Western Energy Imbalance Market: Transparency In Practice

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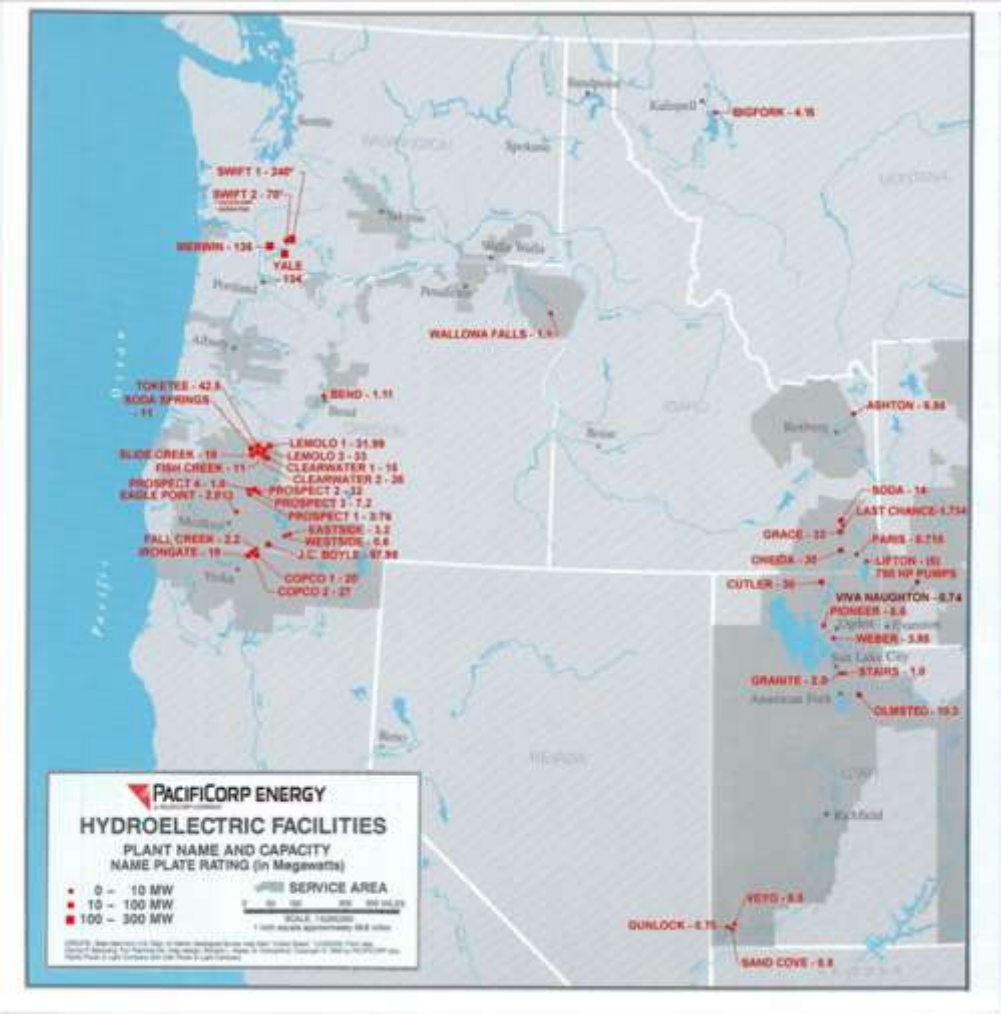
PacifiCorp System Overview

- Two divisions –
  - Rocky Mountain Power (UT, ID, WY)
  - Pacific Power (OR, WA, CA)
- Approximately 4,800 employees
- 2 million electricity customers
- 141,503 square miles of service territory in six states
- 17,770 miles of transmission
- 11,597 MW owned generation capacity
- 13,582 MW 2025 summer peak load

