

# WESTERN EIM BENEFITS REPORT

**Fourth Quarter 2018** 

January 31, 2019

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## EXECUTIVE SUMMARY

Gross benefits from EIM since November 2014

**\$564.88 million**

This report presents the benefits associated with participation in the western Energy Imbalance Market (EIM) for the fourth quarter of 2018. The benefits include cost savings and the use of surplus renewable energy.

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

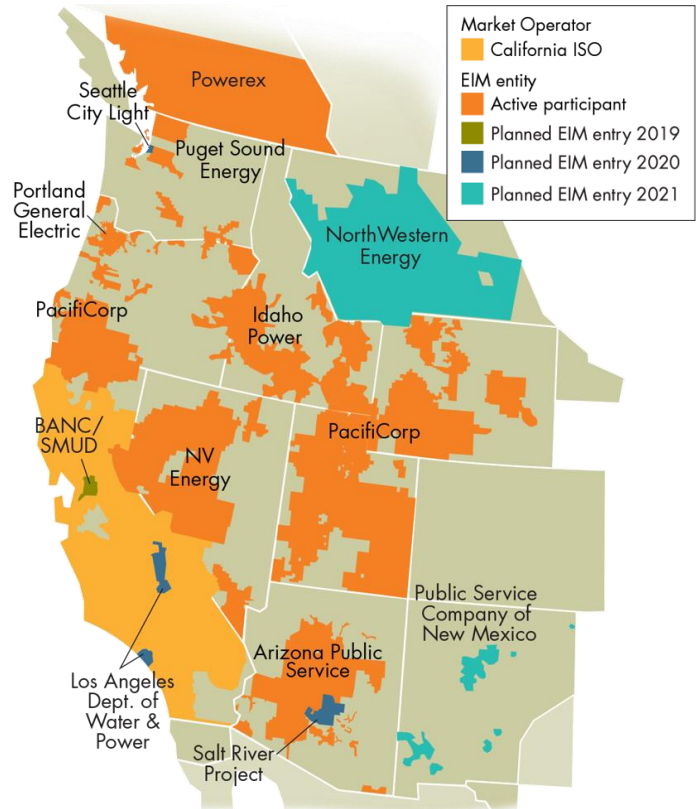
This analysis demonstrates the real-time market's ability to select the most economic resources across the EIM footprint.

### Q4 2018 Gross Benefits by Participant

	(millions \$)
Arizona Public Service	\$10.03
California ISO	\$4.14
Idaho Power	\$5.82
NV Energy	\$4.95
PacifiCorp	\$21.68
Portland General Electric	\$9.12
Powerex	\$2.92
Puget Sound Energy	\$3.91
<b>Total</b>	<b>\$62.57</b>

\*EIM Quarterly Benefit Report Methodology, [https://www.caiso.com/Documents/EIM\\_BenefitMethodology.pdf](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>



## 2018 Q4 BENEFITS

### ECONOMICAL

**\$62.57M**

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

### ENVIRONMENTAL

**10,026**

Metric tons of CO<sub>2</sub>\*\* avoided curtailments

### OPERATIONAL

**46%**

Average reduction in flexibility reserves across the footprint

## ■ BACKGROUND

The 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. Most recently, Idaho Power and Powerex began participating on April 4, 2018. The EIM footprint now includes portions of Arizona, California, Idaho, Nevada, Oregon, Utah, Washington, Wyoming, and extends to the border with Canada. The EIM facilitates renewable resource integration and increases reliability by sharing information between balancing authorities on electricity delivery conditions across the EIM region.

The ISO began publishing quarterly EIM benefit reports in January 2015. Prior reports can be accessed at <https://www.westerneim.com/Pages/About/QuarterlyBenefits.aspx>. The benefits quantified in this report fall into three main categories and were described in earlier studies<sup>1</sup>.

## ■ EIM BENEFITS IN Q4 2018

Table 1 shows the estimated EIM gross benefits by each region per month<sup>2</sup>. The monthly savings presented in the table show \$18.17 million for October, \$19.90 million for November, and \$24.50 million for December with a total estimated benefit of \$62.57 million for the quarter.

