

October 17, 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: ER15-2565-\_\_\_\_\_**  
**Independent Assessment by the Department of Market Monitoring  
March 2017 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 March 2017. APS entered the EIM on October 1, 2016, and this will be the last transition period report for APS.

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 March 2017

October 17, 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 July 17, 2017 covering the period from March 1 through March 31, 2017 (March 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 March report. This report includes a summary of power balance excesses, or over-supply infeasibilities, and a discussion of the effects transition period pricing had on prices. DMM recommended in prior reports that the ISO consider adding this analysis to reports on energy imbalance market areas. DMM also continues to point out key differences in figures reported in the ISO report and this report. Key findings in this report include the following:

- During March, the Arizona Public Service area frequently failed the downward flexible ramping sufficiency test, during more than 35 percent of hours. This contributed to valid power balance excesses during more than 10 percent of all intervals in the 15-minute and 5-minute markets.
- Transition period pricing significantly impacted prices during March. Without transition period pricing in place, average prices would have been about \$0/MWh in the 15-minute market, and about -\$7/MWh in the 5-minute market. These prices can be compared to actual market prices, with the transition period pricing in place, of about \$16/MWh and \$13/MWh in each market, respectively. This price difference was mostly the result of the transition period pricing mechanism replacing intervals with over-supply infeasibilities, where prices were set using the -\$155/MWh penalty parameter, with prices from the last economic bid within the area.
- Real-time prices in Arizona Public Service with transition period pricing in place tracked just below Southern California Edison area prices during most hours. During March, Arizona Public Service prices averaged around \$16/MWh in the 15-minute market and \$13/MWh in the 5-minute market, while prices in Southern California Edison averaged around \$21/MWh and \$17/MWh in each market, respectively. This price difference was mostly explained by greenhouse gas (GHG) costs applicable to energy deemed delivered to California from energy imbalance market areas.
- The frequency of valid power balance constraint shortages continued to be low during March, as well as the number of hours that Arizona Public Service failed the upward flexible ramping sufficiency test.
- The load bias limiter continued to have a relatively small impact on prices, particularly when compared to the impact of transition period pricing. During the month, the overall impact of the load bias limiter would have decreased 15-minute and 5-minute market prices by \$0.65/MWh and \$2.40/MWh, respectively.
- During DMM's review of the ISO's March report, DMM identified several key differences in the portrayal of infeasibilities, the impact of transition period pricing, and the pass rate of the flexible

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<sup>1</sup> The ISO's March 2017 Report was filed at FERC on July 17, 2017 and posted on the ISO website on August 15, 2017. [http://www.caiso.com/Documents/Aug15\\_2017\\_EIMInformationalReport-TransitionPeriod\\_ArizonaPublicService\\_Mar2017\\_ER15-2565.pdf](http://www.caiso.com/Documents/Aug15_2017_EIMInformationalReport-TransitionPeriod_ArizonaPublicService_Mar2017_ER15-2565.pdf).

ramping sufficiency test. In particular, the ISO's report does not account for the number of power balance excesses, or over-supply infeasibilities, in its analysis, and DMM observed a lower pass rate for the downward sufficiency test.

Section 1 of this report provides a description of prices and power balance constraint impacts, section 2 discusses the load bias limiter, and section 3 discusses the flexible ramping sufficiency test.

## 1 Energy imbalance market prices

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Figure 1.1 and Figure 1.2 show hourly average 15-minute and 5-minute prices during March in Arizona Public Service and Southern California Edison, as well as the bilateral prices DMM uses as an additional benchmark for energy imbalance market prices.

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

In the Arizona Public Service area during the month, prices averaged about \$16/MWh in the 15-minute market and about \$13/MWh in the 5-minute market. In comparison, Southern California Edison 15-minute prices averaged around \$24/MWh, while 5-minute prices averaged around \$21/MWh and \$17/MWh during the month, respectively. This price difference was mostly explained by greenhouse gas (GHG) costs applicable to energy deemed delivered to California from energy imbalance market areas.

