

May 1, 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
January 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 January 2017. 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

Report on energy imbalance market issues and performance: Arizona Public Service for January 2017

May 1, 2017

Prepared by: Department of Market Monitoring

Executive summary

Pursuant to the Commission's October 29, 2015 Order on the ISO's energy imbalance market (EIM), the ISO filed a report on April 4, 2017 covering the period from January 1 through January 31, 2017 (January report) for the Arizona Public Service area in the energy imbalance market.¹ 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 January 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. Key findings in this report include the following:

- During January, the Arizona Public Service area frequently failed the downward flexible ramping sufficiency test (21 percent of hours). This contributed to power balance constraint excesses during more than 4.5 percent of 15-minute and 5-minute market intervals.
- Transition period pricing significantly impacted prices during January. Without transition period pricing in place, 15-minute market prices would have been almost \$6/MWh (25 percent) lower in the 15-minute and 5-minute markets. This price difference was the result of power balance constraint excesses penalty prices (-\$155/MWh) being replaced with prices matching the last economic unit bid into the market.
- Arizona Public Service 15-minute and 5-minute prices with transition period pricing tracked just below Southern California Edison area prices within the ISO during most hours. For Arizona Public Service during January, prices averaged around \$25/MWh and \$22/MWh for the 15-minute and 5-minute markets, respectively, while prices in the Southern California Edison area averaged around \$32/MWh and \$28/MWh during the same period. This price difference was mostly driven by the \$5/MWh greenhouse gas (GHG) costs applicable to energy deemed delivered to California.
- The frequency of valid under-supply infeasibilities was relatively low during January as well as the number of intervals that Arizona Public Service failed the upward flexible ramping sufficiency test.
- Without transition period pricing provisions in place, the load bias limiter would have triggered infrequently in both real-time markets and impacted prices by only about 1 percent. The load bias limiter would have been triggered in nine intervals in the 15-minute market and six intervals in the 5-minute market during January.

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 The ISO's January 2017 Report was filed at FERC and posted on the ISO website on April 4, 2017, http://www.caiso.com/Documents/Apr4_2017_EIMInformationalReport-TransitionPeriod_ArizonaPublicService_Jan2017_ER15-2565.pdf.

1 Energy imbalance market prices

Figure 1.1 and Figure 1.2 show hourly average 15-minute and 5-minute prices during January 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.

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 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 \$25/MWh and \$22/MWh in the 15-minute and 5-minute market, respectively. In comparison, Southern California Edison 15-minute prices averaged around \$32/MWh, while 5-minute prices averaged around \$28/MWh during the month.

Average 15-minute and 5-minute prices in Arizona Public Service during the month were just below prices in the ISO, often by around \$5/MWh during most hours of the day. When energy from Arizona Public Service is deemed delivered into the ISO, the greenhouse gas costs cause prices to be about \$5/MWh lower in Arizona Public Service than in the ISO, which explains most of the price differences observed in the real-time markets. Additional price deviations occurred mostly when export capability was limited during intervals when the Arizona Public Service area failed the downward flexible ramping sufficiency test. In the 15-minute market, this was noticeable during hours ending 5. Similarly, there were larger price deviations in the 5-minute market during hours when loads and prices were highest in the ISO in the early evening during hours ending 18 and 19.