<i>Region</i>	October	November	December	Total
<i>APS</i>	\$3.94	\$2.92	\$3.17	\$10.03
<i>ISO</i>	\$0.27	\$1.17	\$2.70	\$4.14
<i>IPCO</i>	\$2.01	\$1.70	\$2.11	\$5.82
<i>NVE</i>	\$1.73	\$1.51	\$1.71	\$4.95
<i>PAC</i>	\$5.25	\$6.79	\$9.64	\$21.68
<i>PGE</i>	\$3.20	\$3.04	\$2.88	\$9.12
<i>PWRX</i>	\$0.62	\$1.23	\$1.07	\$2.92
<i>PSE</i>	\$1.15	\$1.54	\$1.22	\$3.91
<b>Total</b>	\$18.17	\$19.90	\$24.50	\$62.57

**TABLE 1: Fourth quarter 2018 benefits in millions USD by month**

<sup>1</sup> PacifiCorp-ISO, Energy Imbalance Market Benefits, <http://www.caiso.com/Documents/PacifiCorp-ISOEnergyImbalanceMarketBenefits.pdf>

<sup>2</sup> 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 Fifteen-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 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.

<i>Month</i>	<b>From BAA</b>	<b>To BAA</b>	<b>15min EIM transfer</b>	<b>5min EIM transfer</b>
			<b>(15m - base)</b>	<b>(5m - base)</b>
	AZPS	CISO	268,032	225,871
	AZPS	NEVP	16,165	16,001
	AZPS	PACE	6,736	13,685
	PWRX	CISO	6,195	12,223
	PWRX	PSEI	12,608	10,948
	CISO	AZPS	23,670	32,188
	CISO	PWRX	13,852	57,896

