

**UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION**

California Independent System) Docket Nos. ER15-554
Operator Corporation)

**Informational Report
of the California Independent System Operator Corporation**

The California Independent System Operator Corporation (CAISO) submits this informational report concerning the performance of resources providing regulation up and regulation down in response to the Commission's directive.¹ The report is based on operational data from January 1, 2015 up to and including September 30, 2017 and reflects the accuracy of resources' response to the CAISO's regulation control signal under the CAISO's Order No. 755 market design.² The CAISO submitted a similar report in June 2016 for the time period from January 1, 2015 up to and including March 31, 2016. In this report, the CAISO also provides information regarding the provision of regulation by electric storage resources and the impact those resources have had on the overall resource accuracy measurements in CAISO's regulation market.

In general, the data in this report reflects that the accuracy of resources responding to the CAISO's regulation control signal has increased for the time period April 1, 2016 up to and including September 30, 2017, when compared to the time period from January 1, 2015 up to and including March 31, 2016. The CAISO has also observed an increase in the number of electric storage resources providing

¹ *Cal. Indep. Sys. Operator Corp*, 150 FERC ¶ 61,056 (2015) at P 16.

² *Frequency Regulation Compensation in the Organized Wholesale Power Markets*, FERC Stats. & Regs. ¶ 31,324 (2011) (Order 755), *rehearing denied*, 138 FERC ¶ 61,123 (2012) (Order 755-A).

regulation. This increase may have had a positive impact on overall resource accuracy measurements in CAISO's regulation market. However, the increased percentage of regulation provided by electric storage resources is relatively small and these resources have an accuracy level that is similar to natural gas-fired and hydroelectric resources. As a result, the CAISO does not draw any conclusions at this time regarding whether the participation by electric storage resources has improved overall resource accuracy measurements in CAISO's regulation market.

I. Background and Scope of Report

Under the CAISO's tariff, regulation up and regulation down are separate ancillary services provided by resources certified to respond automatically to control signals in an upward or downward direction to balance demand and supply in real-time. The CAISO market systems procure regulation up and regulation down for many reasons to balance supply and demand within 5-minute intervals and to provide frequency response.

In October 2011, the Commission issued Order No. 755, which adopted a final rule for compensation of frequency regulation in organized wholesale power markets. The Commission determined that the then-effective compensation methods for regulation service in organized markets failed to acknowledge the inherently greater amount of regulation service provided by faster-ramping resources and that certain practices result in economically inefficient dispatch of resources providing regulation service. To remedy these issues, the Commission's final rule required organized markets to compensate regulation resources based on the actual service provided, including a capacity payment that reflects the marginal unit's opportunity costs and a performance payment that reflects the quantity of regulation service actually provided by a resource when the resource accurately follows a

dispatch signal. Order No. 755 required the use of a market-based price rather than an administrative price on which to base performance payments.³

In response to the final rule, the CAISO developed a market design, which the Commission accepted effective June 1, 2013.⁴ The design uses a two-part structure to establish capacity and mileage clearing prices for bid-in and self-provided regulation. As part of this structure, the CAISO estimates the expected mileage from the capacity a resource bids-in or self-provides based on that resource's specific mileage multiplier. This expected mileage allows the CAISO to optimize capacity offered to satisfy regulation requirements and to establish a market clearing price for performance payments as adjusted for accuracy. Under the CAISO's market design, a resource responding to the CAISO's control signal receives a performance payment based on the resource's actual movement in response to the control signal. In other words, the CAISO adjusts a resource's performance payment based on how accurately it responds to the CAISO's control signal.

Additionally, the CAISO proposed that resources meet a minimum performance threshold of 50 percent accuracy over a calendar month.⁵ If a resource failed to meet the minimum performance threshold over the month, the CAISO's tariff required the resource to recertify to offer regulation up or regulation down within 90 days from the date the CAISO provided notice of the resource's failure to meet the minimum performance threshold.

³ Order 755 at P 128.

