

Western Energy Imbalance Market Benefits
Fourth Quarter 2022

January 31, 2023

CONTENTS

EXECUTIVE SUMMARY 3

BACKGROUND 4

WEIM ECONOMIC BENEFITS IN Q4 2022 4

 CUMULATIVE ECONOMIC BENEFITS SINCE INCEPTION..... 5

 INTER-REGIONAL TRANSFERS 6

 WHEEL-THROUGH TRANSFERS..... 22

REDUCED RENEWABLE CURTAILMENT AND GHG REDUCTIONS..... 29

FLEXIBLE RAMPING PROCUREMENT DIVERSITY SAVINGS 31

CONCLUSION..... 36

APPENDIX 1: GLOSSARY OF ABBREVIATIONS 37

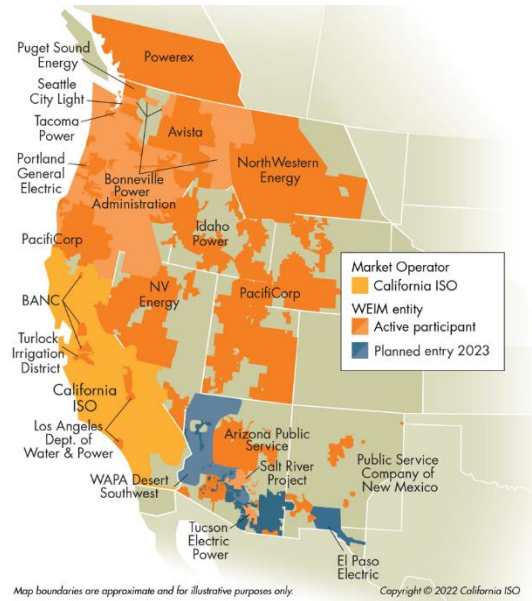
EXECUTIVE SUMMARY

Gross benefits from WEIM since November 2014
\$3.40 billion

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

The measured benefits of participation in the WEIM 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 WEIM footprint with diverse resources and geography.



2022
Q4 BENEFITS

Q4 2022 Gross Benefits by Participant

	(millions \$)
Arizona Public Service	\$34.87
Avista	\$9.73
BANC	\$83.44
BPA	\$12.96
California ISO	\$88.53
Idaho Power	\$17.18
LADWP	\$25.17
NV Energy	\$42.33
NorthWestern Energy	\$12.95
PacifiCorp	\$53.87
Portland General Electric	\$21.11
PNM	\$11.55
Puget Sound Energy	\$14.81
Powerex	\$3.45
Seattle City Light	\$4.71
Salt River Project	\$31.04
Tacoma Power	\$4.07
TEP	\$11.21
TID	\$2.31
Total	\$485.29

ECONOMICAL

\$485.29 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

10,960

Metric tons of CO₂** avoided curtailments

OPERATIONAL

58%

Average reduction in flexibility reserves across the footprint

*WEIM Quarterly Benefit Report Methodology: <https://www.westerneim.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 WEIM. 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.

In 2021, 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.

Avista Utilities (AVA) and Tacoma Power (TPWR), two utilities serving a combined 600,000 electric customers in the Pacific Northwest, became the newest members of the WEIM, with both beginning their participation on March 2, 2022. On May 3, 2022, the Bonneville Power Administration (BPA) and Tucson Electric Power (TEP) both joined the WEIM.

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.

■ WEIM ECONOMIC BENEFITS IN Q4 2022

Table 1 shows the estimated WEIM gross benefits by each region per month¹. The monthly savings presented show \$99.25 million for October, \$129.34 million for November, and \$256.70 million for December with a total estimated benefit of \$485.29 million for this quarter². This level of WEIM benefits accrued from having additional WEIM areas participating in the market and economical transfers displacing more expensive generation.

¹ The WEIM 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 were calculated on a variation of the counterfactual methodology. For CAISO only the logic had considered offline resources as part of the bid stack in the counterfactual. In Q4 2021, CAISO identified some questionable results that drove persistent negative benefits for CAISO when considering offline resources. Since Q4 2021, the benefit calculation for CAISO area follows the same methodology applicable to all WEIM entities in which only online resources are used.

<i>Region</i>	October	November	December	Total
<i>APS</i>	\$4.68	\$3.32	\$26.87	\$34.87
<i>AVA</i>	\$1.60	\$2.43	\$5.70	\$9.73
<i>BANC</i>	\$13.91	\$24.57	\$44.96	\$83.44
<i>BPA</i>	\$2.15	\$2.24	\$8.57	\$12.96
<i>CISO</i>	\$26.39	\$40.63	\$21.51	\$88.53
<i>IPCO</i>	\$3.92	\$4.00	\$9.26	\$17.18
<i>LADWP</i>	\$3.72	\$6.74	\$14.71	\$25.17
<i>NVE</i>	\$7.38	\$9.69	\$25.26	\$42.33
<i>NWMT</i>	\$2.83	\$1.68	\$8.44	\$12.95
<i>PAC</i>	\$12.40	\$10.85	\$30.62	\$53.87
<i>PGE</i>	\$3.73	\$4.67	\$12.71	\$21.11
<i>PNM</i>	\$2.19	\$2.50	\$6.86	\$11.55
<i>PSE</i>	\$2.11	\$2.60	\$10.10	\$14.81
<i>PWRX</i>	\$0.52	\$0.18	\$2.75	\$3.45
<i>SCL</i>	\$0.97	\$1.07	\$2.67	\$4.71
<i>SRP</i>	\$6.63	\$8.51	\$15.90	\$31.04
<i>TPWR</i>	\$0.59	\$0.95	\$2.53	\$4.07
<i>TEP</i>	\$3.01	\$1.90	\$6.30	\$11.21
<i>TID</i>	\$0.52	\$0.81	\$0.98	\$2.31
Total	\$99.25	\$129.34	\$256.70	\$485.29