Average 15-minute and 5-minute prices in Arizona Public Service during the month were generally lower than prices in the ISO but the two prices moved together, during most hours of the day. The greenhouse gas costs for energy deemed delivered into the ISO explains some difference between the two prices, and is reflective of Arizona Public Service exporting energy via the energy imbalance market to the ISO during much of the day.<sup>2</sup> Hours with larger price separations occurred when export capability was limited because Arizona Public Service failed the downward flexible ramping sufficiency test. During many of these intervals, Arizona Public Service was subject to local flexible ramping product shadow prices or was isolated from higher prices in the ISO.<sup>3</sup>

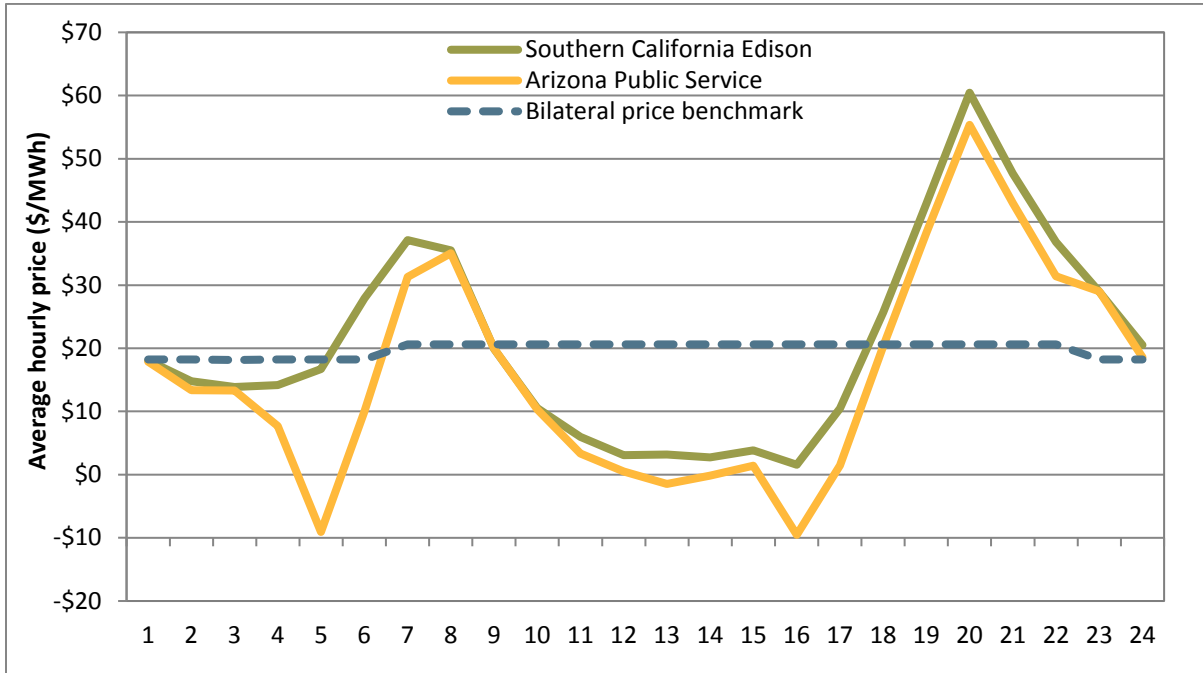
The area-specific flexible ramping capacity demand curve bound frequently in the downward direction for Arizona Public Service during hours when they failed the downward sufficiency test. This pushed average prices down in the 15-minute market during hours ending 4 through 6 as well as hours ending 16 and 17. In addition, there were multiple 5-minute market price spikes in the ISO as a result of tight supply conditions while ramping toward the evening net load peak. Some of these were not reflected in Arizona Public Service because of reduced export limits were reached during intervals when the area failed the downward sufficiency test.

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<sup>2</sup> Greenhouse gas prices were typically just over \$5/MWh, and are applied to an energy imbalance area when energy was deemed delivered from that area into the ISO.