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

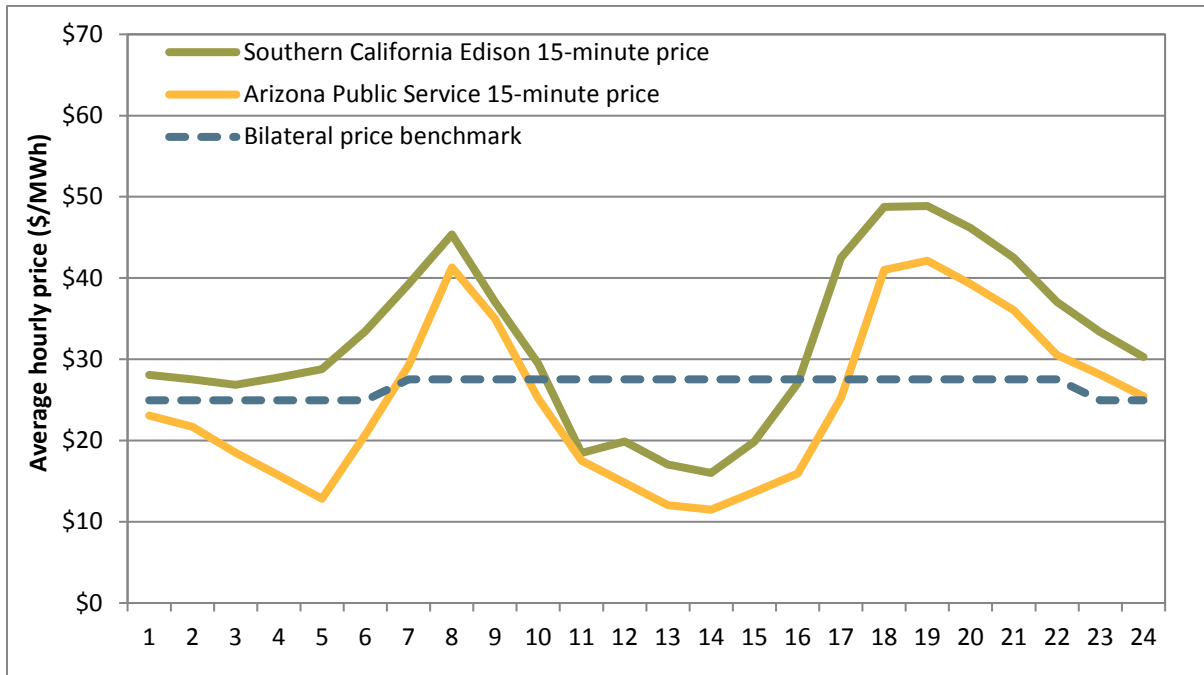
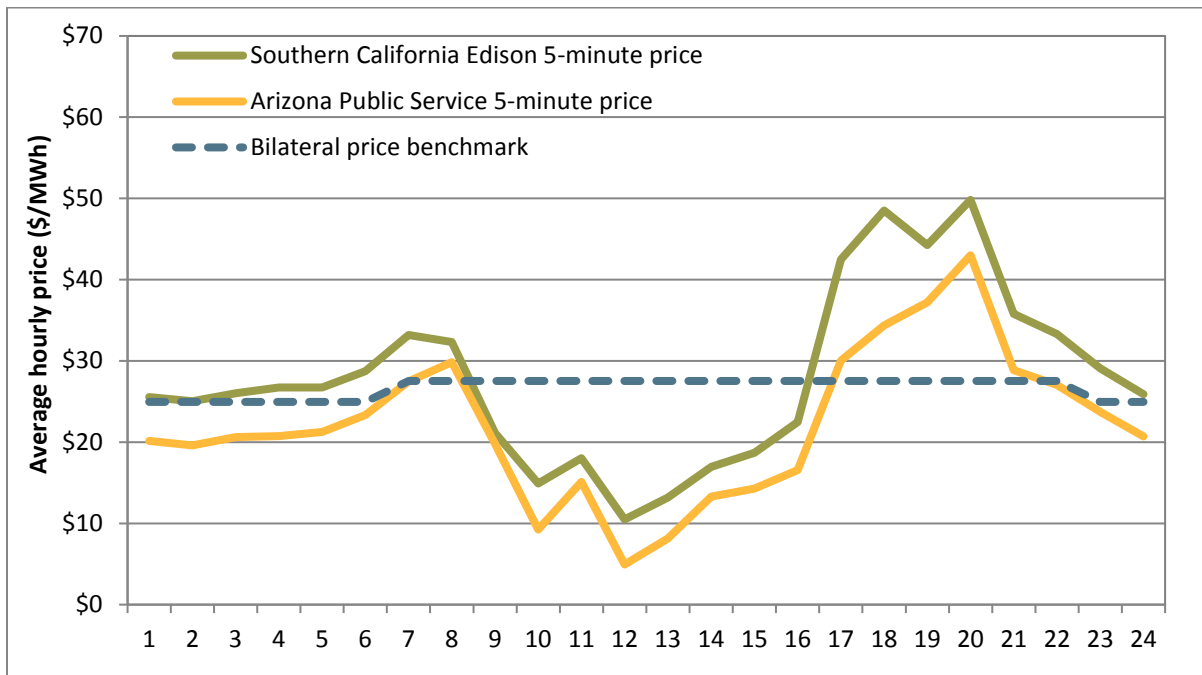


