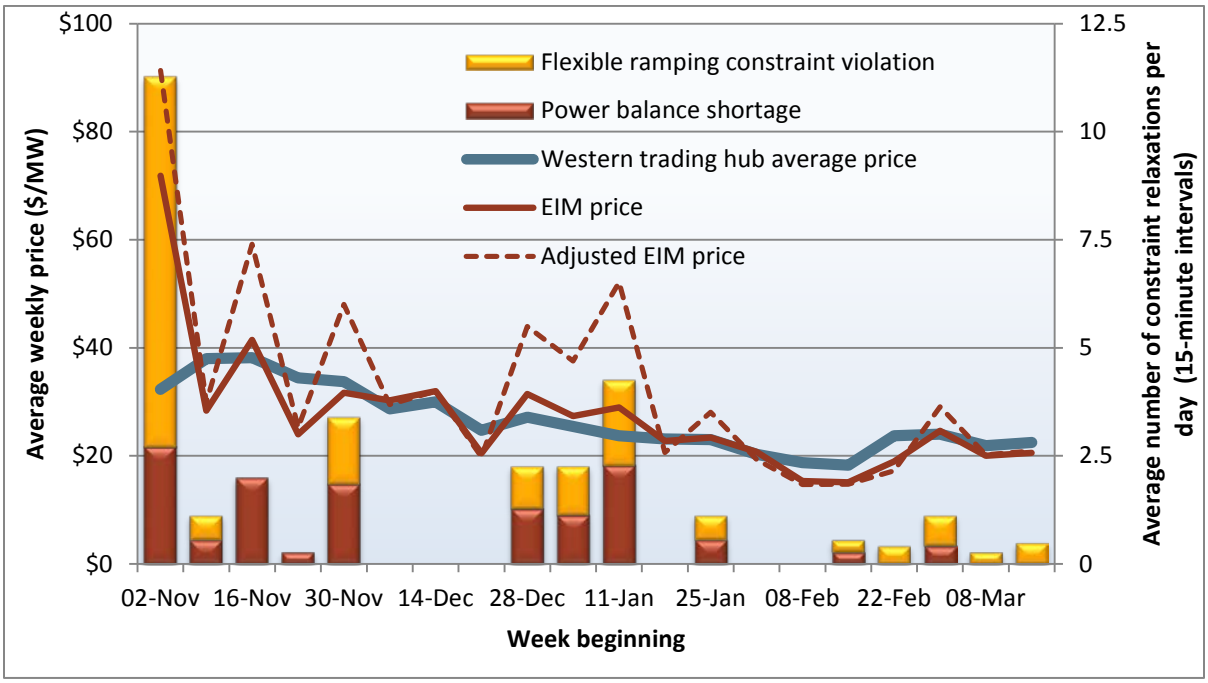


Figure 2.7 Frequency of constraint relaxation and average prices by week
PacifiCorp East - 5-minute market

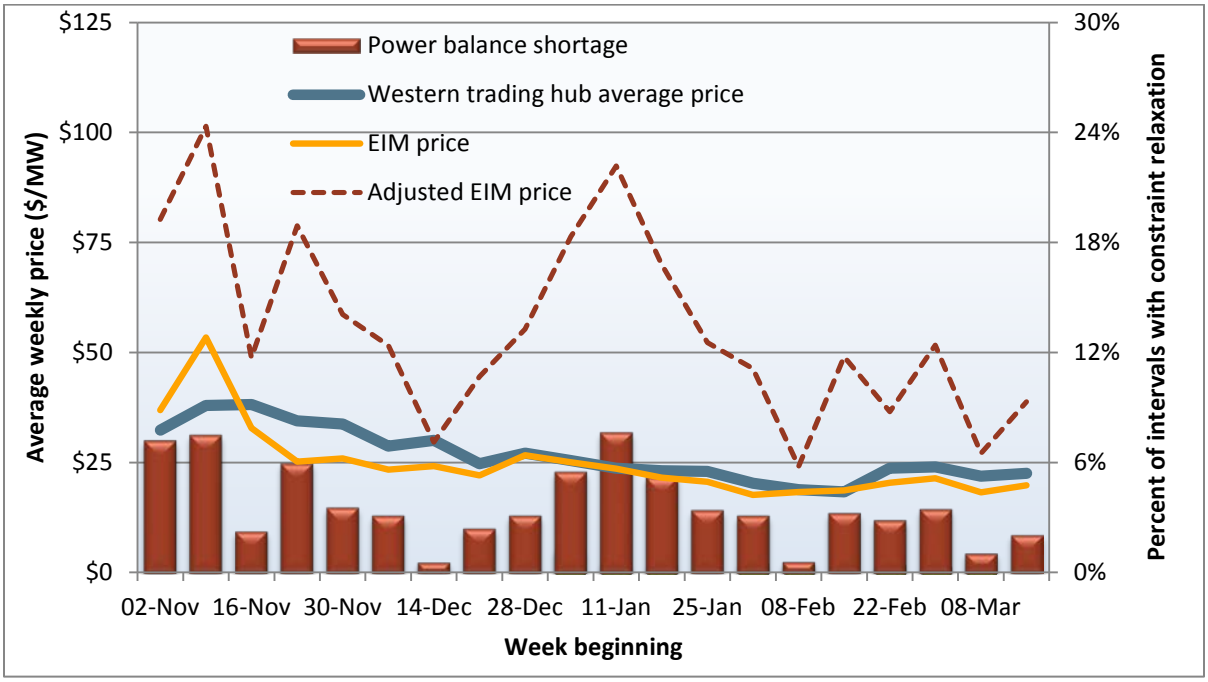
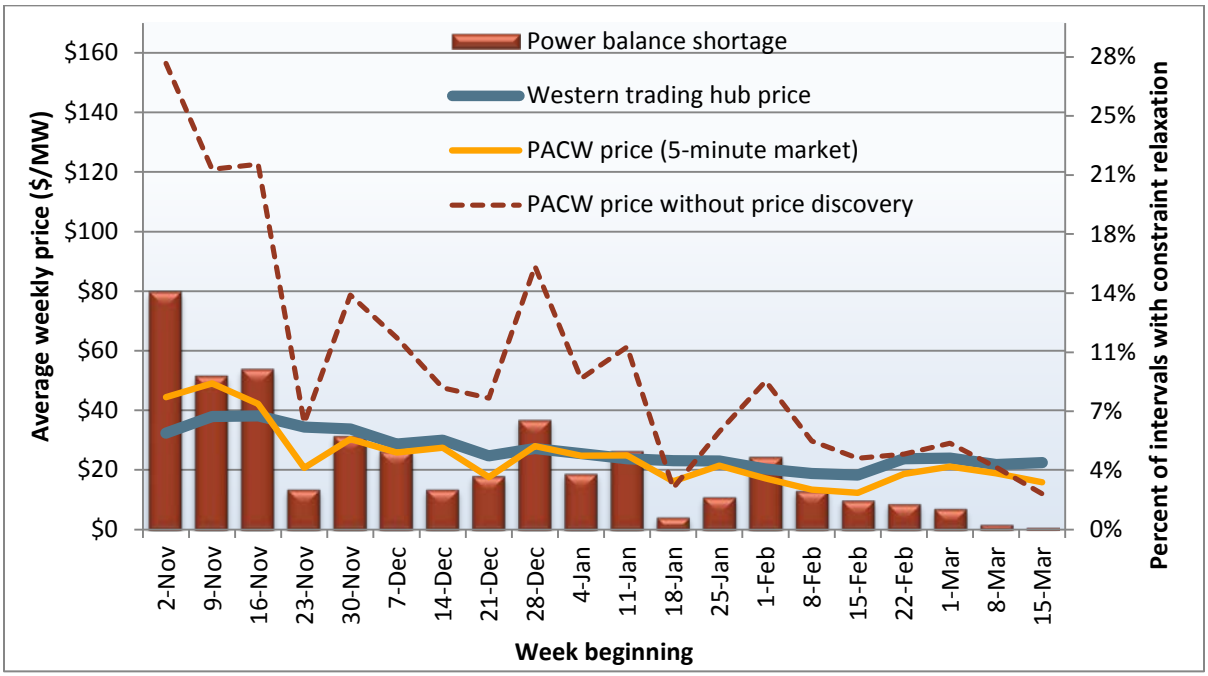


Figure 2.8 Frequency of constraint relaxation and average prices by week
PacifiCorp West - 5-minute market



- Without price discovery, prices in PacifiCorp West have been about equal to the bilateral market prices in both the 15-minute and 5-minute market prices since about mid-February, though they are substantially higher for the period since mid-November. This highlights an improvement in EIM pricing in the PacifiCorp West area. This improvement is potentially related to the change in the DTC that occurred in early February. In addition, PacifiCorp began making available additional capacity in the EIM in March from units that are also providing regulation.
- In PacifiCorp East, prices would be about 2.3 times higher than bilateral market price indices without price discovery in the 15-minute and about twice as high in the 5-minute market relative to these bilateral market prices since mid-November. Unlike PacifiCorp East, this relationship remained fairly consistent when reviewing the price relationship since mid-February.

Table 2.1 Average prices in EIM and bilateral markets (November 14, 2014 – March 16, 2015)

	Western trading hub average price	Average EIM price	EIM price without price discovery
PacifiCorp East			
15-minute market (FMM)	$25.99	$25.39	$58.68
5-minute market (RTD)	$25.99	$22.76	$52.54
PacifiCorp West			
15-minute market (FMM)	$25.99	$25.29	$30.27
5-minute market (RTD)	$25.99	$22.54	$47.54

Flexible ramping sufficiency test

As previously noted, DMM's estimates of EIM prices that would result without price discovery include price discovery that would be triggered when the EIM balancing area had failed to pass the flexible ramping requirement test under a business practice manual modification made shortly prior to full EIM implementation on November 1, 2014.

The ISO tariff specifies that when an EIM area fails to pass the flexible ramping sufficiency test, transfers of energy into that EIM area may not increase. As noted in the ISO report:

> As specified in section 29.34(n) of the CAISO tariff and section 10.3.2.1 of the Business Practice Manual for the Energy Imbalance Market, if the EIM Entity balancing authority area fails the sufficient ramp test, or is deemed to have failed the test because it failed the capacity (resource plan) test, CAISO will restrict additional EIM Transfer imports into that EIM Entity balancing authority area during the hour starting at T beyond the optimal solution for T-7.5 minutes. The CAISO will enforce the individual EIM Entity balancing authority area flexible ramp requirement in the isolated EIM

Entity balancing authority area and will not include that balancing authority area in area group constraints.[10]

This provision was included in the EIM design to deter "capacity leaning" and provide a strong incentive for each EIM area to ensure it has enough ramping capacity available to meets its own needs. In practice, this provision means that if an EIM area fails the sufficiency test, transfers of energy into that EIM area in the 15-minute market may not increase. For instance, if 100 MW is being transferred into the EIM area, transfers are constrained not to exceed 100 MW. If 100 MW is being exported from an EIM area when the area fails the ramping sufficiency test, the transfer out of that EIM area may be reduced to 0 MW, but the constraint on imports into that area is set to 0 MW.