<sup>3</sup> A balancing area is subject to its area-specific flexible ramping capacity demand curve when it is unable to benefit from flexible capacity from other areas because of insufficient transfer capability, for instance after failing the sufficiency test. However, when the power balance constraint is relaxed the transition period pricing mechanism sets the shadow price for the power balance constraint *and* the flexible ramping constraint to \$0/MWh and uses the last economic bid to set prices.

**Figure 1.1 Average hourly 15-minute price – Arizona Public Service**



**Figure 1.2 Average hourly 5-minute price – Arizona Public Service**

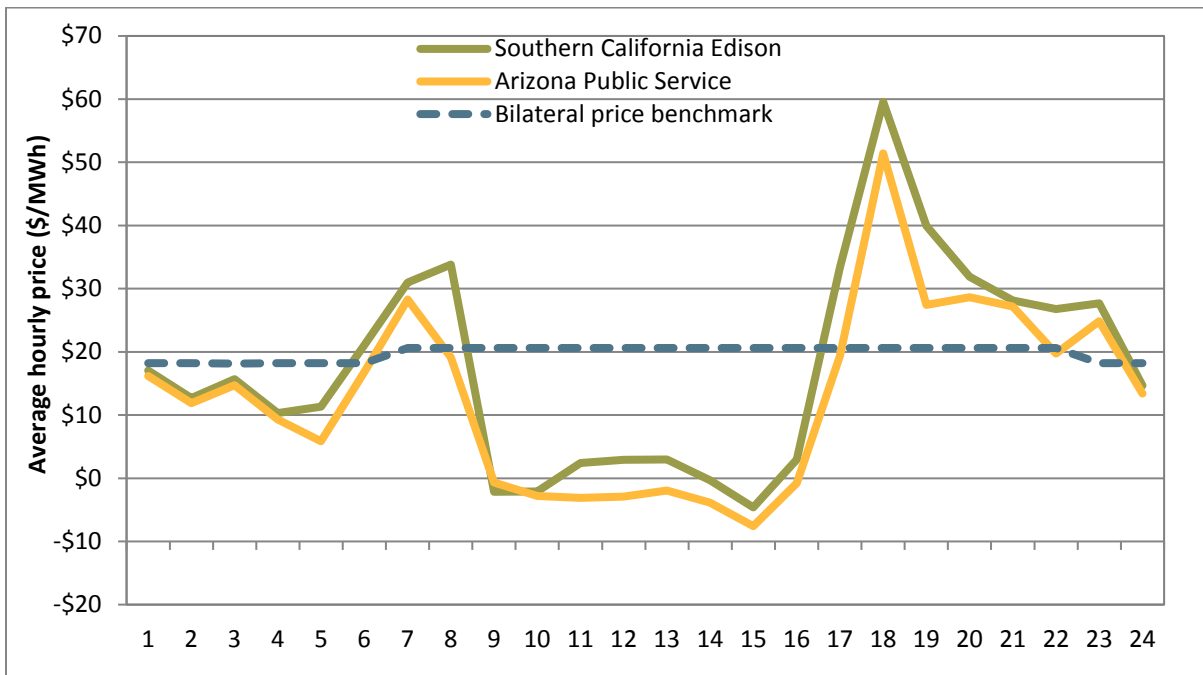


Figure 1.3 and Figure 1.4 show the frequency of power balance constraint relaxations in the 15-minute and 5-minute markets by month. All power balance constraint relaxations that occurred in March were subject to the six-month transition period pricing that expired in April 2017. This feature set prices equal to the last economic unit dispatched instead of the \$1,000/MWh penalty parameter while relaxing the constraint for shortages, or the -\$155/MWh penalty parameter while relaxing the constraint for excess energy. Each power balance constraint relaxation can be grouped in one of the following categories:

- **Valid under-supply infeasibility** (power balance constraint shortage). These occurred when the power balance constraint was relaxed because load exceeded available generation. The ISO validated that ISO software was working appropriately during these instances.
- **Valid over-supply infeasibility** (power balance constraint excess). These occurred when the power balance constraint was relaxed because generation exceeded load. The ISO validated that ISO software was working appropriately during these instances.
- **Load bias limiter would have resolved infeasibility.** These occurred when a load adjustment entered by Arizona Public Service exceeded the amount of the power balance constraint relaxation and the load adjustment and relaxation were in the same direction. During the transition period, the impacts of the load bias limiter did not change price outcomes because transition period pricing was applied during these intervals. However, in these cases, the load bias limiter would have reduced the operator adjustment in the pricing run to prevent the infeasibility had transition period pricing not been in effect.
- **Correctable infeasibility.** These occurred when the ISO software relaxed the power balance constraint because of either a software error or data error. These required a price correction or would have triggered price corrections if transition period pricing was not active.<sup>4</sup>

As shown in these figures, there were frequent energy excesses in the Arizona Public Service area during March in both the 15-minute and 5-minute markets. Valid excesses occurred in more than 10 percent of intervals in both markets. The large majority of these infeasibilities occurred during hours when the area failed the flexible ramping sufficiency test in the downward direction. When Arizona Public Service failed the downward sufficiency test it limited the balancing area's ability to export excess energy and contributed to frequent over-supply infeasibilities.

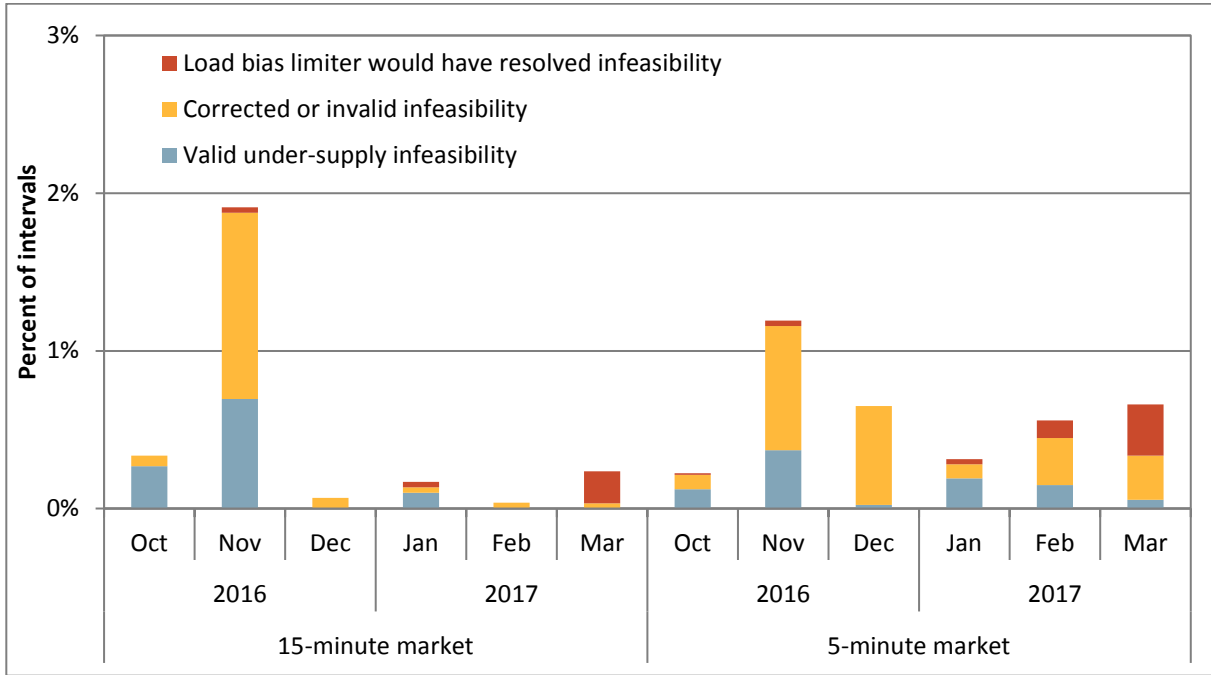
Arizona Public Service failed the flexible ramping sufficiency test in the upward direction during 18 hours in March, and the frequency of valid under-supply infeasibilities was infrequent in either real-time market.

