

Five Minute Dispatch and Pricing

MIC

August 7, 2019

Catherine Tyler

Siva Josyula

Joel Luna

Joe Bowring



Monitoring Analytics

Background

- Problem Statement and Issue Charge
 - First read at May MIC
 - Approved at June MIC
 - First Education Session at July MIC on RT SCED execution



Background

- August MIC – Education on LPC
- Key work activities:
 3. Review and provide education on the current LPC execution process, including but not limited to the frequency of cases, the inputs used, the target interval of the cases, approval process, solution time frame, and use of solution output.
 4. Review and provide education on the criteria for selecting RT SCED cases to be used in LPC.
 5. Review and provide education on the criteria for triggering reruns of LPC cases, and LMPs.

LPC Background and Timeline

- LPC uses an approved RT SCED solution to calculate real time LMPs and ancillary service prices.
- Linear optimization engine, same as RT SCED.
- LPC is executed every five minutes.
- For each five minute interval that LPC calculates prices for, LPC is executed 90 seconds into that five minute interval.
- For example, LPC is executed at 10:16:30 to calculate prices for the five minute interval beginning 10:15:00.
- Majority of LPC cases solve in less than 90 seconds.



SCED cases used in LPC

- Not all RT SCED cases used to send dispatch signals are used to calculate LMPs in LPC.
- On average, dispatch signals are sent with approximately 1.5 times the frequency with which prices are calculated (every 5 minutes)

Month (2019)	Number of Five Minute Intervals	Number of Approved RT SCED Cases	Number of Approved RT SCED Cases Used in LPC	Percent of Approved RT SCED Cases Used in LPC
Jan	8,928	12,177	7,656	62.9%
Feb	8,064	11,484	7,186	62.6%
Mar	8,916	12,942	7,966	61.6%
Apr	8,640	12,759	7,768	60.9%
May	8,928	12,890	7,808	60.6%
Jun	8,640	12,988	7,651	58.9%

LPC Reuse of RT SCED Cases

- LPC uses the latest approved SCED case at the time it is executed.
- If there is no new approved RT SCED case, LPC continues to use the latest approved RT SCED case to calculate prices for multiple intervals.
 - In the first six months of 2019, 11.4% of approved RT SCED cases were used in multiple LPC cases.

