Exh. RJM-9
Docket UE-25____
Witness: Ramon J. Mitchell

BEFORE THE WASHINGTON

UTILITIES AND TRANSPORTATION COMMISSION

WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION, Complainant, v. PACIFICORP dba PACIFIC POWER & LIGHT COMPANY Respondent.	Docket UE-25_____

PACIFICORP

EXHIBIT OF RAMON J. MITCHELL

Energy Imbalance Market Benefits Forecasting Update

April 2025

2025

PacifiCorp's Proposal for Improving Western Energy Imbalance Market Benefits Forecasting Models

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SUMMARY OF PACIFICORP'S CURRENT MODELING METHODOLOGY

PacifiCorp builds logarithmic regression models from historical WEIM benefits, power prices, gas prices, assumptions about transfer capabilities, and other variables to forecast future WEIM benefits. There are models for PacifiCorp East (PACE) Exports, PacifiCorp West (PACW) Exports, PACE Imports, and PACW Imports. Each model takes the form log(Y) ~ log(X), where Y is the outcome variable and X is the predictor variable. The models are built as follows:

- PACE Exports: log(WEIM Benefits) ~ log(Power Price) + log(Gas Price) + Bilateral_EIM + Enbridge
- PACW Exports: log(WEIM Benefits) ~ log(Power Price) + log(Gas Price) + Enbridge
- PACE Imports: log(WEIM Benefits) ~ log(Power Price) + Total Transmission Capacity + Spring_Increasing
- PACW Imports: log(WEIM Benefits) ~ log(Power Price) + Total Transmission Capacity + Spring_Increasing

Below is a description of the variables above.

- WEIM Benefits: Historical WEIM transfer benefits.
- Power Price: Monthly, weighted average power prices. Prices from the Mona electricity hub are used for PACE models while prices from the Mid-Columbia electricity hub are used for PACW models.
- Gas Price: Monthly average gas prices. Prices from the Opal gas hub are used for PACE models while prices from the Stanfield gas hub are used for PACW models.
- Bilateral_EIM: A binary variable that is set to one when it was only PacifiCorp and California Independent System Operator (CAISO) in the WEIM. The variable is set to zero for all other historical and future months.
- Enbridge: A binary variable that is set to one when WEIM benefits were impacted by the Enbridge pipeline explosion.
- Total Transmission Capacity: Transmission capacity between the CAISO and PacifiCorp balancing areas through an intermediary balancing area. The variable is used to estimate the amount of excess solar from California that may be transferred to the PacifiCorp balancing areas in the WEIM.
- Spring_Increasing: Variable used to estimate the amount of solar capacity in California that may be available for transfer in the WEIM.

After PacifiCorp builds the above models with historical data, forecasts on power prices, gas prices, and solar capacity growth in California are inputted to the model to predict future WEIM benefits.

PROPOSED CHANGES TO FORECAST MODELS

The Company proposes including WEIM transfers as a predictive variable in the models. After visually analyzing WEIM transfers and performing a statistical test, PacifiCorp found WEIM transfers likely have some correlation with WEIM benefits. An increase of energy transfers indicates that energy is being dispatched more efficiently across the WEIM footprint. WEIM entities generally receive more benefits from the WEIM when they are able to freely transfer energy with a variety of other market participants.

Changes to the Forecasting Models

Based on recent experience evaluating WEIM transfers and their relationship to WEIM benefits, PacifiCorp hypothesized that WEIM transfers may be a good variable to build the WEIM benefit forecast models. To evaluate this, PacifiCorp used the Kendall rank correlation test. The Kendall rank correlation is a statistical method that measures the strength and direction of the relationship between two variables by calculating a score ranging from negative one to positive one. A score over 0.5 indicates a high correlation, a score over 0.3 indicates medium correlation, and below 0.3 indicates low correlation. Table 1 shows the Kendall rank correlation values for the four models, comparing WEIM benefits with transfers, power prices, and gas prices.