⁴ *Cal. Indep. Sys. Operator Corp.*, 140 FERC ¶ 61,206 (2012); *Cal. Indep. Sys. Operator Corp.*, 142 FERC ¶ 61,233 (2013). The Commission originally accepted the market design effective January 1, 2013, but subsequently the Commission granted successive motions for extension of time filed by the CAISO to implement the market design effective May 1, 2013 and then effective June 1, 2013. *Cal. Indep. Sys. Operator Corp.*, 141 FERC ¶ 61,184 (2012); Notice of Extension of Time, Docket Nos. ER12-1630-000, *et al.* (Apr. 30, 2013).

⁵ CAISO Tariff section 8.2.3.1.1.

As part of its approval of the CAISO's market design, the Commission directed the CAISO to conduct an operational review of its Order 755 market design based on one year of experience and submit an informational report within 14 months of the effective date of its tariff revisions.⁶ Based on that review and subsequent stakeholder discussions, the CAISO requested a change to its market design to reduce its monthly minimum performance threshold for resources providing regulation up and regulation down from 50 percent accuracy to 25 percent accuracy.

The Commission authorized this change, effective January 1, 2015, but directed the CAISO to file two informational reports to review the minimum performance threshold, with the first due no later than 18 months from January 1, 2015.⁷ For purposes of the first informational report, the Commission asked the CAISO to evaluate the appropriateness of the minimum performance threshold, considering the accuracy of resources providing regulation capacity based on historical data.⁸ The Commission directed the CAISO to include a study of how resources' accuracy measurements changed as the minimum performance threshold reduced from 50 percent to 25 percent, while also taking into consideration the level of recertification that would be needed at various threshold percentage levels, and any other analysis CAISO deems appropriate. The CAISO submitted its first informational report in June of 2016.⁹

⁶ *Cal. Indep. Sys. Operator Corp.*, 140 FERC ¶ 61,206 (2012) at P 75.

⁷ *Cal. Indep. Sys. Operator Corp.*, 150 FERC ¶ 61,056 (2015) at P 16.

⁸ *Id.* at P 16.

⁹ See Informational Report on Performance of Resources under Order 755 Market Design of the California Independent System Operator Corporation filed on June 30, 2016 in Commission Docket ER15-554: <https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14296652>

The Commission also recognized that data collected for the initial informational report may not be ripe in considering the performance of emerging technologies. Accordingly, the Commission directed the CAISO to file a second, subsequent informational report no later than 36 months from January 1, 2015. As part of this second information report, the Commission asked the CAISO to perform an analysis of how the entrance of new and faster-responding technologies may have influenced overall resource accuracy measurements in CAISO's regulation up and regulation down market.

