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Avista Energy Imbalance Market Benefits Assessment

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Energy+Environmental Economics

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Overview

Since its creation in 2014 through September 2017, the Western Energy Imbalance Market (EIM) has expanded to include four participating EIM entities (which are each balancing authority areas, or BAAs) and the California Independent System Operator (CAISO). Portland General Electric (PGE) entered the EIM in October 2017, and six additional EIM entities are expected to enter between 2018 and 2020.[1] Before deciding whether to enter the EIM, prospective participants have undertaken studies to assess the EIM's value proposition for their customers, to weigh the potential benefits against the costs of participation.

This report estimates potential benefits to Avista Utilities from participating in the Western EIM, based on benchmarking and statistical analyses that draw on nine publicly-available EIM potential benefit studies and the CAISO's quarterly *Western EIM Benefits Reports*. With this approach, the report provides reasonable estimates of the range of expected benefits from EIM participation for Avista, without the need to undertake a detailed modeling study.

Based on this approach, the study estimates that EIM gross benefits to Avista in 2023 would range from $2 million to $13 million per year (all values in 2017$). Actual benefits to Avista will depend primarily on the availability of its hydropower resources to participate in the EIM, the transmission capacity that is available for use by the EIM, expansion of wind and solar resources within the Avista balancing area, and EIM market conditions.

This report is organized into three sections:

- Section 1 provides a general overview of the kinds of potential benefits and costs for EIM participants, as background;
- Section 2 describes methods and results from the benchmarking and statistical analyses; and
- Section 3 summarizes key conclusions from the analyses.

[1] Entities that are currently committed to join include Idaho Power Company (IPC) and Powerex, which are scheduled to go online in 2018, Seattle City Light (SCL), Sacramento Municipal Utility District (SMUD) and Los Angeles Department of Water and Power (LADWP) in 2019, and Salt River Project (SRP) in 2020.

1. EIM Benefits and Costs

Quantitative benefit projections in EIM studies have largely focused on the value of interregional dispatch savings and, to a lesser extent, reduced flexibility reserve needs. The CAISO's *Western EIM Benefits Reports* include ex-post estimates of actual interregional dispatch savings (in dollars), reduced flexibility reserve needs (in MW and percent reduction), reduced wind and solar energy curtailment (in GWh), and reduced greenhouse gas (GHG) emissions (in metric tons of CO_2). Table 1 describes five categories of expected benefits for participating entities in the Western EIM.

Table 1. Descriptions of EIM benefit categories

Benefit Category	Description
Interregional dispatch savings	Cost savings from more efficient real-time dispatch of generation across the EIM footprint including access to excess renewable energy from other participating EIM entities.
Reduced flexibility reserve needs	Cost savings from lower flexibility or "load following" reserve requirements to balance within-hour changes in load, wind generation, and solar generation
Reduced wind and solar curtailment	Fuel cost savings, and avoided loss of renewable energy credits and tax credits where applicable, from reduced curtailment of wind and solar generation
Reduced GHG emissions	Reductions in GHG emissions from more efficient dispatch of thermal generation and reduced wind and solar curtailment
Improved reliability	Reduced risk of reliability violations, through greater regional visibility and situational awareness of system conditions and contingencies, automated security-constrained response to congestion, and mitigation of delays in manually finding generation to replace operating reserves

The scope of this report on EIM benefits is limited to interregional dispatch savings. This focus on dispatch savings is not because it is necessarily the largest benefit, but rather because it is the most straightforward to quantify and is the only metric that has been quantified across all EIM studies. To the extent that other benefit categories are also applicable to Avista, those benefits would represent additional upside potential from EIM participation.

Incremental costs to EIM participants have included the initial, upfront cost of software and system integration, estimated at $10-20 million, and annual operating costs, estimated at $1-3 million per year.[2] The wide range of estimated up-front costs are a result of EIM entities treating internal costs, such as meter upgrades, differently and starting at different integration points. Recent experience shows that improvements made by the CAISO and application vendors should result in integration costs towards the lower end of this range. Of this amount, the CAISO-related costs are estimated to be $400,000 up-front and $250,000 annually. The sum of upfront costs and the present value of annual costs can be compared against the present value of annual EIM benefits over a specified time horizon, to assess the cost-effectiveness of EIM entry.

[2] See, for instance, cost estimates in the APS and NV Energy EIM benefit studies, available at https://www.westerneim.com/Pages/About/default.aspx.

2. Avista Benefits Assessment

This study uses two approaches to estimate EIM benefits to Avista: (1) a benchmarking analysis, and (2) a statistical (regression) analysis. This section describes the data sources, methods, and results for both approaches.

Data Sources

Both the benchmarking and regression analyses draw on publicly-available EIM potential benefit studies[3] and the CAISO's quarterly *Western EIM Benefits Report*[4] series. Table 2Table 1 lists 50 total modeled scenarios, based on study-specific assumptions about a range of sensitivity variables including transmission availability, hydropower generation levels, and natural gas prices. CAISO and the eight utilities in Table 2 are referred to as 'EIM entities' in the remainder of this report.

