# Western EIM Benefits Report

# Third Quarter 2017

## October 18, 2017

# Contents

## Executive Summary

This report presents the benefits associated with participation in the western Energy Imbalance Market (EIM) for the third quarter of 2017. The benefits include cost savings and the use of surplus renewable energy to displace conventional generating resources.

The estimated gross benefits for July, August and September2017 are $40.55 million, bringing the total benefits of EIM to $254.98 million since the California Independent System Operator (ISO) expanded its real-time market to balancing authority areas outside the ISO in November 2014.

The report also shows that EIM is helping to displace less-clean energy supplies with surplus renewable energy that otherwise may have been curtailed.[1] In Q3, the EIM used 23,331 MWh of surplus renewable energy to displace 9,986 metric tons of $CO_2$ emissions.

The benefit calculation methodology is described in a separate document.[2] This analysis demonstrates the real-time market's ability to select the most economic resources across the ISO, PacifiCorp, NVE, APS and PSE balancing authority areas (BAAs), which comprise the EIM footprint. The benefits quantified in this report fall into three categories and were described in earlier studies:[3]

- ***More efficient dispatch, both inter-and intra-regional, in the Fifteen-Minute Market (FMM) and Real-Time Dispatch (RTD). Q3 estimated savings = $40.55 million.***
- ***Reduced renewable energy curtailment. Q3 estimated reduction = 23,331 MWh displacing approximately 9,986 metric tons of $CO_2$.***
- ***Reduced flexibility ramping reserves needed in all balancing authority areas. Q3 reduction = 425 MW – 452 MW in the upward direction and 487 MW – 507 MW in the downward direction.***

[1] 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

[2] EIM Quarterly Benefit Report Methodology, https://www.caiso.com/Documents/EIM_BenefitMethodology.pdf

[3] PacifiCorp-ISO, Energy Imbalance Markets Benefits, http://www.caiso.com/Documents/PacifiCorp-ISOEnergyImbalanceMarketBenefits.pdf

## Background

The EIM began financially-binding operation on November 1, 2014 by optimizing resources across the ISO and PacifiCorp BAAs. NV Energy, operating in Nevada, began participating in December 2015. Arizona Public Service and Puget Sound Energy began operations October 1, 2016. Portland General Electric began participation on October 1, 2017 and will be included in this benefit analysis for Q4. The EIM footprint now includes portions of Arizona, California, Idaho, Nevada, Oregon, Utah, Washington, and Wyoming. 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 Q3 2017

Table 1 shows the estimated EIM gross benefits by each region per month. The monthly savings presented in the table show $10.57 million for July, $18.57 million for August, and $11.41 million for September with a total estimated benefit of $40.55 million.

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.

| Region | July | August | September | Total |
|---|---|---|---|---|
| APS | $2.52 | $4.92 | $3.64 | $11.08 |
| ISO | $2.01 | $4.59 | $1.03 | $7.63 |
| NV Energy | $2.28 | $3.41 | $2.86 | $8.55 |
| PacifiCorp | $2.79 | $4.52 | $3.00 | $10.31 |
| PSE | $0.97 | $1.13 | $0.88 | $2.98 |
| Total | $10.57 | $18.57 | $11.41 | $40.55 |

**Table 1: Third quarter 2017 benefits in millions USD**

## 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 in RTD. The RTD transfer capacities between PACW 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.

