Benefits for Participating in EIM

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Revision History

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Table of Contents

Executive Summary

This is the third "Quantifying EIM Benefits" report released and it quantifies the estimated gross benefits for April, May, and June 2015 to be $10.18 million, which is consistent with pre-launch projections. The increase in benefits reflects the inclusion of the five-minute granularity, increased transfer volumes from PacifiCorp, the first Energy Imbalance Market (EIM) participant, to the ISO, and higher prices in the market.

This analysis continues to prove EIM's ability to select the lowest cost resource across the PacifiCorp and ISO balancing authority areas (BAAs) to serve demand and measures benefits within the following categories, which were described in an earlier study conducted by Energy + Environmental Economics (E3)[1] for PacifiCorp and the ISO.

- ***More efficient dispatch, both inter- and intra-regional, in the Fifteen-Minute Market (FMM) and Real-Time Dispatch (RTD)*** by automating dispatch every fifteen minutes and every five minutes within PacifiCorp's two BAAs and between the PacifiCorp and California ISO BAAs.
- ***Reduced renewable energy curtailment*** by allowing BAAs to export or reduce imports of renewable generation when it would otherwise need to be economically curtailed.
- ***Reduced flexibility reserves needed in PacifiCorp BAAs,*** which saves cost by aggregating the load, wind, and solar variability and forecast errors of the combined EIM footprint. This report introduces the flexibility reserve benefits for PacifiCorp but defers measurement of reduced flexibility reserve benefits for the ISO to future reports due to the need to develop additional measurement techniques.

Comparing with past reports, the ISO made the following enhancements in this report:

- ***Quantify benefits on a five-minute market interval basis***. In the previous reports, the ISO quantified EIM benefits on a fifteen-minute market interval basis. In this report, the ISO quantified the EIM benefits using the five-minute EIM interval results.
- ***Enhanced benefits accounting of greenhouse gas (GHG) allocation method***. In this report, the ISO enhanced the GHG allocation accounting method to divide the benefits between BAAs more precisely.

Table 1 below shows the estimated benefits summary for the second quarter of 2015 in millions of dollars per BAA. The EIM benefit is calculated based on the methodology discussed in an earlier ISO Technical Bulletin with the practical simplifications described in the 2014 Q4 report, and on five-minute market interval basis.

[1] PacifiCorp, Energy Imbalance Markets Summary, http://www.caiso.com/Documents/PacifiCorp-ISOEnergyImbalanceMarketBenefits.pdf

BAA	April	May	June	Total
ISO	$0.62	$1.00	$0.84	$2.46
PACE	$0.62	$0.97	$1.67	$3.26
PACW	$0.66	$1.21	$2.59	$4.46
Total	**$1.90**	**$3.18**	**$5.10**	**$10.18**

Table 1: Estimated benefits shown are in millions and accrued in the second quarter of 2015

One of the important contributors to the EIM benefit are transfers, which allows lower cost supply from one BAA to meet demand in another. As such, the transfer volume is a good indicator of a portion of the EIM benefit. Transfers can take place in both the FMM and RTD. The transfer limits between PACW and the ISO in the FMM are based on the Interchange Rights PacifiCorp utilized for EIM transfers. This report does not consider PacifiCorp's opportunity cost that the utility considered when using its transfer rights for the EIM.

The transfer limits in the five-minute RTD market are dynamically determined based on allocated dynamic transfer capability limiting the five-minute transfers around the fifteen-minute transfer scheduled in the FMM, and system operating conditions. Table 2 below provides the FMM transfer volume as well as the RTD dynamic transfer volume. The total EIM transfer for both fifteen-minute transfers and five-minute dynamic transfers for April through June 2015 were approximately 260,452 megawatt hours (MWh) from PacifiCorp to the ISO and 35,368 MWh from the ISO to PacifiCorp.

Negative RTD dynamic transfer values, such as those realized in May and June and shown in Table 2, can occur when the RTD dynamic transfer flows in the opposite direction of the FMM transfer. For example, for a particular hour, the FMM transfer can be 100 MWh from the ISO to PacifiCorp, and the RTD dynamic transfer can be 20 MWh from PacifiCorp to the ISO, resulting in a 80 MWh total transfer from the ISO to PacifiCorp. In this case, they will be reported as transfer from ISO to PacifiCorp with FMM = 100 Mwh, RTD (dynamic) = -20 MWh, and total = 80 MWh.

market	Month	PAC_ISO	ISO_PAC	PACE_PACW
FMM	April	38,688	14,094	22,111
	May	75,382	13,134	58,954
	June	98,742	7,489	77,234
RTD (dynamic)	April	12,924	1,033	4,275
	May	14,191	292	-404
	June	20,525	-674	-8,335
Total	**All**	**260,452**	**35,368**	**153,835**

Table 2: Energy transfers (MWh) in the FMM and RTD for the second quarter of 2015

While market conditions will vary, the EIM continues to provide benefits to participating entities and their customers as demonstrated in this report.