Shortly prior to full EIM implementation, the EIM Business Practice Manual for the Energy Imbalance Market was changed so that when an EIM area failed the ramping sufficiency test, the price discovery mechanism would be applied in the event any constraint such as the power balance or flexible ramping constraint was relaxed in the 15-minute or 5-minute market.[11]

To provide market transparency on the impact of this BPM change, DMM has included information on the frequency with which constraint relaxation occurred during hours when the flexible ramping sufficiency test failed prior to application of price discovery provisions on November 14 pursuant to FERC's December 1 Order. DMM continues to provide information on this issue to provide market transparency on the potential impact of this BPM change if price discovery provisions approved in the December 1 Order were not in effect.

Figure 2.9 through Figure 2.12 show the frequency of failures of the ramping sufficiency test, along with the portion of these events during which the power balance or flexible ramping constraint was subsequently relaxed in the 15-minute or 5-minute market in the PacifiCorp areas.

As shown in Figure 2.9 through Figure 2.12:

- While the power balance or flexible ramping constraints occasionally need to be relaxed in the 15-minute market when an area fails to meet the ramping sufficiency test, there are many intervals when this is not the case.
- When an area fails to meet the ramping sufficiency test, chances are increased that the power balance constraint will need to be relaxed in the 5-minute market.

[10] See pp. 10-11 (ii) in *Energy Imbalance Market Pricing Waiver Report*, December 1 - 31, 2014, January 15, 2015, http://www.caiso.com/Documents/Jan15_2015_EnergyImbalanceMarket_REPORT_ER15-402.pdf.

[11] See p. 35, Business *Practice Manual for The Energy Imbalance Market*, as revised 10/30/2014: http://bpmcm.caiso.com/BPM%20Document%20Library/Energy%20Imbalance%20Market/BPM_for_Energy%20Imbalance%20Market_V2_redline.pdfhttp://bpmcm.caiso.com/BPM%20Document%20Library/Energy%20Imbalance%20Market/BPM_for_Energy%20Imbalance%20Market_V2_redline.pdf.

Figure 2.9 Frequency of constraint relaxation when flexible ramping sufficiency test failed PacifiCorp East - 15-minute market

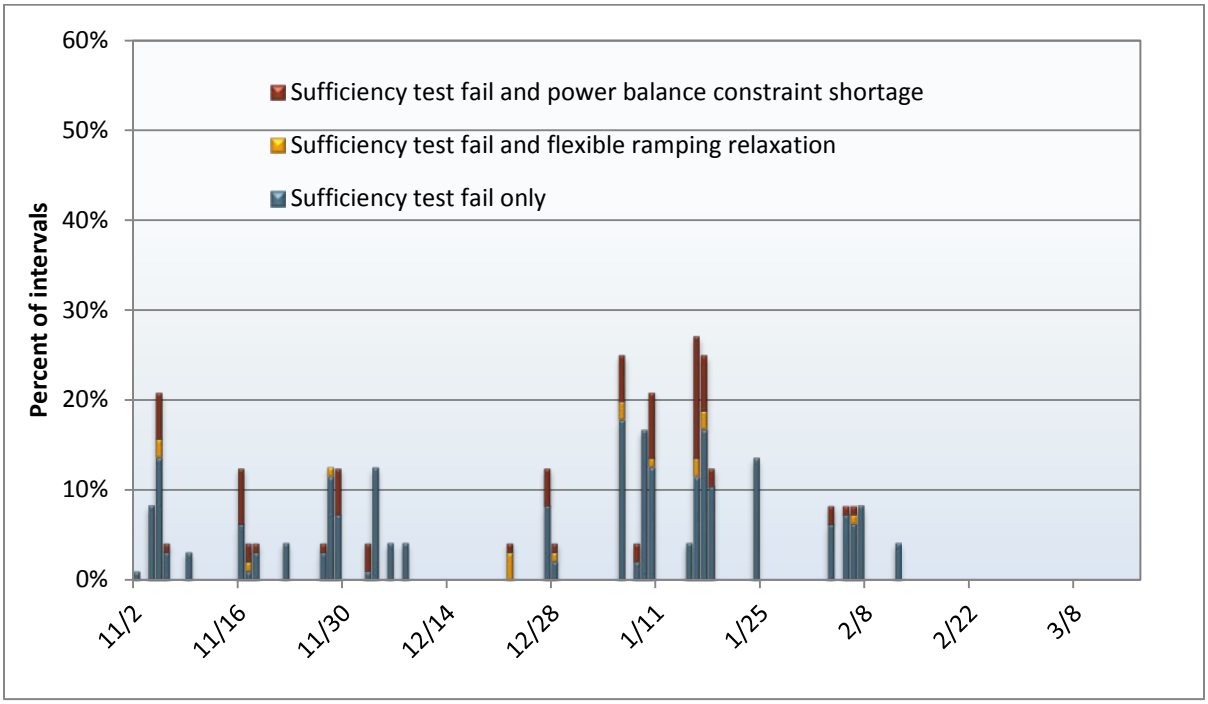


Figure 2.10 Frequency of constraint relaxation when flexible ramping sufficiency test failed PacifiCorp West - 15-minute market

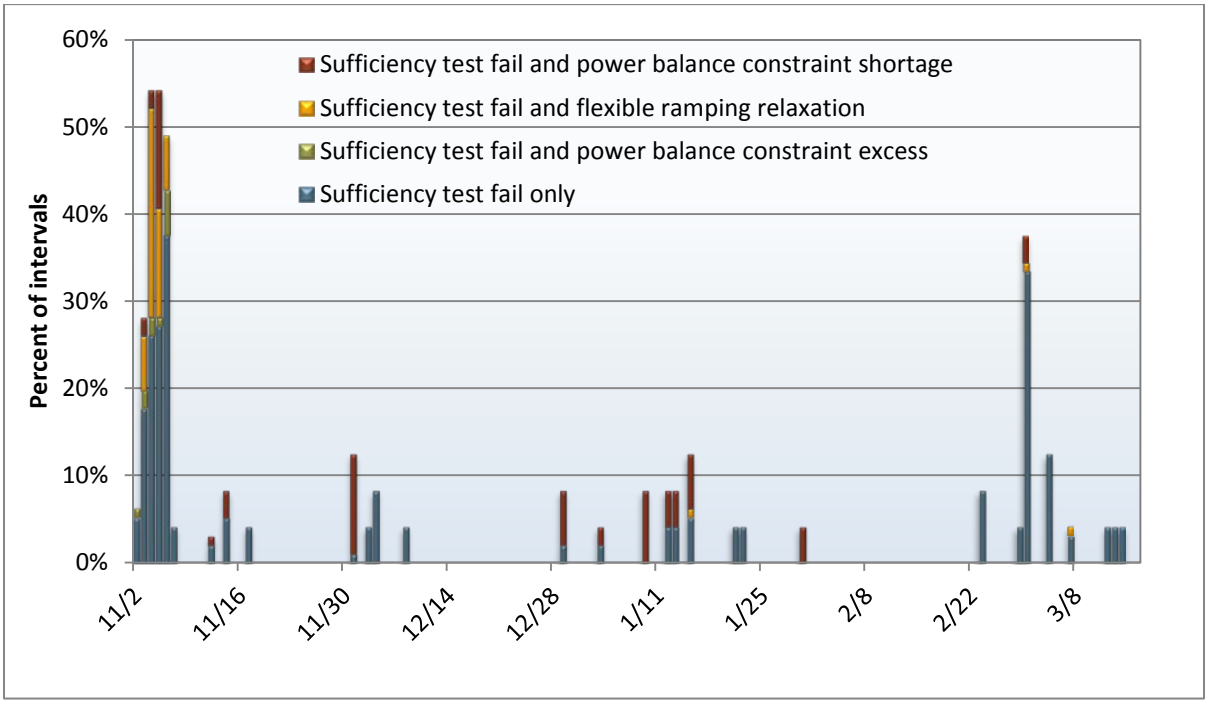


Figure 2.11 Frequency of constraint relaxation when flexible ramping sufficiency test failed PacifiCorp East - 5-minute market

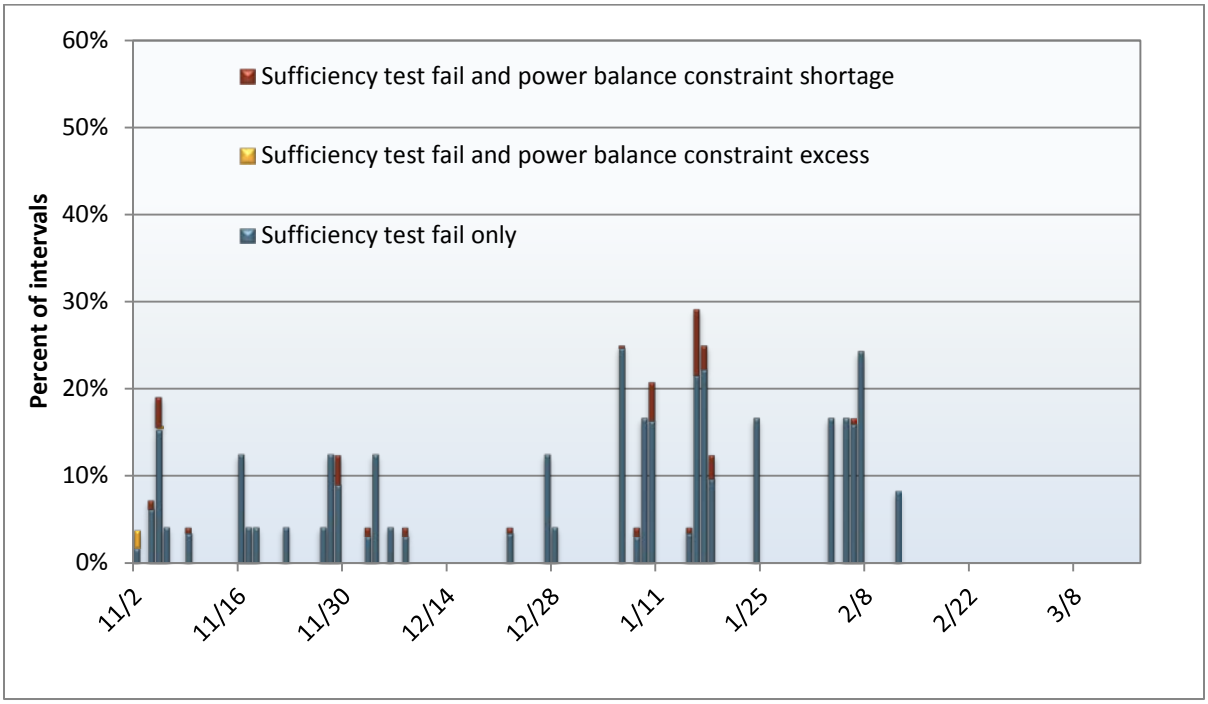
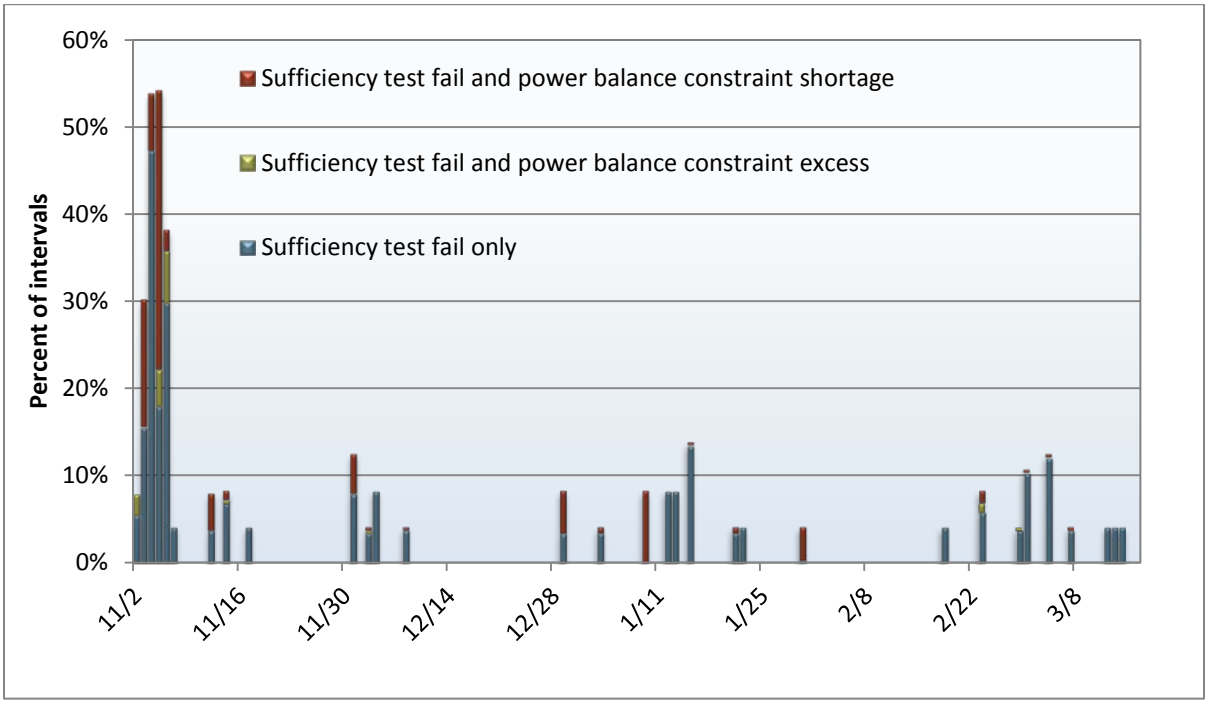


