Powerex

Analysis of the January 2024 Winter Weather Event

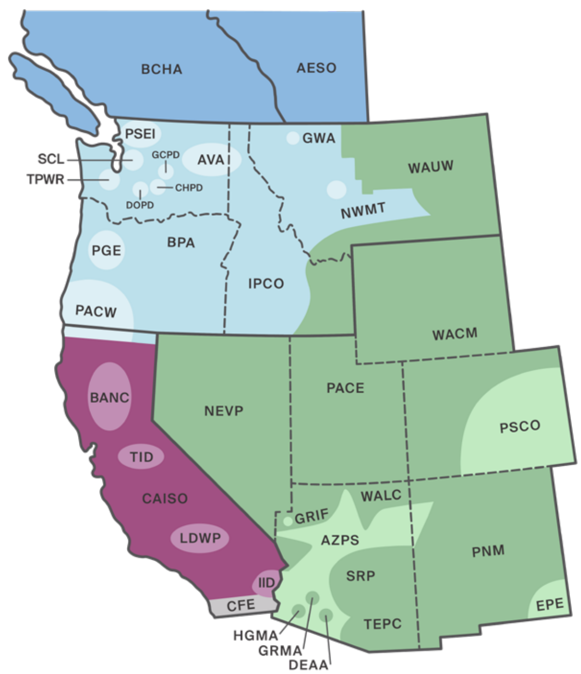
Analysis of the January 2024 Winter Weather Event

From January 11th to 17th, 2024, British Columbia, Alberta and the U.S. Northwest region experienced a multi-day cold weather event resulting in high levels of electricity demand. In the U.S. Northwest region, wholesale market prices were elevated throughout the period and multiple entities experienced reliability challenges, leading to the declaration of a number of energy emergencies on multiple days. This report draws upon publicly available data on the key conditions observed during the period, including demand, sources of supply, use and availability of transmission service, and market prices. The report focuses on the most challenging days for the U.S. Northwest region, which were January 12th to 16th (referred to herein as the “January 2024 Event”). Where applicable, references are provided to analyses by other authors.

Powerex believes that the January 2024 Event holds important lessons, particularly for the U.S. Northwest region, and that inclusive and productive discussions require accurate data. Unlike regions operating in an ISO or RTO, however, there is no single entity with full visibility of electricity markets in the west and a mandate to evaluate and report on the performance of that market. This report is intended to provide data that is publicly available, but that often requires time and effort to compile and analyze, and may therefore not be equally accessible to all stakeholders. This report also provides Powerex’s initial view of lessons that can be taken from the January 2024 Event, and potential steps to strengthen reliability through improved resource adequacy and expanded connectivity between the U.S. Northwest and Southwest and Rockies regions. Powerex hopes its analysis of the January 2024 Event and a discussion of potential steps to enhance reliability will trigger further beneficial discussions.

The U.S. Northwest Region Experienced Reliability Challenges

During the January 2024 Event, the U.S. Northwest region (light blue region in map) declared reliability emergencies, experienced elevated wholesale market prices, and required substantial imports from outside the region, the majority of which were supplied from entities in the U.S. Southwest and Rockies region (green in map).



Energy Emergency Alerts

Multiple utilities experienced reliability challenges during the January 2024 Event. Four Balancing Authority Areas ("BAAs") in the U.S. Northwest, along with the Alberta Electric System Operator (AESO), declared energy emergencies.

ENTITY	NUMBER OF EEA EVENTS	NUMBER OF HOURS
Northwest BAA1	1	8
Northwest BAA2	3	13
Northwest BAA3	2	45
Northwest BAA4	2	6
AESO	4	22

Source: RC West, AESO

These reliability challenges occurred on multiple days, and also for multiple hours, including hours in which demand was well below the daily peak. As described herein, the U.S. Northwest region faced two separate and distinct reliability challenges:

1. ***Inadequate capacity*** during peak demand hours, and
2. ***Insufficient fuel supply*** across the multi-day event.

The U.S. Northwest Region Experienced Capacity Adequacy Challenges During Peak Demand Hours

I. Temperatures in B.C., Alberta, and the U.S. Northwest Were Similar to the December 2022 Winter Weather Event

While some locations in the U.S. Northwest saw record low temperatures during the January 2024 Event, this was not the case in others. Overall, most locations in the U.S. Northwest region experienced temperatures broadly similar to the cold weather event in December 2022.

Daily Low Temperature
Degrees F

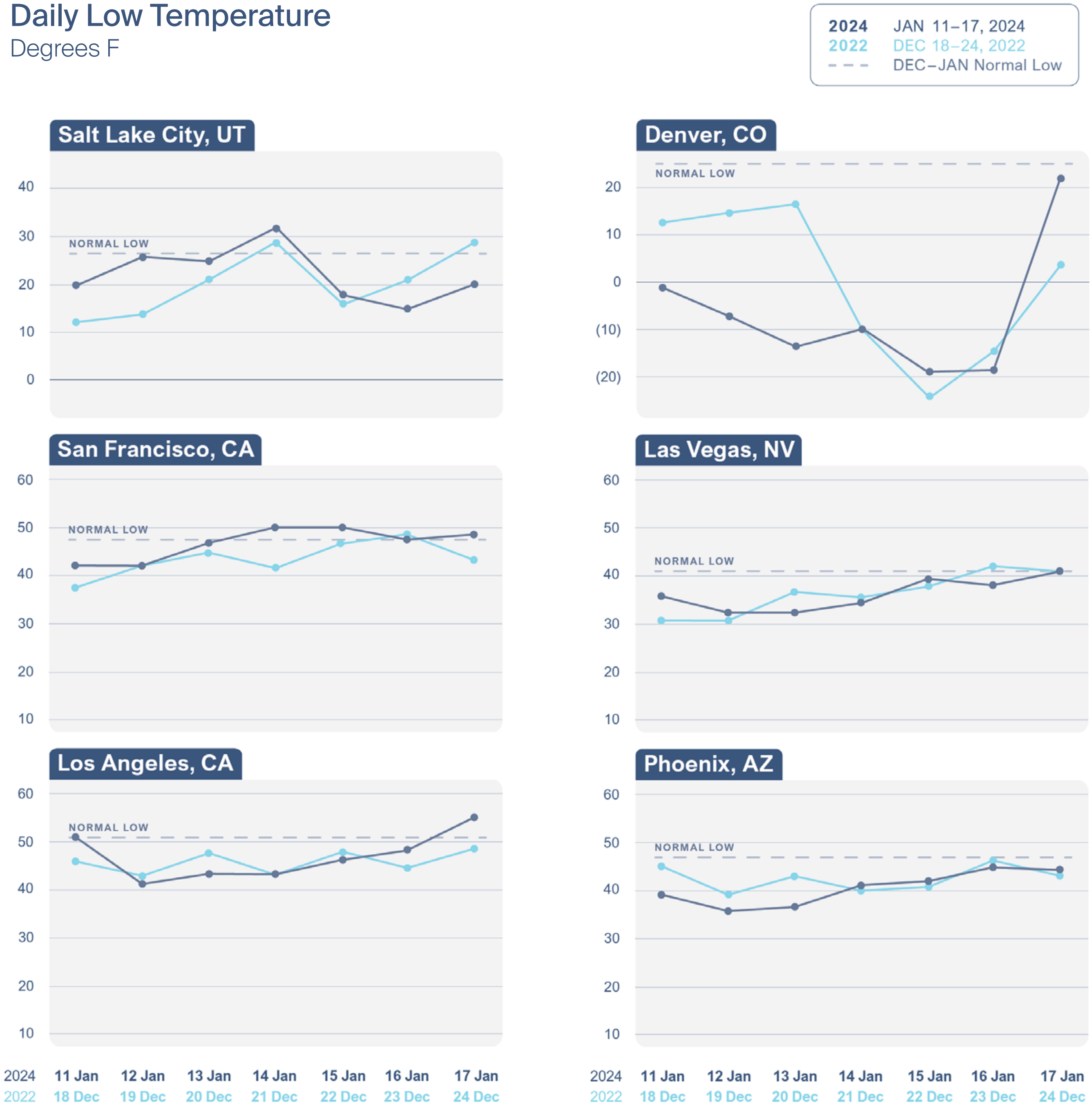
2024 JAN 11–17, 2024
2022 DEC 18–24, 2022
– – – DEC–JAN Normal Low

Source: WSI Trader

The cold weather experienced in B.C., Alberta and the U.S. Northwest was also prevalent in the Rockies region, but did not extend into California or the Southwest as shown below.

