



When wind doesn't hold water: The Pacific Northwest's unusual grid

By James Conca

Washington state has trouble on the horizon—trouble with its electrical grid. Trouble as in not being reliable. Trouble as in big risks of rolling blackouts.

The trouble stems from attempts to decarbonize our society. Getting rid of coal, oil, and gas in generating electricity is the low-hanging fruit, but just getting rid of them without a realistic plan to replace them will do more harm than good.

Seeing this trouble in Washington state is scary. Aside from usually having the lowest cost of electricity in the country, the Pacific Northwest has never had a big problem with

reliability. Washington is one of the most decarbonized states in the union, with utilities getting about 55 percent of their electricity from hydro, about 4 percent from nuclear, 5 percent from wind with some solar and bio (another 1 percent), 13 percent from gas, 10 percent from coal (from a single in-state coal plant as well as imports from neighboring states), and 11.3 percent from “unspecified power.”

Compare Washington's 2020 emissions of around 90 million metric tons CO₂ equivalent to the U.S. 2020 total emissions of 6,000 million metric tons CO₂ equivalent.

The state is part of the Western Inter-

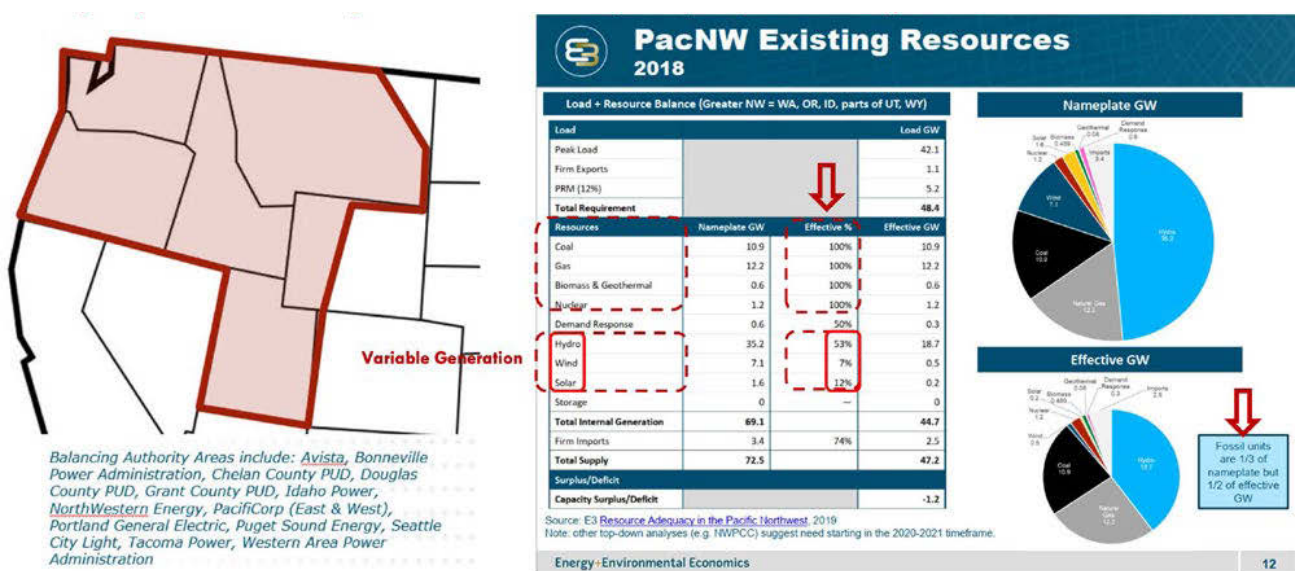


Fig. 1. The PNW, which includes Utah, faces a significant power generation capacity shortfall in this decade, about 7 GW by 2025 and 10 GW by 2030, compared to this figure drafted in 2018. Note that when planning for balancing, the effective capacity (that which can be depended on at any given time, especially during extreme weather) for wind is only 7 percent, not the 34 percent usually listed as the capacity factor. (Source: Energy + Environmental Economics, *Resource Adequacy in the Pacific Northwest*, 2019)