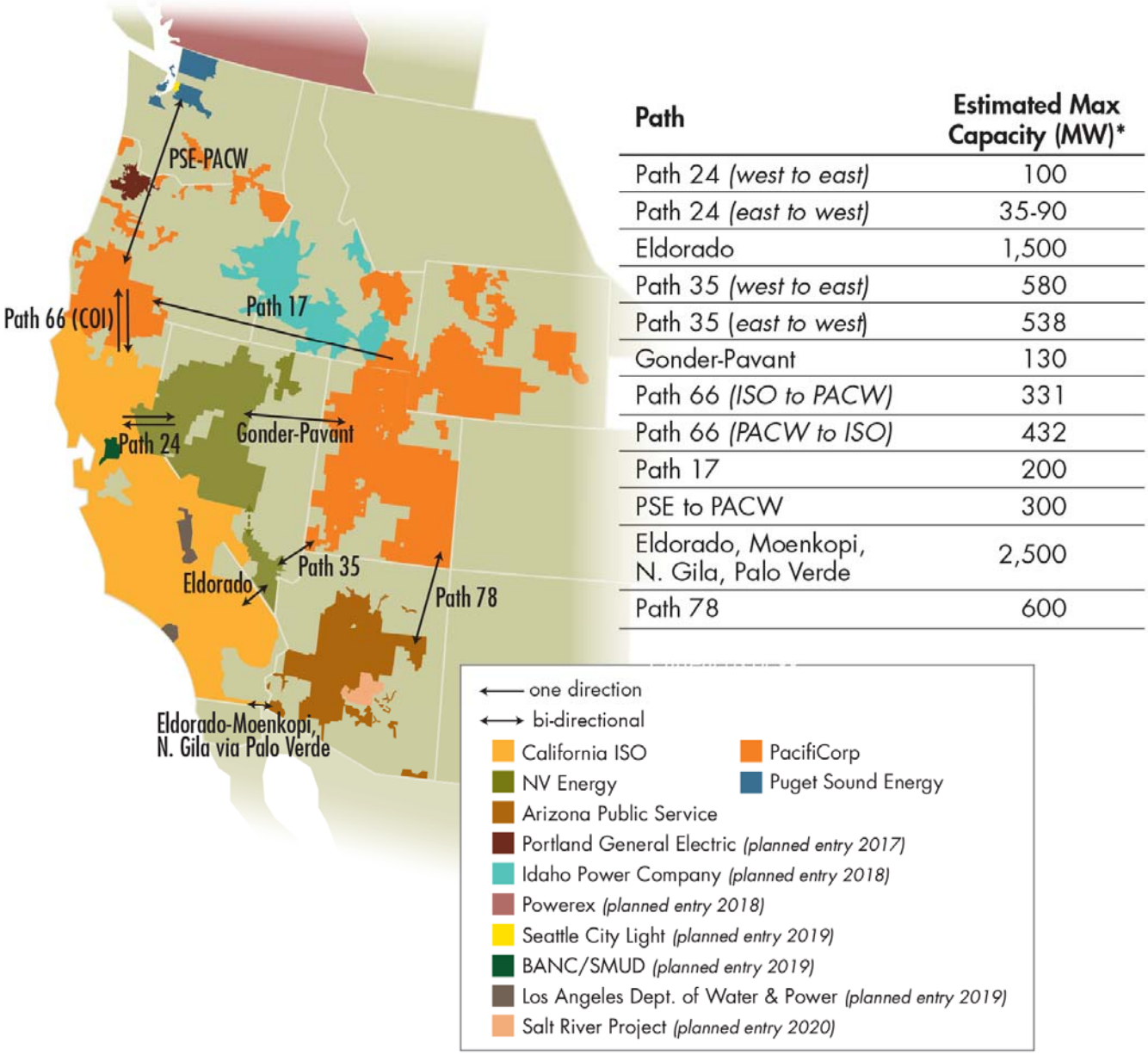
Table 2 provides the 15-minute and 5-minute EIM transfer volumes with base schedule transfers excluded. The EIM entities submit inter-BAA transfers in their base schedules. The benefits quantified in this report are only attributable to the transfers that occurred through the EIM. The benefits do not 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.