Figure 2.12 Frequency of constraint relaxation when flexible ramping sufficiency test failed PacifiCorp West - 5-minute market



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 additional information on the frequency and causes of various constraint violations in the EIM by calendar month.

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.

- As shown in Figure 3.1, in PacifiCorp East the frequency of power balance constraint relaxation dropped notably in February, while flexible ramping constraint relaxations in the 15-minute market increased slightly.
- As shown in Figure 3.2, in PacifiCorp West the frequency of constraint relaxation in the 15-minute market during February dropped significantly to about 0.2 percent. The power balance constraint was relaxed during about 2 percent of intervals in the 5-minute market in PacifiCorp West during February.

As described in the ISO's reports, the ISO has reviewed each interval in which the power balance constraint was relaxed due to supply insufficiency and categorized each of these in terms of a primary cause of this supply insufficiency.[12] DMM has aggregated the ISO data to highlight the relative magnitude of the different factors driving supply insufficiency events in Figure 3.3 through Figure 3.6.

Provided below is a summary of the primary cause of EIM supply insufficiencies in the approximate order of the frequency of which these issues caused supply insufficiencies based on data underlying the ISO report.

- **Resource data alignment.** The ISO report explains that "this group accounts for resource deviating from their dispatch, differences between base schedules and bids or dispatches, and changes between markets."[13] Based on DMM's review of the ISO's analysis and discussions with the ISO, many of these events appear to be related to issues related to how multi-stage generating units are scheduled, bid and dispatched in the market. The ISO and PacifiCorp have indicated they are working to improve how this software functionality is utilized to reduce this type of issue.

[12] See Figures 10 and 12, pp. 16-18, in *Energy Imbalance Market Pricing Waiver Report*, January 1 – February 12, 2015, February 19, 2015: http://www.caiso.com/Documents/Feb19_2015_EIM_Informational_Report_ER15-402.pdf.

[13] See page 15, in *Energy Imbalance Market Pricing Waiver Report*, January 1 – February 12, 2015, February 19, 2015: http://www.caiso.com/Documents/Feb19_2015_EIM_Informational_Report_ER15-402.pdf.

Figure 3.1 Frequency of constraint relaxation by month – PacifiCorp East (PACE)

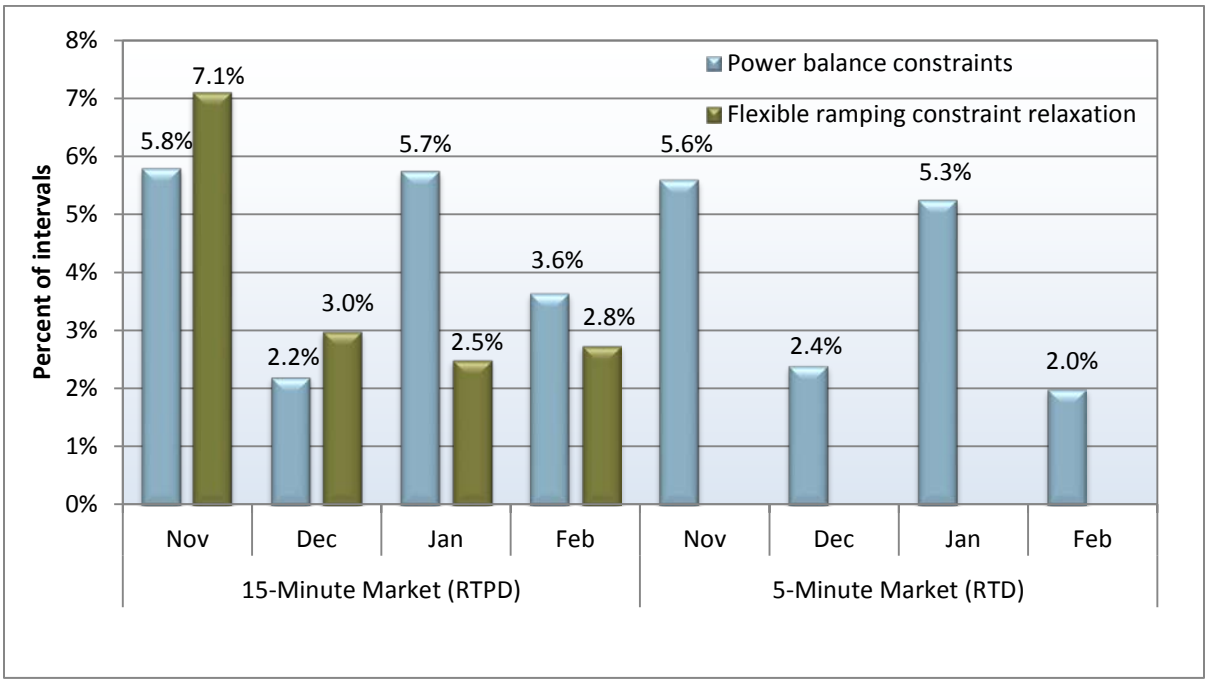


Figure 3.2 Frequency of constraint relaxation by month – PacifiCorp West (PACW)

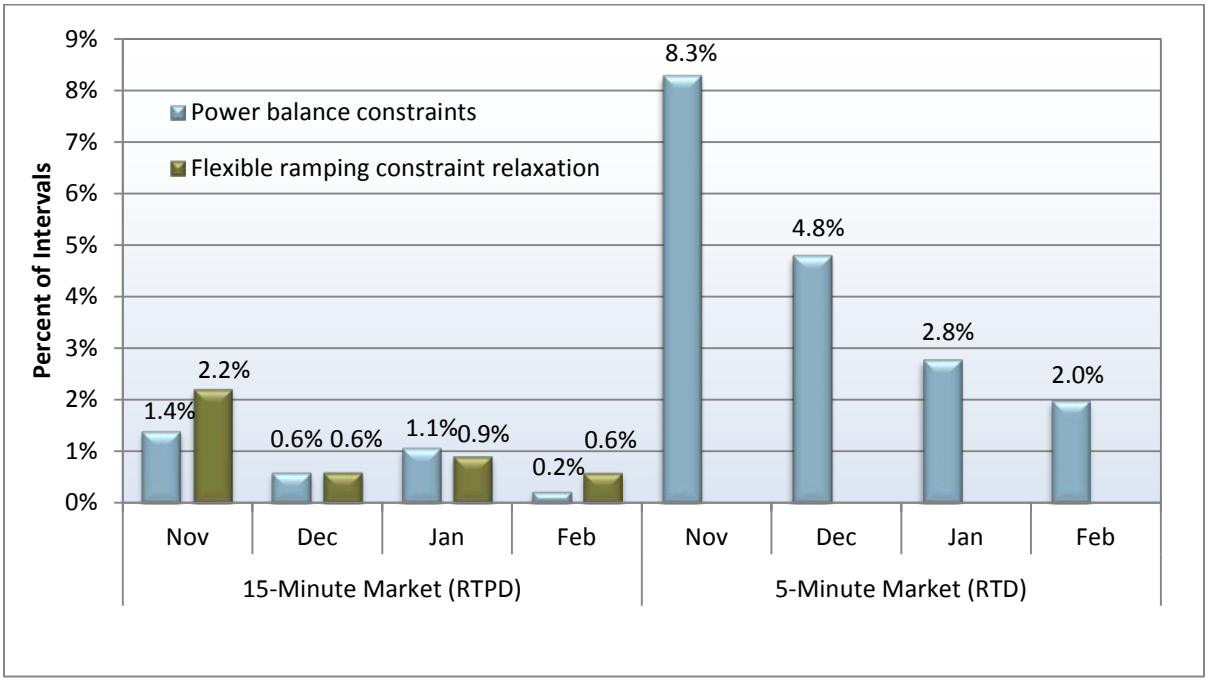


Figure 3.3 Major causes of power balance constraint relaxation
PacifiCorp East - 15-minute market (February/March 2015)

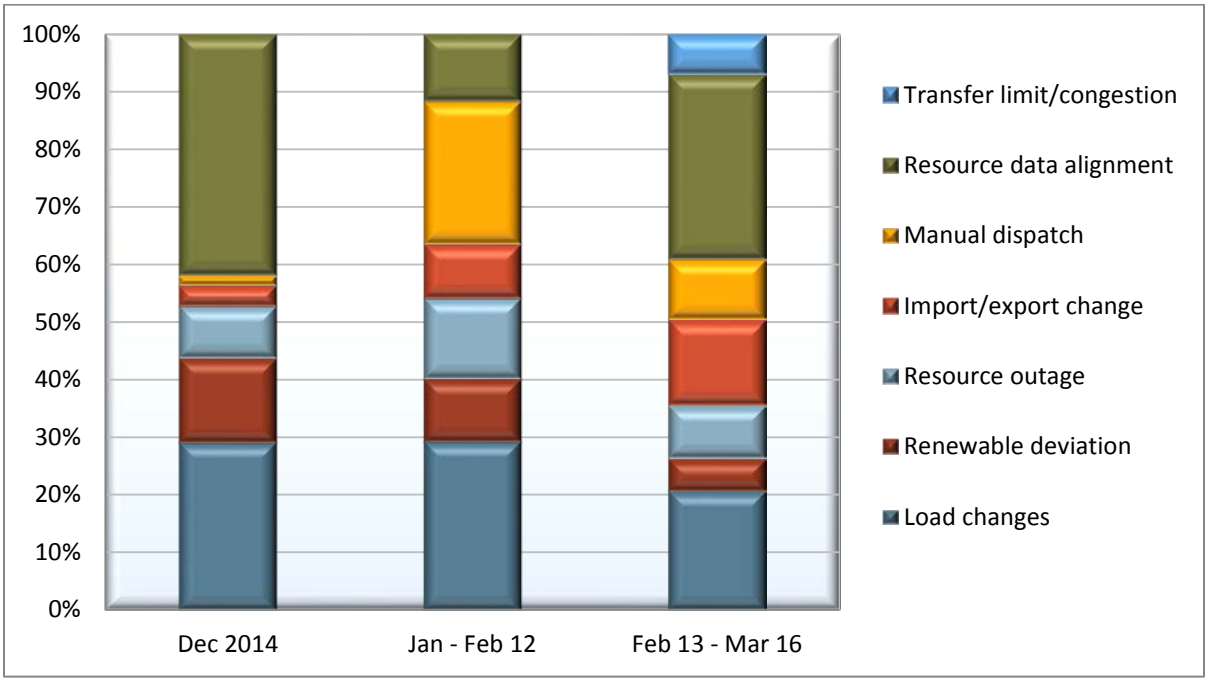


Figure 3.4 Major causes of power balance constraint relaxation
PacifiCorp West - 15-minute market (February /March 2015)

