

July 14, 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\_\_\_\_  
May 2015 Informational Report  
Energy Imbalance Market - Price Waiver Report**

Dear Secretary Bose:

The California Independent System Operator Corporation (CAISO) hereby submits its report on the performance of the Energy Imbalance Market for May 1 – May 31, 2015.<sup>1</sup>

The Commission also directed the Department of Market Monitoring to submit independent assessments on the causes and solutions identified by CAISO. The CAISO intends to submit the independent assessment of the Department of Market Monitoring in about eight days.

The CAISO will continue filing such reports consistent with the Commission's order to continue submitting reports on a 30 day interval until the 206 investigation is concluded or the Commission issues a directive, whichever is earlier.

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

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Please contact the undersigned with any questions.

Respectfully submitted

**By: /s/ Anna A. McKenna**

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# California ISO

**Energy Imbalance Market  
Pricing Waiver Report  
May 1 – May 31, 2015**

July 14, 2015

## I. Introduction and Background

On December 1, 2014, the Federal Energy Regulatory Commission (FERC) granted the California Independent System Operator Corporation's (CAISO) petition for limited waiver of the pricing parameters in sections 27.4.3.2 and 27.4.3.4 of its tariff for 90 days, as they pertain to the Energy Imbalance Market (EIM), effective November 14, 2014, as requested.<sup>1</sup> In addition, FERC directed CAISO to submit informational reports as further described. The CAISO will submit monthly the requested reports in Attachments A through E. This report covers the CAISO's reporting requirements for May 1 through May 31, 2015.

The Commission also directed the Department of Market Monitoring (DMM) to submit independent assessments on the causes and solutions identified by CAISO. The DMM requires some additional days to fully review and evaluate the CAISO's report and provide an independent assessment. The DMM will file its report within approximately eight days of the CAISO having filed this report.

On November 1, 2014, the CAISO fully activated the EIM. The EIM allows balancing authorities outside of the CAISO balancing authority area to participate voluntarily in the imbalance energy portion of the CAISO locational marginal price-based real-time market. PacifiCorp, the CAISO, and market participants participated in market simulations prior to the start of the EIM on November 1, including parallel production from October 1 to November 1. However, shortly after go live the CAISO observed challenges that led to artificially high prices where the market application had to relax transmission constraints or the power balance constraint to clear the market.

On November 13, 2014, the CAISO sought a 90-day waiver of the applicability of section 27.4.3.2 and the second sentence of section 27.4.3.4 of its tariff to permit CAISO to address, without suspending the EIM, those circumstances which produced atypically high prices. Those two sections of the tariff require that when there is a lack of economic bids, considering resource ramping and other constraints, to clear the fifteen-minute and five-minute markets, the CAISO's market will price the shortages (and therefore establish locational marginal prices) based on the pricing parameters specified in those sections. The pricing parameter is \$1,000/MWh (the maximum energy bid price specified in tariff section 39.6.1.1).

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<sup>1</sup> *California Indep. Sys. Operator Corp.*, 149 FERC ¶ 61,194 (2014) (December 1 Order).

The waiver addresses three sets of transitional conditions in the EIM that together have caused the transmission and system energy-balance constraints described in tariff sections 27.4.3.2 and 27.4.3.4 to bind more frequently than expected in the weeks since the EIM began operation on November 1, causing prices in these intervals to be set by the \$1,000/MWh relaxation parameter. Because of these transitional conditions, the high prices are not always indicative of actual physical conditions on the system, and reflect challenges in providing timely and complete data to ensure system visibility under the new procedures, exacerbated by limitations on the resources available to PacifiCorp for the EIM and several forced outages of large EIM participating resources.

On December 1, 2014, FERC granted the CAISO its waiver request and directed monthly reports to FERC on the progress of the issues that led to the need for the waiver. On February 12, 2015, the Commission extended the term of this waiver to March 16, 2015, in its order issued in FERC Docket ER15-861.<sup>2</sup>

On March 16, 2015, the Commission again extended the waiver to 90 days after the date on which the Commission's order issued on March 16, 2015, in FERC Docket No. ER15-861 is registered in the Federal Register (June 22, 2015).<sup>3</sup> In the March 16 order, the Commission also directed the CAISO to refine the monthly reports to "assist the Commission and the parties in determining the extent to which the price spikes continue to be caused by transitional issues, and the extent to which they may be triggered by lack of adequate supply in the EIM."<sup>4</sup> This report includes the following additional information requested by the Commission in its March 16 order:

... identify, for each such event, whether the cause was due to transitional issues or was due to insufficient supply of resources bid into the EIM.

... clarify the information presented in the tables included in Attachment A, Section 2 of the future reports. At a minimum, the clarifications should: (1) differentiate supply deficiencies from transitional issues; (2) provide concise information on required remedial measures, execution responsibility, completion time frame and status; and (3) provide transparent identification of the frequency and market impact of each root cause issue.

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<sup>2</sup> *California Indep. Sys. Operator Corp.*, 150 FERC ¶ 61,086 (2015).

<sup>3</sup> *California Indep. Sys. Operator Corp.*, 150 FERC ¶ 61,191 (2015).

<sup>4</sup> See 150 FERC ¶ 61,191 at P 38.

... identify any [...] seasonal challenges that occur during the reporting period, and describe the operational or business process revisions planned or implemented, as applicable, to address such issues.

The CAISO will continue filing such reports monthly consistent with the Commission's order to continue submitting reports on a 30-day interval until the 206 investigation is concluded or the Commission issues a directive, whichever is earlier.

## II. Reports

**Attachment A:** Provides a quantitative and qualitative description of the issues that prompted the CAISO's waiver request and those observed during the reporting period. This attachment also reports on any such seasonal challenges that occur during the reporting period.

**Attachment B:** Identifies any remedial measures, execution responsibility, completion timeline, and status for the category of issues identified above.

**Attachment C:** Provides a description of each relaxation event and a summary of the magnitude and frequency of such events overall, and data on instances where the \$1,000/MWh price would have occurred but for this waiver. This attachment also identifies the frequency and market impact of each root cause issue.

**Attachment D:** Provides a quantitative and qualitative analysis of the market performance impact of the issues that prompted the CAISO's request for a waiver.

**Attachment E:** Provides a summary of the magnitude and frequency of the post implementation issues described in Attachment A overall.

## ATTACHMENT A

### **Quantitative and qualitative descriptions of market performance related to the issues that prompted the CAISO's waiver request - CAISO.**

This attachment describes the issues that prompted the CAISO to file for the pricing waiver and those observed during the term of the waiver. This attachment also reports on any such seasonal challenges that occurred during the reporting period.

#### **A. Qualitative Description of Issues**

The CAISO and the EIM entity have evaluated each interval of infeasibility to determine the root cause of the infeasibility. There are seven categories of issues observed. Each interval of infeasibility may be the product of one or more category of issues. Sometimes, a single reason may drive an infeasibility; but in some cases, a combination of a number of conditions led to the infeasibility. Therefore, it is not possible to identify a single cause for each infeasibility. However, to provide meaningful reports, the CAISO identified what appears to be the most prevalent issue that gave rise to the infeasibility in each interval and assigned the interval to that category. The reports included in this submission qualify and quantify the issues according to these categories, which are as described below:

#### **1. Renewable Deviations**

The *Renewable Deviations* category identifies intervals in which the infeasibilities were primarily due to wind and/or solar output deviations from the resource's hourly base schedules that led to the loss of capacity and the need to increase generation from other resources. These types of deviations were beyond deviations the flexible ramping requirement could resolve by the available system ramping capacity. In some cases, there were significant deviations between wind forecasts and the resource's actual output over a period of a number of days. The CAISO utilizes the wind forecast as an indicator of the maximum level to which it can dispatch the resource. If the forecast is significantly flawed, this can create discrepancies between the wind resource's actual output and their forecast. The accuracy of the forecast is dependent on the accuracy of telemetry, which in some cases was problematic. Such issues caused energy imbalance, over-generation, or under-generation conditions as observed by the market systems, leading to infeasibilities.

## 2. Load Changes

The *Load Changes* category identifies those intervals in which the infeasibility was predominately due to either problematic operator adjustments of load forecasts or changes to those adjustments. The EIM entity grid operators can adjust (or “bias”) the load forecast for reliability to account for any non-modeled issues causing discrepancies between forecast load and actual load in real-time. The operator can make these adjustments after the base schedules are submitted. The operator sets the bias based on his/her judgment of system operational and reliability needs. In some cases, because operators make the adjustments manually, they make these adjustments at a less granular level than is precisely necessary to consider the capability of the system. For example, the operator believes it needs to make an adjustment of 100 MWs due to load changes in real-time. However, because the system is ramp constrained, the operator should make an adjustment of 100.5 MWs to obtain the extra capacity needed to address the system ramp limitations, which is not possible because the operator cannot observe the ramp constrained nature of the system.

In some cases, the load forecast issues were caused by the practice of including large industrial load forecasts in the EIM total load forecast. The EIM entity can adjust these large-scale industrial loads as part of an interruptible load program to balance its system. Prior to April 1, these demand resources were included in the total balancing area load forecast and treated as conforming load, although these loads are non-conforming and independent from the regular conforming loads. After April 1, the CAISO excluded the large industrial load forecast from the total forecast and instead modeled these demand resources as participating resources. This allows the EIM entity to account for their contribution to total supply more effectively and adjust supply as needed.

Distributed energy resources are also included in the market load forecast as conforming load. These resources have both load and generation components, which net to a positive or negative net injection at the load bus. The market systems do not see when these resources are generating and therefore it accounts for more load than what is actually occurring in real time operations. The lack of base schedules for such resources further prevents the market from observing the impact of their output in the market systems.

## 3. Import/Export Changes

The *Import/Export Changes* category identifies intervals in which the infeasibilities were primarily due to the lack of visibility in the market systems of updates to imports and exports schedules or adjustments made for such updates after the deadline for submitting base schedules at forty minutes before the



trading hour (T-40). When the CAISO performs the balancing test, the market systems assume that the import and/or export base schedules transactions will materialize. For example, the feasibility test assumes that an import base schedule of 600 MW will be delivered. However, after the deadline for submitting base schedules has passed, *i.e.*, after T-40, only 300 MW is actually tagged, which can be done up to T-20. If market systems do not see sufficient capacity to cover the difference of 300 MW, the power balance constraint will be relaxed and trigger the parameter based pricing.

#### **4. Resource Outages**

The *Resource Outages* category identifies intervals in which the infeasibilities were primarily due to outages of supply resources that resulted in loss of capacity observed in the fifteen or five minute market which had been previously identified as available. Sometimes there was untimely or inaccurate communication of outage cancellations, which led to the market systems to perceive insufficient supply. When resources experience full or partial forced outages, the market must be informed in a timely manner of the outage event and the corresponding grid operator measures taken to compensate for the lost megawatt capacity.

The timing in which the EIM entity reports the outage is very important. If the outage occurred before T-75 (*i.e.*, seventy-five minutes before the trading or operating hour) and the entity expects it to last during the operating hour, then it should adjust both the economic bid and base schedule to account for the outage. Otherwise, the assumptions and data used by the market application for the balance test and the look-ahead fifteen-minute market contradict real-time system conditions, which results in less capacity available to the EIM than what was computed before the start of the operating hour, and high prices are imminent due to limited unloaded economic capacity offered into the market.

Sometimes the issues identified in this category are due to purely physical outages such as unit trips, which the market systems may observe through telemetry. However, at times the market systems are not informed of the actions taken by the EIM entity to replace that loss of supply. This results in a perception of insufficiency when none exists because the operator deployed operating reserve or curtailed industrial load but the information was not conveyed to the market.

The CAISO does not approve or reject outages of resources in the EIM entity balancing authority area. However, the EIM entity must provide outage information of EIM participating and non-participating resources in a timely and accurate manner. The CAISO incorporates the outage information submitted by the EIM entity into the real-time market to ensure the market clears on the most accurate outage information available.

Because the EIM entity remains in control of the outage approval process, the outages may be unrelated to actual physical conditions. In some cases, the EIM entity may submit an out-of-service or MW range restriction outage on a resource as it moves capacity around to manage its contingency reserves and takes corresponding manual dispatch actions. However, if the manual dispatch actions are not conveyed timely and correctly, the market software might observe an infeasibility when in reality the EIM entity is sufficiently resourced.

## **5. Manual Dispatches**

The *Manual Dispatches* category identifies intervals in which the infeasibility was predominantly due to a manual dispatch action taken by the EIM entity. For example, when system operating conditions for a resource change in real time after the resource's base schedule is submitted, the EIM entity may submit a manual dispatch indicating the maximum capacity to which the resource may be dispatched, which would reduce the available capacity to the market but it is more representative of actual system operating conditions. The manual dispatches are in the form of a fixed megawatt value instruction, a minimum megawatt value, a maximum megawatt value, a start-up instruction, or a shut-down instruction. The EIM entity performs Manual Dispatches to address resource bid issues, market system issues, outage management system issues, reliability needs, reserve sharing events, or variable energy forecast deviations that occur after the deadline for submission of base schedules to maintain the reliability of the balancing authority area. The balancing test does not recognize the manual dispatch information, because it occurs after T-75 but before T-40. If the balanced schedules conflict with the manual dispatch, they may trigger an infeasibility.

## **6. Resource Data Alignment**

The *Resource Data Alignment* category identifies intervals where the infeasibilities were not due to any of the other categories, but in which the following issues were observed: 1) resources were deviating from their dispatch, 2) there were differences between base schedules and bids or dispatch operating targets, and 3) multi-stage resources were operating in configurations that contradicted their base schedules. In addition, sometimes, multi-stage resources had large overlapping ranges and long transition times, which created physical infeasibilities and limited the range of flexibility for the market to move the resource.

Many of these issues were driven by the EIM entity transitioning to a new market paradigm and learning how best to manage its fleet within the new

paradigm using a series of complex systems. For example, initially the EIM entity believed it had registered the characteristics of its multi-stage generating resources consistent with how it intended the units to operate. Multi-stage generating resources have multiple configurations that the operator must carefully manage in the real-time market. The scheduling coordinator registers the configuration characteristics in the master file and the market applications observe and honor them. These include physical, registered characteristics such as transition time, minimum up time and minimum down time, and minimum capacity (Pmin) and maximum capacity output (Pmax) MWs and any overlapping MW regions between configurations. If a configuration is out of service, the EIM entity must submit a timely outage card to inform the market that the corresponding economic bid or base schedule is not available and another configuration is. If it does not perform this task promptly and accurately, or bids do not exist on other configurations, then the market cannot move the resource to other configurations and fails to account for the plant's full available capacity. Through actual operations experience and the EIM entity's evaluation of the dispatch solutions over time, PacifiCorp learned that it should model certain resources differently to allow the market systems to move the resources more efficiently. PacifiCorp modified its practices to find workable market solutions within the technical feasibilities of its resources, and the technical boundaries of the CAISO market features.

On occasion, resources were seen to be deviating from their market dispatch signal because either 1) the plant was unavailable, 2) an outage ticket was not entered on time, or 3) there was a delay in setting the plant on automatic generation control to be dispatched directly from the market signal. Sometimes it was necessary for the EIM entity to make direct phone calls to plant operators to communicate the market signal to move the resource up or down according to the plant's market dispatch signal, which was problematic because these actions take time and are manual in nature.

The EIM entity is sending telemetry values for all PacifiCorp resources registered in the master file. When the quality of the telemetry values is poor, the state estimator solution quality is negatively impacted, which affects the quality of the market solution and the dispatch operating targets of these resources. During the first few weeks of operation, the CAISO found that some resources had telemetry measurements of their auxiliary load and others had gross telemetry measurements that did not include the auxiliary load. In addition, certain wind resources and other small non-participating resources did not have telemetry at all.

The energy management system (EMS) and automatic generation control (AGC) monitors and accounts for the energy of multi-stage generating resources during the startup and shutdown periods when their output is below the PMin.

However, the market does not account for this energy because it is below the PMin of the resource. This creates a discrepancy in the load balance test, and the imbalance calculations between market and actual conditions as seen by AGC, which led grid operators to bias the load forecast.

## **7. Transfer/Congestion Constraints**

The *Transfer/Congestion Constraints* category identifies intervals in which the infeasibility was primarily due to the interplay of EIM transfer constraints or congestion in either a PacifiCorp balancing authority area or the CAISO's balancing authority area, which restrict the incremental generation of resources.