Daily Low Temperature

Degrees F



Source: *WSI Trader*

II. Peak Demand Was Higher than the December 2022 Winter Weather Event

Demand in the U.S. Northwest region during the January 2024 Event was approximately 2% to 6% higher than the winter weather event in December 2022, despite temperatures across the region being somewhat comparable. This is consistent with recent projections of accelerating demand growth for U.S. Northwest utilities.[1]

Demand by BA: Dec 2022 Vs Jan 2024

	Max MW 2022 Dec	Max MW 2024 Jan	% Change	Low Temp 2022 Dec	Low Temp 2024 Jan
PNW All	35,905	35,991	0.2%		
AVA	2,514	2,515	0.0%	-10	-10
BPA	11,068	11,001	-0.6%		
CHPD	556	572	2.8%	-6	-9
DOPD	517	553	6.7%	-6	-9
GCPD	955	999	4.5%	-6	-9
IPC	2,841	2,988	5.0%	6	3
NWMT	1,975	2,079	5.1%	-19	-22
PACW	3,721	3,971	6.5%	20	15
PGE	4,150	3,991	-3.9%	20	15
PSEI	5,154	5,293	2.7%	18	15
SCL	1,906	2,027	6.2%	18	15
TPWR	973	984	1.1%	18	15

East Side Average	4.0%
West Side Average*	4.1%

** PGE Excluded: 165,000 customer outages on coldest day.*

Source: Analysis of January Cold Snap in the Pacific Northwest, EnergyGPS Presentation at PNUCC Board Meeting February 9, 2024. Available at: https://www.pnucc.org/wp-content/uploads/2024-02-08-EnergyGPS_January_2024_ColdEvent_Analysis.pdf

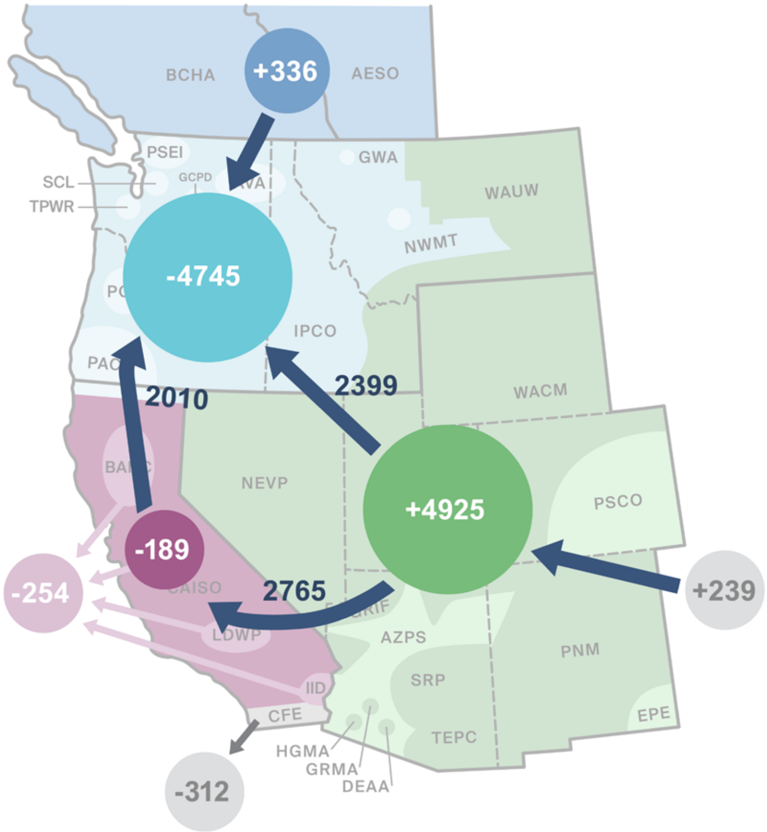
[1] See PNCC 2023 *Northwest Regional Forecast*, at Tbl. 3 (showing 3% annual growth in winter peak demand for 2024-2027) and Fig. 1 (showing 2023 peak demand growth projections substantially greater than 2022 projections). Available at: https://www.pnucc.org/wp-content/uploads/2023-PNUCC-Northwest-Regional-Forecast-final.pdf

In Canada, Alberta experienced a new hourly peak demand record of 12,384 MW on January 11, 2024, which was 1.6% higher than its previous hourly peak demand record on December 21, 2022. In B.C., a new record peak demand of 12,334 MW was set on January 12, 2024, which is about 3% higher than the previous peak set on December 19, 2022. Further details on BC Hydro's peak demand history are available in Appendix A, as provided by Powerex.

III. The U.S. Northwest Imported Large Quantities of Electricity During Peak Demand Hours

Peak demand generally occurred between 4 p.m.–8 p.m. PT each day during the January 2024 Event. Data on delivery schedules published by transmission service providers, together with data from the U.S. Energy Information Administration, shows that the U.S. Northwest region imported an average of 4,745 MW during these peak demand hours. The most significant supply during these hours came from the Southwest and Rockies region, which had average hourly net exports of nearly 5,000 MW. Canada also supplied an average of 336 MW to the U.S. Northwest region. In contrast, the California ISO, and other California utilities that are not part of the California ISO, were net importers on average of approximately 443 MW (189 MW and 254 MW respectively) during these peak demand hours. Further details are provided in the map below, which shows whether each sub-region was a net exporter or net importer in the peak hours, and the respective magnitude of such transfers.

Regional Net Imports & Exports, 4pm–8pm



Source: Open Access Same-Time Information Systems (OASIS) Transaction Schedules (scheduledetail), BPA Transmission Operations Data (AC Intertie Path data), Form EIA-930 Interchange data, CAISO OASIS.

Appendix A contains additional information Powerex has made available regarding the sales it made in peak hours to entities in the U.S. Northwest in the pre-schedule and real-time time frames.

In sum, the available data shows that the U.S. Northwest region experienced a substantial capacity adequacy challenge during the January 2024 Event, as:

1) Multiple utilities declared energy emergencies,
2) Peak demand that was near or in excess of past records, and
3) A large volume of imports was required.

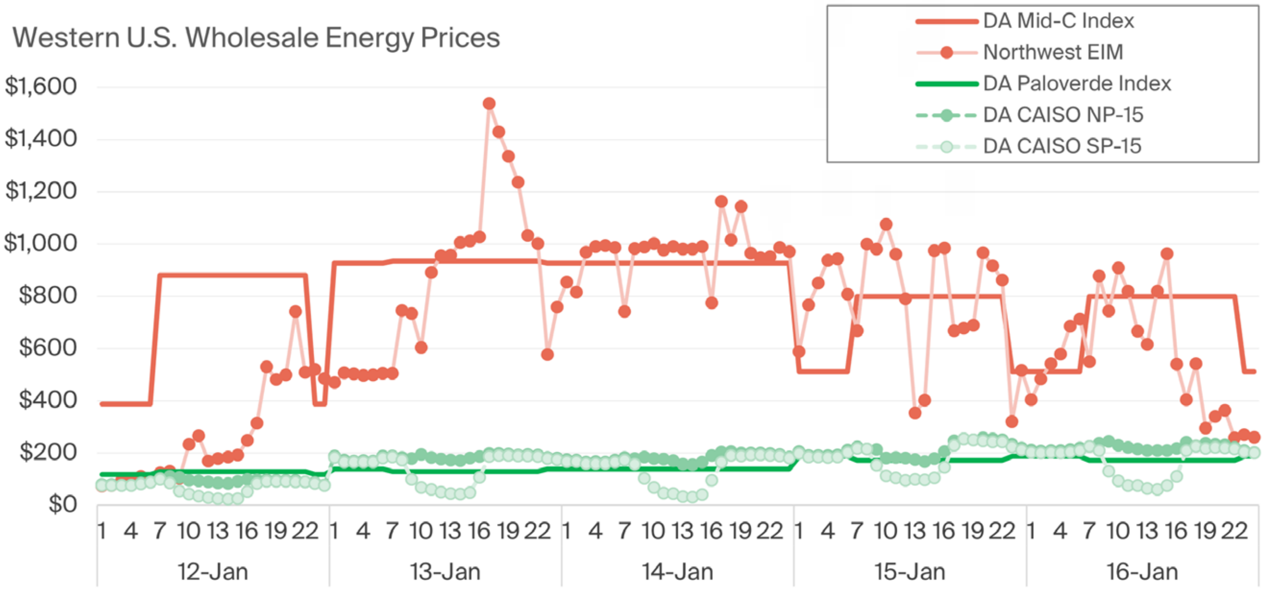
Weather conditions during the January 2024 Event appear to have been broadly comparable to weather conditions experienced in the region in recent winters, suggesting the primary factor was demand growth and a lack of available resources to meet that demand, rather than an unprecedented weather event.

