WESTERN EIM BENEFITS REPORT

Third Quarter **2019**

October 29, 2019

CONTENTS

EXECUTIVE SUMMARY

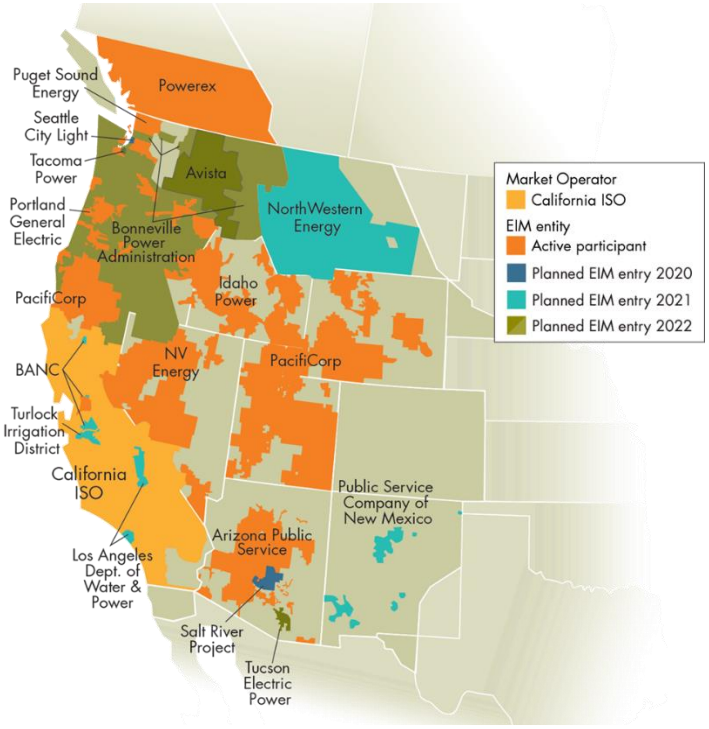
Gross benefits from EIM since November 2014

$801.07 million

This report presents the benefits associated with participation in the Western Energy Imbalance Market (EIM) for the third quarter of 2019. The benefits include cost savings and the use of surplus renewable energy.

The Western EIM is helping to displace less-clean energy supplies with surplus renewable energy that otherwise may have been curtailed.

This analysis demonstrates the benefit of economic dispatch in the real time market across a larger EIM footprint with more diverse resources and geography.



Q3 2019 Gross Benefits by Participant

	(millions $)
Arizona Public Service	$20.36
BANC	$4.37
California ISO	$5.77
Idaho Power	$5.36
NV Energy	$5.92
PacifiCorp	$9.54
Portland General Electric	$9.48
Powerex	$1.04
Puget Sound Energy	$2.97
Total	$64.81

*EIM Quarterly Benefit Report Methodology, https://www.caiso.com/Documents/EIM_BenefitMethodology.pdf

**The GHG emission reduction reported is associated with the avoided curtailment only. The current market process and counterfactual methodology cannot differentiate the GHG emissions resulting from serving ISO load via the EIM versus dispatch that would have occurred external to the ISO without the EIM. For more details, see http://www.caiso.com/Documents/GreenhouseGasEmissionsTrackingReport-FrequentlyAskedQuestions.pdf

2019 Q3 BENEFITS

ECONOMICAL

$64.81M

Gross benefits realized due to more efficient inter-and intra-regional dispatch in the Fifteen-Minute Market (FMM) and Real-Time Dispatch (RTD)*

ENVIRONMENTAL

14,485

Metric tons of CO_2** avoided curtailments

OPERATIONAL

49%

Average reduction in flexibility reserves across the footprint

BACKGROUND

The Western EIM began financially binding operation on November 1, 2014 by optimizing resources across the ISO and PacifiCorp Balancing Authority Areas (BAAs). NV Energy began participating in December 2015, Arizona Public Service and Puget Sound Energy began participating on October 1, 2016, and Portland General Electric began participating on October 1, 2017. Idaho Power and Powerex began participating on April 4, 2018. Most recently, the Balancing Authority of Northern California (BANC)[1], began participating on April 3, 2019. The EIM footprint now includes portions of Arizona, California, Idaho, Nevada, Oregon, Utah, Washington, Wyoming, and extends to the border with Canada.