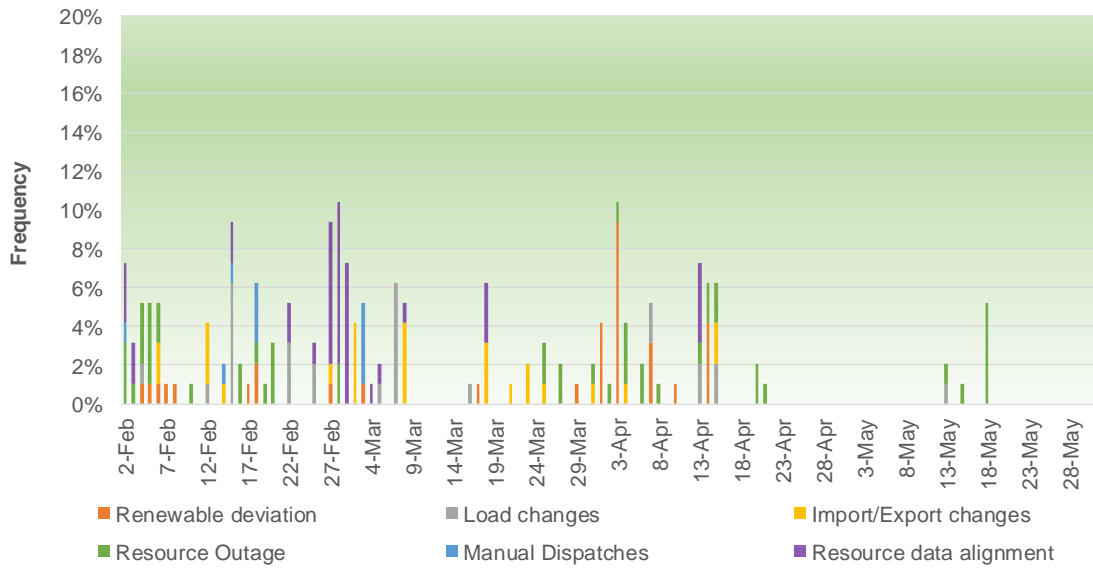
The EIM re-optimizes the EIM transfer capacity in both the fifteen-minute and five-minute markets. Regarding the California Oregon Intertie, the added restriction of the dynamic five-minute limit, which is an incremental limit around the fifteen-minute solution, may create infeasibilities. The five-minute dynamic limit constrains the market application from fully re-optimizing the fifteen-minute EIM transfer beyond the amount allowed by the five-minute incremental dynamic limit, which is especially restrictive during on-peak hours.

In addition, the rate-of-change constraints across the Bonneville Power Administration (BPA) network are five-minute flow limit constraints that limit five-minute movement of PacifiCorp West balancing authority area participating resources around the corresponding resources' fifteen-minute schedules due to their flow impact on certain paths and flowgates internal to the BPA balancing authority area. This restriction on the resources' five-minute movements or the corresponding rate-of-change constraint at times created infeasibilities on the affected resources when the corresponding path or flowgate five-minute limit constraint is binding.

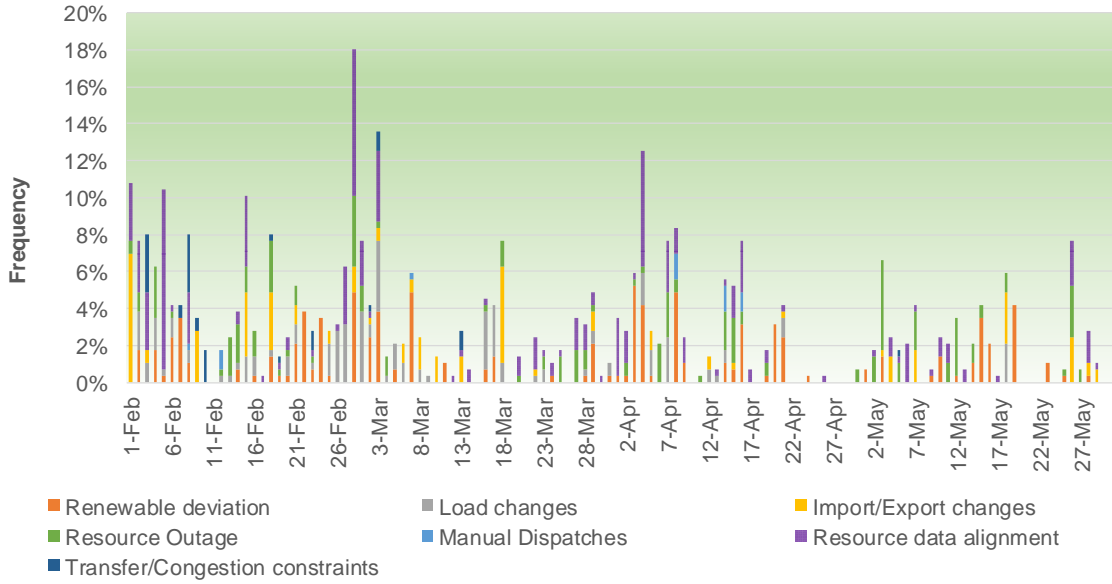
### **B. Frequency with Which Issues Caused Infeasibilities**

Figure 1 through Figure 4 show the frequency with which each of the categories of issues discussed above caused price excursions in both the fifteen and five-minute markets. In any market interval, more than one category of issues may have contributed to the price excursion because there are numerous elements at play in any given market run that can influence its outcome. However, as discussed above, the CAISO determined which of the categories of issues was most prevalent in each interval and assigned it that category. The CAISO produced the frequency diagrams based on that data.

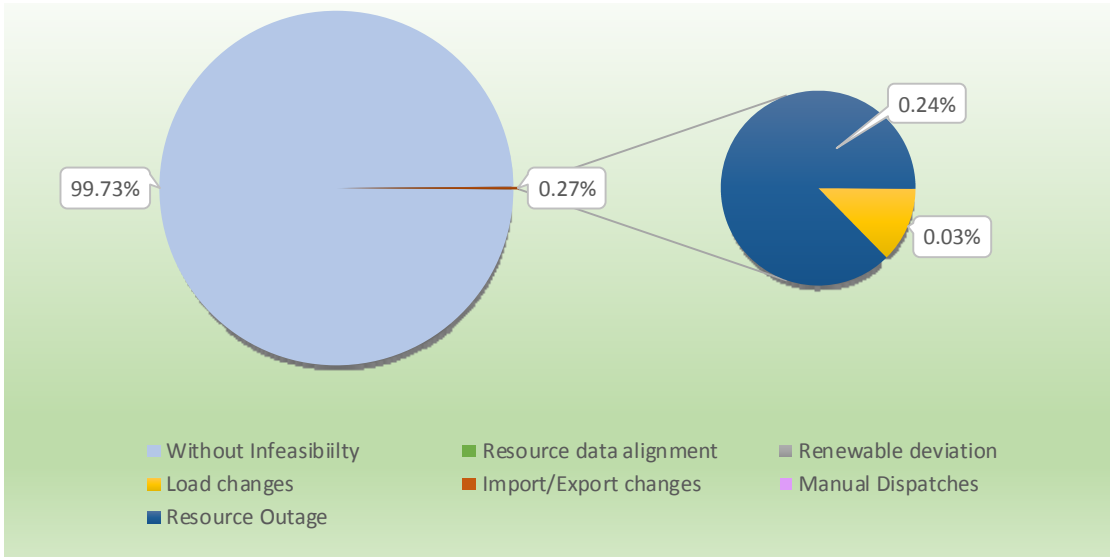
**Figure 1: Reasons for intervals with undersupply infeasibility in the fifteen-minute market in February 1 to May 31 - PAC West and PAC East combined.**



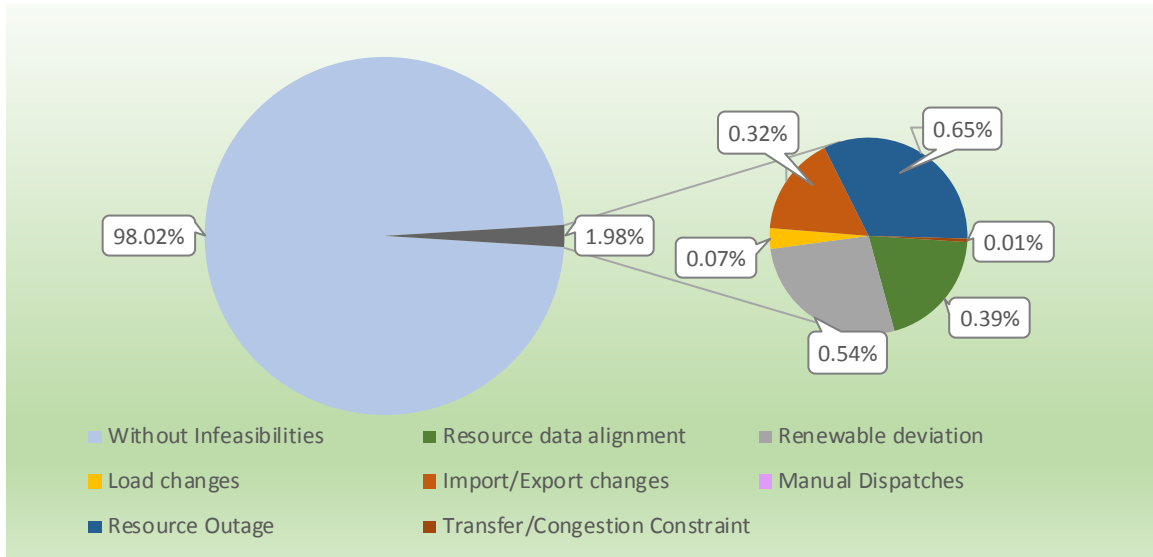
**Figure 2: Reasons for intervals with undersupply infeasibility in the five-minute market in February 1 to May 31 - PAC West and PAC East combined.**



**Figure 3: Frequency of undersupply infeasibility in the fifteen-minute market in May - PAC West and PAC East combined.**



**Figure 4: Frequency of undersupply infeasibility in the five-minute market in May - PAC West and PAC East combined.**





## ATTACHMENT B

### Remedial Actions

This attachment includes a report on measures already taken and planned to address the issues discussed above. This report also identifies any remaining deficiencies in processes, procedures, and tools and any additional market issues related to these pricing concerns that the CAISO considers necessary to sustain stable market operations, with the CAISO's plan to address such issues.<sup>5</sup>

**Table 1: Remedial Actions taken and planned by the CAISO and PacifiCorp**

<i>Number</i>	<i>Solution</i>	<i>Actions and Responsibility</i>	<i>Tariff Changes</i>	<i>Implementation Timeline</i>
1.	<i>Recognition of EIM entity operating practices in EIM market. This allows the market to recognize additional capacity available to the EIM entity, while still enabling the EIM entity to retain control over the management of this capacity for operational purposes.</i>	PacifiCorp changed its bidding and use of the outage reporting system to enable the EIM/RTM to recognize the use of the PacifiCorp's reserves (operating and regulation) and additional available capacity in operating its system. Leading to and through the initial stages of implementation, PacifiCorp designed the bid range of units to separate capacity associated with units holding contingency reserves from the bid range. This was based upon an assumption that contingency reserve obligations should be separately accounted for and that capacity	Will require enabling language for automated recognition of the additional capacity.  The CAISO presented the proposal at the April 9, 2015, technical conference and submitted the details of the proposal in comments on April	Effective at the beginning of April 2015, PacifiCorp has implemented the management of its contingency reserve through outage cards in both the PACW BAA and the PACE BAA.  The automated feature for recognition of the available capacity that can only be used inside the EIM BAA when it is short of supply is currently being developed and scheduled to be ready to implement mid to end of August 2015.

<sup>5</sup> December 1 Order at P 25.

Number	Solution	Actions and Responsibility	Tariff Changes	Implementation Timeline
		<p>associated with contingency reserves could not be made available. This had the unintentional consequence of overly restricting the capacity of these units when the market models assess potential infeasible market solutions and PacifiCorp’s ability to make operational adjustments to units required by real-time system conditions. The result of this approach was that the bid range and operational capacity of these units were essentially fixed for 75 minutes prior to the operating hour when EIM bids are due and during the operating hour (or approximately 135 minutes), even when system conditions changed.</p> <p>The current solution better approximates PacifiCorp’s actual contingency reserve management using outage cards. Currently, PacifiCorp bids full unit capacity into the market and control the dispatch of contingency reserves with outage cards (as well as through PacifiCorp’s EMS system). PacifiCorp continues to</p>	<p>23, 2015 in its initial comments in FERC Docket No. EL15-53.</p>	

Number	Solution	Actions and Responsibility	Tariff Changes	Implementation Timeline
		<p>meet its contingency reserve obligation by holding sufficient contingency reserves on its units, but is also able to convey adjustments that it makes to which units are carrying the reserves in real time through outage cards. For example, when reserves are deployed or shifted to other units, the associated outage card can be adjusted for reserves being deployed or transferred to other units. This allows for a more transparent, efficient and timely market awareness of contingency reserve management and the ability to increase the amount of capacity available to the EIM, without affecting PacifiCorp’s contingency reserve obligations.</p> <p>After further analysis of the post-implementation challenges, the CAISO and PacifiCorp have an enhanced appreciation of the importance of recognizing all available capacity in the market system, even though the EIM entity</p>		

Number	Solution	Actions and Responsibility	Tariff Changes	Implementation Timeline
		<p>retains full operational control of its resources.</p> <p>The CAISO and PacifiCorp also agree that it is necessary to develop procedures that will allow for the automatic recognition of the available capacity that can only be used within the balancing area when it is short of supply. The CAISO is developing functionality that will enable the EIM entity to reflect the full range of available capacity in the market but retain the ability to ensure the deployment of such capacity is limited to addressing infeasibilities in the EIM balancing area with no allowed transfer of this set aside energy outside the corresponding balancing area.</p>		
2.	<p><i>Refined management of multi-stage generating resources, and addition of multi-stage generation resources configurations</i></p>	<p>PacifiCorp and the CAISO continue to consult to understand better the quality of the dispatch solution based on the recorded characteristics of the multi-stage generating resources.</p> <p>PacifiCorp reviewed and redefined the registered parameters based on</p>	None identified.	<p>Complete.</p> <p>Based on better understanding of the definition of the multi-stage generation resources parameters, PacifiCorp continues to refine certain multi-stage generation resource parameters and adjust</p>

Number	Solution	Actions and Responsibility	Tariff Changes	Implementation Timeline
		<p>greater understanding of how the market dispatches those resources based on their configuration. PacifiCorp also defined additional configurations with smaller energy range to help balance their base schedules during startup and shutdown processes when the produced energy is below the previously registered PMin values.</p>		<p>transition times between resource configurations to reflect their physical characteristics.                      During the month of April, and throughout May, the CAISO implemented numerous market software fixes to handle transitions between configurations as well as during startup and shutdown. The CAISO has also added additional business logic in the software to protect against invalid Dispatch Operating Target instructions. The CAISO and PacifiCorp continue to review and evaluate performance of multi-stage generating resources.</p>
3.	<p><i>Account for start-up energy in balancing process</i></p>	<p>CAISO is developing a tool to enable better recognition of start-up profile for multi-stage generating resources.</p> <p>The CAISO is modeling the transition ramping for multi-stage generating resources and has scoped the requirements to add startup and shutdown profiles to the 15-minute market since these features are already in the 5-minute market.</p>	None identified	<p>PacifiCorp started bidding all configurations and maximized bid ranges in March 2015.</p> <p>CAISO is in the process of refining the startup and transition profile logic by introducing the two-segment approach. This is to better model the energy output during startup or transition. This feature is currently in design</p>

Number	Solution	Actions and Responsibility	Tariff Changes	Implementation Timeline
		<p>PacifiCorp is in the process of collecting data to define the startup and shutdown profiles for many of the resources with high PMin values. PacifiCorp has also made improvements to the bid configurations of PacifiCorp EIM Participating Resources in order to maximize fully the bid range available to the market. This includes recognizing start-up hours for CCGT plants, working to bid in all possible plant operating configurations and accounting for reserves to reflect fully the operational capability to respond to real-time market conditions.</p>		<p>phase.</p>
<p><b>4.</b></p>	<p><i>Effort to improve consistency interchange schedule tags and base schedules</i></p>	<p>PacifiCorp reviewed its internal process of preparing to submit base schedules at T-40 and changes to interchange values within the hour after T-20 and identified any delayed submission tags. PacifiCorp also improved the accuracy of base schedules submitted for non-EIM export energy share of PacifiCorp joint-owned resources.</p>	<p>None identified</p>	<p>Complete. PacifiCorp improved its awareness about the importance of consistent interchange bases schedules and real-time interchange schedules on market results. CAISO is in the process of defining additional monitoring to show the interchange megawatt differences to the operator. The implementation is anticipated to</p>

Number	Solution	Actions and Responsibility	Tariff Changes	Implementation Timeline
		<p>PacificCorp has agreed to provide further base schedules based on the existing tagged values for future hours to help ISO short-term-unit-commitment.</p>		<p>be towards end of May 2015                      PacifiCorp fixed the interchange scheduling software intermittent use of invalid interchange schedules around top of hour the last part of April 2015.                      The CAISO and PacifiCorp have also agreed on submission of base schedules for several hours in the future to cover the short-term-unit commitment horizon, currently set at 4.5 hour's. The data transfer of future hour's base schedules was implemented towards end of May 2015.</p>
5.	<p><i>CAISO formalized a production system support plan for Outage Management System to respond quickly to questions or situations encountered by PacifiCorp operator when entering outage tickets.</i></p>	<p>CAISO implemented a support plan. This support plan consists of a 24/7 email address and telephone number available to PacifiCorp for immediate response to any outage management system issues and for troubleshooting any discrepancy in resources' availability megawatt values.</p> <p>PacifiCorp participated in identifying additional requirements and enhancements to outage</p>	None identified	Completed in early March 2015.

