

April 4, 2017

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

**Re: California Independent System Operator Corporation  
Docket: ER15-2526-\_\_\_\_\_**  
**Independent Assessment by the Department of Market Monitoring  
November 2016 Energy Imbalance Market Transition Period  
Report – Arizona Public Service**

Dear Secretary Bose:

The Department of Market Monitoring (DMM) hereby submits its independent assessment on the transition period of Arizona Public Service (APS) during its first six months of participation in the Energy Imbalance Market (EIM) for November 2016. APS entered the EIM on October 1, 2016, and the transition period will apply to its balancing authority area until April 1, 2017.

Please contact the undersigned directly with any questions or concerns regarding the foregoing.

Respectfully submitted,

**By: /s/ Eric Hildebrandt**

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## California ISO

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# Report on energy imbalance market issues and performance: Arizona Public Service for November, 2016

April 4, 2017

Prepared by: Department of Market Monitoring



## Executive summary

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Pursuant to the Commission's October 29, 2015 Order on the ISO's Energy Imbalance Market (EIM), the ISO filed a report on March 13, 2017 covering the period from November 1 through November 30, 2016 (November 2016 Report) for the Arizona Public Service area in the energy imbalance market.<sup>1</sup> This report provides a review by the Department of Market Monitoring (DMM) of energy imbalance market performance in the Arizona Public Service area during the period covered in the ISO's November report.

This report includes a summary of the frequency of the downward flexible ramping sufficiency test, along with discussion of impacts this test had on market outcomes including power balance constraint relaxations for excess energy. DMM recommends the ISO consider adding this analysis to its future monthly reports. During our review of the ISO's November report, DMM worked with the ISO to reconcile differences and create an accurate portrayal of constraint relaxations. DMM will continue to work with the ISO on this going forward. Key findings in this report include the following:

- In November, the ISO implemented a downward flexible ramping sufficiency test in addition to the existing upward flexible ramping sufficiency test. This change coincided with the release of the flexible ramping product. During the month, the Arizona Public Service area frequently failed the sufficiency tests, particularly in the downward direction. This contributed to frequent power balance constraint relaxations, particularly when generation exceeded forecast demand. However, this did not have a large impact on Arizona Public Service prices because of the transition period pricing feature that is in place until April 2017.
- Arizona Public Service settlement prices tracked closely with Southern California Edison area prices within the ISO during most hours. The average price used for load settlement, which combines 15-minute and 5-minute prices, was about \$25/MWh in Arizona Public Service area during November, compared to about \$31/MWh in Southern California Edison for the same period. This price difference was driven by limited export capability from Arizona Public Service because of failed downward sufficiency tests and greenhouse gas (GHG) costs applicable to prices in California.
- The percentage of intervals when the power balance constraint was relaxed during November increased significantly compared to October, the first month that Arizona Public Service participated in the energy imbalance market. Almost all of the infeasibilities occurred during hours when Arizona Public Service failed the flexible ramping sufficiency test. However, the ISO identified many of these flexible ramping sufficiency test failures as invalid during their price validation process because of underlying issues with the accuracy of the test results, such as incorrect accounting of an area's flexible capability.
- Without special transition period pricing provisions in place, the frequency of intervals the load bias limiter would have triggered increased from the previous month but remained relatively infrequent overall. In the 15-minute market, the load bias limiter would have triggered during four intervals when the power balance constraint was relaxed for under-supply conditions. The resulting market prices would have been about 3 percent lower during the month had the load bias limiter been in

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<sup>1</sup> The ISO's November 2016 Report was filed at FERC and posted in the ISO website on March 13, 2017, [http://www.caiso.com/Documents/Mar13\\_2017\\_EIMInformationalReport-TransitionPeriod\\_APS\\_Nov2016\\_ER15-2565.pdf](http://www.caiso.com/Documents/Mar13_2017_EIMInformationalReport-TransitionPeriod_APS_Nov2016_ER15-2565.pdf).

place and not transition period pricing. In the 5-minute market the load bias limiter would have triggered more frequently for power balance excesses than power balance shortages.

