California ISO

WESTERN EIM BENEFITS REPORT

Fourth Quarter 2021

Prepared by: Market Analysis and Forecasting

January 31, 2022

CONTENTS

EXECUTIVE SUMMARY

Gross benefits from EIM since November 2014

$1.93 billion

This report presents the benefits associated with participation in the Western Energy Imbalance Market (EIM).

The measured benefits of participation in the Western EIM include cost savings, increased integration of renewable energy, and improved operational efficiencies including the reduction of the need for real-time flexible reserves.

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

Q4 2021 Gross Benefits by Participant

	(millions $)
Arizona Public Service	$9.95
BANC	$31.44
California ISO	$55.50
Idaho Power	$7.09
LADWP	$10.60
NorthWestern Energy	$5.87
NV Energy	$9.38
PacifiCorp	$39.81
PNM	$3.44
Portland General Electric	$7.41
Powerex	-$0.02
Puget Sound Energy	$5.42
Salt River Project	$11.99
Seattle City Light	$4.65
TID	$1.61
Total	$204.14

*EIM Quarterly Benefit Report Methodology: https://www.westerneim.com/Documents/EIM-BenefitMethodology.pdf.

2021 Q4 BENEFITS

ECONOMICAL

$204.14 M

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

ENVIRONMENTAL

16,283

Metric tons of CO_2** avoided curtailments

OPERATIONAL

53%

Average reduction in flexibility reserves across the footprint

**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

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 in October 2016, and Portland General Electric began participating in October 2017. Idaho Power and Powerex began participating in April 2018, and the Balancing Authority of Northern California (BANC) began participating in April 2019. Seattle City Light and Salt River Project began participating in April 2020.

Most recently, new balancing authorities began participating in the Western EIM, with the Turlock Irrigation District (TID) in March 2021, the second phase of BANC in March 2021, and the Los Angeles Department of Water and Power (LADWP) and Public Service Company of New Mexico (PNM) in April 2021, followed by NorthWestern Energy (NWMT) starting in June 2021.

The Western EIM footprint now includes portions of Arizona, California, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming, and extends to the border with Canada.

WESTERN EIM ECONOMIC BENEFITS IN Q4 2021

Table 1 shows the estimated EIM gross benefits by each region per month[1]. The monthly savings presented show $87.62 million for October, $54.74 million for November, and $61.78 million for December with a total estimated benefit of $204.14 million for this quarter[2][3]. This level of EIM benefits accrued from having additional EIM areas participating in the market and economical transfers displacing more expensive generation. The benefits accrued in 2021 totaled $738.9 million.

[1] 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 points of the total intervals.
[2] For several quarterly estimates, CAISO benefits have been calculated on a variation of the counterfactual methodology. For CAISO only the logic has considered offline resources as part of the bid stack in the counterfactual. In Q4 2021, CAISO has identified some questionable results that drove persistent negative benefits for CAISO when considering offline resources. Consequently this logic has been not used for Q4 CAISO benefits in the meantime CAISO further asses this logic component. With this approach the counterfactual calculation for CAISO follows the same methodology applicable to all EIM entities.
[3] There were negative EIM benefits for Powerex due to small price variations from congestion effects between the EIM cost and the counterfactual costs. The EIM market fully accounts and prices for the effects of energy, congestion and losses while the counterfactual is an estimate based only on energy prices.

Region	October	November	December	Total
APS	$3.71	$3.11	$3.13	$9.95
BANC	$9.95	$11.79	$9.70	$31.44
CISO	$37.43	$5.00	$13.07	$55.50
IPCO	$2.28	$2.76	$2.05	$7.09
LADWP	$4.68	$2.90	$3.02	$10.60
NVE	$2.87	$3.37	$3.14	$9.38
NWMT	$1.79	$2.22	$1.86	$5.87
PAC	$13.53	$13.15	$13.13	$39.81
PGE	$2.56	$2.13	$2.72	$7.41
PNM	$0.49	$1.68	$1.27	$3.44
PSE	$1.58	$1.71	$2.13	$5.42
PWRX	-$0.09	-$0.13	$0.20	-$0.02
SCL	$1.38	$1.59	$1.68	$4.65
SRP	$4.86	$2.98	$4.15	$11.99
TID	$0.60	$0.48	$0.53	$1.61
Total	$87.62	$54.74	$61.78	$204.14