Table 2. EIM benefit studies and CAISO reports used in this analysis

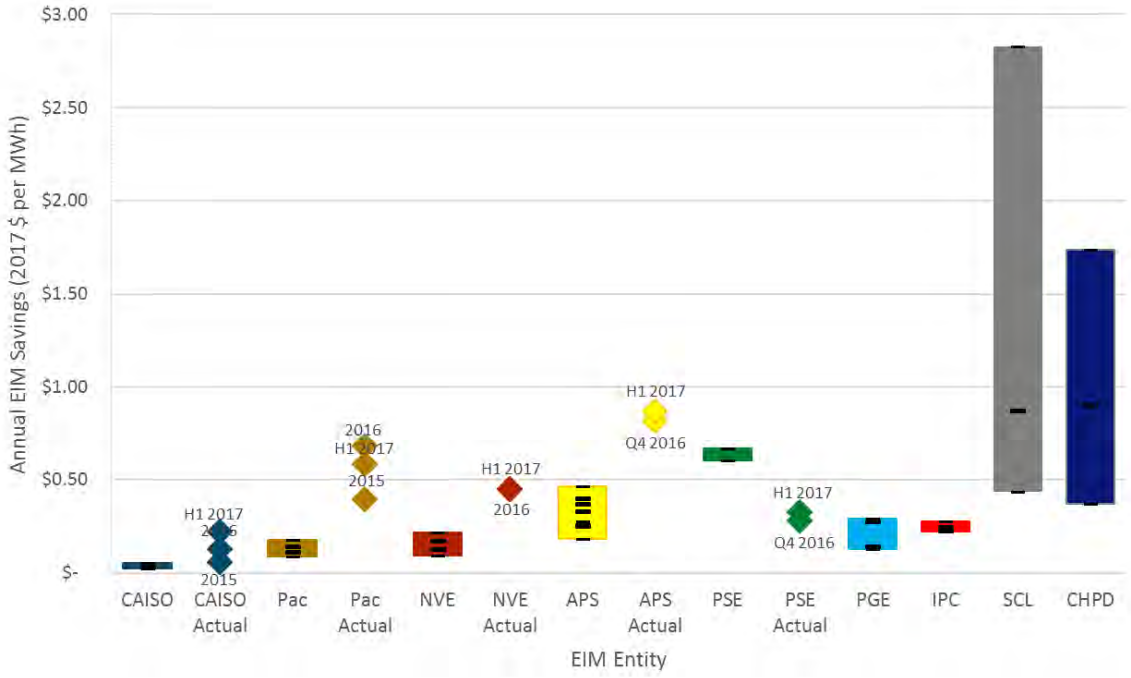
EIM Entity	Acronym	EIM Benefit Potential Study Scenarios	CAISO Report Coverage
CAISO	CAISO	6	Q4 2014 - Q2 2017
PacifiCorp	PAC	6	Q4 2014 - Q2 2017
NV Energy	NVE	4	Q4 2015 - Q2 2017
Puget Sound Energy	PSE	2	Q4 2016 - Q2 2017
Arizona Public Service	APS	13	Q4 2016 - Q2 2017
Portland General Electric	PGE	4	n/a
Idaho Power Company	IPC	4	n/a
Seattle City Light	SCL	8	n/a
Chelan County Public Utility District	CHPD	3	n/a

The 50 benefit potential scenarios and CAISO quarterly benefit reports create a wide range of projected and reported benefits (dispatch savings) to EIM entities, shown in Figure 1.

For comparability among EIM entities, this study normalized the benefits in Figure 1 to each entity's load for the historical year or projected study year. An exception is that the CHPD's benefits, which are normalized by generation rather than load, because of the large amount of hydropower in its balancing area relative to the size of its load. If normalized to load, the upper end of CHPD's benefit range would be higher than that of SCL. This study extrapolated partial year benefits for APS and PSE in 2016 and for all participating entities in 2017.

[3] See reference section for list of published benefit studies. CAISO and PacifiCorp benefits were studied jointly. CHPD results based on information described in Clearing Up, 1783, January 20, 2017 (Source: Energy News Data).
[4] See references section.

Figure 1. Range of annual load normalized benefits ($/MWh) to EIM entities, based on EIM studies and CAISO reports ("Actual")



The range of projected benefits in EIM potential studies (columns in Figure 1) is driven by scenario assumptions, while the range of CAISO-reported benefits (diamonds in Figure 1) is driven by actual market, weather and other operational conditions. Differences between projected benefits and actual benefits (as reported by CAISO) are driven both by differences between study assumptions and actual conditions and by the fact that modeling studies tend to underestimate the value of automated, centralized real-time dispatch relative to (non-EIM) business as usual operations.

CAISO-reported actual benefits for EIM entities have typically been higher than the estimated benefits in potential studies. PSE actual benefits for the first 3 quarters of EIM participation have thus far been lower than studied amounts, though CAISO staff indicates that one factor that may contribute to the lower actual observed savings are constraints applied by BPA on the rate of change of EIM flows across BPA flow gates. CAISO is working with BPA to enhance when and how such rate of change constraint limits should be applied.

A key question in this study is: **How can the range of benefit estimates across EIM entities in Figure 1 be narrowed to arrive at EIM benefit estimates that are consistent with the characteristics of Avista's electricity system?** Both the benchmark and regression analyses seek to address this question, using different approaches.

Benchmarking Analysis Methods and Results

The benchmarking analysis involves three steps:

1) Compare Avista with other EIM entities using five key metrics;
2) Narrow the range of load normalized benefits from Figure 1, based on the results of (1);
3) Estimate benefits to Avista in 2023, by multiplying the range of load normalized benefits from (2) by Avista's forecasted 2023 load.