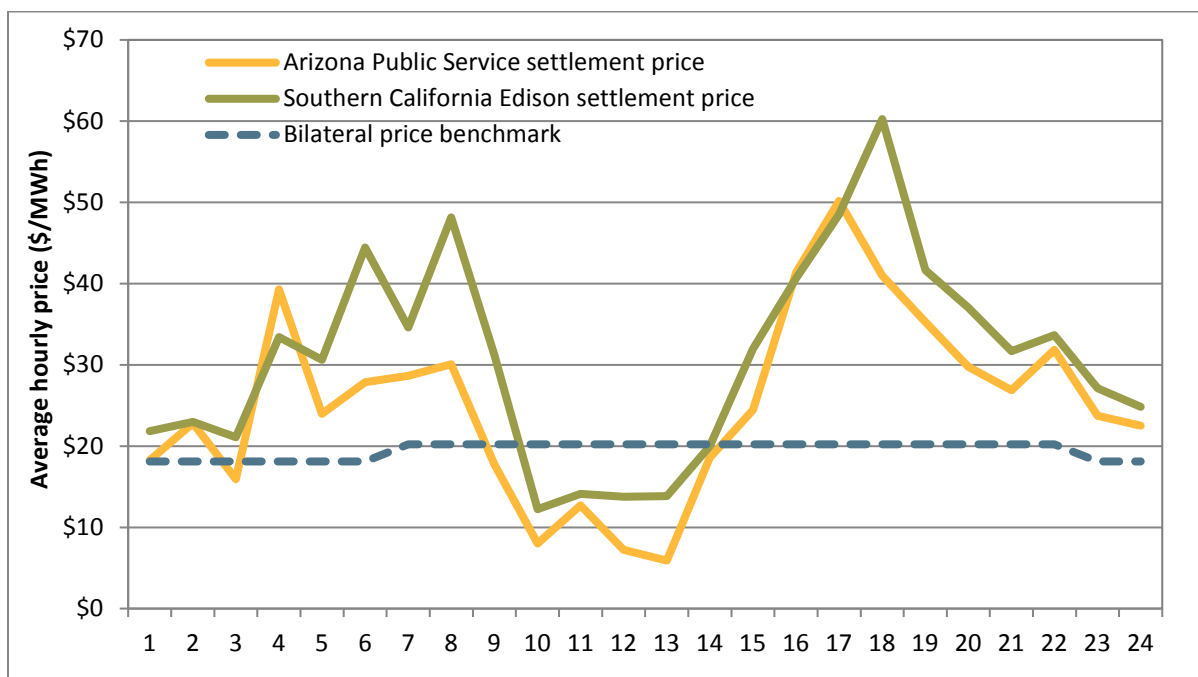
Section 1 of this report provides a description of prices in the market and impacts from the power balance constraint, section 2 provides details on the impact of the load bias limiter, and section 3 provides details and results from the flexible ramping sufficiency test.

## 1 Energy imbalance market prices

Figure 1.1 shows hourly average settlement prices during November in Arizona Public Service and Southern California Edison, as well as the bilateral prices DMM used as an additional benchmark for energy imbalance market prices.<sup>2</sup>

The bilateral price benchmark includes peak and off-peak prices at various trading hubs using day-ahead ICE indices that are representative of an EIM entity’s pricing for settling imbalance prior to EIM implementation. For Arizona Public Service, the bilateral price benchmark reflects average prices at three major western trading hubs: Mead, Palo Verde, and Four Corners.

**Figure 1.1 Settlement prices and bilateral price benchmark – Arizona Public Service**



Average settlement prices in Arizona Public Service during the month often reflected market outcomes in the ISO because of large transfer capabilities and little congestion. However, prices diverged between Arizona Public Service and Southern California Edison during some hours in November partly because of limited exports from failures of the downward flexible ramping sufficiency test and greenhouse gas compliance costs when energy was deemed delivered from Arizona Public service to the ISO. When any energy imbalance market area fails the downward sufficiency test, exports are limited to base schedules, and for Arizona Public Service this frequently contributed to power balance constraint

<sup>2</sup> The load settlement price is an average of 15-minute and 5-minute prices, weighted by the amount of estimated load imbalance in each of those markets. For the energy imbalance market, 15-minute prices are weighted by the imbalance between base load and forecast load in the 15-minute market, while 5-minute prices are weighted by the imbalance between forecast load in the 15-minute market and forecast load in the 5-minute market.

relaxations for excess supply during November.<sup>3</sup> Settlement prices averaged about \$25/MWh in Arizona Public Service and \$31/MWh in the Southern California Edison load aggregation area during the month.

Figure 1.2 through Figure 1.5 show the frequency of power balance constraint relaxations in the 15-minute and 5-minute markets by week. All power balance constraint relaxations that occurred in November are subject to the six-month transition period pricing that expires in April 2017. This feature sets prices equal to the last economically dispatched unit instead of the \$1,000/MWh penalty parameter while relaxing the constraint for shortages and the -\$155/MWh penalty parameter while relaxing the constraint for excess energy. Power balance constraint relaxations in Arizona Public Service during November can be grouped in the following categories:

- **Valid under-supply infeasibility** (or power balance constraint shortage). These occurred when the power balance constraint was relaxed because load exceeded available generation. The ISO validated that the ISO software was working appropriately during these instances.
- **Valid over-supply infeasibility** (or power balance constraint excess). These occurred when the power balance constraint was relaxed because generation exceeded load. The ISO validated that the ISO software was working appropriately during these instances.
- **Load bias limiter resolved infeasibility.** These occurred when a load adjustment entered by Arizona Public Service exceeded that amount of relaxation of the power balance constraint and the load adjustment was in the same direction. In these cases the load bias limiter automatically reduced the operator adjustment in the pricing run to prevent the infeasibility, resulting in the same outcome as the transition period pricing feature.
- **Invalid sufficiency test failure.** These occurred when the ISO software relaxed the power balance constraint during an hour the area also failed the flexible ramping sufficiency test (either upward or downward). However, unlike valid infeasibilities, the ISO later identified the result as invalid because of an underlying issue with accuracy of the test, such as incorrect accounting of the area's flexible capability.<sup>4</sup>
- **Price corrected infeasibility.** These occurred when a power balance constraint was relaxed, and resulting prices were corrected by the ISO afterwards under Section 35 of the ISO tariff.<sup>5</sup>