The ISO began publishing quarterly EIM benefit reports in April 2015. Prior reports can be accessed at https://www.westerneim.com/Pages/About/QuarterlyBenefits.aspx.

WESTERN EIM ECONOMIC BENEFITS IN Q3 2019

Table 1 shows the estimated EIM gross benefits by each region per month[2]. The benefits in the third quarter of this year reflected typical ranges, tracking lower load levels and fuel prices generally associated with market conditions for this period. The monthly savings presented in the table show $22.48 million for July, $19.32 million for August, and $23.01 million for September with a total estimated benefit of $64.81 million for the quarter.

Region	July	August	September	Total
APS	$6.08	$7.55	$6.73	$20.36
BANC	$1.63	$1.35	$1.39	$4.37
CISO	$2.96	$1.33	$1.48	$5.77
IPCO	$1.57	$1.52	$2.27	$5.36
NVE	$1.47	$1.52	$2.93	$5.92
PAC	$3.19	$2.70	$3.65	$9.54
PGE	$3.97	$2.10	$3.41	$9.48
PWRX	$0.66	$0.21	$0.17	$1.04
PSE	$0.95	$1.04	$0.98	$2.97
Total	$22.48	$19.32	$23.01	$64.81

TABLE 1: Third quarter 2019 benefits in millions USD by month

[1] The benefits reflect the Sacramento Municipal Utility District as the participating resource within BANC.
[2] The EIM benefits reported here are calculated based on available data. Intervals without complete data are excluded in the calculation. The intervals excluded due to unavailable data are normally within a few percent of the total intervals.

INTER-REGIONAL TRANSFERS

A significant contributor to EIM benefits is transfers across balancing areas, providing access to lower cost supply, 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 15-Minute Market 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 and the Portland General Electric (PGE)-ISO transfer limit in RTD. These RTD transfer capacities between PACW/PGE 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 and 5-minute EIM transfer volumes with base schedule transfers excluded. The 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 scheduled 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, if there is a 100 Megawatt-Hour (MWh) transfer during a 5-minute interval, in addition to a base transfer from ISO to NVE, it will be reported as 100 MWh from_BAA ISO to_BAA NEVP, and 0 MWh from_BAA NEVP to_BAA ISO in the opposite direction. The 15-minute transfer volume is the result of optimization in the 15-minute market using all bids and base schedules submitted into the EIM. The 5-minute transfer volume is the result of optimization using all bids and base schedules submitted into EIM, based on unit commitments determined in the 15-minute market optimization. The maximum transfer capacities between EIM entities are shown in Graph 1 below.