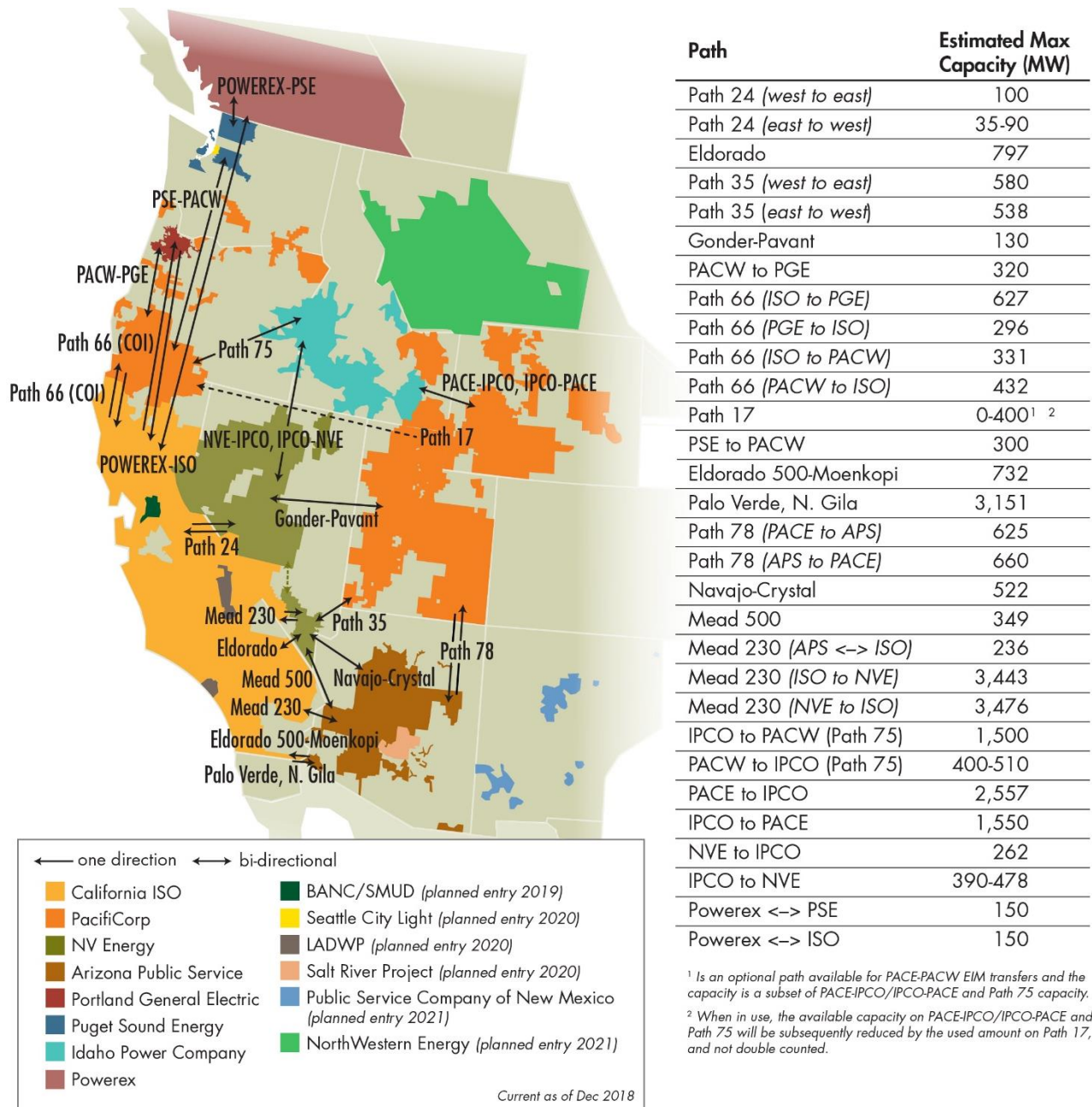
	CISO	NEVP	37,645	54,413
	CISO	PACW	30,949	36,199
	CISO	PGE	25,572	42,618
	IPCO	NEVP	35,456	21,214
	IPCO	PACE	1,627	344
	IPCO	PACW	19,198	25,888
	NEVP	AZPS	1,278	1,032
	NEVP	CISO	114,251	80,962
	NEVP	IPCO	19,553	25,635
<i>October</i>	NEVP	PACE	27,818	35,086
	PACE	AZPS	155,165	125,119
	PACE	IPCO	77,359	82,985
	PACE	NEVP	45,144	39,034
	PACE	PACW	42,878	49,660
	PACW	CISO	35,625	41,972
	PACW	IPCO	33,926	27,655
	PACW	PGE	63,566	63,175
	PACW	PSEI	86,778	70,492
	PGE	CISO	13,754	11,531
	PGE	PACW	13,417	14,884
	PSEI	PWRX	59,268	50,768
	PSEI	PACW	18,657	13,711
	AZPS	CISO	183,991	188,198
	AZPS	NEVP	7,268	9,480
	AZPS	PACE	6,844	12,966
	PWRX	CISO	3,317	10,210
	PWRX	PSEI	3,666	2,560

<i>November</i>	CISO	AZPS	12,597	17,832
	CISO	PWRX	13,604	55,802
	CISO	NEVP	32,739	41,804
	CISO	PACW	21,578	24,133
	CISO	PGE	20,394	31,463
	IPCO	NEVP	43,739	40,839
	IPCO	PACE	3,862	4,790
	IPCO	PACW	13,979	17,530
	NEVP	AZPS	1,433	774
	NEVP	CISO	133,783	99,555
	NEVP	IPCO	13,045	13,723
	NEVP	PACE	32,717	43,534
	PACE	AZPS	98,914	102,251
	PACE	IPCO	44,800	47,716
	PACE	NEVP	96,508	78,199
	PACE	PACW	24,261	26,700
	PACW	CISO	42,659	59,195
	PACW	IPCO	42,150	38,690
	PACW	PGE	78,729	68,864
	PACW	PSEI	66,472	53,287
	PGE	CISO	5,576	5,285
	PGE	PACW	21,310	21,493
	PSEI	PWRX	75,701	73,797
	PSEI	PACW	15,706	18,095
	AZPS	CISO	155,376	143,656
	AZPS	NEVP	7,274	8,802
	AZPS	PACE	5,968	11,512