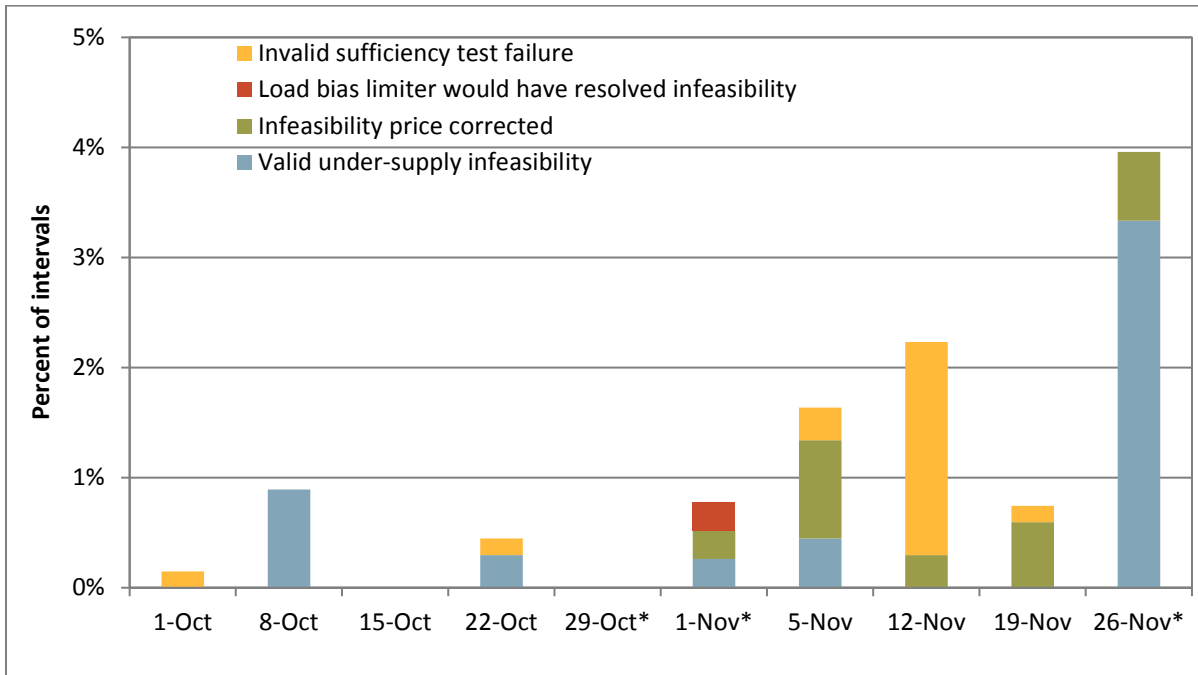
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<sup>3</sup> When a balancing area fails the flexible ramping sufficiency test, EIM transfers are limited. For example, when a participant fails the downward flexible ramping sufficiency test, the participant cannot transfer more exports from its system. Conversely, when a participant fails the upward flexible ramping sufficiency test, the participant cannot transfer more imports into the area. These rules were implemented to prevent leaning on different balancing areas for ramping resources.

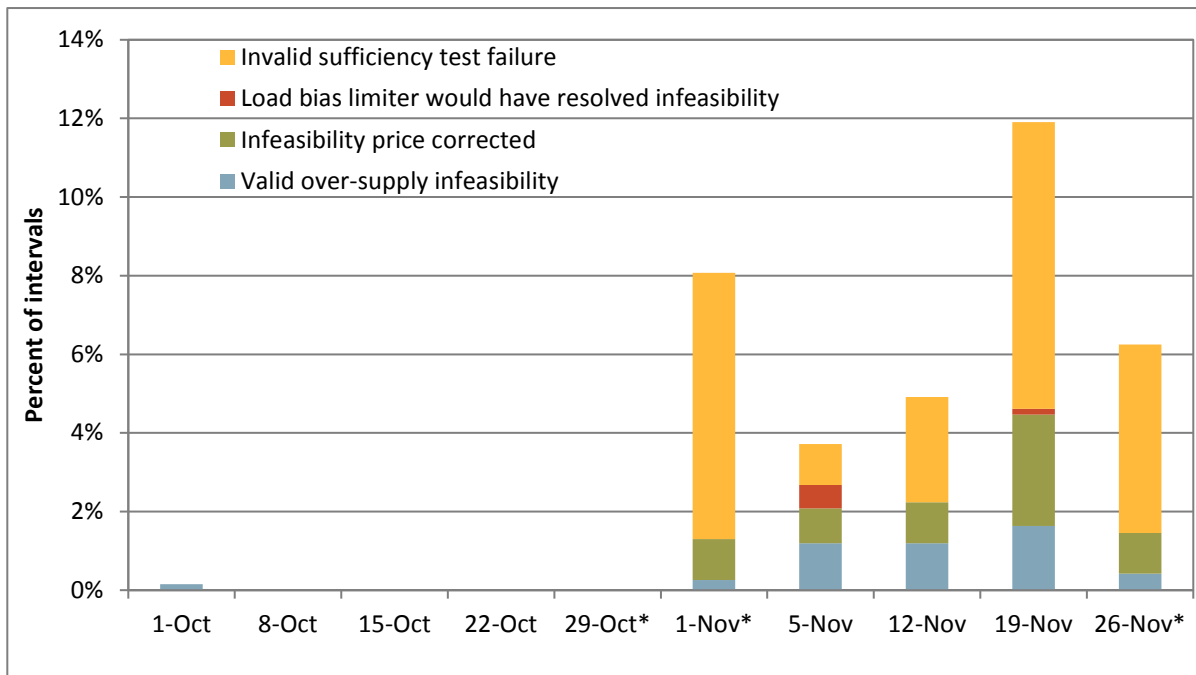
<sup>4</sup> The ISO maintains that some invalid sufficiency test failures do not necessarily invalidate power balance constraint relaxations. In particular, several consecutive hours of invalid sufficiency test failures on November 12 resulted in under-supply infeasibilities in the 15-minute and 5-minute markets. These infeasibilities were flagged as valid by the ISO because they would have been essentially infeasible regardless of the result of the sufficiency test. DMM treats all power balance constraint relaxations during hours with invalid sufficiency test failures as invalid infeasibilities throughout this report.