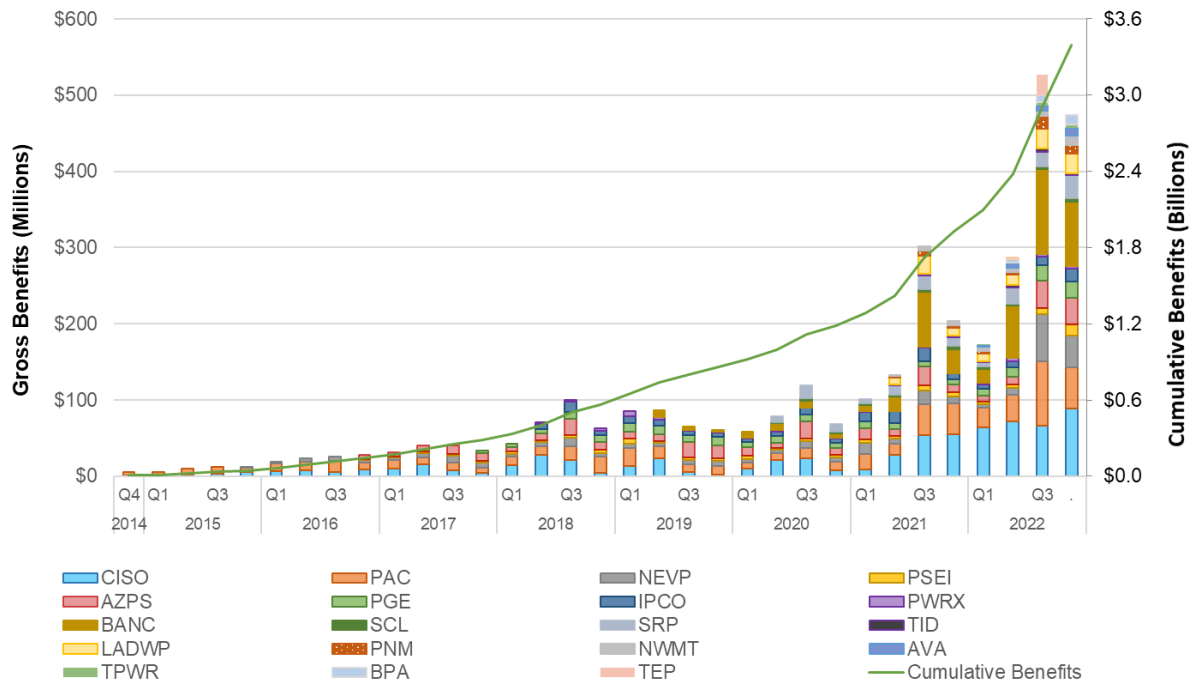
TABLE 1: Q4 2022 benefits in millions USD

■ CUMULATIVE ECONOMIC BENEFITS SINCE INCEPTION

Since the start of the WEIM in November 2014, the cumulative economic benefits of the market have totaled \$3.40 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 WEIM benefit reports in April 2015.³

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

³ 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 WEIM. 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 WEIM, 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 WEIM transfer volumes with base schedule transfers excluded. The WEIM 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 WEIM. 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 WEIM. The 5-minute transfer volume is the result of optimization using all bids and base schedules submitted into WEIM, based on unit commitments determined in the 15-minute market optimization. The maximum transfer capacities between WEIM entities are shown in Graph 2 below.

Month	From BAA	To BAA	15min WEIM transfer (15m – base)	5min WEIM transfer (5m – base)
October	AVA	BPAT	15,158	12,587
	AVA	CISO	0	0
	AVA	IPCO	26,459	30,539
	AVA	NWMT	1,270	1,446
	AVA	PACW	1,320	1,715
	AVA	PGE	0	0
	AVA	PSEI	48	0
	AVA	SCL	3	0
	AVA	TPWR	0	0
	AZPS	CISO	192,466	157,183
	AZPS	LADWP	21,821	24,761
	AZPS	NEVP	4,788	7,232
	AZPS	PACE	18,644	12,065
	AZPS	PNM	7,838	11,773
	AZPS	SRP	6,054	4,026
	AZPS	TEPC	14,440	16,207
	BANC	BPAT	0	0
	BANC	CISO	975	2,168
	BANC	TIDC	32	0
	BPAT	AVA	7,866	9,835
BPAT	BANC	0	0	
BPAT	CISO	22,265	28,438	
BPAT	IPCO	1,871	0	

<i>October</i>	BPAT	LADWP	0	0	
	BPAT	NEVP	0	0	
	BPAT	NWMT	5,158	3,882	
	BPAT	PACW	1,618	2,544	
	BPAT	PGE	18,376	19,890	
	BPAT	PSEI	15,371	13,882	
	BPAT	PWRX	3,154	116	
	BPAT	SCL	2,308	2,148	
	BPAT	TPWR	7,834	8,742	
	CISO	AVA	0	0	
	CISO	AZPS	10,968	10,765	
	CISO	BANC	176,979	181,497	
	CISO	BPAT	29,414	37,685	
	CISO	LADWP	32,588	41,322	
	CISO	NEVP	7,163	9,378	
	CISO	PACW	3,856	23,974	
	CISO	PGE	19,121	32,229	
	CISO	PWRX	182,958	202,784	
	CISO	SRP	39,021	47,568	
	CISO	TEPC	0	50	
	CISO	TIDC	2,904	3,495	
	IPCO	AVA	18,149	15,602	
	IPCO	BPAT	1,447	24	
	IPCO	NEVP	17,199	15,814	
	IPCO	NWMT	129	329	
	IPCO	PACE	3,919	2,623	
	IPCO	PACW	19,330	16,217	
	<i>October</i>	IPCO	PSEI	0	0

<i>October</i>	IPCO	SCL	3,050	2,414
	LADWP	AZPS	1,020	783
	LADWP	BPAT	0	0
	LADWP	CISO	72,253	60,516
	LADWP	NEVP	13,252	14,137
	LADWP	PACE	36,626	40,015
	LADWP	TEPC	0	0
	NEVP	AZPS	2,331	2,585
	NEVP	BPAT	0	0
	NEVP	CISO	151,640	113,102
	NEVP	IPCO	80,489	71,536
	NEVP	LADWP	51,010	56,748
	NEVP	PACE	9,150	5,830
	NWMT	AVA	17,794	16,950
	NWMT	BPAT	16,143	11,477
	NWMT	IPCO	26,879	29,525
	NWMT	PACE	10,900	6,778
	NWMT	PACW	46	0
	NWMT	PGE	2	0
	NWMT	PSEI	0	0
	NWMT	TPWR	1,668	1,410
	PACE	AZPS	60,262	64,728
	PACE	IPCO	116,013	124,712
	PACE	LADWP	38,487	33,775
	PACE	NEVP	58,737	55,391
	PACE	NWMT	12,863	10,755
	PACE	PACW	29,618	25,279
	<i>October</i>	PACE	SRP	0