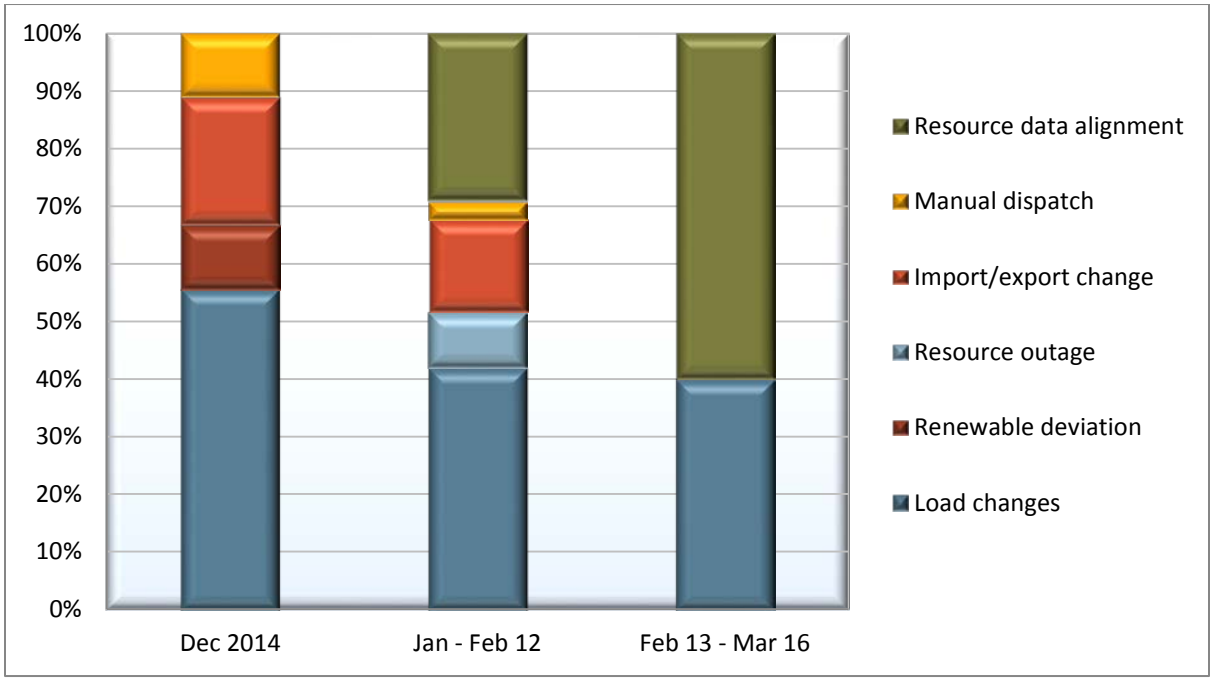


Figure 3.5 Major causes of power balance constraint relaxation PacifiCorp East - 5-minute market (February/March 2015)

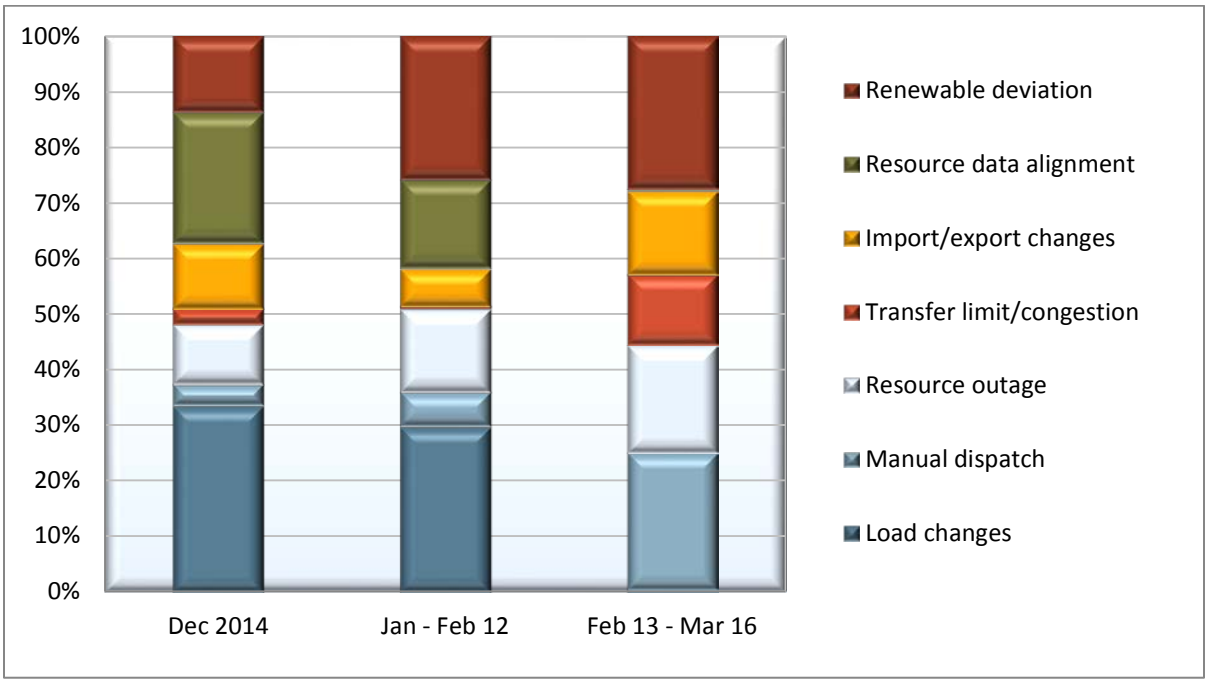
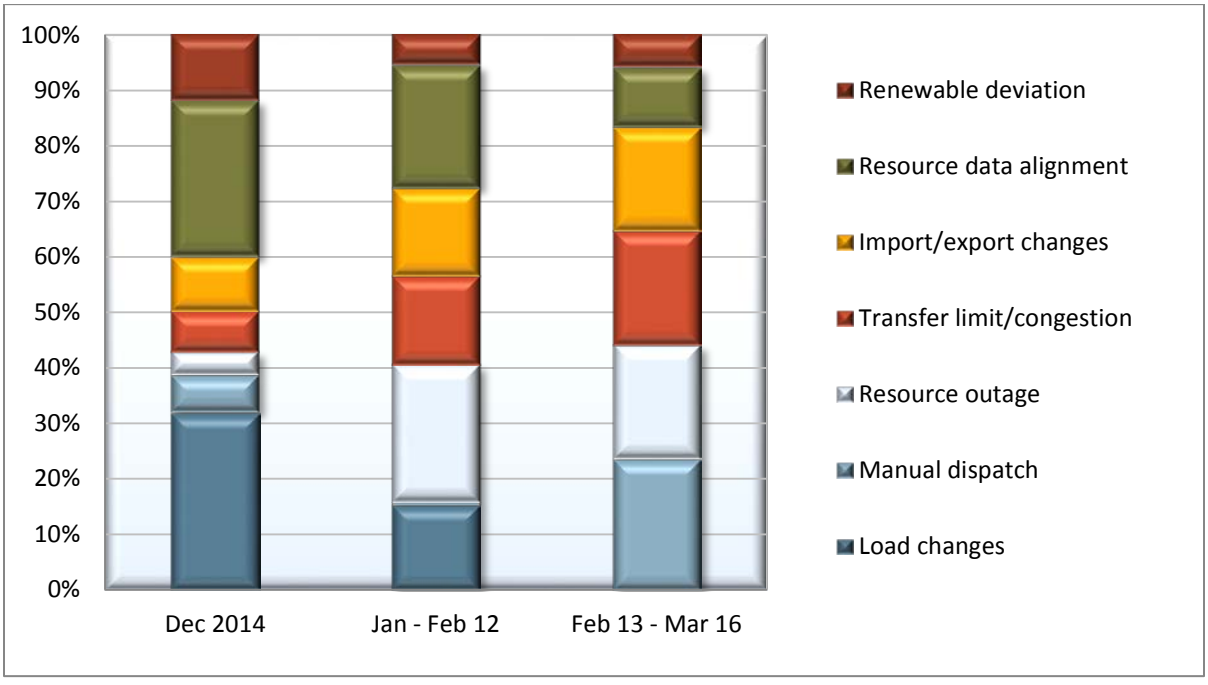


Figure 3.6 Major causes of power balance constraint relaxation PacifiCorp West - 5-minute market (February/March 2015)



- **Load changes.** The ISO report indicates that this category includes conditions where either the load forecast is adjusted or there is a change in the load bias. In practice, it should be noted that load forecast adjustments or biasing is often the tool by which the EIM operator may seek to account for many sources of modeling discrepancies besides actual fluctuation in loads versus forecasts. For instance, if the EIM operator overestimates the amount of load adjustment or bias actually needed, this may create a supply insufficiency that does not reflect actual system conditions. DMM notes that the need to rely on load adjustments may be reduced by modeling improvements, and that use of adjustments may improve as EIM operators gain additional experience, as occurred in the ISO over time.

  Update: As discussed in Section 6 of this report, the ISO's March 26 report indicates that the ISO is prepared to implement a software enhancement in the EIM that is currently in place in the ISO real-time market that would mitigate the impacts of excessive load biasing in the pricing run.[14] *Analysis by DMM presented in Section 6 of this report indicates this software enhancement could mitigate the impacts of over biasing in the pricing run during about 50 percent of all intervals in which the power balance constraint has been relaxed in the scheduling run.*

- **Renewable deviation.** This category represents cases in which changes in wind generation lead to the loss of capacity and for the need to increase generation from other resources. DMM notes that wind deviations appear to represent a higher portion of total load in PacifiCorp than the ISO. As noted in the ISO report, PacifiCorp is working to improve the forecast of wind generation in its area.

- **Resource outages.** When a generating resource outage occurs, the market software needs to increase generation from other resources. When a resource is no longer on outage and is scheduled by an EIM entity, it is also important that the outage cancellation be reported in a timely manner so that the market software represents that this capacity is available. Otherwise, the market software perceives that there is capacity shortage to meet the load. As noted in the ISO report, PacifiCorp is working to improve the timeliness with which outages are reported and outages are cancelled for units no longer on outage.