Based on our experience identifying drivers of dispatch savings in previous EIM studies, this study selected the following five key metrics to compare Avista with other EIM entities:

1) Annual energy (load or generation);
2) Hydropower capacity as a share of generating capacity;
3) Transmission transfer capability to the rest of the EIM;
4) Solar and wind generating capacity as a share of generating capacity; and
5) Combustion turbine (CT) capacity.

The five figures that follow compare Avista to other EIM entities on the basis of these five metrics.

Figure 2. Annual load comparison:
Avista's annual load is most comparable to SCL, IPC, and PGE

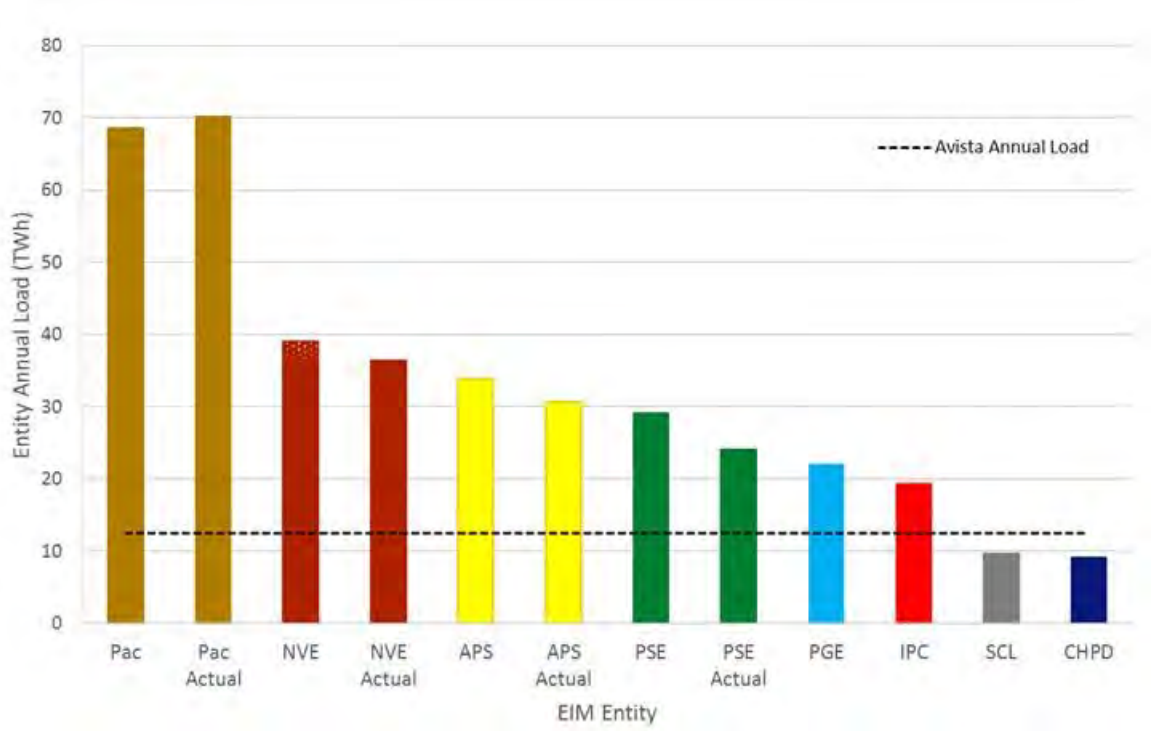


Figure 3. Hydropower share comparison:
Avista's share of hydropower capacity as a share of total generating capacity is most comparable to IPC, SCL, and CHPD