Number	Solution	Actions and Responsibility	Tariff Changes	Implementation Timeline
		management system based on operational needs.		
6.	<i>Enhanced situational awareness displays and improved monitoring of generator availability, capacity, available regulation on a 5 and 15 min basis, and ramp capacity.</i>	<p>PacifiCorp created and/or improved certain Grid Operations displays to monitor generator availability, capacity, and ramp capacity. PacifiCorp has finalized enhancements to its generator database (Pi) displays to provide Grid Operations with situational awareness when there is a deviation between the Dispatch Operating Target (DOT) and the actual dispatch.</p> <p>PacifiCorp developed and implemented additional tools and displays to provide its grid operations personnel with increased visibility and situational awareness regarding available capacity on a 5- and 15-minute basis.</p> <p>PacifiCorp has coordinated with the CAISO to improve the accuracy of</p>	None identified	<p>Major enhancements completed.</p> <p>The CAISO and PacifiCorp continue to monitor and analyze for timely responses to inform the market about any out-of-market manual actions the EIM entity takes or plans to take.</p>



Number	Solution	Actions and Responsibility	Tariff Changes	Implementation Timeline
		<p>how the EIM understands PacifiCorp’s balancing authority operations by using the information communication tools available in the EIM, including outage cards, to ensure that the EIM is accurately consuming real time system conditions and unit capacity available in PacifiCorp’s balancing authority area.</p> <p>Since go-live, PacifiCorp and the CAISO have engaged in regular discussions to evaluate the root cause of remaining infeasible schedules. PacifiCorp has made improvements to its systems that interface with the CAISO’s base schedules and economic bids systems, as well as systems designed for bidding resources during start-up and shutdown hours for multi-stage generating resources.</p> <p>PacifiCorp further narrowed the gap between the persistence forecast methods it uses for VER forecasting and the submission of those forecasts</p>		

Number	Solution	Actions and Responsibility	Tariff Changes	Implementation Timeline
		<p>to the market. This ensures the market has a more current view of wind conditions and results in an improved market solution.</p> <p>Additionally, PacifiCorp has worked with the CAISO to improve the load forecast during ramping hours. This has resulted in an even more accurate load forecast during these hours and improved the flexibility available to the market as fewer resource are needed to cover forecast error.</p> <p>For troubleshooting purposes, PacifiCorp continues to work with the CAISO on tools and displays that can compare interchange deviations between EIM entity submissions and confirmation of interchange data used by the Market Operator. PacifiCorp Grid Operations also continues to work with neighboring balancing authority areas to improve visibility and tools.</p> <p>PacifiCorp has utilized the CAISO's</p>		

Number	Solution	Actions and Responsibility	Tariff Changes	Implementation Timeline
		<p>new displays to identify quickly discrepancies between base schedules and derated maximum capacity of resources. The CAISO added additional information related to re-rated minimum capacity to existing displays to help PacifiCorp identify and fix discrepancies between base schedules and re-rated minimum capacity.</p> <p>The CAISO enhanced situational awareness screens to report on un-qualified MWhs when base schedules were submitted for the resource on an outage to more timely inform the EIM entity of inconsistencies between base schedules and outages.</p>		
7.	<i>Improvements to Flexible Ramp Sufficiency Test</i>	PacifiCorp and the CAISO are coordinating to identify needed improvements. The CAISO is collecting and analyzing both wind and load variability in PacifiCorp’s two balancing areas. PacifiCorp and the CAISO have addressed several wind forecasting issues but wind forecast deviations from base	None identified yet; possible solutions could require additional changes.	On 02/03/2015, CAISO implemented a feature to limit the flexible ramping capacity credit by dynamic transfer limit. Before this change, the fifteen-minute market calculated the flexible ramping capacity credit as the EIM transfer export in the last 15 minutes of the previous hour. It erroneously

Number	Solution	Actions and Responsibility	Tariff Changes	Implementation Timeline
		<p>schedules continues to be among the main reasons for price excursions and infeasibilities.</p> <p>The CAISO is in the process of assessing the flexible ramping requirement for PacifiCorp’s two balancing areas based on the collected data for the actual real-time imbalance conditions. The CAISO is also revisiting and reviewing the flexible ramping constraint and associated credit accounting in the flexibility sufficiency test and towards satisfying the flexible ramp requirements in the market optimization.</p>		<p>assumed that the entire export transfer can be reduced in RTD, which was not true because of the 5 min dynamic limit. As a result, the fifteen-minute market procured less flexible ramping capacity than needed by the system leading potentially to more frequent price excursions. This change was to limit the credit by the five-minute incremental dynamic EIM Transfer limit.</p> <p>On 06/03/2015, CAISO has implemented a feature to separate the flexible ramping capacity requirement into ‘net movement’ and ‘uncertainty’. This allows the “uncertainty” requirement not to be accumulated over the four 15-minute intervals of the hour upon which the flexible ramping sufficiency test is performed.</p> <p>CAISO developed improved forecasting of flex ramp requirements for PACE and PACW and started to use these values in</p>

Number	Solution	Actions and Responsibility	Tariff Changes	Implementation Timeline
				the EIM early March 2015. CAISO is also reviewing its flex ramp sufficiency test implementation for possible simplification to be completed by end of mid-May 2015
8.	<i>Unit deviation displays</i>	The CAISO provided the EIM entity additional user interfaces that provide the grid operator information related to differences between any combination of telemetry, state estimation, base schedules, and cleared target operating points for all resources. The CAISO and PacifiCorp continue to coordinate and provide feedback of additional needed enhancements.	None identified.	Completed.
9.	<i>Load bias logic correction</i>	There were several instances where operators made incorrect load biases to dispatch more capacity when the system was out of ramping capability. The CAISO will be implementing software functionality to limit such erroneous load biases, similar to the logic currently used for the CAISO operator bias of load. This feature limits operator bias of load forecast that are not consistent with system	None identified.  The CAISO will add detail in its business practice manual to describe the procedure further.	The CAISO implemented this feature for EIM on March 20, 2015. However, the feature does not currently trigger because the price waiver-based pricing requires the pricing run to establish prices based on the last economic bid when the market software relaxes the transmission or power balance constraint. For May 2015 about 89 intervals with RTD infeasibilities

Number	Solution	Actions and Responsibility	Tariff Changes	Implementation Timeline
		<p>available ramp.</p> <p>The CAISO will provide training to PacifiCorp to ensure operators are familiar with how the feature will work, including explanations on the use of prices as a signal to indicate an issue in meeting load or balancing the system.</p>		<p>were covered by this functionality and, therefore, were no longer considered in the metrics of this report.</p>
<p><b>10.</b></p>	<p><i>Increase Pool of EIM Participating Resources</i></p> <p><i>PacifiCorp coordinated with the CAISO to increase the pool of owned and third-party resources available to participate in the EIM.</i></p>	<p>PacifiCorp coordinated with the CAISO to increase the pool of owned and third-party resources available to participate in the EIM.</p> <p>This will result in the Swift 1&amp;2 units becoming a single aggregated PacifiCorp EIM Participating Resource and will add approximately 68 MWs of upper bid range capability.</p> <p>In addition, PacifiCorp continues to work with other transmission customers who may be interested in participating in the EIM with resources, including the recent filing of a construction agreement at FERC to enable resource-metering upgrades, which would facilitate</p>	<p>None identified.</p>	<p>PacifiCorp aggregated Swift 1&amp;2 in May 2015.</p> <p>CAISO removed non-conforming Industrial Loads from PACE BAA starting April 1, 2015. PacifiCorp started submission of industrial load base schedules April 1, 2015, and has been bidding them economically since mid May 2015.</p>

Number	Solution	Actions and Responsibility	Tariff Changes	Implementation Timeline
		<p>further steps towards participation of resources in the EIM (FERC Docket No. ER15-711). At this time, PacifiCorp has not certified any third-party transmission customers for participation in the EIM, but is hopeful that these efforts will result in additional EIM participation.</p> <p>PacifiCorp has modeled certain industrial customer interruptible loads as participating resources. This was necessary because some of PacifiCorp’s industrial customer loads have on-site generation and, as a result, this presents additional complexity for accurate forecasting and balancing. Adding these elements as participating resources has improved operational visibility and added approximately 200 MW of flex capacity in its PACE Balancing Authority Area (“BAA”) when they are bid economically in the EIM. PacifiCorp is also improving the modeling of its jointly owned generating resources. Such improvements will further minimize</p>		

<b>Number</b>	<b>Solution</b>	<b>Actions and Responsibility</b>	<b>Tariff Changes</b>	<b>Implementation Timeline</b>
		imbalance issues and improve forecast accuracy.		
<b>11.</b>	<i>Training  Additional training of personnel and improvement of systems with increased EIM operational experience.</i>	<p>PacifiCorp provided personnel with training on outage entry and required the provision of daily spreadsheets from PacifiCorp EIM Participating Resources that describe any operational issues and the resources' ambient conditions.</p> <p>PacifiCorp's Grid Operations provided its balancing agent real-time continued training on CAISO EIM tools during the first two weeks of February 2015.</p> <p>PacifiCorp worked with the CAISO to improve load conforming errors. Software enhancements have been introduced that help protect against over-conforming that can exacerbate issues when capacity in the market is near its limit.</p>	None identified.	PacifiCorp and the CAISO have completed the bulk of identified training and the CAISO continues to evaluate training requirements.
<b>12.</b>	<i>Improve Internal Processes and Tools to address identified market performance issues.</i>	PacifiCorp's Grid Operations drafted and made available to operations personnel, "best practices" procedure documents to aid in personnel's implementation of	None identified.	Completed.



Number	Solution	Actions and Responsibility	Tariff Changes	Implementation Timeline
		critical EIM Entity tasks. PacifiCorp will continue to update these procedure documents in real-time as needed. PacifiCorp also developed a Desk Guide for the 24/7 Grid Operations desk and an EIM Division of Responsibilities document.		
13.	<i>Improve dynamic transfer capability</i>	<p>PacifiCorp is engaged in ongoing discussions with the Bonneville Power Administration (BPA) to understand the nature and allocation of the dynamic transfer capability on the COI. BPA is in the process of conducting a detailed dynamic transfer capability study. Any additional five-minute capability will help the five-minute market re-optimize the fifteen-minute decisions that are based on system conditions and information available at approximately 30 minutes prior to the five-minute market. The five-minute dynamic COI limits were increased for the off-peak hours but still very limited during on-peak hours.</p> <p>PacifiCorp is engaged in discussions</p>	None identified.	<p>In progress – BPA is in the process of determining new COI dynamic transfer capability limits based on study results.</p> <p>For BPA rate of change constraints, the CAISO, PacifiCorp, and BPA are currently examining two methodologies or approaches in the ISO testing environment to identify which methodology is superior and acceptable to BPA to the method currently in place. The first methodology was deployed mid May 2015. The CAISO/PacifiCorp/BPA are committed and continue to discuss on weekly calls the effectiveness of approach 1, as well as potential better alternatives.</p>

Number	Solution	Actions and Responsibility	Tariff Changes	Implementation Timeline
		<p>with BPA to understand the nature and basis behind the five-minute flowgate limits and possible change in the calculation of those limits. BPA is reviewing the five-minute limits, which are based on historical movement of PacifiCorp West resources before the EIM. BPA has also requested more data points to perform a review of the current rate-of-change limits based on actual EIM data. Any additional five-minute capability will help the five-minute market re-optimize the fifteen-minute market decisions that are based on system conditions and information available approximately 30 minutes prior to the five-minute market. The CAISO had provided BPA the requested data points and answered any relevant questions. The CAISO is coordinating with both BPA and PacifiCorp to revise the implementation model for the rate-of-change constraint to reflect ramping 15-minute schedule values.</p>		

## ATTACHMENT C

This attachment includes a discussion of whether the cause was due to transitional issues or was due to insufficient supply of resources bid into the EIM, including the time of the instance, the duration, the cause, and the affected node(s) and load. The CAISO evaluated each interval of infeasibility to determine whether it was infeasible due to actual supply insufficiency by calculating the degree to which the infeasibility was in excess of PacifiCorp's available capacity to balance its system. This measure was determined by calculating the difference between the total amount of reserves carried and the minimum amount of reserves required by NERC. The CAISO then subtracted the MWs of infeasibility from that amount to determine the amount of available capacity above the magnitude of the infeasibilities. This amount is displayed for the PACE and PACW areas for each interval. If that value were zero or negative, the CAISO would qualify that interval as infeasible due to an insufficiency of supply. Otherwise, the CAISO concludes the EIM entity had enough capacity available to dispatch as needed to address the infeasibility observed in the market systems. However, the CAISO does not present this measurement to demonstrate that the available capacity could have actually addressed the infeasibility. It is not certain that the available capacity would have been capable to meet the ramping needs to meet the infeasibility. It is merely a measure of the total capacity available at the time of the infeasibility for a future operating interval. An important aspect of the CAISO market runs is that the CAISO conducts the market runs from 37.5 and up to 7.5 minutes ahead of the actual operating interval respectively for the fifteen-minute market and five-minute market. The measurements of the infeasibility below do not reflect the actions taken between the time the market systems detect the infeasible market run and the actual operating interval. The CAISO presumes the EIM entity actually takes manual actions to dispatch available capacity during that time interval to meet their load.

The tables below show that there were certain intervals during which there measure of excess reserves presented were negative and there was an infeasibility due to market imbalances exceeding supply bids available to clear the market. All the events were in the five-minute real-time dispatch and none occurred in the fifteen-minute market. The CAISO and PacifiCorp have evaluated market and reliability conditions during all of these intervals and have determined that while the magnitude of the infeasibility is greater than the amount of reserves available, at all times during these intervals based on the ACE and available capacity, the PACE and PACW systems were operated reliably. The system issues were not apparent during the price corrections time horizon to determine if these instances should have been

excluded from the list of infeasibilities. The infeasibilities were due to lack of visibility of the market to the available capacity.

Table 1: List of undersupply infeasibilities in the fifteen-minute market for both PAC East and West

Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
13-May	7	2	61.3	103.0			Resource Outage	All locations in PAC East
13-May	22	1	14.5	134.3			Load Changes	All locations in PAC East
15-May	18	4	20.3	146.4			Resource Outage	All locations in PAC East
18-May	20	4	11.0	184.5			Resource Outage	All locations in PAC East
18-May	22	1	101.9	93.3			Resource Outage	All locations in PAC East
18-May	22	2	54.8	46.5			Resource Outage	All locations in PAC East
18-May	23	1	86.9	94.5			Resource Outage	All locations in PAC East
18-May	23	2			7.7	157.3	Resource Outage	All locations in PAC West

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
1-May	24	2			36.8	182.1	Renewable Deviation	All locations in PAC West
1-May	24	3			10.0	209.0	Renewable Deviation	All locations in PAC West
2-May	22	2			24.0	140.1	Resource Outage	All locations in PAC West
2-May	22	3			24.8	139.3	Resource Outage	All locations in PAC West
2-May	22	5			74.7	0.0	Resource Outage	All locations in PAC West
2-May	22	6	60.5	144.1			Resource Outage	All locations in PAC East
2-May	23	2	59.2	171.3			Resource Data Alignment	All locations in PAC East
3-May	4	5	0.7	294.1			Renewable Deviation and Resource Data Alignment	All locations in PAC East
3-May	4	9	7.1	254.6			Renewable Deviation and Resource Data Alignment	All locations in PAC East

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
3-May	4	10	19.4	271.7			Renewable Deviation and Resource Data Alignment	All locations in PAC East
3-May	4	11	13.4	277.7			Renewable Deviation and Resource Data Alignment	All locations in PAC East
3-May	20	8	55.9	216.4			Resource Outage and Renewable Deviation	All locations in PAC East
3-May	20	9	44.0	228.2			Resource Outage and Renewable Deviation	All locations in PAC East
3-May	20	10	213.4	-11.4			Resource Outage and Renewable Deviation	All locations in PAC East
3-May	20	11	185.4	16.6			Resource Outage and Renewable Deviation	All locations in PAC East
3-May	20	12	176.9	25.0			Resource Outage and Renewable Deviation	All locations in PAC East
3-May	21	1	61.1	108.5			Resource Outage and Renewable Deviation	All locations in PAC East
3-May	21	2	52.2	117.5			Resource Outage and Renewable Deviation	All locations in PAC East

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
3-May	21	4	98.3	65.1			Resource Outage and Renewable Deviation	All locations in PAC East
3-May	21	5	114.0	49.4			Resource Outage and Renewable Deviation	All locations in PAC East
3-May	21	6	136.9	26.5			Resource Outage and Renewable Deviation	All locations in PAC East
3-May	21	7	112.3	53.9			Resource Outage and Renewable Deviation	All locations in PAC East
3-May	21	8	106.5	59.7			Resource Outage and Renewable Deviation	All locations in PAC East
3-May	21	9	92.0	74.2			Resource Outage and Renewable Deviation	All locations in PAC East
3-May	21	10	12.3	135.0			Resource Outage and Renewable Deviation	All locations in PAC East
3-May	23	3	51.6	122.0			Import/Export Changes and Renewable Deviation	All locations in PAC East
4-May	1	2	10.2	292.7			Resource Data Alignment and Renewable Deviation	All locations in PAC East

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
4-May	10	5	13.3	215.3			Import/Export Changes and Renewable Deviation	All locations in PAC East
4-May	10	6	13.3	215.2			Import/Export Changes and Renewable Deviation	All locations in PAC East
4-May	10	10	44.6	38.2			Import/Export Changes and Renewable Deviation	All locations in PAC East
4-May	10	11	47.5	35.3			Import/Export Changes and Renewable Deviation	All locations in PAC East
4-May	23	1	45.7	316.1			Resource Data Alignment	All locations in PAC East
4-May	23	2	19.0	342.9			Resource Data Alignment	All locations in PAC East
5-May	8	7	26.0	143.7			Resource Data Alignment and Renewable Deviation	All locations in PAC East
5-May	18	7			1.2	224.2	Transfer/Congestion Constraints	All locations in PAC West
5-May	21	4			126.2	90.5	Resource Outage	All locations in PAC West



Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
5-May	21	5			124.7	92.0	Resource Outage	All locations in PAC West
5-May	23	1	93.4	119.2			Resource Outage	All locations in PAC East
6-May	24	2	3.6	244.3			Resource Data Alignment and Renewable Deviation	All locations in PAC East
6-May	24	4	10.0	180.0			Resource Data Alignment and Renewable Deviation	All locations in PAC East
6-May	24	5	8.9	181.1			Resource Data Alignment and Renewable Deviation	All locations in PAC East
6-May	24	6	4.6	185.4			Resource Data Alignment and Renewable Deviation	All locations in PAC East
6-May	24	7	1.1	195.6			Resource Data Alignment and Renewable Deviation	All locations in PAC East
6-May	24	9	3.9	192.8			Resource Data Alignment and Renewable Deviation	All locations in PAC East
7-May	6	10			61.7	44.9	Import/Export Changes	All locations in PAC West

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
7-May	6	11			52.1	54.5	Import/Export Changes	All locations in PAC West
7-May	7	10			52.2	75.0	Import/Export Changes	All locations in PAC West
7-May	7	11			69.3	57.9	Import/Export Changes	All locations in PAC West
7-May	7	12			56.4	70.8	Import/Export Changes	All locations in PAC West
7-May	10	8	38.2	221.1			Resource Data Alignment	All locations in PAC East
7-May	21	4			59.7	8.0	Resource Outage	All locations in PAC West
7-May	21	5			64.4	3.4	Resource Outage	All locations in PAC West
7-May	21	6			51.6	16.1	Resource Outage	All locations in PAC West
7-May	21	7			50.7	33.1	Resource Outage	All locations in PAC West

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
7-May	21	8			30.0	53.8	Resource Outage	All locations in PAC West
7-May	21	9			26.3	57.4	Resource Outage	All locations in PAC West
9-May	8	1	93.7	222.6			Renewable Deviation	All locations in PAC East
9-May	20	7			11.1	167.4	Resource Data Alignment	All locations in PAC West
10-May	14	10			60.4	86.2	Resource Data Alignment	All locations in PAC West
10-May	14	11			5.6	141.0	Resource Data Alignment	All locations in PAC West
10-May	14	12			21.0	125.6	Resource Data Alignment	All locations in PAC West
10-May	22	2			13.2	129.6	Renewable Deviation	All locations in PAC West
10-May	22	4			38.7	148.9	Renewable Deviation	All locations in PAC West

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
10-May	22	5			56.0	131.7	Renewable Deviation	All locations in PAC West
10-May	22	6			5.3	182.3	Renewable Deviation	All locations in PAC West
11-May	10	6			26.7	124.4	Resource Outage	All locations in PAC West
11-May	10	10			68.7	69.9	Resource Outage	All locations in PAC West
11-May	10	11			47.3	91.3	Resource Outage	All locations in PAC West
11-May	12	1			73.8	86.6	Resource Data Alignment	All locations in PAC West
11-May	12	2			51.4	109.0	Resource Data Alignment	All locations in PAC West
11-May	12	3			49.9	110.4	Resource Data Alignment	All locations in PAC West
12-May	1	3	221.9	71.1			Resource Outage	All locations in PAC East

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
12-May	1	4	26.3	143.0			Resource Outage	All locations in PAC East
12-May	1	5	23.2	146.1			Resource Outage	All locations in PAC East
12-May	1	6	12.6	156.7			Resource Outage	All locations in PAC East
12-May	1	7	42.9	119.1			Resource Outage	All locations in PAC East
12-May	1	8	39.2	122.7			Resource Outage	All locations in PAC East
12-May	1	9	40.5	121.5			Resource Outage	All locations in PAC East
12-May	1	10	39.3	163.9			Resource Outage	All locations in PAC East
12-May	1	11	26.7	176.5			Resource Outage	All locations in PAC East
12-May	18	7			24.0	221.0	Renewable Deviation and Transfer/Congestion Constraints	All locations in PAC West

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
13-May	22	1	95.8	52.9			Resource Data Alignment and Resource Outage	All locations in PAC East
13-May	22	2	65.0	83.8			Resource Data Alignment and Resource Outage	All locations in PAC East
14-May	11	4			107.3	-31.2	Resource Outage	All locations in PAC West
14-May	11	5	122.5	15.2			Resource Outage and Renewable Deviation	All locations in PAC East
14-May	11	6	142.3	-4.6			Resource Outage and Renewable Deviation	All locations in PAC East
14-May	20	10	33.2	165.3			Renewable Deviation	All locations in PAC East
14-May	20	11	126.9	71.6			Renewable Deviation	All locations in PAC East
14-May	20	12	27.9	170.6			Renewable Deviation	All locations in PAC East
15-May	2	11	9.7	239.7			Renewable Deviation	All locations in PAC East

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
15-May	2	12	15.2	234.2			Renewable Deviation	All locations in PAC East
15-May	3	1	8.5	233.0			Renewable Deviation	All locations in PAC East
15-May	3	2	3.4	238.1			Renewable Deviation	All locations in PAC East
15-May	3	5	19.0	215.1			Renewable Deviation	All locations in PAC East
15-May	3	6	44.7	189.4			Renewable Deviation	All locations in PAC East
15-May	3	7	8.8	180.9			Renewable Deviation	All locations in PAC East
15-May	3	8	15.0	174.8			Renewable Deviation	All locations in PAC East
15-May	3	9	11.2	178.5			Renewable Deviation	All locations in PAC East
15-May	3	10	23.2	162.3			Renewable Deviation	All locations in PAC East

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
15-May	10	9			2.1	66.4	Resource Outage	All locations in PAC West
15-May	10	10			2.6	124.3	Resource Outage	All locations in PAC West
16-May	14	8			65.2	28.3	Renewable Deviation	All locations in PAC West
16-May	14	9			57.0	36.5	Renewable Deviation	All locations in PAC West
16-May	14	10			52.6	92.8	Renewable Deviation	All locations in PAC West
16-May	14	11			46.4	99.0	Renewable Deviation	All locations in PAC West
16-May	14	12			48.2	97.2	Renewable Deviation	All locations in PAC West
16-May	15	12			12.5	182.9	Renewable Deviation	All locations in PAC West
17-May	22	5			41.7	107.2	Resource Data Alignment and Renewable Deviation	All locations in PAC West



Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
18-May	19	5			39.2	158.4	Load Changes	All locations in PAC West
18-May	19	6			49.0	148.5	Load Changes	All locations in PAC West
18-May	22	1	46.5	148.7			Load Changes	All locations in PAC East
18-May	22	2	42.5	152.7			Load Changes and Import/Export Changes	All locations in PAC East
18-May	22	3	30.4	164.7			Load Changes and Import/Export Changes	All locations in PAC East
18-May	22	4	107.1	-5.7			Load Changes and Import/Export Changes	All locations in PAC East
18-May	22	5	87.1	14.2			Import/Export Changes	All locations in PAC East
18-May	22	6	92.3	9.0			Import/Export Changes	All locations in PAC East
18-May	22	7	52.4	79.8			Import/Export Changes	All locations in PAC East

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
18-May	22	8	61.2	70.9			Import/Export Changes	All locations in PAC East
18-May	23	2			66.3	135.3	Resource Outage and Import/Export Changes	All locations in PAC West
18-May	23	4	53.7	130.7	62.3	102.8	Resource Outage ,Renewable Deviation and Resource Data Alignment	All locations in PAC East and West
18-May	23	5	19.6	164.8	45.7	119.4	Resource Outage ,Renewable Deviation and Resource Data Alignment	All locations in PAC East and West
18-May	24	3			12.7	197.3	Import/Export Changes	All locations in PAC West
18-May	24	4			28.0	209.1	Import/Export Changes	All locations in PAC West
18-May	24	5			66.8	170.2	Import/Export Changes	All locations in PAC West
18-May	24	6			58.9	178.1	Import/Export Changes	All locations in PAC West
19-May	22	3	51.9	180.3			Renewable Deviation	All locations in PAC East

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
19-May	23	2			19.2	186.6	Renewable Deviation	All locations in PAC West
19-May	24	2	6.2	259.7			Renewable Deviation and Resource Data Alignment	All locations in PAC East
19-May	24	3	67.0	198.9			Renewable Deviation and Resource Data Alignment	All locations in PAC East
19-May	24	4	20.3	119.3			Renewable Deviation and Resource Data Alignment	All locations in PAC East
19-May	24	5	12.7	126.9			Renewable Deviation and Resource Data Alignment	All locations in PAC East
19-May	24	6	33.4	106.3			Renewable Deviation and Resource Data Alignment	All locations in PAC East
19-May	24	7	17.8	95.8			Renewable Deviation and Resource Data Alignment	All locations in PAC East
19-May	24	8	13.8	99.8			Renewable Deviation and Resource Data Alignment	All locations in PAC East
19-May	24	9	8.8	104.7			Renewable Deviation and Resource Data Alignment	All locations in PAC East

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
19-May	24	10	85.7	101.9			Renewable Deviation and Resource Data Alignment	All locations in PAC East
19-May	24	11	56.8	130.7			Renewable Deviation and Resource Data Alignment	All locations in PAC East
23-May	22	7	16.0	284.6			Renewable Deviation and Resource Data Alignment	All locations in PAC East
23-May	22	8	20.2	280.4			Renewable Deviation and Resource Data Alignment	All locations in PAC East
23-May	22	12	40.4	353.9			Renewable Deviation and Resource Data Alignment	All locations in PAC East
25-May	7	9			1.5	134.0	Resource Outage	All locations in PAC West
25-May	13	7			59.5	0.1	Renewable Deviation and Import/Export Changes	All locations in PAC West
26-May	10	7			3.2	140.6	Import/Export Changes	All locations in PAC West
26-May	10	8			9.7	134.1	Import/Export Changes	All locations in PAC West

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
26-May	10	9			190.5	-46.7	Resource Outage and Import/Export Changes	All locations in PAC West
26-May	10	10			75.6	160.0	Resource Outage and Import/Export Changes	All locations in PAC West
26-May	10	11			120.4	115.1	Resource Outage and Import/Export Changes	All locations in PAC West
26-May	10	12			234.7	0.9	Resource Outage and Import/Export Changes	All locations in PAC West
26-May	11	6			126.0	75.8	Resource Data Alignment and Renewable Deviation	All locations in PAC West
26-May	11	7			21.4	194.3	Resource Data Alignment and Renewable Deviation	All locations in PAC West
26-May	11	8			84.1	131.6	Resource Data Alignment and Renewable Deviation	All locations in PAC West
26-May	11	9			38.0	177.7	Resource Data Alignment and Renewable Deviation	All locations in PAC West
26-May	11	10			118.3	33.7	Resource Data Alignment and Renewable Deviation	All locations in PAC West

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
26-May	11	11	80.6	108.7			Resource Data Alignment and Renewable Deviation	All locations in PAC East
26-May	11	12	37.4	151.9			Resource Data Alignment and Renewable Deviation	All locations in PAC East
26-May	12	1			29.6	126.4	Resource Outage and Import/Export Changes	All locations in PAC West
26-May	12	2			14.8	141.2	Resource Outage and Import/Export Changes	All locations in PAC West
26-May	12	3	6.7	110.2			Resource Outage and Import/Export Changes	All locations in PAC East
26-May	19	11			32.7	179.6	Import/Export Changes and Renewable Deviation	All locations in PAC West
26-May	19	12			3.6	208.7	Import/Export Changes and Renewable Deviation	All locations in PAC West
26-May	22	1			0.1	174.3	Import/Export Changes	All locations in PAC West
26-May	22	2			44.0	130.4	Import/Export Changes	All locations in PAC West

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
26-May	22	3			2.4	171.9	Import/Export Changes	All locations in PAC West
26-May	22	6			5.6	166.7	Resource Outage and Import/Export Changes	All locations in PAC West
27-May	7	12			56.1	47.5	Resource Outage	All locations in PAC West
27-May	8	4			50.3	108.6	Resource Outage	All locations in PAC West
28-May	7	5	135.8	257.0	7.2	117.0	Resource Data Alignment	All locations in PAC East and West
28-May	7	6	105.5	287.3	16.8	107.5	Resource Data Alignment	All locations in PAC East and West
28-May	7	7	111.0	109.5			Resource Data Alignment	All locations in PAC East
28-May	7	8			23.3	94.2	Resource Data Alignment	All locations in PAC West
28-May	8	1	49.4	91.5			Resource Data Alignment	All locations in PAC East

Table 2: List of undersupply infeasibilities in the five-minute market for both PAC East and West								
Trade Date	Hour Ending	Interval	Infeasibility PACE (MW)	Excess of Reserves PACE (MW)	Infeasibility PACW (MW)	Excess of Reserves PACW (MW)	Reason for infeasibility	Affected locations
28-May	10	10			22.2	83.1	Import/Export Changes	All locations in PAC West
28-May	10	11			37.8	67.5	Import/Export Changes	All locations in PAC West
28-May	20	11			62.1	-36.2	Renewable Deviation	All locations in PAC West
29-May	10	11	27.1	89.8			Resource Data Alignment	All locations in PAC East
29-May	12	11	36.5	167.7			Import/Export Changes and Renewable Deviation	All locations in PAC East
29-May	13	1	15.1	155.8			Import/Export Changes and Renewable Deviation	All locations in PAC East



## **ATTACHMENT D:**

This attachment provides a quantitative and qualitative analysis of the market performance impact of the issues that prompted the CAISO's request for a waiver.

### **A. Impact of Issues on Market Prices**

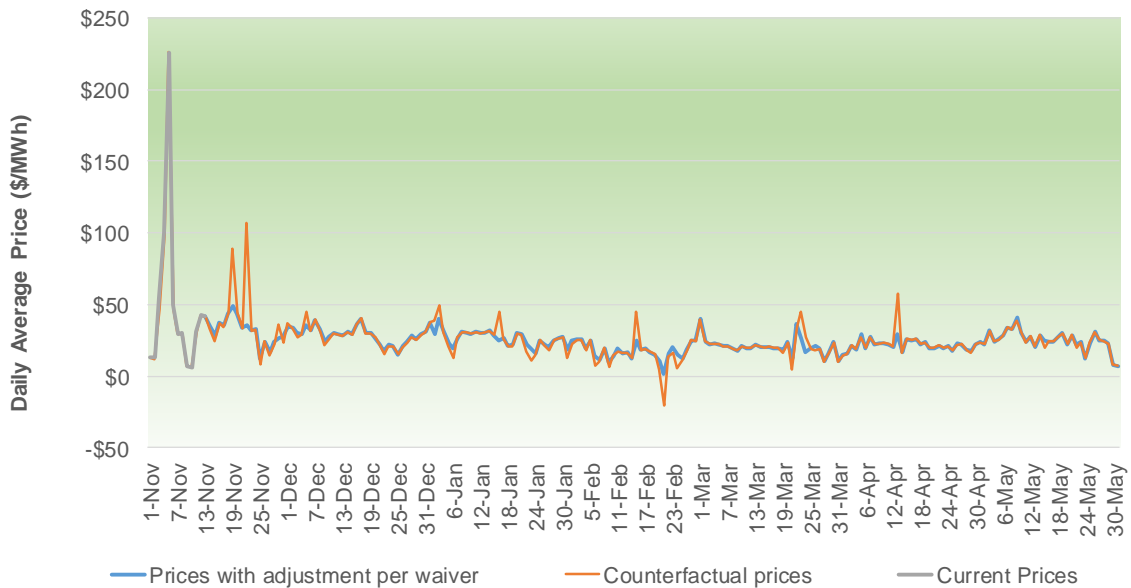
The figures in this subpart summarize the impact the issues would have had on prices absent the waiver pricing. During the term of the waiver, the CAISO established prices based on the price discovery mechanism and not based on the penalty prices that would have otherwise been in effect. The market does not produce prices as they would have been absent the waiver. Therefore, the CAISO created a counterfactual set of prices it compares to the prices that cleared based on the pricing in effect during the waiver. Because pricing under the waiver pricing is based on the last economic bid price signal, it is a proxy of what the prices would have been absent the seven category of issues. Therefore, the difference between the counterfactual pricing and the price in effect during the term of these reports illustrates the market impact.

The figures in this subpart also summarize the frequency with which the EIM entity failed the flexibility tests during the term of this report and the daily average price trends in the EIM organized by market and area. These trends include pricing for both the PAC West and PAC East external load aggregation points (ELAPs). The report focuses on the ELAP prices because these aggregate prices represent pricing in each area – PAC West and PAC East –, which allows the CAISO to reflect short-term imbalance shortage for the aggregate area. These daily averages reflect all prices of the real-time market, including the price corrected through the price correction process and the price adjustments under the waiver associated with this report.<sup>6</sup>

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<sup>6</sup> Note a separate waiver has been submitted requesting relief for period of November 1-November 13. These reports do not reflect any adjustments for this separate waiver request, which has not yet ruled on as of the date of this report.

**Figure 5: Daily average of fifteen-minute market prices in PAC West.<sup>7</sup>**



<sup>7</sup> From November 14 through November 30 the CAISO implemented the price adjustments under the waiver retroactively and is making the adjustments in settlement statements after the December 1 order was issued. After December 1, there are no retroactive adjustments since the logic of the price discovery feature implemented under the waiver is implemented through the market clearing solution process. These prices, like any other prices, are still subject to the price validation and correction process. Section 35.4 of the CAISO tariff already 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 inconsistent with the CAISO tariff.