II. Most resources are meeting the CAISO's minimum performance threshold for regulation up and regulation down

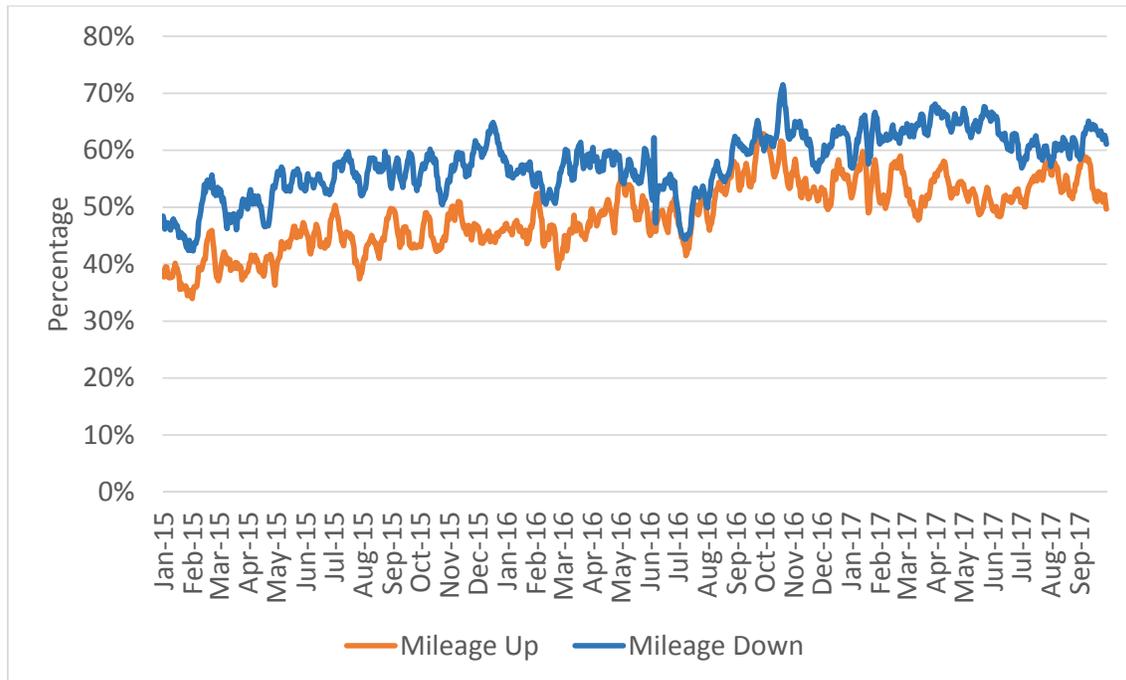
Under its current Order No. 755 market design, resources providing regulation up or regulation down must meet a minimum performance threshold of 25 percent accuracy.¹⁰ For purposes of this threshold, the CAISO measures a resource's accuracy in responding to a four second control signal. The CAISO sums a resource's automatic generation control set points for each four second regulation interval every fifteen (15) minutes and then sums the total deviations from the automatic generation control set point for each four second regulation interval during that fifteen (15) minute period. The CAISO then divides the sum of the resource's automatic generation control set points less the sum of the resource's total deviations by the sum of the resource's automatic generation control set points.¹¹ The CAISO calculates the resource's monthly performance by taking a simple average of 15-minute intervals during a calendar month.

¹⁰ CAISO tariff sections 8.2.3.1.1 and 8.4.1.1(h); CAISO tariff, Appendix K, Part A 1.1.5.

¹¹ CAISO tariff section 8.2.3.1.1.

Based on a review operational data from January 2015 through September 2017, resources providing both regulation up and regulation down have generally met the minimum performance threshold. Figure 1 reflects the average performance of resources across the CAISO system providing regulation up and regulation down during this time period.

Figure 1- Performance of CAISO System for Regulation Up and Regulation Down (January 1, 2015 – September 30, 2017)



This data reflects that, on the whole, resources have performed at a level that exceeds the minimum performance threshold of 25 percent accuracy for both regulation up and regulation down. In addition, there is a general trend over the period reflecting higher accuracy scores for both regulation up and regulation down.

Since its last report, the CAISO has continued to track regulation up and regulation down performance by resource types, including gas turbine, steam turbine, hydro, combined cycle and limited energy storage resources. Table A and Table B provide data on the performance of each resource type for the period

January 2015 through the end of September 2017. This data reflects that each resource type has on average exceeded the 25 percent accuracy measurement in most months for both regulation up and regulation down. Based on this data, the CAISO currently does not believe its current minimum performance threshold of 25 percent accuracy for regulation up and regulation down creates an unreasonable expectation for resource performance.