<sup>5</sup> Section 35 of the ISO tariff provides the ISO authority to correct prices if it detects an invalid market solution or prices due to issues such as data input failure, occurrence of hardware or software failure, or a result that is inconsistent with the ISO tariff.

**Figure 1.2 Frequency of under-supply power balance infeasibilities by week  
Arizona Public Service (15-minute market)**

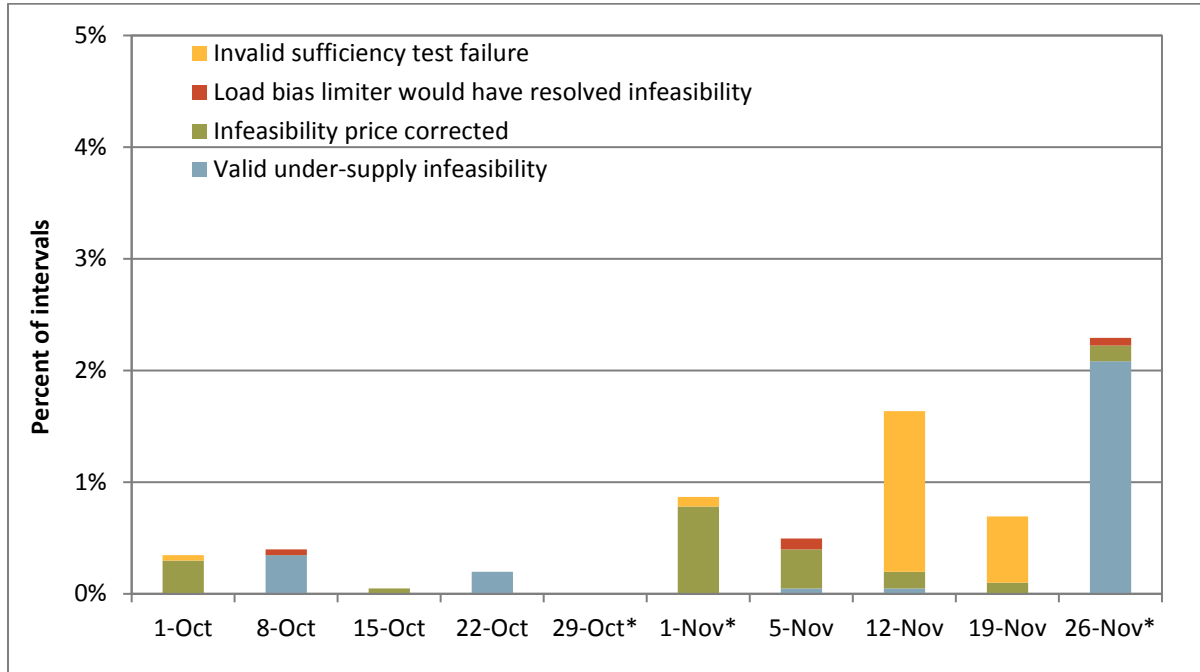


**Figure 1.3 Frequency of over-supply power balance infeasibilities by week  
Arizona Public Service (15-minute market)**