**Figure 6: Daily average of fifteen-minute market prices in PAC East.**

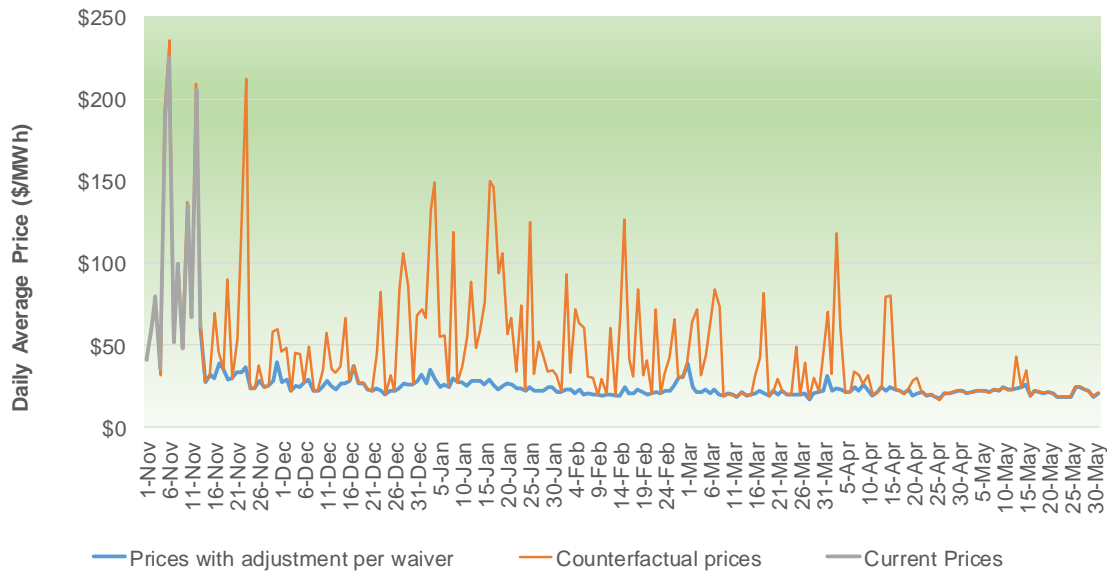


Figure 5 and Figure 6 each compare two trends for the same market and same area, PAC East and West respectively. The blue line illustrates daily average prices from November 14 on and represents the actual and final prices after any price corrections or price adjustments pursuant to the December 1 Waiver, which is the subject of this report. After November 14, even when there were power supply infeasibilities, per the December 1 Waiver, this trend reflects prices that are set based on the the marginal economic signal in the market and are not based on constraint relaxation pricing parameters. The price trends for November 1 through November 13 are represented in a different color than the the prices after November 14 because those represent the final prices as of this date, after all price corrections have been made. The prices for the November 1-13 include prices based on the constraint relaxation pricing parameters.

The orange line was constructed to estimate the counterfactual case of what prices would have been if they were based on the constraint relaxation pricing parameters, pegged to the \$1000/MWh bid cap. As of December 1, the CAISO adopted the waiver-based pricing in its systems, which means that the market systems produced prices consistent with the pricing mechanism under the waiver and not based on the constraint relaxation pricing parameters. Therefore, the CAISO had to find a way to reconstruct those cases, which it is referred to as the counterfactual case. In other words, the prices represented by the orange line represent the CAISO’s estimate of what prices would have been absent the December 1 Waiver. These two lines compare together prices under the December 1 Wavier to what they would have been without that waiver.

The orange line is more volatile and spiky because those prices are calculated based on the \$1000/MWh any time there is an observed undersupply infeasibility. Whereas the blue line shows a more stable pricing trend reflecting dispatched economic bids. For the first 13 days of November, the lines in grey and orange track closely to each other but not exactly. The prices represented by the grey line are final as of now and include prices that even though there was infeasibility, for other reasons the prices were not based on the constraint relaxation pricing parameters. In the counterfactual case, the CAISO estimated that any interval with infeasibility would produce a price based on the constraint relaxation pricing parameter.

In addition, the prices for the counterfactual case in Figure 5 and Figure 6 were constructed based on the following two factors. First, because the goal of this report is to quantify and explain the price changes associated with the implementation of the December 1 Waiver, these trends do not include the reconstruction of prices related to price corrections and flexible ramping constraint infeasibility because:

- i) Price corrections. If a price was associated with a power balance infeasibility, but the interval was rendered to have an invalid price and was subject to price corrections for other reasons, the CAISO did not estimate the counterfactual price and instead the estimated and counterfactual price is equal to the final and current price. This is based on the premise that had the CAISO not experienced the issue that supported the price correction in the first place, the power balance infeasibility would not have triggered. Therefore, the market price would have been based on the tariff-based rules that consider the submitted economic bid prices rather than the penalty prices specified in the tariff.
- ii) Flexible ramp sufficiency test. As specified in section 29.34(n) of the CAISO tariff and section 10.3.2.1 of the Business Practice Manual for the EIM, 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. For the duration of the restricted interval, the market clearing price in the affected EIM Entity balancing authority area will also be based on the tariff-based rules that look at the last economic bid cleared in the fifteen-minute or five-minute interval in the EIM Entity balancing authority area. This logic is outside waiver of this report and with or without the waiver, the pricing mechanism will be in place. Therefore, the original price for market intervals that had power balance infeasibilities and that failed the flexible ramp test would have remained unchanged absent the waiver as they will not be set by

relaxation parameter prices under Section 10.3.2.1 of the BPM for the EIM.

- iii) Load Bias Limiter. The data shown in this report do not include intervals in which the CAISO has determined that the load-bias limiter functionality would have eliminated the infeasibility. The load bias limiter functionality does not serve the same purpose as the waiver pricing. As fully described in this proceeding, the waiver pricing applies in all instances to ensure learning curve type issues do not trigger parameter pricing.

The load-bias limiter is a feature in the CAISO markets that works independent of the waiver to ensure that an operator's adjustment of the load forecast is consistent with the system conditions. The feature essentially ensures a bias that exceeds the capabilities of the system does not create an infeasibility. The balancing authority operators can adjust the load forecast to ensure the load forecast reflects system need. The CAISO creates a forecast for the EIM balancing authority area as it does for the CAISO balancing authority area. However, the operator adjustments to load forecasts tend to be coarse adjustments, in increments of 10 to 50 MW. Also, the operator cannot know at that time exactly what the system ramp is and in making the adjustment, it could exceed the system's ability to respond. For example, an adjustment of 50-100 MW could exhaust 5-minute ramping capability. Such coarse adjustments, if more than necessary, can produce unnecessarily infeasible market solutions. To prevent such over-adjustment, the CAISO employs a load bias limiter in the CAISO balancing authority area, which automatically limits the course operator adjustment to the market systems to what is feasible as long as the quantify of the infeasibility is less than the operator adjustment and is in the same direction as the operator adjustment.

The CAISO employs the load bias limiter feature through the scheduling and pricing run as follows. If the scheduling run MW quantity of the infeasibility is less than or equal to the load bias, in the pricing run the infeasibility will be removed and will not trigger the pricing. This feature does not take effect if the MW quantity of the infeasibility exceeds the load bias or if the infeasibility is in the opposite direction of the load bias. This feature as applied in the CAISO area has avoided the artificial constraints that may arise from coarse adjustments. It is appropriate to apply the load-bias limiter regardless of the waiver because this is a feature that prevents an infeasibility that would occur only because of the course adjustment exceeds the capabilities of the system and, and not because it is actually needed. The CAISO's development of this feature pre-dated the implementation of the EIM and is unrelated to the EIM issues that led to the waiver

request. The CAISO did not deploy this feature as part of the EIM. However, after implementation and through analysis of infeasibilities and discussions with DMM, the ISO found that certain infeasibilities were caused by biases to load forecast by operators that were not consistent with the system capabilities at the time. In previous reports the ISO reported such instances under the classification of Load Adjustment. Through discussions with DMM, the CAISO pursued to adopt the load bias limiter feature for the EIM as well to prevent the system from observing infeasibilities due to biases that exceed system requirements. This feature was made available to the EIM area starting on March 20, 2015. However, during the term of the waiver, because the waiver pricing procedure does not allow the CAISO to set the price based on the tariff-based parameter when there infeasibility whether or not there is a load bias in a given interval, the load bias limiter is superseded by the waiver based pricing and is not active in the EIM balancing authority area. Once the waiver terminates, the load bias limiter will be active in the EIM as it is in the CAISO balancing authority area.

An important feature of the load bias limiter is that it only prevents the infeasibility in the interval in which there is a bias. If there is no bias the feature does not kick in. Another important aspect of the feature is that eventually, the load forecast itself will catch up to reflect actual load. Therefore, if the load bias was consistent with actual load, the load forecast increases to reflect actual load, and the operator no longer biases the load forecast, the load bias limiter will not trigger. If in such intervals, the power balance constraint is relaxed, absent the waiver pricing rules currently in effect, the CAISO will use the tariff-based parameters to establish prices.

Because but for the waiver the load bias limiter would be effective starting on March 20, in its March report and in this April report, the CAISO did not include in the data reported in Attachment A those intervals in which the load bias limiter would have prevented the infeasibility. These reports target infeasibilities related to learning issues that led to the CAISO's request for the waiver. However, the frequency of these infeasibilities is explicitly provided in Attachment E together with the overall classification of infeasibilities.

Finally, the CAISO is exploring enhancements to the load bias limiter feature for both the CAISO and EIM balancing authority areas, including the recommendation by the Department of Market Monitoring to better reflect the impact of excessive load bias adjustments on creating power balance shortages. Specifically, DMM recommended that the CAISO consider that the adjustment made by the load limit biaser

be based on the *change* in load bias from one interval to the next instead of the *absolute value* of any positive load bias.<sup>8</sup>

Under the current approach, the CAISO may be missing correction of infeasibilities due to sudden changes in biases. For example, the operator may first bias the load forecast down to 500 and then in the next interval down to 300 MW. The reduction to 300MW will not trigger the load bias limiter if the infeasibility is in the positive direction given that the bias was in the opposite direction. However, the sudden change bias causes an infeasibility itself. The CAISO is considering enhancements to ensure that such sudden changes in biases that cause infeasibilities are captured by the feature as well.

The current approach may also result in unnecessary triggering of the load bias limiter in intervals that have a persistent bias that is not really intended. For example, as discussed above operators make coarse biases to the load forecast and sometimes set the bias for a number of intervals and then inadvertently do not remove the bias even when it is no longer necessary. The CAISO is considering enhancements to reduce such persistent bias because they may trigger the load limit biaser unnecessarily.

Second, the prices reflecting the tariff-based relaxation parameters were reconstructed for both under-supply and over-supply infeasibilities. This means that when an instance of undersupply was reconstructed, the price was set to the bid cap plus/minus marginal loss component. Similarly, when an oversupply instance was reconstructed, the prices in the counterfactual case were set to the bid floor relaxation parameter plus/minus marginal loss prices.

During the term of these reports, in some intervals the market clearing process experienced “degenerate cases” during which the market may clear at multiple pricing run solutions equally valid from an economic perspective. The CAISO has recently stakeholdered and the CAISO board of governors has approved a solution to this phenomena and intends to file a tariff amendment to implement this change. These upcoming market rule changes eliminate the multiplicity of pricing issue and produce one price that reflects the lack of congestion at the locations. During such cases, even had the market systems observed an infeasibility that would have led to the relaxation of a constraint and triggered the penalty pricing parameters, the pricing run could have landed at a price based on the marginal resource economic bid price, which could differ from the price had it been based on the \$1000/MWh parameter. The CAISO observed many intervals in which this phenomena occurred, in particular in the five minute real-time dispatch. The CAISO does not correct and believes these to be optimal

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<sup>8</sup> See DMM Report, p. 13 (May 7, 2015).

from the perspective of the energy market alone. But because of issues this may cause in associated markets such as the congestion revenue rights, the CAISO will modify its market rules prospectively to eliminate such occurrences.<sup>9</sup>

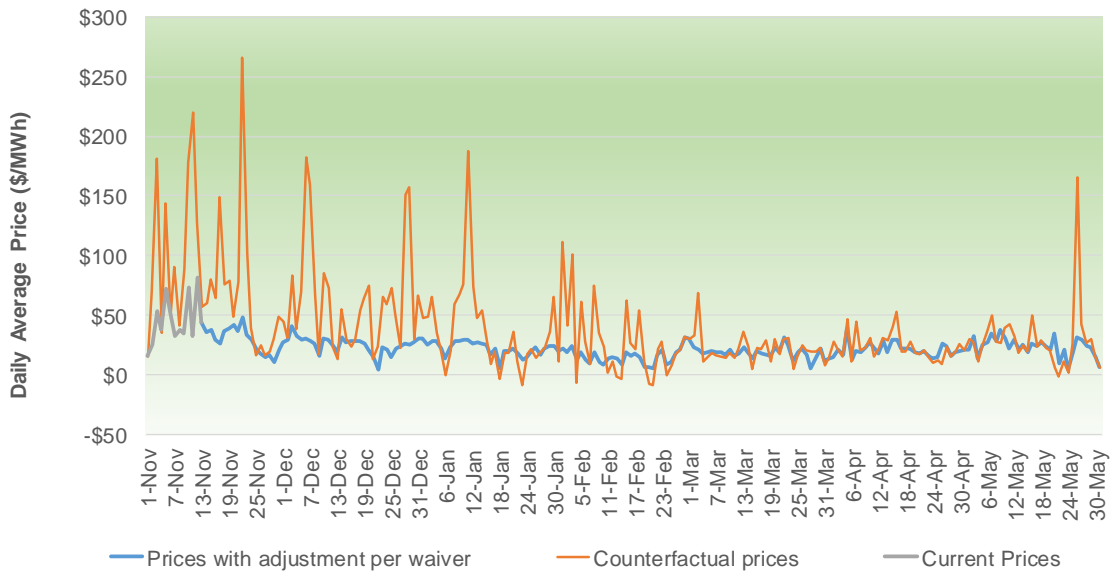
The counterfactual case represented by the orange line cannot account for the degeneracy and represents what prices would have been for those intervals based on the tariff-based constraint relaxation pricing parameters because there was an infeasibility. This has implications regarding the trends in the figures below. For the first 13 days in November, the CAISO has not yet modified posted prices based on the waiver-type pricing. The CAISO filed for an additional waiver to conduct this pricing adjustment and it is pending before the Commission in FERC Docket No. ER15-817. Without the waiver, the prices as posted would remain as they are. One would expect the counterfactual case represented by the orange line to be close to the posted prices represented by the blue line. This is the case for the fifteen-minute markets. However, for the real-time dispatch, the lines diverge because in several intervals posted prices appear to have not been determined based on the \$1000/MWh parameter even if there was infeasibility. The CAISO believes this was because many of the affected intervals were subject to degeneracy. After November 13, however, whether or not there would have been degeneracy in the pricing run, is immaterial, because pricing under the December 1 waiver or degeneracy is based on the last economic bid price signal.

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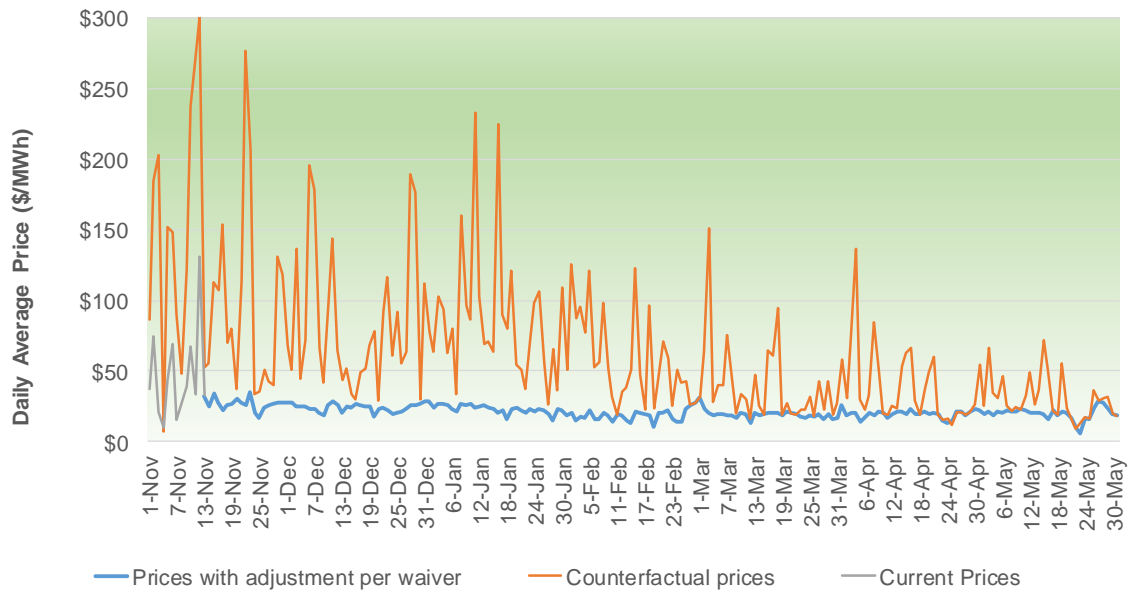
<sup>9</sup> Additional information regarding the stakeholder process and the resulting policy changes is available at: <http://www.caiso.com/informed/Pages/StakeholderProcesses/PricingEnhancements.aspx>. This will be the subject of an upcoming tariff amendment with the Commission.