- **Manual dispatch.** Manual dispatches are issued to dispatch additional generation when outages or other issues occur causing a sudden need for additional generation. However, if these out-of-market dispatches are not entered into the market software, this generation is not reflected in the available supply modeled in the market software, which can cause a supply insufficiency in the market software. As indicated in the ISO report, the ISO and PacifiCorp have discussed the need for improvement in the timeliness of manual dispatch logging processes.

- **Import/export changes**. This category involves delays in making adjustments and updates to import and export schedules in the market software during resource outage times or steep load ramping conditions. Although additional energy may be procured for import in the bilateral market, e-tags are not due until 20 minutes prior to the operating hour. If this energy is not e-tagged before the 15-minute market is run 37.5 minutes prior to the operating hour, this energy is not available to meet supply in the EIM 15-minute market.

[14] See Category 5 (Load Forecast Accuracy, Issue 1 (Load forecast biasing), which notes under the column labeled *Remedial Action and Status* that "CAISO will be implementing software functionality to limit erroneous excessive load bias, similar to logic used for CAISO operator bias of load. This feature corrects operator bias of load forecast that exceeds available ramp." See the ISO's *Energy Imbalance Market Pricing Waiver Report February 13 – March 16*, March 26, 2015, p. 31: http://www.caiso.com/Documents/Mar26_2015_EIM_InformationalRpt_Feb13-Mar16_2015_ER15-402.pdf.

- **Transfer constraints/congestion**. This category appears to include cases where energy was transferred out of an EIM area in the 15-minute market, and then was needed to meet demand within that area, but was not available since transfers out of the EIM area could not be reduced to the limits placed on EIM transfers in the 5-minute market. In practice, due to ISO software limitations, the amount of changes made to 15-minute schedules in the 5-minute market in the EIM was set to not more than 0.003 MW during most intervals until early February, so that no significant changes can be made to net EIM transfers in the 5-minute market. DMM identified this as a major contributing factor to supply insufficiencies in the EIM during many intervals.

  Update: The ISO's March 26 report briefly notes that "the five-minute dynamic COI limits were recently increased for the off-peak hours but still very limited in peak hours."[15] Section 6 of this report provides a more detailed description of the reason and magnitude of this change, and its potential impact on reducing the need relax the power balance constraint in the 5-minute market.

Figure 3.7 through Figure 3.10 show the frequency of various constraint relaxations by operating hour in PacifiCorp East and PacifiCorp West in the 15-minute market during January and February 2015. These charts also include the average total load (green line) in the PacifiCorp areas in each hour.

As shown in Figure 3.7 through Figure 3.10, the overall frequency of constraint relaxations decreased in February in both PacifiCorp East and West. In PacifiCorp East, the need for constraint relaxation dropped most significantly during peak hours, with most constraint relaxation occurring in off-peak hours during February.

[15] See Category 9: EIM Transfer Limits, Issue 1: Static and dynamic transfer limit restrictions on California-Oregon Interties (COI), column labeled *Remedial Action and Status*, on pp. 36-37 of the ISO's March 26, 2015 report.

Figure 3.7 Constraint relaxation by operating hour (January 2015)
PacifiCorp East - 15-minute market

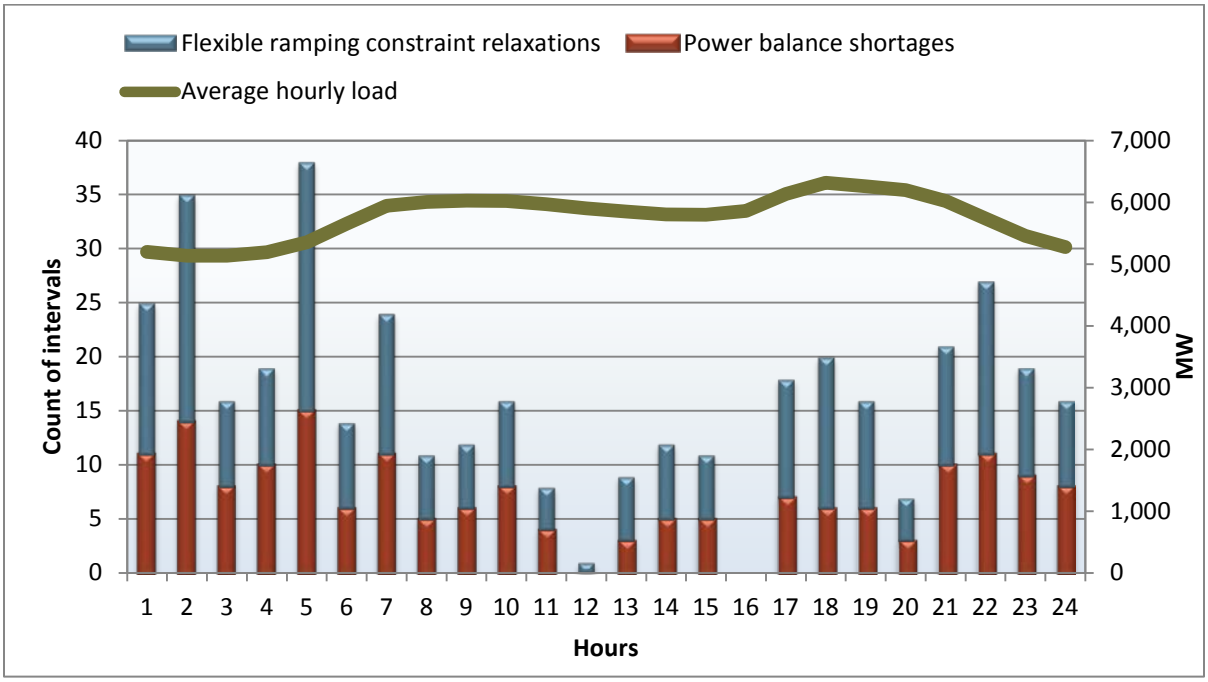


Figure 3.8 Constraint relaxation by operating hour (February 2015)
PacifiCorp East - 15-minute market

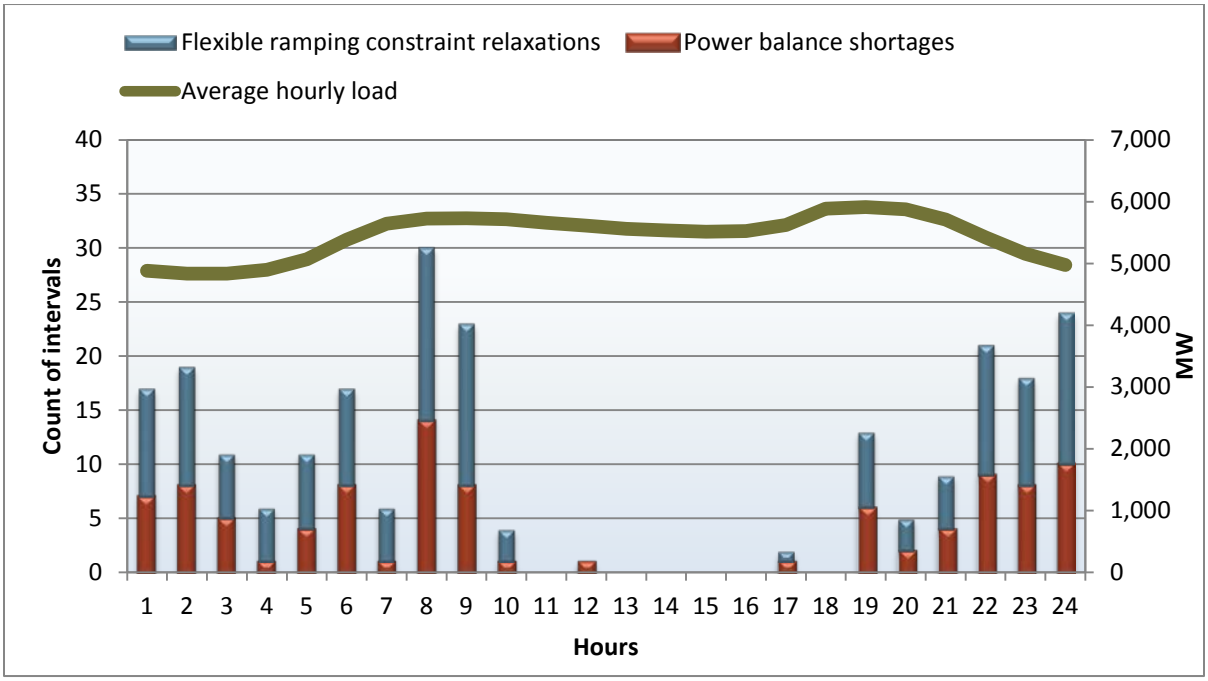


Figure 3.9 Constraint relaxation by operating hour (January 2015)
PacifiCorp West - 15-minute market

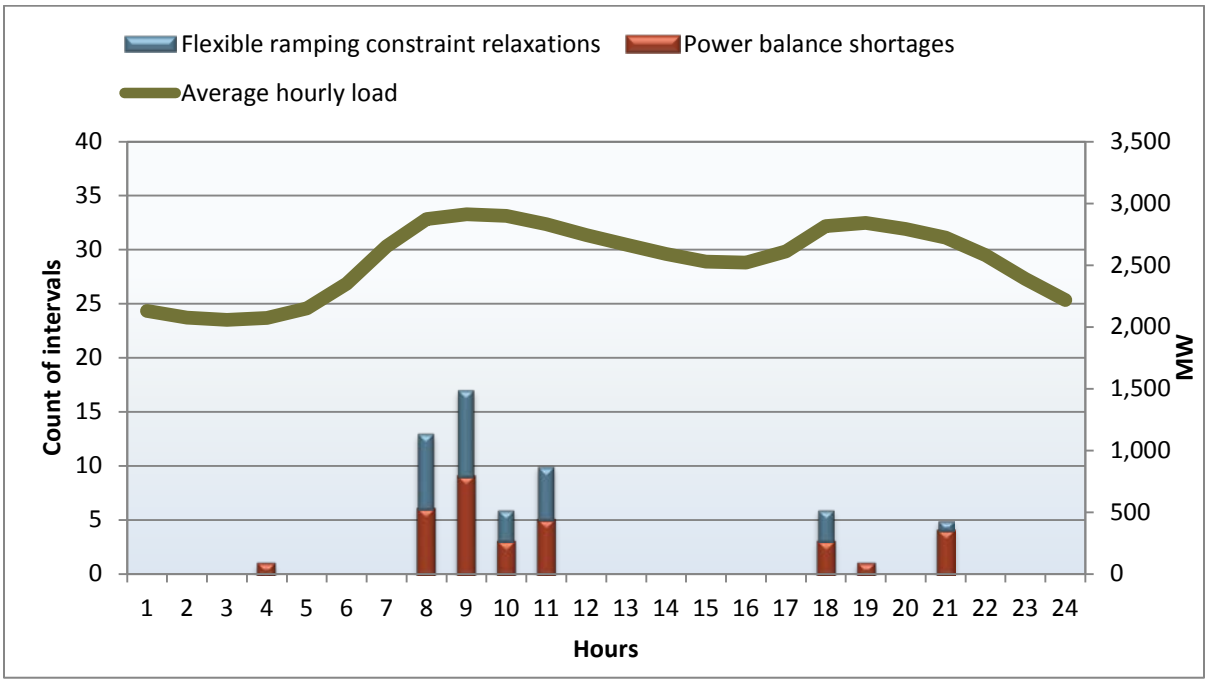
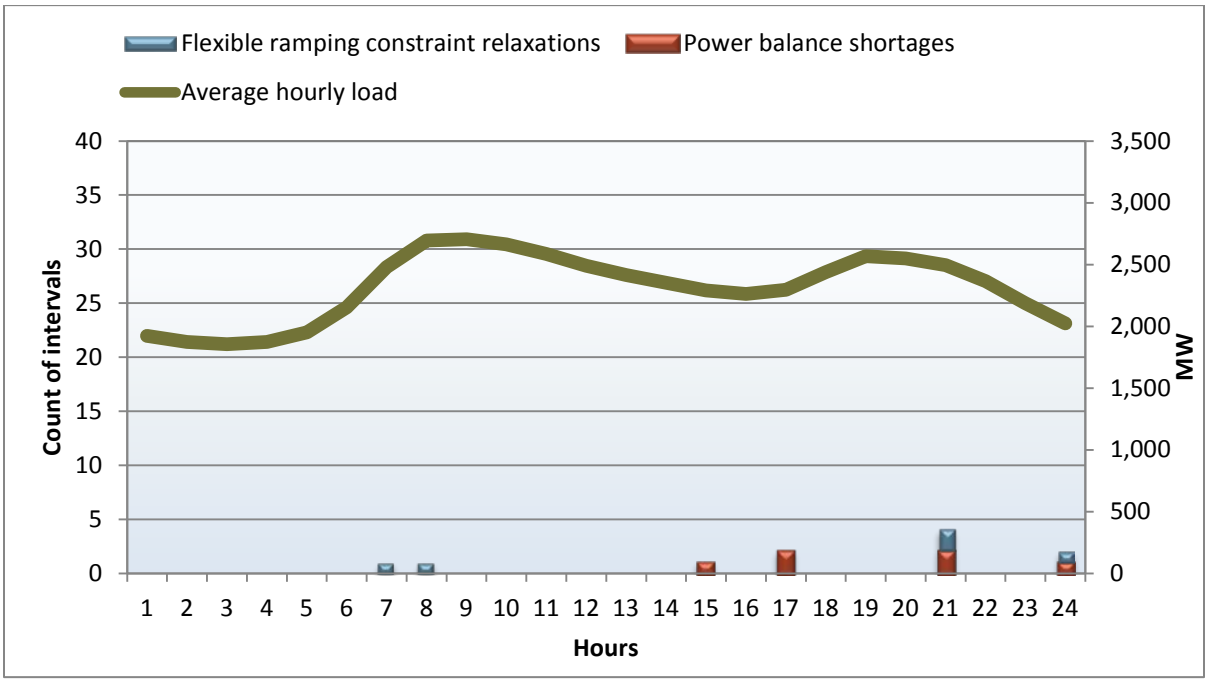