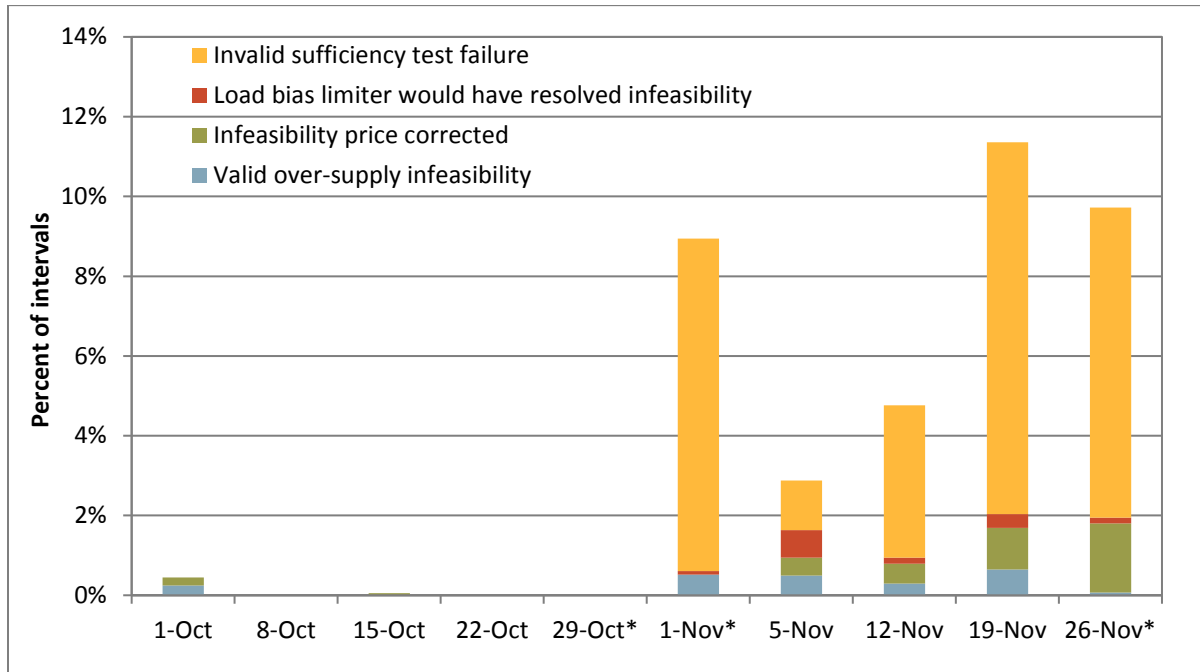




**Figure 1.4 Frequency of under-supply power balance infeasibilities by week  
Arizona Public Service (5-minute market)**



**Figure 1.5 Frequency of over-supply power balance infeasibilities by week  
Arizona Public Service (5-minute market)**



As shown in these figures, the frequency of all infeasibilities in the Arizona Public Service area increased significantly during November from the previous month.<sup>6</sup> Almost all of these infeasibilities occurred after failing the flexible ramping sufficiency test in either the upward or downward direction. In particular, Arizona Public Service failed the downward sufficiency test frequently which limited the balancing area's ability to export excess energy and frequently contributed to over-supply infeasibilities.

In previous DMM reports, price corrected infeasibilities were assumed to be invalid because of the underlying error that caused the infeasibility. However, the ISO has indicated that many of the corrections during November were used to address issues with the transition period pricing mechanism when infeasibilities were still valid. Specifically, when transition pricing provisions were triggered by power balance constraint relaxations, shadow prices associated with the flexible ramping product were not always set to \$0/MWh as intended, which allowed the market software to use the last economic bid. Price corrections for these results were entered by the ISO as a result.

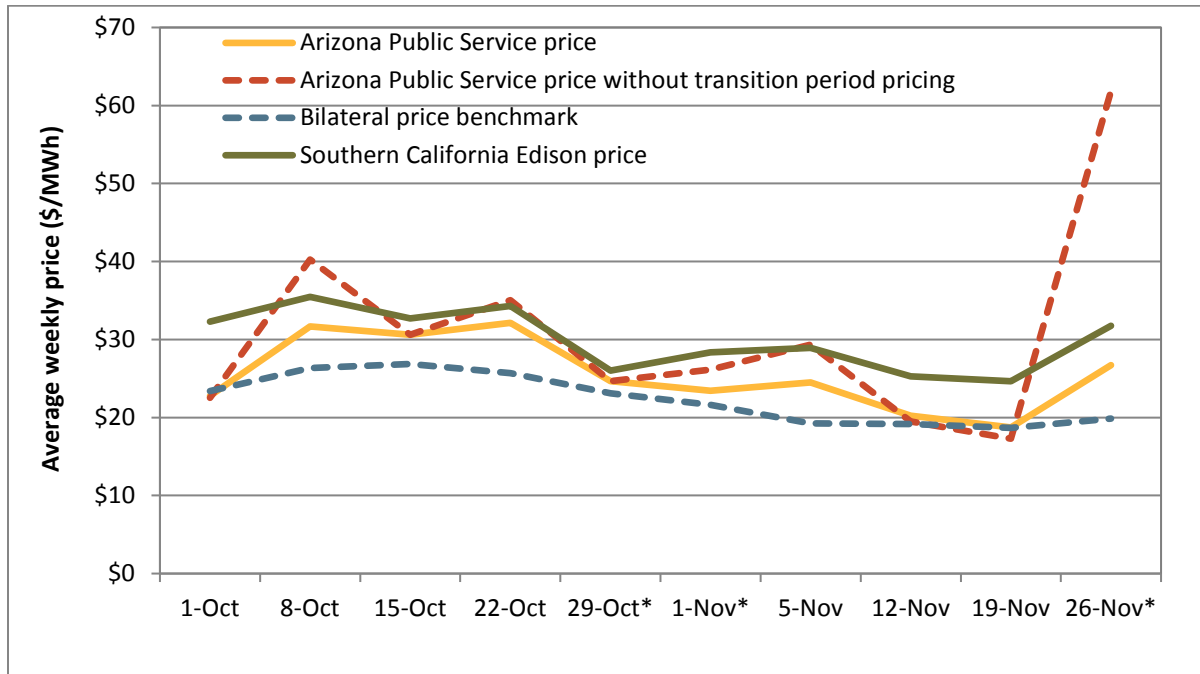
Figure 1.6 and Figure 1.7 show the average weekly prices in the 15-minute market and 5-minute market *with* and *without* the special transition period pricing provisions applied to mitigate prices in the Arizona Public Service area during November. These figures also include the average bilateral price benchmark for comparison to Arizona Public Service prices, depicted by the dashed blue lines. For this analysis, the estimated price without transition period pricing is calculated as follows:

- When the power balance constraint was relaxed for an energy shortage and the conditions for the load bias limiter were not met, we assume prices would be \$1,000/MWh minus estimated losses, which averaged around 3 percent during these intervals.
- When the power balance constraint was relaxed in the market software for an excess of energy and the conditions for the load bias limiter were not met, it is assumed prices would be -\$155/MWh plus estimated losses, which also averaged around 3 percent during these intervals.
- When the load bias limiter would have triggered, the counterfactual price would be equal to the actual price that resulted with transition period pricing in effect.
- When the power balance constraint was relaxed under conditions that triggered a price correction and the flexible ramping sufficiency test result was valid, then these intervals were treated as *valid* infeasibilities because the corrections were primarily to account for issues with the transition period pricing mechanism rather than an underlying error that produced the infeasibility. As such, penalty parameters were included in the counterfactual price when the conditions for the load bias limiter were not met. Because some of these infeasibilities may have been invalid, this may overestimate the impact of transition period pricing.
- Otherwise, when the power balance constraint was relaxed following an underlying issue including an invalid failure of the sufficiency test, then these intervals were treated as *invalid* infeasibilities and the penalty parameters were not included in the counterfactual price. The ISO has indicated that an invalid failure of the flexible ramping sufficiency test does not necessarily indicate an invalid power balance constraint relaxation. To the extent that some of these infeasibilities should be flagged valid, this may underestimate the impact of transition period pricing.

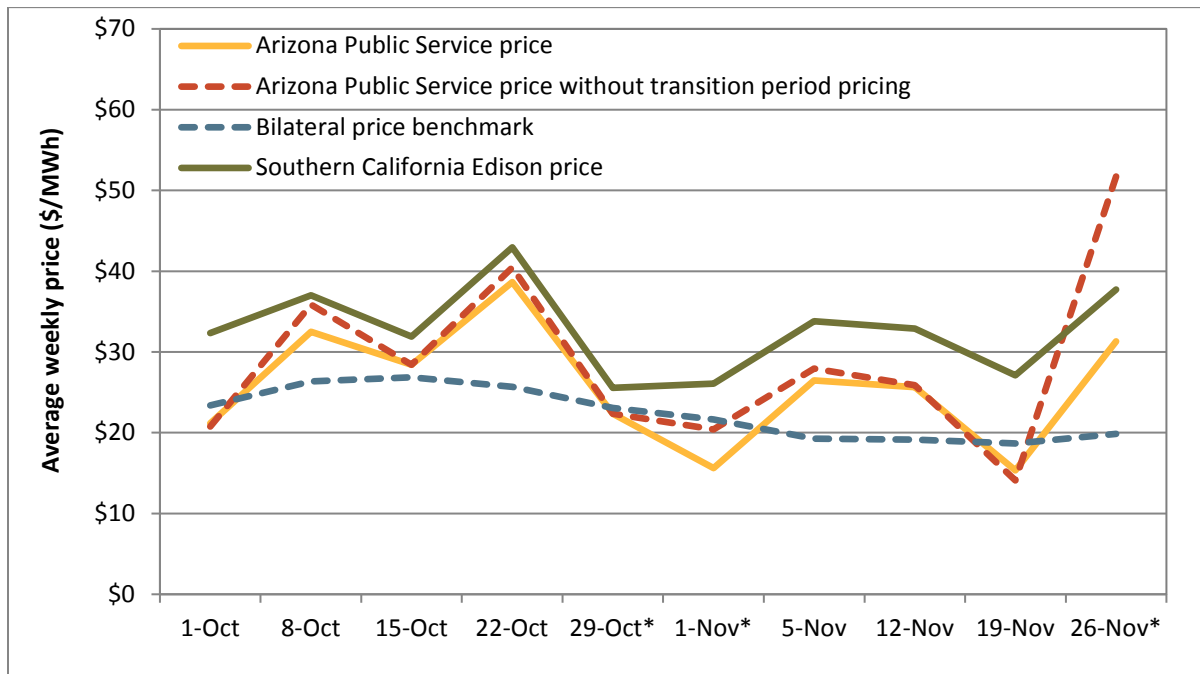
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<sup>6</sup> All weekly figures in this report contain some partial weeks marked with an asterisk. This includes the end of October and beginning of November.