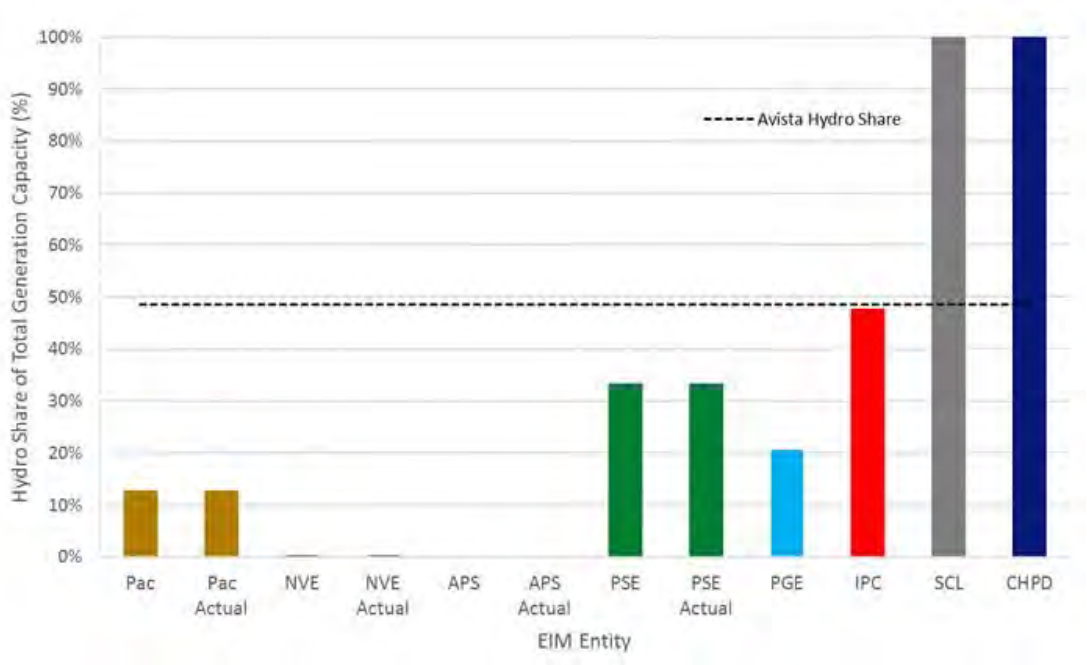


Figure 4. EIM transmission comparison:
Avista's transmission transfer capability to the rest of the EIM is most comparable to SCL, PSE, and PGE

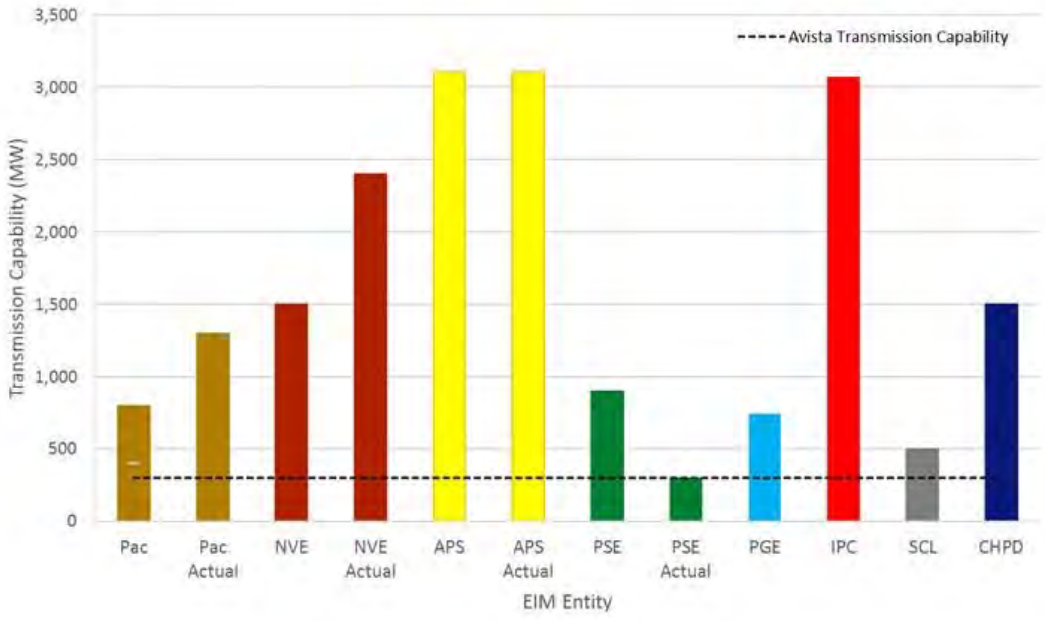


Figure 5. Solar and wind share comparison: ***Avista's wind and solar capacity as a share of total generating capacity is most comparable to PGE and NVE***