**Figure 7: Daily average of five-minute market prices in PAC West.**



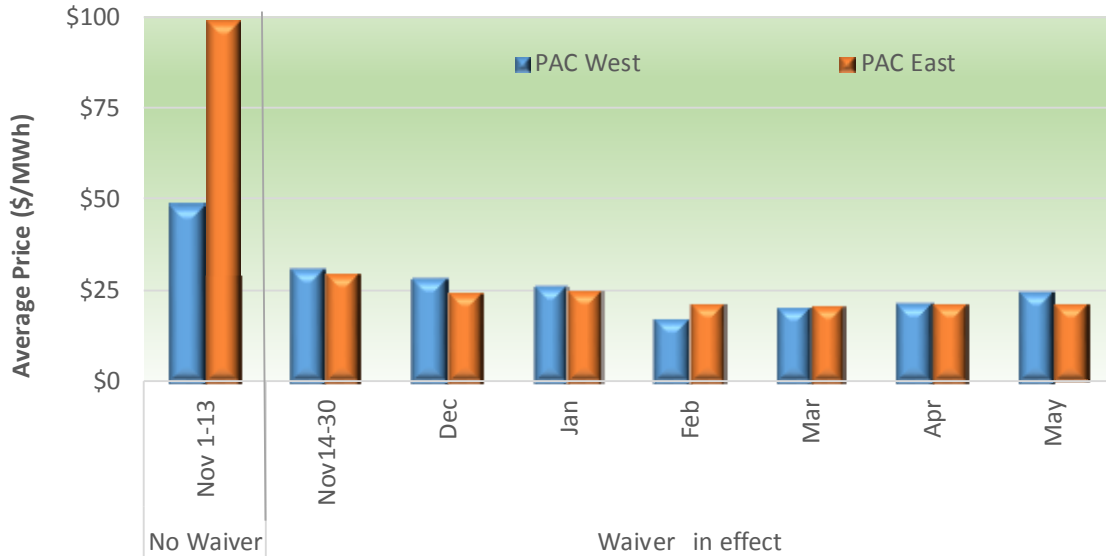
**Figure 8: Daily average of five-minute market prices in PAC East.**



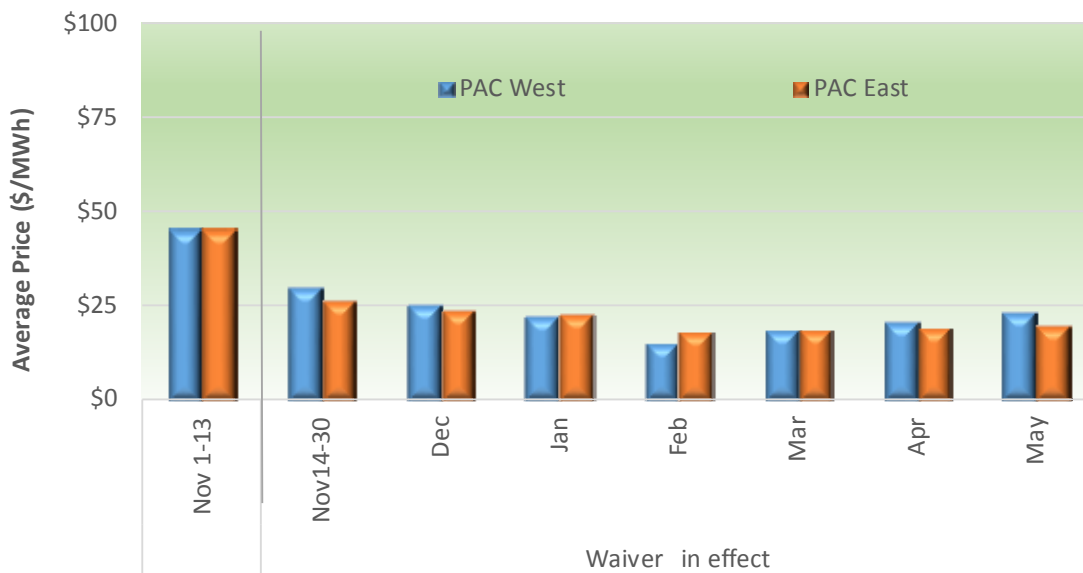
Overall, PAC East is more volatile and subject to more frequent price excursions than PAC West. This may be due to limited transfers into the PAC East area. PAC West does not share such limitations that enable more transfers in and out of the CAISO balancing authority areas to PAC West.

In both PAC East and PAC West, the five-minute real-time dispatch is notably more volatile than the fifteen-minute market. This is because the fifteen-minute market embodies more flexibility as it is further in time than the intervals whereas the five-minute real-time dispatch is closer to real-time. In the five-minute dispatch, ramping capability is more limited. Figure 9 and Figure 10 provide monthly averages of the prices as modified under the December 1 Waiver and are final as of now. These include price corrections and price adjustments under waiver of this report. These figures show that the average price for energy in both the PAC East and West have increased slight in April 2015, around \$21.8/MWh in the fifteen-minute market and around \$20/MWh in the five-minute market.

**Figure 9: Monthly average of fifteen-minute market prices in PAC West and East.**



**Figure 10: Monthly average of five-minute market prices in PAC West and East.**



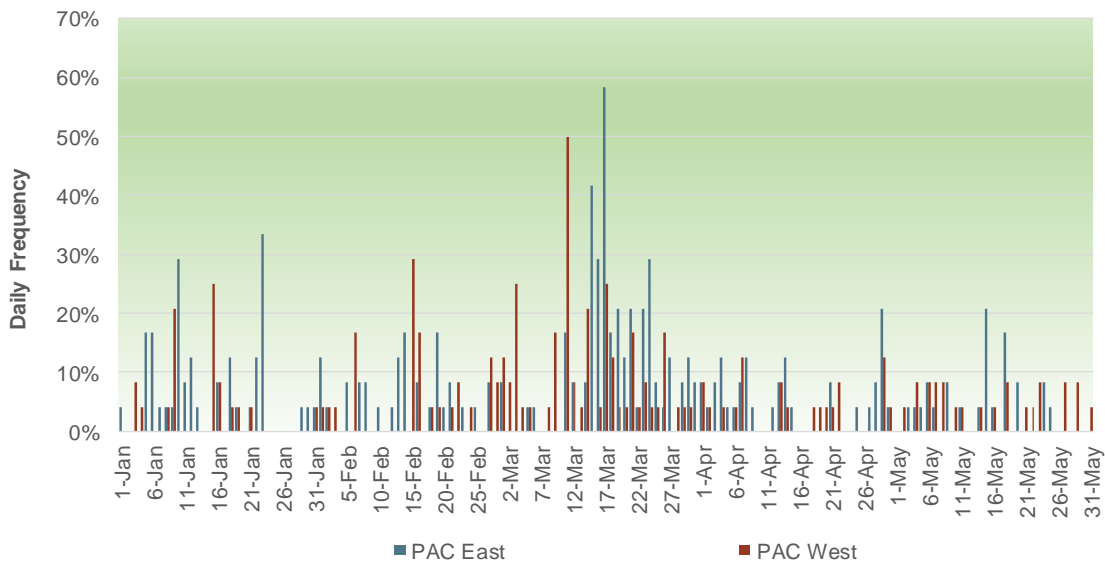
**B. Balance Test Failures**

shows the trend of balancing test failures for the period of January 1, 2015, through April 30, 2015, of operation of the EIM by area, PAC West and East. The frequency of balancing test failures decreased to a daily average of 3.9 percent in the month of April. The average imbalance was 98 MW and 34 MW in PAC East and West, respectively. The increase in frequency of balancing test failure appears to be driven by two issues: 1) an error in the net schedule

interchange for both PACE and PACW reported for the balancing test compared to the net schedule interchange supplied for the fifteen- and five-minute markets; and 2) incorrect disqualification of base schedules from certain multi-stage generating units. These issues did not appear to influence imbalance infeasibilities.

Figure 11 shows the trend of balancing test failures for the period of January 1, 2015, through April 30, 2015, of operation of the EIM by area, PAC West and East. The frequency of balancing test failures decreased to a daily average of 3.9 percent in the month of April. The average imbalance was 98 MW and 34 MW in PAC East and West, respectively. The increase in frequency of balancing test failure appears to be driven by two issues: 1) an error in the net schedule interchange for both PACE and PACW reported for the balancing test compared to the net schedule interchange supplied for the fifteen- and five-minute markets; and 2) incorrect disqualification of base schedules from certain multi-stage generating units. These issues did not appear to influence imbalance infeasibilities.

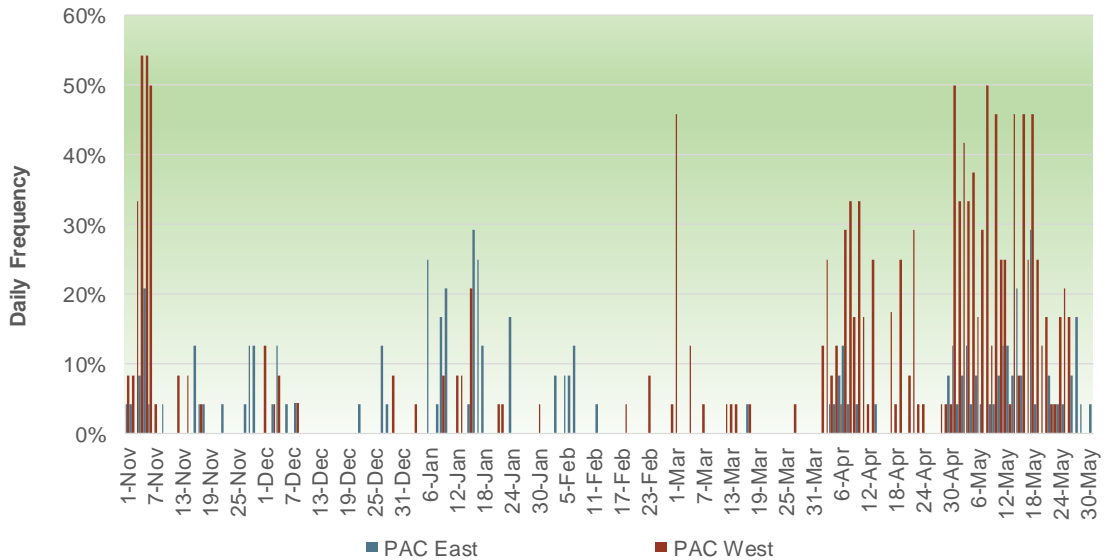
**Figure 11: Frequency of balancing test failures in PAC West and East.**



As specified in section 29.34(n) of the CAISO tariff and section 10.3.2.1 of the Business Practice Manual for the EIM, 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. 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 those balancing authority area-to-area group constraints. This sufficiency

test applies to each PAC West and East area on an hourly basis. Figure 12 shows the trend of test failures for flexible ramping for the first two months of operation of the energy imbalance market. The CAISO obtained the frequency by dividing the number of hours failed by 24 hours of a day.<sup>10</sup>

**Figure 12: Frequency of flexible ramp sufficiency test failures in PAC West and East.**



<sup>10</sup> During the term of the waiver, the procedure described in Section 10.3.2.1 of the Business Practice Manual is made ineffective under the pricing procedure under the waiver.

## ATTACHMENT E

In addition to the CAISO reporting on each relaxation event in Attachment B, this Attachment E provides a summary of the magnitude and frequency of such events overall.<sup>11</sup>

The relaxation events affect numerous market intervals as the CAISO real-time markets contain many fifteen- and five-minute intervals. The CAISO provides the information at summary level because the data is significant and detailed reporting of such events would not be meaningful. The report focuses on the external load aggregation points (ELAP) prices because these aggregate prices represent pricing in each area – West and East – and therefore, reflect short-term imbalance shortage for the aggregate area.

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<sup>11</sup> *December 1 Order*, at P 26.

Figure 13 through Figure 20 provide summary information on the instances of power balance relaxation for undersupply (shortage) in the fifteen- and five-minute market in the PAC West and East area. Normally, when there are such infeasibilities, prices will be based on the constraint relaxation pricing parameter, and prices will be near or at \$1000/MWh. However, there are three cases where this would not occur and this is reflected in the data supporting the figures in this report. First, as of December 1<sup>st</sup> consistent with the December 1 tariff waiver, the price is based on the last economic signal consistent with the pricing principles in the tariff. Second, as described in more detail in Attachment A, when the EIM Entity fails the flexible ramping sufficiency test, prices are calculated using the same approach based on the last economic signal for the duration of the restricted interval. Therefore, in these intervals, even if the CAISO had not received the waiver, the CAISO would have implemented the procedure described in Section 10.3.2.1 of the Business Practice Manual, and price based the last economic bid cleared in the fifteen-minute or five-minute interval in the EIM Entity balancing authority area as opposed to the \$1000/MWh bid cap.<sup>12</sup>

In the December 15, 2014 report, the CAISO noted there was a third case in which it had observed the power balance constraint was relaxed in the scheduling run, but prices did not reflect the \$1000/MWh. The CAISO has since evaluated these cases more closely and as discussed in Attachment A, sometimes the market is in a degeneracy case, and the market clears based on the last economic signal. The CAISO is continuing to investigate these intervals to ensure these events are not due to other abnormalities and are due to degeneracy. As explained in Attachment A, after implementing the pricing procedure under the December 1 waiver there is no pricing based on the degeneracy cases because the pricing procedure under the December 1 waiver governs over the pricing.

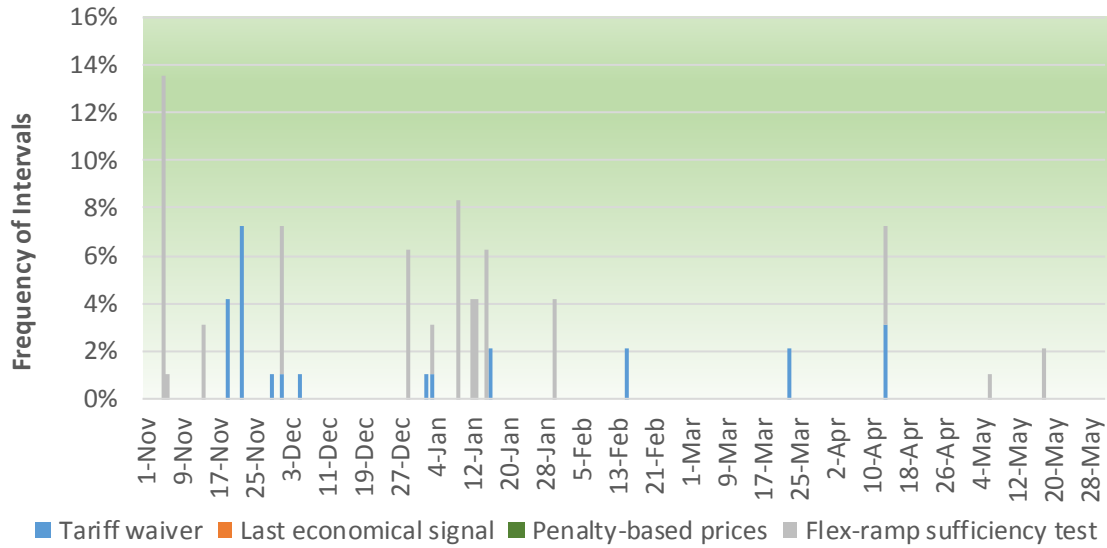
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<sup>12</sup> The price discovery mechanism under the procedure described in Section 10.3.2.1 of the BPM for Energy Imbalance Market is, however, essentially the same price discovery procedure used under the December 1 Order waiver.

Figure 13 through Figure 20 exclude the intervals invalid. These figures show the frequency of infeasibilities organized by instances in which the prices were set based on 1) the last economic bid price signal as per the tariff waiver, referred to in the figures as “Tariff waiver,” 2) the \$1000/MWh penalty price parameter, referred to in the figures as “Penalty-based prices” 3) last economical signal from degeneracy referred as “Last economical signal” and 4) the last economic signal but because for those intervals the EIM entity failed the flexible ramping sufficient test, referred to as the “Flex-ramp sufficient test.” Each figure of the frequency of infeasibilities is accompanied with a figure the magnitude of infeasibilities. The reported events are also aggregated daily and depicted with an infeasibility range shown by the vertical line in blue. The ends of the vertical blue lines represent the minimum and maximum values of power balance relaxation in each day. The average magnitude of the infeasibility is shown by the red marker on the blue vertical lines.