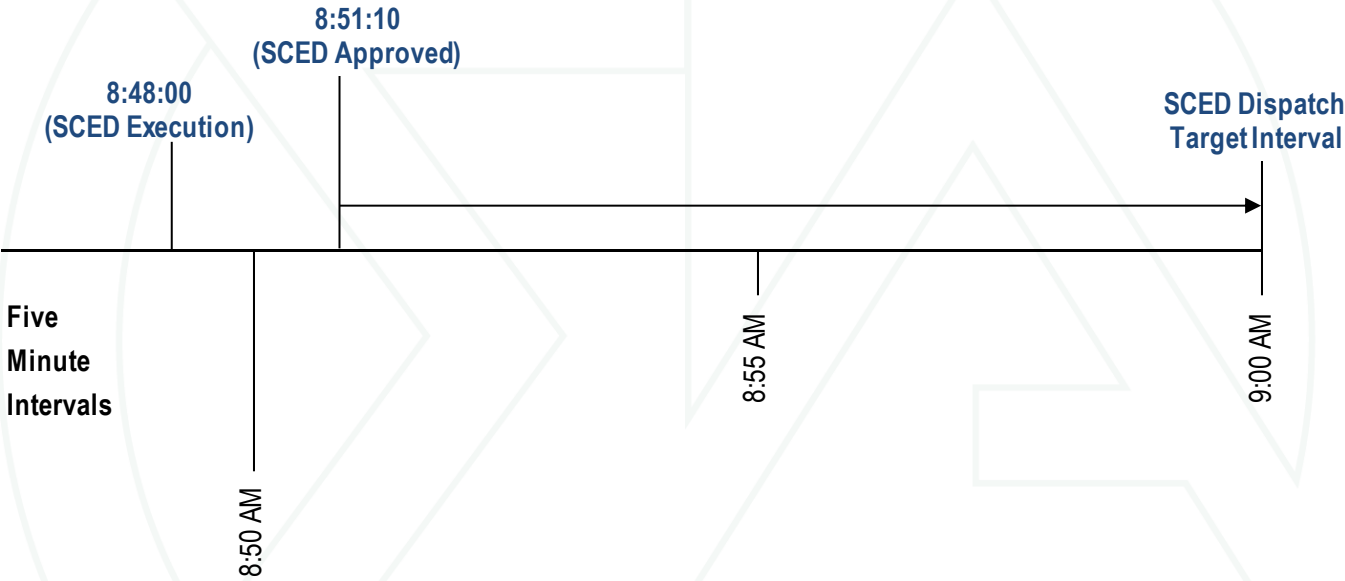
LPC vs RT SCED Target Interval

- For 94.3 percent of the intervals, the five minute interval for which LPC calculates the prices is not the same as the target interval of the RT SCED case used to calculate the prices.
- For 93 percent of intervals, LPC assigns LMPs based on RT SCED dispatch for a future target interval.

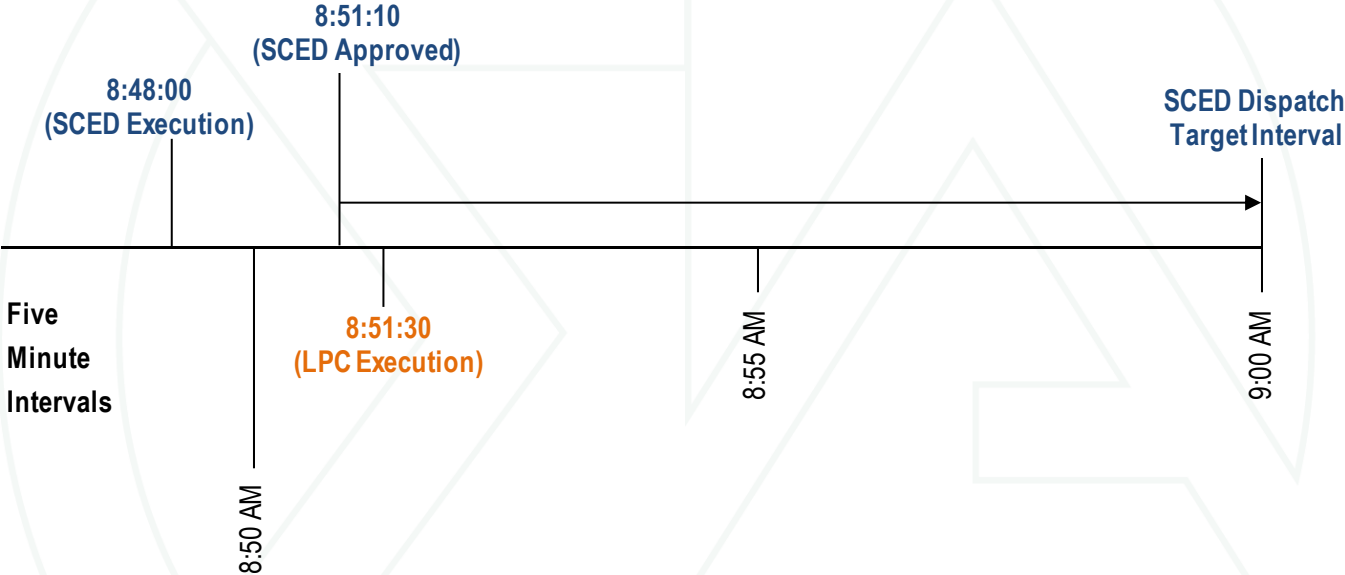
Difference between RT SCED and LPC Target Intervals (mins)	Percent of Five Minute Intervals	
	2018	2019 (Jan - Jun)
(10)	0.2%	0.1%
(5)	0.9%	0.5%
0	5.7%	4.0%
5	30.5%	27.7%
10	62.5%	67.6%

*Five minute settlements implemented April 1, 2018.