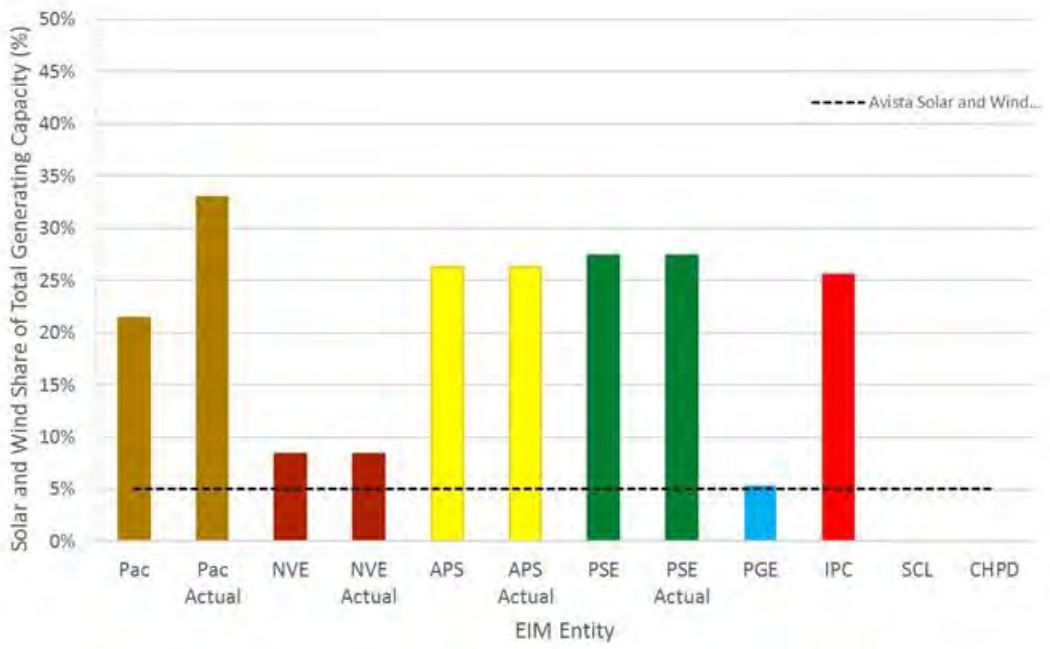
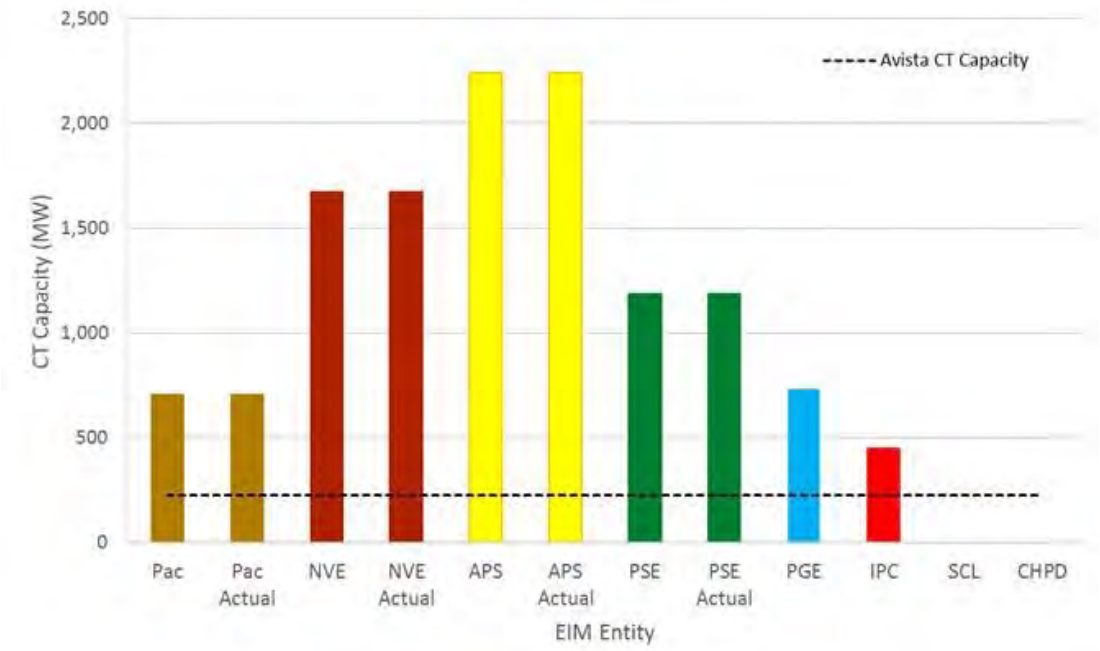


Figure 6. CT capacity comparison: ***Avista's CT capacity is most comparable to IPC and PGE***

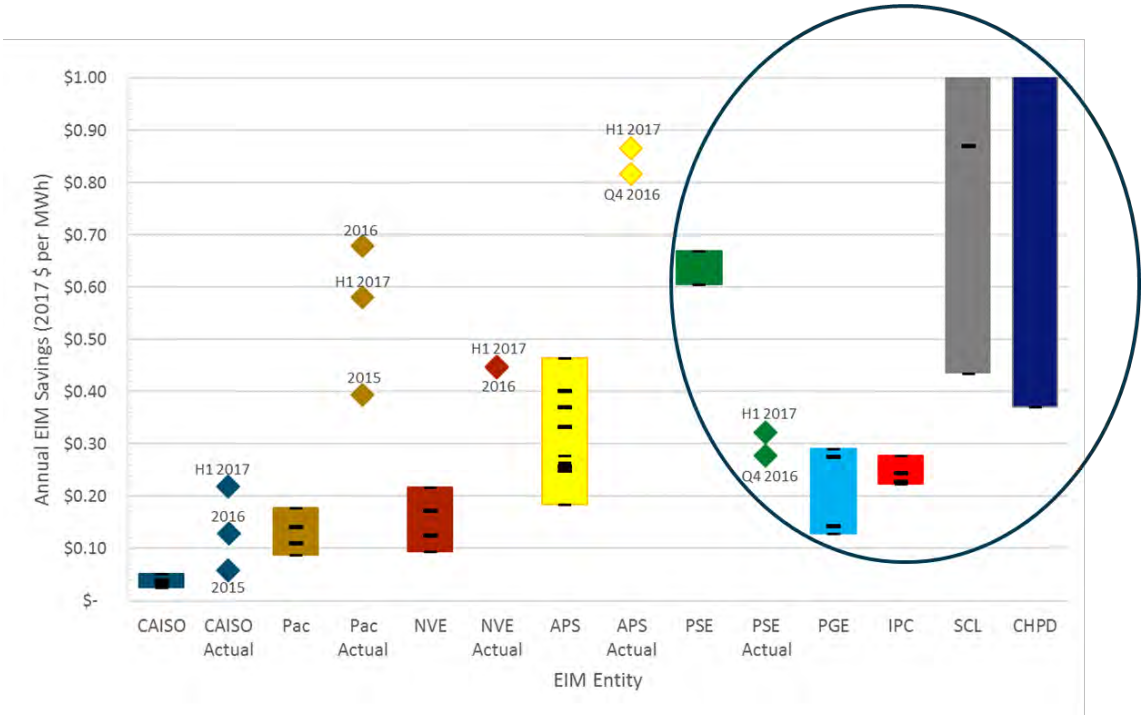


Across these five metrics, Avista most closely resembles PGE, SCL, IPC, PSE, and CHPD, as summarized in Table 3. The range of normalized benefits for these five utilities is highlighted in Figure 7, with benefits ranging from $0.13/MWh (PGE lowest case) to $2.83/MWh (SCL highest case). To be conservative, this study limited the maximum end of this range to $1.00/MWh, as shown in Figure 7.

