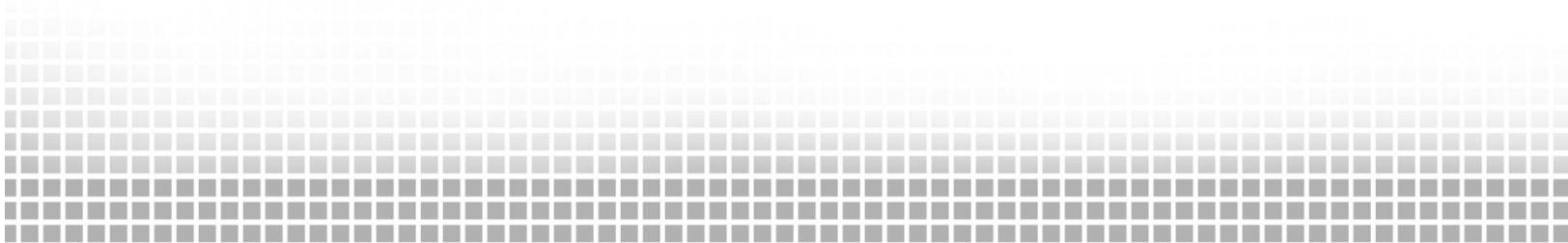


WESTERN EIM BENEFITS REPORT

Third Quarter 2021 ■ ■ ■

Prepared by: Market Analysis and Forecasting

October 29, 2021



CONTENTS

EXECUTIVE SUMMARY 3

BACKGROUND..... 4

WESTERN EIM ECONOMIC BENEFITS IN Q3 2021 4

 CUMULATIVE ECONOMIC BENEFITS SINCE INCEPTION 5

 INTER-REGIONAL TRANSFERS 6

 WHEEL THROUGH TRANSFERS..... 16

REDUCED RENEWABLE CURTAILMENT AND GHG REDUCTIONS22

FLEXIBLE RAMPING PROCUREMENT DIVERSITY SAVINGS.....24

CONCLUSION.....28

APPENDIX 1: GLOSSARY OF ABBREVIATIONS.....29

EXECUTIVE SUMMARY

Gross benefits from EIM since November 2014
\$1.72 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.



2021
Q3 BENEFITS

Q3 2021 Gross Benefits by Participant

	(millions \$)
Arizona Public Service	\$24.58
BANC	\$72.52
California ISO	\$54.01
Idaho Power	\$17.76
LADWP	\$23.57
NV Energy	\$18.04
NorthWestern Energy	\$5.16
PacifiCorp	\$40.12
Portland General Electric	\$7.12
PNM	\$6.77
Puget Sound Energy	\$6.78
Powerex	\$0.92
Seattle City Light	\$3.92
Salt River Project	\$17.78
TID	\$2.13
Total	\$301.18

ECONOMICAL

\$301.18 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

9,862

Metric tons of CO₂** avoided curtailments

OPERATIONAL

56%

Average reduction in flexibility reserves across the footprint

*EIM 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 EIM. For more details, see <http://www.aiso.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, three 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 (NWMET) starting in June 2021.

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

■ WESTERN EIM ECONOMIC BENEFITS IN Q3 2021

Table 1 shows the estimated EIM gross benefits by each region per month¹. The monthly savings presented show \$129.10 million for July, \$78.57 million for August, and \$93.51 million for September with a total estimated benefit of \$301.18 million for this quarter.

The increased benefits observed in Q3 2021 were largely driven by the heat waves resulting in high loads and tight supply conditions across the EIM footprint. These conditions resulted in high electric energy prices.

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 of the total intervals.

<i>Region</i>	July	August	September	Total
<i>APS</i>	\$10.16	\$6.62	\$7.80	\$24.58
<i>BANC</i>	\$26.62	\$17.75	\$28.15	\$72.52
<i>CISO</i>	\$29.80	\$15.19	\$9.02	\$54.01
<i>IPCO</i>	\$9.59	\$4.20	\$3.97	\$17.76
<i>LADWP</i>	\$9.85	\$5.67	\$8.05	\$23.57
<i>NVE</i>	\$7.44	\$3.08	\$7.52	\$18.04
<i>NWMT</i>	\$1.53	\$2.25	\$1.38	\$5.16
<i>PAC</i>	\$14.10	\$10.95	\$15.07	\$40.12
<i>PGE</i>	\$2.67	\$2.32	\$2.13	\$7.12
<i>PNM</i>	\$3.29	\$1.45	\$2.03	\$6.77
<i>PSE</i>	\$2.32	\$2.70	\$1.76	\$6.78
<i>PWRX</i>	\$0.61	\$0.23	\$0.08	\$0.92
<i>SCL</i>	\$1.79	\$1.08	\$1.05	\$3.92
<i>SRP</i>	\$8.54	\$4.51	\$4.73	\$17.78
<i>TID</i>	\$0.79	\$0.57	\$0.77	\$2.13
Total	\$129.10	\$78.57	\$93.51	\$301.18