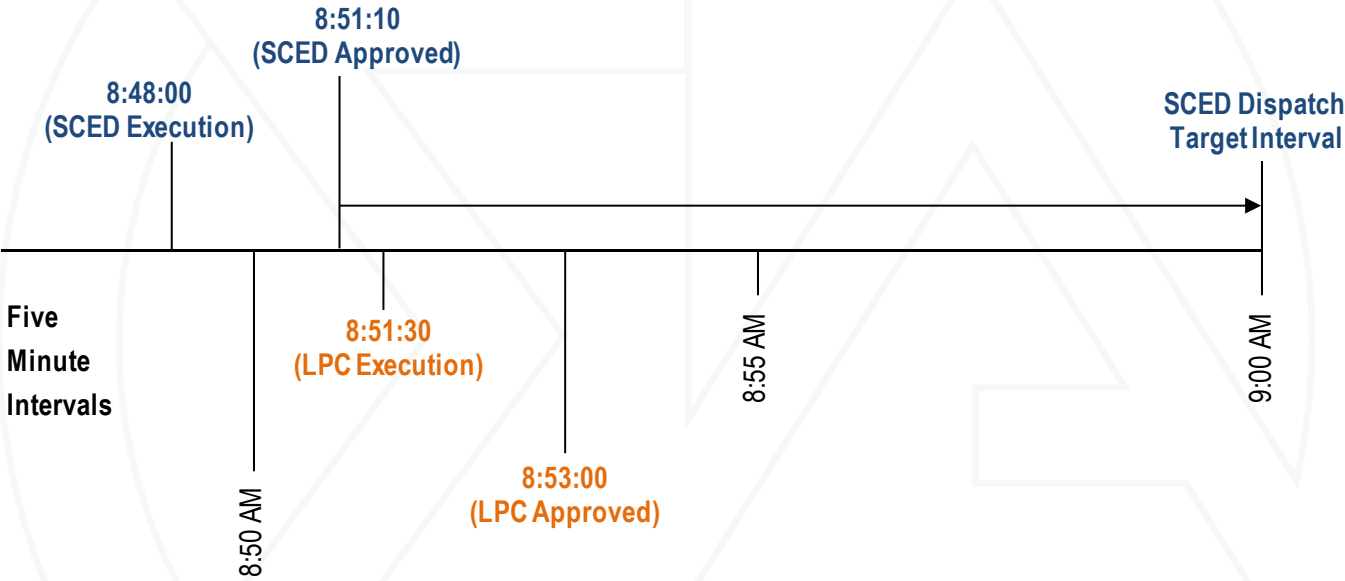
Timeline



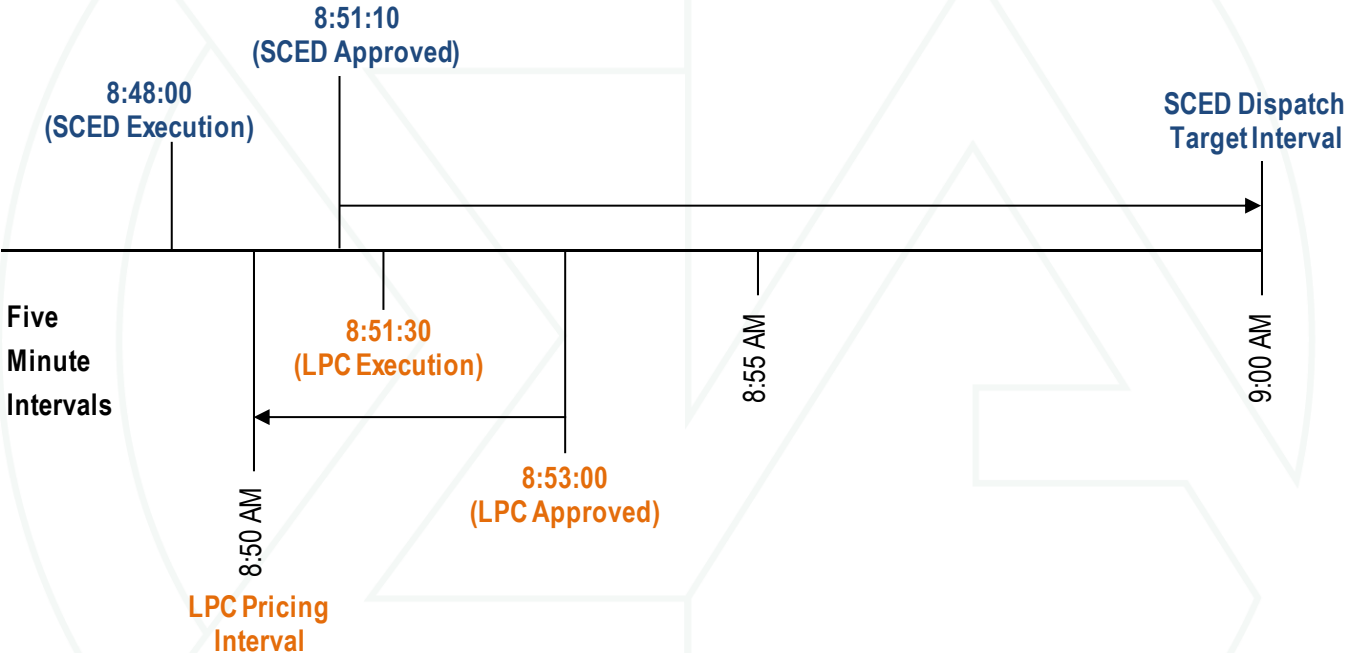
Timeline



Timeline



Timeline



Impact of Interval Difference - Energy

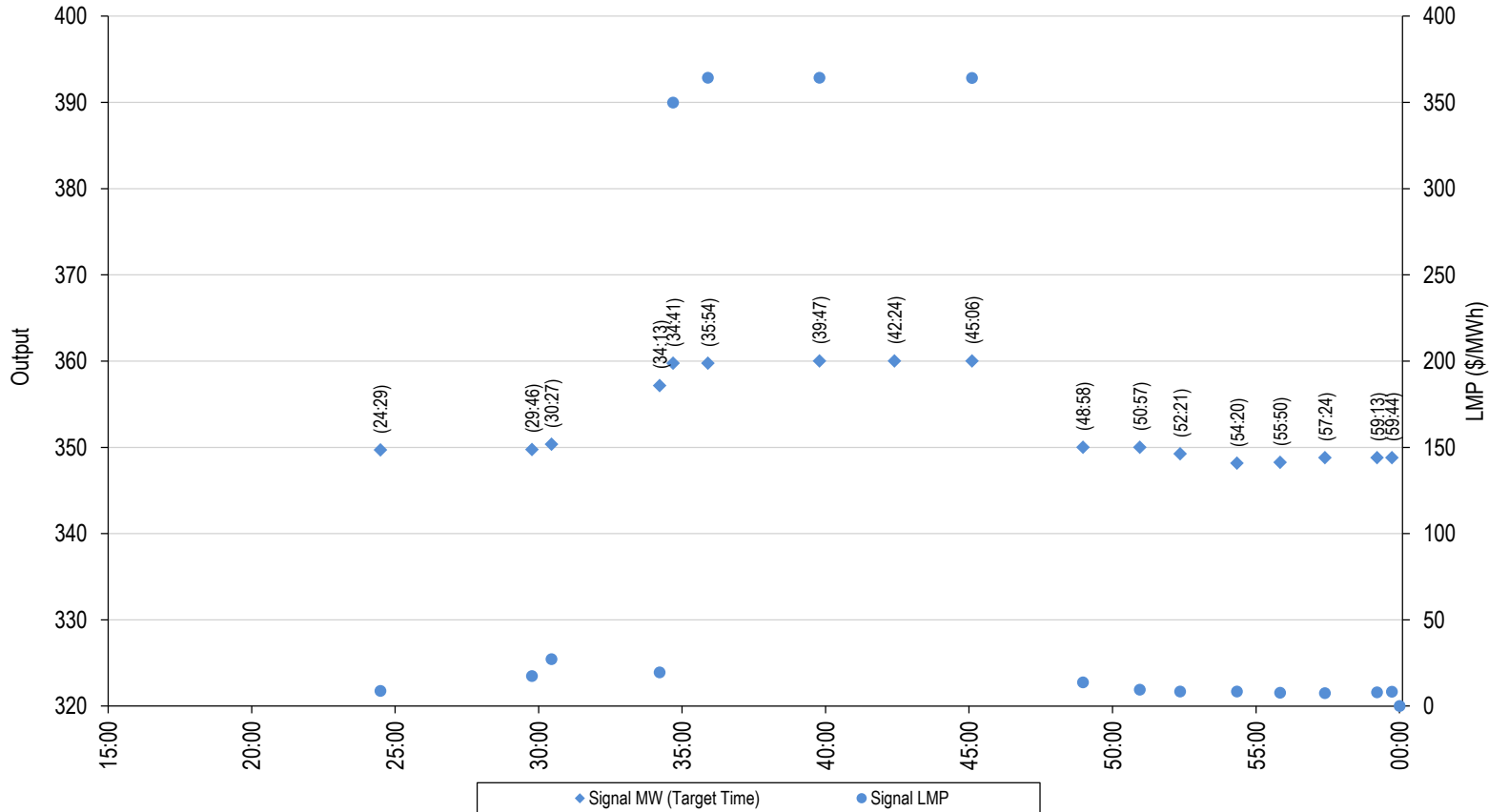
- The MMU observed, for energy settlements:
 - The MW come from Power Meter submissions by generators.
 - The prices come from LPC for each five minute interval.
 - The interval for which LPC calculates prices, does not match the target interval from the SCED case used to calculate the dispatch signals.
- As a result, a unit that follows dispatch is not settled using the price consistent with the dispatch signal.
- The MMU is further looking into the settlements impact.
 - Impact on uplift