Figure 1.2 Average hourly 5-minute price – Arizona Public Service



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 January are subject to the six-month transition period pricing that expired in April 2017. This feature sets prices equal to the last economic

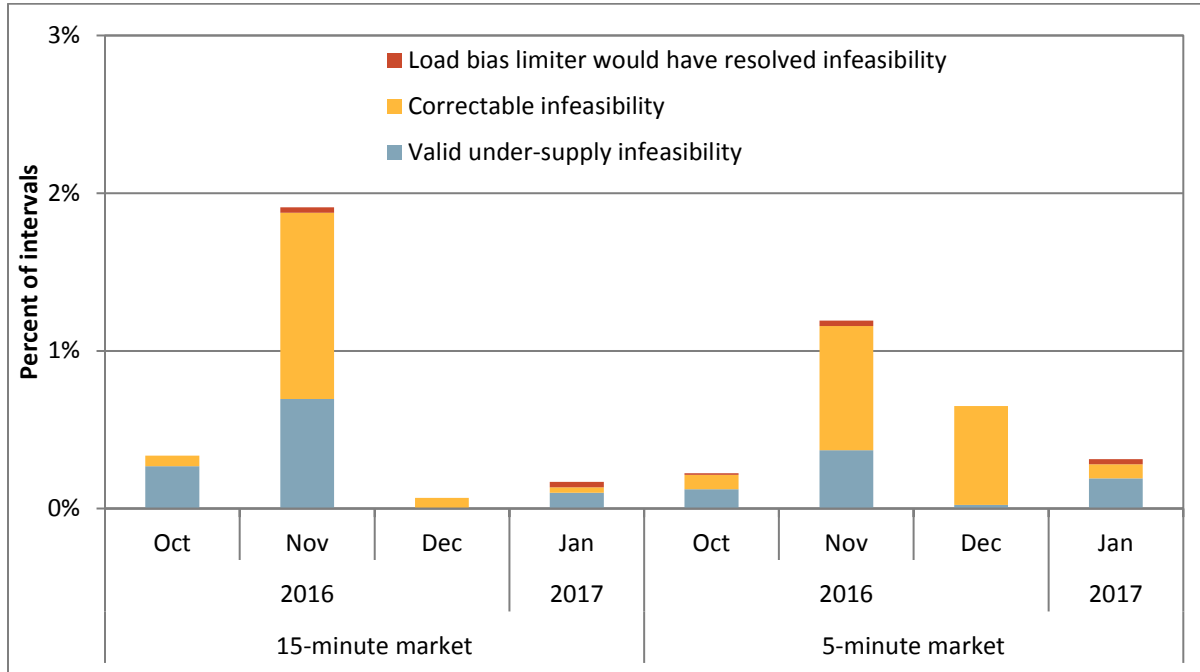
unit dispatched instead of the \$1,000/MWh penalty parameter while relaxing the constraint for shortages or the -\$155/MWh penalty parameter while relaxing the constraint for excess energy. Power balance constraint relaxations in Arizona Public Service during January can be grouped in the following categories:

- **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 power balance constraint relaxation and the load adjustment was 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 correction if transitional period pricing was not active.²

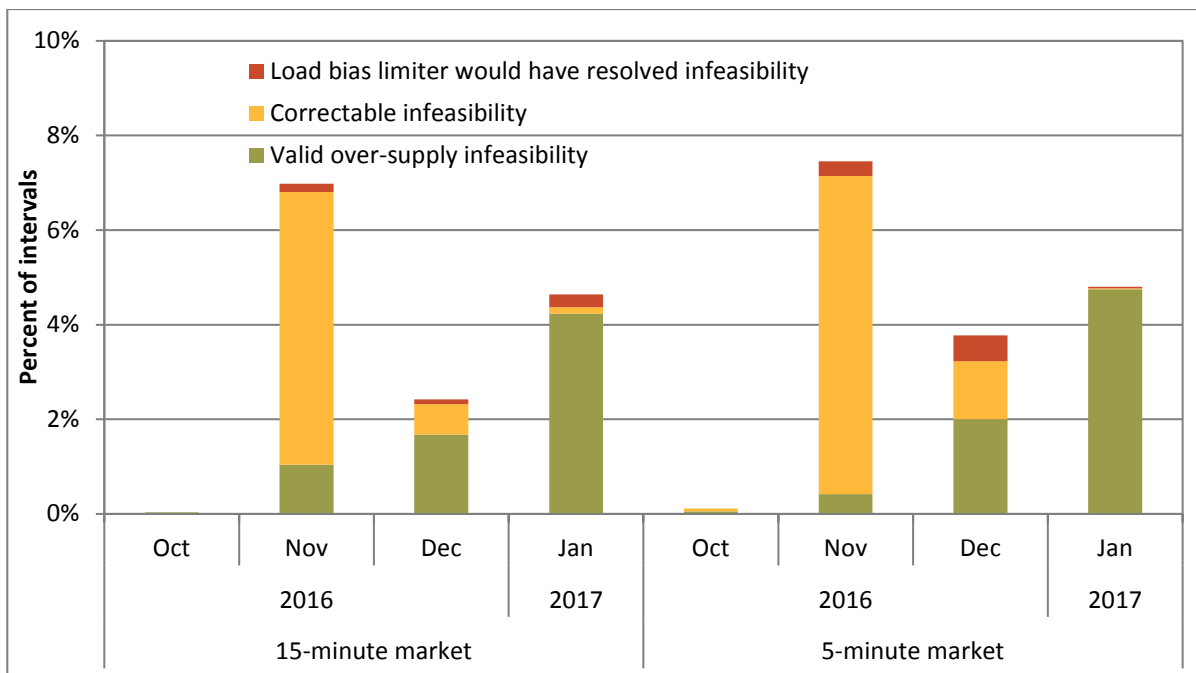
² Section 35 of the ISO tariff provides the ISO authority to correct prices if it detects an invalid market solution or issues due to a data input failure, occurrence of hardware or software failure, or a result that is inconsistent with the ISO tariff. During erroneous intervals, the ISO determined that prices resulting under transitional 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.

**Figure 1.3 Frequency of under-supply power balance infeasibilities by month
Arizona Public Service**



**Figure 1.4 Frequency of over-supply power balance infeasibilities by month
Arizona Public Service**



As shown in these figures, there were frequent over-supply infeasibilities in the Arizona Public Service area during January in both the 15-minute and 5-minute markets. In both markets, energy excesses occurred in more than 4.5 percent of all intervals during the month, and almost all of these infeasibilities occurred during intervals 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 relatively infrequently, during about 2 percent of hours. Similarly, the frequency of valid under-supply infeasibilities increased during the month but remained relatively infrequent overall in either real-time market.