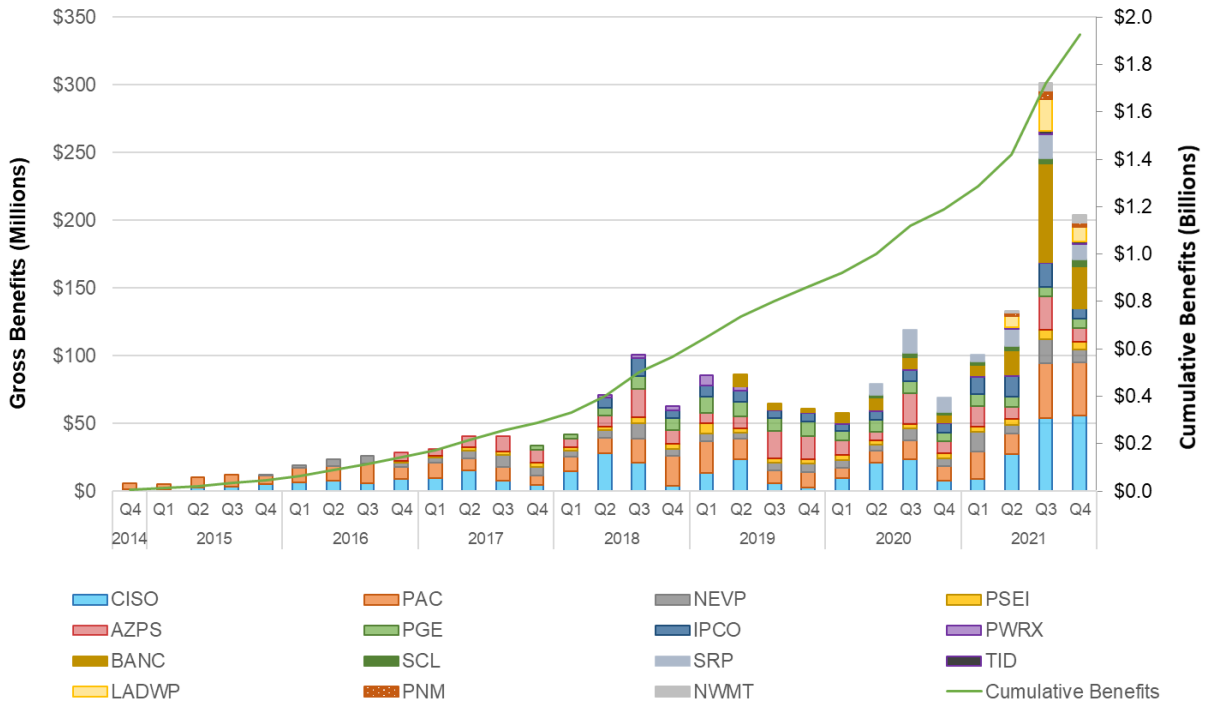
TABLE 1: Q4 2021 benefits in millions USD

CUMULATIVE ECONOMIC BENEFITS SINCE INCEPTION

Since the start of the EIM in November 2014, the cumulative economic benefits of the market have totaled $1.93 billion. The quarterly benefits have grown over time as a result of the participation of new BAAs, which results in benefits for both the individual BAA but also compounds the benefits to adjacent BAAs through additional transfers. The ISO began publishing quarterly EIM benefit reports in April 2015.[4]

Graph 1 illustrates the gross economic benefits of the EIM by quarter for each participating BAA.

[4] Prior reports are available at https://www.westerneim.com/Pages/About/QuarterlyBenefits.aspx



GRAPH 1: Cumulative economic benefits for each quarter by BAA

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 2 below.

Month	From BAA	To BAA	15min EIM transfer (15m – base)	5min EIM transfer (5m – base)
October	AZPS	CISO	126,718	95,247
	AZPS	LADWP	23,564	23,724
	AZPS	NEVP	5,178	6,691
	AZPS	PACE	5,448	6,430
	AZPS	PNM	29,136	33,129
	AZPS	SRP	47,541	48,839
	BANC	CISO	19,948	14,544
	BANC	TIDC	113	200
	CISO	AZPS	9,057	11,044
	CISO	BANC	63,826	78,042
	CISO	LADWP	57,014	75,039
	CISO	NEVP	9,693	14,486
	CISO	PACW	0	3,125
	CISO	PGE	1,915	5,895
	CISO	PWRX	73,389	16,712
	CISO	SRP	53,548	67,826
	CISO	TIDC	30,677	31,673
	IPCO	NEVP	52,571	32,273
	IPCO	NWMT	0	1
	IPCO	PACE	7,187	4,584
	IPCO	PACW	68,875	79,249
	IPCO	PSEI	3,959	4,000
	IPCO	SCL	6,511	5,968

	LADWP	AZPS	1,560	1,770
	LADWP	CISO	133,723	103,311
	LADWP	NEVP	9,125	11,045
	LADWP	PACE	36,789	42,820
	NEVP	AZPS	1,979	1,628
	NEVP	CISO	152,236	108,835
	NEVP	IPCO	21,807	25,021
	NEVP	LADWP	45,032	46,058
	NEVP	PACE	925	1,612
	NWMT	IPCO	24,406	23,294
	NWMT	PACE	4,199	3,500
	NWMT	PACW	0	5
	NWMT	PGE	18	55
	NWMT	PSEI	25	42
	PACE	AZPS	144,903	143,801
	PACE	IPCO	83,161	97,022
	PACE	LADWP	91,731	81,717
	PACE	NEVP	153,423	140,279
	PACE	NWMT	2,447	885
October	PACE	PACW	17,211	23,342
	PACE	SRP	0	0
	PACW	CISO	16,227	35,010
	PACW	IPCO	33,564	18,648
	PACW	NWMT	0	5
	PACW	PGE	64,254	71,792
	PACW	PSEI	27,835	21,528
	PACW	SCL	870	622
	PGE	CISO	22,073	628