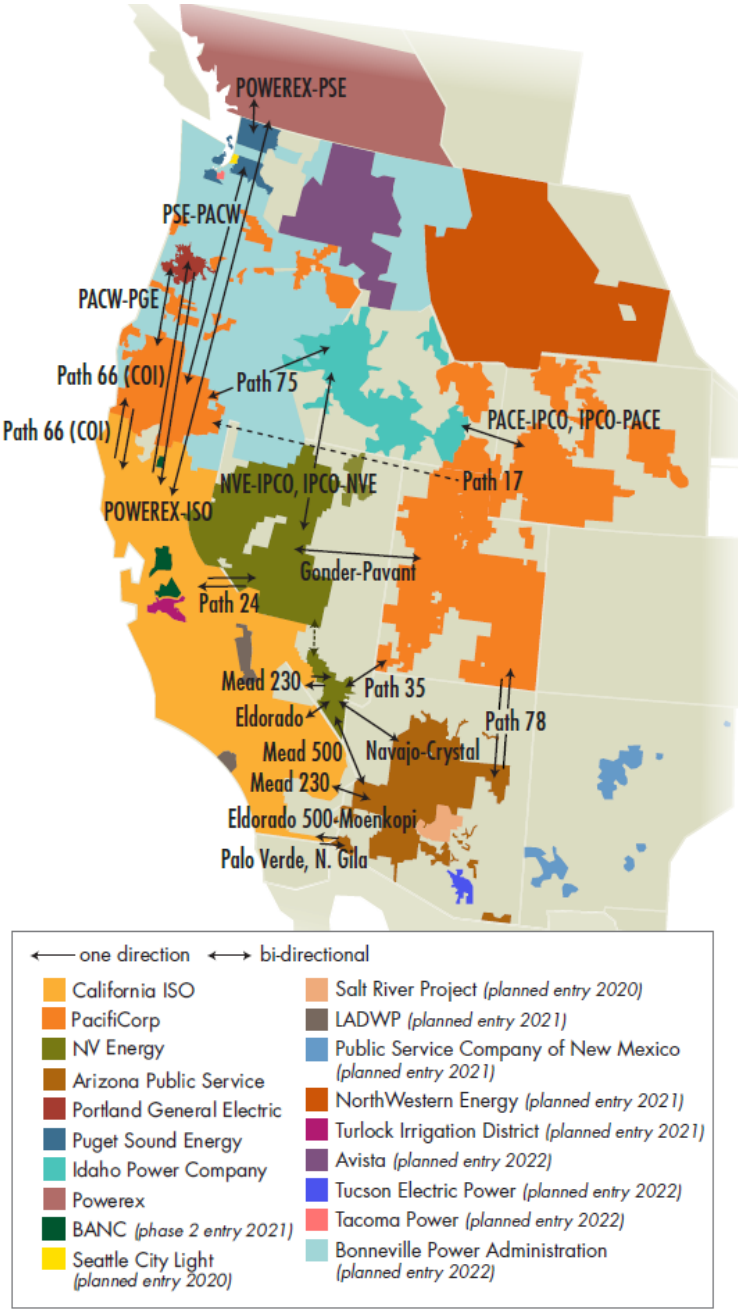
Month	From BAA	To BAA	15min EIM transfer	5min EIM transfer
			(15m - base)	(5m - base)
	AZPS	CISO	198,528	169,708
	AZPS	NEVP	11,602	15,044
	AZPS	PACE	60,895	69,232
	BANC	CISO	29,623	22,291
	PWRX	CISO	0	0
	PWRX	PSEI	3,675	5,396
	CISO	AZPS	61,185	74,320
	CISO	BANC	99,553	116,228

	CISO	PWRX	68,309	81,070
	CISO	NEVP	75,763	90,349
	CISO	PACW	24,837	32,583
	CISO	PGE	38,026	60,168
	IPCO	NEVP	23,634	19,143
	IPCO	PACE	10,745	10,900
	IPCO	PACW	21,283	23,604
	NEVP	AZPS	3,629	3,758
	NEVP	CISO	109,430	68,383
	NEVP	IPCO	30,126	37,753
July	NEVP	PACE	71,391	85,066
	PACE	AZPS	82,489	74,935
	PACE	IPCO	32,447	38,135
	PACE	NEVP	70,766	46,179
	PACE	PACW	44,574	49,232
	PACW	CISO	67,760	79,935
	PACW	IPCO	19,847	20,814
	PACW	PGE	57,409	54,301
	PACW	PSEI	41,857	38,526
	PGE	CISO	2,734	2,495
	PGE	PACW	60,004	62,064
	PSEI	PWRX	59,511	58,767
	PSEI	PACW	30,106	41,598
	AZPS	CISO	211,676	184,635
	AZPS	NEVP	15,617	21,680
	AZPS	PACE	13,940	19,332
	BANC	CISO	31,565	24,787
	PWRX	CISO	0	0
	PWRX	PSEI	10,897	13,418
	CISO	AZPS	12,766	17,384

	CISO	BANC	86,540	103,262
	CISO	PWRX	26,175	39,644
	CISO	NEVP	25,661	34,429
	CISO	PACW	17,619	23,150
	CISO	PGE	12,541	27,971
	IPCO	NEVP	18,449	13,395
	IPCO	PACE	3,505	2,389
August	IPCO	PACW	22,152	23,969
	NEVP	AZPS	3,968	4,147
	NEVP	CISO	77,069	54,146
	NEVP	IPCO	17,256	27,696
	NEVP	PACE	62,492	73,349
	PACE	AZPS	97,468	81,050
	PACE	IPCO	61,062	67,009
	PACE	NEVP	35,345	19,561
	PACE	PACW	50,840	64,038
	PACW	CISO	72,917	80,163
	PACW	IPCO	12,892	11,806
	PACW	PGE	53,520	53,906
	PACW	PSEI	29,975	27,494
	PGE	CISO	1,502	1,421
	PGE	PACW	41,492	38,052
	PSEI	PWRX	33,628	33,576
	PSEI	PACW	41,700	48,427
	AZPS	CISO	234,767	213,864
	AZPS	NEVP	11,877	14,266
	AZPS	PACE	16,733	19,408
	BANC	CISO	27,478	25,098
	PWRX	CISO	0	0
	PWRX	PSEI	9,758	12,522