	PWRX	CISO	4,301	16,887
	PWRX	PSEI	9,140	6,301
	CISO	AZPS	14,545	23,147
	CISO	PWRX	34,029	75,432
	CISO	NEVP	31,481	48,599
	CISO	PACW	25,258	29,450
	CISO	PGE	16,842	32,983
	IPCO	NEVP	49,070	40,381
	IPCO	PACE	165	230
	IPCO	PACW	12,519	15,466
<i>December</i>	NEVP	AZPS	1,911	2,367
	NEVP	CISO	153,235	116,901
	NEVP	IPCO	25,786	30,883
	NEVP	PACE	21,645	28,426
	PACE	AZPS	131,106	122,285
	PACE	IPCO	16,429	20,933
	PACE	NEVP	133,096	123,342
	PACE	PACW	41,966	46,627
	PACW	CISO	81,620	96,236
	PACW	IPCO	41,026	41,317
	PACW	PGE	88,244	84,008
	PACW	PSEI	100,221	83,195
	PGE	CISO	6,718	6,309
	PGE	PACW	10,030	12,275
	PSEI	PWRX	58,646	55,110
	PSEI	PACW	14,719	12,624

TABLE 2: Energy transfers (MWh) in the FMM and RTD markets for Q4 2018





**GRAPH 1: Estimated maximum transfer capacity (EIM entities operating in Q4 2018)**

**WHEEL THROUGH TRANSFERS**

As the footprint of the 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 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 wheels through in the EIM market in the quarterly reports. In order to derive the wheels through for each EIM BAA, the ISO uses the following calculation for every real-time interval dispatch:

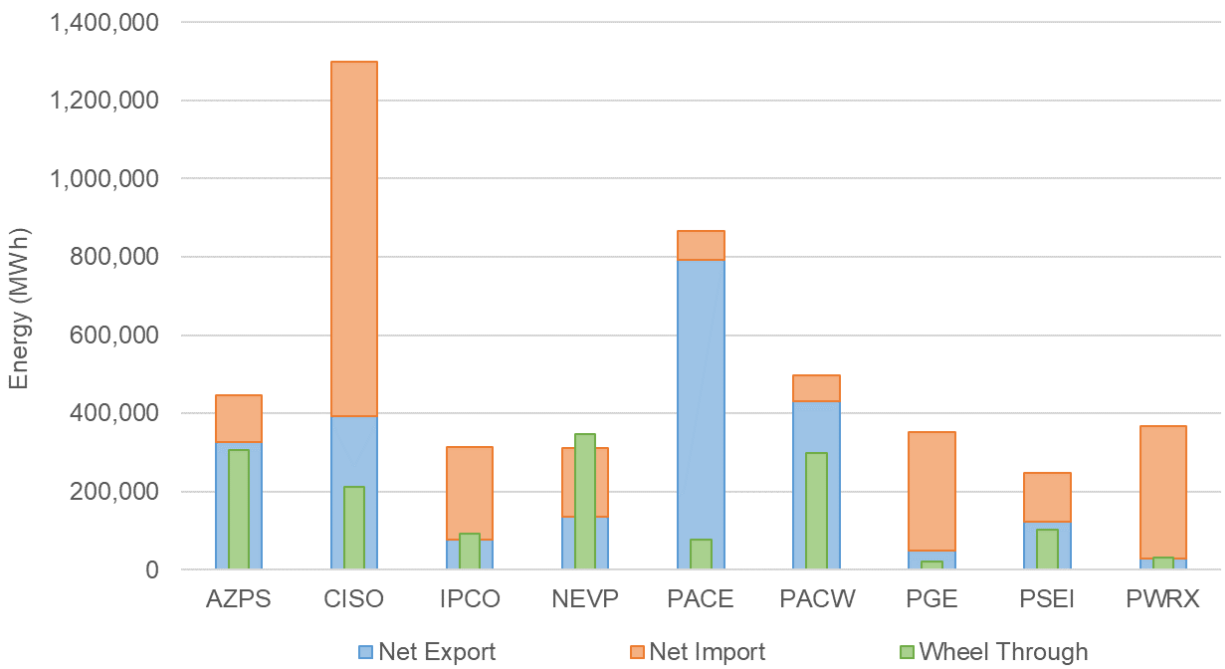
- Total import: summation of transfers above base transfers coming into the EIM BAA under analysis
- Total export: summation of all transfers above base transfers going out of the EIM BAA under analysis
- Net import: the maximum of zero or the difference between total imports and total exports
- Net 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 throughs are summed over both the month and the quarter. This volume reflects the total wheels through 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.