	PGE	NWMT	39	49
	PGE	PACW	19,823	23,770
	PGE	PSEI	0	0
	PGE	SCL	863	680
	PNM	AZPS	22,668	20,019
	PNM	SRP	0	0
	PSEI	IPCO	0	0
	PSEI	NWMT	12	42
	PSEI	PACW	0	0
	PSEI	PGE	0	0
	PSEI	PWRX	19,936	20,714
	PSEI	SCL	17,936	20,106
	PWRX	CISO	0	571
	PWRX	PSEI	6,681	7,794
	SCL	IPCO	7,440	8,950
	SCL	PACW	1,458	1,891
	SCL	PGE	1,997	2,371
	SCL	PSEI	8,950	10,177
	SRP	AZPS	18,992	17,278
	SRP	CISO	115,398	106,186
	SRP	PACE	0	0
	SRP	PNM	1,931	3,171
	TIDC	BANC	24	153
	TIDC	CISO	14,808	13,117
November	AZPS	CISO	104,205	75,933
	AZPS	LADWP	11,246	12,165
	AZPS	NEVP	3,498	3,142
	AZPS	PACE	6,248	5,610

	AZPS	PNM	31,753	30,710
	AZPS	SRP	23,178	22,748
	BANC	CISO	2,220	1,650
	BANC	TIDC	20	88
	CISO	AZPS	17,693	21,769
	CISO	BANC	114,241	138,041
	CISO	LADWP	25,232	35,924
	CISO	NEVP	17,405	14,661
	CISO	PACW	2,980	14,664
	CISO	PGE	11,986	6,649
	CISO	PWRX	98,295	21,741
	CISO	SRP	30,491	40,835
	CISO	TIDC	18,992	21,176
	IPCO	NEVP	41,632	27,786
	IPCO	NWMT	2,166	1,651
	IPCO	PACE	7,240	5,327
	IPCO	PACW	42,402	47,884
	IPCO	PSEI	0	0
	IPCO	SCL	6,056	6,908
	LADWP	AZPS	4,208	5,613
	LADWP	CISO	135,486	100,422
	LADWP	NEVP	5,930	5,983
	LADWP	PACE	17,286	21,691
November	NEVP	AZPS	6,507	7,031
	NEVP	CISO	148,978	101,253
	NEVP	IPCO	36,622	36,686
	NEVP	LADWP	19,841	24,145
	NEVP	PACE	1,117	1,296

	NWMT	IPCO	16,653	20,962
	NWMT	PACE	5,976	2,991
	NWMT	PACW	62	77
	NWMT	PGE	9	86
	NWMT	PSEI	56	81
	PACE	AZPS	102,288	100,270
	PACE	IPCO	93,119	116,384
	PACE	LADWP	108,195	99,891
	PACE	NEVP	128,747	116,462
	PACE	NWMT	12,050	15,109
	PACE	PACW	24,858	36,049
	PACE	SRP	0	0
	PACW	CISO	54,142	42,294
November	PACW	IPCO	36,762	25,026
	PACW	NWMT	0	4
	PACW	PGE	65,825	74,364
	PACW	PSEI	28,713	28,753
	PACW	SCL	969	933
	PGE	CISO	37,222	565
	PGE	NWMT	519	118
	PGE	PACW	17,942	20,014
	PGE	PSEI	2,810	3,398
	PGE	SCL	966	967
	PNM	AZPS	29,247	29,338
	PNM	SRP	0	0
	PSEI	IPCO	0	0
	PSEI	NWMT	16	25
	PSEI	PACW	27,184	33,199