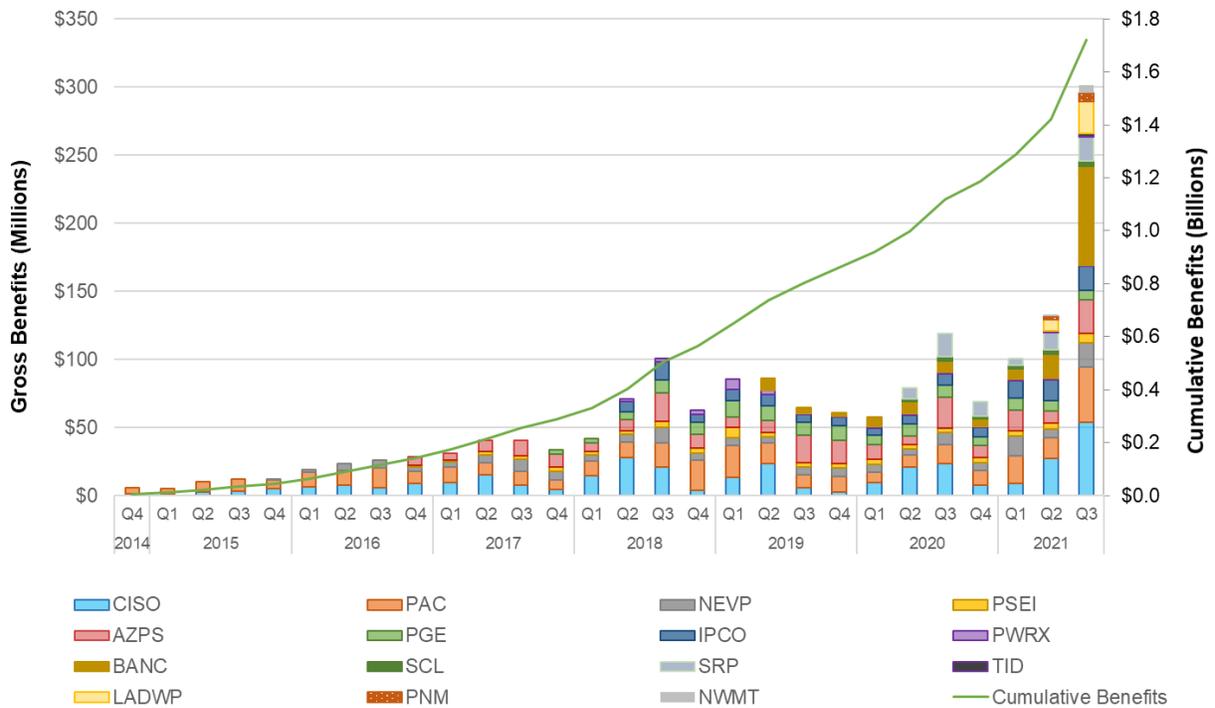
TABLE 1: Q3 2021 benefits in millions USD

■ CUMULATIVE ECONOMIC BENEFITS SINCE INCEPTION

Since the start of the EIM in November 2014, the cumulative economic benefits of the market have totaled \$1.72 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 2015.²

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

² 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)
<i>July</i>	AZPS	CISO	296,277	265,859
	AZPS	LADWP	29,718	31,143
	AZPS	NEVP	17,900	24,961
	AZPS	PACE	10,875	15,755
	AZPS	PNM	9,804	13,527
	AZPS	SRP	14,246	14,318
	BANC	CISO	15,648	12,316
	BANC	TIDC	36	25
	CISO	AZPS	6,782	9,387
	CISO	BANC	118,099	135,441
	CISO	LADWP	16,958	23,611
	CISO	NEVP	11,345	15,299
	CISO	PACW	7,332	5,605
	CISO	PGE	5,243	5,957
	CISO	PWRX	7,305	8,980
	CISO	SRP	10,776	13,081
	CISO	TIDC	9,625	11,829
	IPCO	NEVP	52,278	39,174
	IPCO	NWMT	4,829	5,758
	IPCO	PACE	1,195	1,621
IPCO	PACW	11,291	14,523	
IPCO	PSEI	7,329	7,578	

<i>July</i>	IPCO	SCL	6,148	6,281
	LADWP	AZPS	834	1,299
	LADWP	CISO	165,437	139,638
	LADWP	NEVP	17,924	21,917
	LADWP	PACE	8,888	9,487
	NEVP	AZPS	874	1,265
	NEVP	CISO	197,892	151,613
	NEVP	IPCO	26,591	36,681
	NEVP	LADWP	22,284	24,816
	NEVP	PACE	1,615	3,364
	NWMT	IPCO	9,233	9,682
	NWMT	PACE	994	1,029
	NWMT	PACW	0	0
	NWMT	PGE	0	0
	NWMT	PSEI	0	0
	PACE	AZPS	66,206	59,241
	PACE	IPCO	155,963	164,174
	PACE	LADWP	98,545	91,710
	PACE	NEVP	108,264	97,329
	PACE	NWMT	16,227	21,082
	PACE	PACW	43,205	53,664
	PACE	SRP	0	0
	PACW	CISO	10,981	53,300
	PACW	IPCO	39,220	33,284
	PACW	NWMT	0	0
	PACW	PGE	63,670	61,182
	PACW	PSEI	26,167	25,092
	PACW	SCL	1,116	932