<i>October</i>	PACE	TEPC	702	2,084
	PACW	AVA	2,440	2,992
	PACW	BPAT	6,910	6,058
	PACW	CISO	41,606	59,413
	PACW	IPCO	15,321	19,077
	PACW	NWMT	0	0
	PACW	PGE	38,473	33,653
	PACW	PSEI	23,217	20,909
	PACW	SCL	1,460	1,189
	PGE	AVA	0	0
	PGE	BPAT	40,539	38,923
	PGE	CISO	18,375	16,560
	PGE	NWMT	0	0
	PGE	PACW	19,409	31,612
	PGE	PSEI	0	0
	PGE	SCL	1,402	1,059
	PGE	TPWR	1,834	1,837
	PNM	AZPS	50,316	42,351
	PNM	SRP	1,609	1,431
	PNM	TEPC	24,024	22,571
	PSEI	AVA	0	0
	PSEI	BPAT	14,148	19,217
	PSEI	IPCO	0	0
	PSEI	NWMT	2	0
	PSEI	PACW	0	0
	PSEI	PGE	0	0
	PSEI	PWRX	18,178	18,857
<i>October</i>	PSEI	SCL	8,355	7,596

<i>October</i>	PSEI	TPWR	6,452	11,381
	PWRX	BPAT	3,299	218
	PWRX	CISO	0	0
	PWRX	PSEI	8,918	10,556
	SCL	AVA	0	0
	SCL	BPAT	1,138	2,710
	SCL	IPCO	1,775	2,887
	SCL	PACW	669	1,147
	SCL	PGE	831	1,382
	SCL	PSEI	5,400	10,023
	SRP	AZPS	7,000	8,635
	SRP	CISO	169,609	159,863
	SRP	PACE	0	0
	SRP	PNM	92	189
	SRP	TEPC	31,310	38,448
	TEPC	AZPS	649	0
	TEPC	CISO	46,986	42,114
	TEPC	LADWP	0	0
	TEPC	PACE	7	27
	TEPC	PNM	5,722	5,558
	TEPC	SRP	2,796	2,212
	TIDC	BANC	36	0
	TIDC	CISO	19,733	18,321
	TPWR	AVA	0	0
	TPWR	BPAT	8,764	12,810
	TPWR	NWMT	670	1,113
	TPWR	PGE	607	1,156
	TPWR	PSEI	10,490	9,840

<i>November</i>	AVA	BPAT	9,872	9,792
	AVA	CISO	0	0
	AVA	IPCO	27,850	24,185
	AVA	NWMT	5,106	5,780
	AVA	PACW	2,175	2,744
	AVA	PGE	48	0
	AVA	PSEI	0	0
	AVA	SCL	0	0
	AVA	TPWR	0	0
	AZPS	CISO	169,811	123,910
	AZPS	LADWP	17,593	13,016
	AZPS	NEVP	9,297	11,454
	AZPS	PACE	25,509	23,635
	AZPS	PNM	18,378	24,773
	AZPS	SRP	5,415	4,088
	AZPS	TEPC	3,491	3,962
	BANC	BPAT	0	0
	BANC	CISO	405	233
	BANC	TIDC	25	0
	BPAT	AVA	8,159	6,366
	BPAT	BANC	0	0
	BPAT	CISO	9,885	16,776
	BPAT	IPCO	2,127	0
	BPAT	LADWP	0	0
	BPAT	NEVP	0	0
	BPAT	NWMT	9,659	4,329
	BPAT	PACW	4,465	5,948
<i>November</i>	BPAT	PGE	22,607	20,730

<i>November</i>	BPAT	PSEI	13,237	13,088
	BPAT	PWRX	4,764	0
	BPAT	SCL	2,841	2,101
	BPAT	TPWR	11,212	12,518
	CISO	AVA	0	0
	CISO	AZPS	17,159	20,078
	CISO	BANC	234,883	238,370
	CISO	BPAT	18,391	24,670
	CISO	LADWP	22,495	26,855
	CISO	NEVP	17,012	20,969
	CISO	PACW	18,738	38,561
	CISO	PGE	22,570	37,719
	CISO	PWRX	116,263	128,587
	CISO	SRP	26,378	33,224
	CISO	TEPC	0	0
	CISO	TIDC	3,407	3,462
	IPCO	AVA	14,643	14,186
	IPCO	BPAT	1,816	0
	IPCO	NEVP	38,862	22,356
	IPCO	NWMT	534	1,004
	IPCO	PACE	3,679	2,057
	IPCO	PACW	11,779	17,466
	IPCO	PSEI	0	0
	IPCO	SCL	5,841	5,584
	LADWP	AZPS	1,470	1,894
	LADWP	BPAT	0	0
	LADWP	CISO	101,230	92,703
<i>November</i>	LADWP	NEVP	15,365	19,462

<i>November</i>	LADWP	PACE	20,870	23,045
	LADWP	TEPC	0	0
	NEVP	AZPS	1,685	3,980
	NEVP	BPAT	0	0
	NEVP	CISO	172,364	121,695
	NEVP	IPCO	39,730	38,318
	NEVP	LADWP	20,804	26,069
	NEVP	PACE	18,659	16,759
	NWMT	AVA	13,472	13,343
	NWMT	BPAT	10,242	6,741
	NWMT	IPCO	13,944	13,045
	NWMT	PACE	12,126	6,640
	NWMT	PACW	5	0
	NWMT	PGE	12	0
	NWMT	PSEI	28	0
	NWMT	TPWR	0	0
	PACE	AZPS	62,929	66,771
	PACE	IPCO	75,414	73,707
	PACE	LADWP	23,204	21,709
	PACE	NEVP	86,307	75,628
	PACE	NWMT	12,517	15,086
	PACE	PACW	24,706	25,635
	PACE	SRP	0	0
	PACE	TEPC	267	770
	PACW	AVA	6,109	6,452
	PACW	BPAT	9,244	6,035
	PACW	CISO	64,046	92,137
<i>November</i>	PACW	IPCO	19,534	23,428