	CISO	AZPS	28,526	33,739
	CISO	BANC	66,931	74,065
	CISO	PWRX	46,783	64,272
	CISO	NEVP	38,264	44,932
	CISO	PACW	35,503	43,925
	CISO	PGE	34,558	55,963
	IPCO	NEVP	25,773	22,449
	IPCO	PACE	5,334	3,450
	IPCO	PACW	55,252	49,400
September	NEVP	AZPS	5,722	7,266
	NEVP	CISO	113,227	93,334
	NEVP	IPCO	30,265	30,263
	NEVP	PACE	48,155	53,892
	PACE	AZPS	90,359	77,558
	PACE	IPCO	47,224	49,229
	PACE	NEVP	59,466	48,166
	PACE	PACW	58,991	67,417
	PACW	CISO	56,804	65,856
	PACW	IPCO	16,527	14,471
	PACW	PGE	83,176	78,710
	PACW	PSEI	52,737	47,300
	PGE	CISO	4,553	4,311
	PGE	PACW	22,257	25,541
	PSEI	PWRX	44,258	42,918
	PSEI	PACW	24,764	33,194

TABLE 2: Energy transfers (MWh) in the FMM and RTD markets for Q3 2019



Path	Estimated Max Capacity (MW)
Path 24 *(west to east)*	100
Path 24 *(east to west)*	35-90
Eldorado	797
Path 35 *(west to east)*	580
Path 35 *(east to west)*	538
Gonder-Pavant	130
PACW to PGE	320
Path 66 *(ISO to PGE)*	627
Path 66 *(PGE to ISO)*	296
Path 66 *(ISO to PACW)*	331
Path 66 *(PACW to ISO)*	432
Path 17	0-400[1] [2]
PSE to PACW	300
Eldorado 500-Moenkopi	732
Palo Verde, N. Gila	3,151
Path 78 *(PACE to APS)*	625
Path 78 *(APS to PACE)*	660
Navajo-Crystal	522
Mead 500	349
Mead 230 *(APS <–> ISO)*	236
Mead 230 *(ISO to NVE)*	3,443
Mead 230 *(NVE to ISO)*	3,476
IPCO to PACW (Path 75)	1,500
PACW to IPCO (Path 75)	400-510
PACE to IPCO	2,557
IPCO to PACE	1,550
NVE to IPCO	262
IPCO to NVE	390-478
Powerex <–> PSE	150
Powerex <–> ISO	150

[1] *Is an optional path available for PACE-PACW EIM transfers and the capacity is a subset of PACE-IPCO/IPCO-PACE and Path 75 capacity.*

[2] *When in use, the available capacity on PACE-IPCO/IPCO-PACE and Path 75 will be subsequently reduced by the used amount on Path 17, and not double counted.*

Current as of October 2019

GRAPH 1: Estimated maximum transfer capacity (EIM entities operating in Q3 2019)

WHEEL THROUGH TRANSFERS

As the footprint of the Western EIM grows and continues to change, wheel-through transfers may become more common. Currently, an EIM entity facilitating a wheel through receives no direct financial benefit for facilitating the wheel; only the sink and source directly benefit. As part of the Western EIM Consolidated Initiatives stakeholder process, the ISO committed to monitoring the wheel through volumes to assess whether, after the addition of new EIM entities, there is a potential future need to pursue a market solution to address the equitable sharing of wheeling benefits. The ISO will continue to track the volume of wheel-through transfers in the EIM market in the quarterly reports. In order to derive the wheel-through transfers for each EIM BAA, the ISO uses the following calculation for every real-time interval dispatch:

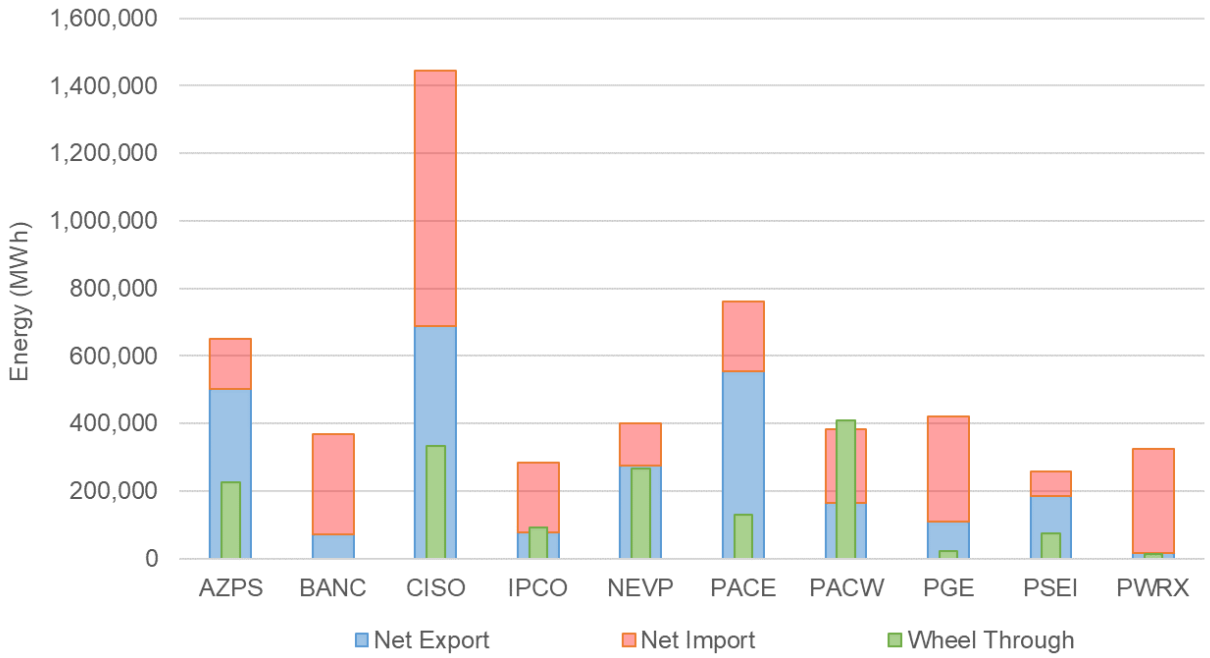
- Total import: summation of transfers above base transfers coming into the EIM BAA under analysis
- Total export: summation of all transfers above base transfers going out of the EIM BAA under analysis
- Net import: the maximum of zero or the difference between total imports and total exports
- Net export: the maximum of zero or the difference between total exports and total imports
- Wheel through: the minimum of the EIM transfers into (total import) or EIM transfer out (total export) of a BAA for a given interval

All wheel-through transfers are summed over both the month and the quarter. This volume reflects the total wheel-through transfers for each EIM BAA, regardless of the potential paths used to wheel through. The net imports and exports estimated in this section reflect the overall volume of net imports and exports; in contrast, the imports and exports provided in Table 2 reflect the gross transfers between two EIM BAAs.

The metric is measured as energy in MWh for each month and the corresponding calendar quarter, as shown in Tables 3 through 6 and Figures 2 through 5.

BAA	*Net Export*	*Net Import*	*Wheel Through*
AZPS	502,133	148,880	226,584
BANC	72,314	294,707	-
CISO	688,168	758,022	334,097
IPCO	78,005	207,248	91,230
NEVP	274,115	124,895	266,546
PACE	553,303	207,615	130,751
PACW	164,861	217,991	409,684
PGE	110,714	308,774	23,572
PSEI	185,867	71,806	73,404
PWRX	17,826	307,368	13,683