	PGE	CISO	16,884	26
	PGE	NWMT	0	0
	PGE	PACW	21,384	29,994
	PGE	PSEI	366	499
	PGE	SCL	1,090	930
	PNM	AZPS	83,660	77,220
	PNM	SRP	0	0
	PSEI	IPCO	0	0
	PSEI	NWMT	0	0
	PSEI	PACW	39,905	44,507
	PSEI	PGE	1,998	2,243
	PSEI	PWRX	15,718	13,346
	PSEI	SCL	27,457	25,181
	PWRX	CISO	14,981	85
	PWRX	PSEI	10,847	12,860
	SCL	IPCO	9,869	9,709
	SCL	PACW	926	1,234
	SCL	PGE	1,449	1,693
	SCL	PSEI	6,450	9,746
	SRP	AZPS	14,307	16,895
	SRP	CISO	280,825	273,569
	SRP	PACE	0	0
	SRP	PNM	38	55
	TIDC	BANC	3,421	2,579
	TIDC	CISO	19,861	17,487
<i>August</i>	AZPS	CISO	272,766	250,526
	AZPS	LADWP	43,125	45,810
	AZPS	NEVP	23,072	25,476

	AZPS	PACE	8,249	9,691
	AZPS	PNM	10,097	15,078
	AZPS	SRP	34,945	33,638
	BANC	CISO	19,767	17,202
	BANC	TIDC	3	0
	CISO	AZPS	11,274	16,698
	CISO	BANC	94,172	106,328
	CISO	LADWP	22,637	30,664
	CISO	NEVP	12,370	14,801
	CISO	PACW	8,035	11,691
	CISO	PGE	3,242	16,176
	CISO	PWRX	9,358	10,811
	CISO	SRP	43,344	48,267
	CISO	TIDC	14,096	15,376
	IPCO	NEVP	52,108	40,166
	IPCO	NWMT	559	969
	IPCO	PACE	801	769
	IPCO	PACW	45,198	49,679
	IPCO	PSEI	9,771	9,351
	IPCO	SCL	6,690	6,428
	LADWP	AZPS	1,046	1,094
	LADWP	CISO	136,099	110,843
	LADWP	NEVP	15,199	18,520
	LADWP	PACE	9,785	9,142
<i>August</i>	NEVP	AZPS	1,056	823
	NEVP	CISO	153,696	123,993
	NEVP	IPCO	26,805	32,311
	NEVP	LADWP	34,822	36,531

<i>August</i>	NEVP	PACE	989	876
	NWMT	IPCO	23,425	24,674
	NWMT	PACE	2,462	1,766
	NWMT	PACW	0	0
	NWMT	PGE	0	0
	NWMT	PSEI	0	0
	PACE	AZPS	110,864	93,052
	PACE	IPCO	202,096	203,495
	PACE	LADWP	98,262	93,735
	PACE	NEVP	138,027	125,513
	PACE	NWMT	11,359	13,669
	PACE	PACW	30,208	35,228
	PACE	SRP	0	0
	PACW	CISO	21,266	45,505
	PACW	IPCO	35,964	27,071
	PACW	NWMT	0	0
	PACW	PGE	67,960	64,600
	PACW	PSEI	24,388	21,668
	PACW	SCL	1,025	789
	PGE	CISO	7,744	16
	PGE	NWMT	0	0
	PGE	PACW	24,706	31,825
	PGE	PSEI	0	0
	PGE	SCL	1,041	932
	PNM	AZPS	66,998	58,505
	PNM	SRP	0	0
	PSEI	IPCO	0	0
	PSEI	NWMT	0	0