<i>November</i>	PACW	NWMT	7	0	
	PACW	PGE	33,945	31,961	
	PACW	PSEI	19,253	18,488	
	PACW	SCL	1,479	1,248	
	PGE	AVA	0	0	
	PGE	BPAT	36,874	37,663	
	PGE	CISO	44,156	41,706	
	PGE	NWMT	22	0	
	PGE	PACW	19,603	31,002	
	PGE	PSEI	0	0	
	PGE	SCL	1,420	1,244	
	PGE	TPWR	0	0	
	PNM	AZPS	51,866	39,582	
	PNM	SRP	1,545	1,342	
	PNM	TEPC	15,852	16,442	
	PSEI	AVA	7	0	
	PSEI	BPAT	15,156	17,988	
	PSEI	IPCO	0	0	
	<i>November</i>	PSEI	NWMT	40	0
		PSEI	PACW	13,153	16,071
PSEI		PGE	0	0	
PSEI		PWRX	11,824	11,395	
PSEI		SCL	12,130	10,341	
PSEI		TPWR	8,472	11,446	
PWRX		BPAT	5,169	0	
PWRX		CISO	0	0	
PWRX	PSEI	15,870	16,888		
SCL	AVA	0	0		

<i>November</i>	SCL	BPAT	1,904	2,695
	SCL	IPCO	4,640	4,581
	SCL	PACW	666	980
	SCL	PGE	805	1,158
	SCL	PSEI	5,586	8,341
	SRP	AZPS	24,218	24,520
	SRP	CISO	178,030	154,174
	SRP	PACE	0	0
	SRP	PNM	1,109	1,248
	SRP	TEPC	22,138	28,468
	TEPC	AZPS	269	0
	TEPC	CISO	24,735	19,095
	TEPC	LADWP	0	0
	TEPC	PACE	54	385
	TEPC	PNM	10,725	10,931
	TEPC	SRP	28,475	22,127
	TIDC	BANC	17	0
	TIDC	CISO	18,516	17,906
	TPWR	AVA	0	0
	TPWR	BPAT	9,018	11,092
TPWR	NWMT	0	0	
TPWR	PGE	0	0	
TPWR	PSEI	10,053	10,147	
<i>December</i>	AVA	BPAT	16,513	16,892
	AVA	CISO	354	361
	AVA	IPCO	20,615	15,885
	AVA	NWMT	8,675	3,211
	AVA	PACW	2,182	1,879

<i>December</i>	AVA	PGE	0	0
	AVA	PSEI	50	0
	AVA	SCL	0	0
	AVA	TPWR	0	0
	AZPS	CISO	217,909	187,535
	AZPS	LADWP	40,012	42,673
	AZPS	NEVP	21,042	22,865
	AZPS	PACE	73,138	72,884
	AZPS	PNM	57,843	37,746
	AZPS	SRP	5,860	3,921
	AZPS	TEPC	7,254	6,300
	BANC	BPAT	0	0
	BANC	CISO	360	295
	BANC	TIDC	33	0
	BPAT	AVA	21,382	14,912
	BPAT	BANC	0	0
	BPAT	CISO	18,784	23,780
	BPAT	IPCO	3,299	297
	BPAT	LADWP	0	0
	BPAT	NEVP	0	0
	BPAT	NWMT	14,272	3,753
	BPAT	PACW	3,807	4,382
	BPAT	PGE	16,120	16,001
	BPAT	PSEI	17,181	15,102
	BPAT	PWRX	6,119	0
	BPAT	SCL	6,427	6,174
	BPAT	TPWR	11,931	12,834
	CISO	AVA	50	49

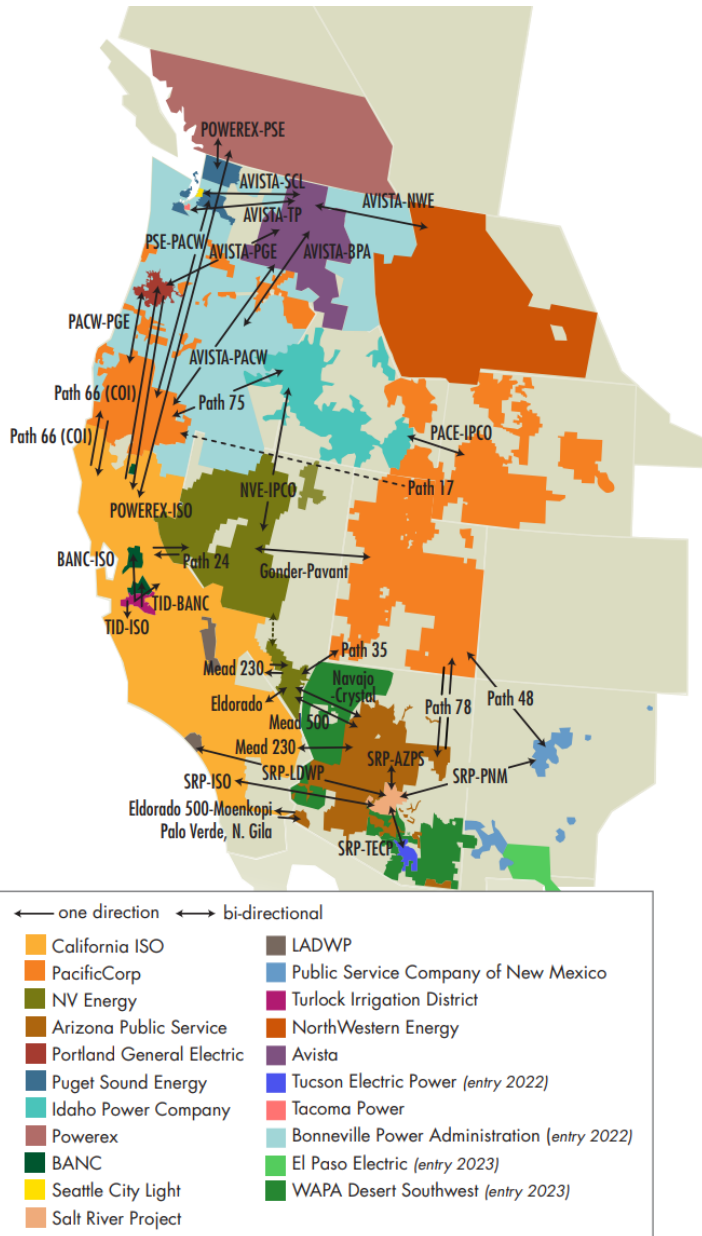
<i>December</i>	CISO	AZPS	10,910	13,784
	CISO	BANC	243,805	245,309
	CISO	BPAT	31,124	38,622
	CISO	LADWP	18,592	22,935
	CISO	NEVP	47,868	49,634
	CISO	PACW	24,801	54,705
	CISO	PGE	35,322	55,003
	CISO	PWRX	67,544	76,385
	CISO	SRP	6,169	10,517
	CISO	TEPC	0	16
<i>December</i>	CISO	TIDC	7,962	7,231
	IPCO	AVA	30,665	30,978
	IPCO	BPAT	713	0
	IPCO	NEVP	34,077	23,009
	IPCO	NWMT	395	1,472
	IPCO	PACE	16,019	6,920
	IPCO	PACW	41,591	27,917
	IPCO	PSEI	0	0
	IPCO	SCL	10,017	9,044
	LADWP	AZPS	6,205	6,437
LADWP	BPAT	0	0	
LADWP	CISO	86,038	76,740	
LADWP	NEVP	28,959	34,065	
LADWP	PACE	27,482	24,068	
LADWP	TEPC	0	0	
NEVP	AZPS	5,931	7,783	
NEVP	BPAT	0	0	
<i>December</i>	NEVP	CISO	126,215	92,655

