

August 15, 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
February 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 February 2017. APS entered the EIM on October 1, 2016.

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

Respectfully submitted,

By: /s/ Eric Hildebrandt

Eric Hildebrandt
Director of Market Monitoring
California Independent System
Operator Corporation
250 Outcropping Way
Folsom, CA 95630
Tel: (916) 608-7123
Fax: (916) 608-7222
ehildebrandt@caiso.com

California ISO

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

July 5, 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 May 4, 2017 covering the period from February 1 through February 28, 2017 (February 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 February report. This report includes a summary of over-supply infeasibilities and a discussion of the effects transition period pricing had on prices. DMM recommends the ISO consider adding this analysis to its March report. Key findings in this report include the following:

- During February, the Arizona Public Service area frequently failed the downward flexible ramping sufficiency test, during 23 percent of hours. This contributed to over-supply infeasibilities during more than 7 percent of intervals in the 15-minute market and almost 9 percent of intervals in the 5-minute market.
- Transition period pricing significantly impacted prices during February. Without transition period pricing in place, average prices would have been over \$10/MWh lower in the real-time markets. This price difference was the result of the transition period pricing mechanism replacing intervals with over-supply infeasibilities where prices were set using the -\$155/MWh penalty parameter.
- 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 February, Arizona Public Service prices averaged around \$17/MWh in both the 15-minute and 5-minute markets, while prices in Southern California Edison averaged around \$24/MWh. 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 under-supply infeasibilities was very low during February as well as the number of hours that Arizona Public Service failed the upward flexible ramping sufficiency test.
- The load bias limiter would have triggered during about 5 percent of infeasibilities in the 15-minute market and about 10 percent of infeasibilities in the 5-minute market. The majority of these were because of over supply infeasibilities when the load bias limiter would have increased real-time prices, had transition period pricing not been in effect. The overall impact on prices would have been less than \$1/MWh in both real-time markets.
- During DMM's review of the ISO's February report, DMM identified several key differences in the portrayal of infeasibilities, the impact of transition period pricing, and the pass rate of the flexible ramping sufficiency test. In particular, the ISO's report does not account for the number of over-supply infeasibilities in its conclusion related to the minimal impact of transition period pricing and DMM observed a lower pass rate for the downward sufficiency test.

¹ The ISO's February 2017 Report was filed at FERC on May 4, 2017 and posted on the ISO website on May 5, 2017. http://www.caiso.com/Documents/May4_2017_EIMInformationalReport-TransitionPeriod_ArizonaPublicService_Feb2017_ER15-2565.pdf.

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

Figure 1.1 and Figure 1.2 show hourly average 15-minute and 5-minute prices during February 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 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 \$17/MWh in both the 15-minute and 5-minute markets. In comparison, Southern California Edison 15-minute prices averaged around \$24/MWh, while 5-minute prices averaged around \$23/MWh during the month. 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. 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.² 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.³

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 3 through 5 and 15 through 17. In addition, there were multiple 5-minute market price spikes in the ISO during hours ending 15 through 18, as a result of tight supply conditions, while ramping toward the evening net load peak. These were not reflected in Arizona Public Service because of reduced limits on the constraints from failed downward sufficiency tests.

² 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.