Table 3. Summary of EIM Entities that Most Closely Resemble Avista for the Five Metrics

Key Metric	Avista Most Closely Resembles
Annual load/generation	SCL, IPC, PGE
Hydropower share of total generating capacity	IPC, SCL, CHPD
Transmission transfer capability to EIM	SCL, PSE, PGE
Solar and wind capacity share of total generating capacity	PGE, NVE
CT capacity share of total generating capacity	IPC, PGE

Figure 7. Range of Annual Load Normalized Benefits from Figure 1, Highlighting PGE, SCL, IPC, PSE, and CHPD



To estimate potential EIM benefits to Avista, this study multiplies the load-normalized range of benefits for the five utilities highlighted in Figure 7 ($0.13 to $1.00/MWh) by Avista's projected balancing authority area load of 12.45 terawatt-hours (TWh) for 2023. This produces an EIM benefits range for Avista of approximately $2 million to $13 million per year.

Statistical Analysis

For the statistical analysis, this study developed a regression model that estimates annual EIM benefits (dependent variable) as a function of key explanatory factors (independent variables). This study uses the regression to predict annual EIM benefits to Avista in 2023. All of the regression analysis and prediction was done using the SAS statistical software package.

Table 4 shows dependent and independent variables used in the regression. This study chose independent variables based on a combination of our experience with EIM studies and practical considerations around data availability. For instance, hydro generating capacity share of total generation is a proxy for hydropower capacity that is available to participate in the EIM, because data were insufficient to distinguish EIM-available hydropower for all entities included in the regression model.

Table 4. Description of regression variables[5]

Variable	Transformation	Units
Dependent Variable		
Annual EIM benefits	Natural log	Million 2017$
Independent Variables		
Benefit estimate source (1 = study, 0 = actual)	None	Dummy variable
Annual load	Natural log	TWh
Generating capacity	Natural log	MW
Natural gas price	Natural log	$/MMBtu
Transmission transfer capability to the EIM	Natural log	MW
Total EIM participants	Natural log	Number
California renewables as a share of sales (RPS)	None	%
Hydro share of total generation capacity	None	%
Wind and solar share of total generation capacity	None	%
CT share of total generation	None	%

Table 5 shows regression model coefficient and probability value results, with statistically significant coefficient estimates highlighted in bold text and coefficients color coded on the basis of their sign.

Table 5. Regression model coefficient estimates and p-values

Variable	Coefficient	p-value
Benefit estimate source (1 = study, 0 = actual)	**-0.294**	**0.0070**
Annual load	0.320	0.1101
Generating capacity	-0.224	0.1664
Natural gas price	0.906	0.2380
Transmission transfer capability to the EIM	**0.382**	**0.0002**
Total EIM participants	**-1.376**	**0.0006**
California renewables as a share of sales (RPS)	5.895	0.0769
Hydro share of total generation capacity	**1.870**	**0.0012**
Wind and solar share of total generation capacity	0.303	0.7544
CT share of total generation	-1.013	0.3750

[5] The value of most of the Table 4 variables in the regression varies for each EIM entity depending on when the EIM study was conducted or when the applicable CAISO report was released. “California renewables as a share of sales (RPS)” is California’s equivalent RPS at the time the EIM study was conducted or when the applicable CAISO report was released.

The coefficient signs and p-values in Table 5 suggest four statistically significant results:

1) Actual benefits tend to be higher than modeled benefits;
2) Higher transmission transfer capability between an entity and the rest of the EIM tends to increase EIM benefits for that entity;
3) On average, incremental EIM benefits tend to decrease as the number of participants increases;
4) An EIM entity's hydropower capacity (as a share of total generation capacity) tends to increase EIM benefits for that entity.

This study estimates EIM benefits to Avista by applying Avista-specific inputs (Table 6) to the regression model. This study uses low, mid, and high scenarios for Avista to capture how EIM benefits vary with four inputs: (1) whether the EIM benefits are consistent with EIM studies ("modeled") or CAISO reports ("actual"); (2) the amount of Avista's transmission transfer capability to the EIM; (3) Avista's hydropower capacity as a share of its total generating capacity, as a proxy for Avista's hydropower capacity available to participate in the EIM; and (4) Avista's wind and solar generation capacity as a share of its total generation capacity.

Table 6. Avista-specific regression inputs[6]

Variable	Units	Inputs		
Fixed Inputs				
Annual Avista BAA load	TWh	12.45		
Generating capacity	MW	2,366		
Natural gas price	$/MMBtu	3.81		
Total EIM participants	#	12		
California renewables as a share of sales (RPS)	%	40%		
CT share of total generation	%	11% (253 MW)		
Avista Scenario Inputs		**Low**	**Mid**	**High**
Benefit estimate source	Dummy	1	-	0
Transmission transfer capability to the EIM	MW	300	-	500
Hydro share of generation capacity	%	13% (298 MW)	24% (578 MW)	49% (1158 MW)
Wind and solar share of generation capacity	%	5% (120 MW)	-	26% (620 MW)

The scenario inputs in Table 6 lead to 24 EIM benefit scenario results. Table 7shows predicted EIM benefits to Avista (rightmost column) for each of these 24 scenarios.