| Year | Month | from_BAA | to_BAA | 15m EIM transfer (15m - base) | 5m EIM transfer (5m - base) |
|---|---|---|---|---|---|
| 2017 | July | AZPS | CISO | 134,044 | 80,869 |
| | | AZPS | NEVP | 15,347 | 13,025 |
| | | AZPS | PACE | 10,844 | 18,019 |
| | | CISO | AZPS | 34,213 | 47,080 |
| | | CISO | NEVP | 49,117 | 72,134 |
| | | CISO | PACW | 7,723 | 7,985 |
| | | NEVP | AZPS | 9,469 | 10,566 |
| | | NEVP | CISO | 57,378 | 58,525 |
| | | NEVP | PACE | 31,888 | 50,159 |
| | | PACE | AZPS | 112,375 | 88,155 |
| | | PACE | NEVP | 75,379 | 58,277 |
| | | PACE | PACW | 22,924 | 39,897 |
| | | PACW | CISO | 106,635 | 115,985 |
| | | PACW | PSEI | 28,820 | 31,222 |
| | | PSEI | PACW | 53,054 | 49,653 |

| Year | Month | from_BAA | to_BAA | 15m EIM transfer (15m - base) | 5m EIM transfer (5m - base) |
|---|---|---|---|---|---|
| 2017 | August | AZPS | CISO | 188,104 | 142,716 |
| | | AZPS | NEVP | 4,963 | 5,366 |
| | | AZPS | PACE | 14,659 | 25,476 |
| | | CISO | AZPS | 35,534 | 49,701 |
| | | CISO | NEVP | 23,452 | 35,949 |
| | | CISO | PACW | 14,142 | 16,289 |
| | | NEVP | AZPS | 17,708 | 18,570 |
| | | NEVP | CISO | 90,989 | 95,772 |
| | | NEVP | PACE | 35,264 | 53,459 |
| | | PACE | AZPS | 119,997 | 82,976 |
| | | PACE | NEVP | 67,119 | 60,968 |
| | | PACE | PACW | 21,600 | 45,867 |
| | | PACW | CISO | 85,047 | 92,087 |
| | | PACW | PSEI | 45,607 | 51,947 |
| | | PSEI | PACW | 32,553 | 29,239 |
| 2017 | September | AZPS | CISO | 126,311 | 77,278 |
| | | AZPS | NEVP | 5,021 | 4,707 |
| | | AZPS | PACE | 17,587 | 21,246 |
| | | CISO | AZPS | 94,687 | 123,058 |
| | | CISO | NEVP | 56,797 | 97,018 |
| | | CISO | PACW | 23,556 | 26,341 |
| | | NEVP | AZPS | 14,757 | 14,962 |
| | | NEVP | CISO | 49,519 | 46,328 |
| | | NEVP | PACE | 84,605 | 121,362 |
| | | PACE | AZPS | 118,185 | 74,619 |
| | | PACE | NEVP | 25,683 | 26,454 |
| | | PACE | PACW | 15,832 | 39,011 |
| | | PACW | CISO | 77,650 | 79,897 |
| | | PACW | PSEI | 39,570 | 42,117 |
| | | PSEI | PACW | 41,868 | 42,459 |

**Table 2: Energy transfers (MWh) in the FMM and RTD for the Third quarter 2017**




| Path | Estimated Max Capacity (MW)* |
|---|---|
| Path 24 *(west to east)* | 100 |
| Path 24 *(east to west)* | 35-90 |
| Eldorado | 1,500 |
| Path 35 *(west to east)* | 580 |
| Path 35 *(east to west)* | 538 |
| Gonder-Pavant | 130 |
| Path 66 *(ISO to PACW)* | 331 |
| Path 66 *(PACW to ISO)* | 432 |
| Path 17 | 200 |
| PSE to PACW | 300 |
| Eldorado, Moenkopi, N. Gila, Palo Verde | 2,500 |
| Path 78 | 600 |

**Graph 1: Estimated maximum transfer capacity (EIM entities operating in Q3)**

## 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 committed to tracking the volume of wheels through in the EIM market in this quarterly report. In order to derive the wheels through for each EIM BAA, the ISO uses the following calculation for every real-time interval dispatch:

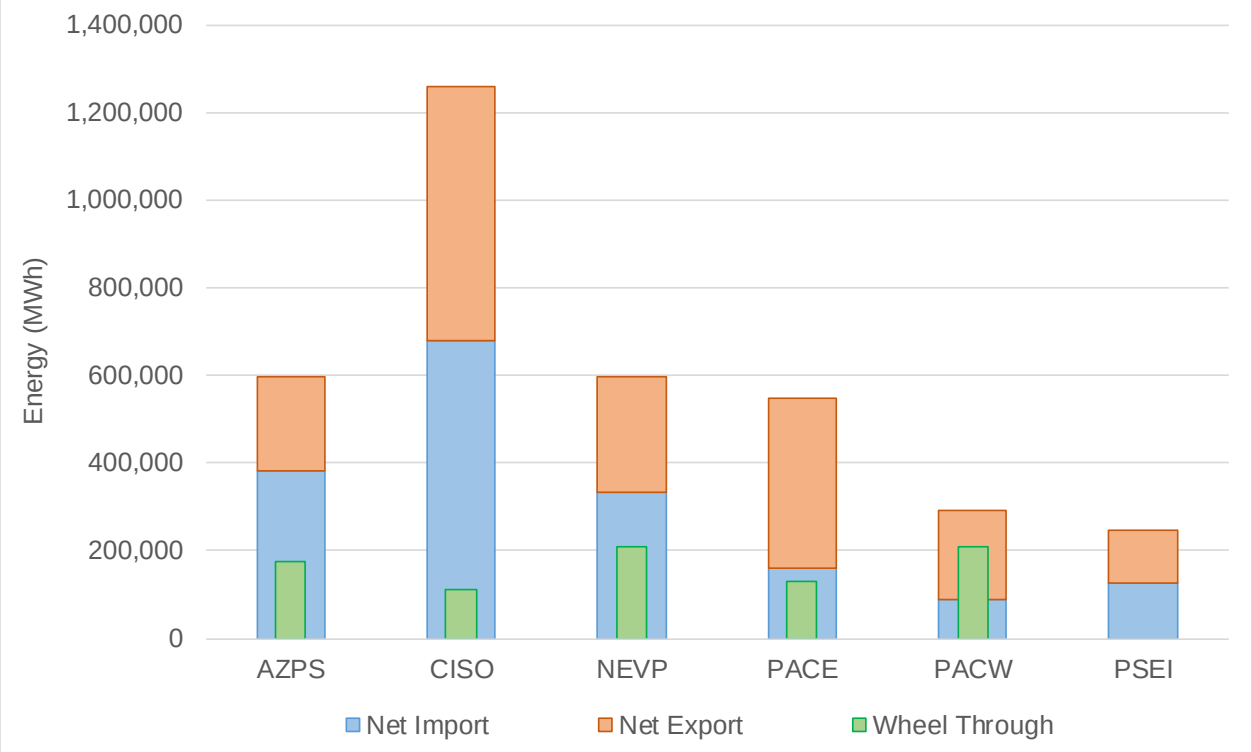
- Total import: summation of transfers above base transfers coming into the EIM BAA under analysis
- Total export: summation of all transfers above base transfers leaving the EIM BAA under analysis
- Net import: the maximum of zero or the difference between all imports and exports
- Net export: the maximum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

| BAA | Net Import | Net Export | Wheel Through |
|---|---|---|---|
| AZPS | 382,490 | 212,900 | 176,195 |
| CISO | 678,980 | 580,146 | 111,276 |
| NEVP | 333,112 | 264,232 | 208,611 |
| PACE | 161,778 | 386,694 | 129,131 |
| PACW | 87,725 | 204,238 | 209,871 |
| PSEI | 125,705 | 121,579 | - |