<i>December</i>	NEVP	IPCO	74,249	63,113
	NEVP	LADWP	16,409	16,169
	NEVP	PACE	32,771	23,723
	NWMT	AVA	29,257	32,584
	NWMT	BPAT	9,227	7,194
	NWMT	IPCO	16,759	16,697
	NWMT	PACE	26,611	9,625
	NWMT	PACW	44	0
	NWMT	PGE	45	0
	NWMT	PSEI	355	0
	NWMT	TPWR	0	0
	PACE	AZPS	34,112	23,767
	PACE	IPCO	60,699	60,112
	PACE	LADWP	21,211	24,983
	PACE	NEVP	86,163	75,891
	PACE	NWMT	12,889	19,264
	PACE	PACW	24,651	24,279
	PACE	SRP	0	0
	PACE	TEPC	573	306
	PACW	AVA	5,636	4,509
	PACW	BPAT	14,823	12,052
	PACW	CISO	46,461	66,361
	PACW	IPCO	20,463	21,587
	PACW	NWMT	3	0
	PACW	PGE	40,592	37,467
	PACW	PSEI	23,009	21,643
	PACW	SCL	1,597	1,456
<i>December</i>	PGE	AVA	0	0

<i>December</i>	PGE	BPAT	42,026	42,746	
	PGE	CISO	43,528	41,651	
	PGE	NWMT	298	0	
	PGE	PACW	12,010	20,839	
	PGE	PSEI	0	0	
	PGE	SCL	1,605	1,450	
	PGE	TPWR	0	0	
	PNM	AZPS	63,186	78,499	
	PNM	SRP	2,494	2,653	
	PNM	TEPC	18,123	20,165	
	PSEI	AVA	2	0	
	PSEI	BPAT	17,207	17,624	
	PSEI	IPCO	0	0	
	PSEI	NWMT	132	0	
	PSEI	PACW	12,207	14,049	
	PSEI	PGE	0	0	
	PSEI	PWRX	6,210	6,361	
	PSEI	SCL	16,491	16,172	
	PSEI	TPWR	5,473	6,745	
	PWRX	BPAT	9,262	0	
	PWRX	CISO	0	0	
	PWRX	PSEI	19,063	19,179	
	SCL	AVA	0	0	
	SCL	BPAT	2,506	2,789	
	SCL	IPCO	4,734	5,644	
	SCL	PACW	603	806	
	SCL	PGE	792	988	
	<i>December</i>	SCL	PSEI	6,638	8,276

<i>December</i>	SRP	AZPS	31,010	27,353
	SRP	CISO	112,006	103,851
	SRP	PACE	0	0
	SRP	PNM	3	3
	SRP	TEPC	26,398	26,296
	TEPC	AZPS	416	188
	TEPC	CISO	72,158	68,914
	TEPC	LADWP	547	640
	TEPC	PACE	1,332	887
	TEPC	PNM	18,980	12,548
	TEPC	SRP	8,538	9,468
	TIDC	BANC	122	0
	TIDC	CISO	8,770	8,897
	TPWR	AVA	0	0
	TPWR	BPAT	12,015	13,298
	TPWR	NWMT	0	0
	TPWR	PGE	0	0
TPWR	PSEI	17,779	17,616	

TABLE 2: Energy transfers (MWh) in the FMM and RTD markets for Q4 2022



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
Avista <-> BPA	3,600
Avista <-> NorthWestern	764
Avista <-> PACW	500
Avista <-> SCL	500
Avista <-> TP	500
Avista <-> PGE	500

GRAPH 2: Estimated maximum transfer capacity

WHEEL-THROUGH TRANSFERS

As the footprint of the WEIM grows, wheel-through transfers may become more common. In order to derive the wheel-through transfers for each WEIM BAA, the ISO uses the following calculation for every real-time interval dispatch:

- *Total import*: summation of transfers above base transfers coming into the WEIM BAA under analysis

- *Total export*: summation of all transfers above base transfers going out of the WEIM 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 WEIM transfers into (total import) or WEIM 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, a WEIM 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 WEIM Consolidated Initiatives stakeholder process, the ISO committed to monitoring the wheel through volumes to assess whether, after the addition of new WEIM 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 WEIM market in the quarterly reports.

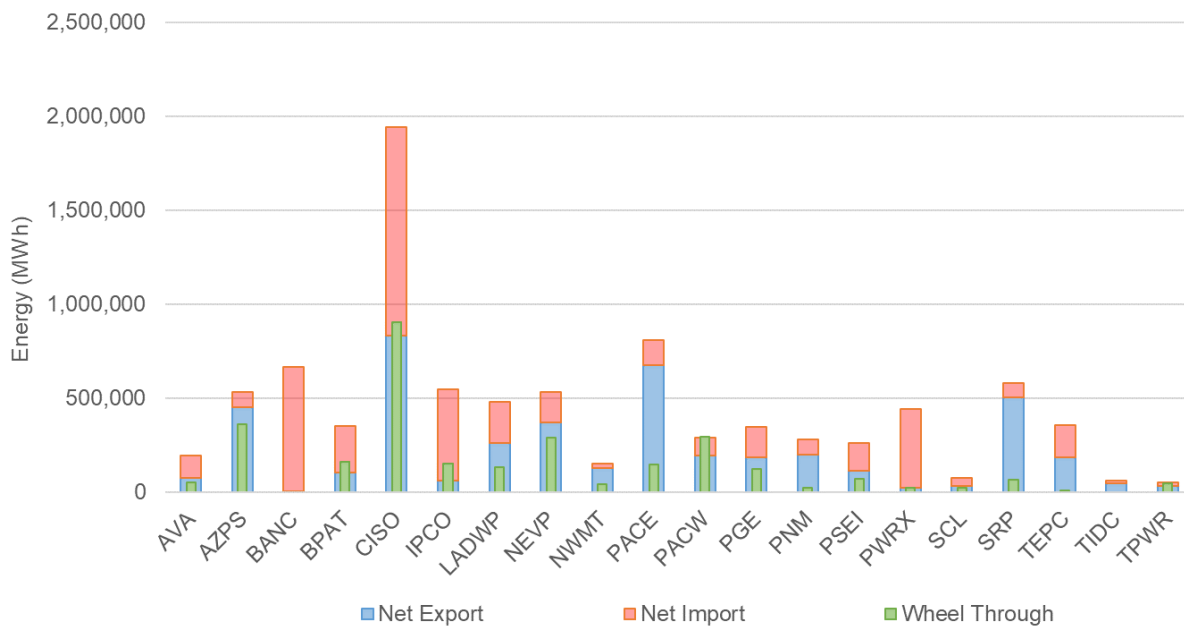
This volume reflects the total wheel-through transfers for each WEIM BAA, regardless of the potential paths used to wheel through. The net imports and exports estimated in this section reflect the overall volume of net imports and exports; in contrast, the imports and exports provided in Table 2 reflect the gross transfers between two WEIM 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
AVA	76,406	118,148	50,611
AZPS	450,985	83,461	361,025
BANC	2,697	665,176	-
BPAT	106,572	247,609	161,995
CISO	834,232	1,105,856	903,198
IPCO	61,352	485,208	153,667
LADWP	260,650	218,438	133,216
NEVP	368,747	165,967	291,319
NWMT	127,090	26,505	44,920