[6] Fixed inputs were obtained directly from Avista. Annual load is 2023 forecasted load. Generating capacity is based on current Avista generating mix. Natural gas price is based on 2023 annual average for the Malin hub.

Table 7. Predicted EIM benefits to Avista in 2023 by scenario

Scenario	Model	Transmission (MW)	Hydro share (%)	Wind/solar share (%)	Predicted Annual EIM Benefits (million 2017$ per year)
1	1	300	13%	5%	1.54
2	1	300	13%	26%	1.63
3	1	300	24%	5%	1.88
4	1	300	24%	26%	2.00
5	1	300	49%	5%	2.92
6	1	300	49%	26%	3.10
7	1	500	13%	5%	1.84
8	1	500	13%	26%	1.96
9	1	500	24%	5%	2.27
10	1	500	24%	26%	2.41
11	1	500	49%	5%	3.51
12	1	500	49%	26%	3.73
13	0	300	13%	5%	4.94
14	0	300	13%	26%	5.17
15	0	300	24%	5%	6.12
16	0	300	24%	26%	6.40
17	0	300	49%	5%	9.66
18	0	300	49%	26%	10.11
19	0	500	13%	5%	5.96
20	0	500	13%	26%	6.22
21	0	500	24%	5%	7.39
22	0	500	24%	26%	7.72
23	0	500	49%	5%	11.69
24	0	500	49%	26%	12.22

Because the "hydro share of generating capacity" variable is a proxy for hydropower owned or contracted by Avista and able to participate in the EIM, the "low" scenario for this variable should be seen as representing a situation in which Avista's EIM-available hydropower is less than anticipated. These scenarios provide indicative guidance on the impact of low water flow years. The 13% (298 MW), 24% (578 MW), and 48% (1,158 MW) values do not imply that Avista would have this amount of hydropower capacity available to participate in the EIM. For SCL, for instance, the "hydro share of generating capacity" is 100%, but less than 100% of its total hydropower capacity is available to participate in the EIM.

The range of potential EIM benefits for Avista in Table 7 is approximately $2 million to $12 million per year. This range is consistent with the $2 million to $13 million range of potential benefits from the benchmark analysis, which multiplies the load-normalized range of benefits for the five utilities highlighted in Figure 7 ($0.13 to $1.00/MWh) by Avista's projected balancing authority area load for 2023.

Seasonal Considerations for EIM Entry

As part of this analysis, this study reviewed CAISO-reported EIM benefits by quarter to determine if there has been significant seasonal variation in benefits that might influence when a new entity would want to join the EIM. The results, shown in Figure 8, indicate that there is no definite trend thus far in the variation of the quarterly benefits across current entities in the EIM. Additionally, there is no definite pattern in the quarterly share of total annual EIM benefits (for all participants), as shown in Figure 9.