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<sup>4</sup> Section 35 of the ISO tariff provides the ISO authority to correct prices if it detects an invalid market solution or issues due to a data input failure, occurrence of hardware or software failure, or a result that is inconsistent with the ISO tariff. During erroneous intervals, the ISO determined that prices resulting under transition pricing were equivalent to prices that would result from a price correction, so no further price adjustment was appropriate.  
[http://www.caiso.com/Documents/Section35\\_MarketValidationAndPriceCorrection\\_May1\\_2014.pdf](http://www.caiso.com/Documents/Section35_MarketValidationAndPriceCorrection_May1_2014.pdf).



**Figure 1.3 Frequency of power balance constraint shortages by month  
Arizona Public Service**



**Figure 1.4 Frequency of power balance constraint excesses by month  
Arizona Public Service**

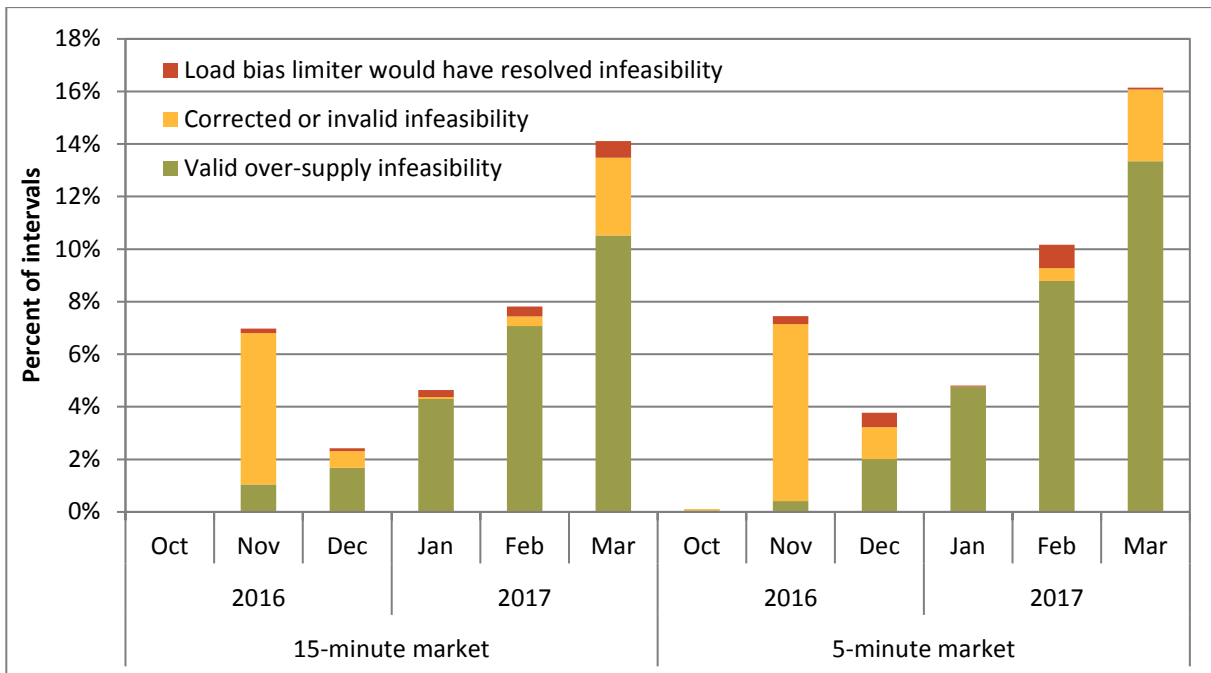
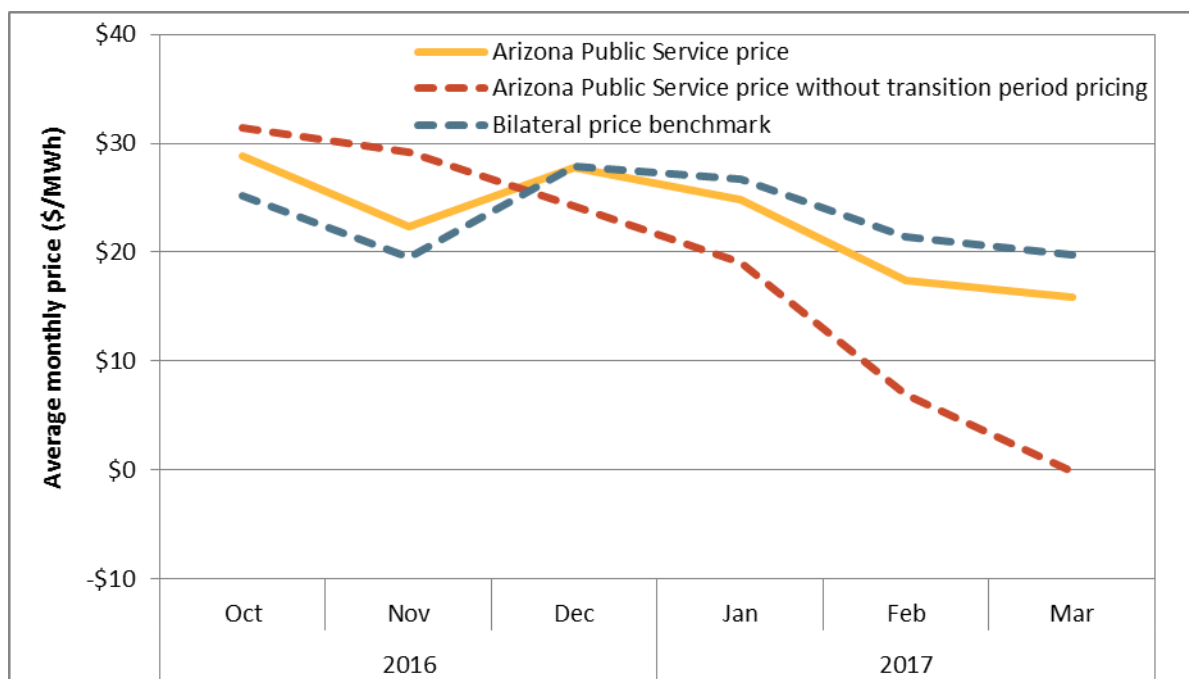