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 January. 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.
- When the power balance constraint was relaxed in the market software for excess energy and the conditions for the load bias limiter were not met, it is assumed prices would be -\$155/MWh plus estimated losses.
- 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.
- Otherwise, when the power balance constraint was relaxed following an underlying software or data error including an invalid failure of the sufficiency test, these intervals were treated as invalid infeasibilities and the penalty parameters were not included in the counterfactual price.³

Prices with and without transition period pricing continued to diverge in January because of frequent over-supply infeasibilities in the 15-minute and 5-minute markets. As a result, prices without transition period pricing tracked significantly below Southern California Edison prices and the bilateral price benchmark – by more than \$5/MWh – during the month in both real-time markets. This was the result of frequent power balance constraint excesses and the associated penalty price (-\$155/MWh) being excluded from prices with the transition period pricing mechanism in place.

³ During November and December 2016, price corrections were mostly 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 allows the market software to use the last economic bid. Price corrections for these results were entered by the ISO as a result. A fix for this issue was implemented on December 12, 2016.

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

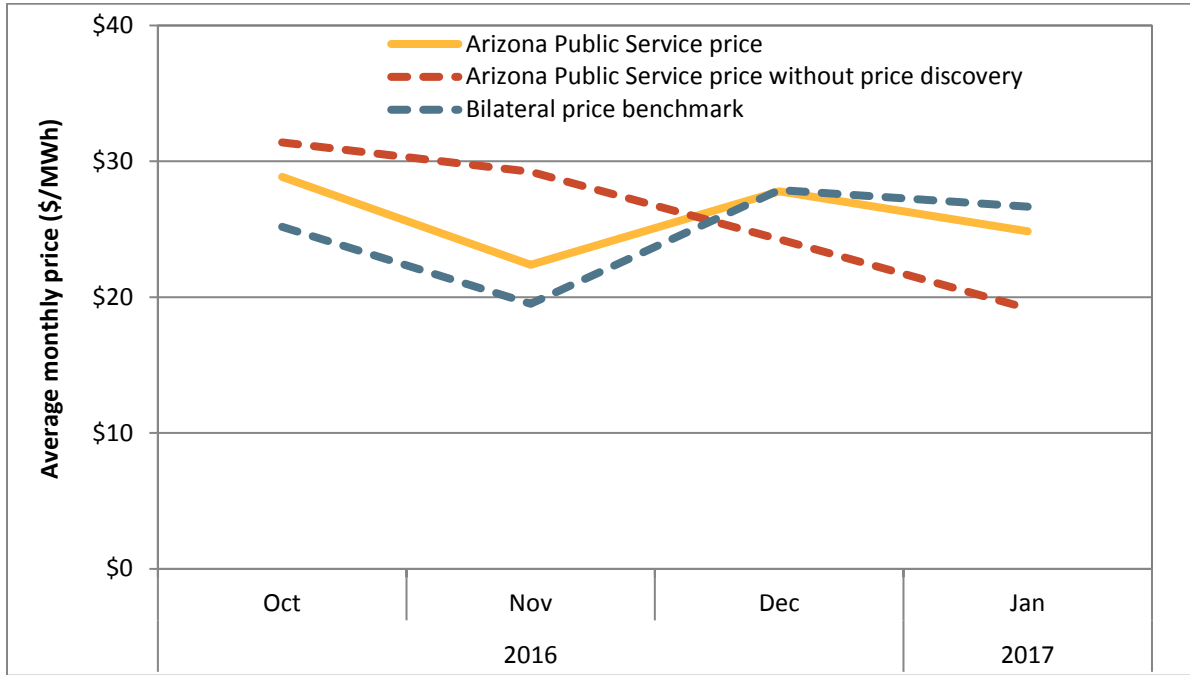
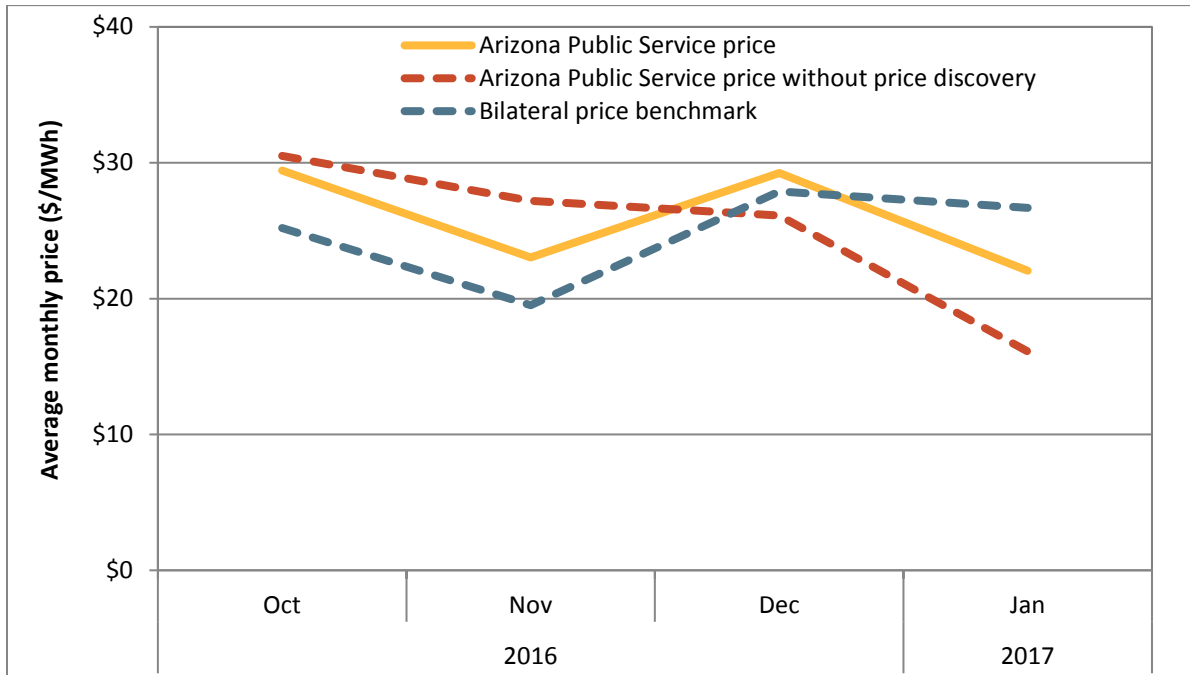