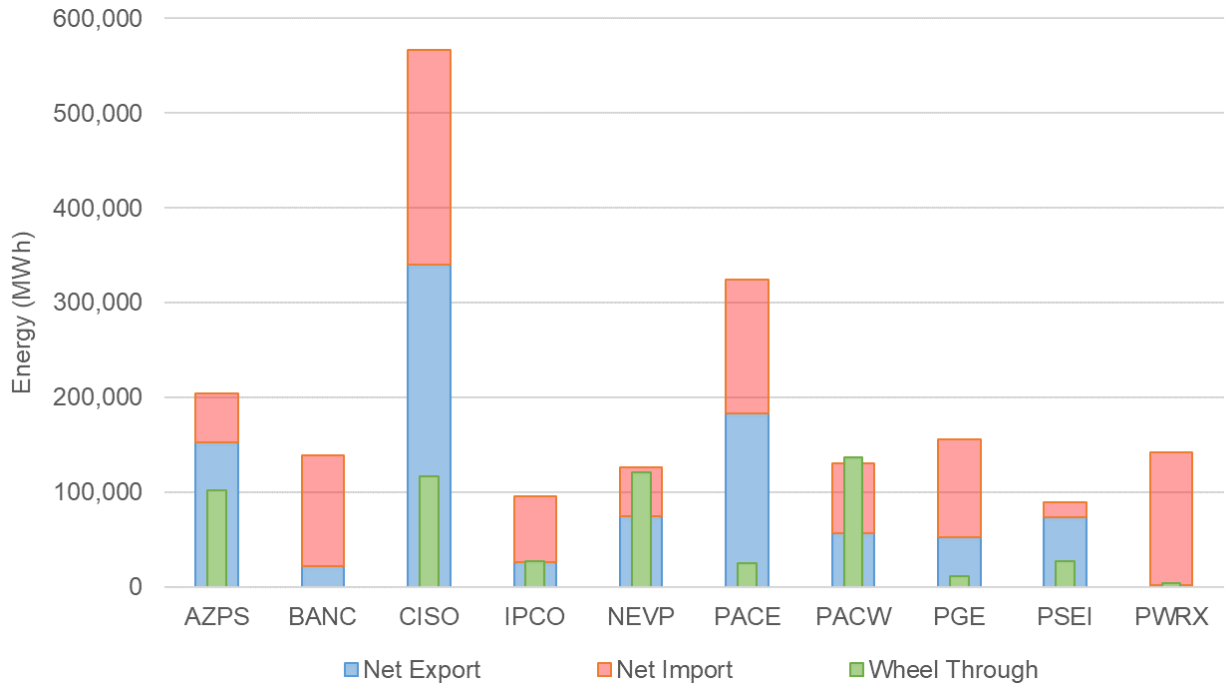
TABLE 3: Estimated wheel-through transfers in Q3 2019



GRAPH 2: Estimated wheel-through transfers in Q3 2019

BAA	Net Export	Net Import	Wheel-Through
AZPS	152,397	51,648	102,269
BANC	22,291	116,647	-
CISO	340,590	226,317	116,922
IPCO	26,059	69,537	27,684
NEVP	75,095	51,005	120,635
PACE	183,634	140,800	25,345
PACW	57,087	72,947	136,761
PGE	52,971	103,102	11,846
PSEI	73,290	16,618	27,407
PWRX	1,858	140,115	3,568

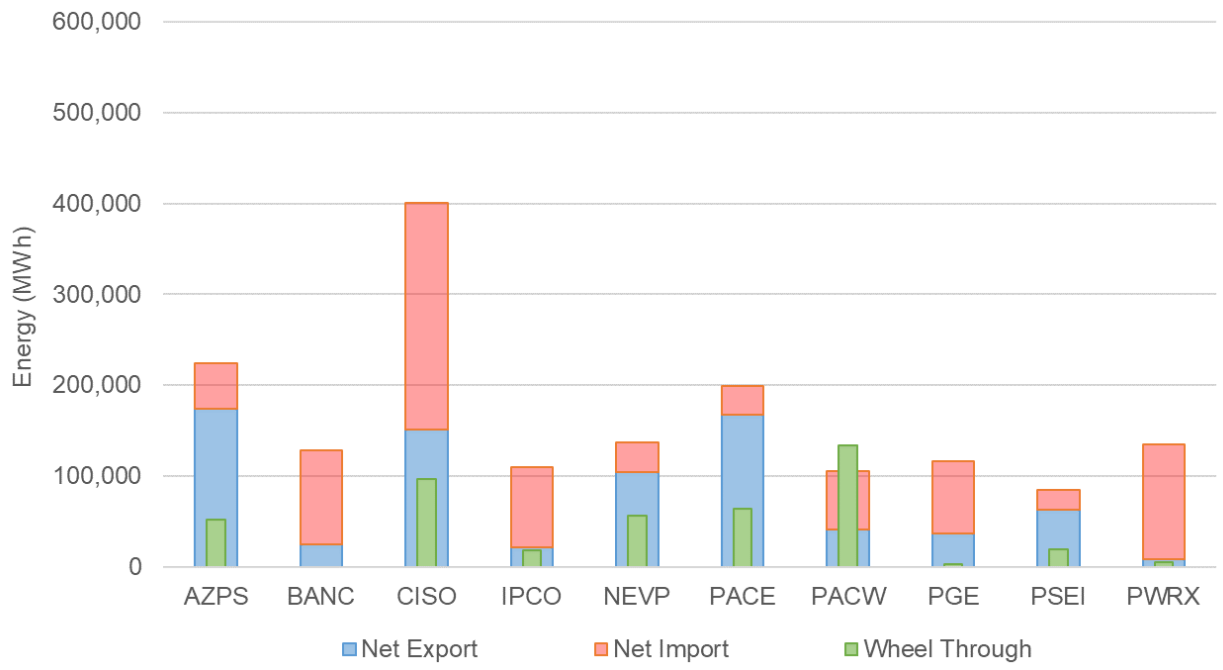
TABLE 4: Estimated wheel-through transfers in July 2019