Figure 8. Quarterly and annual average benefits to EIM entities

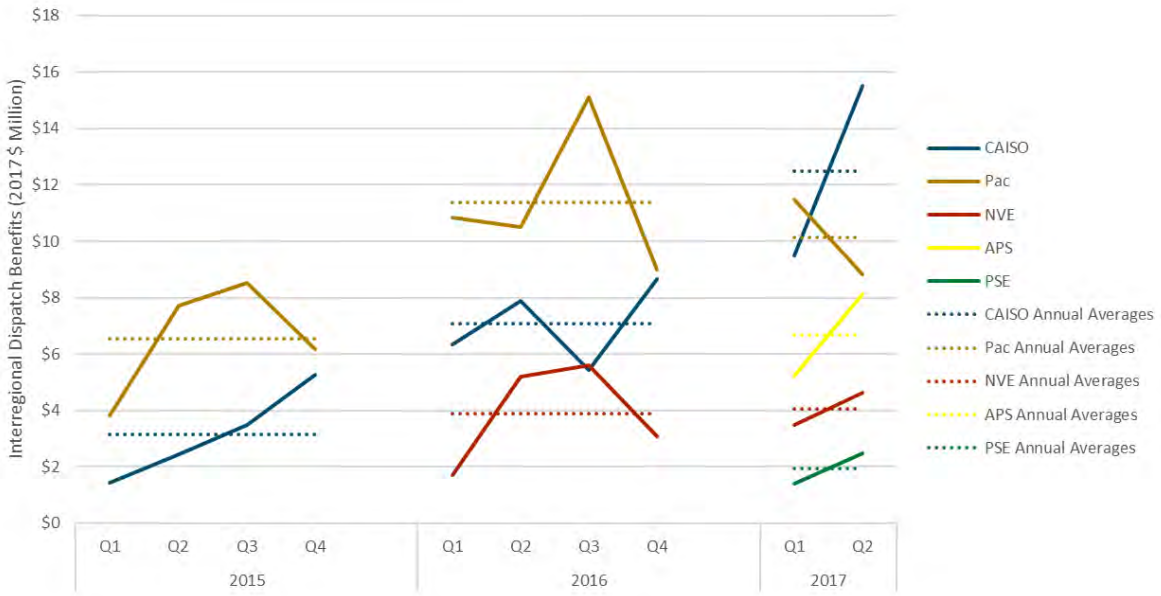
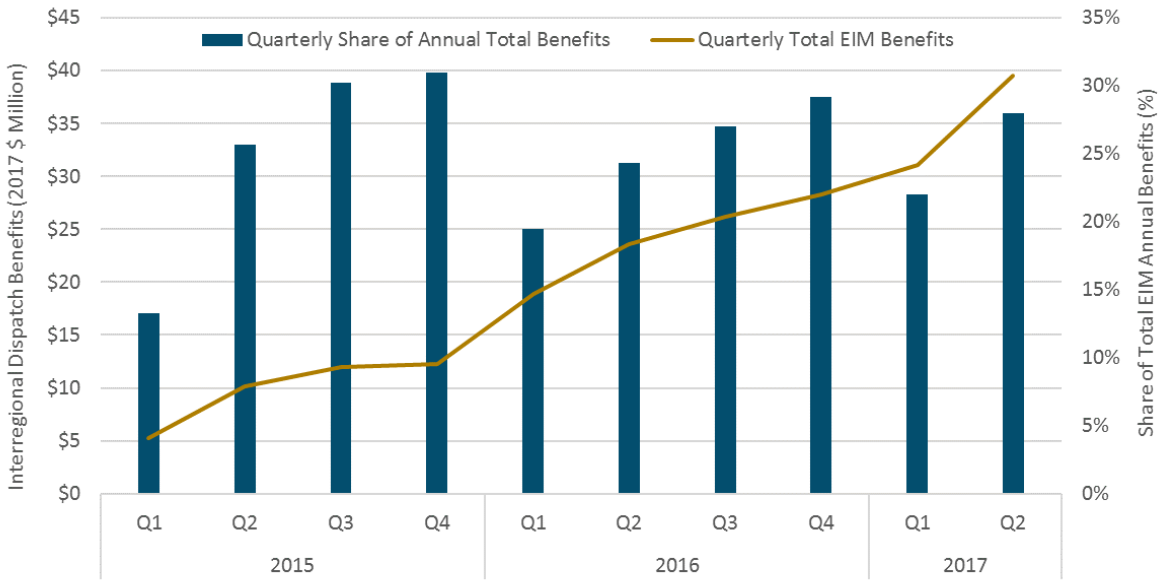


Figure 9. Quarterly share of annual total EIM benefits



3. Summary and Conclusions

This report assesses the range of potential benefits to Avista from participating in the Western EIM, focusing on dispatch cost savings. Drawing on publicly-available data, this study used benchmarking and statistical analyses to estimate a range of potential EIM benefits to Avista.

The benchmarking analysis compared Avista to other EIM entities using five key metrics: (1) annual load, (2) hydropower capacity as a share of generating capacity, (3) transmission transfer capability to the rest of the EIM, (4) solar and wind generating capacity as a share of generating capacity, and (5) CT capacity. Through this comparison, it was determined that Avista most closely resembles Portland General Electric, Seattle City Light, Idaho Power Company, Puget Sound Energy, and Chelan County Public Utility District.

This study used a range of load- or generation-normalized EIM benefits to these entities ($0.13/MWh to $1.00/MWh) to estimate EIM benefits to Avista by multiplying this range by Avista's forecasted load for 2023. This analysis produced an estimated range of annual EIM benefits to Avista of approximately $2 million to $13 million (2017$) per year.

The statistical analysis used a regression model to predict annual EIM benefits to Avista as a function of 10 explanatory variables. The study used this model to predict annual EIM benefits to Avista in 2023, using inputs obtained from Avista. The regression analysis produced an estimated range of annual EIM benefits to Avista of approximately $2 million to $12 million (2017$) per year.

In both analyses, the range of projected annual EIM benefits to Avista is driven by the amount of hydropower capacity available to participate in the EIM, transmission transfer capability available for the EIM, expansion of wind and solar generation capacity, and actual EIM market conditions. Within base case conditions modeled, based on Avista's current expectation for characteristics of its system for the test year of 2023, estimated savings could range from $3 million to $10 million (represented as the range of savings between the regression-based scenarios 5 and 17, respectively). Avista's realized benefits are more likely to fall toward the upper end of this range (or possibly beyond) under conditions with more volatile sub-hourly prices in the EIM, high availability of flexible hydropower in Avista to respond to EIM prices, and available transmission for Avista to transact with other EIM participants at those prices, as well as higher penetration of wind in the Avista BAA, which would increase the value of market flexibility to Avista. A dampening of EIM price volatility, or generation or transmission conditions that more tightly constrict Avista's ability to respond to EIM prices could lead to benefits at the lower end of this range.

This study also reviewed CAISO-reported quarterly EIM benefits, to determine whether seasonal variation in benefits might influence when a prospective entity might want to join the EIM. This review did not identify any clear patterns in quarterly benefits among individual EIM benefits or for the EIM as a whole.

It is important to note that the potential EIM benefits quantified in this analysis are focused exclusively on interregional dispatch savings because it is the most straightforward to quantify and is the only metric that has been quantified across all EIM studies. To the extent that other EIM benefit categories such as improved reliability as a result of real-time regional system awareness provided by the EIM, are applicable to Avista, those benefits would represent additional upside potential from EIM participation.

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