PACE	677,683	131,016	146,951
PACW	195,076	96,713	293,040
PGE	183,493	164,535	124,801
PNM	200,941	80,674	24,095
PSEI	115,928	144,662	69,316
PWRX	23,028	420,672	23,813
SCL	31,497	46,312	22,908
SRP	505,405	74,935	67,643
TEPC	183,825	170,815	11,269
TIDC	45,124	14,187	-
TPWR	31,920	21,761	45,153

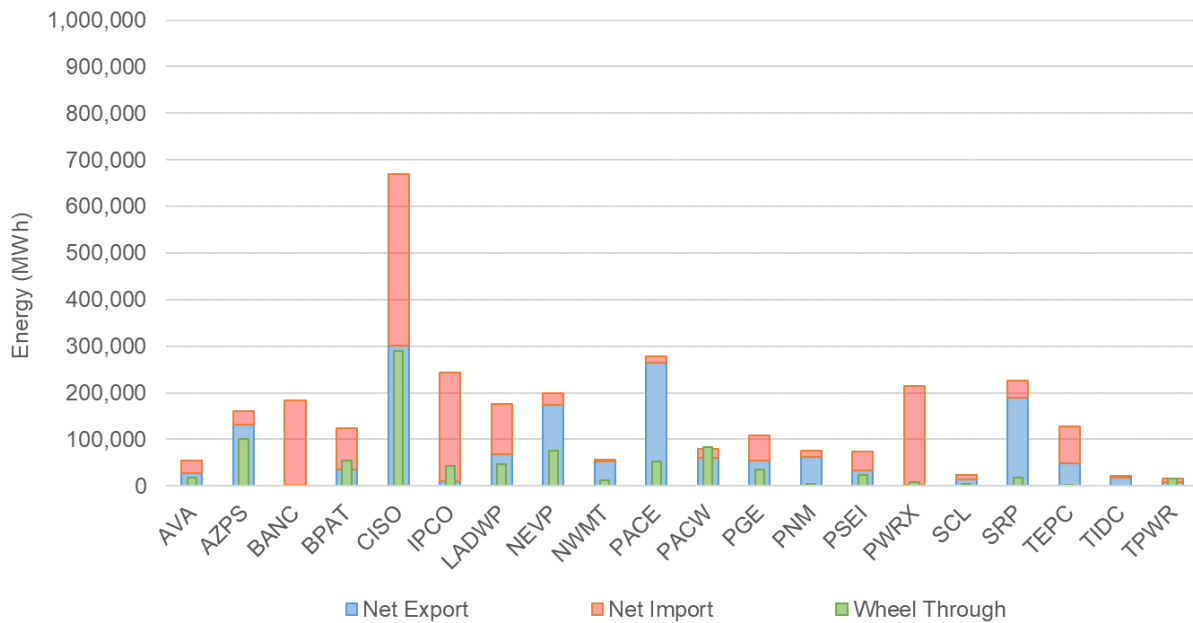
TABLE 3: Estimated wheel-through transfers in Q4 2022



GRAPH 3: Estimated wheel-through transfers in Q4 2022

BAA	Net Export	Net Import	Wheel Through
AVA	28,087	27,179	18,200
AZPS	131,719	28,320	101,527
BANC	2,168	181,497	-
BPAT	35,475	87,708	54,002
CISO	301,772	368,703	288,975
IPCO	9,475	234,727	43,549
LADWP	67,890	109,045	47,561
NEVP	173,265	25,418	76,536
NWMT	52,954	4,340	13,186
PACE	264,269	14,882	52,457
PACW	60,473	19,671	82,818
PGE	54,798	53,116	35,194
PNM	62,616	13,783	3,737
PSEI	32,766	40,925	24,286
PWRX	1,809	212,792	8,965
SCL	13,725	9,984	4,423
SRP	188,884	36,986	18,251
TEPC	48,947	78,396	964
TIDC	18,321	3,495	-
TPWR	8,878	7,329	16,041