Example of Interval Difference Impact - Energy

- Unit receives MW signals to ramp up around minute 24 for minute 34.
- SCED LMPs reflect the need for the unit to ramp up.
 - SCED LMPs provide a price signal consistent with the MW dispatch signal.



Example of Interval Difference Impact - Energy

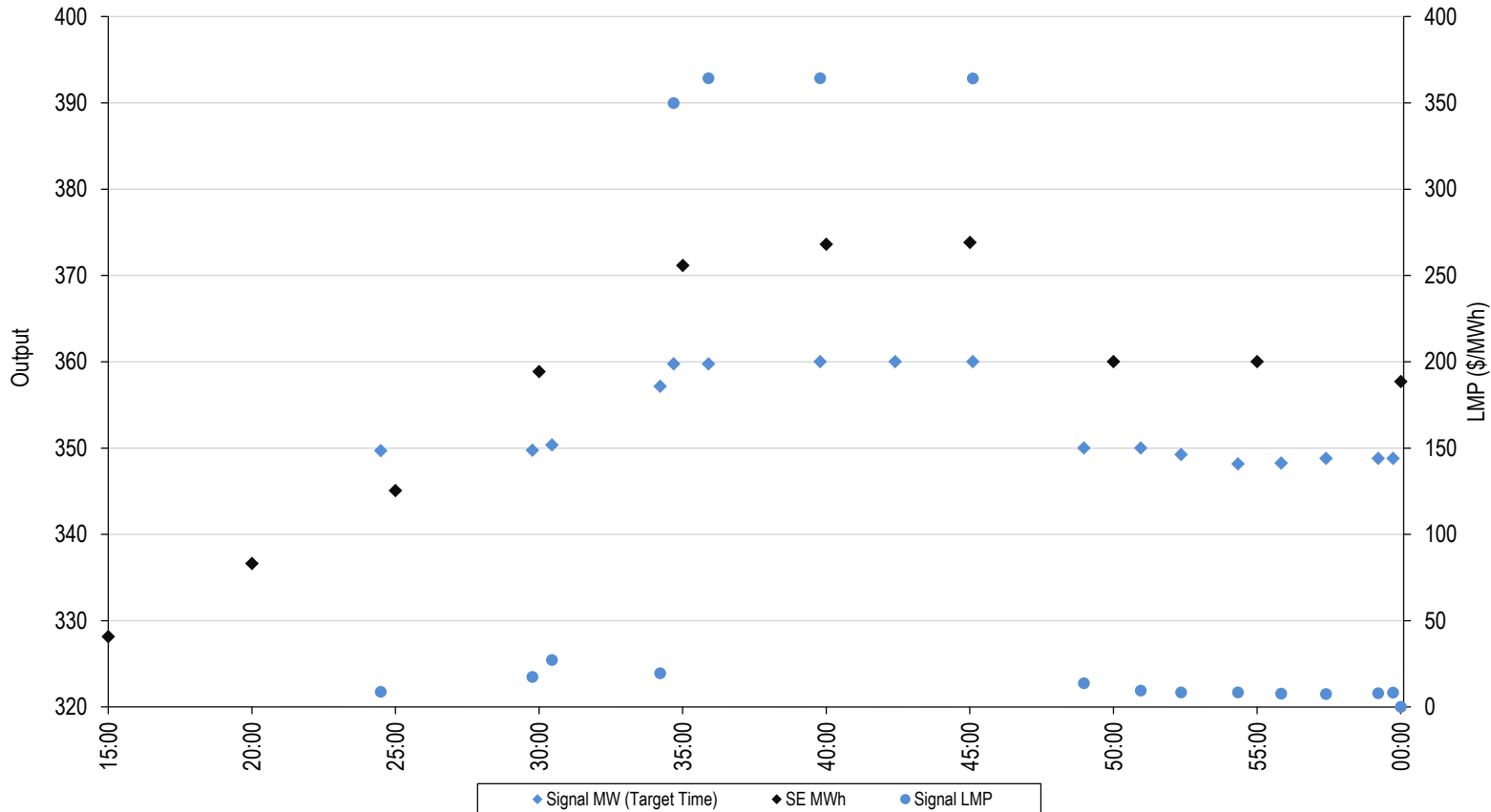


Example of Interval Difference Impact - Energy

- Unit follows dispatch
 - In this example, the unit exceeds the dispatch MW instruction, most likely based on an incorrect and outdated ICAP MW ambient adjustment.
- When instructed, the unit ramps down.