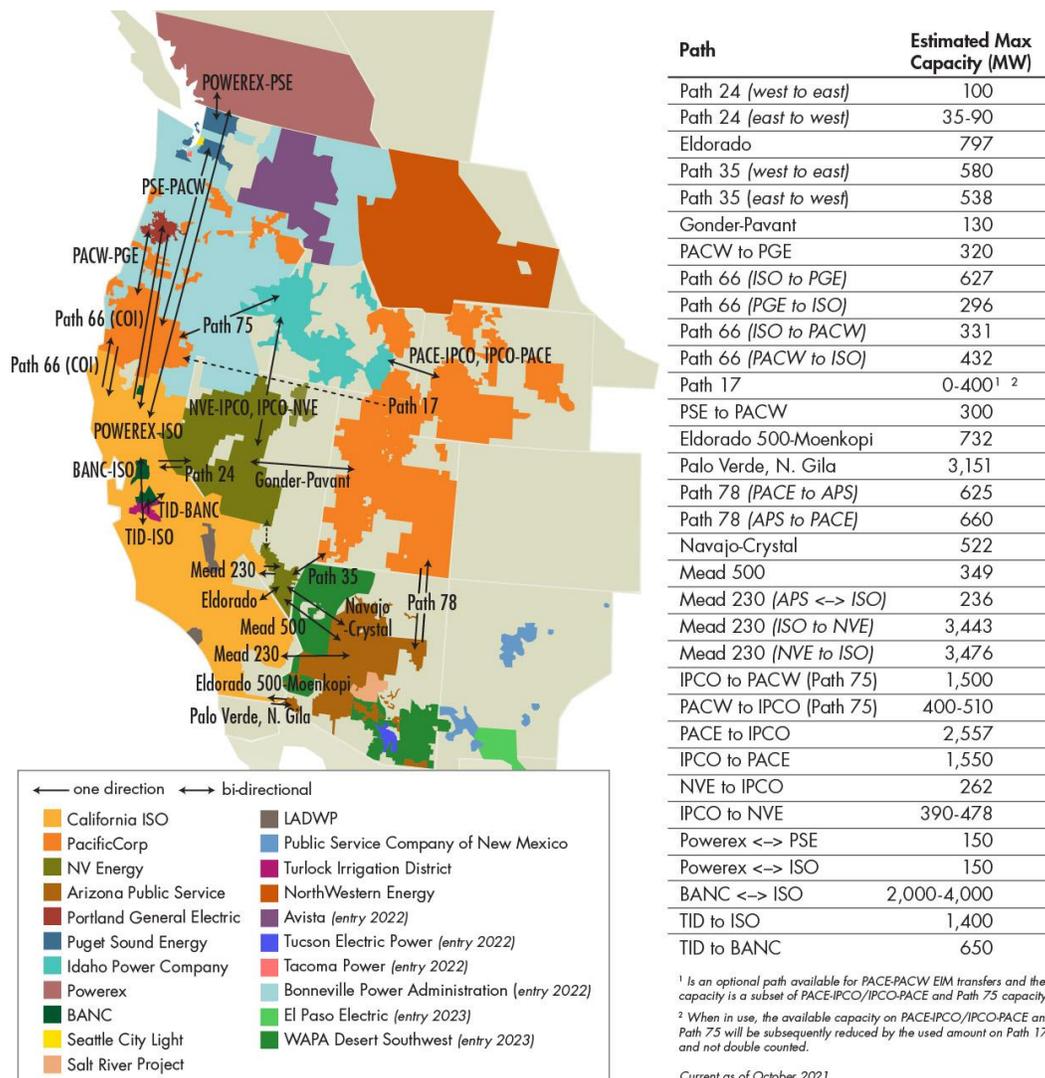
	PSEI	PACW	35,660	41,681
	PSEI	PGE	0	0
	PSEI	PWRX	14,825	14,057
	PSEI	SCL	24,936	22,877
	PWRX	CISO	15,144	4
	PWRX	PSEI	10,004	11,502
	SCL	IPCO	7,613	8,334
	SCL	PACW	839	1,212
	SCL	PGE	1,454	1,639
	SCL	PSEI	5,362	7,207
	SRP	AZPS	59,661	60,669
	SRP	CISO	144,196	140,815
	SRP	PACE	0	0
	SRP	PNM	0	0
	TIDC	BANC	212	0
	TIDC	CISO	19,526	18,438
<i>September</i>	AZPS	CISO	199,062	182,791
	AZPS	LADWP	24,469	24,737
	AZPS	NEVP	7,744	9,400
	AZPS	PACE	5,603	7,477
	AZPS	PNM	20,547	28,473
	AZPS	SRP	35,525	35,158
	BANC	CISO	9,846	6,517
	BANC	TIDC	7	44
	CISO	AZPS	13,172	14,844
	CISO	BANC	141,187	149,532
	CISO	LADWP	31,147	35,925
	CISO	NEVP	17,619	20,401

	CISO	PACW	2,122	16,392
	CISO	PGE	5,584	21,727
	CISO	PWRX	36,744	11,809
	CISO	SRP	41,465	52,045
	CISO	TIDC	21,931	23,409
	IPCO	NEVP	109,382	103,947
	IPCO	NWMT	349	429
	IPCO	PACE	902	963
	IPCO	PACW	25,919	24,928
	IPCO	PSEI	16,547	15,564
	IPCO	SCL	7,541	6,932
	LADWP	AZPS	5,841	6,630
	LADWP	CISO	146,716	123,433
	LADWP	NEVP	9,958	9,914
	LADWP	PACE	7,221	9,479
	NEVP	AZPS	5,363	5,825
	NEVP	CISO	200,648	177,095
	NEVP	IPCO	13,248	14,905
	NEVP	LADWP	35,626	41,213
	NEVP	PACE	2,607	4,250
	NWMT	IPCO	20,137	21,320
	NWMT	PACE	3,625	3,483
	NWMT	PACW	29	14
	NWMT	PGE	9	12
	NWMT	PSEI	4	2
<i>September</i>	PACE	AZPS	112,443	108,763
	PACE	IPCO	149,496	161,367
	PACE	LADWP	90,477	86,042

<i>September</i>	PACE	NEVP	121,678	112,794
	PACE	NWMT	6,203	6,801
	PACE	PACW	21,531	23,293
	PACE	SRP	0	0
	PACW	CISO	11,929	25,588
	PACW	IPCO	6,390	4,125
	PACW	NWMT	0	4
	PACW	PGE	64,497	60,642
	PACW	PSEI	21,096	17,362
	PACW	SCL	426	338
	PGE	CISO	13,593	171
	PGE	NWMT	23	15
	PGE	PACW	18,180	25,031
	PGE	PSEI	0	0
	PGE	SCL	349	326
	PNM	AZPS	45,351	38,596
	PNM	SRP	0	8
	PSEI	IPCO	0	0
	PSEI	NWMT	0	1
	PSEI	PACW	0	0
	PSEI	PGE	0	0
	PSEI	PWRX	16,592	17,154
	PSEI	SCL	17,213	17,291
	PWRX	CISO	15,544	171
	PWRX	PSEI	8,848	9,254
	SCL	IPCO	7,818	8,969
	SCL	PACW	1,116	1,269
	SCL	PGE	1,374	1,464