TABLE 4: Estimated wheel-through transfers in October 2022

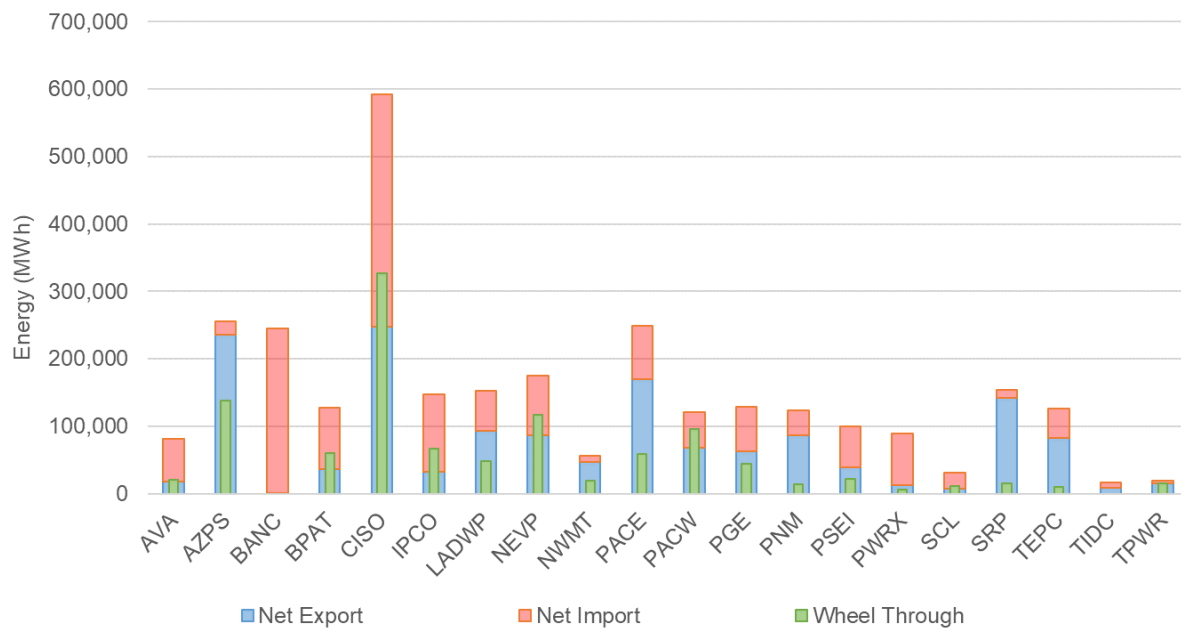


GRAPH 4: Estimated wheel-through transfers in October 2022

BAA	Net Export	Net Import	Wheel Through
AVA	30,282	28,128	12,218
AZPS	83,298	35,284	121,541
BANC	233	238,370	-
BPAT	34,377	69,198	47,478
CISO	284,906	392,748	287,587
IPCO	19,904	134,514	42,749
LADWP	99,728	50,273	37,376
NEVP	109,099	52,146	97,723
NWMT	26,794	13,225	12,974
PACE	243,821	37,035	35,485
PACW	65,859	24,518	113,890
PGE	65,789	45,741	45,827
PNM	51,010	30,596	6,356

PSEI	43,754	43,463	23,488
PWRX	8,116	131,210	8,771
SCL	10,059	12,822	7,696
SRP	173,991	26,363	34,419
TEPC	52,114	49,217	425
TIDC	17,906	3,462	-
TPWR	7,478	10,203	13,761

TABLE 5: Estimated wheel-through transfers in November 2022

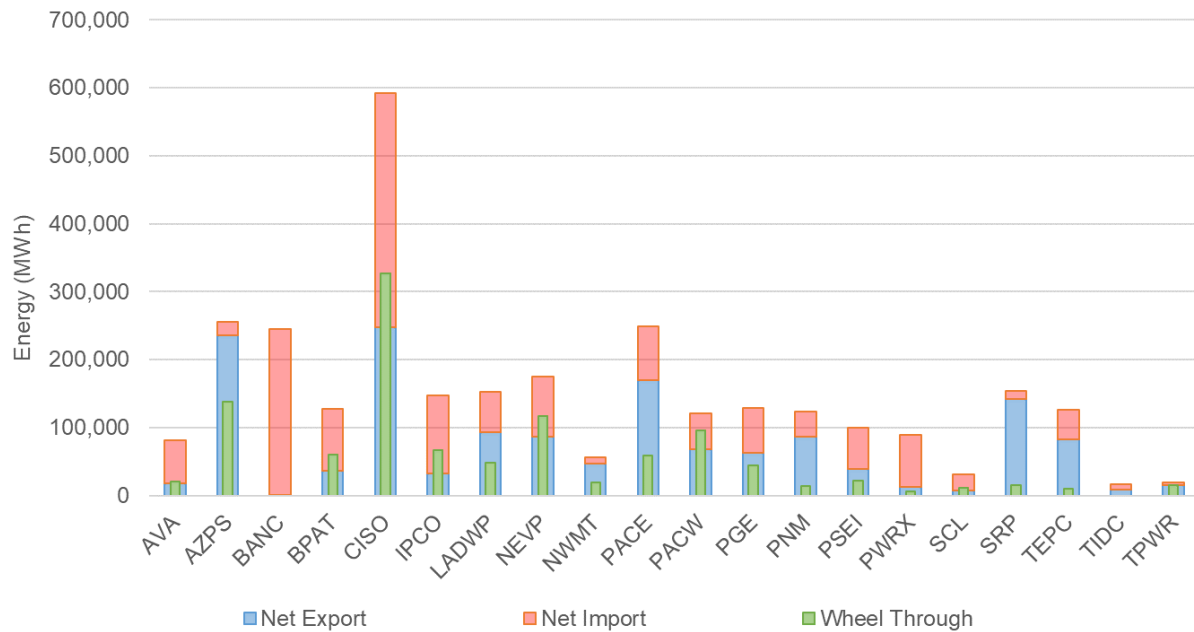


GRAPH 5: Estimated wheel-through transfers in November 2022

BAA	Net Export	Net Import	Wheel Through
AVA	18,037	62,841	20,192

AZPS	235,968	19,857	137,956
BANC	295	245,309	-
BPAT	36,720	90,703	60,515
CISO	247,554	344,404	326,636
IPCO	31,972	115,968	67,369
LADWP	93,031	59,120	48,279
NEVP	86,383	88,403	117,061
NWMT	47,342	8,940	18,759
PACE	169,592	79,098	59,009
PACW	68,744	52,524	96,332
PGE	62,906	65,678	43,781
PNM	87,315	36,295	14,001
PSEI	39,409	60,275	21,541
PWRX	13,102	76,669	6,076
SCL	7,713	23,507	10,790
SRP	142,530	11,586	14,973
TEPC	82,764	43,202	9,881
TIDC	8,897	7,231	-
TPWR	15,564	4,229	15,351

TABLE 6: Estimated wheel-through transfers in December 2022



GRAPH 6: Estimated wheel-through transfers in December 2022

■ REDUCED RENEWABLE CURTAILMENT AND GHG REDUCTIONS

The WEIM 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 WEIM, 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 2022 was calculated to be 10,571 MWh (October) + 9,270 MWh (November) + 5,767 MWh (December) = 25,609 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 CO₂/MWh, avoided curtailments displaced an estimated 10,960 metric tons of CO₂ for Q4 2022. 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 CO₂, 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
2022	1	94,168	40,304
	2	118,352	50,655
	3	42,468	18,176
	4	25,609	10,960
Total		1,850,797	792,061

