Western EIM Benefits Report

Third Quarter 2016

October 26, 2016

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Executive Summary

This report presents the benefits associated with participation in the western Energy Imbalance Market (EIM) for the third quarter of 2016. The benefits include cost savings and the use of surplus renewable energy to displace conventional generating resources.

The estimated gross benefits for July, August and September 2016 is $26.16 million, bringing the total benefits of EIM to $114.35 million since the California Independent System Operator (ISO) expanded its real-time market to balancing areas outside the ISO in November 2014.

The increase in total gross benefits in Q3 2016 from the previous quarter was attributed primarily to seasonal changes in supply and demand. A similar trend was also observed in 2015 from Q2 to Q3.

The report also showed the EIM is helping to displace less-clean energy supplies with surplus renewable energy that otherwise may have been curtailed. In Q3, the EIM used 33,094 MWh of surplus renewable energy to displace nearly 14,164 metric tons of CO2 emissions.

The benefit calculation method is described in a separate document.[1] This analysis demonstrates the EIM's ability to select the most economic resources across the PacifiCorp, NV Energy (NVE) and the ISO balancing authority areas (BAAs) that comprise the EIM footprint. The benefits quantified in this report fall into three categories and were described in earlier studies.[2]

- ***More efficient dispatch, both inter-and intra-regional, in the Fifteen-Minute Market (FMM) and Real-Time Dispatch (RTD). Q3 estimated savings = $26.16 million.***
- ***Reduced renewable energy curtailment. Q3 estimated reduction = 33,094 MWh displacing approximately 14,164 metric tons of CO2.***
- ***Reduced flexibility reserves needed in all balancing authority areas. Q3 reduction = 270 – 276 MW which equates to a reduction in flexibility reserves of approximately 35%.***

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 portions of California, Oregon, Washington, Utah, Idaho and Wyoming. NV Energy, operating in Nevada, began participating in December 2015. The EIM facilitates renewable resource integration and increases reliability by sharing information between balancing

[1] EIM Quarterly Benefit Report Methodology, https://www.caiso.com/Documents/EIM_BenefitMethodology.pdf
[2] PacifiCorp-ISO, Energy Imbalance Markets Benefits, http://www.caiso.com/Documents/PacifiCorp-ISOEnergyImbalanceMarketBenefits.pdf

authorities on electricity delivery conditions across the EIM region. The ISO began publishing quarterly EIM benefit reports in January 2015. As other BAAs join the EIM, this report will be expanded to include the benefits associated with their participation.

NV Energy's EIM benefits mainly reflect inter-regional transfer benefits resulting from intra-hour transactions. This is attributed to NV Energy's optimization of its base schedules prior to submission to the EIM.

EIM Benefits in Q3 2016

Table 1 shows the estimated EIM gross benefits by each BAA per month. The monthly savings presented in the table show $10.21 million for July, $8.46 million for August, and $7.49 million for September with a total estimated benefit of $26.16 million.

Region	July	August	September	Total
ISO	2.24	1.38	1.82	5.44
NV Energy	1.88	2.16	1.55	5.60
PacifiCorp	6.09	4.92	4.12	15.12
Total	10.21	8.46	7.49	26.16

Table 1: Third quarter 2016 benefits

Inter-Regional Transfers

A significant contributor to the EIM benefits are transfers across balancing areas, providing access to lower cost supply, even while factoring in the cost of compliance with greenhouse gas (GHG) emissions regulations when energy is transferred into the ISO. As such, the transfer volumes are a good indicator of a portion of the benefits attributed to the EIM. Transfers can take place in both the Fifteen Minute Market (FMM) and Real-Time Dispatch (RTD). Generally, transfer limits are based on transmission and interchange rights that participating balancing authority areas make available to the EIM, with the exception of the PacifiCorp West (PACW)-ISO transfer limit in RTD. The RTD transfer capacities between PACW and the ISO are determined based on the allocated dynamic transfer capability driven by system operating conditions. This report does not quantify a BAA's opportunity cost that the utility considered when using its transfer rights for the EIM. Table 2 provides the 15-minute EIM transfer volume and the 5-minute EIM transfer volume, both with base schedule transfers excluded. The three EIM Entities submit inter-BAA transfers in their base schedules. The benefits quantified in this report are only attributable to the transfers that occurred through the EIM. The benefits do not include any transfers attributed to transfers submitted in the base schedules that are schedule prior to the start of the EIM.

