

# WESTERN EIM BENEFITS REPORT

**First Quarter 2019** ■ ■ ■

April 29, 2019

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## EXECUTIVE SUMMARY

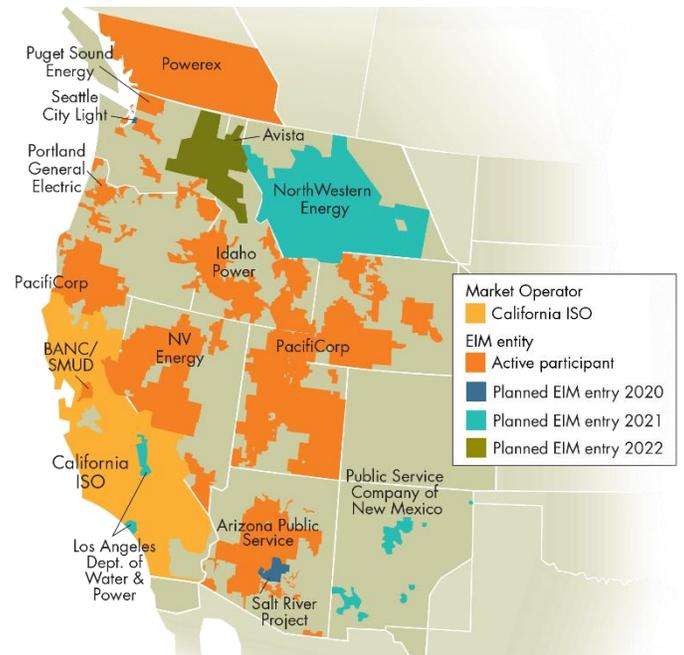
Gross benefits from EIM since November 2014

**\$650.26 million**

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

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.



### Q1 2019 Gross Benefits by Participant

	(millions \$)
Arizona Public Service	\$8.20
California ISO	\$13.08
Idaho Power	\$8.45
NV Energy	\$5.71
PacifiCorp	\$23.76
Portland General Electric	\$11.74
Powerex	\$7.23
Puget Sound Energy	\$7.21
<b>Total</b>	<b>\$85.38</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>

## 2019 Q1 BENEFITS

**\$85.38M**

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

### ENVIRONMENTAL

**22,365**

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

### OPERATIONAL

**45%**

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. Idaho Power and Powerex began participating on April 4, 2018. Most recently, the Sacramento Municipal Utility District (SMUD), part of the Balancing Authority of Northern California (BANC), began participating on April 3, 2019<sup>1</sup>. 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>.

## ■ EIM BENEFITS IN Q1 2019

Table 1 shows the estimated EIM gross benefits by each region per month<sup>2</sup>. The monthly savings presented in the table show \$14.08 million for January, \$40.26 million for February, and \$31.04 million for March with a total estimated benefit of \$85.38 million for the quarter. Higher benefits in February and March were driven by increased transfers compounded with higher energy prices.

<i>Region</i>	January	February	March	Total
<i>APS</i>	\$1.10	\$4.76	\$2.34	\$8.20
<i>ISO</i>	\$1.25	\$5.63	\$6.20	\$13.08
<i>IPCO</i>	\$1.64	\$4.21	\$2.60	\$8.45
<i>NVE</i>	\$1.09	\$2.20	\$2.42	\$5.71
<i>PAC</i>	\$5.56	\$11.01	\$7.19	\$23.76
<i>PGE</i>	\$1.36	\$5.36	\$5.02	\$11.74
<i>PWRX</i>	\$1.23	\$2.91	\$3.09	\$7.23
<i>PSE</i>	\$0.85	\$4.18	\$2.18	\$7.21
<b>Total</b>	\$14.08	\$40.26	\$31.04	\$85.38

**TABLE 1: First quarter 2019 benefits in millions USD by month**

<sup>1</sup> BANC/SMUD will be included in the quarterly benefits report starting in Q2 2019

<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.