**Table A – Performance by Resource Type for Regulation Up
(January 2015 – September 2017)¹²**

Month	Combined Cycle	Gas Turbine	Hydro	Limited Energy Storage Resource	Pump Turbine	Steam Turbine
Jan-2015	37.50%	64.81%	33.09%		29.71%	22.64%
Feb-2015	43.11%	74.33%	35.97%	8.81%	27.77%	19.52%
Mar-2015	42.06%	72.55%	35.76%	14.02%	30.95%	23.74%
Apr-2015	41.14%	73.39%	39.18%	11.07%	22.52%	35.65%
May-2015	48.46%	62.94%	43.36%	55.16%	44.78%	33.99%
Jun-2015	49.59%	58.98%	44.98%	67.02%	43.79%	37.39%
Jul-2015	45.68%	58.71%	43.96%	67.12%	31.73%	42.28%
Aug-2015	46.54%	64.26%	48.03%	64.52%	41.57%	46.38%
Sep-2015	45.80%	59.79%	46.94%	79.56%	44.44%	44.63%
Oct-2015	49.28%	56.79%	47.75%		44.85%	44.28%
Nov-2015	50.68%	64.44%	47.12%		35.21%	46.86%
Dec-2015	56.66%	47.39%	41.38%	69.30%	51.35%	50.80%
Jan-2016	56.92%	31.70%	42.50%	73.73%	49.78%	42.80%
Feb-2016	47.21%	52.63%	38.29%	64.82%	42.70%	34.23%
Mar-2016	50.02%	69.50%	38.66%	62.35%	50.03%	46.80%
Apr-2016	39.56%	76.75%	45.35%	63.41%	54.10%	38.80%
May-2016	43.95%	75.89%	48.14%	54.19%	50.50%	44.76%
Jun-2016	55.78%	78.55%	45.23%	56.12%	51.23%	42.62%
Jul-2016	55.16%	70.19%	48.94%	34.79%	38.22%	44.41%
Aug-2016	58.83%	73.74%	53.06%	61.48%	45.38%	46.63%
Sep-2016	60.07%	75.31%	55.91%	69.32%	30.68%	49.98%
Oct-2016	59.85%	69.10%	54.40%	68.51%	49.16%	42.46%
Nov-2016	57.80%	75.05%	47.91%	69.93%	42.38%	41.18%
Dec-2016	57.00%	66.40%	50.88%	62.36%	51.47%	44.82%
Jan-2017	60.26%	63.14%	50.59%	62.80%	50.39%	45.07%
Feb-2017	61.90%	58.18%	47.87%	67.22%	54.86%	39.69%
Mar-2017	57.17%	64.58%	46.79%	60.92%	51.67%	35.89%
Apr-2017	52.30%	65.90%	44.74%	64.35%	54.64%	34.49%
May-2017	51.91%	61.48%	44.46%	61.47%	48.44%	40.07%
Jun-2017	47.75%	55.00%	46.14%	60.12%	47.09%	41.51%
Jul-2017	50.62%	62.48%	55.55%	65.30%	54.97%	45.15%
Aug-2017	47.92%	65.96%	56.28%	63.47%	43.13%	47.76%
Sep-2017	52.93%	68.83%	54.01%	65.64%	42.69%	43.55%

¹² For those table entries with no monthly values, the CAISO does not have recorded accuracy values for these resource types providing regulation up.