**Figure 1.6 Average prices by week – Arizona Public Service (15-minute market)**



**Figure 1.7 Average prices by week – Arizona Public Service (5-minute market)**



Prices with and without transition period prices diverged significantly on November 26 when insufficient economic bids submitted from Arizona Public Service resulted in multiple hours of valid under-supply infeasibilities in the 15-minute and 5-minute markets. During other weeks in November these prices tracked closely with each other because of the relatively low frequency of valid under-supply infeasibilities. Additionally, the high frequency of over-supply infeasibilities near  $-\$155/\text{MWh}$  without transition period pricing significantly offset the impact of under-supply infeasibilities near  $\$1,000/\text{MWh}$ .



## 2 Load bias limiter

When the load bias limiter is triggered this would have the same effect as the price discovery feature and caused prices to be set by the last economic bid dispatched rather than the \$1,000/MWh penalty price for energy power balance shortage relaxations. A more detailed description of the load bias limiter is included in DMM's April 2015 report.<sup>7</sup> The ISO also included a discussion of the load bias limiter in its answer to comments regarding available balancing capacity on November 24, 2015.<sup>8</sup>

Table 2.1 shows the average 15-minute and 5-minute market price with transition period pricing as well as counterfactual estimates for prices without transition period pricing and without either transition period pricing or the load bias limiter. The estimates for the counterfactual prices use the same methodology discussed in the previous section.

The frequency of intervals in which both the power balance constraint was relaxed and the load bias limiter would have triggered increased from the previous month for Arizona Public Service in both real-time markets, but remained relatively infrequent overall. The majority of intervals in which these conditions were met occurred because of over-supply conditions, particularly in the 5-minute market. As a result, hypothetical 5-minute market prices without the load bias limiter would have been about \$0.24/MWh higher. In the 15-minute market, the load bias limiter would have been triggered during four intervals when the power balance constraint was relaxed for under-supply conditions such that the load bias limiter would have reduced 15-minute prices by about 3 percent, had the load bias limiter been in place and not transition period pricing.

**Table 2.1 Impact of load bias limiter on Arizona Public Service prices (November 2016)**

	Average proxy price	Price with transition period pricing	Estimated price without transition period pricing	Estimated price without transition period pricing or load bias limiter	Potential impact of load bias limiter	
					Dollars	Percent
<i>Arizona Public Service</i>						
15-minute market (FMM)	\$19.51	\$22.38	\$29.22	\$30.11	-\$0.89	-3.0%
5-minute market (RTD)	\$19.51	\$23.04	\$27.19	\$26.95	\$0.24	0.9%

<sup>7</sup> *Report on Energy Imbalance Market Issues and Performance*, Department of Market Monitoring, April 2, 2015, pp.34-35. [http://www.caiso.com/Documents/Apr2\\_2015\\_DMM\\_AssessmentPerformance\\_EIM-Feb13-Mar16\\_2015\\_ER15-402.pdf](http://www.caiso.com/Documents/Apr2_2015_DMM_AssessmentPerformance_EIM-Feb13-Mar16_2015_ER15-402.pdf)

<sup>8</sup> Answer of the California Independent systems Operator Corporation to Comments, November 24, 2015, pp. 13-21. [http://www.caiso.com/Documents/Nov24\\_2015\\_Answer\\_Comments\\_AvailableBalancingCapacity\\_ER15-861-006.pdf](http://www.caiso.com/Documents/Nov24_2015_Answer_Comments_AvailableBalancingCapacity_ER15-861-006.pdf)



### 3 Flexible ramping sufficiency test

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The flexible ramping sufficiency test ensures that each balancing area has enough ramping resources over an hour to meet expected upward and downward ramping needs. The test is designed to ensure that each energy imbalance market area has sufficient ramping capacity to meet real-time market requirements without relying on transfers from other balancing areas. This test is performed prior to each operating hour.

When the energy imbalance market was initially implemented there was an upward ramping sufficiency test. In November 2016, the ISO implemented an additional downward ramping sufficiency test in the market with the introduction of the flexible ramping product. These tests are designed to ensure that there is sufficient resource capacity available to meet forecasts and net exports for any given hour. Therefore, the test is implemented so that if an area fails the upward sufficiency test, energy imbalance market transfers are frozen and cannot be increased above base schedules.<sup>9</sup> Similarly, if an area fails the downward sufficiency test exports cannot be increased. In addition to the sufficiency test, each area is also subject to a capacity test. If an area fails the capacity test, then the flexible ramping sufficiency test fails as a result.

In November, the ISO implemented the flexible ramping product, which replaced the flexible ramping constraint, as a new mechanism to ensure sufficient upward and downward ramping capability available to meet forecast net load changes and ramping uncertainty. The ramping requirement also changed with the implementation of the flexible ramping product. Unlike the flexible ramping constraint, the demand for flexible ramping was no longer set at a single target, but rather with a demand curve. As such, the ISO changed the input to the flexible ramping sufficiency test requirement. Specifically, the ISO began to use the maximum requirement from the demand curve.<sup>10</sup> DMM has asked the ISO to reconsider how it uses the requirement from the demand curve and how the flexible ramping credit is calculated.

Limiting transfers can impact the frequency of power balance constraint relaxations and thus price separation across balancing areas. Almost all of the power balance constraint relaxations occurred after failing the flexible ramping sufficiency test in Arizona Public Service during November. Constraining transfer capability may also impact the efficiency of the energy imbalance market by limiting transfers into and out of a balancing area that could potentially provide benefits to other balancing areas.