The U.S. Northwest Region also Experienced a Fuel Sufficiency Challenge Across the Multi-Day Event

In addition to experiencing a lack of adequate generating capacity during peak demand hours, the U.S. Northwest also appears to have experienced a separate and distinct reliability challenge: a lack of sufficient "fuel" (i.e., water at hydro facilities) across the duration of the January 2024 Event.

I. Wholesale Market Prices Were Elevated in Nearly All Hours

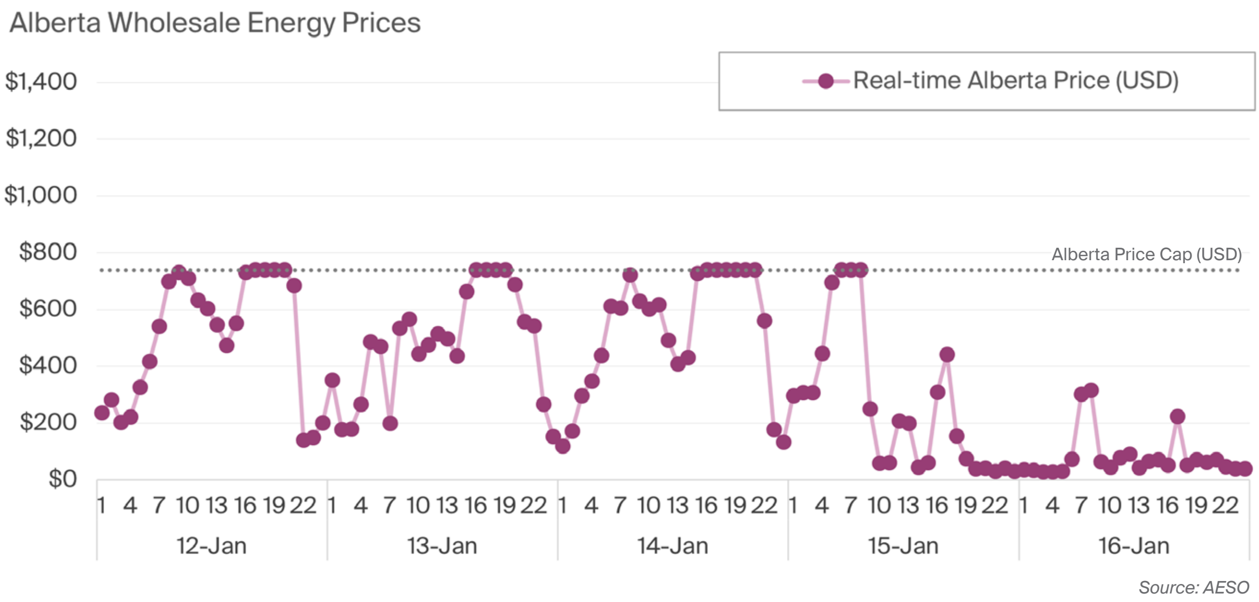
Day-ahead and real-time wholesale market prices in the U.S. Northwest were elevated for most hours throughout the January 2024 Event, including many hours when demand was well below the daily peak demand. This indicates fuel scarcity across the period (i.e., a lack of water at hydro facilities). Prices in other western regions, including California and the Southwest, were also elevated, but they were substantially lower than in the U.S. Northwest.



Northwest EIM reflects the average of the 15-minute EIM prices for Bonneville Power Administration, PacifiCorp West, Portland General Electric, Puget Sound Energy and Seattle City Light.

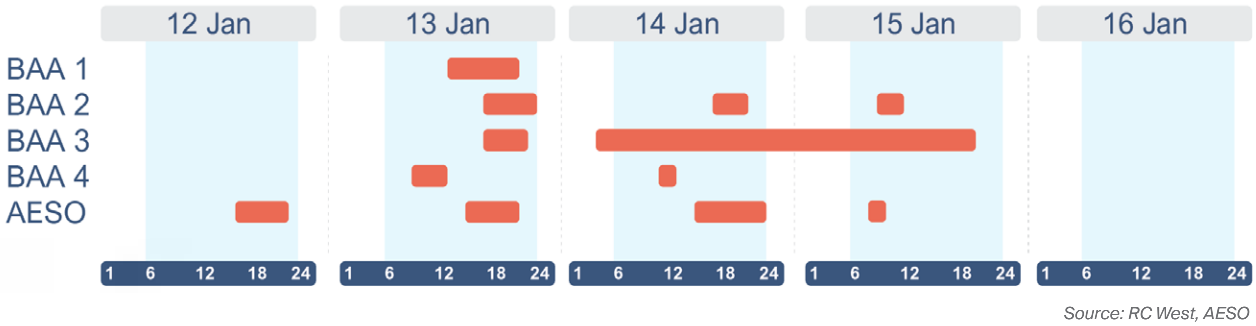
Source: ICE, CAISO OASIS

As shown below, Alberta wholesale energy prices were also elevated, but in contrast to U.S. Northwest prices, very high prices in Alberta generally occurred only in the morning and evening peak demand hours. This indicates that Alberta experienced a capacity adequacy challenge, but it did not experience a fuel sufficiency challenge, as prices returned to lower levels in the hours that demand was lower. This is consistent with Alberta having no known natural gas supply challenges and limited installed hydro resources.



II. Energy Emergencies Were Not Limited to Peak Demand Hours

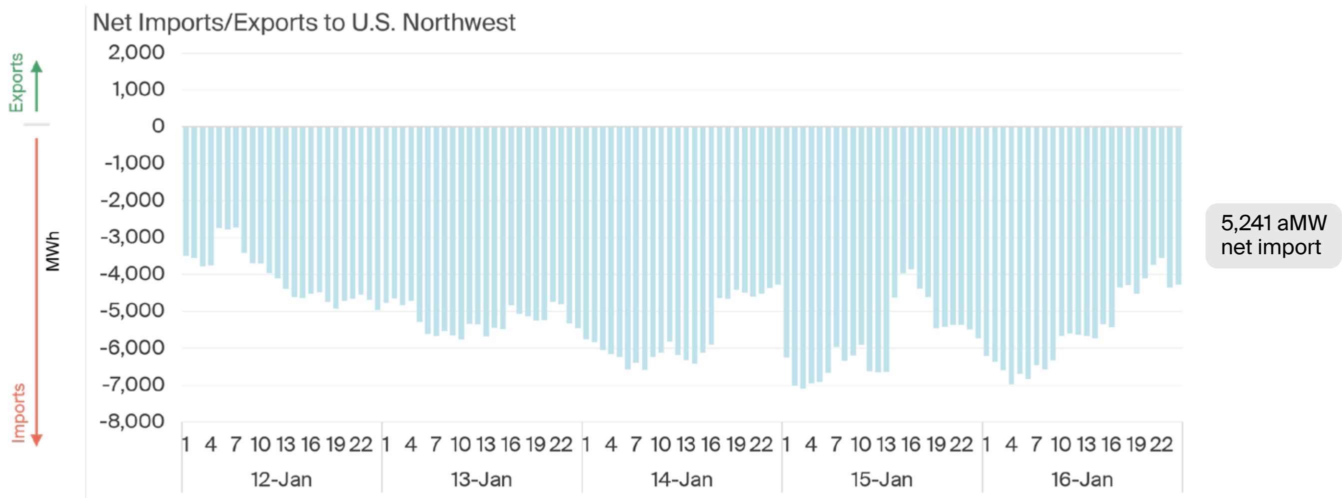
The fuel sufficiency challenge is also seen in the timing and duration of the declared energy emergencies in the U.S. Northwest region, which extend well beyond the typical hours of peak demand (i.e., 4 p.m. – 8 p.m.).