**Table B – Performance by Resource Type for Regulation Down
(January 1, 2015 – March 31, 2016)¹³**

Row Labels	Combined Cycle	Gas Turbine	Hydro	Limited Energy Storage Resource	Pump Turbine	Steam Turbine
Jan-2015	45.91%	57.55%	45.11%		48.11%	49.25%
Feb-2015	54.73%	66.92%	50.60%	39.18%	59.28%	47.45%
Mar-2015	51.79%	64.16%	45.16%	40.40%		47.70%
Apr-2015	53.70%	65.19%	44.04%	43.49%	4.39%	57.36%
May-2015	58.11%	69.27%	50.80%	60.49%		58.15%
Jun-2015	59.67%	65.95%	51.21%	72.45%	50.69%	46.67%
Jul-2015	59.41%	63.08%	53.41%	70.05%	1.09%	57.02%
Aug-2015	61.53%	69.32%	52.11%	69.97%	2.15%	55.16%
Sep-2015	61.41%	72.71%	51.33%	76.12%		53.42%
Oct-2015	57.63%	71.14%	51.79%		44.60%	57.16%
Nov-2015	63.71%	73.15%	54.30%		34.56%	64.85%
Dec-2015	69.33%	66.29%	50.35%	67.88%	51.57%	69.18%
Jan-2016	65.06%	60.17%	47.53%	72.52%	49.35%	55.68%
Feb-2016	60.30%	67.81%	48.30%	63.23%	53.82%	49.42%
Mar-2016	55.88%	81.10%	56.14%	69.36%	47.34%	56.37%
Apr-2016	52.52%	82.05%	54.71%	68.06%	62.54%	50.65%
May-2016	53.43%	80.24%	54.42%	61.30%	52.62%	51.34%
Jun-2016	57.27%	83.12%	49.02%	65.15%	46.02%	46.28%
Jul-2016	61.26%	29.08%	50.95%	27.41%	12.52%	51.23%
Aug-2016	63.76%	80.82%	51.54%	71.33%	23.82%	53.32%
Sep-2016	67.83%	84.34%	54.96%	71.35%	14.42%	58.42%
Oct-2016	69.98%	83.07%	58.87%	69.70%	58.38%	57.07%
Nov-2016	66.87%	77.90%	55.17%	74.64%	53.31%	48.51%
Dec-2016	65.83%	76.57%	56.91%	70.23%	59.55%	58.65%
Jan-2017	67.52%	72.85%	59.58%	70.02%	59.43%	58.85%
Feb-2017	68.70%	78.64%	56.81%	54.91%	64.00%	56.01%
Mar-2017	64.83%	80.44%	64.95%	65.53%	59.79%	58.01%
Apr-2017	58.34%	69.13%	63.86%	70.98%	52.38%	63.90%
May-2017	60.02%	70.56%	63.82%	70.15%	48.02%	44.49%
Jun-2017	61.40%	63.30%	61.81%	59.52%	52.73%	63.61%
Jul-2017	59.65%	68.36%	59.36%	62.93%	39.58%	57.43%
Aug-2017	62.44%	67.62%	61.12%	62.90%	71.45%	51.78%
Sep-2017	67.69%	72.49%	62.97%	61.95%	58.74%	57.98%

III. The CAISO has observed an increase in the provision of regulation up and regulation down by electric storage resources

Since the CAISO submitted its last informational report in this docket, the CAISO has observed an increase in electric storage resources providing regulation up and regulation down in its markets. Table C and Table D provide data on the amount of regulation up and regulation down provided by different resource types for

¹³ For those table entries with no monthly values, the CAISO does not have recorded accuracy values for these resource types providing regulation down.

the period of March 2016 through the end of September 2017. During some months, this data reflects an increase in the provision of regulation up and regulation down by energy storage resources. The percentage increase, however, is relatively small in some months and is not constant. In addition, the performance accuracy of energy storage resources during this time frame is similar to natural gas-fired and hydroelectric resources. Based on these facts, the CAISO has not identified a strong correlation between the increase in electric storage resources providing regulation and overall system accuracy.