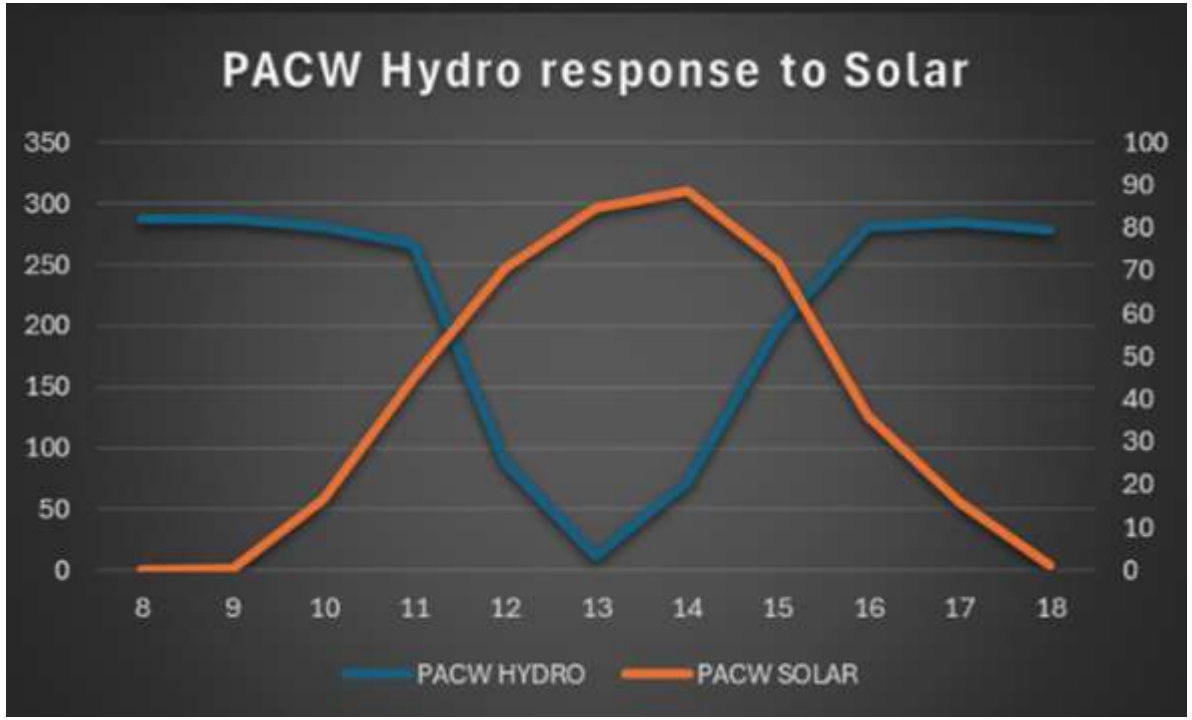
Hydro Resource Overview



- 1,215 MWs total of hydroelectric generation.
- 968 MWs owned, 247 MWs qualifying facilities.
- 597 MWs of PacifiCorp's hydroelectric generation is dispatchable in the Western Energy Imbalance Market.
  - Lewis River generates 427 MWs
  - Mid-Columbia generates 170 MWs

PacifiCorp Operations and Hydro Generation

- Hydro generation provides flexible supply which ramps faster than other sources of generation, such as gas or coal.
- Hydro allows for the system to adapt to rapidly changing conditions
  - Increases in load
  - Changes in solar and wind output
- Fast ramp rate of hydro resources allow for the onboarding of solar and wind resources.
- Hydro resources provide a mechanism to maintain grid stability.
- Hydro will continue to remain vital in the future as they assist with regulating for battery charge and discharge.



Western Energy Imbalance Market

*Avangrid office; generation only BAA with distribution across multiple states.
Map boundaries are approximate and for illustrative purposes only.

PacifiCorp and the California Independent System Operator launched the Western Energy Imbalance Market (WEIM) in November 2014. The WEIM uses a sophisticated system to automatically balance demand every five minutes with the lowest cost energy available across the combined grid.