Example of Interval Difference Impact - Energy

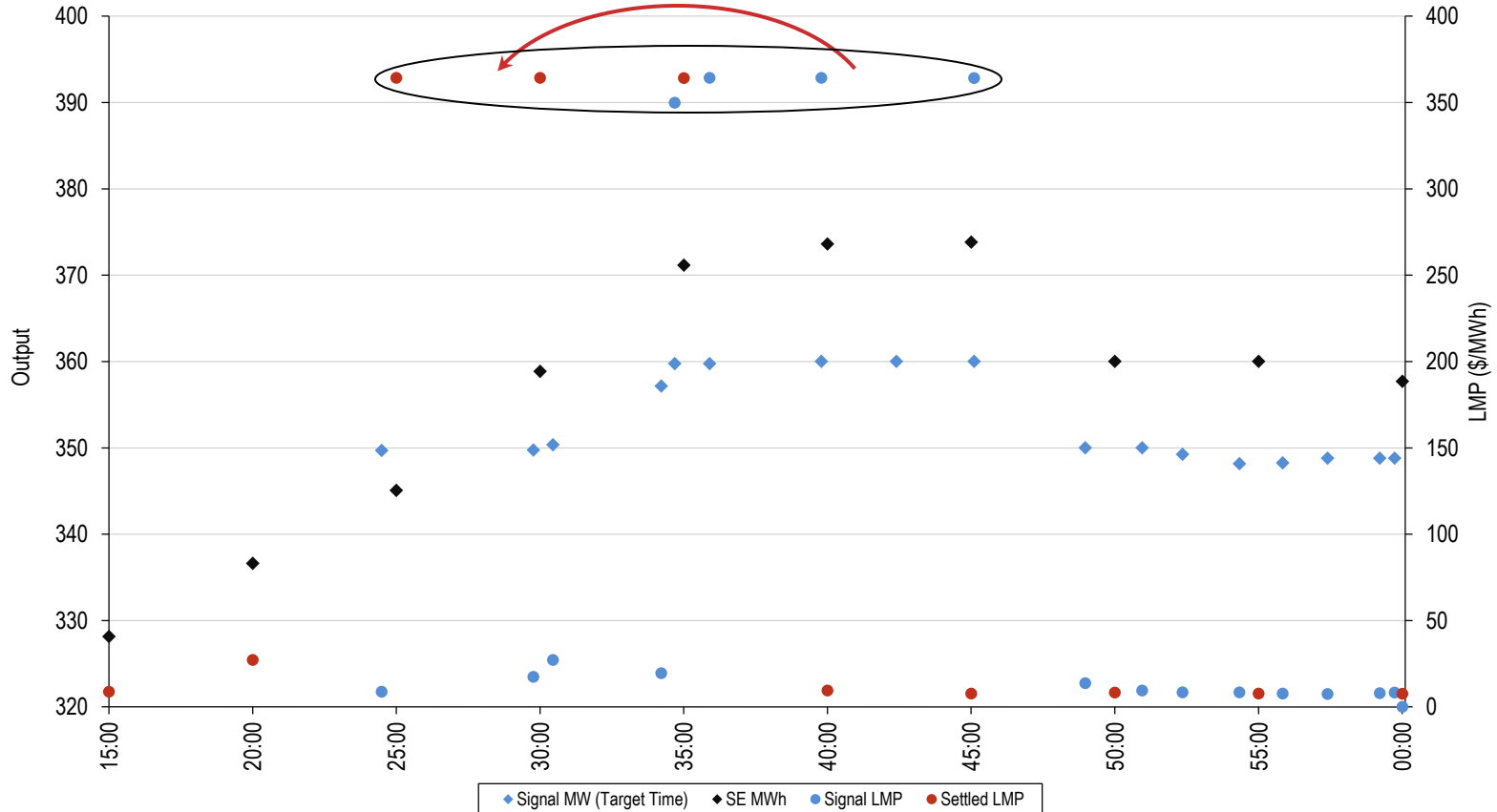


Example of Interval Difference Impact - Energy

- LMPs are generally calculated based on the last SCED case approved prior to the LPC calculation.
- LPC (and settlements) assigns the LMPs to the interval in which the LPC case was executed.
- LPC assigns LMPs to an interval prior to the target interval of the SCED case producing the dispatch MW.
- The result is a mismatch between the LMP and the dispatch MW.
- The unit is paid the high LMPs for intervals in which the unit was not instructed to ramp up and paid the low LMPs for intervals in which the unit was instructed to ramp up.



Example of Interval Difference Impact - Energy



Example Revenue Loss

Interval	MW Output	SCED Price	LPC Price	SCED Revenue	LPC Revenue	Difference
0:00:00						
0:05:00						
0:10:00						
0:15:00	328.1		\$8.78			
0:20:00	336.6		\$27.12			
0:25:00	345.1	\$8.78	\$364.24	\$3,029.06	\$125,689.41	\$122,660.35
0:30:00	358.8	\$27.12	\$364.25	\$9,732.01	\$130,710.30	\$120,978.30
0:35:00	371.2	\$364.24	\$364.06	\$135,187.49	\$135,120.68	-\$66.81
0:40:00	373.6	\$364.25	\$9.44	\$136,083.51	\$3,527.17	-\$132,556.34
0:45:00	373.8	\$364.06	\$7.73	\$136,094.81	\$2,888.93	-\$133,205.88
0:50:00	360.0	\$9.44	\$8.28	\$3,398.76	\$2,979.72	-\$419.04
0:55:00	360.0	\$7.73	\$7.61	\$2,782.08	\$2,741.04	-\$41.04
1:00:00	357.7	\$8.28	\$7.50	\$2,960.70	\$2,682.77	-\$277.93
Total Revenue				\$429,268.41	\$406,340.02	-\$22,928.39

Interval Difference Impact - Reserves

- For reserve settlements:
 - The MW assigned come from the last approved SCED case for the target five minute interval.