SCL	PSEI	9,367	11,227
SRP	AZPS	12,695	13,803
SRP	CISO	155,763	153,947
SRP	PACE	0	0
SRP	PNM	295	527
TIDC	BANC	8	44
TIDC	CISO	10,888	9,299

TABLE 2: Energy transfers (MWh) in the FMM and RTD markets for Q3 2021



GRAPH 2: Estimated maximum transfer capacity (EIM entities operating in Q3 2021)

■ WHEEL THROUGH TRANSFERS

As the footprint of the Western EIM grows, wheel-through transfers may become more common. Currently, an EIM entity facilitating a wheel through receives no direct financial benefit for facilitating the wheel; only the sink and source directly benefit. As part of the Western EIM Consolidated Initiatives stakeholder process, the ISO committed to monitoring the wheel through volumes to assess whether, after the addition of new EIM entities, there is a potential future need to pursue a market solution to address the equitable sharing of wheeling benefits.

The ISO will continue to track the volume of wheel-through transfers in the EIM market in the quarterly reports. In order to derive the wheel-through transfers for each EIM BAA, the ISO uses the following calculation for every real-time interval dispatch:

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

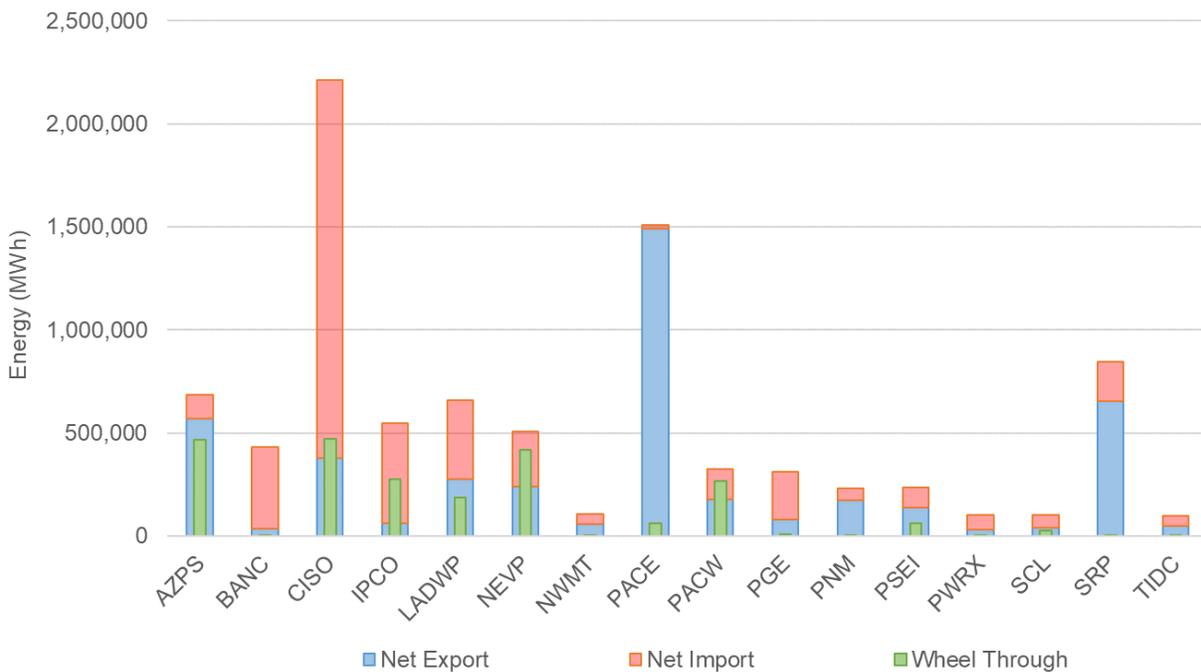
All wheel-through transfers are summed over both the month and the quarter. This volume reflects the total wheel-through transfers for each EIM BAA, regardless of the potential paths used to wheel through. The net imports and exports estimated in this section reflect the overall volume of net imports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

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

<i>BAA</i>	<i>Net Export</i>	<i>Net Import</i>	<i>Wheel Through</i>
<i>AZPS</i>	569,120	118,075	468,090
<i>BANC</i>	36,316	394,711	45
<i>CISO</i>	376,087	1,836,395	471,210
<i>IPCO</i>	61,682	487,517	274,213
<i>LADWP</i>	277,753	382,761	184,701
<i>NEVP</i>	241,823	265,294	416,010

NWMT	59,122	45,981	2,913
PACE	1,491,075	15,765	63,798
PACW	176,643	146,472	266,305
PGE	81,027	228,790	9,014
PNM	174,753	57,750	14
PSEI	137,017	97,415	61,839
PWRX	29,236	71,572	4,746
SCL	37,863	63,425	25,989
SRP	656,167	190,960	5,763
TIDC	47,875	50,676	122