<i>BAA</i>	<i>Net Export</i>	<i>Net Import</i>	<i>Wheel Through</i>
<i>AZPS</i>	325,227	121,580	306,653
<i>CISO</i>	393,149	905,963	212,642
<i>IPCO</i>	75,652	239,138	91,853
<i>NEVP</i>	134,185	177,799	346,543
<i>PACE</i>	792,070	75,036	75,904
<i>PACW</i>	430,822	66,377	299,342
<i>PGE</i>	50,008	302,013	21,937
<i>PSEI</i>	122,841	125,345	102,066
<i>PWRX</i>	27,934	338,638	31,513

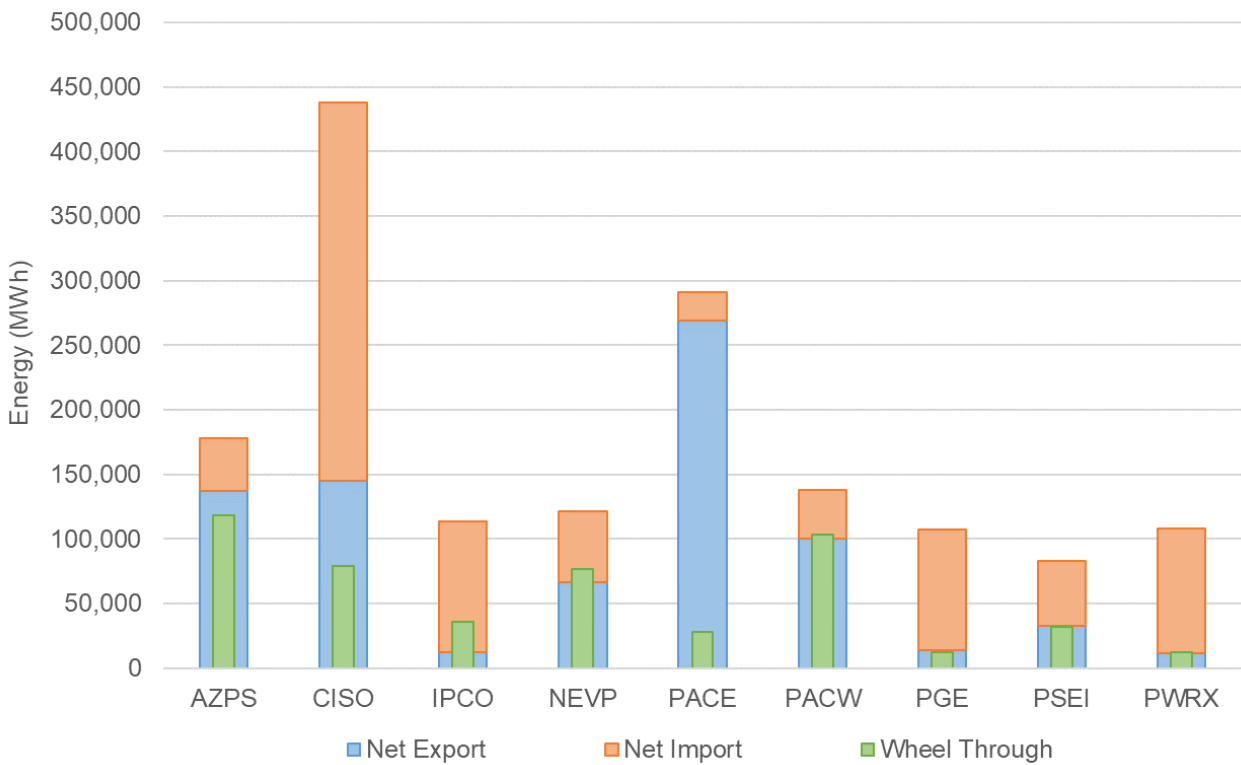
**TABLE 3: Estimated wheel through transfers in Q4 2018**