Figure 1.6 Average prices by month – Arizona Public Service (5-minute market)



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 and -\$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.⁴ The ISO also included a discussion of the load bias limiter in its answer to comments regarding available balancing capacity on November 24, 2015.⁵

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.

During January, the load bias limiter would have triggered during only nine intervals in the 15-minute market and six intervals in the 5-minute market. In the 15-minute market, the majority of these were because of over-supply conditions such that hypothetical 15-minute market prices with only the load bias limiter would have been about 1 percent higher. In the 5-minute market, half were due to under-supply conditions such that the load bias limiter would have decreased hypothetical 5-minute prices by \$0.19/MWh 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 (January 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)	\$26.67	\$24.85	\$19.17	\$19.06	\$0.11	0.6%
5-minute market (RTD)	\$26.67	\$22.05	\$16.11	\$16.30	-\$0.19	-1.2%

⁴ 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

⁵ 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

3 Flexible ramping sufficiency test

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, 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. 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.⁶ 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 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.⁷ DMM 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 in the Arizona Public Service area occurred during hours when the area failed the flexible ramping sufficiency test in January. 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. In addition, the chart shows the number of hours where an underlying issue caused the sufficiency test to fail. For Arizona Public Service in January, the frequency of valid upward sufficiency test failures decreased while the frequency of valid downward sufficiency test failures was about the same from the previous month. This includes 15 hours that the sufficiency test failed in the upward direction and 158 hours in which the sufficiency test failed in the downward direction, or