³ 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

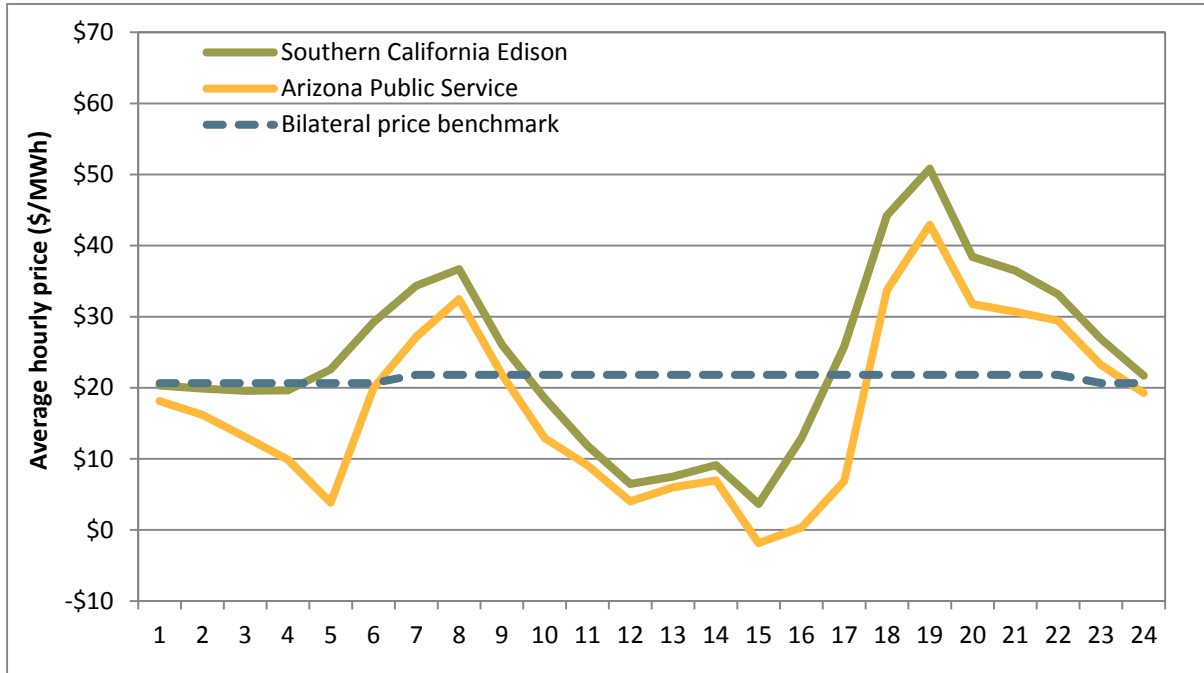


Figure 1.2 Average hourly 5-minute price – Arizona Public Service

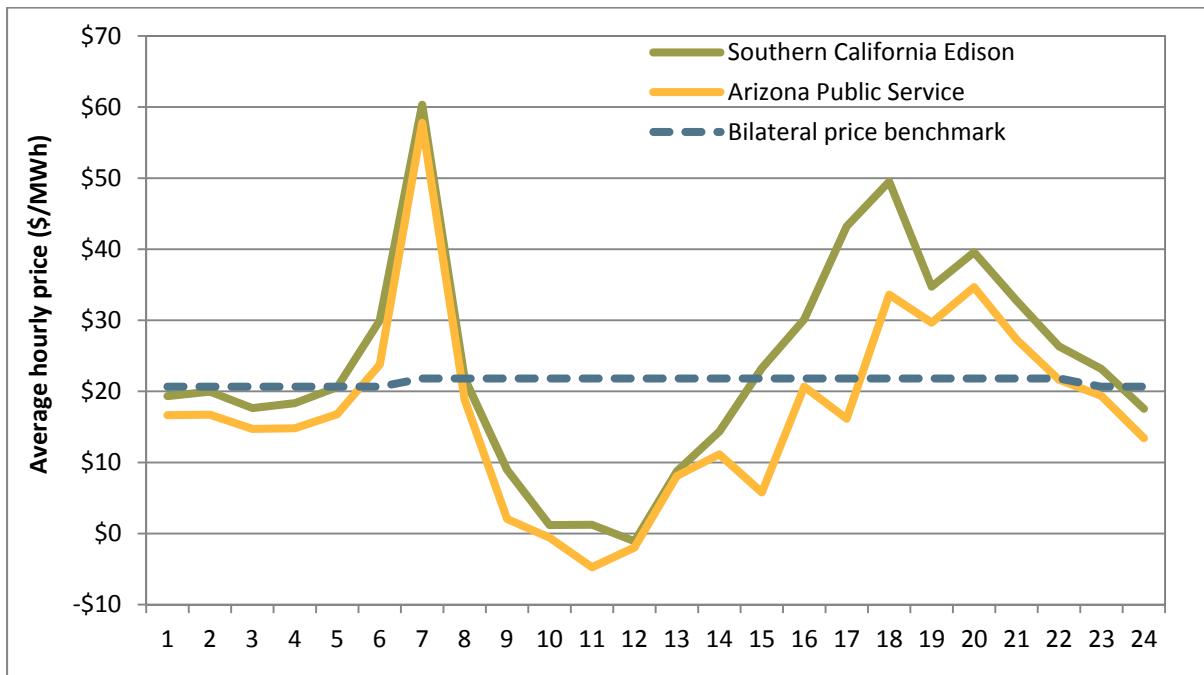


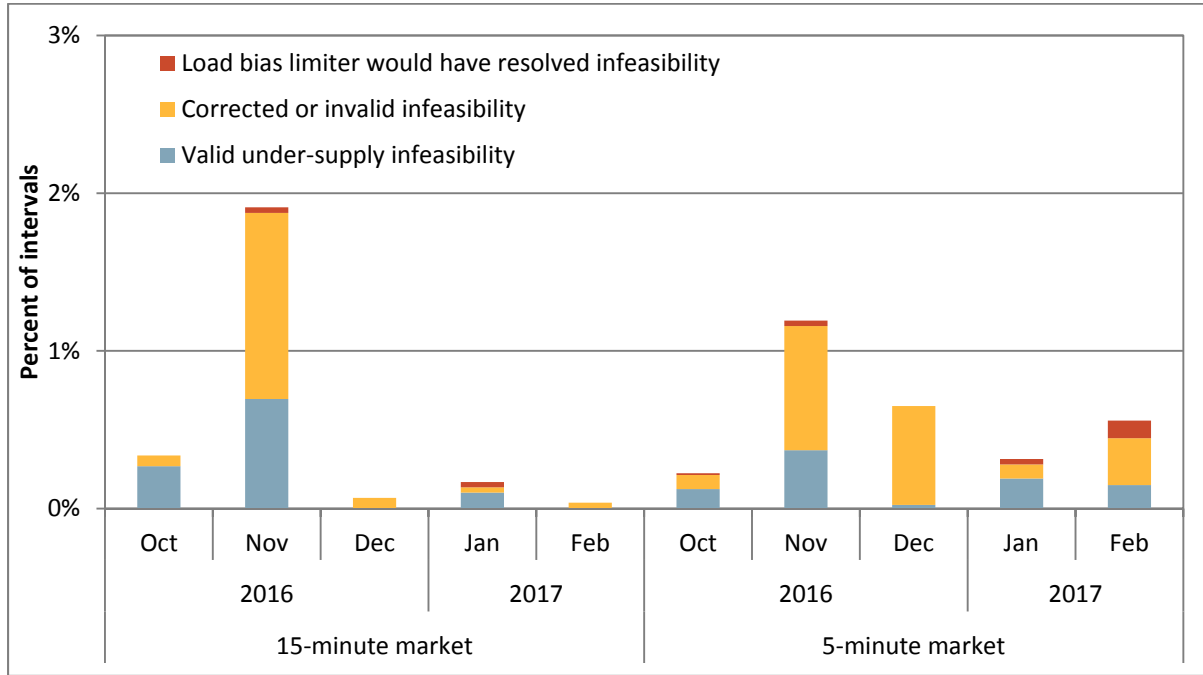
Figure 1.3 and Figure 1.4 show the frequency of power balance constraint relaxations in the 15-minute and 5-minute markets by month. All power balance constraint relaxations that occurred in February were subject to the six-month transition period pricing that expired in April 2017. This feature sets 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 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 the 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 corrections if transition period pricing was not active.⁴