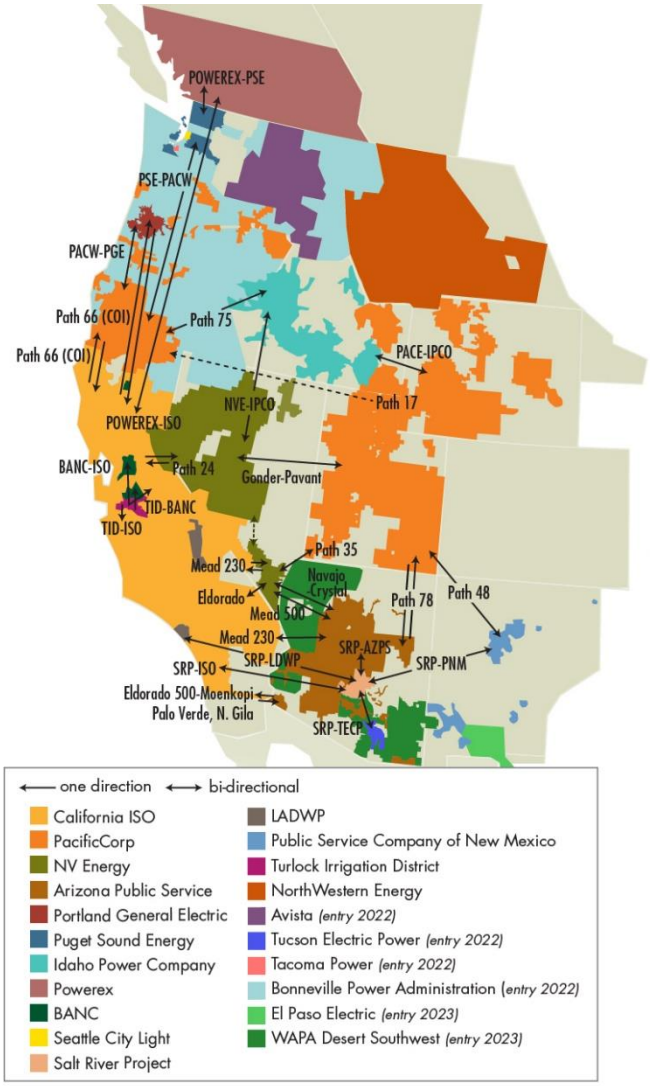
	PSEI	PGE	7,586	8,679
	PSEI	PWRX	22,889	22,224
	PSEI	SCL	16,265	17,510
	PWRX	CISO	0	442
	PWRX	PSEI	5,372	7,101
	SCL	IPCO	8,769	7,642
	SCL	PACW	956	1,185
	SCL	PGE	2,112	2,354
	SCL	PSEI	25,917	26,330
	SRP	AZPS	29,530	28,095
	SRP	CISO	84,284	72,394
	SRP	PACE	0	0
	SRP	PNM	1,857	2,649
	TIDC	BANC	2,286	1,985
	TIDC	CISO	9,732	5,567
December	AZPS	CISO	85,385	58,979
	AZPS	LADWP	9,874	11,809
	AZPS	NEVP	8,074	12,620
	AZPS	PACE	6,239	10,617
	AZPS	PNM	53,480	47,956
	AZPS	SRP	15,330	17,701
	BANC	CISO	12,456	6,719
	BANC	TIDC	51	488
	CISO	AZPS	27,797	35,313
	CISO	BANC	89,230	112,811
	CISO	LADWP	30,622	43,740
	CISO	NEVP	26,410	31,965
	CISO	PACW	10,863	29,855

	CISO	PGE	6,603	11,285
	CISO	PWRX	21,054	10,071
	CISO	SRP	36,605	48,050
	CISO	TIDC	9,674	11,570
	IPCO	NEVP	34,783	21,240
	IPCO	NWMT	921	1,212
	IPCO	PACE	3,172	2,663
	IPCO	PACW	46,462	44,975
	IPCO	PSEI	0	0
	IPCO	SCL	4,248	4,588
	LADWP	AZPS	7,730	6,581
	LADWP	CISO	92,737	56,678
	LADWP	NEVP	6,211	8,254
	LADWP	PACE	17,132	27,634
	NEVP	AZPS	14,664	13,940
	NEVP	CISO	137,125	79,328
	NEVP	IPCO	46,632	53,305
	NEVP	LADWP	23,009	34,544
	NEVP	PACE	3,406	3,670
	NWMT	IPCO	20,427	20,816
	NWMT	PACE	8,820	5,482
	NWMT	PACW	46	24
	NWMT	PGE	45	56
	NWMT	PSEI	8	43
December	PACE	AZPS	58,186	52,146
	PACE	IPCO	89,195	99,725
	PACE	LADWP	91,985	74,351
	PACE	NEVP	165,210	141,369

December	PACE	NWMT	10,412	14,236
	PACE	PACW	27,028	39,355
	PACE	SRP	0	0
	PACW	CISO	58,589	34,744
	PACW	IPCO	26,405	20,960
	PACW	NWMT	2	252
	PACW	PGE	42,828	48,863
	PACW	PSEI	18,166	17,755
	PACW	SCL	716	600
	PGE	CISO	32,808	688
	PGE	NWMT	27	284
	PGE	PACW	39,354	37,772
	PGE	PSEI	0	0
	PGE	SCL	1,010	862
	PNM	AZPS	22,283	21,475
	PNM	SRP	0	0
	PSEI	IPCO	0	0
	PSEI	NWMT	15	68
	PSEI	PACW	47,668	49,857
	PSEI	PGE	0	0
	PSEI	PWRX	11,057	11,876
	PSEI	SCL	16,547	17,112
	PWRX	CISO	0	479
	PWRX	PSEI	16,366	16,174
	SCL	IPCO	11,799	11,041
	SCL	PACW	1,377	1,582
	SCL	PGE	1,717	1,993
	SCL	PSEI	14,182	15,476

SRP	AZPS	32,980	34,603
SRP	CISO	106,135	96,060
SRP	PACE	0	0
SRP	PNM	3,553	5,184
TIDC	BANC	79	150
TIDC	CISO	14,395	11,401

TABLE 2: Energy transfers (MWh) in the FMM and RTD markets for Q4 2021



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
BANC <–> ISO	2,000-4,000
TID to ISO	1,400
TID to BANC	650
Path 48	2,100
SRP <–> TEPC	9,988
SRP <–> PNM	400
SRP <–> AZPS	10,021
SRP <–> ISO	14,488
SRP <–> LDWP	349

[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 January 2022

GRAPH 2: Estimated maximum transfer capacity (EIM entities operating in Q4 2021)

WHEEL THROUGH TRANSFERS

As the footprint of the Western EIM grows, wheel-through transfers may become more common. 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.