⁶ Business Practice Manual for the Energy Imbalance Market, August 30, 2016, p. 45-52:

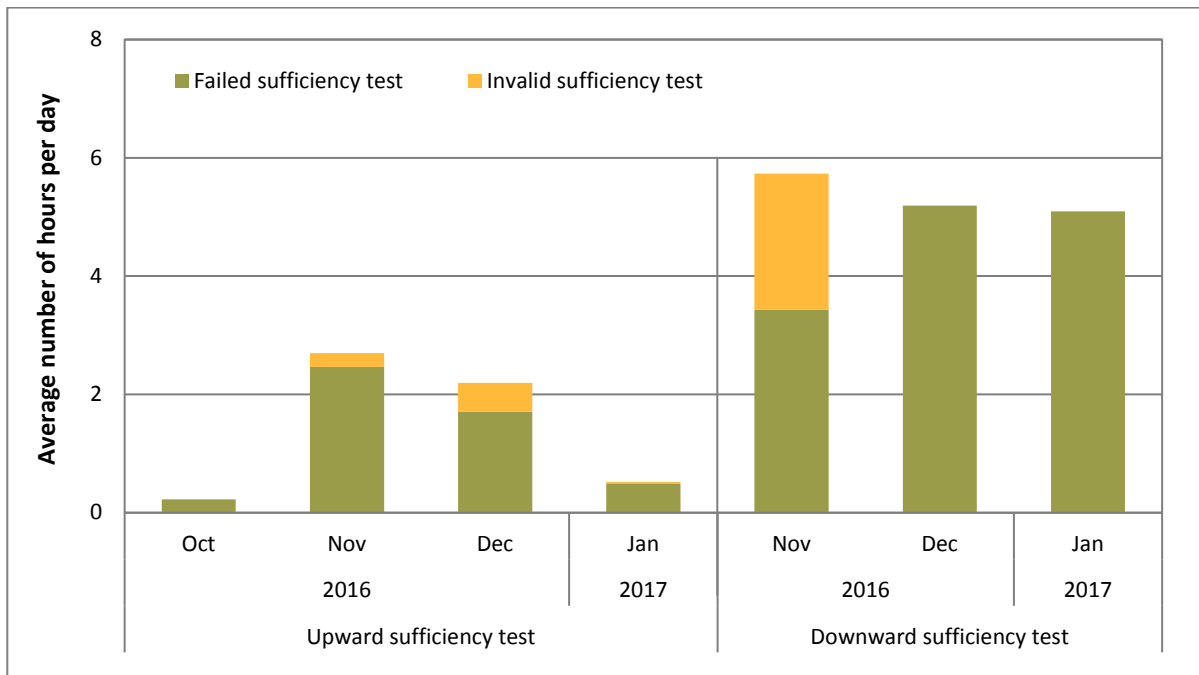
https://bpmcm.caiso.com/BPM%20Document%20Library/Energy%20Imbalance%20Market/BPM_for_Energy%20Imbalance%20Market_V6_clean.docx.

⁷ 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.

failures in about 23 percent of all hours. The ISO listed multiple reasons for the high frequency of failed flexible ramping sufficiency tests in its December report.⁸

In addition, the number of sufficiency tests in the downward direction that failed due to an underlying issue decreased significantly during January. This was related to several enhancements and fixes that were created in the market software during November and December to ensure that the inputs for the test were being calculated correctly.

Figure 3.1 Arizona Public Service flexible ramping sufficiency test results



⁸ These are listed in the ISO’s December 2016 Report:
http://www.caiso.com/Documents/Apr4_2017_EIMInformationalReport-TransitionPeriod_ArizonaPublicService_Dec2016_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 1st day of May, 2017.

Is/ Anna Pascuzzo
Anna Pascuzzo