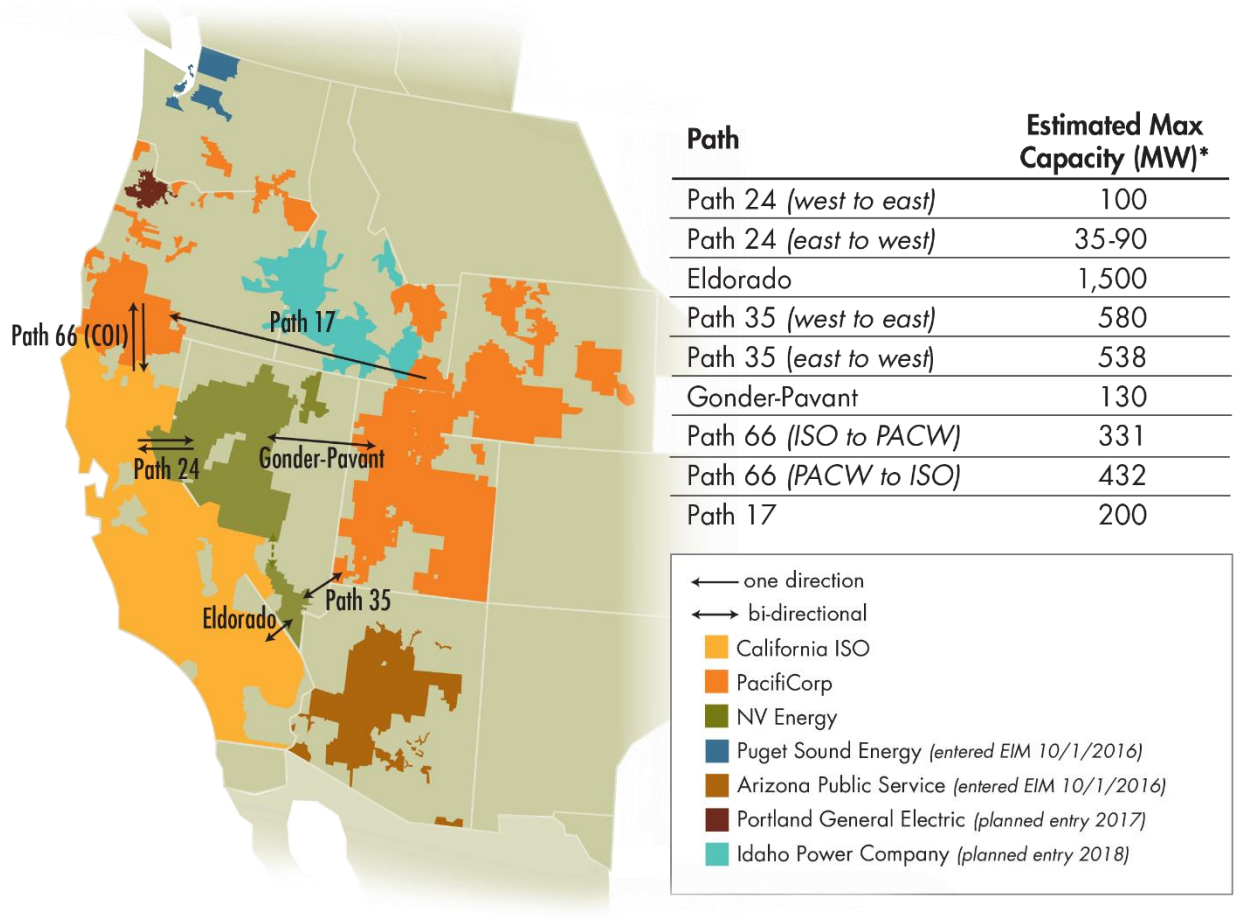
The transfer from BAA_x to BAA_y and the transfer from BAA_y to BAA_x are separately reported. For example, in an interval, if there is 100 MWh transfer on top of base transfer from ISO to NVE, it will be reported as 100 MWh with from_BAA=ISO and to_BAA=NVE, and it will be reported as 0 MWh with from_BAA=NVE and to_BAA=ISO in the opposite direction. The 15-minute transfer volume results from

EIM optimization in the 15-minute market with all bids and base schedules submitted into the EIM. The 5-minute transfer volume results from EIM optimization in the 5-minute market with all bids and base schedules submitted into EIM, and unit commitments determined in the 15-minute market optimization. The maximum transfer capacities between EIM entities is shown in Graph 1.

The ISO continued to export a significant amount of energy to NV Energy and PacifiCorp during Q3, which was first observed in Q1 2016. It is also worth noting that a significant level of energy exported by the ISO consisted of renewable generation.