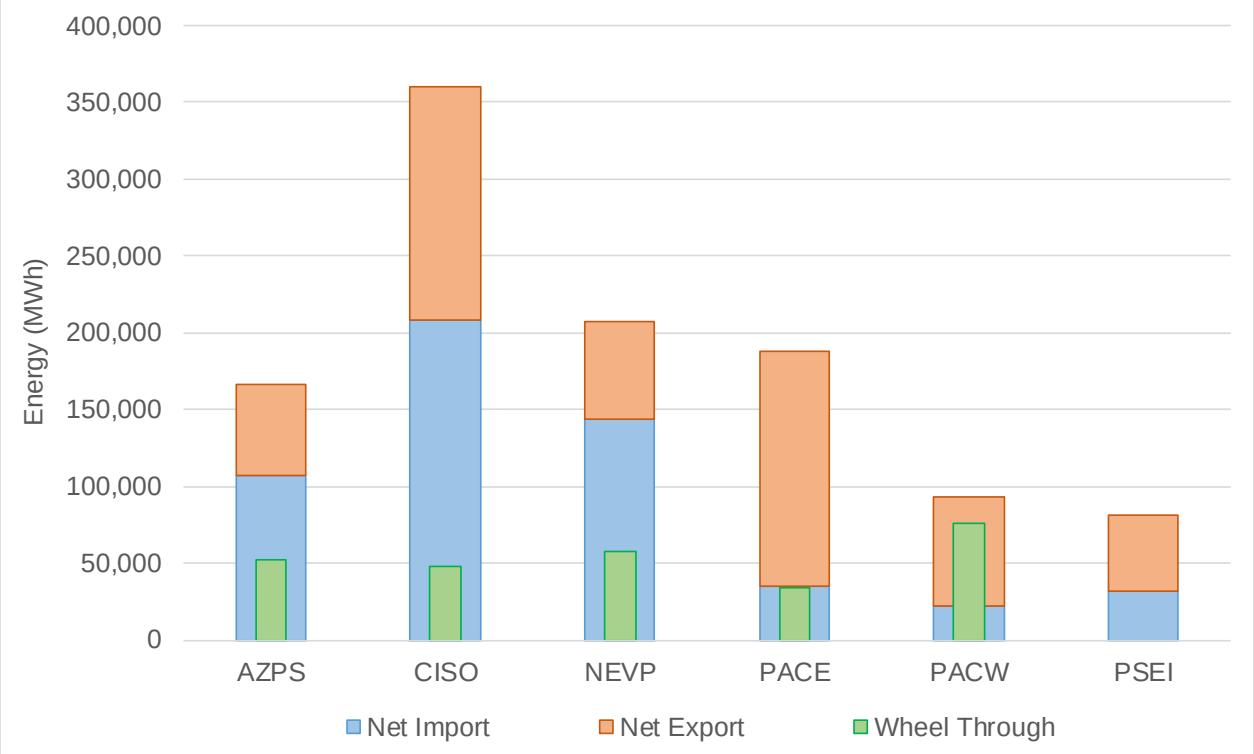
**Table 3: Estimated wheel through transfers in Q3 2017**




**Graph 2: Estimated wheel through transfers in Q3 2017**

| BAA | Net Import | Net Export | Wheel Through |
|---|---|---|---|
| AZPS | 106,663 | 59,646 | 52,431 |
| CISO | 208,367 | 150,912 | 47,483 |
| NEVP | 144,173 | 62,621 | 57,761 |
| PACE | 35,174 | 152,919 | 33,504 |
| PACW | 21,679 | 71,478 | 76,266 |
| PSEI | 31,380 | 49,859 | - |