GRAPH 3: Estimated wheel-through transfers in July 2019

BAA	Net Export	Net Import	Wheel- Through
AZPS	173,909	50,383	52,290
BANC	24,833	103,742	-
CISO	150,806	249,675	96,130
IPCO	21,311	88,605	18,503
NEVP	103,844	33,496	56,048
PACE	167,871	30,962	64,400
PACW	40,787	64,917	133,127
PGE	36,743	79,596	2,771
PSEI	63,004	21,851	19,179
PWRX	8,652	126,525	4,845

TABLE 5: Estimated wheel-through transfers in August 2019



GRAPH 4: Estimated wheel-through transfers in August 2019

BAA	Net Export	Net Import	Wheel Through
AZPS	175,827	46,849	72,024
BANC	25,190	74,317	-
CISO	196,773	282,031	121,045
IPCO	30,635	49,106	45,043
NEVP	95,177	40,394	89,863
PACE	201,798	35,853	41,007
PACW	66,987	80,127	139,795
PGE	21,000	126,075	8,955
PSEI	49,573	33,338	26,817
PWRX	7,316	93,700	5,271

TABLE 6: Estimated wheel-through transfers in September 2019

GRAPH 5: Estimated wheel-through transfers in September 2019

REDUCED RENEWABLE CURTAILMENT AND GHG REDUCTIONS

The Western EIM benefit calculation includes the economic benefits that can be attributed to avoided renewable curtailment within the ISO footprint. 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 2019 was calculated to be 12,922 MWh (July) + 3,126 MWh (August) + 17,794 MWh (September) = 33,843 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 CO_2/MWh, avoided curtailments displaced an estimated 14,485 metric tons of CO_2 for Q3 2019. Avoided renewable curtailments also may have contributed to an increased volume of renewable credits that would otherwise have been unavailable. 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 CO_2 are shown in Table 7.

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
	4	23,390	10,011
2017	1	52,651	22,535
	2	67,055	28,700
	3	23,331	9,986
	4	18,060	7,730
2018	1	65,860	28,188
	2	129,128	55,267
	3	19,032	8,146
	4	23,425	10,026
2019	1	52,254	22,365
	2	132,937	56,897
	3	33,843	14,485
	Total	976,896	418,031

TABLE 7: Total reduction in curtailment of renewable energy and the associated reductions in CO_2

FLEXIBLE RAMPING PROCUREMENT DIVERSITY SAVINGS

The Western 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 requirements. This difference is known as flexible ramping procurement diversity savings. Starting in November 2016, the ISO replaced the flexible ramping constraint with flexible ramping products that provide both upward and downward ramping. The minimum and maximum flexible ramping requirements for each BAA and for each direction are listed in Table 8.