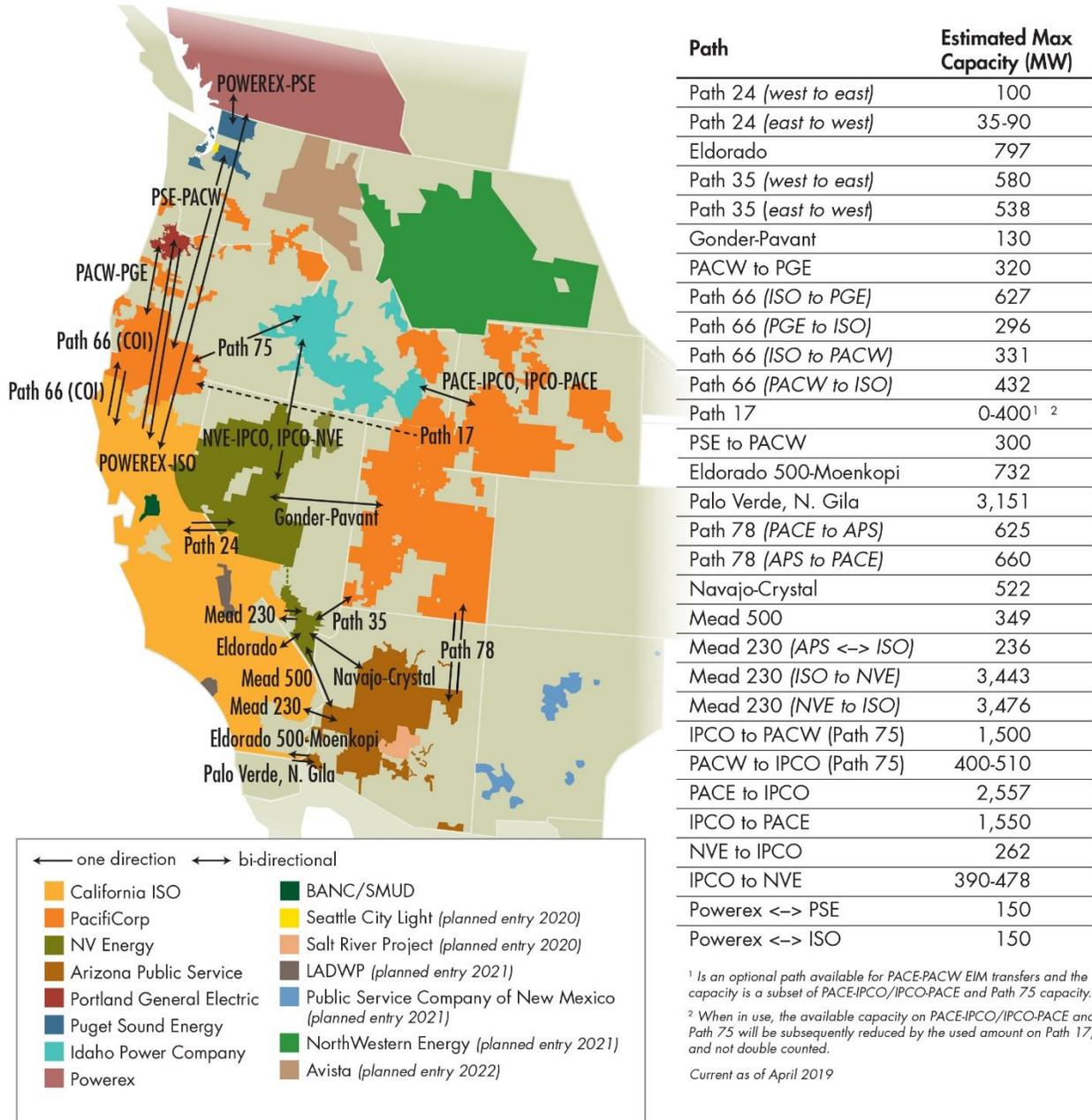
<i>Month</i>	<b>From BAA</b>	<b>To BAA</b>	<b>15min EIM transfer</b>	<b>5min EIM transfer</b>
			<b>(15m - base)</b>	<b>(5m - base)</b>
	AZPS	CISO	163,672	127,183
	AZPS	NEVP	8,471	11,289
	AZPS	PACE	8,614	15,975
	PWRX	CISO	10,806	40,547
	PWRX	PSEI	22,508	13,933
	CISO	AZPS	14,376	24,891
	CISO	PWRX	20,473	37,502