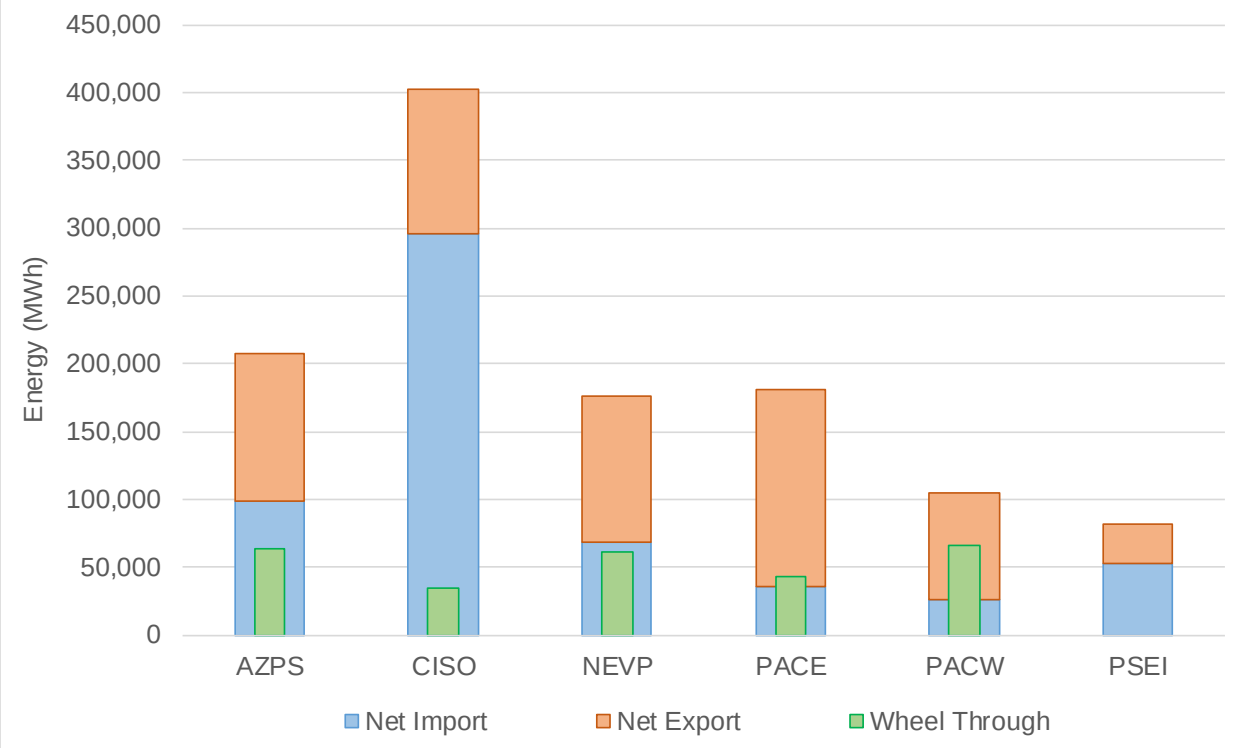
**Table 4: Estimated wheel through transfers in July 2017**




**Graph 3: Estimated wheel through transfers in July 2017**

| BAA | Net Import | Net Export | Wheel Through |
|---|---|---|---|
| AZPS | 98,255 | 109,778 | 64,040 |
| CISO | 296,127 | 105,953 | 34,775 |
| NEVP | 68,826 | 107,189 | 61,105 |
| PACE | 35,433 | 146,029 | 43,579 |
| PACW | 26,115 | 78,721 | 65,579 |
| PSEI | 52,156 | 29,244 | - |