Figure 1.5 and Figure 1.6 show the average monthly prices in the 15-minute market and 5-minute market *with* and *without* the special transition period pricing provisions applied to mitigate prices in the Arizona Public Service area during March.<sup>5</sup> These figures also include the average bilateral price benchmark for comparison to Arizona Public Service prices, depicted by the dashed blue lines.

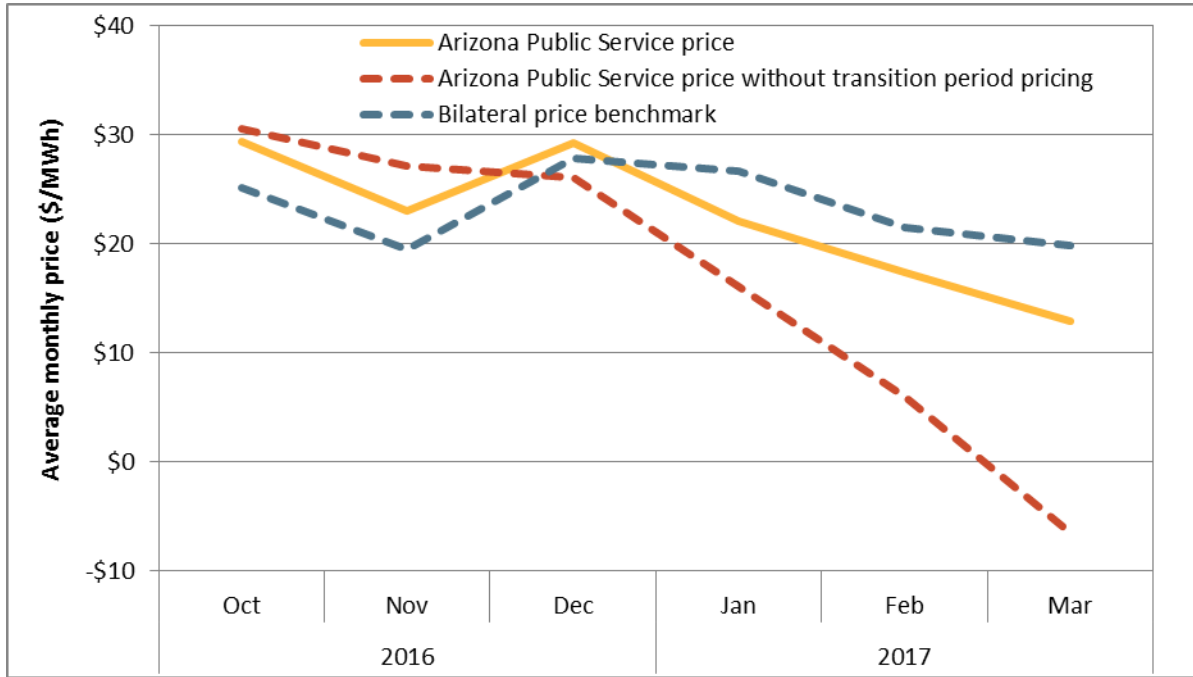
Prices with and without transition period pricing continued to diverge in March because of frequent power balance constraint excesses in the 15-minute and 5-minute markets. During the month transition period pricing increased average prices in Arizona Public Service by about \$16/MWh in the 15-minute market and by nearly \$20/MWh in the 5-minute market. Prices without transition period pricing tracked significantly below the bilateral price benchmark during the month in both real-time markets. This was the result of frequent power balance excesses and the associated penalty price (-\$155/MWh) that were avoided with the transition period pricing mechanism in place.

**Figure 1.5 Average prices by month – Arizona Public Service (15-minute market)**



<sup>5</sup> A detailed description of the methodology used to calculate counterfactual prices resulting without transition period pricing was provided on p. 7 of the January 2017 report for Arizona Public Service from DMM: <https://records.oe.caiso.com/sites/GCA/legal/mm/Records/EIM/FERC%20Report/2017-01%20Arizona/EIM%20Special%20Report%20January%20APS.pdf>.

**Figure 1.6 Average prices by month – Arizona Public Service (5-minute market)**



## 2 Load bias limiter

When the load bias limiter is triggered it has the same effect as the transition period pricing feature and causes prices to be set by the last economic bid dispatched rather than the \$1,000/MWh penalty price for under-supply power balance relaxations or the -\$155/MWh penalty price for over-supply power balance relaxations. A more detailed description of the load bias limiter is included in DMM’s April 2015 report.<sup>6</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>7</sup>

Table 2.1 shows average 15-minute and 5-minute market prices with transition period pricing, counterfactual estimates for prices without transition period pricing, counterfactual estimates for prices without either transition period pricing or the load bias limiter.

During March, the load bias limiter would have triggered during most of the valid power balance constraint shortages that were not corrected by the ISO, and during about 3 percent of all power balance constraint excesses. However, because shortages occurred very infrequently the impact of the load bias limiter had a small impact on prices in nominal terms.

The load bias limiter’s impact on Arizona Public Service prices would have been considerably smaller than the transition period pricing impact during March because of the relatively low frequency of intervals that it would have triggered. During the month, the load bias limiter would have decreased hypothetical 15-minute and 5-minute market prices by \$0.65/MWh and \$2.40/MWh, respectively, 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 (March 2017)**

	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)	\$19.81	\$15.88	-\$0.18	\$0.46	-\$0.65	-139.9%
5-minute market (RTD)	\$19.81	\$12.92	-\$6.59	-\$4.19	-\$2.40	57.3%

<sup>6</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>7</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 during 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 a new downward ramping sufficiency test in the market with the introduction of the flexible ramping product, which replaced the flexible ramping constraint. These tests are designed to ensure that there is sufficient resource capacity available to meet forecasts and net exports for any given hour. This was implemented so that if an area fails the upward sufficiency test then energy imbalance market transfers are frozen and cannot be increased above base schedules.<sup>8</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.