In contrast, energy emergencies in Alberta were only declared during the peak demand hours of each applicable day, further indicating that Alberta did not appear to experience a fuel sufficiency challenge.

II. Large Imports Into the U.S. Northwest Were Sustained Across All Hours of the January 2024 Event to Meet this Fuel Sufficiency Challenge

The U.S. Northwest region continued to import large volumes of electricity from outside the region, beyond the peak demand hours. Data on electricity delivery schedules published by transmission service providers and U.S. EIA data show that the U.S. Northwest region imported even larger volumes of electricity outside of the peak demand hours. Specifically, the U.S. Northwest averaged 5,241 MW of imports across all 120 hours of the January 2024 Event, compared to average imports of 4,745 MW during the peak demand hours. The chart below shows the hourly net imports into the U.S. Northwest during the January 2024 Event:

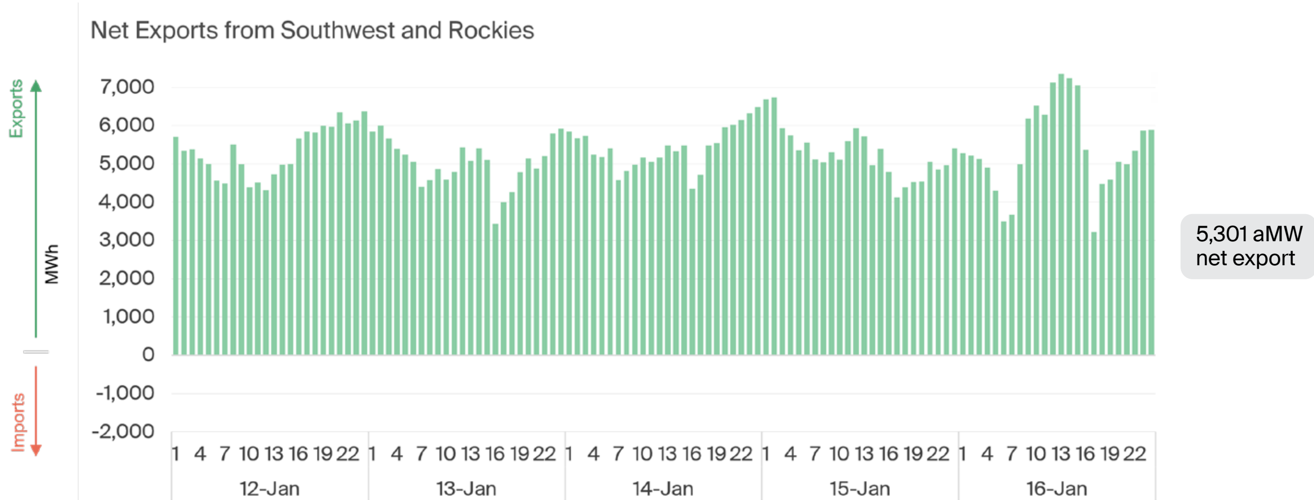


Sources: OASIS Transaction Schedules (scheduledetail), CAISO OASIS

Supply to the U.S. Northwest Was Primarily from the Southwest and Rockies Region, as Well as Canada

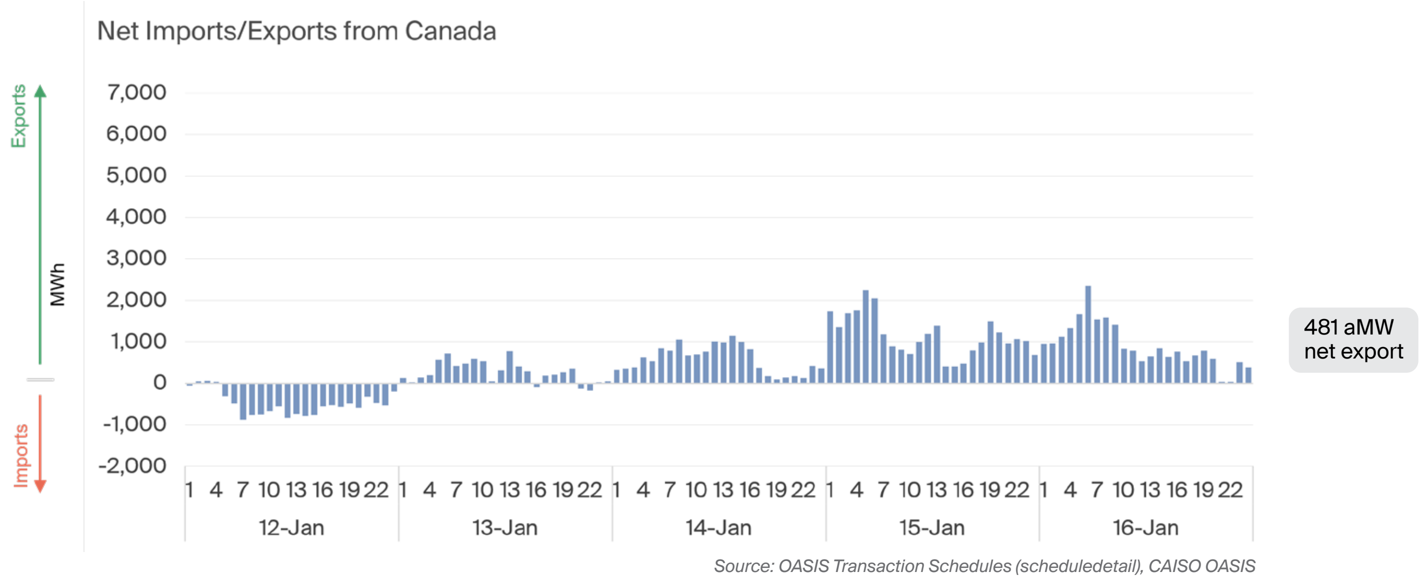
---

Examination of hourly imports and exports for other western regions during the same period indicates that the source of the imports into the U.S. Northwest region was primarily from the Southwest and Rockies region.



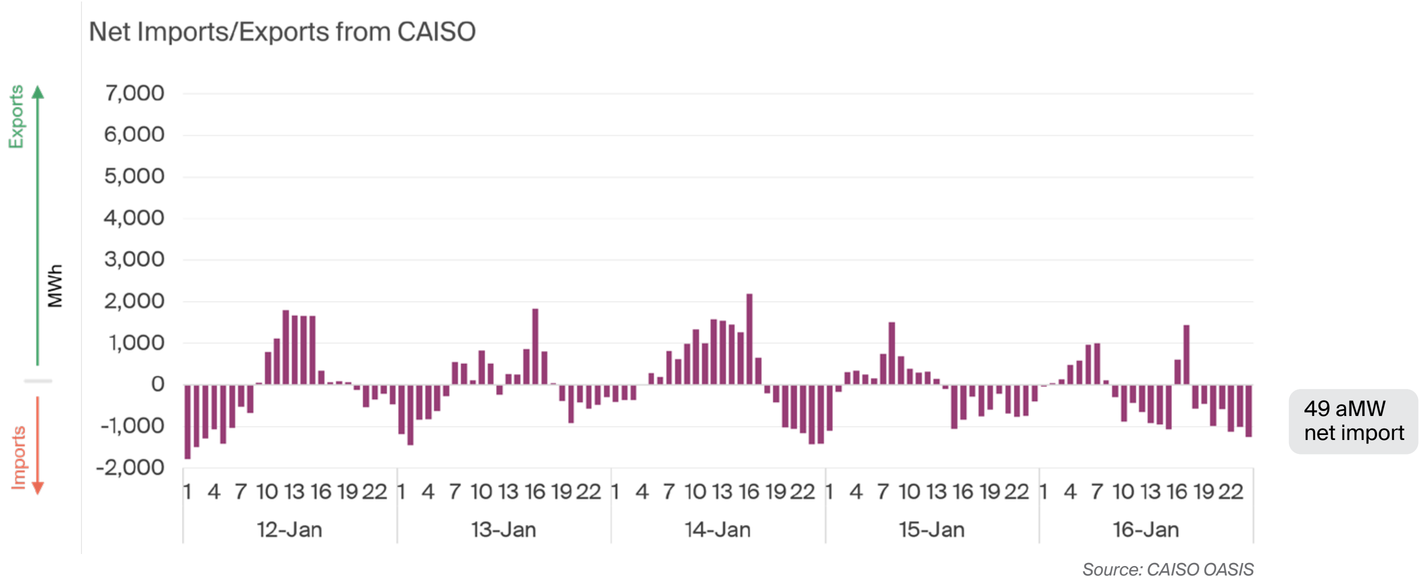
Source: OASIS Transaction Schedules (scheduledetail), Form EIA-930 Interchange data, CAISO OASIS