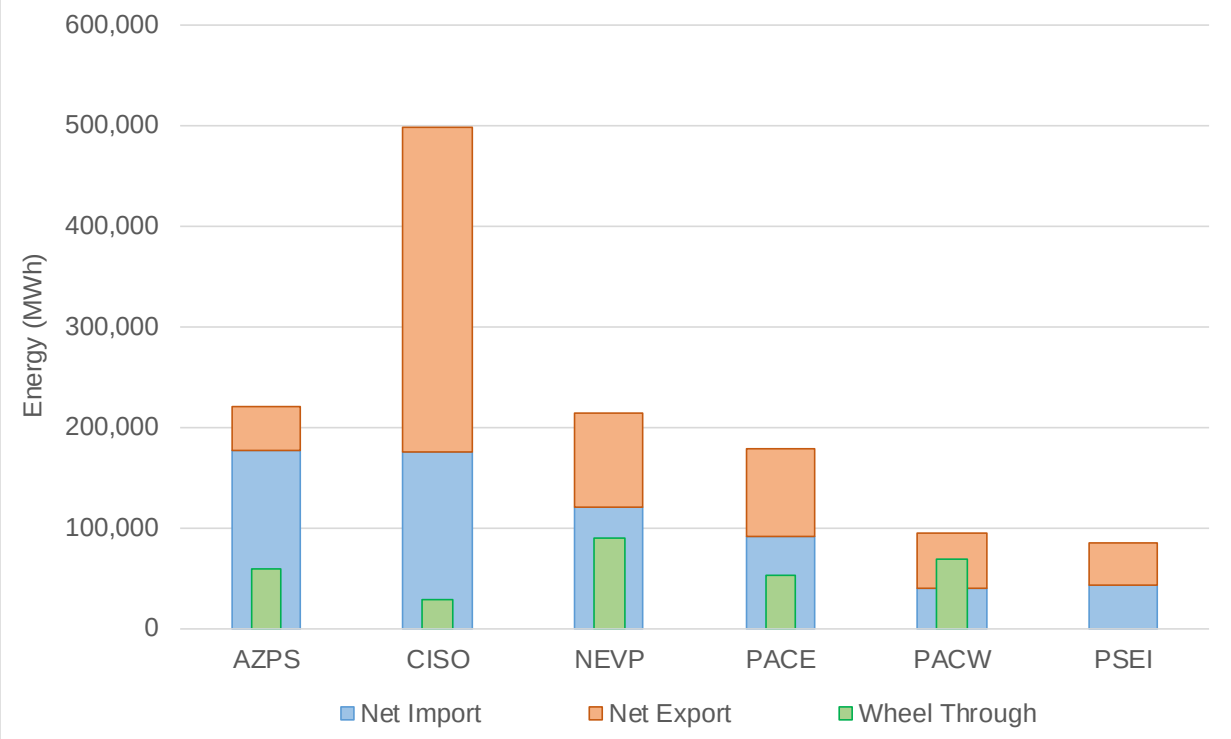
**Table 5: Estimated wheel through transfers in August 2017**




**Graph 4: Estimated wheel through transfers in August 2017**

| BAA | Net Import | Net Export | Wheel Through |
|---|---|---|---|
| AZPS | 177,573 | 43,476 | 59,724 |
| CISO | 174,486 | 323,282 | 29,018 |
| NEVP | 120,113 | 94,423 | 89,745 |
| PACE | 91,171 | 87,745 | 52,048 |
| PACW | 39,931 | 54,039 | 68,027 |
| PSEI | 42,169 | 42,477 | - |

**Table 6: Estimated wheel through transfers in September 2017**




**Graph 5: Estimated wheel through transfers in September 2017**

## 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. 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 2017 was calculated to be 1,162 MWh (July) + 2,944 MWh (August) + 19,225 MWh (September) = 23,331 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 $CO_2$/MWh, avoided curtailments displaced an estimated 9,986 metric tons of $CO_2$ for Q3 2017. 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 $CO_2$ are shown in Table 7.

| Year | Quarter | MWh | Eq. Tons CO2 |
|---|---|---|---|
| 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 |
| | Total | 502,357 | 214,927 |

**Table 7: Total reduction in curtailment of renewable energy along with the associated reductions in $CO_2$**

## Flexible ramping procurement diversity savings

The EIM facilitates procurement of flexible ramping capacity in the FMM to address variability that may occur in the RTD. Because variability across different BAAs may happen in opposite directions, the flexible ramping requirement for the entire EIM footprint can be less than the sum of individual BAA's requirements. This difference is known as flexible ramping procurement diversity savings. Starting in November 2016, the ISO replaced the flexible ramping constraint with flexible ramping products that provide both upward and downward ramping. The minimum and maximum flexible ramping requirements for each BAA and for each direction are listed in Table 8.