Figure 3.10 Constraint violations by operating hour (February 2015)
PacifiCorp West - 15-minute market



4 Resource schedules, bids and dispatches

This section provides a summary of the amount of capacity being scheduled, bid and dispatched in the EIM. As noted in DMM's prior reports, the amount of capacity bid into the EIM continues to generally exceed the amount of energy dispatched from EIM resources.

Figure 4.1 and Figure 4.2 show the total amount of gas and coal capacity participating in EIM from January through mid-March 2015, along with the portion of this capacity reported on outage. Outages have averaged as a higher percentage of resources in PacifiCorp East compared to PacifiCorp West.

Figure 4.3 and Figure 4.4 show the average amount of gas and coal capacity scheduled, bid and dispatched in PacifiCorp East and PacifiCorp West in the 15-minute market during January 2015 by operating hour.

- The red lines represent the average of total gas and coal capacity participating in EIM, which has remained constant since December 2014 (4,729 MW in PacifiCorp East and 3,171 MW in PacifiCorp West).[16]
- The black lines represent the average amount of this capacity that was available after accounting for outages and de-rates reported in the ISO outage system. DMM's review of reasons codes recorded in outage logs suggests that some of the outages may be due to generator restrictions, such as minimum off-line times and other operating limitations, rather than operational problems.
- The darker blue area represents the average base schedules for all gas and coal capacity from participating EIM resources by operating hour during January.
- The white line shows the average amount of gas and coal capacity bid-in and dispatched in the EIM 15-minute market.
- The green area shows DMM's estimate of the amount of undispatched bids available within a 15-minute ramp beyond the level at which units were actually dispatched in the 15-minute market.
- The yellow area shows DMM's estimate of the additional amount of undispatched bids available beyond a 15-minute ramping horizon.

This analysis differentiates the estimated level of bid-in capacity available on a 15-minute horizon (shown in green) from capacity that is bid-in but only available on a longer time-frame (shown in yellow), since much of the capacity shown in yellow may not be available for dispatch in response to many of the factors driving constraint violations in the EIM.

A more detailed discussion of the data in these figures was provided in DMM's prior reports.[17]

[16] The total capacity participating in EIM in PacifiCorp East and PacifiCorp West during each day in February 2015 is provided in Figure 4.1 and Figure 4.2, respectively.

[17] *Report on Energy Imbalance Market Issues and Performance*, March 3, 2015, Department of Market Monitoring, pp.24-27. http://www.caiso.com/Documents/Mar4_2015_DMMAssessment_EIMInformationalReport_Jan-Feb2015_ER15-402.pdf

Figure 4.1 Participating capacity and outages (gas and coal)
PacifiCorp East

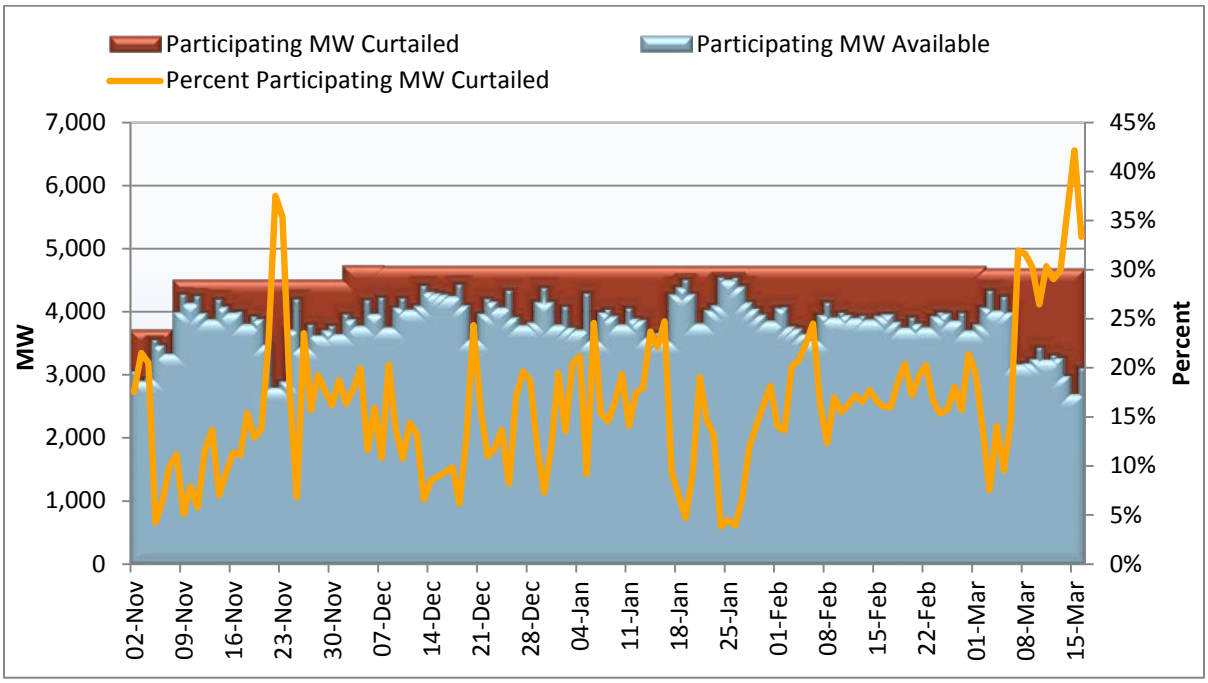


Figure 4.2 Participating capacity and outages (gas and coal)
PacifiCorp West

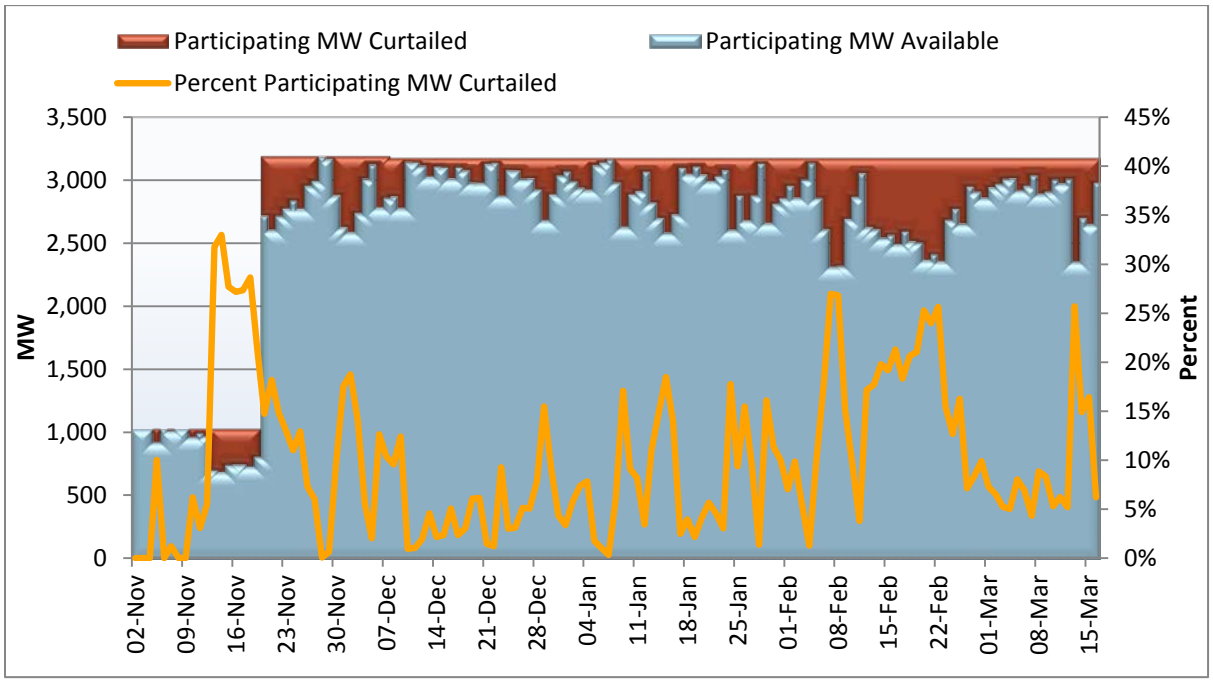


Figure 4.3 Average schedules, bids and dispatches by operating hour – February 2015
PacifiCorp East - 15-minute market (gas and coal units)