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.

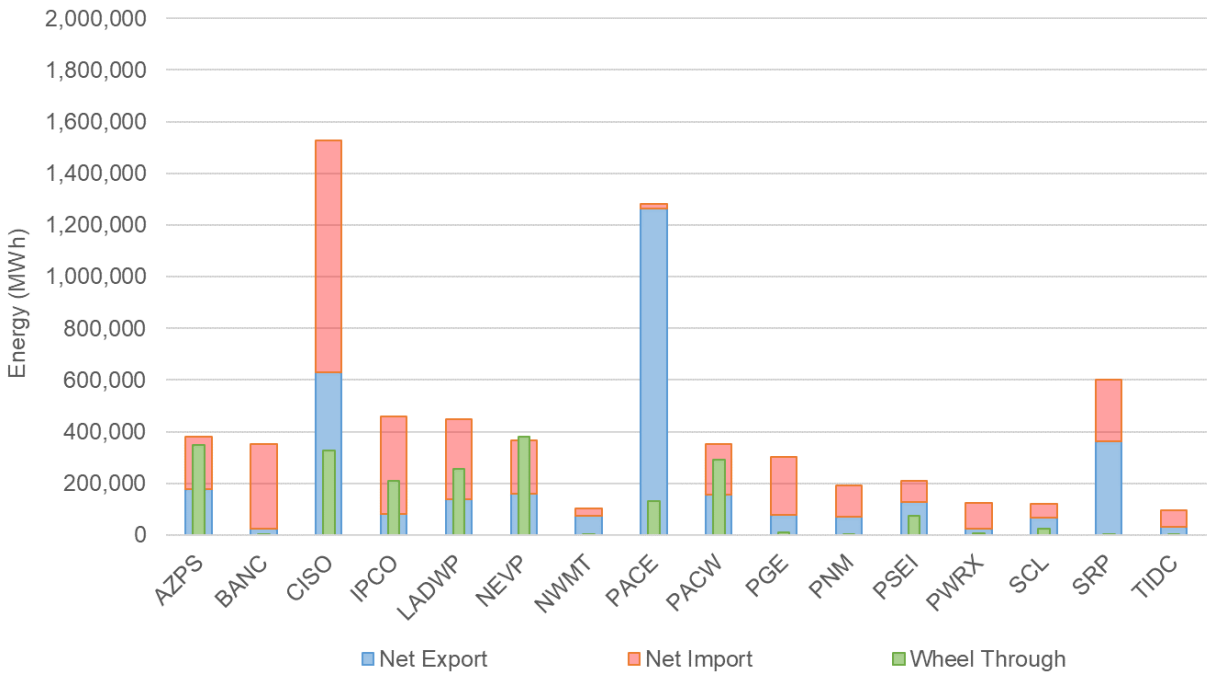
This volume reflects the total wheel-through transfers for each EIM BAA, regardless of the potential paths used to wheel through. The net imports and exports estimated in this section reflect the overall volume of net imports and exports; in contrast, the imports and exports provided in Table 2 reflect 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 Graphs 3 through 6.

BAA	*Net Export*	*Net Import*	*Wheel Through*
AZPS	176,908	204,314	348,075
BANC	23,010	330,987	703
CISO	628,521	897,656	326,830
IPCO	81,067	377,181	209,501

LADWP	137,939	309,628	254,405
NEVP	158,684	209,032	380,011
NWMT	73,879	30,252	3,740
PACE	1,263,130	18,339	131,309
PACW	154,857	196,962	291,736
PGE	78,381	223,041	11,705
PNM	70,534	122,714	341
PSEI	126,317	83,156	75,604
PWRX	25,999	97,117	6,591
SCL	67,429	53,283	23,707
SRP	361,538	241,690	4,628
TIDC	31,895	64,738	513