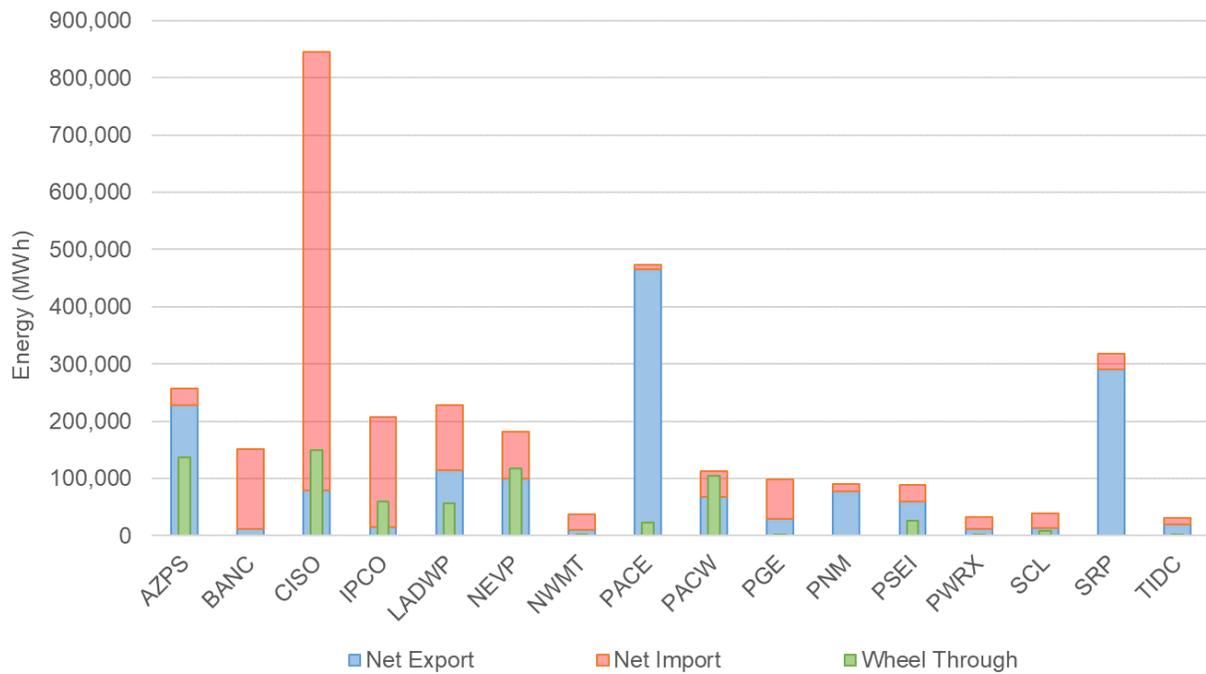
TABLE 3: Estimated wheel-through transfers in Q3 2021



GRAPH 3: Estimated wheel-through transfers in Q3 2021

BAA	Net Export	Net Import	Wheel-Through
<i>AZPS</i>	228,581	28,086	137,746
<i>BANC</i>	12,387	138,453	0
<i>CISO</i>	79,217	765,957	150,414
<i>IPCO</i>	14,479	193,474	60,686
<i>LADWP</i>	115,077	113,960	57,655
<i>NEVP</i>	100,800	81,569	117,622
<i>NWMT</i>	10,670	26,911	49
<i>PACE</i>	465,824	8,423	22,858
<i>PACW</i>	68,764	44,579	105,488
<i>PGE</i>	29,365	68,901	2,220
<i>PNM</i>	77,312	13,651	-
<i>PSEI</i>	59,621	29,951	25,920
<i>PWRX</i>	11,498	20,838	1,508
<i>SCL</i>	14,022	24,977	8,410
<i>SRP</i>	291,269	27,417	-
<i>TIDC</i>	20,058	11,795	81