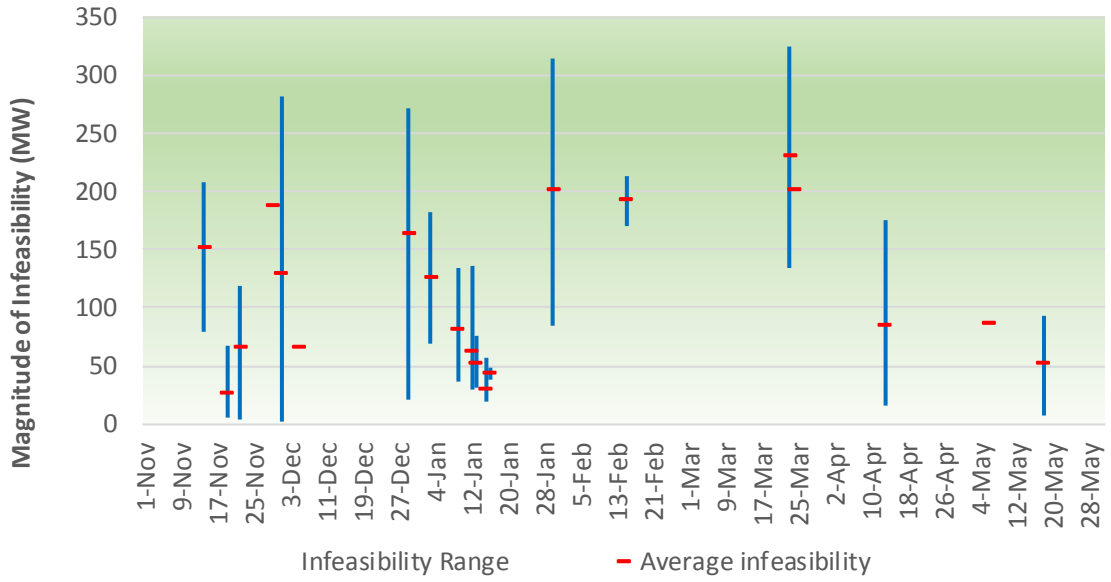


**Figure 13: Frequency of under-supply infeasibility in PAC West. Fifteen-minute market.**

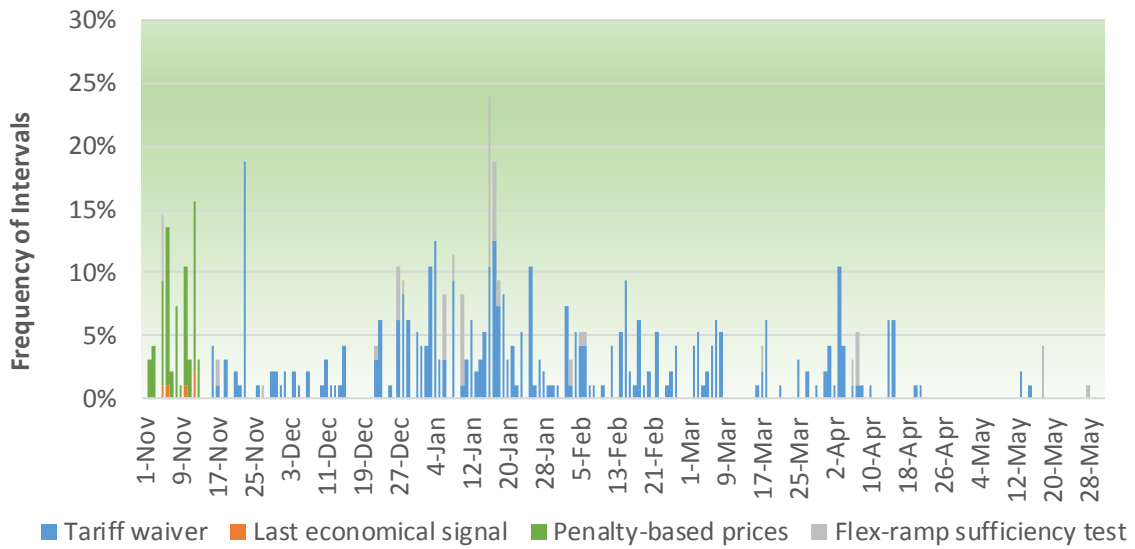


For the period of November 1 through November 13, the data on the magnitude of infeasibility in the fifteen-minute market was not preserved in the data system. This impedes the CAISO’s ability to identify the cases with infeasibility and quantify their magnitude. However, such instances were conservatively estimated by analyzing the cases where prices reached the relaxation-based levels of \$1000/MWh.

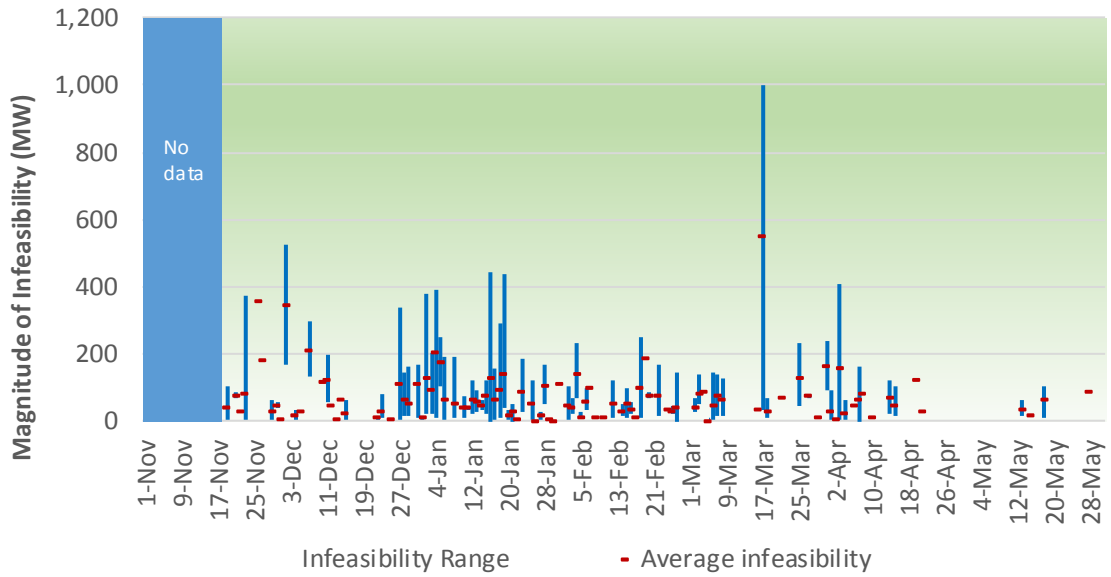
**Figure 14: Magnitude of undersupply infeasibility in PAC West. Fifteen-minute market.**



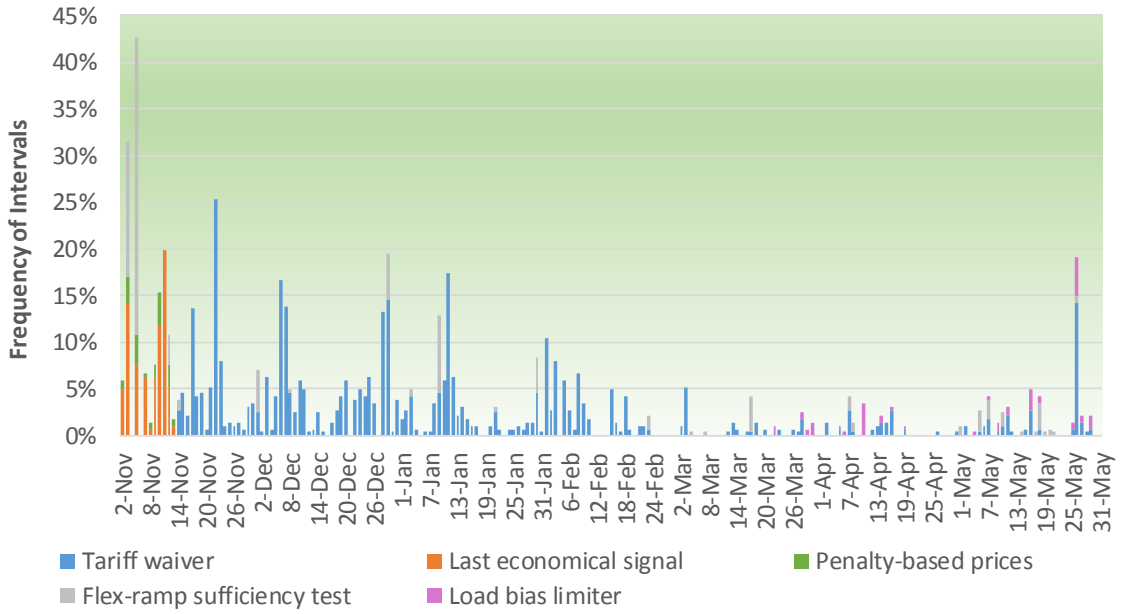
**Figure 15: Frequency of undersupply infeasibility PAC East. Fifteen-minute market.**



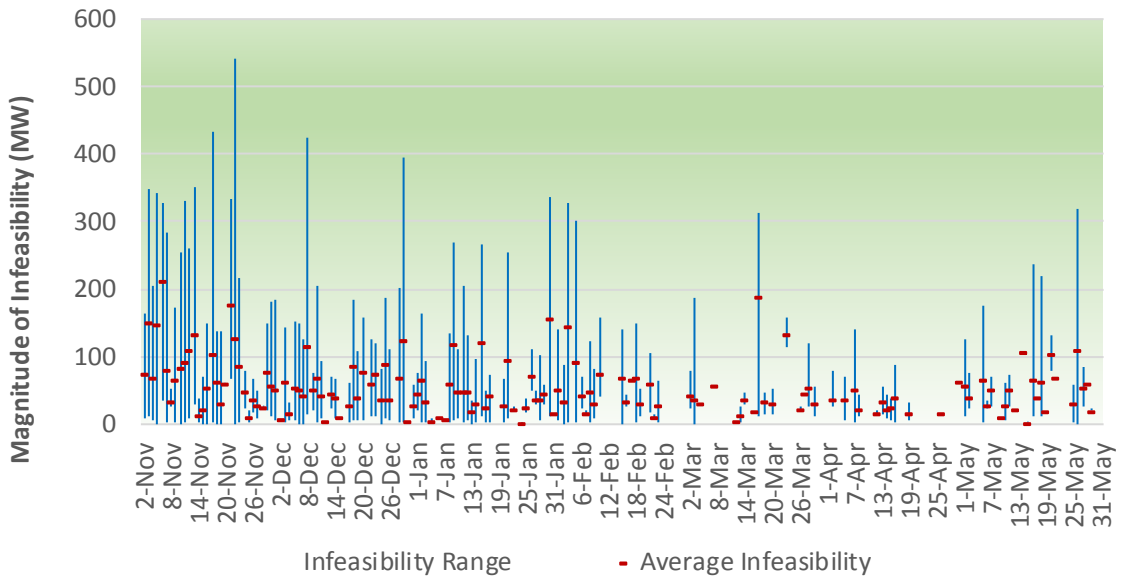
**Figure 16: Magnitude of undersupply infeasibility PAC East. Fifteen-minute market.**



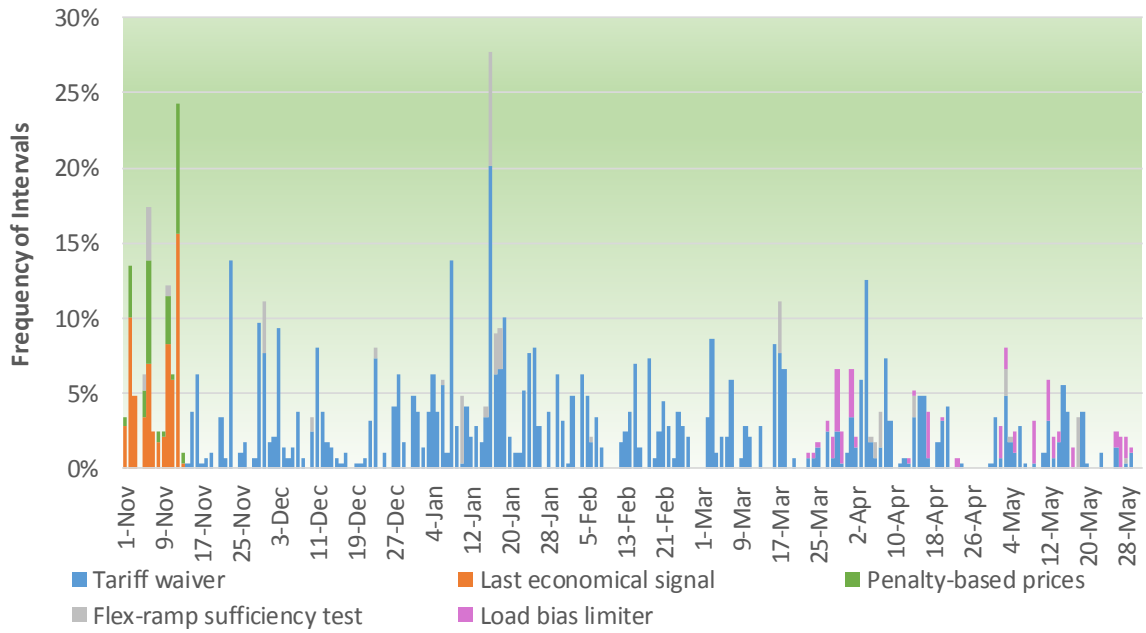
**Figure 17: Frequency of undersupply infeasibility PAC West. Five-minute market.**



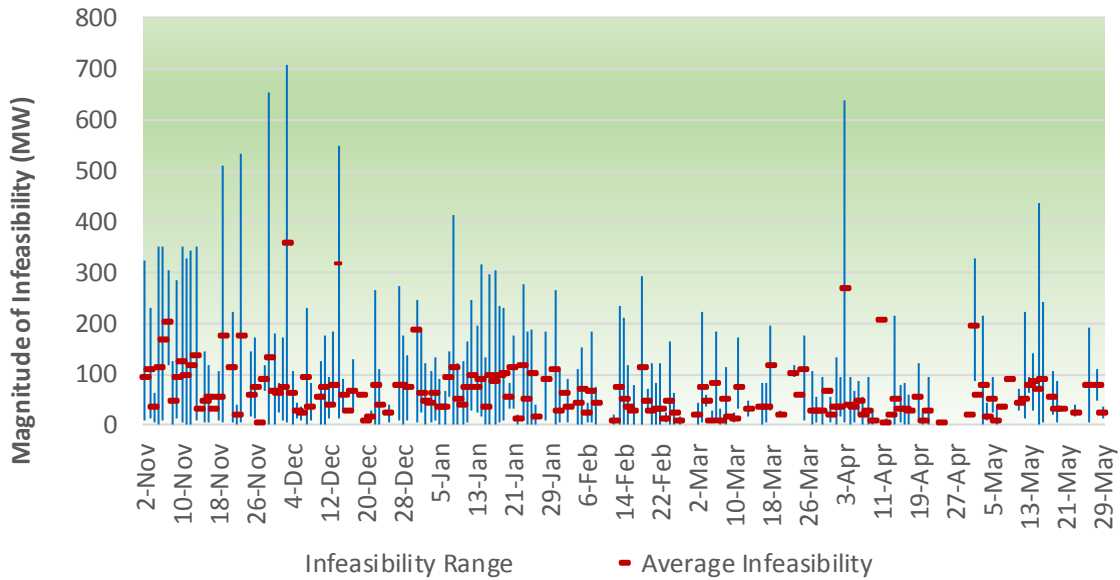
**Figure 18: Magnitude of undersupply infeasibility PAC West. Five-minute market.**



**Figure 19: Frequency of undersupply infeasibility PAC East. Five-minute market.**



**Figure 20: Magnitude of undersupply infeasibility PAC East. Five-minute market.**



The imbalance energy transfers may also be subject to relaxation to address infeasibilities. There were few instances only in the PAC East transfer that resulted in relaxation and there were no instances of relaxation of EIM transfers between PAC and CAISO. The summary of these instances are listed in Table 1.



Table 2. All these instances occurred before the period applicable for the waiver associated with this report; there were no valid EIM transfer infeasibilities observed in January and February. Three invalid infeasibilities were on PAC East on January 15 due to a software issue addressed through the standard process of price corrections.

**Table 1: Statistics of EIM transfer infeasibilities for PAC East.  
Fifteen-minute market.**

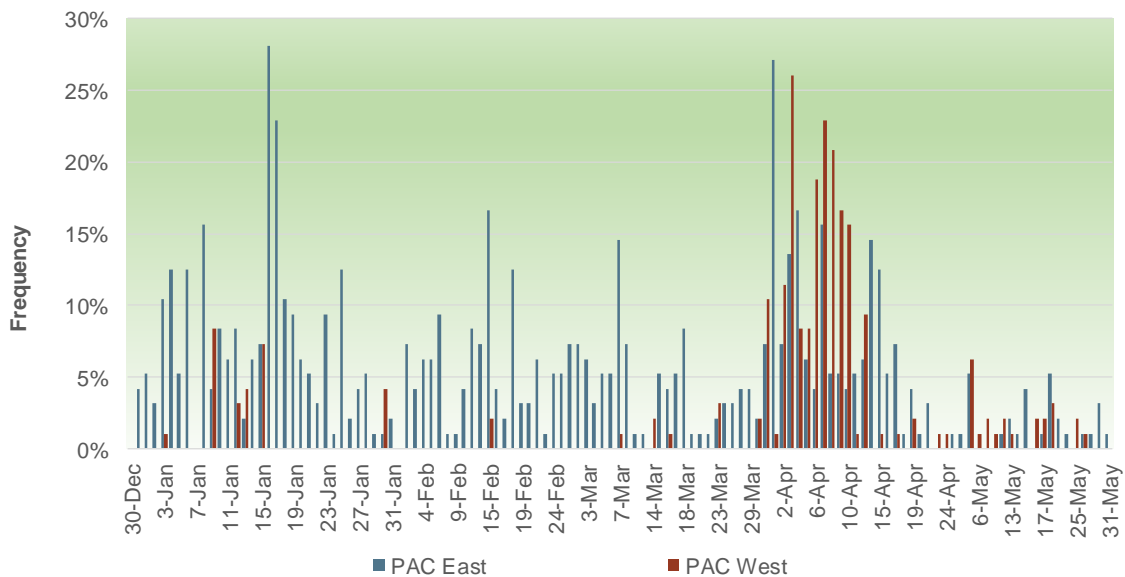
Date	Maximum	Minimum	Average	Count
6-Nov-14	51.4	1.1	26.2	2
10-Nov-14	121.0	121.0	121.0	1
12-Nov-14	126.7	72.0	99.3	2
13-Nov-14	130.9	16.9	76.2	3

**Table 2: Statistics of EIM transfer infeasibilities for PAC East. Five-minute market.**

Date	Maximum	Minimum	Average	Count
6-Nov-14	65.2	65.2	65.2	1
10-Nov-14	114.3	97.9	106.1	2

For completeness, the data in this report also includes those cases in which there was a relaxation of flexible ramp constraint; the data is organized by PAC West and East in Figure 21.