**Table C – Percentage of Regulation Up by Resource Type
(March 2016 – September 2017)**

Month	Combined Cycle	Gas Turbine	Hydro	Limited Energy Storage Resource	Pump Turbine	Steam Turbine
Mar-2016	27.00%	7.97%	34.05%	0.46%	29.56%	0.95%
Apr-2016	22.33%	12.92%	52.83%	0.48%	10.41%	1.03%
May-2016	15.10%	2.89%	61.40%	1.70%	13.97%	4.94%
Jun-2016	32.45%	5.76%	54.31%	0.93%	1.93%	4.62%
Jul-2016	32.44%	4.17%	52.79%	1.69%	0.32%	8.60%
Aug-2016	25.16%	1.18%	60.81%	2.17%	0.26%	10.41%
Sep-2016	23.48%	1.09%	67.33%	2.48%	0.14%	5.48%
Oct-2016	23.41%	0.59%	67.34%	2.26%	1.77%	4.64%
Nov-2016	18.21%	0.69%	74.20%	2.10%	1.56%	3.22%
Dec-2016	27.92%	2.33%	62.42%	2.05%	4.40%	0.88%
Jan-2017	57.96%	3.73%	27.81%	0.58%	9.79%	0.13%
Feb-2017	64.98%	1.14%	17.50%	0.02%	15.02%	1.35%
Mar-2017	34.08%	1.55%	44.67%	8.80%	9.43%	1.46%
Apr-2017	20.42%	2.39%	50.74%	9.27%	16.87%	0.31%
May-2017	27.97%	1.45%	52.45%	9.77%	6.86%	1.49%
Jun-2017	25.53%	1.48%	58.46%	9.68%	2.48%	2.37%
Jul-2017	37.68%	3.11%	49.07%	6.07%	1.66%	2.40%
Aug-2017	29.28%	2.08%	55.74%	8.86%	0.86%	3.18%
Sep-2017	26.78%	0.27%	65.99%	4.46%	0.36%	2.15%

**Table D– Percentage of Regulation Down by Resource Type
(March 2016 – September 2017)**

Row Labels	Combined Cycle	Gas Turbine	Hydro	Limited Energy Storage Resource	Pump Turbine	Steam Turbine
Mar-2016	9.21%	8.35%	78.45%	0.67%	2.42%	0.91%
Apr-2016	5.73%	8.95%	82.28%	0.72%	1.23%	1.08%
May-2016	20.99%	7.44%	59.28%	1.41%	5.95%	4.92%
Jun-2016	37.05%	1.72%	54.32%	0.93%	0.61%	5.38%
Jul-2016	47.79%	0.90%	38.41%	2.07%	0.03%	10.79%
Aug-2016	47.53%	0.60%	35.57%	2.82%	0.04%	13.43%
Sep-2016	51.47%	2.50%	34.61%	3.23%	0.00%	8.18%
Oct-2016	56.64%	3.64%	30.92%	1.81%	0.33%	6.67%
Nov-2016	38.07%	5.90%	51.18%	1.18%	0.53%	3.13%
Dec-2016	49.31%	4.24%	43.80%	1.48%	0.64%	0.54%
Jan-2017	58.11%	6.41%	34.02%	0.59%	0.71%	0.15%
Feb-2017	62.36%	8.06%	25.27%	0.02%	2.77%	1.53%
Mar-2017	10.75%	4.61%	76.52%	6.44%	0.29%	1.39%
Apr-2017	7.99%	2.33%	82.02%	6.96%	0.32%	0.37%
May-2017	12.99%	1.49%	77.52%	6.20%	0.26%	1.53%
Jun-2017	23.79%	1.65%	64.13%	6.93%	0.28%	3.22%
Jul-2017	51.55%	3.57%	36.83%	4.51%	0.01%	3.53%
Aug-2017	49.94%	5.74%	36.39%	2.52%	0.28%	5.13%
Sep-2017	46.81%	5.57%	40.96%	1.24%	0.35%	5.07%

IV. Conclusion

The CAISO’s market design for regulation performance assesses whether resources respond accurately in all intervals to a four second control signal. The CAISO recognizes that this is an aggressive metric. On the other hand, the CAISO expects and needs regulation resources to respond accurately to its control signal. The current minimum performance threshold of 25 percent accuracy for resources providing regulation up and regulation down does not appear to create an unreasonable expectation for resource performance. The threshold imposes a reasonable floor in terms of required accuracy for resources to respond to the CAISO’s control signal. The CAISO will continue to monitor the performance of regulation resources and, if appropriate, will work with stakeholders to explore

refinements to the implementation of Order No. 755.

Dated: December 28, 2018

Respectfully submitted,

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CERTIFICATE OF SERVICE

I hereby certify that I have served the foregoing document upon the parties listed on the official service list in the captioned proceeding, 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, CA this 28th day of December, 2017.

Anna Pascuzzo
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