TABLE 4: Estimated wheel-through transfers in July 2021

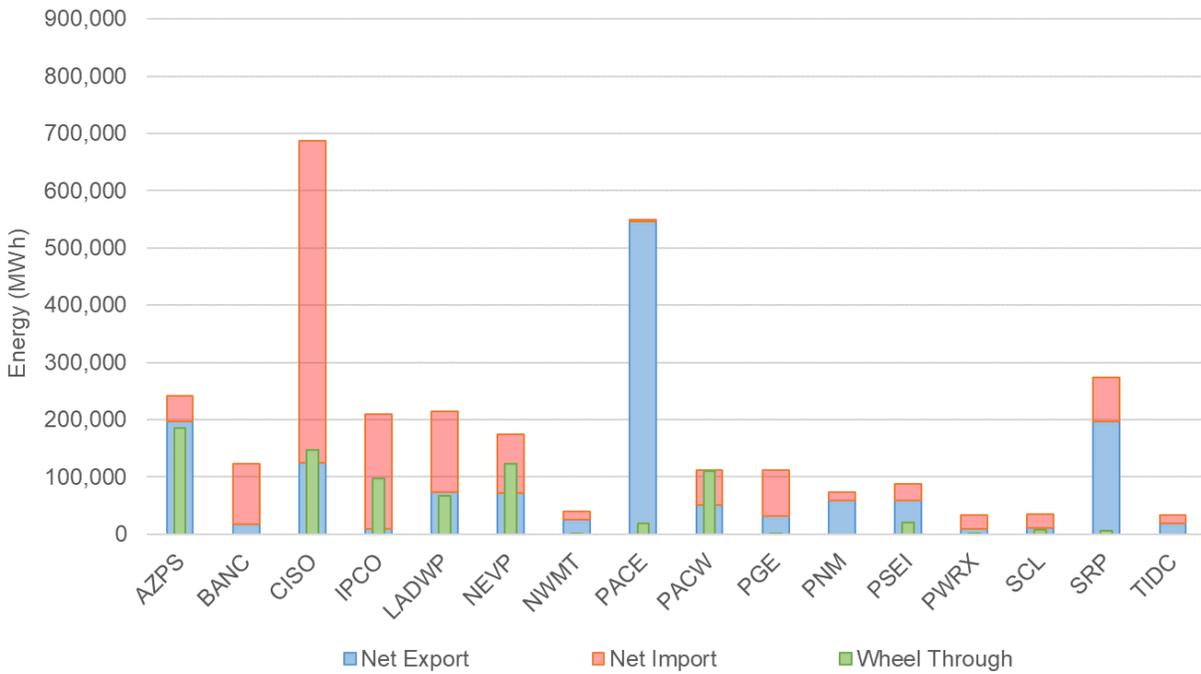


GRAPH 4: Estimated wheel-through transfers in July 2021

BAA	Net Export	Net Import	Wheel- Through
AZPS	196,446	45,986	185,470
BANC	17,409	106,441	-
CISO	124,056	563,565	146,994
IPCO	10,016	198,873	97,539
LADWP	73,582	140,984	66,510
NEVP	72,457	102,222	122,811
NWMT	25,718	13,928	742
PACE	546,801	3,238	19,038
PACW	50,341	61,830	109,874
PGE	30,948	80,716	1,964
PNM	58,818	15,078	-
PSEI	58,677	29,712	20,148
PWRX	9,911	23,329	1,630

<i>SCL</i>	10,854	23,518	7,586
<i>SRP</i>	196,641	76,356	5,575
<i>TIDC</i>	18,509	15,407	-

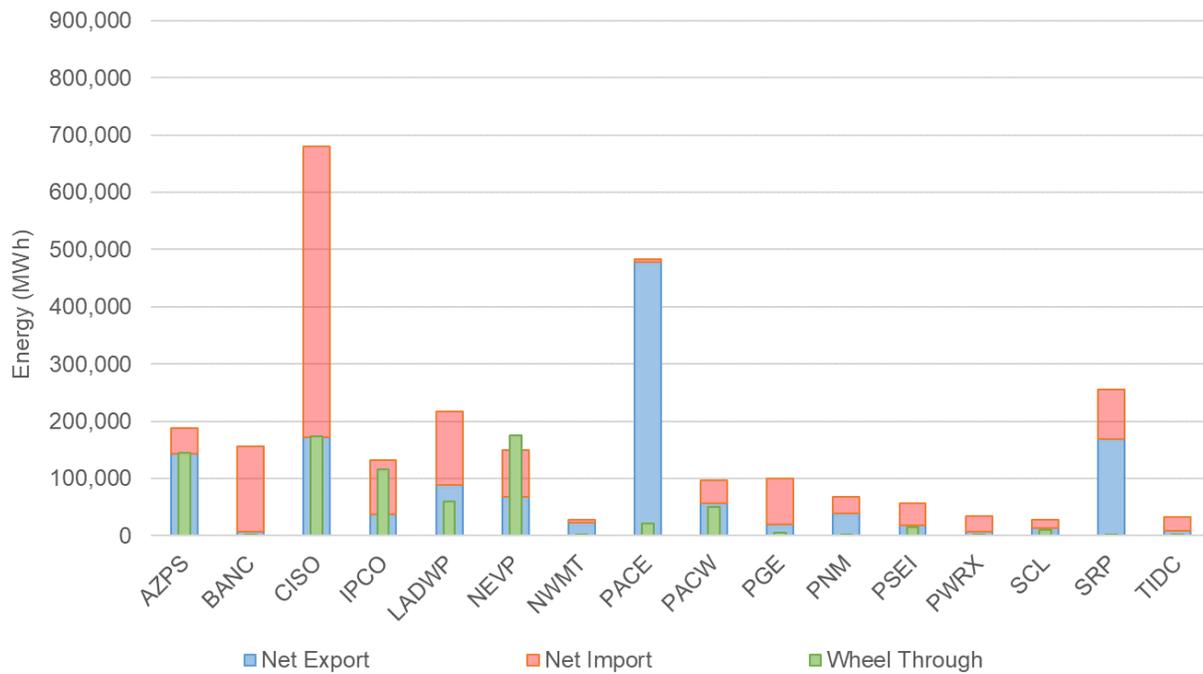
TABLE 5: Estimated wheel-through transfers in August 2021



GRAPH 5: Estimated wheel-through transfers in August 2021

<i>BAA</i>	Net Export	Net Import	Wheel Through
<i>AZPS</i>	144,092	44,003	144,874
<i>BANC</i>	6,520	149,817	45
<i>CISO</i>	172,814	506,873	173,802
<i>IPCO</i>	37,187	95,170	115,988
<i>LADWP</i>	89,094	127,816	60,536
<i>NEVP</i>	68,565	81,502	175,577
<i>NWMT</i>	22,734	5,142	2,122
<i>PACE</i>	478,450	4,104	21,902
<i>PACW</i>	57,538	40,063	50,943
<i>PGE</i>	20,713	79,172	4,830
<i>PNM</i>	38,623	29,021	14
<i>PSEI</i>	18,719	37,752	15,771
<i>PWRX</i>	7,827	27,405	1,608
<i>SCL</i>	12,987	14,930	9,992
<i>SRP</i>	168,258	87,186	188
<i>TIDC</i>	9,309	23,474	41