Table 1: Kendall Rank Correlation Coefficients for Predictor Variables

	Power Price	Gas Price	Transfers
PACE Export Benefits	0.57	0.54	0.57
PACW Export Benefits	0.55	0.29	0.48
PACE Import Benefits	0.04	0.03	0.65
PACW Import Benefits	0.39	0.23	0.64

The Kendall rank correlation values above show that transfers are highly correlated to WEIM benefits for the PACE Export, PACE Import, PACW Import directions and mediumly correlated to WEIM benefits in the PACW Export direction. The values also show that power and gas price may not be a good predictor variable for all the models, particularly for the PACE Import model.

The Company considered any Kendall rank correlation coefficient above 0.3, which indicates medium correlation between the WEIM benefits and predictive variable, to be significant enough to add to the model. Based on testing of various methods, PacifiCorp also found the

Spring_Increasing variable improved model fit and better predicted WEIM benefits in 2024. Furthermore, PacifiCorp found that the Spring_Increasing variable should be expanded to more months because transfers in the WEIM indicate that there is usually excess solar energy on the system that flows from the southwest region to the rest of the WEIM footprint during the spring and early summer months. However, these transfers only seem to affect the EIM benefits in PACE. The Spring_Increasing variable was expanded to cover March through July and was renamed to Solar_Increasing. The variable was used as a predictive variable in the PACE models. Based on the above, the resulting models were changed to:

- PACE Exports: log(WEIM Benefits) ~ log(Power Price) + log(Gas Price) + log(Transfers) + Solar_Increasing
- PACW Exports: log(WEIM Benefits) ~ log(Power Price) + log(Transfers)
- PACE Imports: log(WEIM Benefits) ~ log(Transfers) + Solar_Increasing
- PACW Imports: log(WEIM Benefits) ~ log(Power Price) + log(Transfers)

Testing Model Fit Using Historical Data

PacifiCorp used forecasting models that were created in November 2023 and utilized historical data ranging from January 2015 through October 2023. PacifiCorp used WEIM benefit actuals between January 2024 and September 2024 when testing how well a model change forecasted future benefits.

PacifiCorp compared the adjusted R-Squared values of the original models with the proposed models that included WEIM transfers as a predictor variable. Table 2 shows the comparison.

Table 2: Adjusted R-Squared Values for Original and Proposed Models

	Original Model	Proposed Model
PACE Exports	0.710	0.762
PACW Exports	0.567	0.556
PACE Imports	0.277	0.541
PACW Imports	0.664	0.747

The updated models had higher adjusted R-Squared values for all models except for the PACW Export model, which showed a small decrease. However, the significant increase in adjusted R-Squared for PACE Imports was an encouraging indication that the updated models should be used instead of the original.

Forecasting WEIM Transfers for Proposed Models

An important part of the regression models are assumptions about future gas and electricity prices. Similarly, the updated regression models will need to incorporate assumptions about future WEIM transfers to predict WEIM benefits. PacifiCorp proposes to use two-year historical average transfers for each balancing area and benefit direction to set future WEIM transfer assumptions in the model. Two years' worth of data is reasonable as it includes data for when the WEIM had full membership, and it can capture recent market trends and market participant behavior. Using too many years of historical data may cause the assumptions about future WEIM transfers to under-estimate since there has been consistent growth in WEIM transfers as more entities have joined the WEIM.

Based on visually inspecting the WEIM transfers and WEIM benefits for each balancing area and transfer direction, PacifiCorp hypothesized that WEIM transfers may have some seasonal variability, which could be used to more accurately predict future WEIM transfers. To test this hypothesis, PacifiCorp used the Kruskal-Wallis test. The Kruskal-Wallis test is used to determine if there are statistically significant differences between three or more groups in a dataset. In this case, the WEIM transfers in each season were considered a group. Seasons were considered as follows:

- Winter: December – February
- Spring: March – May
- Summer: June – August
- Fall: September – November

The null hypothesis for the Kruskal-Wallis test is that the medians of two or more groups are the same. If the p-value is less than 0.05, the null hypothesis can be rejected. Table 3 shows the p-values for each of the balancing areas and transfer directions.

Table 3: Results of Kruskal-Wallis Test for Seasonal WEIM Transfers

	PACE Exports	PACW Exports	PACE Imports	PACW Imports
P-Value	0.014	0.888	2.02E-4	0.728

From the Kruskal-Wallis test, PacifiCorp believes it is reasonable to use two-year seasonal averages to predict future WEIM transfers for the PACE models and to use a two-year yearly average for the PACW models.