Background

The EIM began financially-binding operation on November 1, 2014 by optimizing resources across the ISO and PacifiCorp BAAs, which includes California, Oregon, Washington, Utah, Idaho and Wyoming. The EIM improves the integration of renewable resources and increases reliability by sharing information between balancing authorities on electricity delivery conditions across the entire EIM region. The ISO published the first EIM benefit report for November and December 2014 in February 2015,[2] and the second EIM benefit report for the first quarter of 2015 in April 2015.[3] This third report outlines the estimated benefits from the second quarter of 2015. When other entities such as NV Energy begin participating in the EIM, future reports will assess those additional balancing authorities and associated benefits.

Enhancements

The ISO continues to use the simplified method discussed in the last two reports, but has implemented two major enhancements, namely quantifying the benefits of the 5-minute market and improving the GHG revenue accounting method. Both will be explained below.

Separately, the ISO also quantified the benefits using the fifteen minute market results only for comparative purposes to prior quarterly reports.

Five-minute granularity EIM benefit

In the last two reports, the ISO quantified the EIM benefits for each fifteen-minute market interval using the FMM results and counter factual dispatch constructed with fifteen-minute granularity to match the FMM imbalance. The total bid cost difference between the fifteen-minute counter factual dispatch and the FMM dispatch is the fifteen-minute EIM benefit. In this report, the ISO quantifies the benefits for each five-minute market interval using the RTD market results, relevant information from the FMM market and counter factual dispatch constructed with five-minute granularity. The total EIM benefit in terms of cost saving is the total bid cost difference between the five-minute counter factual dispatch and RTD dispatch.

On a high level, constructing the five-minute counter factual dispatch is no different from constructing the fifteen-minute counter factual dispatch except for the market interval granularity. The five-minute counter factual dispatch in PacifiCorp is to meet the five-minute imbalance from the limited resource pool that were used for real-time balancing prior to EIM. ISO assumes each BAA plans to balance real-time energy in a time frame similar to the FMM but with five-minute granularity. Therefore, in the five-

[2] California ISO, http://www.caiso.com/Documents/PacifiCorp_ISO_EIMBenefitsReportQ4_2014.pdf
[3] California ISO, http://www.caiso.com/Documents/PacifiCorp_ISO_EIMBenefitsReportQ1_2015.pdf

minute counter factual dispatch, ISO uses the supply bids subject to the same ramp limitation perceived in the FMM instead of the ramp limitation perceived in the RTD. As discussed the Q4 2014 report, the ramp limitations perceived in the FMM may still be too restrictive for the counter factual dispatch. This is because the ramp limitations are calculated from the actual generation level of previous EIM dispatch, so the ramp limitation in the FMM may not apply for the counter factual dispatch. To mitigate this, ISO extends the last supply segment with highest bid cost in the same BAA to the extent that there is infeasibility in a BAA in the counter factual dispatch.

After the five-minute counter factual dispatch is constructed, the ISO calculates the total EIM benefit by taking the difference between the total counter factual dispatch cost and the total EIM dispatch cost on a five-minute granularity level. In order to divide the total benefit among the BAAs, the ISO models the transfer as supply or demand for each BAA depending on whether it is transferring in or transferring out of the BAA, and assigns the corresponding transfer price to it. As discussed in the Technical Bulletin-Appendix 1, the transfer price will be the BAA's locational marginal price (LMP), plus or minus half of the congestion shadow price on the transfer. As discussed earlier, transfers can take place in both the FMM and the RTD market, and are settled at different prices. In the benefit calculation, the ISO prices the transfer in the same way as it is being settled. For example, if the FMM transfer is 100 MW at transfer price $50, and the RTD dynamic transfer is 50 MW at price $60, then the transfer dollar amount is 100*50 + 50*60 = $8,000 for a total of 150 MWh transfer.

Improved GHG revenue accounting

When the ISO is importing power from PacifiCorp, the imported energy is being allocated to individual resources subject to bid-in GHG adder costs. The allocated GHG awards will also receive a GHG payment at the marginal GHG price. Note that the GHG transfer could be allocated to resources in both PACE and PACW. In the last two reports, ISO did not explicitly calculate the GHG revenue for individual BAAs. Instead, all of the GHG revenue was allocated to PACW. While the total benefit is the same, this tends to overestimate the benefit in PACW, and underestimate the benefit in PACE.

In this report, ISO refined the GHG revenue accounting method so that the GHG revenue will be explicitly calculated based on the individual allocations. Details about this enhancement can be found at the updated EIM Technical Bulletin-Appendix 1.