**GRAPH 2: Estimated wheel through transfers in Q4 2018**

<i>BAA</i>	Net Export	Net Import	Wheel Through
<i>AZPS</i>	137,379	40,237	118,367
<i>CISO</i>	144,699	293,552	79,272
<i>IPCO</i>	12,086	101,270	35,422
<i>NEVP</i>	66,728	54,788	76,278
<i>PACE</i>	269,472	21,277	27,957
<i>PACW</i>	100,306	37,264	103,349
<i>PGE</i>	13,985	93,525	12,435
<i>PSEI</i>	32,761	49,814	31,861
<i>PWRX</i>	11,351	97,041	11,897

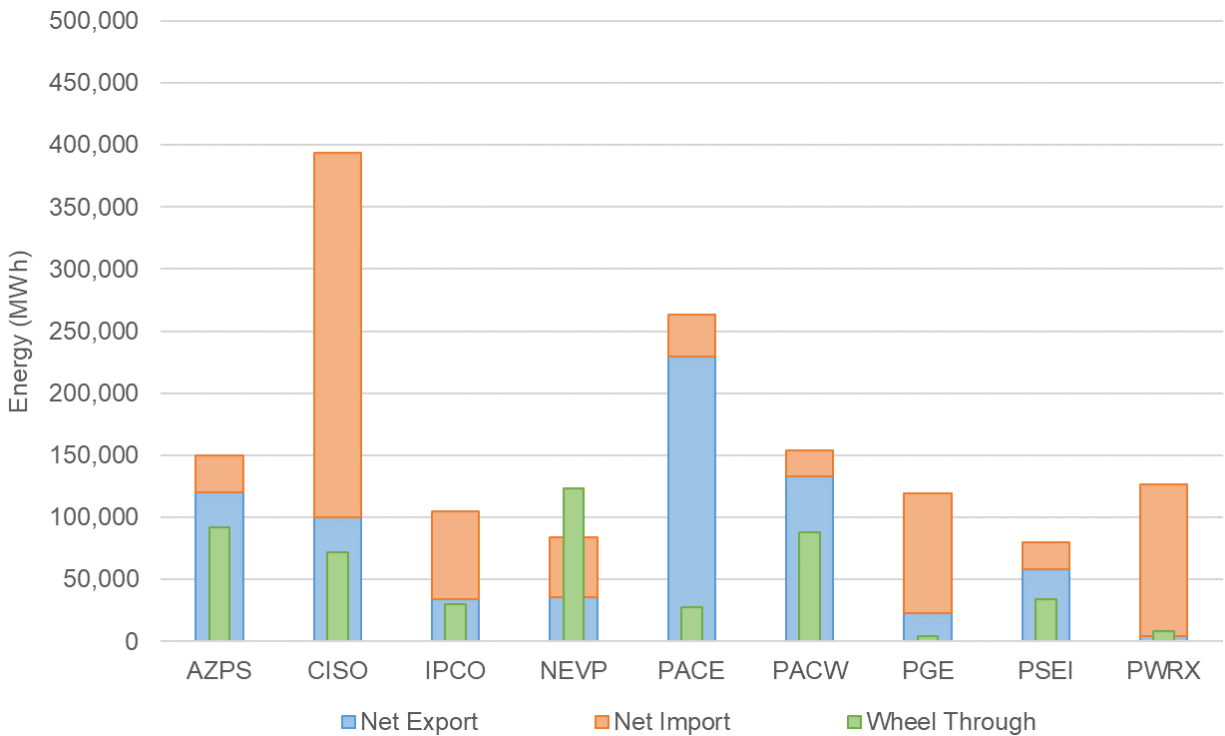
**TABLE 4: Estimated wheel through transfers in October 2018**



**GRAPH 3: Estimated wheel through transfers in October 2018**

<i><b>BAA</b></i>	<b>Net Export</b>	<b>Net Import</b>	<b>Wheel Through</b>
<i>AZPS</i>	120,037	29,869	91,724
<i>CISO</i>	99,767	293,769	71,451
<i>IPCO</i>	33,937	71,021	29,832
<i>NEVP</i>	35,541	48,355	123,262
<i>PACE</i>	229,514	34,079	27,245
<i>PACW</i>	133,167	20,355	87,940
<i>PGE</i>	22,793	96,518	4,118
<i>PSEI</i>	58,158	21,768	34,228
<i>PWRX</i>	4,579	121,757	8,381