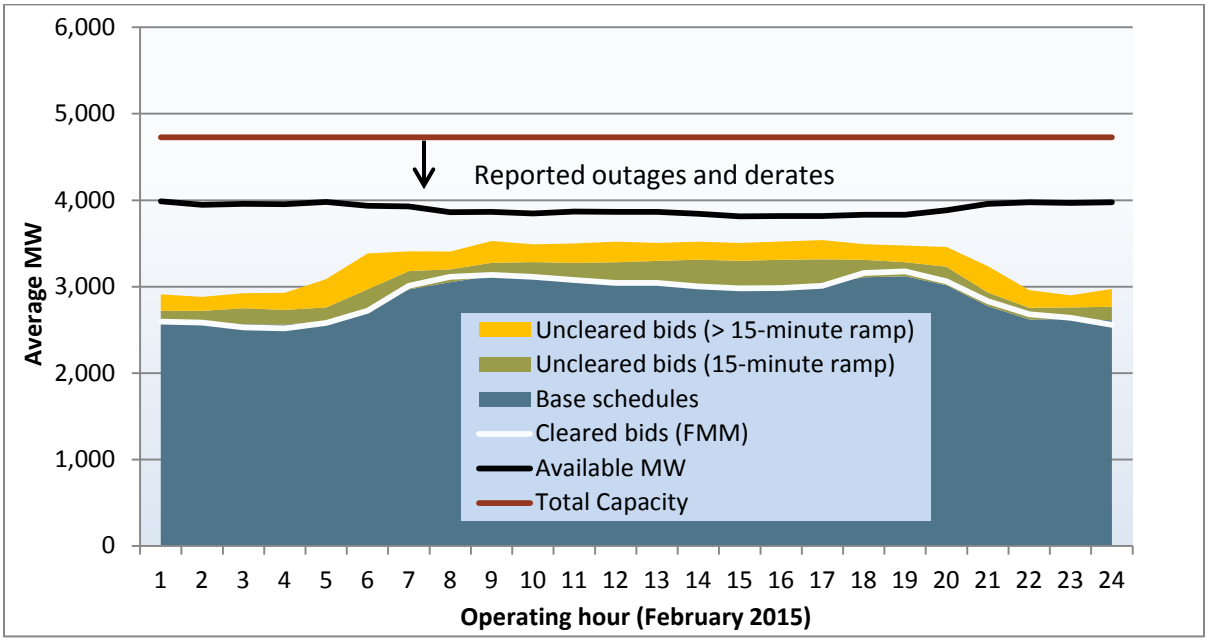


Figure 4.4 Average schedules, bids and dispatches by operating hour – February 2015
PacifiCorp West - 15-minute market (gas and coal units)

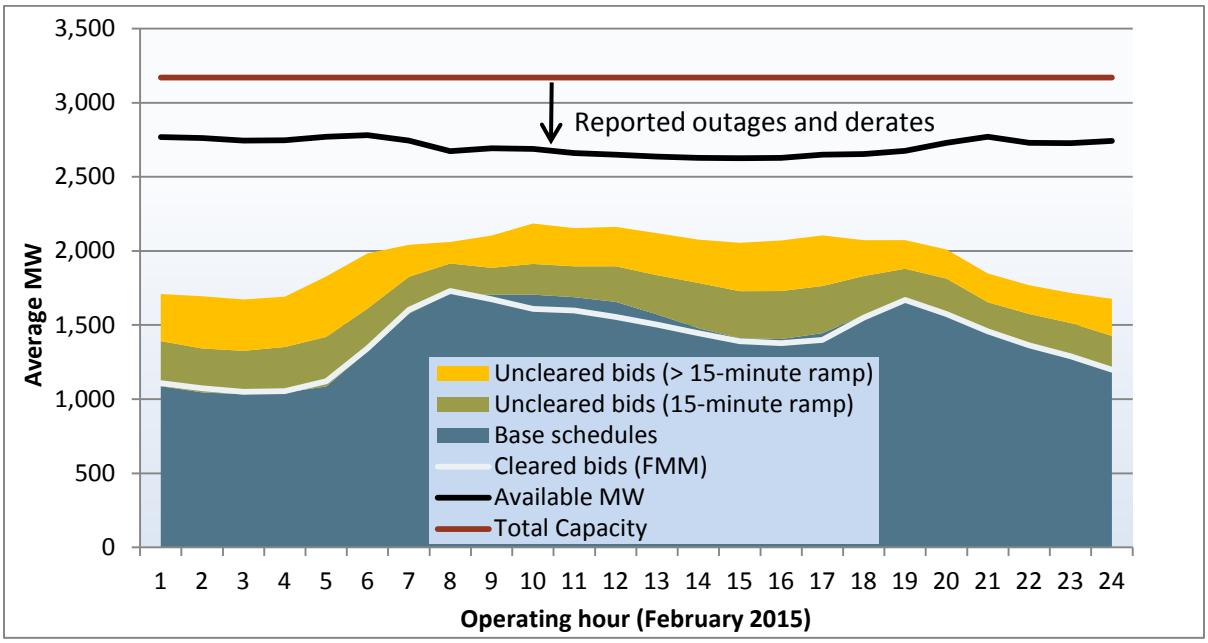


Table 4.1 provides a numerical summary of several metrics derived from the data underlying Figure 4.3 and Figure 4.4. As shown by this analysis, the amount of capacity bid into the EIM continued to generally exceed the amount of energy dispatched in most hours in February. There is generally more capacity scheduled during peak periods compared to off-peak periods, with significantly more unscheduled capacity in PacifiCorp West compared to PacifiCorp East. This is consistent with DMM's prior findings.

Table 4.1 Summary of average schedules, bids and dispatches for gas and coal capacity in EIM (February 2015)

	Percent of nameplate capacity scheduled	Percent of nameplate capacity scheduled+bid	Undispatched bids for incremental energy as percent of base schedules	Undispatched bids as percent of final 15-minute schedules	Undispatched bids as percent of total balancing area load
PacifiCorp East					
Peak	64%	73%	15%	15%	7.7%
Off-peak	55%	63%	15%	15%	7.7%
PacifiCorp West					
Peak	49%	64%	32%	32%	20%
Off-peak	36%	56%	53%	53%	31%

The major change in the summary data provided in Table 4.1 compared to results in prior reports is the amount of undispatched bids in the PacifiCorp East increased in February.

- The amount of undispatched bids for incremental energy averaged 15 percent of the total amount of energy scheduled and dispatched in the EIM from participating capacity during both peak and off-peak hours, compared to only about 11 percent during January.

- Undispatched bids for incremental energy averaged about 7.7 percent of the total load in the PacifiCorp East balancing area, compared to about 5.8 percent during peak-hours and 5.3 percent during off-peak hours in January.

This may reflect an increase in supply that may have played a role in helping to reduce the number of intervals the power balance constraint was relaxed in February and may also explain why power balance constraint relaxations are more common in PacifiCorp East relative to PacifiCorp West.

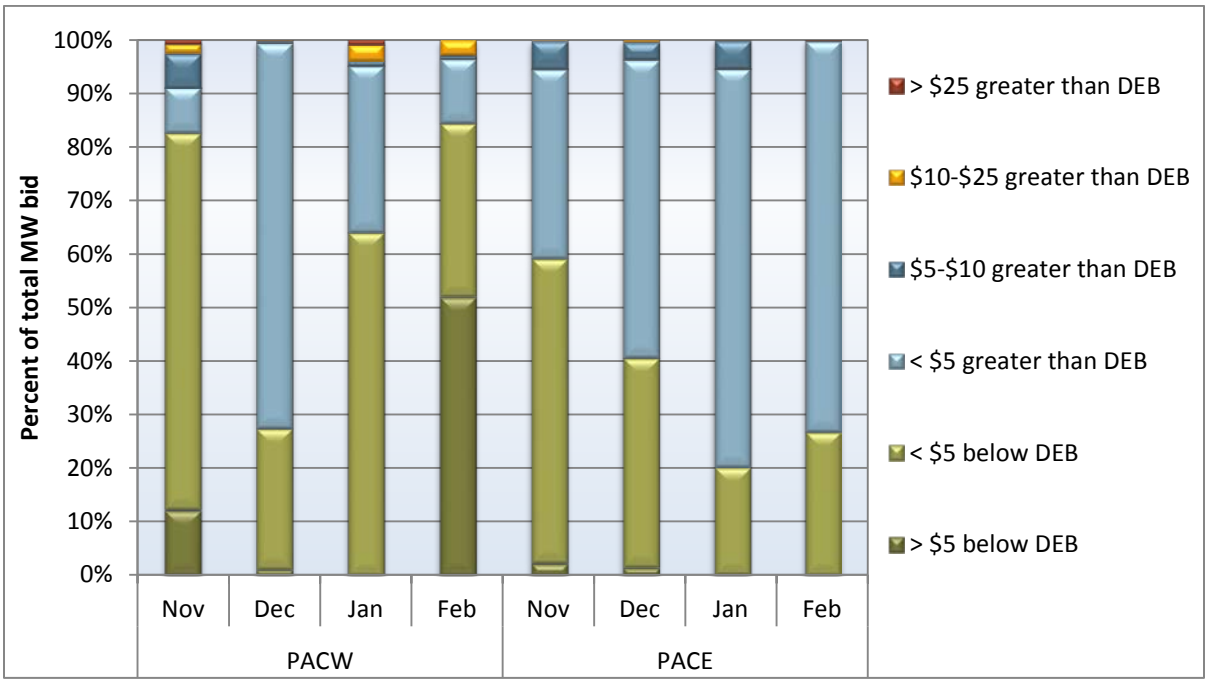
DMM recommends that the ISO consider how modifications to the flexible ramping constraint requirement might help increase the amount of supply available on a 15-minute and 5-minute basis in PacifiCorp East.

5 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 5.1 summarizes a comparison of bid prices in PacifiCorp East and PacifiCorp West for thermal and hydro units compared to default energy bids used in market power mitigation. 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 5.1 Comparison of market bids to default energy bids



6 Software enhancements

The ISO recently completed development of two software enhancements that DMM believes may significantly reduce the need for mitigation under the price discovery measure currently in place. The ISO's March 26 report briefly notes both of these issues. This section provides a more detailed explanation of these issues, along with results of DMM's empirical assessment of the potential impact these changes may have on EIM performance based on historical data.

Dynamic transfer capability

The ISO's March 26 report briefly notes that "the five-minute dynamic COI limits were recently increased for the off-peak hours but still very limited in peak hours."[18] In prior reports, both the ISO and DMM cited these limits as a major factor contributing to the need to relax the power balance constraint in the 5-minute market, particularly in PacifiCorp West.

During the first few months of EIM, the schedules of transfers between the PacifiCorp areas and the ISO were usually set in the 15-minute market, and then held fixed in 5-minute market. The reasons for the restrictions on changes in the 5-minute market relative to the 15- minute market result a few different factors. First, the Bonneville Power Administration (BPA), which manages COI, can only allow a limited amount of change over the COI in a five minute timeframe since it has to maintain reliability standards in other areas impacted by COI. These limits on changes made to schedules on a 5-minute basis are referred to as the dynamic transfer capability (DTC).

While BPA's dynamic transfer capability limits restrict changes in EIM transfer schedules in the 5-minute market, the limits enforced in EIM for the first few months were stricter, effectively allowing no changes to net transfers into or out of the PacifiCorp areas for most intervals. The stricter conditions were due to ISO software issues which have been addressed. Starting in February, the ISO completed software enhancements that allowed the EIM to take advantage of the available dynamic transfer capability over COI. Since early February, the DTC limits now allow 15-minute EIM transfer schedules on COI to be modified by about ±11MW during peak hours and about ±110 MW during off-peak hours.