TABLE 6: Estimated wheel-through transfers in September 2021



GRAPH 6: Estimated wheel-through transfers in September 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 Q3 2021 was calculated to be 4,491 MWh (July) + 7,099 MWh (August) + 11,451 MWh (September) = 23,042 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 9,862 metric tons of CO₂ for Q3 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 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
Total		1,532,156	655,683

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

■ 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
July	AZPS	up	35	319
	BANC	up	6	81
	CISO	up	400	2,059
	IPCO	up	35	256
	LADWP	up	45	359
	NEVP	up	41	303
	NWMT	up	32	83
	PACE	up	115	541
	PACW	up	44	203
	PGE	up	69	220
	PNM	up	53	227
	PSEI	up	31	151
	PWRX	up	58	258
	SCL	up	4	34
	SRP	up	23	160
	TIDC	up	1	16
	ALL EIM	up	589	2,239
	AZPS	down	4	299
	BANC	down	4	118
	CISO	down	0	1,631
IPCO	down	39	239	
LADWP	down	39	218	

July	<i>NEVP</i>	down	14	285
	<i>NWMT</i>	down	25	100
	<i>PACE</i>	down	146	581
	<i>PACW</i>	down	44	159
	<i>PGE</i>	down	36	244
	<i>PNM</i>	down	54	212
	<i>PSEI</i>	down	33	137
	<i>PWRX</i>	down	74	238
	<i>SCL</i>	down	4	34
	<i>SRP</i>	down	20	191
	<i>TIDC</i>	down	2	14
	ALL EIM	down	0	1,775
	August	<i>AZPS</i>	up	41
<i>BANC</i>		up	7	83
<i>CISO</i>		up	505	2,068
<i>IPCO</i>		up	33	256
<i>LADWP</i>		up	40	359
<i>NEVP</i>		up	57	303
<i>NWMT</i>		up	32	83
<i>PACE</i>		up	100	541
<i>PACW</i>		up	42	203
<i>PGE</i>		up	67	273
<i>PNM</i>		up	47	227
<i>PSEI</i>		up	35	151
<i>PWRX</i>		up	64	258
<i>SCL</i>		up	3	34
<i>SRP</i>		up	45	160
<i>TIDC</i>		up	2	16
ALL EIM		up	669	2,541
<i>AZPS</i>		down	5	299
<i>BANC</i>		down	6	118

<i>August</i>	<i>CISO</i>	down	16	1,310
	<i>IPCO</i>	down	23	247
	<i>LADWP</i>	down	29	218
	<i>NEVP</i>	down	13	285
	<i>NWMT</i>	down	25	212
	<i>PACE</i>	down	121	581
	<i>PACW</i>	down	43	159
	<i>PGE</i>	down	36	216
	<i>PNM</i>	down	40	212
	<i>PSEI</i>	down	30	137
	<i>PWRX</i>	down	74	251
	<i>SCL</i>	down	3	41
	<i>SRP</i>	down	20	247
	<i>TIDC</i>	down	2	14
	ALL EIM	down	8	1,639
<i>September</i>	<i>AZPS</i>	up	31	335
	<i>BANC</i>	up	5	89
	<i>CISO</i>	up	428	2,669
	<i>IPCO</i>	up	38	256
	<i>LADWP</i>	up	44	230
	<i>NEVP</i>	up	41	360
	<i>NWMT</i>	up	26	141
	<i>PACE</i>	up	109	568
	<i>PACW</i>	up	25	203
	<i>PGE</i>	up	57	273
	<i>PNM</i>	up	46	227
	<i>PSEI</i>	up	28	160
	<i>PWRX</i>	up	64	228
	<i>SCL</i>	up	3	34
	<i>SRP</i>	up	44	210
<i>TIDC</i>	up	3	14	

September	ALL EIM	up	655	2,917
	AZPS	down	33	403
	BANC	down	9	118
	CISO	down	93	1,057
	IPCO	down	11	239
	LADWP	down	23	269
	NEVP	down	21	580
	NWMT	down	38	173
	PACE	down	157	591
	PACW	down	48	181
	PGE	down	39	215
	PNM	down	41	218
	PSEI	down	38	180
	PWRX	down	85	300
	SCL	down	3	41
	SRP	down	19	382
	TIDC	down	2	14
	ALL EIM	down	66	1,633

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.

<i>Direction</i>	July		August		September	
	Up	Down	Up	Down	Up	Down
<i>Average MW saving</i>	1,317	1,442	1,326	1,461	1,255	1,385
<i>Sum of BAA requirements</i>	2,611	2,267	2,626	2,323	2,580	2,248
<i>Percentage savings</i>	50%	64%	50%	63%	49%	62%

Table 9: Flexible ramping procurement diversity savings in Q3 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 655,683 metric tons of CO₂, roughly the equivalent of avoiding the emissions from 137,854 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
LADWP	Los Angeles Department of Water and Power
MW	Megawatt
MWh	Megawatt-Hour
NVE	NV Energy
NWMT	North West Energy
PAC	PacifiCorp
PACE	PacifiCorp East
PACW	PacifiCorp West
PNM	Public Service Company of New Mexico
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