| Year | Month | BAA | Direction | Minimum requirement | Maximum requirement |
|---|---|---|---|---|---|
| 2017 | July | AZPS | up | 13 | 288 |
| | | CISO | up | 87 | 1,000 |
| | | NEVP | up | 0 | 250 |
| | | PACE | up | 80 | 300 |
| | | PACW | up | 19 | 150 |
| | | PSEI | up | 12 | 135 |
| | | ALL EIM | up | 115 | 1,800 |
| | | AZPS | down | 7 | 350 |
| | | CISO | down | 13 | 1,000 |
| | | NEVP | down | 0 | 250 |
| | | PACE | down | 42 | 300 |
| | | PACW | down | 35 | 175 |
| | | PSEI | down | 1 | 135 |
| | | ALL EIM | down | 0 | 1,200 |
| 2017 | August | AZPS | up | 11 | 288 |
| | | CISO | up | 0 | 1,000 |
| | | NEVP | up | 0 | 250 |
| | | PACE | up | 70 | 300 |
| | | PACW | up | 0 | 150 |
| | | PSEI | up | 12 | 135 |
| | | ALL EIM | up | 5 | 1,800 |
| | | AZPS | down | 4 | 350 |
| | | CISO | down | 0 | 1,000 |
| | | NEVP | down | 0 | 250 |
| | | PACE | down | 1 | 300 |
| | | PACW | down | 10 | 175 |
| | | PSEI | down | 0 | 135 |
| | | ALL EIM | down | 0 | 1,200 |
| 2017 | September | AZPS | up | 0 | 288 |
| | | CISO | up | 42 | 1,000 |
| | | NEVP | up | 0 | 250 |
| | | PACE | up | 39 | 300 |
| | | PACW | up | 0 | 150 |
| | | PSEI | up | 4 | 135 |
| | | ALL EIM | up | 6 | 1,800 |
| | | AZPS | down | 0 | 350 |
| | | CISO | down | 0 | 1,000 |
| | | NEVP | down | 0 | 250 |
| | | PACE | down | 0 | 300 |
| | | PACW | down | 19 | 174 |
| | | PSEI | down | 0 | 135 |
| | | ALL EIM | down | 0 | 1,200 |

**Table 8: Flexible ramping requirements**

The flexible ramping procurement diversity savings for all the intervals averaged over a month are shown in Table 9. The percentage savings is the average MW savings divided by the sum of the four individual BAA requirements.

| | July | | August | | September | |
|---|---|---|---|---|---|---|
| **Direction** | Up | Down | Up | Down | Up | Down |
| **Average MW saving** | 452 | 487 | 452 | 495 | 425 | 507 |
| **Sum of BAA requirements** | 1,236 | 1,232 | 1,246 | 1,247 | 1,274 | 1,259 |
| **Percentage savings** | 37% | 40% | 36% | 40% | 33% | 40% |

**Table 9: Flexible ramping procurement diversity savings for third quarter 2017**

Flexible ramping capacity may be used in RTD to handle uncertainties in the future interval. The RTD flexible ramping capacity is prorated to each BAA. Flexible ramping surplus MW is defined as the awarded flexible ramping capacity in RTD minus its share, and the flexible ramping surplus cost is defined as the flexible ramping surplus MW multiplied by the flexible ramping EIM-wide marginal price. A positive flexible ramping surplus MW is the capacity that a BAA provided to help other BAAs, and a negative flexible ramping surplus MW is the capacity that a BAA received from other BAAs. The EIM dispatch cost for a BAA with positive flexible ramping surplus MW is increased because some capacities are used to help other BAAs. The flexible ramping surplus cost is subtracted from the BAA's EIM dispatch cost to reflect the true dispatch cost of a BAA. Please see the Benefit Report Methodology in the Appendix for more details.

## Conclusion

Participation in the western EIM continues to show that utilities can realize cost benefits and reduced carbon emissions. With $254.98 million in gross benefits to date, the realized savings are in line with analysis conducted by each EIM entity before they joined EIM. The EIM resource sharing also continues to have a positive effect on 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 GHG quantified benefits due to avoided curtailments[4] of 214,927 metric tons from 2015 to date is roughly equivalent to avoiding the emissions from 45,187 passenger cars driven for one year.

[4] See footnote 1 on page 3.