 - The reserve prices come from the LPC case solved during the five minute interval using a SCED case for a later target interval.
 - These two solutions do not match.
- Example (next slide) shows that the settlement MW match the last approved SCED case for the target interval, while the settlement price matches the LPC price using a different SCED case.
- In this example, the unit receives less revenues due to the mismatch between the cleared MW (last approved SCED case for the target interval) and the assigned prices (LPC).

Example of Interval Difference – Reserves

Interval Beginning	Settled Reserve MW	Last SCED Reserve MW	LPC Reserve MW
17:10:00			2.0
17:15:00			
17:20:00	2.0	2.0	
17:25:00			
17:30:00			

Example of Interval Difference – Reserves

Interval Beginning	Settled Reserve MW	Last SCED Reserve MW	LPC Reserve MW
17:10:00			2.0
17:15:00			
17:20:00	2.0	2.0	
17:25:00			
17:30:00			



Example of Interval Difference – Reserves

Interval Beginning	Settled Reserve MW	Last SCED Reserve MW	LPC Reserve MW	Settled Reserve MCP	Last SCED Reserve MCP	LPC Reserve MCP
17:10:00			2.0	\$0.45		\$0.45
17:15:00						
17:20:00	2.0	2.0		\$1.79	\$0.45	\$1.79
17:25:00						
17:30:00					\$1.79	

Example of Interval Difference – Reserves

Interval Beginning	Settled Reserve MW	Last SCED Reserve MW	LPC Reserve MW	Settled Reserve MCP	Last SCED Reserve MCP	LPC Reserve MCP
17:10:00			2.0	\$0.45		\$0.45
17:15:00						
17:20:00	2.0	2.0		\$1.79	\$0.45	\$1.79
17:25:00						
17:30:00					\$1.79	

MCPs are rising. The MW are paid a higher price than required to clear them.