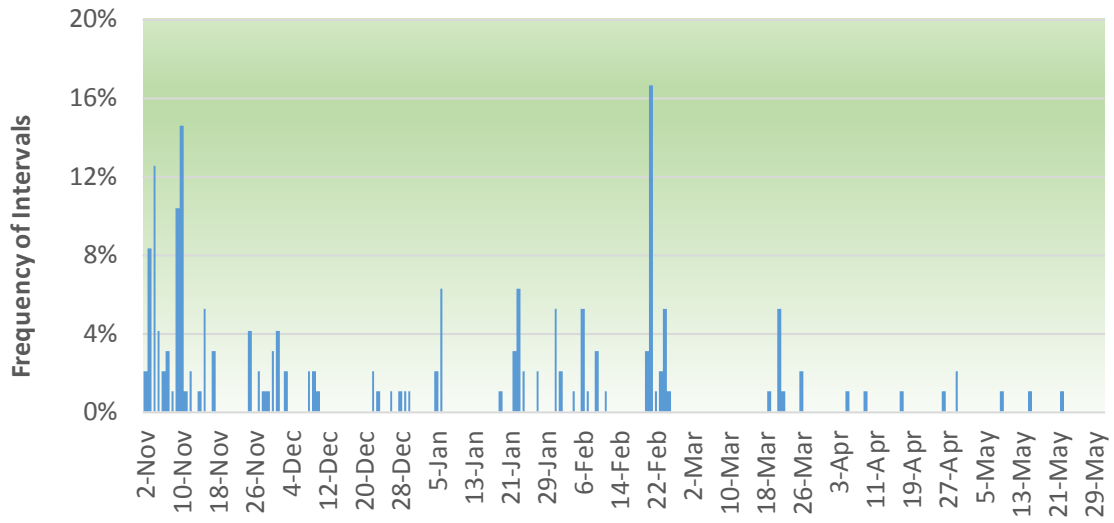
**Figure 21: Frequency of flexible ramp constraint infeasibility in PAC**



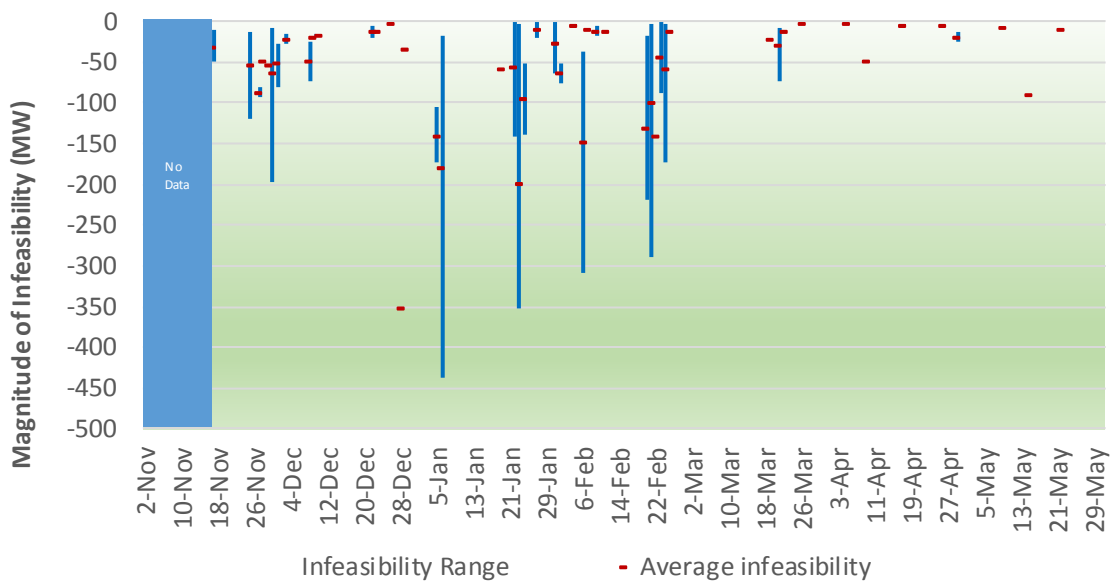
Finally, this report also includes information about infeasibility for over supply conditions even though these cases are not reflected in the waiver requested in this proceeding. The penalty prices specified in sections 27.4.3.2 and 27.4.3.4 only pertain to infeasibility cases in which there is under-supply. The penalty prices for the over-supply conditions are specified in section 6.6.5 of the BPM for Market Operations. Figure 22 through

Figure 29 provide the over-supply metrics.

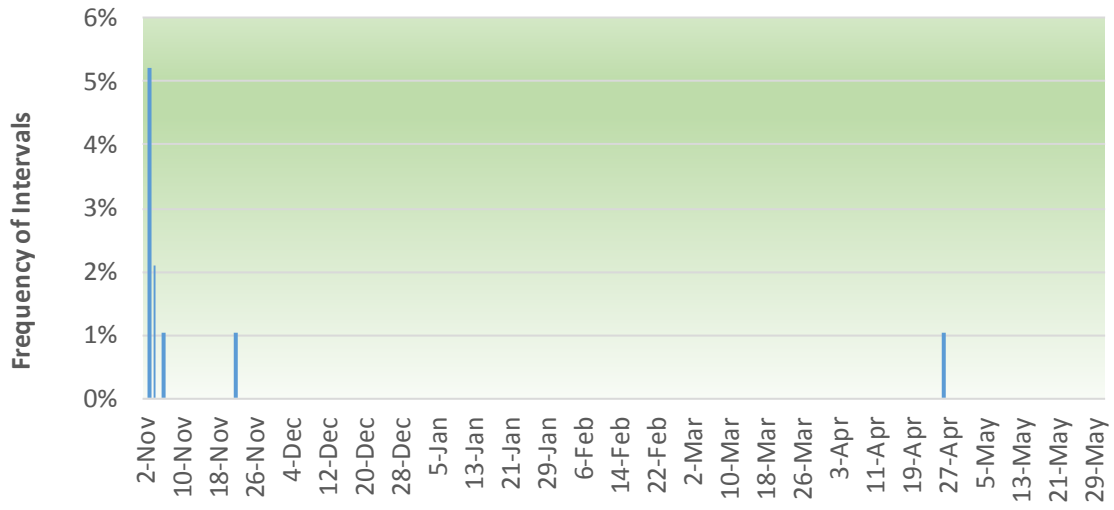
**Figure 22: Frequency of oversupply infeasibility PAC West. Fifteen-minute market.**



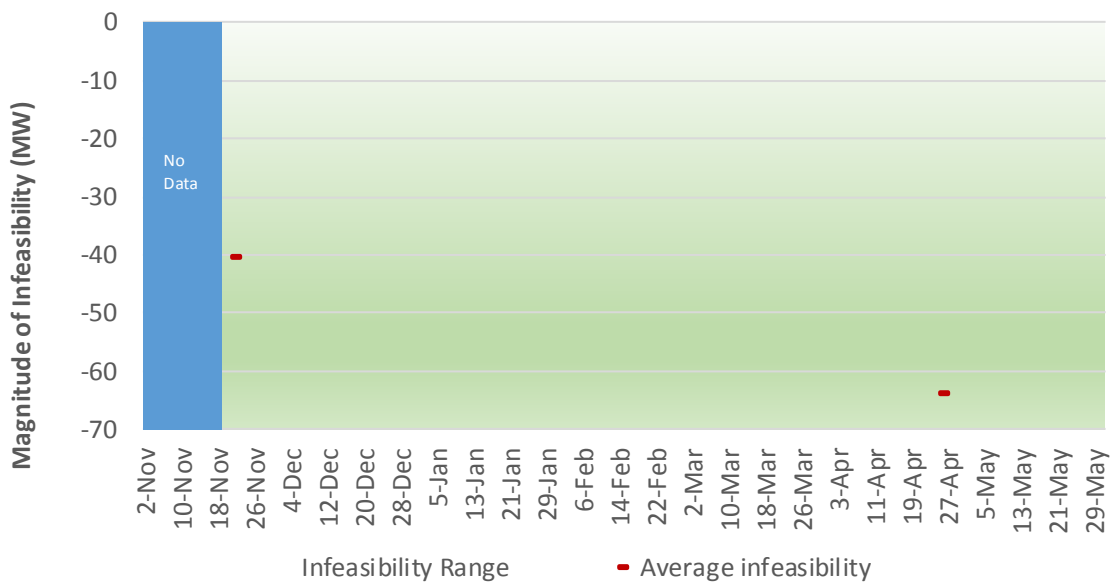
**Figure 23: Magnitude of oversupply infeasibility PAC West. Fifteen-minute market.**



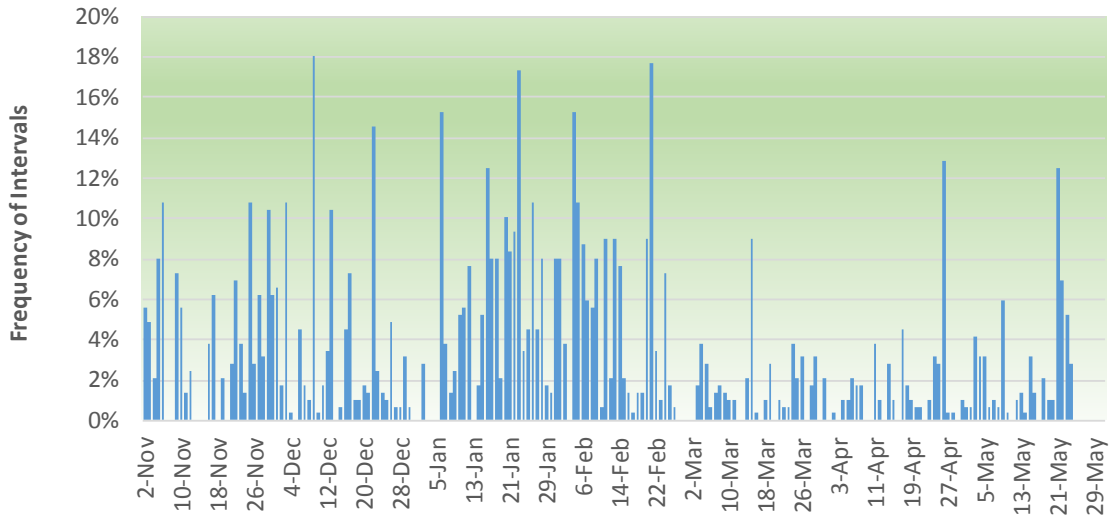
**Figure 24: Frequency of oversupply infeasibility PAC East. Fifteen-minute market.**



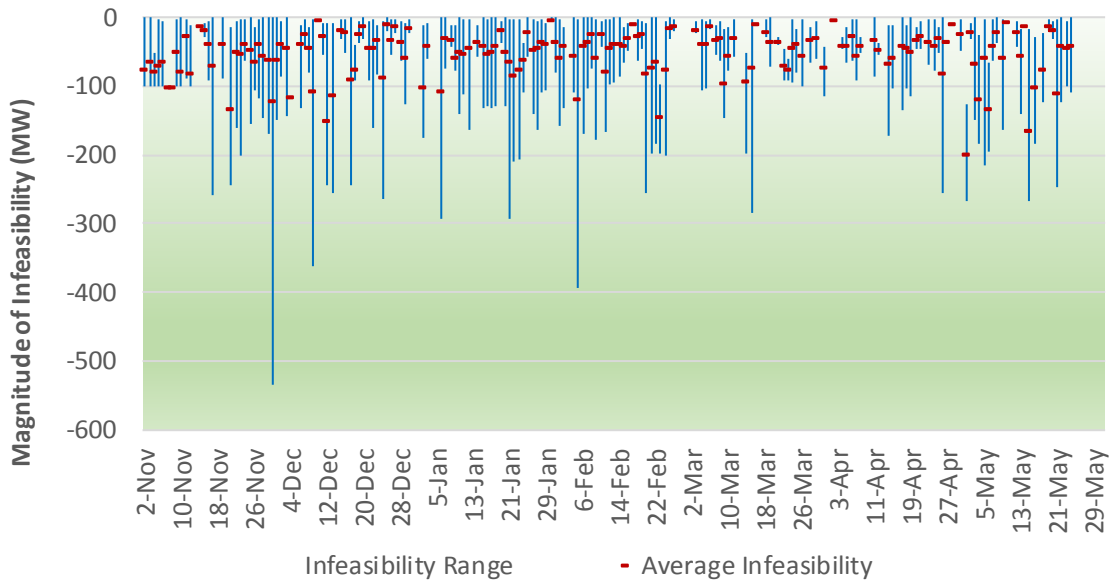
**Figure 25: Magnitude of oversupply infeasibility PAC East. Fifteen-minute market.**



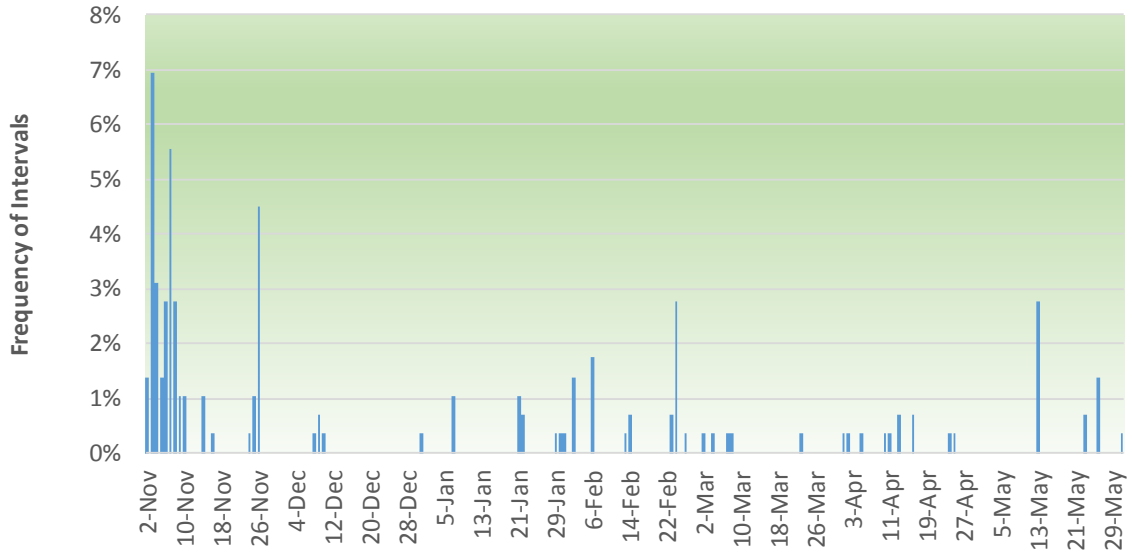
**Figure 26: Frequency of oversupply infeasibility PAC West. Five-minute market.**



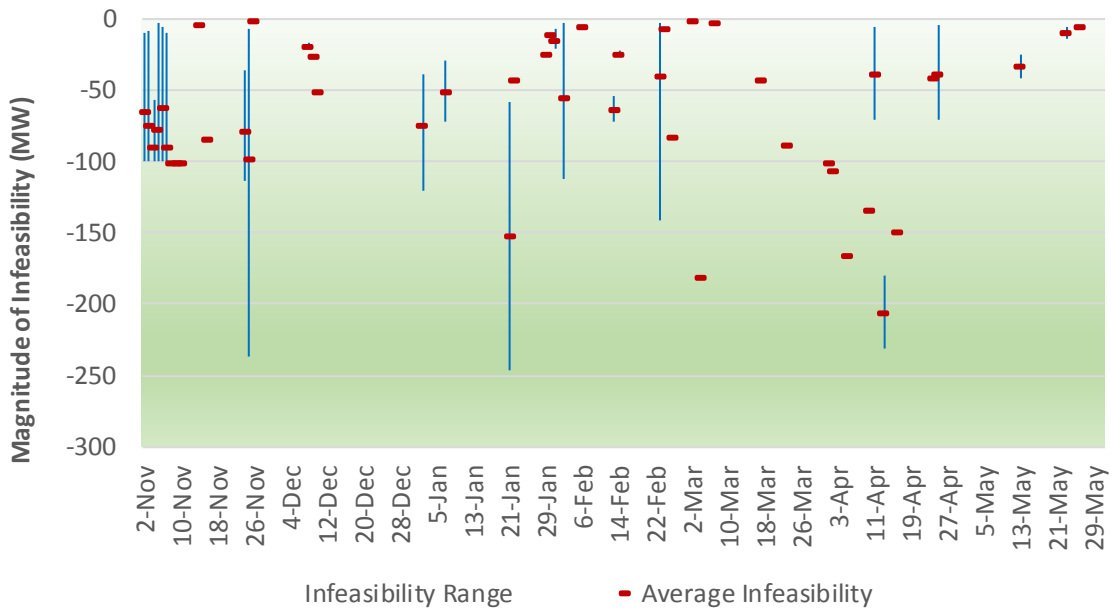
**Figure 27: Magnitude of oversupply infeasibility PAC West. Five-minute market.**



**Figure 28: Frequency of oversupply infeasibility PAC East. Five-minute market.**



**Figure 29: Magnitude of oversupply infeasibility PAC East. Five-minute market.**



## 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 14<sup>th</sup> day of July, 2015.

*Anna Pascuzzo*

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