Performance of Proposed Model

PacifiCorp tested the updated the models used in 2023 to re-forecast 2024 WEIM benefits to determine whether the new models would have produced forecasts closer to the actual benefits that accrued to PacifiCorp in 2024. The Company specifically looked at the total forecast error and mean absolute percent error (MAPE) for each of the four models. Total forecast error refers to the error between the summation of forecasted WEIM benefits and the summation of WEIM benefit actuals in 2024. At the time of this testing, PacifiCorp was comparing against WEIM benefit actuals from January 2024 through September 2024. The MAPE is a measure of the average absolute error between the forecasted WEIM benefits and WEIM benefit actuals for each month in 2024. Table 4 shows forecasted error and MAPE for each of the areas.

Table 4: Comparison Metrics for Original and Proposed Models

	Original Model	Proposed Model
PACE Exports Forecast Error	108%	116%
PACE Exports MAPE	329%	368%
PACW Exports Forecast Error	-17%	5%
PACW Exports MAPE	42%	62%
PACE Import Forecast Error	-45%	-6%
PACE Import MAPE	43%	43%
PACW Import Forecast Error	-60%	-42%
PACW Import MAPE	46%	60%

The table above shows the updated model would have more accurately forecasted PACW Export, PACE Import, and PACW Import benefits and less accurately forecasted PACE Exports. It should be noted that both models significantly over-estimated PACE Export benefits as there has been a big decrease in PACE Export benefits compared to the last few years. By checking the model fit and testing what the 2024 forecasts would have been using the updated model, PacifiCorp believes the forecasting model that includes WEIM transfers as a predictor variable is an improvement over the current models.

Alternative Methods for Improving Forecasting Models

PacifiCorp also tested other methods for improving the forecasting models. Below are the other improvements PacifiCorp tested, a brief description of the model change, and a summary as to why they were not chosen.

- A binary predictor variable was added into model to account for coal shortages in PACE in 2023.

  - PacifiCorp experienced coal shortages in 2023. The Company hypothesized that shortages led to higher electricity generating costs for the coal resources, which in turn would have led the PACE balancing area to export less energy and import more.
  - Model changes slightly improved model fit but did not perform better predicting WEIM benefits in 2024. The model generally over-estimated benefits for the PACE Exports model and under-estimated for the PACE Imports model. This was to be expected as adding in a binary variable effectively signaled to the model that PACE Export benefits were reduced, and PACE Import benefits were increased, due to a coal shortage that only applied in 2023.
- Outliers were removed from historical data.
  - Outliers in past months seemed to create outliers in future months in all the models. There have been extreme weather events in the past that have significantly increased WEIM benefits in a particular model for a single month. An example of this was the summer heatwave in September 2022. This event caused a large increase in PACE Export benefits, but not benefits in the other models. PacifiCorp believed spikes in WEIM benefits like this may have caused over-estimates in the forecasting models.
  - The changes had no impact on model fit and showed mixed results predicting 2024 WEIM benefits. The changes did show some improvements predicting benefits in the PACE Import model during spring months. The changes were not chosen though because the positive effect on the PACE Import was offset by decreases in performance for the other models.

CONCLUSION

PacifiCorp believes the above analysis shows using WEIM transfers as a predictor variable gives the model a better fit, using the adjusted R-Squared as the metric, and can more accurately predict future WEIM benefits, using forecast error and MAPE as the metrics. While the method uses an imperfect method for predicting WEIM transfers that are used as an input in the forecasting model, PacifiCorp believes using two-year historical averages is a reasonable way to capture market trends that give insight into future market behavior. It was found that the PacifiCorp model fit the data significantly better for the PACE Imports model. The Company's proposed model also performed well forecasting 2024 WEIM benefits. Due to these improvements, PacifiCorp believes the Company's recommendation should be adopted.

The recommended changes to the models would be simple for PacifiCorp to implement. The proposed model is a straight-forward change to the forecasting model, and it is not difficult

to predict future WEIM transfers for each balancing area and transfer direction. Therefore, PacifiCorp would be able to easily implement the updated model for future forecasts.

PacifiCorp is planning to re-evaluate the WEIM benefit forecasting models in relation to future work to create Extended Day Ahead Market (EDAM) benefit forecasting models.