<i>January</i>	CISO	NEVP	26,461	43,388
	CISO	PACW	13,660	17,633
	CISO	PGE	11,447	22,603
	IPCO	NEVP	65,219	48,466
	IPCO	PACE	1,141	1,337
	IPCO	PACW	9,155	17,511
	NEVP	AZPS	5,297	4,798
	NEVP	CISO	135,018	94,336
	NEVP	IPCO	7,991	13,217
	NEVP	PACE	41,750	54,001
	PACE	AZPS	148,219	120,937
	PACE	IPCO	47,048	56,553
	PACE	NEVP	98,495	85,123
	PACE	PACW	20,310	29,284
	PACW	CISO	74,258	93,804
	PACW	IPCO	48,830	37,370
	PACW	PGE	59,252	57,684
	PACW	PSEI	49,900	43,861
	PGE	CISO	6,934	7,318
	PGE	PACW	15,839	17,106
PSEI	PWRX	31,913	38,161	
PSEI	PACW	30,759	26,386	
	AZPS	CISO	195,015	174,412
	AZPS	NEVP	9,046	17,136
	AZPS	PACE	6,615	10,568
	PWRX	CISO	8,358	29,965
	PWRX	PSEI	32,635	24,372
	CISO	AZPS	11,843	20,215
	CISO	PWRX	26,747	56,363

<i>February</i>	CISO	NEVP	28,759	47,817
	CISO	PACW	29,968	37,256
	CISO	PGE	24,932	45,611
	IPCO	NEVP	82,473	62,435
	IPCO	PACE	2,451	1,847
	IPCO	PACW	36,277	51,301
	NEVP	AZPS	2,700	2,162
	NEVP	CISO	134,958	95,479
	NEVP	IPCO	7,959	12,527
	NEVP	PACE	45,311	61,457
	PACE	AZPS	104,361	96,904
	PACE	IPCO	25,900	32,644
	PACE	NEVP	69,535	59,355
	PACE	PACW	22,499	31,146
	PACW	CISO	55,088	63,121
	PACW	IPCO	34,453	26,763
	PACW	PGE	72,913	75,099
	PACW	PSEI	64,463	58,874
	PGE	CISO	15,978	16,824
	PGE	PACW	7,659	8,243
PSEI	PWRX	28,527	28,759	
PSEI	PACW	39,891	35,174	
	AZPS	CISO	119,271	114,418
	AZPS	NEVP	2,320	3,531
	AZPS	PACE	87,467	105,988
	PWRX	CISO	1,100	7,907
	PWRX	PSEI	5,584	5,280
	CISO	AZPS	95,191	108,821
	CISO	PWRX	130,714	161,877

<i>March</i>	CISO	NEVP	103,306	108,577
	CISO	PACW	42,997	58,509
	CISO	PGE	58,216	91,156
	IPCO	NEVP	60,982	42,648
	IPCO	PACE	20,297	13,817
	IPCO	PACW	55,133	67,375
	NEVP	AZPS	5,660	5,556
	NEVP	CISO	180,201	110,043
	NEVP	IPCO	41,577	48,951
	NEVP	PACE	104,963	115,626
	PACE	AZPS	59,637	65,902
	PACE	IPCO	16,565	20,955
	PACE	NEVP	95,139	62,051
	PACE	PACW	28,224	34,229
	PACW	CISO	42,253	55,294
	PACW	IPCO	36,512	24,277
	PACW	PGE	45,011	43,871
	PACW	PSEI	63,772	63,387
	PGE	CISO	10,814	11,142
	PGE	PACW	39,146	49,546
PSEI	PWRX	38,625	32,000	
PSEI	PACW	30,382	29,769	