Figure 3.1 shows the number of hours in which Arizona Public Service failed the sufficiency test in the upward or downward direction. In addition, the chart shows the number of hours where an underlying issue caused the sufficiency test to fail. As shown in Figure 3.1, the number of hours in which Arizona Public Service failed the sufficiency test increased significantly from the previous month. This includes 74 valid hours in which the sufficiency test failed in the upward direction and 103 valid hours in which the sufficiency test failed in the downward direction, or about 25 percent of all hours. The ISO listed

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<sup>9</sup> Business Practice Manual for the Energy Imbalance Market, August 30, 2016, p. 45-52:

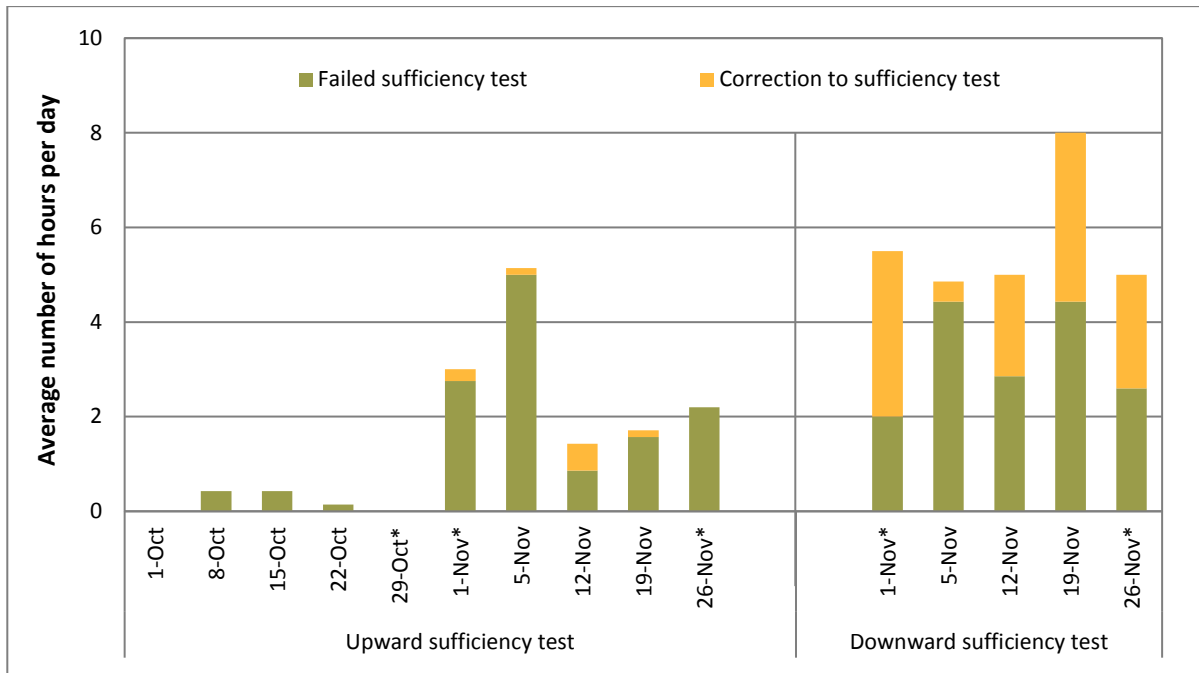
[https://bpmcm.caiso.com/BPM%20Document%20Library/Energy%20Imbalance%20Market/BPM\\_for\\_Energy%20Imbalance%20Market\\_V6\\_clean.docx](https://bpmcm.caiso.com/BPM%20Document%20Library/Energy%20Imbalance%20Market/BPM_for_Energy%20Imbalance%20Market_V6_clean.docx).

<sup>10</sup> For further detail, see DMM's presentation on January 18, 2017 by Keith Collins to the Market Performance and Planning forum on the calculation of the flexible ramping sufficiency requirement: [http://www.caiso.com/Documents/Agenda-Presentation-MarketPerformance-PlanningForum\\_Jan18\\_2017.pdf](http://www.caiso.com/Documents/Agenda-Presentation-MarketPerformance-PlanningForum_Jan18_2017.pdf).



multiple reasons for the high frequency of failed flexible ramping sufficiency tests in its November report.<sup>11</sup> Several enhancements and fixes were created in the market software during November and December to ensure that the inputs for the test were being calculated correctly. Additional enhancements are planned for 2017.

**Figure 3.1 Arizona Public Service flexible ramping sufficiency test results**



<sup>11</sup> These are listed in the ISO’s November 2016 Report: [http://www.caiso.com/Documents/Mar13\\_2017\\_EIMInformationalReport-TransitionPeriod\\_APS\\_Nov2016\\_ER15-2565.pdf](http://www.caiso.com/Documents/Mar13_2017_EIMInformationalReport-TransitionPeriod_APS_Nov2016_ER15-2565.pdf).

## CERTIFICATE OF SERVICE

I 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 4<sup>th</sup> day of April, 2017.

*/s/ Grace Clark*  
Grace Clark