Unlike the flexible ramping constraint, the demand for the flexible ramping product is set by a demand curve, rather than a single target. With the implementation of the flexible ramping product the ISO began using the maximum requirement from the demand curve for the sufficiency test, instead of the old targets.<sup>9</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 price separation across balancing areas. The large majority of valid power balance constraint relaxations in the Arizona Public Service area during March occurred during hours when the area failed the flexible ramping sufficiency test. 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.

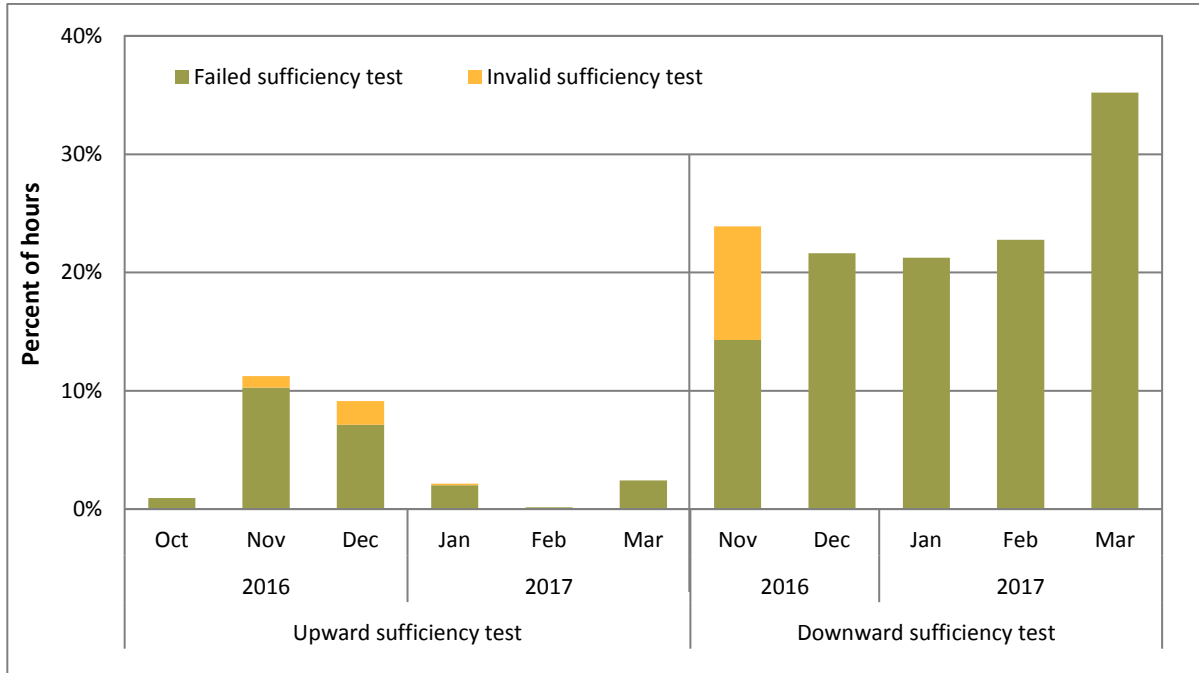
Figure 3.1 shows the frequency that Arizona Public Service failed the sufficiency test in the upward or downward direction. For Arizona Public Service in March, the frequency of valid downward sufficiency test failures continued to be extremely high and increased dramatically from prior months. The sufficiency test was failed during more than 35 percent of all hours (262 individual hours) in the downward direction. Arizona Public Service failed the flexible ramping sufficiency test in the upward direction much less frequently at a rate of about 2 percent of all intervals.

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<sup>8</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>9</sup> For further detail, see DMM's presentation on January 18, 2017 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).

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



## 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, on this 17<sup>th</sup> day of October, 2017.

*/s/ Grace Clark*  
Grace Clark