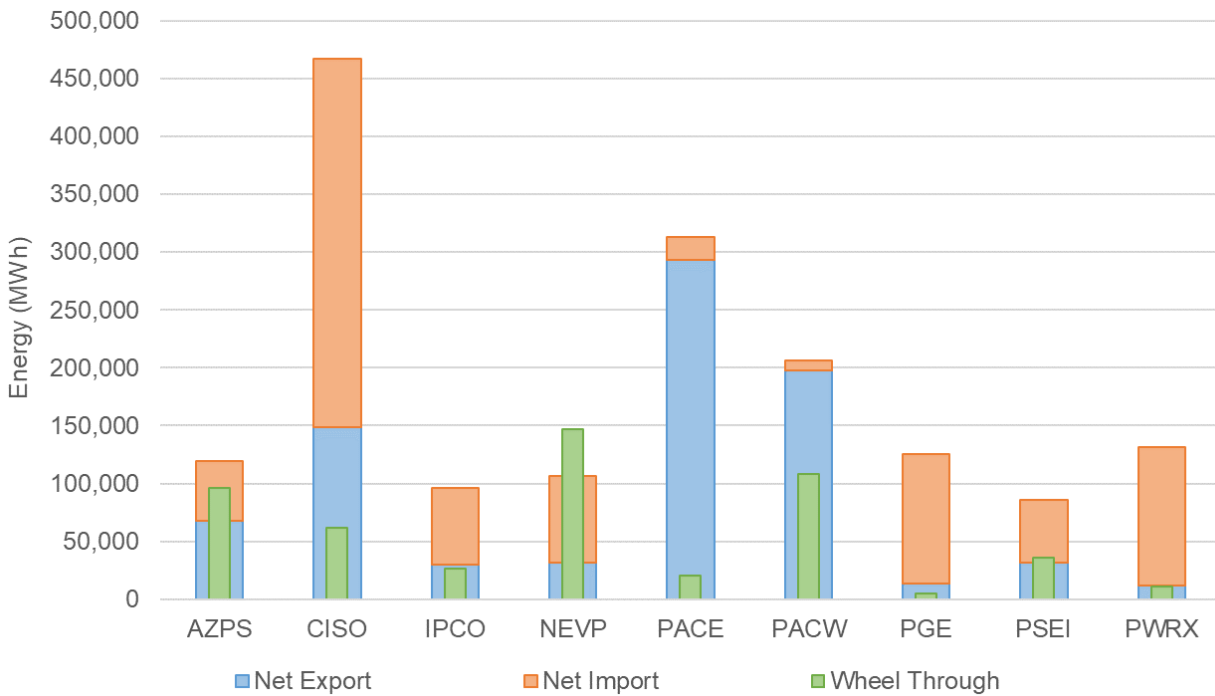
**TABLE 5: Estimated wheel through transfers in November 2018**



**GRAPH 4: Estimated wheel through transfers in November 2018**

<b>BAA</b>	<b>Net Export</b>	<b>Net Import</b>	<b>Wheel Through</b>
<i>AZPS</i>	67,810	51,474	96,562
<i>CISO</i>	148,684	318,643	61,920
<i>IPCO</i>	29,629	66,848	26,599
<i>NEVP</i>	31,916	74,656	147,003
<i>PACE</i>	293,084	19,680	20,701
<i>PACW</i>	197,349	8,757	108,053
<i>PGE</i>	13,230	111,969	5,384
<i>PSEI</i>	31,922	53,762	35,978
<i>PWRX</i>	12,004	119,840	11,234

**TABLE 6: Estimated wheel through transfers in December 2018**



**GRAPH 5: Estimated wheel through transfers in December 2018**

**■ 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 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 Q4 2018 was calculated to be 7,048 MWh (October) + 6,664 MWh (November) + 9,713 MWh (December) = 23,425 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<sub>2</sub>/MWh, avoided curtailments displaced an estimated 10,026 metric tons of CO<sub>2</sub> for Q4 2018. 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<sub>2</sub> are shown in Table 7.