WEIM Overview

- The Western Energy Imbalance Market is a real-time electricity market that allows power providers across the Western U.S. to buy and sell electricity across regional boundaries.
- It helps fix imbalances between supply and demand by allowing participants in different states to trade energy in real time. This means that if one region has too much power and another has too little, the WEIM lets them quickly and efficiently trade with each other.

WEIM Benefits

- Enhanced Grid Reliability
  - Shares resources across a large footprint, improving the ability to balance supply and demand in real time.
  - Helps integrate variable renewables like wind and solar more effectively.
- Economic Efficiency & Cost Savings
  - Uses real-time market signals to dispatch the lowest-cost energy across participating regions.
  - Has delivered hundreds of millions in cumulative economic benefits to participants since its launch.
- Better Renewable Integration
  - Reduces curtailment of renewable energy by finding buyers across the West.
  - Encourages cleaner energy use and supports decarbonization goals.

WEIM Benefits (cont.)

- Resource Optimization
  - Allows utilities to access a broader pool of generation and flexibility.
  - Improves utilization of excess capacity and transmission infrastructure.
- Scalable Market Participation
  - Open to balancing authorities across the West, even those outside California.
  - Helps smaller utilities benefit from a larger, more efficient market.

Hydro Within the WEIM

- Hydroelectric units submit bids into the WEIM for how much energy they're willing to provide and at what price, often reflecting:
  - Opportunity cost of water (since water can be stored for future use)
  - Operational constraints (e.g., flow requirements, reservoir levels)
  - Environmental or regulatory considerations.
- WEIM runs a real-time, 5-minute market that selects the lowest-cost bids from across all participating regions to meet system needs. If hydro is the most cost-effective resource at a given time, it gets dispatched.
- Hydropower is highly dispatchable and fast-ramping, making it ideal for:
  - Filling in gaps caused by intermittent renewables (like solar ramping down at sunset)
  - Responding to sudden grid imbalances or changes in demand.

Hydro Within the WEIM (cont.)

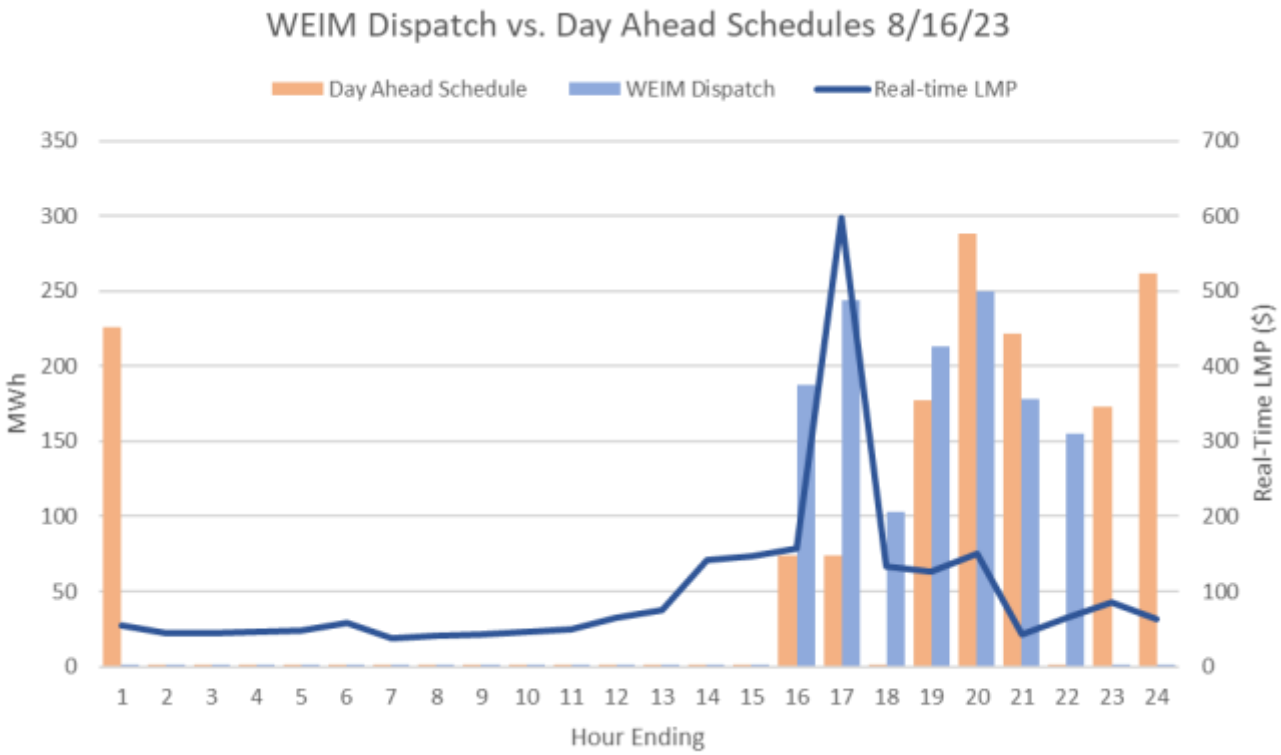
- This flexibility is valued in the market, so hydro operators can earn revenue by strategically bidding during high-demand or high-price periods.
- In isolated systems, excess hydro generation might be curtailed or wasted. In WEIM surplus hydro can be sold to other regions that need it, leading to better water utilization and less energy waste.
- WEIM helps support water management goals. Using economic signals, we can store water during low-price periods, generate during high price periods and better align multi-objective water use goals as a utility.