Year	Month	from_BAA	to_BAA	15m EIM transfer (15m - base)	5m EIM transfer (5m - base)
2016	July	ISO	NVE	98,367	74,066
		ISO	PACW	11,355	10,307
		NVE	ISO	87,320	128,163
		NVE	PACE	21,399	20,360
		PACE	NVE	121,645	134,126
		PACE	PACW	35,009	41,903
		PACW	ISO	77,136	89,060
2016	August	ISO	NVE	86,448	48,552
		ISO	PACW	8,563	7,060
		NVE	ISO	83,739	162,291
		NVE	PACE	27,116	18,591
		PACE	NVE	90,167	119,377
		PACE	PACW	40,312	43,989
		PACW	ISO	71,676	85,137
2016	September	ISO	NVE	79,834	47,666
		ISO	PACW	12,266	11,478
		NVE	ISO	82,438	159,449
		NVE	PACE	43,115	28,130
		PACE	NVE	78,024	103,023
		PACE	PACW	14,351	32,477
		PACW	ISO	62,451	69,885

Table 2: Energy transfers (MWh) in the FMM and RTD for the third quarter 2016



Path	Estimated Max Capacity (MW)*
Path 24 *(west to east)*	100
Path 24 *(east to west)*	35-90
Eldorado	1,500
Path 35 *(west to east)*	580
Path 35 *(east to west)*	538
Gonder-Pavant	130
Path 66 *(ISO to PACW)*	331
Path 66 *(PACW to ISO)*	432
Path 17	200

Graph 1: Estimated maximum transfer capacity

Reduced Renewable Curtailment and GHG Reductions

The EIM benefit calculation includes the economic benefits that can be attributed to avoided renewable curtailment within the ISO. If not for energy transfers facilitated by the EIM, some renewable generation located within the ISO would have been curtailed via either economic or exceptional dispatch. The total avoided renewable curtailment volume in MWh for Q3 2016 was calculated to be 11,915 MWh (July) + 6,050 MWh (August) + 15,129 MWh (September) = 33,094 MWh total.

The environmental benefits of avoided renewable curtailment are significant. Under the assumption that avoided renewable curtailments displace production from other resources at a default emission rate of 0.428 metric tons CO2/MWh, avoided curtailments displaced an estimated 14,164 metric tons of CO2 for Q3 2016. Avoided renewable curtailments also may have reduced the volume of renewable credits that would have been retracted. However, this report does not quantify the additional value in dollars associated with this benefit. Total estimated reductions in the curtailment of renewable energy along with the associated reductions in CO2 are shown in Table 3.

Year	Quarter	MWh	Eq. Tons CO2
2015	1	8,860	3,792
	2	3,629	1,553
	3	828	354
	4	17,765	7,521
2016	1	112,948	48,342
	2	158,806	67,969
	3	33,094	14,164
	Total	335,930	143,695

Table 3: Total reduction in curtailment of renewable energy along with the associated reductions in CO2

Flexible ramping procurement diversity savings

The EIM facilitates procurement of flexible ramping capacity in the FMM to address variability that may occur in the RTD. Because variability across different BAAs may happen in opposite directions, the flexible ramping requirement for the entire EIM footprint can be less than the sum of individual BAA's requirement. This difference is known as the flexible ramping procurement diversity savings. Starting in June 2015, the ISO implemented an automated tool to analyze historical uncertainties and calculate the flexible ramping requirement for each BAA in the EIM. In Q3 2016, the flexible ramping requirement for the ISO varied from 300 MW to 500 MW, the requirement for PACE varied from 80 MW to 150 MW, the requirement for PACW varied from 60 MW to 100 MW, and the requirement for NVE varied from 80 MW to 100 MW. Due to the reduction in flexible ramping requirement associated with the larger EIM footprint, the total requirement across the four BAAs varied from 400 MW to 530 MW.

The flexible ramping procurement diversity savings for all the intervals averaged over a month are shown in Table 4. The percentage saving is the average MW savings divided by the sum of the four individual BAA requirements.

	July	Aug	Sept
Average MW saving	272	270	276
Sum of BAA requirements	771	770	777
Percentage savings	35%	35%	36%

Table 4: Flexible ramping procurement diversity saving for third quarter 2016

Under the current flexible ramping constraint design, the procured flexible ramping capacity can be fully accessed in RTD. If the flexible ramping procurement in the FMM is beneficial, it will reduce the RTD dispatch cost. With the EIM benefits being quantified on a 5-minute level, the benefit of flexible ramping is fully captured in the RTD dispatch. The EIM benefits calculated at a 5-minute level includes

the savings from procuring and deploying flexible ramping. However, this analysis does not breakout the dollar savings separately because the savings are tightly integrated with the RTD dispatch.

Conclusion

Participation in the western EIM continues to show that utilities can realize cost benefits and reduced carbon emissions. With $114.35 million in gross benefits to date, the realized savings are in line with analysis conducted before the market expansion launched in November 2014. The EIM resource sharing also continues to have a positive effect on reducing greenhouse gas emissions by using excess renewable generation that otherwise would be turned off. Using that surplus energy to meet demand across the EIM footprint can replace less clean energy sources. The GHG reductions of 143,695 metric tons through September 2016 shown in Table 3 is roughly equivalent to avoiding the emissions from 30,353 passenger cars driven for one year.