Year	Quarter	MWh	Eq. Tons CO2
<b>2015</b>	1	8,860	3,792
	2	3,629	1,553
	3	828	354
	4	17,765	7,521
<b>2016</b>	1	112,948	48,342
	2	158,806	67,969
	3	33,094	14,164
	4	23,390	10,011
<b>2017</b>	1	52,651	22,535
	2	67,055	28,700
	3	23,331	9,986
	4	18,060	7,730
<b>2018</b>	1	65,860	28,188
	2	129,128	55,267
	3	19,032	8,146
	4	23,425	10,026
	<b>Total</b>	<b>757,862</b>	<b>324,284</b>

**TABLE 7: 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 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.

Year	Month	BAA	Direction	Minimum requirement	Maximum requirement
2018	October	AZPS	up	35	199
		CISO	up	149	1,499
		NEVP	up	28	170
		PACE	up	83	319
		PACW	up	42	146
		PGE	up	37	147
		PSEI	up	28	152
		PWRX	up	73	279
		IPCO	up	47	222
		<b>ALL EIM</b>	<b>up</b>	<b>316</b>	<b>1,630</b>
	AZPS	down	31	180	
	CISO	down	211	1,316	
	NEVP	down	22	152	
	PACE	down	90	269	
	PACW	down	30	173	
	PGE	down	25	189	
	PSEI	down	39	127	
	PWRX	down	65	198	
	IPCO	down	23	208	
	<b>ALL EIM</b>	<b>down</b>	<b>300</b>	<b>1,492</b>	
2018	November	AZPS	up	0	199
		CISO	up	0	1,499
		NEVP	up	0	170
		PACE	up	0	319
		PACW	up	0	179
		PGE	up	0	147



2018	December	PSEI	up	0	152
		PWRX	up	0	268
		IPCO	up	0	222
		<b>ALL EIM</b>	<b>up</b>	<b>0</b>	<b>1,630</b>
		AZPS	down	0	180
		CISO	down	0	1,316
		NEVP	down	0	152
		PACE	down	0	269
		PACW	down	0	151
		PGE	down	0	189
		PSEI	down	0	127
		PWRX	down	0	198
		IPCO	down	0	208
		<b>ALL EIM</b>	<b>down</b>	<b>0</b>	<b>1,492</b>
		AZPS	up	19	199
	CISO	up	182	1,701	
	NEVP	up	35	170	
	PACE	up	93	319	
	PACW	up	50	179	
	PGE	up	30	147	
	PSEI	up	23	152	
	PWRX	up	79	268	
	IPCO	up	43	222	
	<b>ALL EIM</b>	<b>up</b>	<b>348</b>	<b>1,823</b>	
AZPS	down	25	190		
CISO	down	180	1,349		
NEVP	down	19	152		
PACE	down	69	321		

	PACW	down	27	151
	PGE	down	27	189
	PSEI	down	33	145
	PWRX	down	75	230
	IPCO	down	53	208
	<b>ALL EIM</b>	<b>down</b>	<b>161</b>	<b>1,492</b>

**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.

	October		November		December	
<i>Direction</i>	Up	Down	Up	Down	Up	Down
<i>Average MW saving</i>	743	754	753	749	752	765
<i>Sum of BAA requirements</i>	1,645	1,674	1,625	1,674	1,654	1,611
<i>Percentage savings</i>	45%	45%	46%	45%	45%	47%

**Table 9: Flexible ramping procurement diversity savings in Q4 2018**

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 in the Appendix for more details.

## ■ CONCLUSION

With \$564.88 million in gross benefits to date, the Western EIM demonstrates that through increased coordination and optimization in the west, utilities can realize cost benefits and reduce carbon emissions. Sharing resources across a larger geographic area, even if it's just in real-time, 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 324,284 metric tons of CO<sub>2</sub>, roughly the equivalent of avoiding the emissions from 68,179 passenger cars driven for one year.