Canada also provided supply to the U.S. Northwest region across most hours, despite B.C. facing its own fuel supply limitations at its hydro resources:



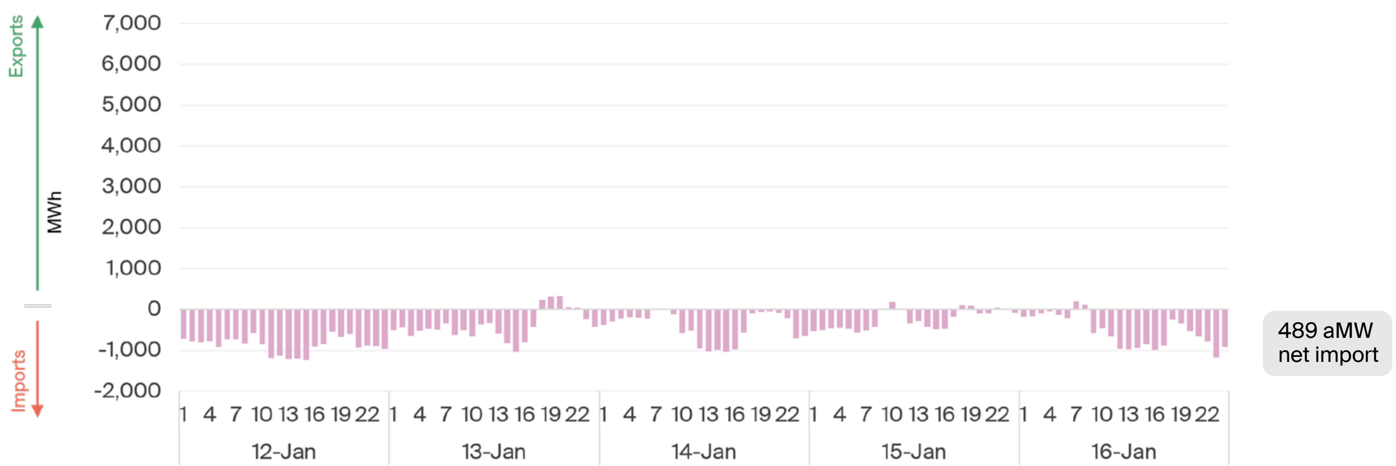
Powerex has provided additional information on its exports to the U.S. Northwest in Appendix A.

The California ISO, as well as the California utilities located outside of the California ISO service territory, were net importers, on average, with exports generally occurring during the solar hours and imports occurring in the evening peak and overnight hours, as shown below:



The California utilities that are not part of the California ISO's service territory were also net importers across most hours of the event, as shown below:

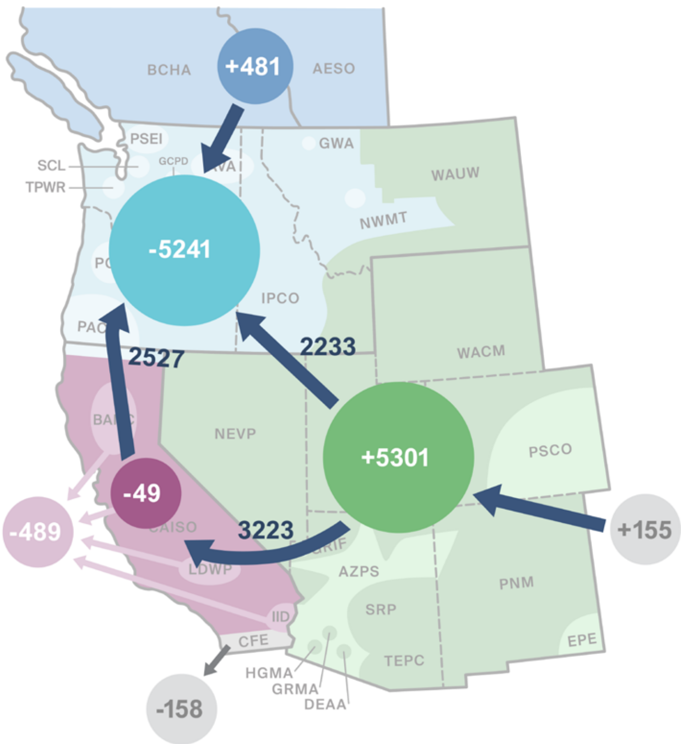
Net Imports/Exports from other California BAAs



Source: Form EIA-930 Interchange data

The average imports and exports for each of the different regions across all 120 hours of the January 2024 Event are shown in the map below, as well as the respective magnitude of such transfers:

Regional Net Imports & Exports, All Hours



Source: OASIS Transaction Schedules (scheduledetail), BPA Transmission Operations Data (AC Intertie Path data), Form EIA-930 Interchange data, CAISO OASIS.

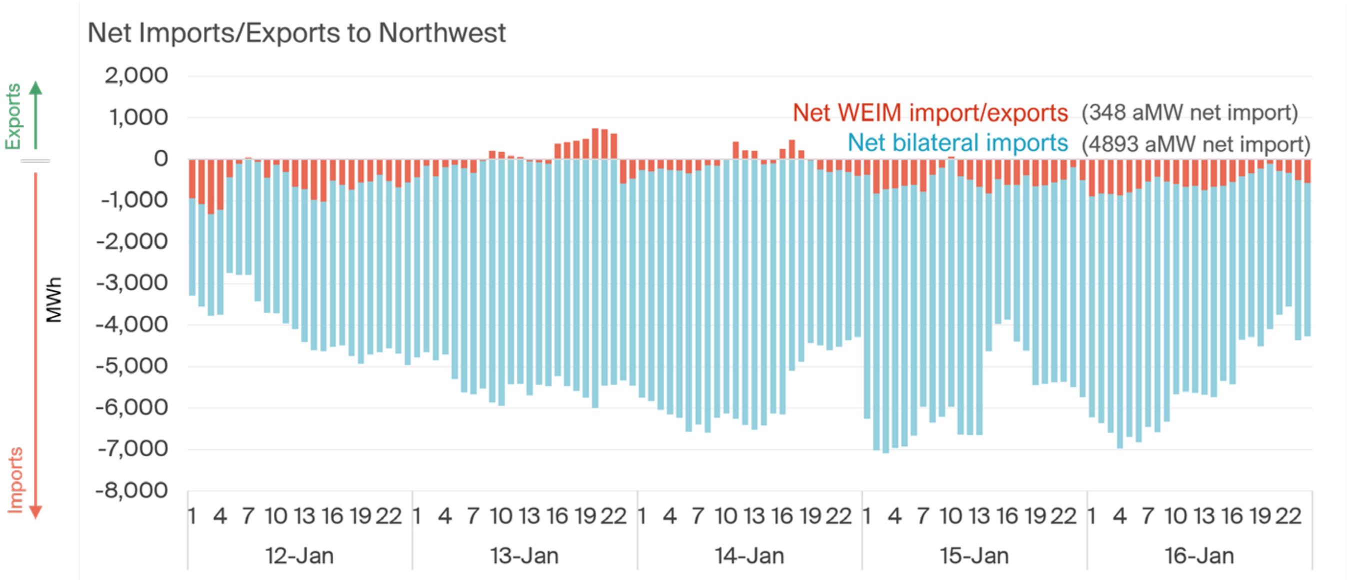
The above charts prepared by Powerex are consistent with separate analyses of inter-regional energy transfers conducted by the Western Power Pool (WPP) and EnergyGPS, using data on hourly BAA net interchange reported to the U.S. Energy Information Administration.[2]

Supply to the U.S. Northwest Was Primarily Arranged Through Bilateral Transactions Prior to Each Operating Hour

Imports and exports can be the result of bilateral transactions arranged prior to the operating hour and scheduled through e-Tags under the contract-path framework, or they can be the result of participation in the Western EIM, which optimizes transfers based on available supply and transmission service across the footprint. Based on data from the Western EIM, the U.S. Northwest received:

- An average of 348 MW of supply through the Western EIM across all hours; and
- An average of 164 MW of supply through the Western EIM between 4 p.m. and 8 p.m.