**TABLE 2: Energy transfers (MWh) in the FMM and RTD markets for Q1 2019**



**GRAPH 1: Estimated maximum transfer capacity (EIM entities operating in Q1 2019)**

**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:

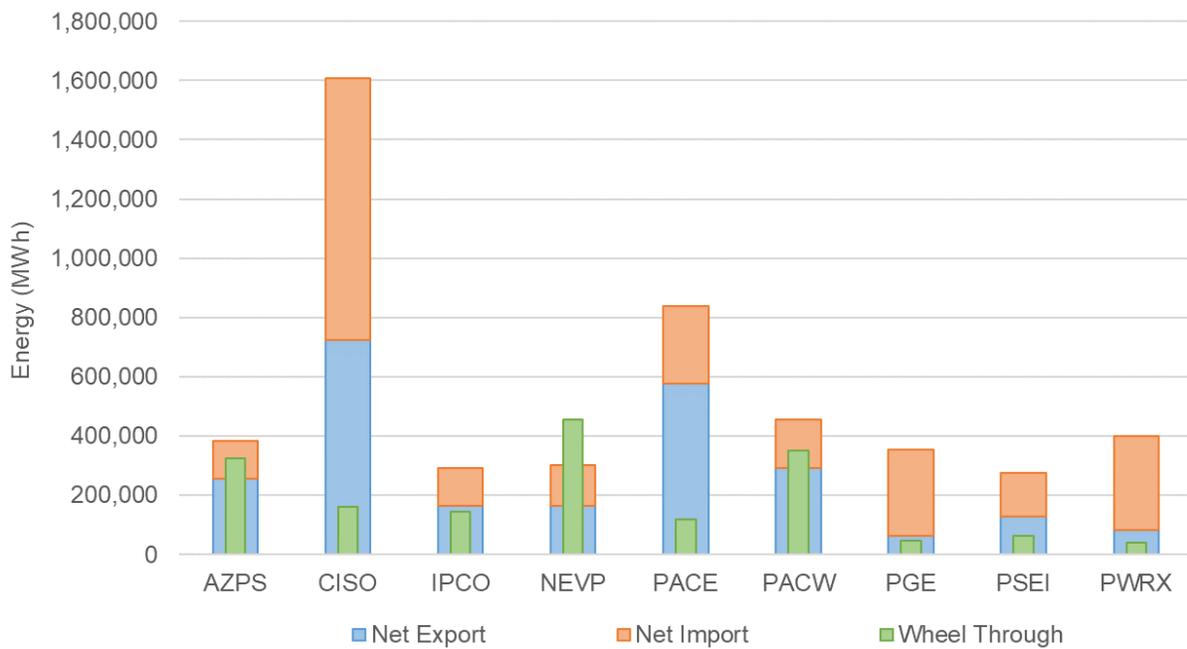
- Total import: summation of transfers above base transfers coming into the EIM BAA under analysis
- Total export: summation of all transfers above base transfers going out of the EIM BAA under analysis
- Net import: the maximum of zero or the difference between total imports and total exports
- Net 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>	257,007	126,174	325,304
<i>CISO</i>	724,239	882,415	161,717
<i>IPCO</i>	163,394	130,030	144,060
<i>NEVP</i>	163,651	137,735	456,023
<i>PACE</i>	576,786	262,131	120,105
<i>PACW</i>	293,261	160,733	351,625
<i>PGE</i>	64,296	290,801	46,381
<i>PSEI</i>	128,155	147,337	62,791
<i>PWRX</i>	83,322	316,754	38,972