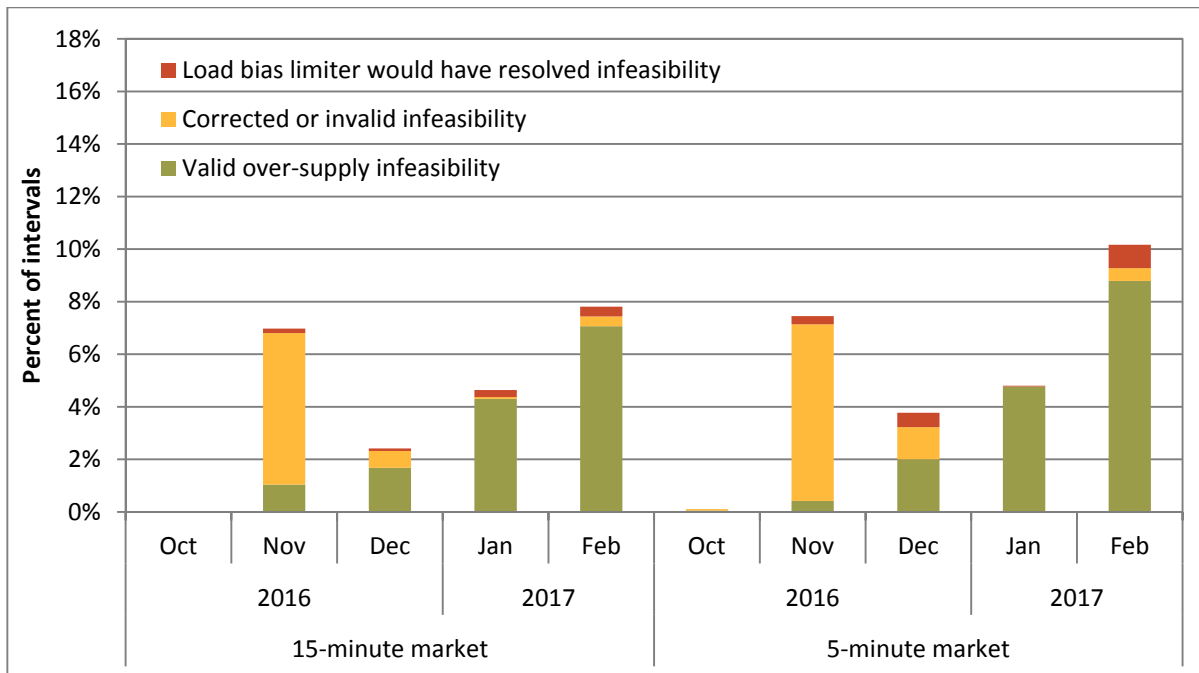
⁴ Section 35 of the ISO tariff provides the ISO authority to correct prices if it detects an invalid market solution or issues due to a data input failure, occurrence of hardware or software failure, or a result that is inconsistent with the ISO tariff. During erroneous intervals, the ISO determined 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.

**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 February in both the 15-minute and 5-minute markets. Valid over-supply infeasibilities occurred in more than 7 percent of intervals in the 15-minute market and almost 9 percent of intervals in the 5-minute market. All 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 very infrequently, during just 1 hour in February. Thus, the frequency of valid under-supply infeasibilities was infrequent in either real-time market.

Figure 1.5 and Figure 1.6 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 February.⁵ 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 February because of frequent over-supply infeasibilities in the 15-minute and 5-minute markets. During the month transition period pricing increased average prices in Arizona Public Service by over \$10/MWh in the 15-minute and 5-minute markets. As a result, prices without transition period pricing tracked significantly below bilateral price benchmark during the month in both real-time markets. This was the result of frequent over-supply infeasibilities and the associated penalty price (-\$155/MWh) that were avoided with the transition period pricing mechanism in place.

⁵ 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.oa.caiso.com/sites/GCA/legal/mm/Records/EIM/FERC%20Report/2017-01%20Arizona/EIM%20Special%20Report%20January%20APS.pdf>.

