Benefits for Participating in EIM

April 30, 2015

Revision History

Date	Version	Description	Author
4/30/2015	1.0		Lin Xu

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Executive Summary

The Energy Imbalance Market (EIM) began financially-binding operation on November 1, 2014 by optimizing resources across the California Independent System Operator (ISO) and PacifiCorp balancing authority areas (BAAs). The ISO published the first EIM benefit report for November and December 2014 in February 2015.[1]

This second report quantifies the estimated gross benefits for January, February, and March 2015 to be $5.26 million, which remains in line with pre-launch projections. The benefit report reflects the EIM's ability to select the lowest cost resource across the PacifiCorp and ISO BAAs to serve demand. The report analysis considers the following categories as described in an earlier study conducted by Energy + Environmental Economics (E3)[2] for PacifiCorp and the ISO.

- ***More efficient dispatch, both inter- and intra-regional***, by automating dispatch 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.

The ISO made the following enhancements in this report from the 2014 Q4 report.

- ***Benefit calculations this report included all fifteen minute market intervals***. In the previous report, the intervals with price differences larger than $50/MWh were excluded to reasonably represent, but not overstate, the benefits from after-the-fact price corrections or changes as a result of the pricing waiver.[3]
- ***Calculations for this quarter used relevant prices including any corrections, rather than raw market prices.*** This not only allows the benefit to be calculated with better accuracy, but also eliminated the need to exclude intervals that may be corrected for prices after the fact.
- ***2015 Q1 calculations included avoided renewable curtailments (in MWh) in the ISO BAA,which contributed to the total EIM benefit.*** This is when a renewable resource is supporting the

[1] California ISO, http://www.caiso.com/Documents/PacifiCorp_ISO_EIMBenefitsReportQ4_2014.pdf
[2] PacifiCorp, Energy Imbalance Markets Summary, http://www.caiso.com/Documents/PacifiCorp-ISOEnergyImbalanceMarketBenefits.pdf
[3] Dec 1, 2014 Order Granting Waiver - EIM Pricing Parameters (ER15-402) http://www.caiso.com/Documents/Dec1_2014_OrderGrantingWaiver_EIMPricingParameters_ER15-402.pdf

transfer from the ISO to PacifiCorp such that without the EIM the renewable generation in the ISO has to be curtailed.

These enhancements improved the accuracy of the benefit calculation. This report, though, has not quantified the benefits in the 5-minute market because the simplified benefit methodology has not been expanded to quantify 5-minute and 5-minute transfers between PacifiCorp and ISO started on February 4, 2015., The ISO plans to add the 5-minute components to future benefits reports

The table below shows the estimated benefits summary for the first 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 simplifications described in the 2014 Q4 report.

BAA	January	February	March	Total
ISO	$0.48	$0.49	$0.48	$1.44
PACE	$0.88	$0.83	$0.91	$2.63
PACW	$0.42	$0.49	$0.28	$1.19
Total	$1.78	$1.81	$1.67	$5.26

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

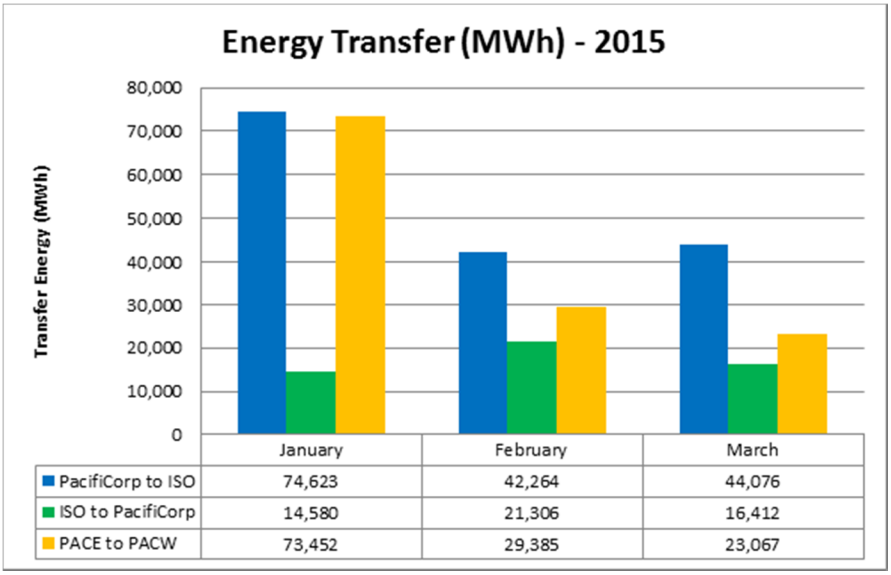
One of the most important contributions to the EIM benefit is the EIM transfer, which allows lower cost supply from one BAA to meet demand in another BAA. As such, the transfer volume is a good indicator of the EIM benefit. The highest level of energy transfers dispatched by the EIM in the 15-minute intervals for this quarter were 421 megawatts (MW) between the PacifiCorp West BAA (PACW) and the ISO, 321 MW from the ISO to PACW, and 200 MW from PacifiCorp East BAA (PACE) to PACW. The level of transfers reflect the economic opportunity between the regions.