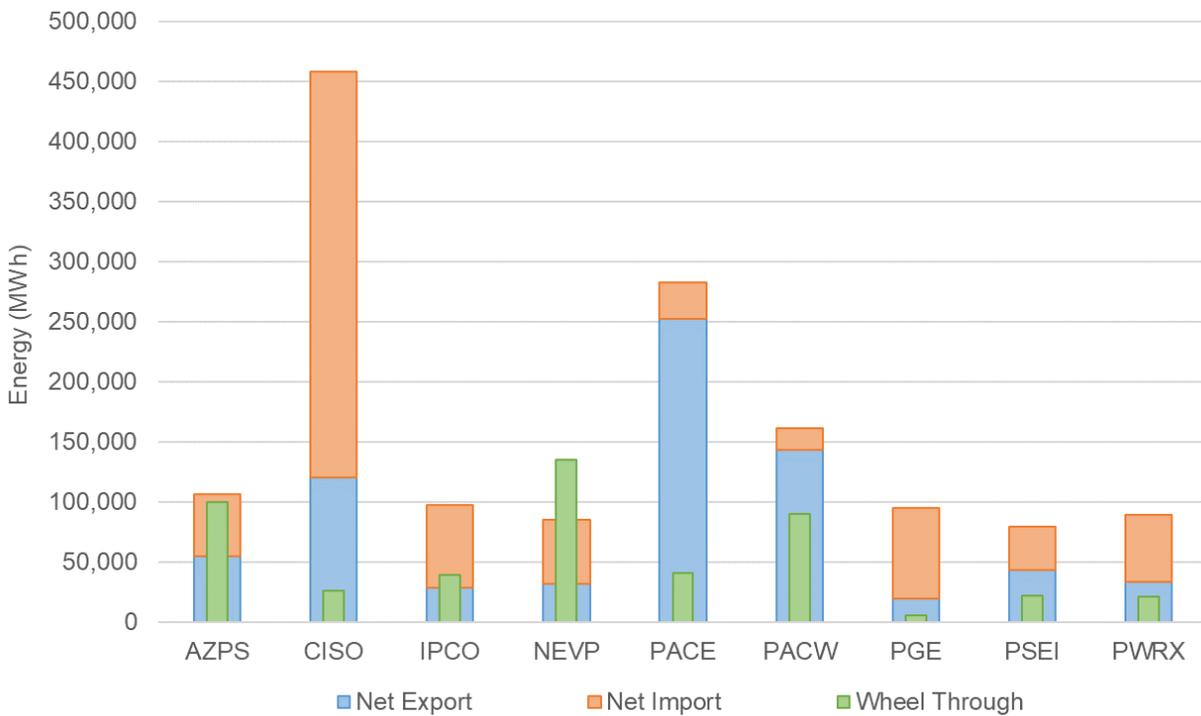
**TABLE 3: Estimated wheel through transfers in Q1 2019**



GRAPH 2: Estimated wheel through transfers in Q1 2019

<b>BAA</b>	<b>Net Export</b>	<b>Net Import</b>	<b>Wheel Through</b>
<i>AZPS</i>	55,095	51,088	100,024
<i>CISO</i>	120,364	338,007	26,408
<i>IPCO</i>	28,634	68,701	38,887
<i>NEVP</i>	31,423	53,466	135,435
<i>PACE</i>	252,092	30,878	40,804
<i>PACW</i>	143,348	18,351	90,023
<i>PGE</i>	19,408	75,383	5,163
<i>PSEI</i>	43,210	36,316	21,663
<i>PWRX</i>	33,822	55,205	20,816

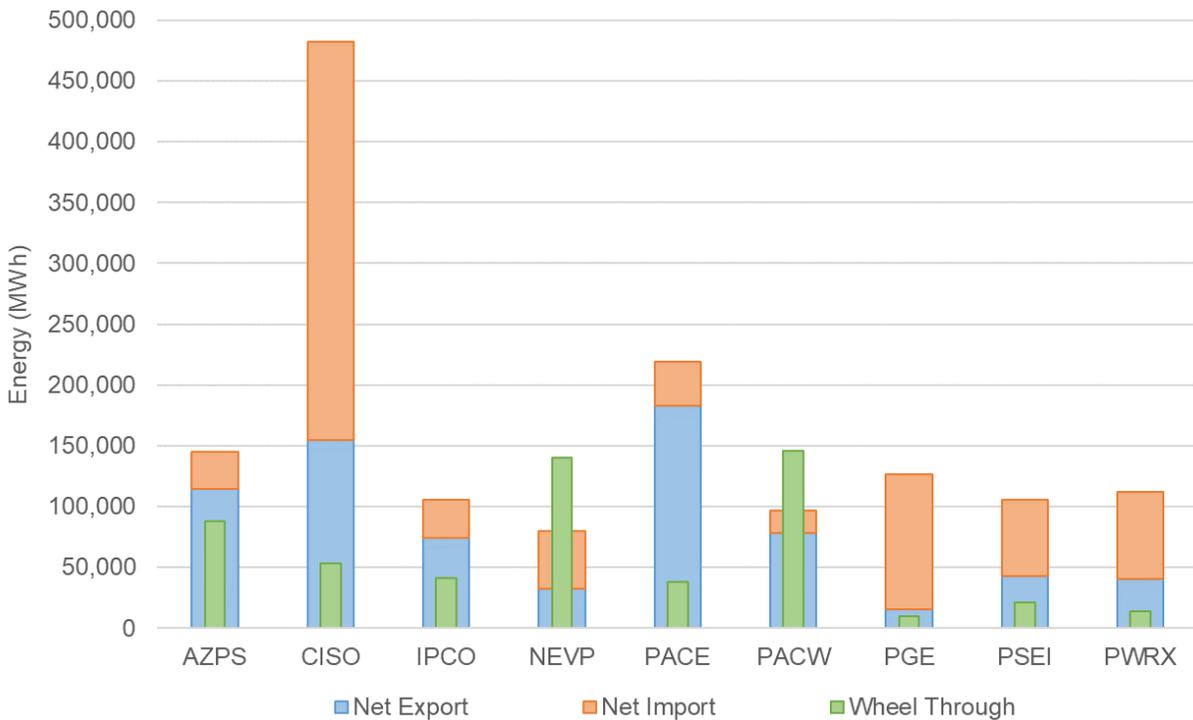
TABLE 4: Estimated wheel through transfers in January 2019