Storage Hydro Rolling 7-Day Optimization

- Optimize our hydro generation over a rolling 7-day time frame
- Using a 7-day price forecast we can use a weighted distribution of MW's with an elevation target in mind to be able to efficiently dispatch our generation over this timeframe barring any other constraints.
- This reaches our elevation goals while also maximizing the higher priced periods to be as economical as possible.
- This is further optimized through our production-cost model that will economically allocate the generation to the highest priced hours of each individual day.

Coordination with Market

- Production-cost model hydro outputs are examined before constructing day-ahead WEIM bids. If the units are not allocated to generate during hours most valuable to WEIM, these can be re-allocated.
- Flexible daily gen limits are determined during the prescheduling period, so that hydro units can be used to contribute further past their base schedule or less than their base schedule if market or overall system conditions require.
- Hydro production for participating units is controlled by bids, so must still be monitored to make sure there are no exceedances of daily generation targets/ranges.



Practical Example

HE	BP1		BP2		BP3	
	MW	$/MW	MW	$/MW	MW	$/MW
01	1	$70.00	100	$70.00		
02	1	$70.00	100	$70.00		
03	1	$70.00	100	$70.00		
04	1	$70.00	100	$70.00		
05	1	$70.00	100	$70.00		
06	1	$70.00	100	$70.00		
07	1	$.01	50	$30.00	100	$30.00
08	1	$.01	50	$30.00	100	$30.00
09	1	$.01	50	$30.00	100	$30.00
10	1	$70.00	100	$70.00		
11	1	$70.00	100	$70.00		
12	1	$70.00	100	$70.00		
13	1	$70.00	100	$70.00		
14	1	$70.00	100	$70.00		
15	1	$70.00	100	$70.00		
16	1	$70.00	100	$70.00		
17	1	$.01	50	$30.00	100	$30.00
18	1	$.01	50	$30.00	100	$30.00
19	1	$.01	50	$30.00	100	$30.00
20	1	$.01	50	$30.00	100	$30.00
21	1	$.01	50	$30.00	100	$30.00
22	1	$70.00	100	$70.00		
23	1	$70.00	100	$70.00		
24	1	$70.00	100	$70.00		

- Basic bid structure of a hypothetical unit with a PMax of 100 MW
- Need to move at least 400 MWh of water at any positive price
- If real time LMP's go above $30 the unit can be run up to a total of 800 MWh

Conclusion

PacifiCorp's participation in WEIM demonstrates transparency in practice and positions hydro as a cornerstone for the clean energy future.

Questions?