PacifiCorp used a large portion of its Interchange Rights Holder mechanism for EIM transfers between PACW and the ISO. This report does not consider PacifiCorp's opportunity cost that the utility considered when using its transfer rights for the EIM.

Total 15-minute market transfers for January through March 2015 are approximately 160,963 megawatt hours (MWh) from PacifiCorp to the ISO and 52,297 MWh from the ISO to PacifiCorp (Figure 1). For the same period, average monthly transfers from PacifiCorp to the ISO and PACE to PACW decreased when compared to November and December 2014. Average monthly transfers from PacifiCorp to the ISO increased for the period January through March 2015 when compared to November and December 2014.

Five-minute incremental transfers were introduced between PacifiCorp and ISO starting on February 4, 2015. Since then, about 6,000 MWh in February and 13,000 MWh in March of incremental energy was transferred above that which was transferred in the 15-minute transfer reflected in Figure 1. This implies that there may be additional benefits in the 5-minute market, which the ISO has planned to quantify in future reports.

Figure 1: Energy transfers in the 15-minute market



While market conditions 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 benefits report for November and December 2014 in February 2015.[4] This 2015 Q1 report is the second quarterly EIM benefits. As 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 2014 Q4 report, but has implemented several enhancements to improve the accuracy of calculation.

Flexibility reserve procurement benefit

The net uncertainty from aggregating the load, wind and solar variability and forecast errors of the combined EIM footprint is typically smaller than the sum of each BAA's individual uncertainty in supply and demand. This is because the one BAA's uncertainty may offset another BAA's uncertainty, so that

[4] California ISO Q4 2014 EIM Benefits Report, http://www.caiso.com/Documents/PacifiCorp_ISO_EIMBenefitsReportQ4_2014.pdf

the net uncertainty is reduced. The reduction of uncertainty in the EIM means less flexibility reserve would be needed to maintain the same level of operational standard. The EIM flexibility reserve reduction is calculated as the sum of each EIM participating BAA's flexibility reserve requirement minus the net total flexibility reserve requirement for the whole EIM footprint.

The EIM co-optimizes the flexibility reserve with energy. Providing flexibility reserve may result in opportunity cost from not being able to provide energy, and the flexibility reserve is priced at the marginal opportunity cost in the EIM. The cost savings from the reduced flexibility reserve requirement, which is part of the total EIM benefit, is estimated to be $74,000 for Q1 2015. The calculation methodology is described below.

> In the counter factual dispatch for PacifiCorp BAAs, its flexible ramp requirement is reset to the standalone BAA's flexible ramping requirement, which does not reflect the diversity benefit. The available supply will be first used to meet the energy demand.
>
> After the BAA's energy demand is met, the remaining unloaded capcity will be used to meet the flexibile ramping. If the BAA does not have enough capacity to meet the flexible ramp requirement on top of its energy demand, then it implies that getting additional flexibility reserve capacity will incur an opportunity cost.
>
> The ISO estimated the per MW opportunity cost by the corresponding flexible ramping price in the EIM. Then the flexibility reserve cost, which equals the extra flexibility reserve needed multiplied by the EIM flexible ramping price, is added to the counter factual dispatch cost for each BAA.
>
> The added flexible ramping cost will increase the EIM benefit by the same amount because the EIM benefit is calculated as the total counter factual dispatch cost minus the total EIM cost.

In summary, by aggregating the load, wind and solar variability and the forecast errors of the combined EIM footprint, PacifiCorp can reduce its procurement of flexibility reserves. This reduction was calculated and averaged as high as 13.8 MW per hour in Q1 2015 at a savings of $74,000. The ISO may also benefit in a similar way, but the dollar savings were not quantified due to the complexity of binding transmission constraints and co-optimization in the ISO's market. The simplified calculation does not support considering these binding constraints.

The flexibility reserve benefit calcuated as above represents only the cost savings due to reduced procurement in the EIM. There may be additional benefits when the flexibility reserve is deployed in the five-minute market. The deployment benefit will be included in future reports.

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 credits. The the avoided renewable curtailment volume for Q1 2015 was 8,860 MWh .

Other enhancements

The ISO made the following enhancements in the 2015 Q1 report. First, the ISO used relevant prices that included corrections in the benefit calculation rather than the raw market output prices. Second, all intervals have been included in the benefit calculation. In the 2014 Q4 report, the EIM benefits were calculated from the intervals where the absolute price difference between MALIN 500 KV bus and PacifiCorp was below $50/MWh. That was to avoid misrepresenting the benefit stemming from after-the-fact price corrections as under the existing pricing waiver[5]. No exclusion was applied in the 2015 Q1 report because the ISO moved to using relevant prices that corrections. These enhancements are expected to improve the benefit calculation accuracy and quality.

EIM Benefits in Q1 2015

The gross estimated EIM benefit is about $1.78 million for January, $1.81 million for February and $1.67 million for March for a total of $5.26 million. The details are provided in Table 3. These numbers represent benefits from all the intervals and include the flexibility reserve benefits discussed above.