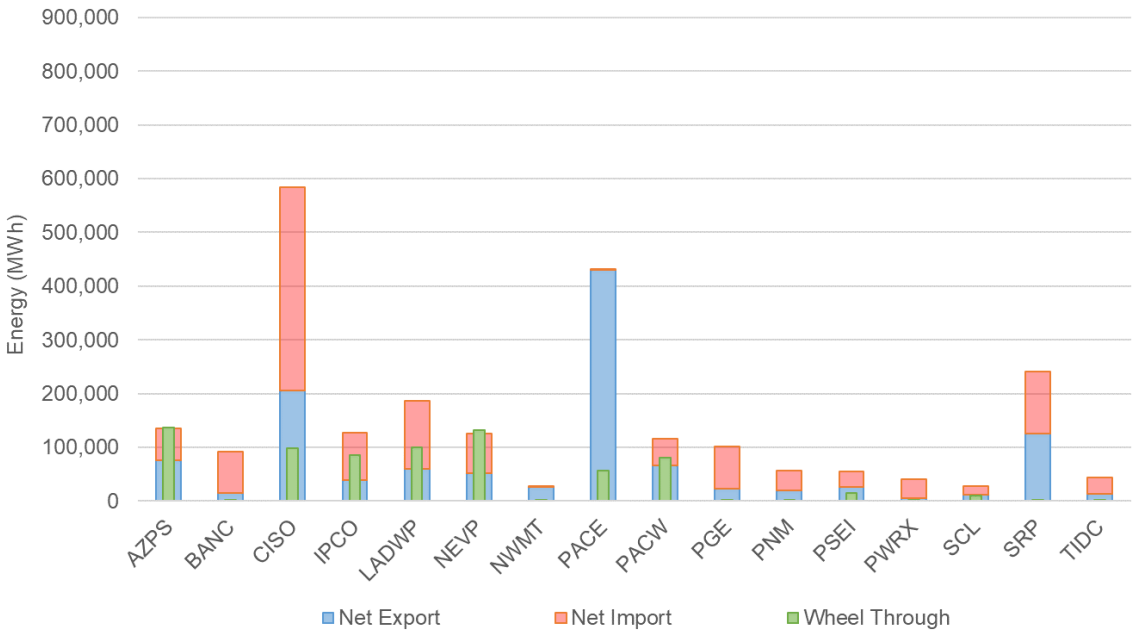
TABLE 3: Estimated wheel-through transfers in Q4 2021



GRAPH 3: Estimated wheel-through transfers in Q4 2021

BAA	Net Export	Net Import	Wheel-Through
AZPS	76,885	58,116	137,748
BANC	14,564	78,087	196
CISO	205,362	379,327	98,986
IPCO	39,911	87,120	86,210
LADWP	59,334	126,986	99,971
NEVP	51,791	73,373	131,593
NWMT	26,316	342	642
PACE	430,340	2,157	57,547
PACW	66,898	50,001	81,656
PGE	23,076	77,940	2,255
PNM	19,956	36,381	65
PSEI	25,992	28,569	14,997
PWRX	5,953	35,242	2,424
SCL	12,358	16,393	11,070
SRP	125,755	115,849	1,120
TIDC	13,114	31,722	167

TABLE 4: Estimated wheel-through transfers in October 2021

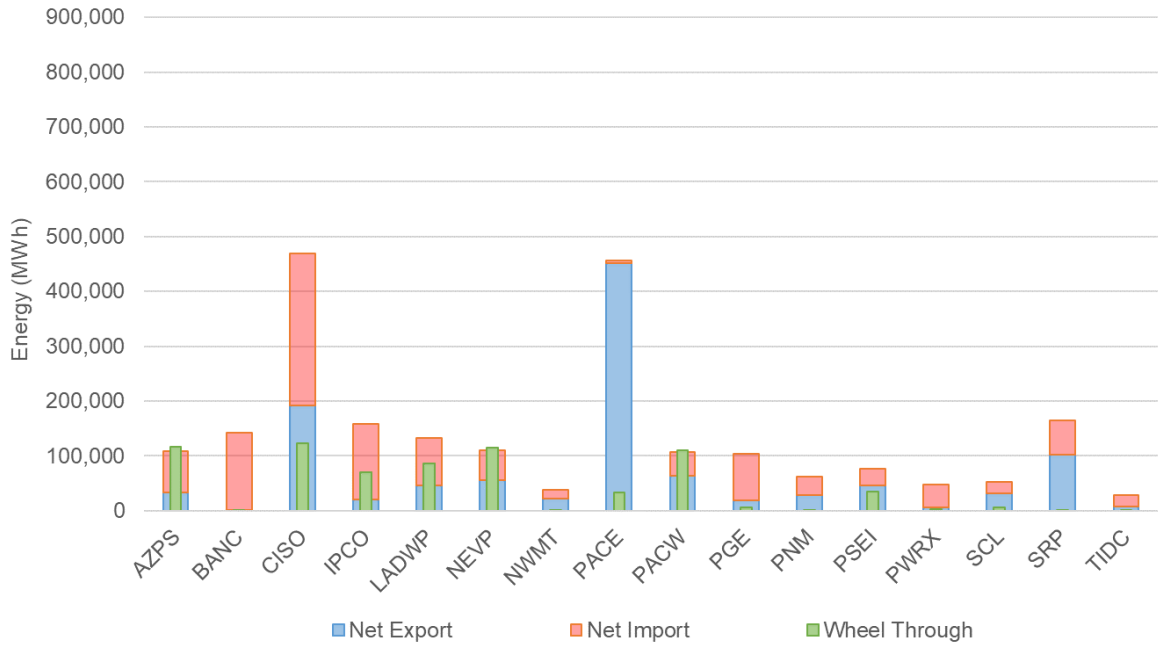


GRAPH 4: Estimated wheel-through transfers in October 2021

BAA	Net Export	Net Import	Wheel- Through
AZPS	33,749	75,597	116,779
BANC	1,636	140,204	101
CISO	192,248	277,032	123,743
IPCO	20,119	137,645	69,644
LADWP	46,870	85,485	86,978
NEVP	55,859	53,896	114,634
NWMT	22,363	15,065	1,864
PACE	451,227	5,318	33,865
PACW	63,652	42,986	110,422
PGE	18,684	85,829	6,412
PNM	29,298	33,403	43
PSEI	46,541	30,395	35,321
PWRX	5,454	41,955	2,106
SCL	32,139	20,944	5,412