The chart below shows the hourly volume of net imports into the U.S. Northwest region during the January 2024 Event arranged through the Western EIM as well as the volume resulting from bilateral trade.



Source: OASIS Transaction Schedules (scheduledetail), CAISO OASIS.

[2] Analysis of January Cold Snap in the Pacific Northwest, EnergyGPS Presentation at PNUCC Board Meeting February 9, 2024. Available at: https://www.pnucc.org/wp-content/uploads/2024-02-08-EnergyGPS_January_2024_ColdEvent_Analysis.pdf
WPP Assessment of January 2024 Cold Weather Event, Western Power Pool. Available at: WPP_Assessment_of_January_2024_Cold_Weather_Event_Final.pdf (westernpowerpool.org)

Summary

During the period of January 11th, 2024 to January 17th, 2024, electricity demand was at record levels for multiple utilities in the U.S. Northwest region, as well as in B.C. and Alberta. Peak demand in the U.S. Northwest ranged from 2% to 6% higher, and peak demand in B.C. was about 3% higher, than the peak demand experienced during a similar winter weather event just thirteen months earlier, in December 2022. This record-high peak demand was a key contributor to reliability challenges in the U.S. Northwest (and in Alberta), and also led to very high wholesale market prices. In the U.S. Northwest, these reliability challenges, and the elevated prices, were observed not only in the highest demand hours of each day, but across all hours of the five-day period of January 12th to January 16th, indicating two distinct resource adequacy challenges:

1. ***Inadequate capacity*** during peak demand hours, and
2. ***Insufficient fuel supply*** across the multi-day event.

U.S. Northwest Capacity Challenges

The capacity challenges experienced in the U.S. Northwest region were most severe between 4 p.m. and 8 p.m. when electricity demand is highest. During these peak demand hours, the U.S. Northwest region received an average of 4,745 MW of supply imported from outside the region. The vast majority of this supply was from the U.S. Southwest and Rockies region, with some additional supply provided by B.C. California did not provide net supply to neighboring regions across these peak demand hours, as the California ISO, and the California utilities located outside the California ISO service territory, were net importers on average across the peak demand hours over the five-day period. Finally, most of the imported supply was transacted in the bilateral markets (including exports from the CAISO using the intertie bidding framework and contract path scheduling), with the Western EIM providing a relatively small volume.

U.S. Northwest Fuel Supply Challenges

Both B.C. and the U.S. Northwest region are heavily dependent on their large fleets of hydroelectric generation facilities to meet electricity demand. Some of these hydroelectric facilities have large storage reservoirs, such as the largest facilities of the BC Hydro system and Bonneville Power Administration's Federal Columbia River Power System. These large storage reservoirs provide access to sufficient fuel (water) to enable the generators at these particular facilities to operate at or near maximum output across all hours of a multi-day weather event.[3]

In contrast, run-of-river hydro facilities, as well as facilities with small- or medium-sized reservoirs, do not have sufficient water inflows or water in storage to generate at or near maximum output throughout all hours of the day. The region's dependence on these hydroelectric generation facilities gives rise to a risk of fuel supply insufficiency during weather events lasting multiple days, such as the January 2024 Event. The risk that other variable energy resources, such as wind facilities, may also experience persistent reduced output during a multi-day weather event also contributes to fuel supply risk.

[3] Although these large storage reservoirs may have sufficient water, there can exist other constraints and risks that can prevent some of these facilities from operating at or near maximum output across all hours of a multi-day weather event.

This fuel supply risk was evident in several key observed outcomes:

1. Market prices in the U.S. Northwest were elevated across the five-day event in both the day-ahead and real-time bilateral markets, as well as in the Western EIM, with prices at or near prevailing price caps for almost all hours. This includes many hours when electricity demand was well below peak demand levels for the applicable day.

2. Multiple utilities in the U.S. Northwest region declared energy emergencies outside of the peak demand hours, including one during the overnight hours when demand is much lower (indicating a reliability challenge other than a lack of generating capacity to meet peak demand, such as a lack of fuel supply).

3. Imports from outside the region continued to be very high across all hours, averaging 5,241 MW, which is even higher than the average import levels into the region during the peak demand hours (4 p.m. to 8 p.m.) of the event. This indicates that the U.S. Northwest region urgently needed all available energy across the five-day period from neighboring regions to conserve fuel (water), as it encountered energy emergencies and very high wholesale prices despite this consistently high level of import activity.

Similar to the U.S. Northwest region's heavy reliance on imports from the U.S. Southwest and Rockies region during peak demand hours of the five-day period, the U.S. Southwest and Rockies region was the source of the vast majority of the import supply across all hours of the period, helping utilities with hydroelectric resources in the U.S. Northwest to manage their fuel supply challenges. In a similar way Canada, particularly Powerex, provided additional net supply to the U.S. Northwest across all hours, in addition to its exports in peak demand hours, notwithstanding the fuel limitations being experienced at numerous hydroelectric facilities in the BC Hydro system. And consistent with its net import activity during the peak hours demand hours, California did not provide net supply to its neighboring regions across all hours of the five-day period. Finally, most of the imported supply across all hours was transacted in the bilateral markets (including exports from the CAISO using the intertie bidding framework and contract path scheduling), with the Western EIM providing a relatively small volume.

Recommendations

The above key observations during the January 2024 Event indicate multiple opportunities to enhance reliability by focusing efforts on **both** the capacity adequacy challenge and fuel supply challenge:

Recommendation 1

Consider Enhancements to WRAP Prior to the First Binding Winter Season

The January 2024 Event provides several opportunities to calibrate aspects of the Western Resource Adequacy Program ("WRAP") to help address the region's capacity adequacy challenges prior to the WRAP's first binding winter season (which may occur as early as winter 2026/2027).

First, the peak demand observed during the January 2024 Event, when compared to the peak demand observed just thirteen months earlier during a similar winter weather event, indicates that multiple utilities may be experiencing material growth in winter peak demand. It would be beneficial to:

- » Review and, if necessary, revise WRAP assumptions of winter peak demand, based on greater insight into the underlying drivers of peak demand growth. Pacific Northwest Utilities Conference Committee (PNUCC) provides exceptional information on average, summer peak and winter peak load forecasts in the U.S. Northwest region, as well as the drivers of the load growth,[4] which may be valuable in this regard;
- » Evaluate the effectiveness of existing demand response programs to reducing demand during the January 2024 Event; and
- » Explore a regional discussion of the opportunities for expanded use of demand response programs to reduce peak demand and/or to reduce multi-day energy needs during future winter weather events.

Second, identifying generation performance during these types of weather events is critical to understanding the current resource adequacy situation and to identifying key resource adequacy improvements. It is recommended that WRAP evaluate the actual performance of WRAP resources during the peak demand hours of the January 2024 Event to each resource's WRAP Qualified Capacity Contribution (QCC) metric for the WRAP winter 2024 season. This review would also help identify any existing data quality issues with specific resources, and potential enhancements to the QCC methodology for different resource types.

[4] Northwest Regional Forecast – Pacific Northwest Utilities Conference Committee (pnucc.org)

Third, the January 2024 Event indicates that multiple entities have existing capacity deficits. This may create challenges for those entities to enter WRAP binding operations, where they may face potentially high capacity deficiency charges until those capacity deficits are resolved. To realize the benefits of entering WRAP binding operations with maximum participation, while upholding robust resource adequacy requirements, it is recommended that the WRAP consider:

» Developing a modified transition framework to enable entities that face near-term capacity deficits due to resource installation timelines to participate in binding operations as early as Summer 2027, by applying significantly discounted WRAP capacity deficiency charges for the period of Summer 2027 through Winter 2028/29. This new transition framework may include a requirement that entities demonstrate that their current capacity deficits are temporary, or otherwise provide confidence of meeting resource adequacy requirements by the end of the new transition period.

» Revising the WRAP modelling assumption of available short-term bi-directional transfer capability between the U.S. Northwest and U.S. Southwest from the current assumption of 0 MW to perhaps 1,000 MW, in both seasons. This would provide at least some recognition of the ability to access seasonal diversity between the two WRAP areas, which would be reflected in a lower Planning Reserve Margin (PRM). This initial assumed value would be replaced once more data is available.