TABLE 7: Total reduction in curtailment of renewable energy and associated reductions in CO₂

FLEXIBLE RAMPING PROCUREMENT DIVERSITY SAVINGS

■ The WEIM 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 WEIM 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	AVA	up	0	95
	AZPS	up	0	328
	BANC	up	0	76
	BPAT	up	0	401
	CISO	up	0	2,768
	IPCO	up	0	253
	LADWP	up	0	361
	NEVP	up	0	410
	NWMT	up	0	111
	PACE	up	0	506
	PACW	up	0	123
	PGE	up	0	191
	PNM	up	0	169
	PSEI	up	0	166
	PWRX	up	0	247
	SCL	up	0	41
	SRP	up	0	302
	TEPC	up	0	220
	TIDC	up	0	19
	TPWR	up	0	15
ALL EIM	up	0	2,583	
AVA	down	0	113	

<i>October</i>	<i>AZPS</i>	down	0	444
	<i>BANC</i>	down	0	134
	<i>BPAT</i>	down	0	581
	<i>CISO</i>	down	0	1,145
	<i>IPCO</i>	down	0	198
	<i>LADWP</i>	down	0	357
	<i>NEVP</i>	down	0	471
	<i>NWMT</i>	down	0	150
	<i>PACE</i>	down	0	613
	<i>PACW</i>	down	0	157
	<i>PGE</i>	down	0	185
	<i>PNM</i>	down	0	218
	<i>PSEI</i>	down	0	137
	<i>PWRX</i>	down	0	307
	<i>SCL</i>	down	0	26
	<i>SRP</i>	down	0	519
	<i>TEPC</i>	down	0	176
	<i>TIDC</i>	down	0	25
	<i>TPWR</i>	down	0	18
		ALL EIM	down	0
<i>November</i>	<i>AVA</i>	up	15	87
	<i>AZPS</i>	up	48	328
	<i>BANC</i>	up	7	76
	<i>BPAT</i>	up	47	371
	<i>CISO</i>	up	321	2,758
	<i>IPCO</i>	up	29	253
	<i>LADWP</i>	up	41	361
	<i>NEVP</i>	up	24	463
	<i>NWMT</i>	up	4	127
	<i>PACE</i>	up	100	447
	<i>PACW</i>	up	36	178

November	<i>PGE</i>	up	35	190
	<i>PNM</i>	up	44	141
	<i>PSEI</i>	up	30	167
	<i>PWRX</i>	up	70	310
	<i>SCL</i>	up	3	30
	<i>SRP</i>	up	27	302
	<i>TEPC</i>	up	43	220
	<i>TIDC</i>	up	2	19
	<i>TPWR</i>	up	2	19
	ALL WEIM	up	491	2,684
	<i>AVA</i>	down	7	103
	<i>AZPS</i>	down	36	369
	<i>BANC</i>	down	4	140
	<i>BPAT</i>	down	72	639
	<i>CISO</i>	down	192	1,250
	<i>IPCO</i>	down	46	198
	<i>LADWP</i>	down	52	285
	<i>NEVP</i>	down	21	471
	<i>NWMT</i>	down	30	126
	<i>PACE</i>	down	176	538
	<i>PACW</i>	down	27	139
	<i>PGE</i>	down	31	230
	<i>PNM</i>	down	38	218
	<i>PSEI</i>	down	32	137
	<i>PWRX</i>	down	79	340
	<i>SCL</i>	down	3	28
	<i>SRP</i>	down	30	344
	<i>TEPC</i>	down	22	167
	<i>TIDC</i>	down	2	25
	<i>TPWR</i>	down	3	24
	ALL EIM	down	308	1,989

<i>December</i>	AVA	up	17	81
	AZPS	up	56	300
	BANC	up	8	83
	BPAT	up	54	386
	CISO	up	313	2,337
	IPCO	up	34	189
	LADWP	up	40	393
	NEVP	up	20	463
	NWMT	up	25	127
	PACE	up	115	460
	PACW	up	48	174
	PGE	up	48	200
	PNM	up	44	155
	PSEI	up	39	167
	PWRX	up	85	294
	SCL	up	5	31
	SRP	up	29	280
	TEPC	up	60	220
	TIDC	up	2	19
	TPWR	up	4	19
	ALL WEIM	up	455	2,771
	AVA	down	17	86
	AZPS	down	26	246
	BANC	down	6	82
	BPAT	down	98	639
	CISO	down	153	1,332
IPCO	down	42	194	
LADWP	down	43	262	
NEVP	down	22	408	
NWMT	down	42	124	
PACE	down	165	501	

<i>December</i>	<i>PACW</i>	down	27	143
	<i>PGE</i>	down	28	204
	<i>PNM</i>	down	37	141
	<i>PSEI</i>	down	35	153
	<i>PWRX</i>	down	56	345
	<i>SCL</i>	down	5	28
	<i>SRP</i>	down	22	344
	<i>TEPC</i>	down	26	165
	<i>TIDC</i>	down	1	17
	<i>TPWR</i>	down	3	24
	ALL WEIM	down	319	2,175

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.

<i>Direction</i>	October		November		December	
	Up	Down	Up	Down	Up	Down
<i>Average MW saving</i>	1,517	1,720	1,551	1,603	1,617	1,606
<i>Sum of BAA requirements</i>	2,908	2,657	2,866	2,622	3,056	2,632
<i>Percentage savings</i>	52%	65%	54%	61%	53%	61%

Table 9: Flexible ramping procurement diversity savings in Q4 2022

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 WEIM-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 WEIM 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 WEIM demonstrates that utilities can realize financial and operational benefits through increased coordination and optimization. In addition to these benefits, the WEIM 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 792,061 metric tons of CO₂, roughly the equivalent of avoiding the emissions from 166,527 passenger cars driven for one year.

APPENDIX 1: GLOSSARY OF ABBREVIATIONS

Abbreviation	Description
APS	Arizona Public Service
AVA	Avista Utilities
BAA	Balancing Authority Area
BANC	Balancing Authority of Northern California
BPA	Bonneville Power Administration
CISO, ISO	California ISO
EIM	Energy Imbalance Market
FMM	Fifteen Minute Market
GHG	Greenhouse Gas
IPCO	Idaho Power
LADWP	Los Angeles Department of Water and 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
TEP	Tucson Electric Power
TID	Turlock Irrigation District
TPWR	Tacoma Power
WEIM	Western Energy Imbalance Market