BAA	January	February	March	Total
ISO	$0.48	$0.49	$0.48	$1.44
PACE	$0.88	$0.83	$0.91	$2.63
PACW	$0.42	$0.49	$0.28	$1.19
Total	$1.78	$1.81	$1.67	$5.26

Table 3: Estimated benefits shown are in millions and accrued for the first quarter of 2015.

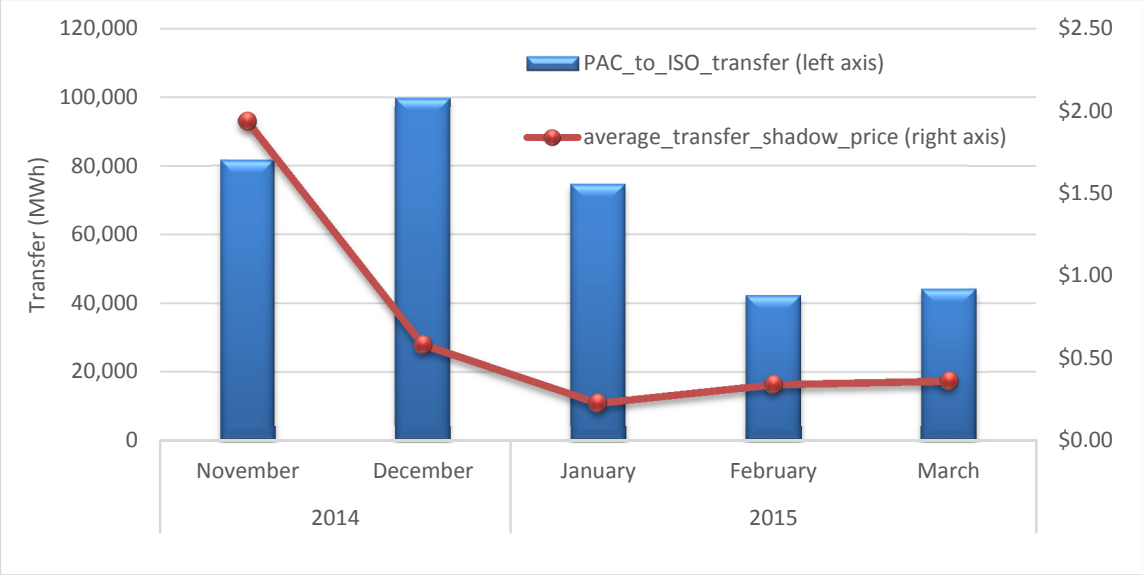
Compared with 2014 Q4, the monthly average EIM benefit was reduced by about $1.23 million. This may be due to the following reasons.

First, the volume of EIM transfers from PacifiCorp to the ISO were less than November and December 2014. As shown in Figure 2, the monthly average transfer volume from PacifiCorp to the ISO decreased by approximately 40 percent from 2014 Q4 to 2015 Q1. Coincidentally, the monthly average transfer shadow price also dropped from $0.60/MW-$1.90/MW range in 2014 Q4 to $0.20/MW-$0.40/MW range in 2015 Q1. The transfer shadow price is the marginal cost difference between the supply in PacifiCorp and the supply in the ISO deliverable to the MALIN 500 KV bus. PacifiCorp's marginal supply cost was lower than that of the ISO when EIM transferred energy from PacifiCorp to the ISO, however,

[5] Dec 1, 2014 Order Granting Waiver - EIM Pricing Parameters (ER15-402)
http://www.caiso.com/Documents/Dec1_2014_OrderGrantingWaiver_EIMPricingParameters_ER15-402.pdf

the marginal cost difference between PacifiCorp and the ISO tightened in 2015 Q1. Note that the EIM transfer benefit captures the total cost difference between PacifiCorp's supply and the ISO's supply for the transferred energy, but not the marginal cost difference. Yet empirically, marginal cost and total cost usually trend the same way. The downward trend of EIM benefit from 2014 Q4 to 2015 Q1 corellated well with decrease in marginal cost difference, which may be related to changes in supply and demand conditions in both the ISO and PacifiCorp.

Figure 2: Energy transfer in the 15-minute market from PacifiCorp to the ISO



Second, as the EIM stabilizes with less price excursions, the benefit resulting from extreme market conditions may reduce. We expect these extreme market outcomes to decrease over time as offers submitted into the EIM increase, and with improvements in the market clearing engine.

Third, improved scheduling practices may also lead to less EIM benefit being quantifiable under the current approach. As EIM BAAs gain more experience with the market, they may start to improve their base scheduling practices. More optimized base schedules will leave less room for the EIM to optimize, and thus less EIM benefit being calculated. However, these improvements would not materialize but for the EIM. We just cannot quantify such benefits through the current calculations.

Conclusion

The benefit continued to accrue in the EIM for the first quarter of 2015 at about $1.75 million per month, which is in line with pre-launch projections. Comparing with 2014 Q4, there was a reduction in the monthly average benefit. This is can be attributable to multiple reasons that includes seasonal transfer reductions, a more stable market and improved scheduling practices. The ISO made several enhancements in this report to improve the benefit accuracy and quality including quantifying the flexibility reserve benefit.