Recommendation 2

Identify Opportunities to Increase Import Capability Using Existing Facilities from the Southwest and Rockies Into the U.S. Northwest

The U.S. Northwest would have benefited from additional volumes of imports during peak demand hours to address the capacity adequacy challenges, and across all hours to address the fuel insufficiency challenges. Additional supply appears to have been available in the Southwest and Rockies, but access to this supply appears to have been primarily limited by inter-regional transmission service. There are at least two opportunities to enable greater transfers from the Southwest and Rockies into the U.S. Northwest using existing transmission facilities:

» One of the major inter-regional transmission paths—the Pacific DC Intertie—was out of service in the south-to-north direction due to a previously scheduled maintenance outage (and challenges experienced in returning the line to service once the winter weather event was forecasted). This line was also out of service during at least one other winter weather events in the U.S. Northwest over the past decade. Scheduling maintenance outages on the major inter-regional transmission paths during the spring or autumn would help ensure key transmission paths are available during periods of weather-driven electricity challenges in both the summer and winter peak demand seasons.

» Transfers of electricity across the West are limited by contract-path scheduling limits on key transmission paths. In addition to applying to deliveries of forward, day-ahead and real-time bilateral transactions, these limits are also applied by the California ISO to transfers between BAAs in the Western EIM and will be applied in its proposed EDAM. In contrast, organized markets elsewhere in the U.S. — as well as the proposed SPP's Markets+ platform — do not generally layer contract-path limits on top of standard flow-based transmission limits. Adopting a Western organized day-ahead and real-time market that largely eliminates these contract-path limits, as would occur under Markets+, could enable greater quantities of inter-regional transfers to occur. Such outcomes could substantially improve reliability for both the U.S. Northwest region and the U.S. Southwest region using existing transmission facilities, in both the winter and summer seasons, at relatively little cost.

  A first step to identifying the reliability benefits of eliminating contract-path scheduling limits to the maximum extent possible would be to conduct a technical study, leveraging the experience and data from the January 2024 Event. This technical study should include key transmission service providers that might join Markets+, and should focus on quantifying the additional transfers to the U.S. Northwest that could have been enabled during the January 2024 Event if existing BAA-to-BAA contract-path scheduling limits were no longer enforced, and instead only flow-based transmission reliability limits were applied.

Recommendation 3

Pursue Transmission Upgrades and Expansion Between the U.S. Southwest and Rockies and the U.S. Northwest Region

The January 2024 Event demonstrated the substantial value of expanding transmission service to deliver additional supply from the Southwest and Rockies to the U.S. Northwest. At a very high level, additional transmission capability could have delivered energy sourced in the Southwest (where the average day-ahead market price was approximately $150/MWh) to the U.S. Northwest (where the average day-ahead market price was approximately $800/MWh) across all 120 hours of the January 2024 Event. Assuming transmission losses of approximately $50/MWh, this implies that an additional 2,000 MW of direct transfer capability between these regions could have provided up to $140 million in additional economic benefit in just five days, while greatly reducing the reliability risk for the U.S. Northwest region.

A second way to look at the potential value of transmission expansion between the Southwest and Rockies region and the U.S. Northwest region is as an alternative to the delivery arrangements for the flows that did occur during the January 2024 Event. Notably, roughly half of the deliveries from the Southwest and Rockies region to the U.S. Northwest region during the event flowed through California, and particularly through the California ISO's service territory. Transmission service through the California ISO's service territory is provided under different terms and conditions than transmission service provided throughout the rest of the West.

Deliveries that pass through the California ISO service territory encounter "seams issues" that can either disrupt the flow of power or result in very high transmission costs, particularly on the jointly-funded multi-state Pacific AC Intertie and Pacific DC Intertie. This is because the California ISO has designed and implemented market rules that:

1. Provide load in the California ISO with priority to access supply using the multi-state transmission lines ahead of serving load located outside of California; and
2. Collect "contract path scheduling limit" congestion charges for use of jointly-funded multi-state transmission paths like the Pacific AC Intertie.

These congestion charges can be extremely high during periods of scarcity: during the five-day January 2024 Event, the California ISO collected approximately $111 million for exports on these multi-state jointly-funded facilities.[5] However, the charges collected by the California ISO are distributed solely to its own customers and participants (including California ISO participants that purchase financial rights through a California ISO auction); they are not shared with the other funders of the multi-state jointly-funded facilities. This seams issue, as well as the service priority issue, will continue to exist in EDAM.

This indicates that 2,000 MW of expanded transmission capability between the U.S. Northwest region and Southwest and Rockies region would be a valuable alternative to both the $111 million of California ISO charges and to the California ISO rules that result in lower-priority service for customers outside of the California ISO service territory.

For these reasons, transmission upgrades and expansion that provide connectivity directly between the U.S. Northwest region and the Southwest and Rockies regions, without traversing California, may provide very substantial reliability and economic benefits to ratepayers of both regions.

[5] See http://www.caiso.com/Documents/WeeklyMarketPerformanceReport_2024-01-03.html.

Recommendation 4

Consider an Examination of the Contribution of Specific Resources and Each Resource Technology to Fuel Sufficiency Challenges Across Multi-Day Weather Events

As previously mentioned, the WRAP, similar to other resource adequacy programs, is a program focused on capacity adequacy in capacity critical hours. The WRAP community has long acknowledged that this is an appropriate starting point for addressing the region's resource adequacy challenges, but that it also must not be the end of the resource adequacy discussion. This is because it is widely recognized that other reliability risks may emerge and grow in the years ahead as the generation resource mix on the western grid continues to evolve.

The January 2024 Event highlights that the U.S. Northwest region not only faces a capacity adequacy challenge, but that it also faces a fuel supply sufficiency challenge during extended weather events. Importantly, the contribution of specific resource technologies toward addressing fuel sufficiency challenges can differ substantially from their respective contribution toward addressing capacity challenges. Some resources, particularly those with base load or dispatchable capabilities and abundant fuel supply, are able to contribute at a very high level to meet both of these reliability challenges. This includes hydro facilities with longer term storage, as well as nuclear, gas, coal and geothermal resources.

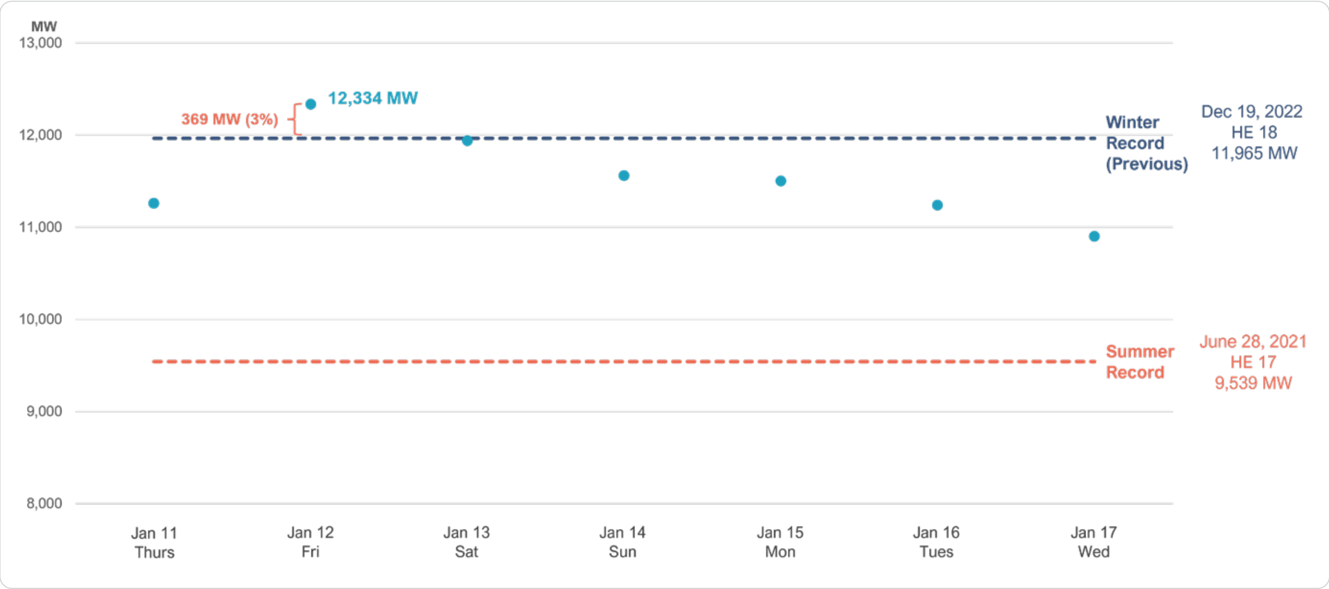
At the other end of the spectrum are shorter and medium duration storage facilities, such as batteries and pumped storage hydro. These technologies contribute substantially towards meeting capacity challenges (through 4-hour or longer discharge cycles) but do little to address (and may actually exacerbate) multi-day fuel supply challenges as they do not provide net energy over the course of one or more full charging/discharging cycles (i.e., they actually consume energy across each day of a multi-day event due to cycle losses).