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

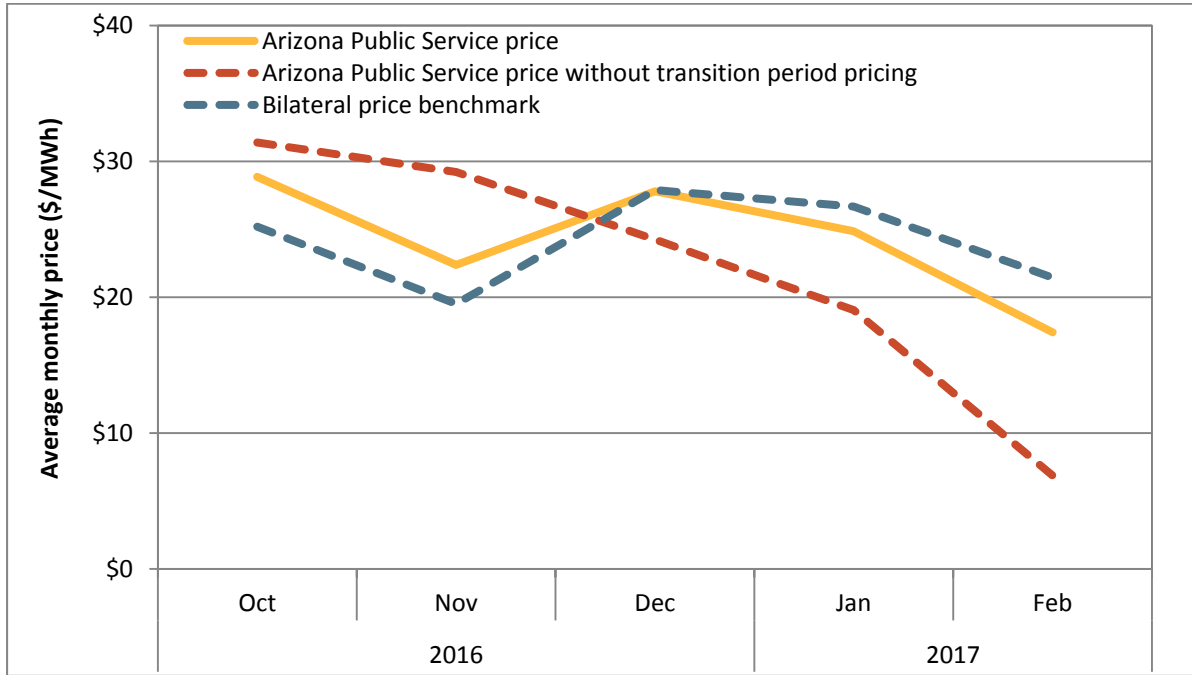
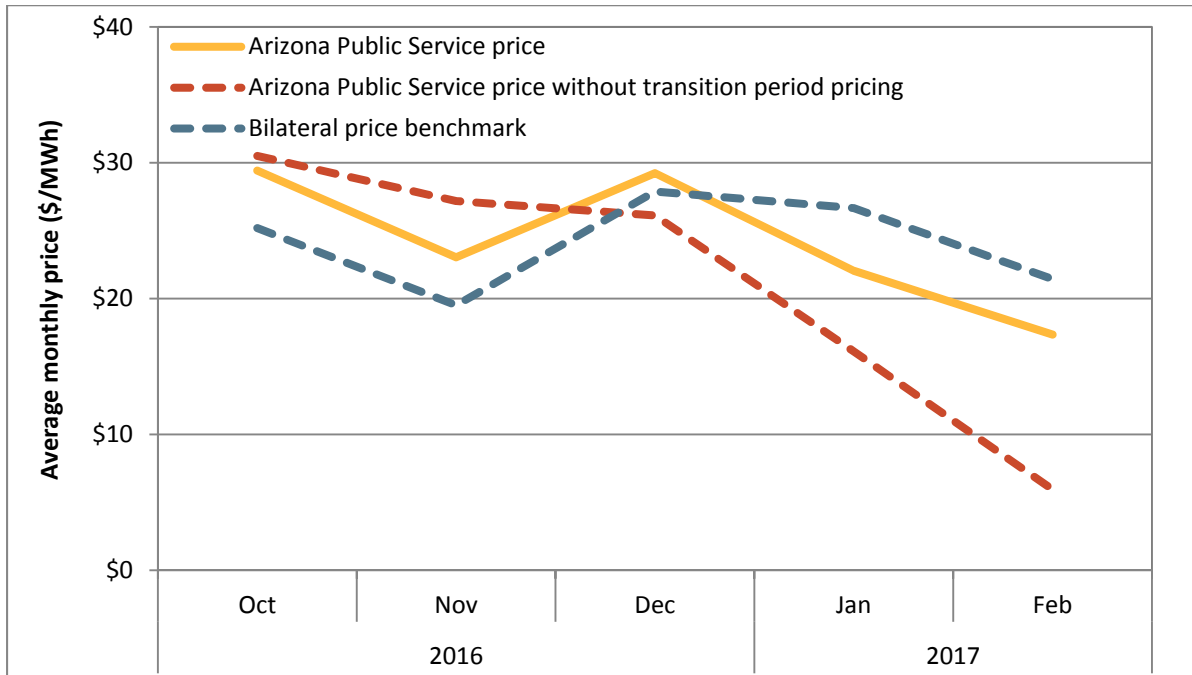


Figure 1.6 Average prices by month – Arizona Public Service (5-minute market)



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 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.⁶ The ISO also included a discussion of the load bias limiter in its answer to comments regarding available balancing capacity on November 24, 2015.⁷

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 February, the load bias limiter would have triggered during about 5 percent of infeasibilities in the 15-minute market and about 10 percent of infeasibilities in the 5-minute market. The majority of these were during of over-supply conditions, such that the load bias limiter would have increased hypothetical 15-minute and 5-minute market prices had transition period pricing not been in effect.