Example of Interval Difference - Reserves

Interval Beginning	Settled Reserve MW	Last SCED Reserve MW	LPC Reserve MW
23:00:00			0.3
23:05:00	0.3	0.3	6.7
23:10:00	6.7	6.7	0.4



Example of Interval Difference - Reserves

Interval Beginning	Settled Reserve MW	Last SCED Reserve MW	LPC Reserve MW	Settled Reserve MCP	Last SCED Reserve MCP	LPC Reserve MCP
23:00:00			0.3	\$870.40		\$870.40
23:05:00	0.3	0.3	6.7	\$310.91	\$870.40	\$310.91
23:10:00	6.7	6.7	0.4	\$91.63	\$310.91	\$91.63

Example of Interval Difference - Reserves

Interval Beginning	Settled Reserve MW	Last SCED Reserve MW	LPC Reserve MW	Settled Reserve MCP	Last SCED Reserve MCP	LPC Reserve MCP
23:00:00			0.3	\$870.40		\$870.40
23:05:00	0.3	0.3	6.7	\$310.91	\$870.40	\$310.91
23:10:00	6.7	6.7	0.4	\$91.63	\$310.91	\$91.63

The settled MCP is lower than the cost of clearing the reserves, resulting in uplift.

Monitoring Analytics, LLC

2621 Van Buren Avenue

Suite 160

Eagleville, PA

19403

(610) 271-8050

MA@monitoringanalytics.com

www.MonitoringAnalytics.com



APPENDIX



LPC Rerun Statistics

- PJM can rerun LPC to recalculate and post revised LMPs.

Month	Number of Five Minute Intervals	Number of Five Minute Intervals for which LMPs were recalculated
January	8,928	10
February	8,064	14
March	8,916	51
April	8,640	19
May	8,928	19
June	8,640	28
Total	52,116	141

Recalculating Prices: OATT Language

- OATT Attachment K Appendix Section 1.10.8 (e):

*If the Office of the Interconnection discovers an error in prices and/or cleared quantities in the Day-ahead Energy Market, Real-time Energy Market, Ancillary Services Markets or Day Ahead Scheduling Reserve Market after it has posted the results for these markets on its Web site, the Office of the Interconnection **shall notify Market Participants of the error** as soon as possible after it is found, **but in no event later than 12:00 p.m. of the second Business Day following the Operating Day for the Ancillary Services Markets and Real-time Energy Market**, and no later than 5:00 p.m. of the second Business Day following the initial publication of the results for the Day-ahead Scheduling Reserve Market and Day-ahead Energy Market.*

Recalculating Prices: OATT Language

*After this initial notification, if the Office of the Interconnection **determines it is necessary to post modified results, it shall provide notification of its intent to do so, together with all available supporting documentation, by no later than 5:00 p.m. of the fifth Business Day following the Operating Day for the Ancillary Services Markets and Real-time Energy Market, and no later than 5:00 p.m. of the fifth Business Day following the initial publication of the results in the Day-ahead Scheduling Reserve Market and the Day-ahead Energy Market. Thereafter, the Office of the Interconnection **must post on its Web site the corrected results by no later than 5:00 p.m. of the tenth calendar day following the Operating Day for the Ancillary Services Markets, Day-ahead Energy Market and Real-time Energy Market, and no later than 5:00 p.m. of the tenth calendar day following the initial publication of the results in the Day-ahead Scheduling Reserve Market.*****

Load Bias in RT SCED

All executed RT SCED cases:

Load Bias	2018		2019 (Jan through June)	
	Average Bias (MW)	Percentage of Executed Cases	Average Bias (MW)	Percentage of Executed Cases
Negative	-874	74.2%	-846	73.3%
Positive	462	14.5%	458	14.5%
Unbiased	0	11.3%	0	12.2%

Approved RT SCED cases:

Load Bias	2018		2019 (Jan through June)	
	Average Bias (MW)	Percentage of Approved Cases	Average Bias (MW)	Percentage of Approved Cases
Negative	-874	77.2%	-837	77.9%
Positive	466	12.2%	463	11.1%
Unbiased	0	10.7%	0	11.1%

Load Bias in RT SCED cases used in LPC

Load Bias	2018		2019 (Jan through June)	
	Average Bias (MW)	Percent of LPC Cases	Average Bias (MW)	Percent of LPC Cases
Negative	-864	77.4%	-828	78.2%
Positive	463	11.7%	457	10.7%
Unbiased	0	10.8%	0	11.0%