Month	BAA	Direction	Minimum requirement	Maximum requirement
July	*AZPS*	up	0	185
	BANC	up	0	72
	CISO	up	0	1701
	IPCO	up	0	157
	NEVP	up	0	152
	PACE	up	0	298
	PACW	up	0	137
	PGE	up	0	129
	PSEI	up	0	106
	PWRX	up	0	200
	ALL EIM	**up**	**0**	**1,823**
	AZPS	down	0	190
	BANC	down	0	72
	CISO	down	0	1,349
	IPCO	down	0	153
	NEVP	down	0	152
	PACE	down	0	321
	PACW	down	0	119
	PGE	down	0	146
	PSEI	down	0	145
	PWRX	down	0	230
	ALL EIM	**down**	**0**	**1,484**
August	*AZPS*	up	41	280
	BANC	up	4	73
	CISO	up	185	1,459
	IPCO	up	3	164
	NEVP	up	20	291
	PACE	up	89	316

	PACW	up	34	133
	PGE	up	43	213
	PSEI	up	20	169
	PWRX	up	50	234
	ALL EIM	**up**	**312**	**1,653**
	AZPS	down	20	358
	BANC	down	0	89
	CISO	down	189	1,305
	IPCO	down	39	185
	NEVP	down	36	297
	PACE	down	59	390
	PACW	down	13	148
	PGE	down	30	242
	PSEI	down	28	201
	PWRX	down	65	270
	ALL EIM	**down**	**0**	**1,526**
September	*AZPS*	up	33	280
	BANC	up	4	73
	CISO	up	185	1,592
	IPCO	up	35	223
	NEVP	up	14	291
	PACE	up	76	320
	PACW	up	36	162
	PGE	up	44	213
	PSEI	up	26	163
	PWRX	up	51	231
	ALL EIM	**up**	**312**	**1,653**
	AZPS	down	28	370
	BANC	down	6	82
	CISO	down	153	1,305

IPCO	down	39	232
NEVP	down	34	297
PACE	down	81	390
PACW	down	27	148
PGE	down	33	242
PSEI	down	26	205
PWRX	down	67	270
ALL EIM	**down**	**79**	**1,521**

Table 8: Flexible ramping requirements

The flexible ramping procurement diversity savings for all the intervals averaged over the month are shown in Table 9. The percentage savings is the average MW savings divided by the sum of the four individual BAA requirements.

	July		**August**		**September**	
Direction	Up	Down	Up	Down	Up	Down
Average MW saving	807	827	798	841	797	846
Sum of BAA requirements	1,750	1,690	1,630	1,679	1,701	1,675
Percentage savings	46%	49%	49%	50%	47%	51%

Table 9: Flexible ramping procurement diversity savings in Q3 2019

Flexible ramping capacity may be used in RTD to handle uncertainties in the future interval. The RTD flexible ramping capacity is prorated to each BAA. Flexible ramping surplus MW is defined as the awarded flexible ramping capacity in RTD minus its share, and the flexible ramping surplus cost is defined as the flexible ramping surplus MW multiplied by the flexible ramping EIM-wide marginal price. A positive flexible ramping surplus MW is the capacity that a BAA provided to help other BAAs, and a negative flexible ramping surplus MW is the capacity that a BAA received from other BAAs. The EIM dispatch cost for a BAA with positive flexible ramping surplus MW is increased because some capacities are used to help other BAAs. The flexible ramping surplus cost is subtracted from the BAA's EIM dispatch cost to reflect the true dispatch cost of a BAA. Please see the Benefit Report Methodology for more details.

CONCLUSION

The first real-time wholesale power market of its kind in the western United States, the Western EIM uses state-of-the-art technology to find and deliver low-cost energy to meet real-time demand across eight western states and a Canadian province. The EIM has proven extensive financial and operational benefits, and cumulative gross economic benefits of the EIM have surpassed $800 million since its inception in November 2014.

In addition, the EIM provides increased situational readiness and environmental benefits through the reduction of renewable curtailments during periods of oversupply. Sharing resources across a larger geographic area continues to have a positive effect of reducing greenhouse gas emissions by using renewable generation that otherwise would have been turned off. Use of this energy to meet demand across the EIM footprint is likely replacing less clean energy sources. The quantified benefits from avoided curtailments of renewable generation from 2015 to-date reached 418,031 metric tons of CO2, roughly the equivalent of avoiding the emissions from 87,889 passenger cars driven for one year.

Entities representing over 77% of the load in WECC are now operating in the EIM or in the implementation phase, demonstrating that utilities can realize cost benefits and reduce carbon emissions through increased coordination and optimization in the West.