**GRAPH 3: Estimated wheel through transfers in January 2019**

<b>BAA</b>	<b>Net Export</b>	<b>Net Import</b>	<b>Wheel Through</b>
<i>AZPS</i>	114,306	31,157	88,281
<i>CISO</i>	154,458	327,789	53,125
<i>IPCO</i>	74,621	30,743	41,318
<i>NEVP</i>	32,059	47,445	139,888
<i>PACE</i>	182,855	36,119	37,763
<i>PACW</i>	78,593	17,795	145,836
<i>PGE</i>	15,399	111,274	9,787
<i>PSEI</i>	43,238	62,219	21,057
<i>PWRX</i>	40,520	71,508	13,903

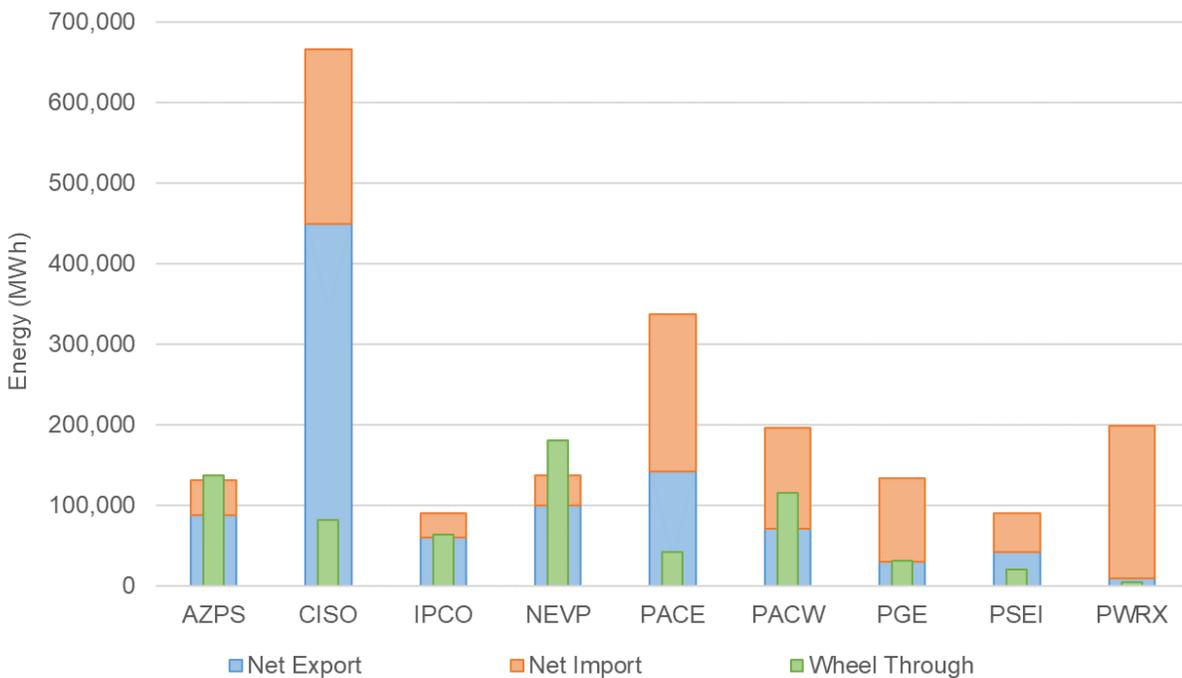
**TABLE 5: Estimated wheel through transfers in February 2019**