Amongst renewable resources, solar and wind resources may also contribute differently, and their contributions may depend on other factors. For example, in regions that already have deep penetration of solar resources, the greatest need for additional capacity may occur near or after sunset (when demand is high and solar resources are no longer producing electricity). In these cases, additional solar resources would provide little or no benefit toward meeting this capacity challenge, but wind resources may provide a substantial capacity contribution. At the same time, these same solar resources may provide a greater contribution to fuel supply challenges over multi-day events than wind resources, since wind resources may be more susceptible to multi-day periods of little or no wind output.

It may be worthwhile for the WRAP community to explore ways to assess the contribution of different resource technologies to the fuel supply challenges faced during the January 2024 Event. This could be done by comparing the total production of each resource technology (and identified sub-groups of resources) over the five-day event to the respective nameplate capacity. This could be a potential first step toward helping participants understand the contributions of different resource technologies towards the region's fuel supply sufficiency challenge. Ultimately, the WRAP may need to evolve to include additional resource adequacy requirements associated with multi-day fuel sufficiency requirements.

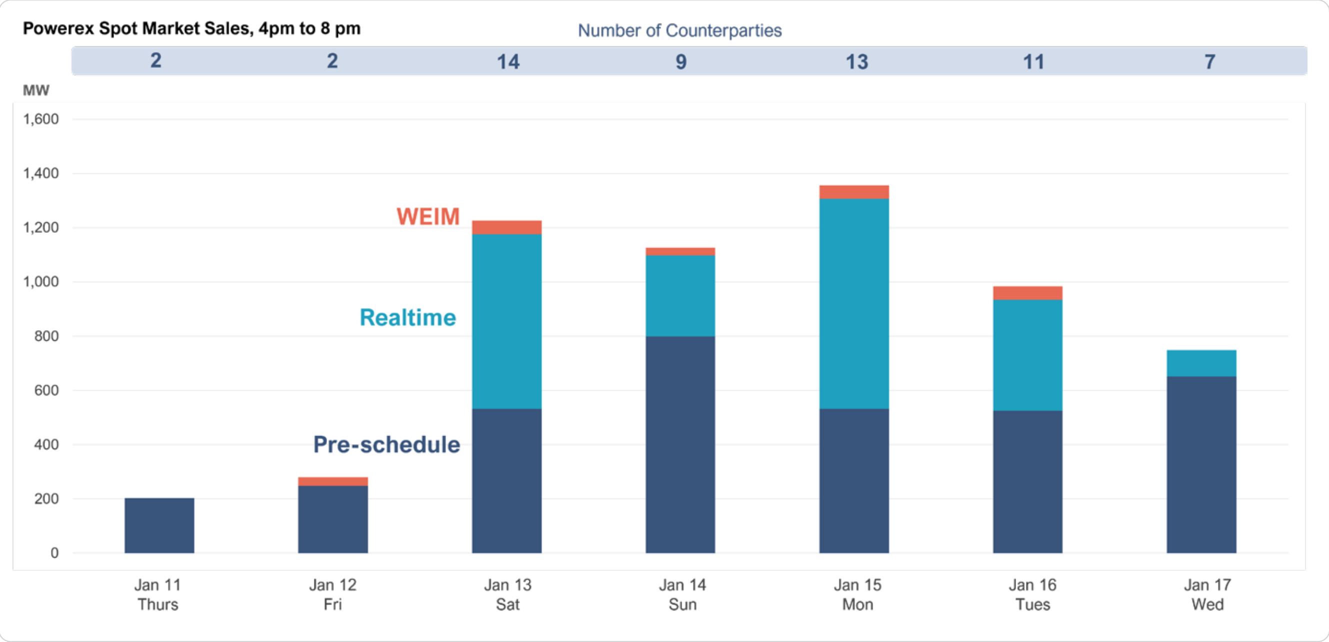
Appendix A

Load in the BC Hydro Balancing Authority Area reached an all-time record hourly peak of 12,334 MW on Friday January 12th, 2024, approximately 3% higher than the previous winter record established on December 19, 2022:



Source: BC Hydro

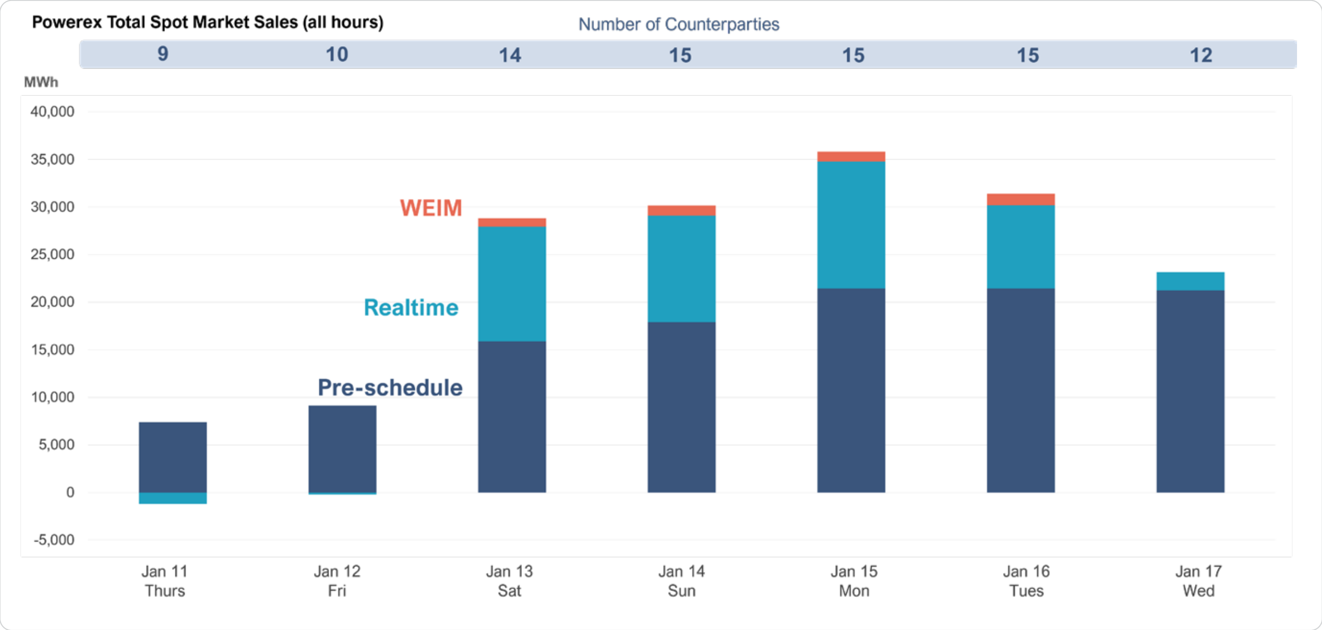
During the highest demand hours of 4pm to 8pm on January 13th to 16th, Powerex made spot market sales in the U.S. Northwest ranging between approximately 1,000 MW and 1,300 MW each hour. Those sales were made to between 9 and 14 different customers each day:



Volumes shown represent net purchases/sales in each temporal market.

Source: Powerex

Across all hours of the day between January 13th to 16th, Powerex made spot market sales in the U.S. Northwest of approximately 29,000 MWh to 36,000 MWh. Those sales were delivered to approximately 15 different customers each day:



Volumes shown represent net purchases/sales in each temporal market. *Source: Powerex*