SRP	101,854	62,200	1,396
TIDC	7,377	21,117	175

TABLE 5: Estimated wheel-through transfers in November 2021

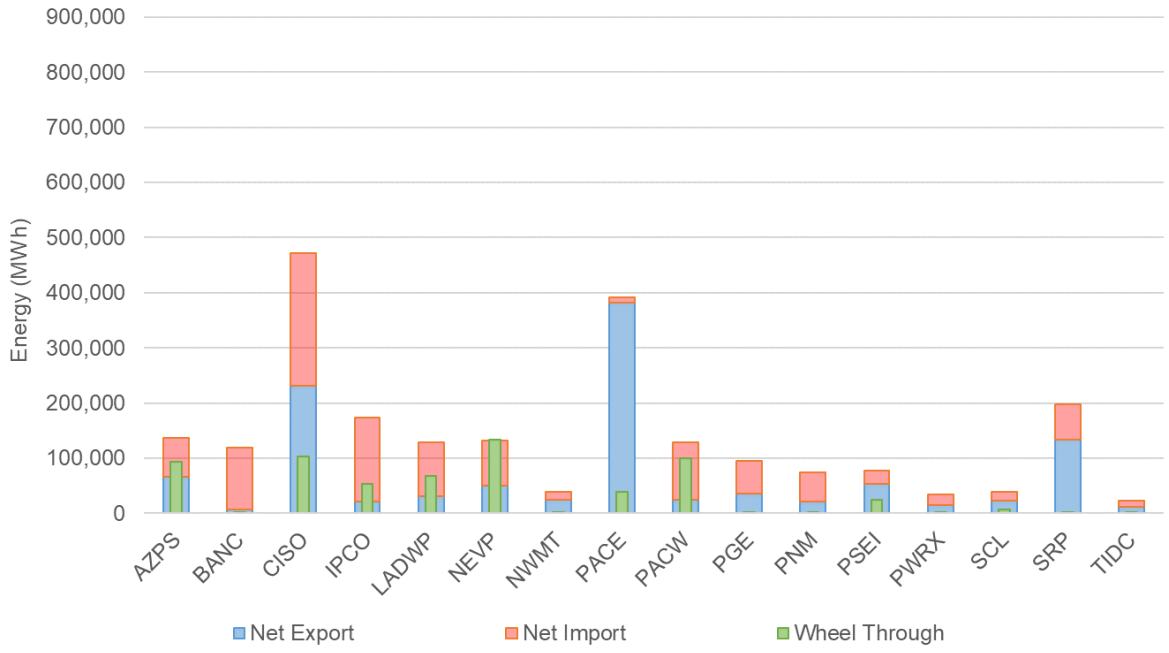


GRAPH 5: Estimated wheel-through transfers in November 2021

BAA	Net Export	Net Import	Wheel Through
AZPS	66,275	70,601	93,547
BANC	6,810	112,696	406
CISO	230,910	241,296	104,101
IPCO	21,037	152,416	53,647
LADWP	31,735	97,157	67,456
NEVP	51,034	81,764	133,784
NWMT	25,199	14,845	1,234
PACE	381,563	10,864	39,898
PACW	24,307	103,974	99,658
PGE	36,620	59,272	3,039

PNM	21,280	52,930	232
PSEI	53,784	24,192	25,286
PWRX	14,592	19,919	2,061
SCL	22,932	15,946	7,225
SRP	133,929	63,640	2,112
TIDC	11,404	11,899	172

TABLE 6: Estimated wheel-through transfers in December 2021



GRAPH 6: Estimated wheel-through transfers in December 2021

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 Q4 2021 was calculated to be 12,075 MWh (October) + 12,817 MWh (November) + 13,152 MWh (December) = 38,044 MWh total.

There are environmental benefits of avoided renewable curtailment as well. 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 16,283 metric tons of CO_2 for Q4 2021. 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 in the ISO footprint, along with the associated reductions in CO_2, are shown in Table 7.