**GRAPH 4: Estimated wheel through transfers in February 2019**

<b>BAA</b>	<b>Net Export</b>	<b>Net Import</b>	<b>Wheel Through</b>
<i>AZPS</i>	87,607	43,930	136,999
<i>CISO</i>	449,417	216,620	82,184
<i>IPCO</i>	60,139	30,586	63,855
<i>NEVP</i>	100,169	36,824	180,700
<i>PACE</i>	141,839	195,135	41,538
<i>PACW</i>	71,320	124,587	115,765
<i>PGE</i>	29,488	104,144	31,431
<i>PSEI</i>	41,707	48,803	20,071
<i>PWRX</i>	8,980	190,041	4,253

**TABLE 6: Estimated wheel through transfers in March 2019**



**GRAPH 5: Estimated wheel through transfers in March 2019**

**■ 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 Q1 2019 was calculated to be 8,216 MWh (January) + 6,243 MWh (February) + 37,795 MWh (March) = 52,254 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 22,365 metric tons of CO<sub>2</sub> for Q1 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<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>2019</b>	1	52,254	22,365
	<b>Total</b>	810,116	346,649

**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.

<i>Month</i>	<b>BAA</b>	<b>Direction</b>	<b>Minimum requirement</b>	<b>Maximum requirement</b>
<i>January</i>	AZPS	up	25	185
	CISO	up	189	1,701
	NEVP	up	32	152
	PACE	up	98	298
	PACW	up	51	137
	PGE	up	41	129
	PSEI	up	32	106
	PWRX	up	85	234
	IPCO	up	41	157
	<b>ALL EIM</b>	<b>up</b>	<b>356</b>	<b>1,823</b>
	AZPS	down	26	190
	CISO	down	143	1,349
	NEVP	down	18	152
	PACE	down	64	300
	PACW	down	25	119
	PGE	down	45	146
	PSEI	down	32	145
	PWRX	down	64	230
	IPCO	down	53	153
	<b>ALL EIM</b>	<b>down</b>	<b>146</b>	<b>1,484</b>
<i>February</i>	AZPS	up	26	185
	CISO	up	117	1,701
	NEVP	up	32	152
	PACE	up	98	298
	PACW	up	47	137
	PGE	up	41	129
	PSEI	up	32	106
	PWRX	up	75	234

	IPCO	up	53	157
	<b>ALL EIM</b>	<b>up</b>	<b>266</b>	<b>1,823</b>
	AZPS	down	23	190
	CISO	down	143	1,349
	NEVP	down	22	152
	PACE	down	108	321
	PACW	down	28	119
	PGE	down	38	146
	PSEI	down	39	145
	PWRX	down	81	230
	IPCO	down	53	153
	<b>ALL EIM</b>	<b>down</b>	<b>207</b>	<b>1,484</b>
<i>March</i>	AZPS	up	33	185
	CISO	up	204	1,701
	NEVP	up	33	152
	PACE	up	93	298
	PACW	up	52	137
	PGE	up	39	129
	PSEI	up	44	106
	PWRX	up	66	234
	IPCO	up	47	157
	<b>ALL EIM</b>	<b>up</b>	<b>274</b>	<b>1,823</b>
	AZPS	down	21	190
	CISO	down	232	1,349
	NEVP	down	12	152
	PACE	down	98	321
	PACW	down	27	119
	PGE	down	44	146
	PSEI	down	43	145
PWRX	down	55	230	

	IPCO	down	53	153
	<b>ALL EIM</b>	<b>down</b>	<b>302</b>	<b>1,484</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.

	January		February		March	
<i>Direction</i>	Up	Down	Up	Down	Up	Down
<i>Average MW saving</i>	753	759	778	761	789	800
<i>Sum of BAA requirements</i>	1,649	1,648	1,692	1,747	1,782	1,853
<i>Percentage savings</i>	46%	46%	46%	44%	44%	43%

**Table 9: Flexible ramping procurement diversity savings in Q1 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 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. Since launching in November 2014, the Western EIM has produced gross economic benefits of \$650.26 million, demonstrating that utilities can realize cost benefits and reduce carbon emissions through increased coordination and optimization in the West.

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 346,649 metric tons of CO<sub>2</sub>, roughly the equivalent of avoiding the emissions from 72,881 passenger cars driven for one year.