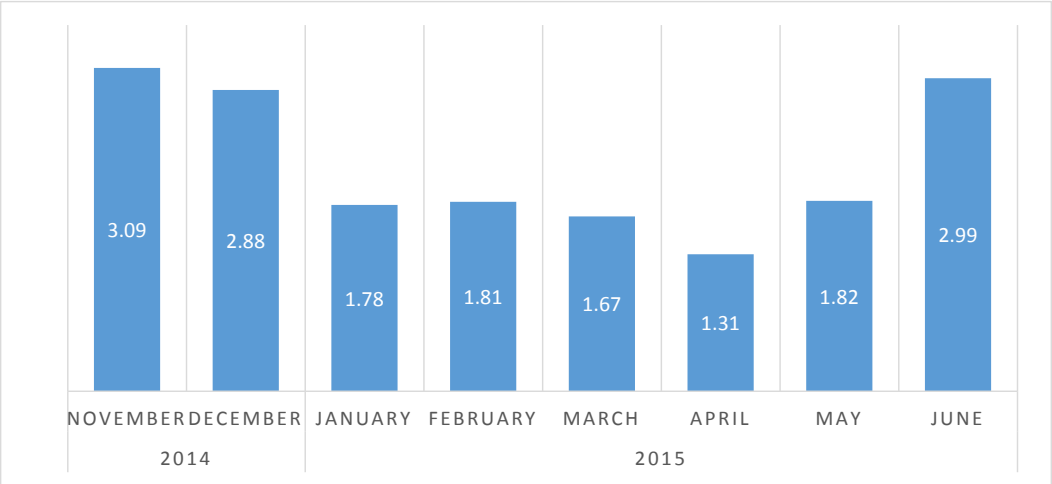
In addition, the GHG allocation awards also have two settlements, the FMM settlement and the RTD settlement. ISO also calculates the GHG revenue in the same way as they are settled.

EIM Benefits in Q2 2015

Figure 2 illustrates the make-up of the Q2 estimated EIM benefit of $10.18 million, which includes $1.90 million for April, $3.18 million for May, and $5.10 million for June. Further details by individual BAA are provided in in Table 1. As stated previously, this is significantly higher than the Q1 2015 benefits due to fact that the Q2 2015 benefits were quantified based on the five-minute interval basis while the Q1 2015 benefits were quantified on a fifteen-minute market interval basis.

For comparison to previous reports, the ISO separately calculated the benefits using the previously fifteen-minute interval results as well. For Q2 2015 this benefit was $6.12 million, which compares to the Q1 2015 number of $5.26 million. The ISO plotted the monthly fifteen-minute EIM benefit since November 2014 in Figure 2. The fifteen-minute benefit is trending upward from April to June, which is likely related to an increase in real-time demand through the quarter and more resources participating in EIM.

Figure 2: Monthly fifteen-minute EIM benefit trend (in million dollars)



The total EIM benefit calculated on a five-minute granularity is about 66 percent more than the EIM benefit quantified on fifteen-minute market intervals in Q2 2015. The increased benefits seen on a five-minute granularity level can be attributable to both the added transfer volume and the larger price difference between PacifiCorp and the ISO in the five-minute intervals. The PacifiCorp to ISO dynamic five-minute transfer is about 22 percent of the fifteen-minute transfer in volume, which is only accounted for in the five-minute EIM benefit calculation. Economic transfers take place as a result of cost difference between PacifiCorp and the ISO until the transfer limit is reached or the marginal cost difference diminishes. When the transfer constraint is not binding, it implies the marginal cost difference has diminished after making the transfer, but the cost difference associated with the transfer is generally not zero. When the transfer constraint is binding, it implies the transfer limit has been reached, then the shadow price of the transfer is the marginal cost difference. In this case, the cost difference associated with the transfer may be higher than the shadow price of the transfer.

To summarize, the benefit of the transfer is the cost difference times the transfer volume. The ISO uses the average transfer shadow price as the indicator of cost difference between PacifiCorp and the ISO. The average transfer shadow price in RTD is 34 percent more than that of FMM. So combining the transfer volume and shadow price, we expect the benefit at the five-minute granularity would be about (1+22%)*(1+34%) = 1.63 times of the fifteen-minute benefit. This simple method estimates that the five-minute benefit would be 63 percent more than the fifteen-minute benefit, which is very close to the observed 66 percent.

Reduced Renewable Curtailment

Included in the EIM benefit is the avoided renewable curtailment in the ISO. This occurs when a renewable resource is supporting the transfer from the ISO to PacifiCorp such that without the EIM the renewable generation in the ISO would need to be curtailed. In addition to the cost saving benefit that is quantified in the report, avoided renewable curtailment may have additional benefit in reducing greenhouse gas emissions and renewable credit. The total avoided renewable curtailment volume in MWh for Q2 2015 was quantified to be 1,474 (April) + 1,253 (May) + 902 (June) = 3,629 MWh. Assuming the avoided renewable curtailement displaces production from other resources at a default emission rate of of 0.428 metric-tons CO2/Mwh, the avoided curtailment displaced an estimated 1553 metric-tons of CO2.

Conclusion

EIM continued to show significant benefits during the second quarter of 2015. The total benefit for Q2 of $10.18 million based on the five minute market results is consistent with pre-launch studies.