However, the load bias limiter’s impact on Arizona Public Service prices would have been smaller than the transition period pricing impact during February because of the relatively low frequency of intervals that it would have triggered. During the month, the load bias limiter would have increased hypothetical 15-minute and 5-minute market prices by \$0.35/MWh and \$0.11/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 (February 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)	\$21.44	\$17.41	\$6.87	\$6.52	\$0.35	5.4%
5-minute market (RTD)	\$21.44	\$17.35	\$5.95	\$5.84	\$0.11	1.8%

⁶ *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

⁷ 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 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.⁸ 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.⁹ 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. Almost all of the power balance constraint relaxations in the Arizona Public Service area during February 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 February, the frequency of valid upward sufficiency test failures decreased while the frequency of valid downward sufficiency test failures increased from the previous month. This includes just 1 hour when the sufficiency test failed in the upward direction and 153 hours in which the sufficiency test failed in the downward direction, or failures in about 23

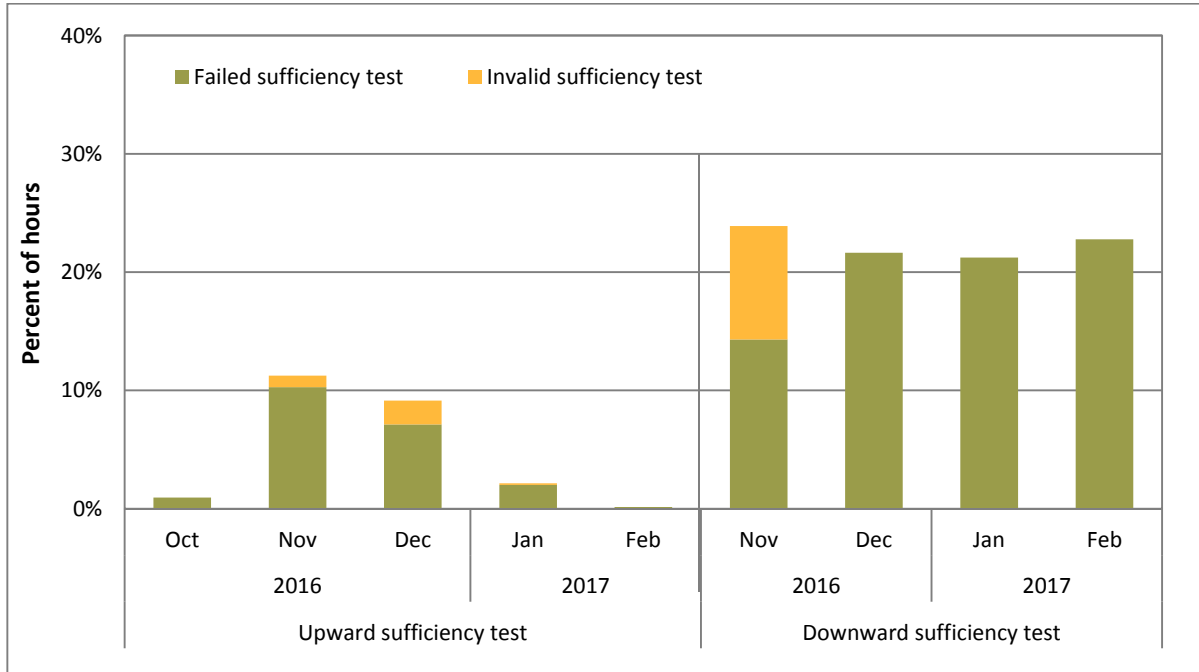
⁸ Business Practice Manual for the Energy Imbalance Market, August 30, 2016, p. 45-52:

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

⁹ 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.

percent of all hours. The ISO listed multiple reasons for the high frequency of failed flexible ramping sufficiency tests in its December report.¹⁰

Figure 3.1 Arizona Public Service flexible ramping sufficiency test results



¹⁰ 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 15th day of August, 2017.

/s/ Grace Clark
Grace Clark