To illustrate the potential impact of this enhancement, DMM analyzed power balance relaxation events in the 5-minute market due to a dynamic transfer limit,[19] that occurred over the first three months of the EIM and estimated how many may have been avoided had the ISO systems been capable of including the available dynamic transfer capability in the market at all times. For this analysis, we compared the size of the power balance relaxation to the increase in 5-minute EIM transfers that would have been available from the ISO into PacifiCorp under current dynamic transfer limits (about +11 MW during peak hours and about +110 MW during off-peak hours). If the magnitude of the power balance

[18] See Category 9: EIM Transfer Limits, Issue 1: Static and dynamic transfer limit restrictions on California-Oregon Interties (COI), column labeled *Remedial Action and Status*, on pp. 36-37 of the ISO's March 26, 2015 report.

[19] We first evaluated whether each power balance constraint relaxation was due to a physical transfer limit or a dynamic one. Physical limits are the limits on transfers that are enforced in all markets, including the 15-minute and 5-minue markets. The dynamic limits only constrain changes in the 5-minute market relative to the 15-minute market.

constraint relaxation was less than the potential increase in 5-minute transfers from the ISO into PacifiCorp under the new level of the dynamic transfer limit, this suggests that the power balance relaxation could have been avoided it if the new limits were in effect.

Results of this analysis are summarized in Figure 6.1 and Figure 6.2. As shown in Figure 6.1:

- Over the first three months of EIM, during about 30 percent of the intervals in which the power balance was relaxed in the 5-minute market in PacifiCorp West, the magnitude of the power balance relaxation was less than current dynamic transfer limits (about +11 MW during peak hours and about +110 MW during off-peak hours).
- This suggests that in PacifiCorp West, incorporating the full amount of additional transfers from the ISO in the 5-minute market under current dynamic transfer limits may have a significant impact on reducing power balance relaxation.

As shown in Figure 6.2:

- Over the first three months of EIM, the magnitude of the power balance relaxation was less than current DTC limits during about 6 percent of the intervals in which the power balance was relaxed in the 5-minute market in PacifiCorp East.
- These results reflect the fact that additional supply available in the 5-minute market due to current dynamic transfer limits is much lower in PacifiCorp East since this area is not directly connected to the ISO and is only indirectly effected by increased supply from the ISO over the COI.

As noted in the ISO's reports, the ISO continues to work with Bonneville Power Administration in an effort to further study and understand the nature and allocation of dynamic 5-minute limits, with the goal of eventually increasing these if possible.

Figure 6.1 Potential power balance relaxations in 5-minute market mitigated by new DTC limits PacifiCorp West (November 3, 2014 through February 3, 2015)

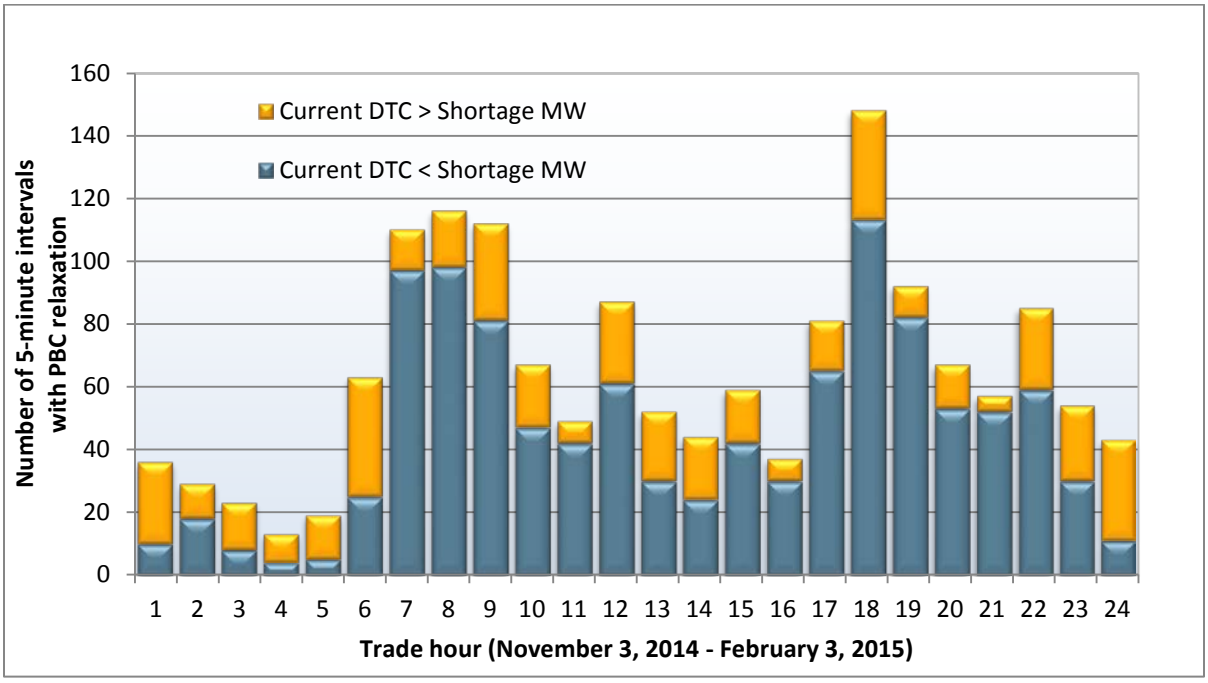
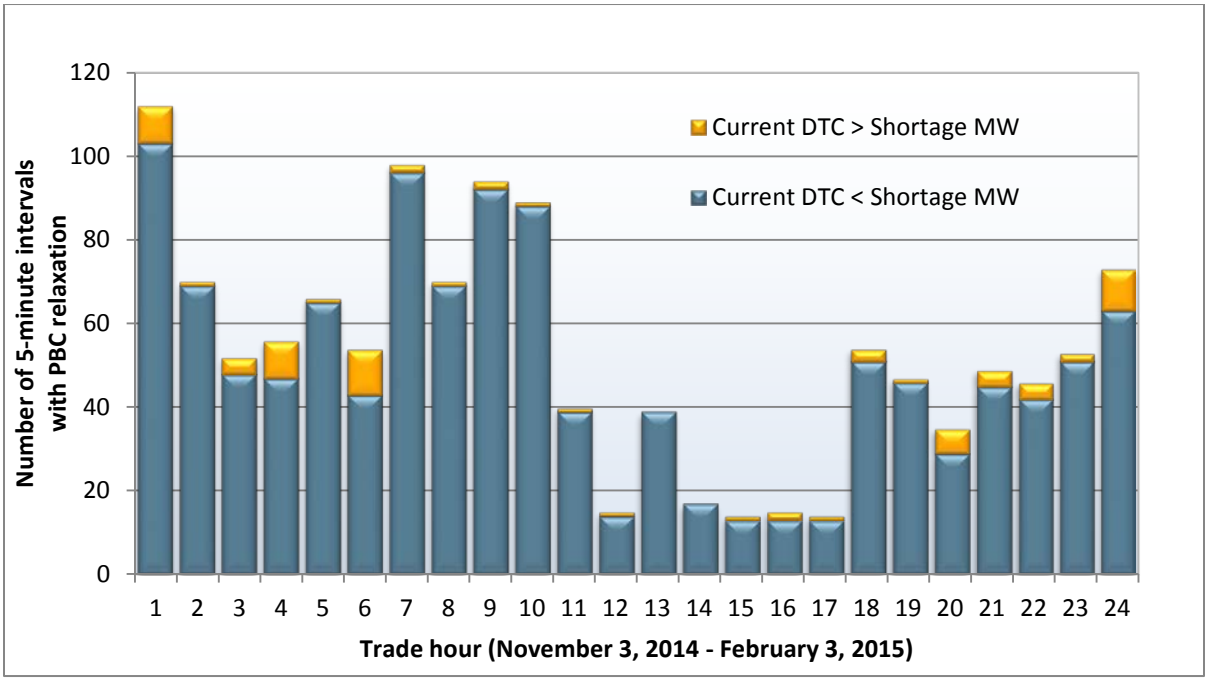


Figure 6.2 Potential power balance relaxations in 5-minute market mitigated by new DTC limits PacifiCorp East (November 3, 2014 through February 3, 2015)



Load bias limiter

The ISO's March 26 report briefly notes that the ISO is prepared to implement a software enhancement in the EIM that is currently in place in the ISO real-time market that would mitigate the impacts of excessive load biasing in the pricing run.[20]

This software functionality is called the *load bias limiter*. The purpose of this software is to ensure that an excessive load bias entered by the grid operator does not cause the total modeled load to exceed the amount of available ramping capacity available for dispatch by the market software. This feature adjusts the load bias used in the pricing run downward in cases when the load bias entered by the grid operator contributed to a supply insufficiency in the scheduling run.[21] When this feature is triggered between the scheduling and pricing runs, it has the same impact as the current price discovery feature: prices are then set by the highest cost supply dispatched to meet demand.

As described in DMM's 2012 Annual Report, this feature was expected to have a significant impact on reducing the frequency of price spikes due to power balance constraint relaxation after being implemented in the ISO market in December 2012.[22] Analysis by DMM of EIM results for the month of February indicates that the load bias limiter as used in the ISO area would have eliminated supply shortages in the pricing run by about 50 percent.

- In PacifiCorp East, DMM's analysis showed that the load bias limiter feature would have been triggered in the pricing run to mitigate price impacts during 63 percent of 15-mintue intervals and 53 percent of 5-minute intervals when power balance relaxations occurred in the scheduling run in February.
- In PacifiCorp West, DMM's analysis showed that the load bias limiter feature would have been triggered in the pricing run to mitigate price impacts during about 40 percent of 15-mintue intervals and 50 percent of 5-minute intervals when power balance relaxations occurred in the scheduling run in February.

Thus, DMM expects this feature will have a significant impact on reducing the impact of power balance constraint relaxation on prices when implemented in the EIM.

The ISO has indicated it plans to implement this load bias limiter in the EIM after the price discovery feature currently in place expires. DMM is recommending that the ISO begin to report on the portion of intervals in which power balance relaxations would be mitigated by the load bias limiter feature after expiration of the price discovery measures currently in place.

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[20] See Category 5 (Load Forecast Accuracy, Issue 1 (Load forecast biasing), which notes under the column labeled *Remedial Action and Status* that "CAISO will be implementing software functionality to limit erroneous excessive load bias, similar to logic used for CAISO operator bias of load …" (March 26, 2015 Report, p. 31).

[21] For instance, assume the grid operator had entered a 100 MW upward load bias for an interval. The load limiter bias adjustment if triggered if the power balance constraint is relaxed less than 100 MW during this interval. For instance, if the power balance constraint is relaxed by 70 MW in the scheduling run with the 100 MW upward load bias in effect, the load used in the pricing run is adjusted to reflect only a 30 MW upward load bias. This effectively limits the upward load bias in the pricing run to the amount of supply bids actually available to the market software given ramping and other constraint (100 MW bias – 70 MW relaxation = 30 MW of available supply).

[22] *2012 Annual Report on Market Issues and Performance*, ISO Department of Market Monitoring, April 2013, p. 189. http://www.caiso.com/Documents/2012AnnualReport-MarketIssue-Performance.pdf.

DMM has also provided the ISO with a recommendation on how the load bias limiter feature might be enhanced to better reflect the impact of excessive load bias adjustments on creating power balance shortages. Specifically, DMM has recommended basing the adjustment on the *change* in load bias from one interval to the next instead of on the *absolute value* of any positive load bias.

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 2nd day of April, 2015.

/s/ Anna Pascuzzo

Anna Pascuzzo