Year	Quarter	MWh	Eq. Tons CO_2
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
	4	35,254	15,089
2020	1	86,740	37,125
	2	147,514	63,136
	3	37,548	16,071
	4	39,956	17,101
2021	1	76,147	32,591
	2	109,059	46,677

	3	23,042	9,862
	4	38,044	16,283
Total		1,570,200	671,966

TABLE 7: Total reduction in curtailment of renewable energy and 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 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
October	*AZPS*	up	0	345
	BANC	up	0	89
	CISO	up	0	2,669
	IPCO	up	0	183
	LADWP	up	0	230
	NEVP	up	0	360
	NWMT	up	0	141
	PACE	up	0	568
	PACW	up	0	182
	PGE	up	0	237
	PNM	up	0	171
	PSEI	up	0	160
	PWRX	up	0	251
	SCL	up	0	36
	SRP	up	0	210
	TIDC	up	0	14
	ALL EIM	**up**	**0**	**2,917**

October	*AZPS*	down	0	404
	BANC	down	0	86
	CISO	down	0	1,122
	IPCO	down	0	200
	LADWP	down	0	269
	NEVP	down	0	469
	NWMT	down	0	173
	PACE	down	0	591
	PACW	down	0	181
	PGE	down	0	215
	PNM	down	0	200
	PSEI	down	0	200
	PWRX	down	0	300
	SCL	down	0	35
	SRP	down	0	382
	TIDC	down	0	15
	ALL EIM	**down**	**0**	**1,413**
November	*AZPS*	up	29	345
	BANC	up	7	89
	CISO	up	337	2,669
	IPCO	up	36	192
	LADWP	up	30	230
	NEVP	up	27	360
	NWMT	up	26	156
	PACE	up	98	612
	PACW	up	36	182
	PGE	up	35	237
	PNM	up	44	171
	PSEI	up	35	192
	PWRX	up	71	286
	SCL	up	4	37

	SRP	up	31	210
	TIDC	up	2	12
	ALL EIM	**up**	**462**	**2,917**
	AZPS	down	32	403
	BANC	down	4	92
	CISO	down	186	1,122
	IPCO	down	44	178
	LADWP	down	29	238
	NEVP	down	18	350
	NWMT	down	36	149
	PACE	down	111	582
November	*PACW*	down	51	180
	PGE	down	46	215
	PNM	down	36	194
	PSEI	down	51	200
	PWRX	down	75	300
	SCL	down	1	35
	SRP	down	16	382
	TIDC	down	1	15
	ALL EIM	**down**	**269**	**1,413**
December	*AZPS*	up	24	276
	BANC	up	8	82
	CISO	up	307	2,445
	IPCO	up	32	192
	LADWP	up	27	230
	NEVP	up	21	326
	NWMT	up	26	156
	PACE	up	83	612
	PACW	up	57	182
	PGE	up	32	214
	PNM	up	34	171

December	*PSEI*	up	36	192
	PWRX	up	78	286
	SCL	up	4	37
	SRP	up	23	128
	TIDC	up	2	14
	ALL EIM	**up**	**409**	**2,917**
	AZPS	down	27	300
	BANC	down	4	92
	CISO	down	193	1,122
	IPCO	down	48	190
	LADWP	down	26	262
	NEVP	down	11	347
	NWMT	down	37	149
	PACE	down	103	459
	PACW	down	60	181
	PGE	down	36	210
	PNM	down	43	161
	PSEI	down	35	200
	PWRX	down	71	300
	SCL	down	5	35
	SRP	down	22	154
	TIDC	down	1	15
	ALL EIM	**down**	**259**	**1,413**

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 individual BAA requirements.

	October		**November**		**December**	
Direction	Up	Down	Up	Down	Up	Down

Average MW saving	1,258	1,322	1,214	1,304	1,175	1,224
Sum of BAA requirements	2,597	2,195	2,546	2,249	2,462	2,162
Percentage savings	48%	60%	48%	58%	48%	57%

Table 9: Flexible ramping procurement diversity savings in Q4 2021

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

Using state-of-the-art technology to find and deliver low-cost energy to meet real-time demand, the Western EIM demonstrates that utilities can realize financial and operational benefits through increased coordination and optimization. In addition to these benefits, the Western EIM provides significant environmental benefits through the reduction of renewable curtailments during periods of oversupply.

Sharing resources across a larger geographic area reduces greenhouse gas emissions by using renewable generation that otherwise would have been turned off. The quantified environmental benefits from avoided curtailments of renewable generation from 2015 to-date reached 671,966 metric tons of CO_2, roughly the equivalent of avoiding the emissions from 141,278 passenger cars driven for one year.

APPENDIX 1: GLOSSARY OF ABBREVIATIONS

Abbreviation	Description
APS	Arizona Public Service
BAA	Balancing Authority Area
BANC	Balancing Authority of Northern California
CISO, ISO	California ISO
EIM	Energy Imbalance Market
FMM	Fifteen Minute Market
GHG	Greenhouse Gas
IPCO	Idaho Power
MW	Megawatt
MWh	Megawatt-Hour
NVE	NV Energy
PAC	PacifiCorp
PACE	PacifiCorp East
PACW	PacifiCorp West
PGE	Portland General Electric
PSE	Puget Sound Energy
PWRX	Powerex
RTD	Real Time Dispatch
SCL	Seattle City Light
SRP	Salt River Project
TID	Turlock Irrigation District