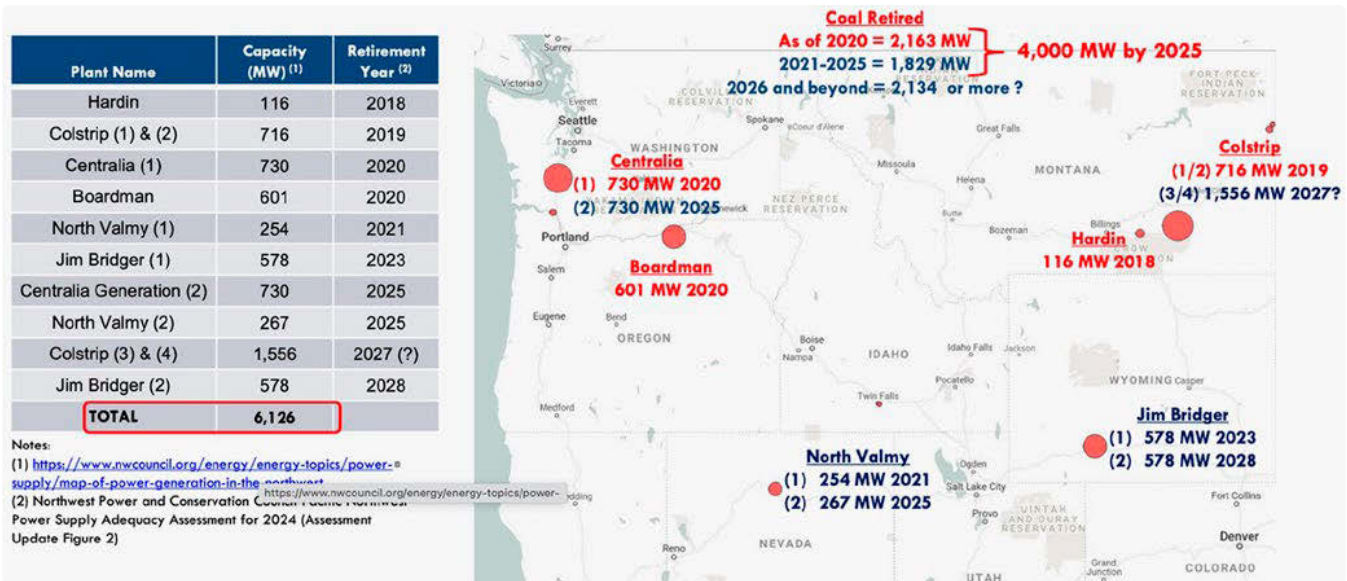


Fig. 2. The PNW is closing about 12 GW of coal generation: six in Washington, Oregon, Nevada, Wyoming, and Montana and six more in Utah. This is good, but there are no plans for replacement except by wind and solar, which is bad.

connection (Fig. 1). As on any grid, electricity is simultaneously produced, delivered, and consumed. Supply and demand balance must be equal at all times to produce the 60 cycles per second sine wave voltages and currents. This balancing requires either generation curtailment or load shedding (e.g., preemptive, localized rolling blackouts). So there must be a mix of energy sources that can be balanced, can satisfy strong baseload needs, and are flexible in the face of changing load.

The PNW's plan to close the dozen or so coal plants on its grid, which account for 12 GW of electricity generation, goes back to the early years of the Obama administration. The plan was to replace them with natural gas plants. Figure 2 shows those plants and the dates of closure for all but those in Utah. Half are already closed. Washington's final unit will close in 2025. Utah's closings have begun but the final dates are fungible.

Indeed, America's electric sector carbon emissions are at a 25-year low, almost strictly because gas has replaced about half the coal plants that we had in 1990. However, in 2019, the Washington state legislature passed the Clean Energy Transformation Act (CETA),

which requires that all utilities eliminate coal by 2025 and provide carbon-neutral electricity by 2030—meaning not natural gas. So, the original replacement plan was thrown out the window along with the bathwater. This level of planning requires a decade to pull off, yet there has been no replacement plan, just vague notions of emplacing more and more wind. Many stakeholders, utility officials, and industry leaders warned that losing baseload sources like coal without emplacing more baseload like nuclear, gas, or hydro would increase the probability of blackouts if demand increased, which it has.

"In our kind of zeal to remove CO₂ emissions and aim for a rapid transition to 100 percent clean energy, there is evidence we are potentially walking up to a reliability cliff," said Benton Public Utility District general manager Rick Dunn when I interviewed him. "Politicians are now designing the power grid in Washington with an unwarranted belief that wind, solar, and batteries are adequate replacements for dependable capacity currently provided by coal and natural gas. I have long advocated for a more rational

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coal-to-natural gas-to-nuclear transition as a way to preserve affordability and reliability on our way to carbon free.” I think he was just being nice using the word “potentially.”

Dunn has warned that over the next decade, Washington will be facing a large gap between electricity demand on the coldest and hottest days and the availability of dependable electrical generation. After nearly two decades of relatively flat growth, both annual and peak electricity loads are forecasted to increase in the region by 5–6

percent, even after accounting for increased energy efficiency.

A similar warning came from the Northwest Power and Conservation Council (NWPCC). The 2019 study, *Resource Adequacy in the Pacific Northwest: Serving Load Reliably under a Changing Resource Mix*, to which NWPCC provided data and technical review, showed that the situation could bring an end to a period of stability dating back to the end of the Enron-precipitated energy crisis of 2000.

The industry considers the state’s decades-long outage risk of less than 5 percent to be safe, but the study warns that Washington is now facing a 26 percent probability of an outage due to insufficient generation to meet an increased load. That increased load-to-generation ratio is the result of the loss of remaining coal plants, an increase in electric vehicle use, and a steady increase in population (Fig. 3). Powerful political forces have forced the NWPCC to tone down their forecast lest it sound alarmist. But those of us in the business *are* alarmed!

On top of this, there is a serious push to decommission four hydroelectric dams on the lower Snake River, which would put

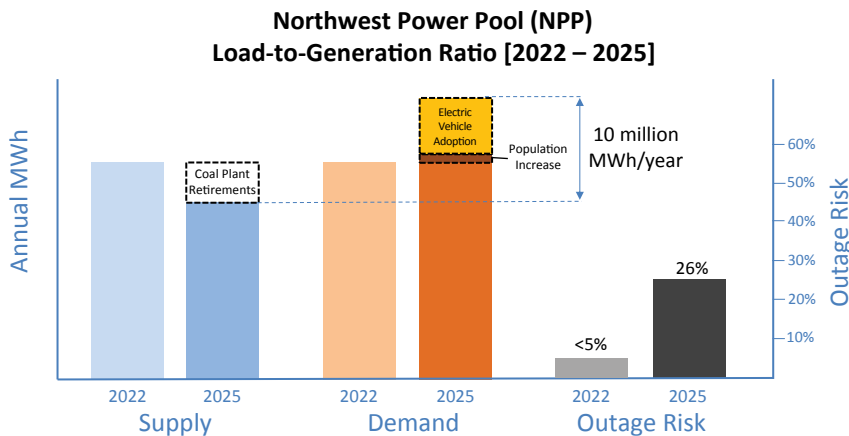


Fig. 3. In Washington state, the grid is balanced by hydro, which must simply be dumped when wind comes to the grid. In the larger PNW, the grid is balanced by hydro and gas.

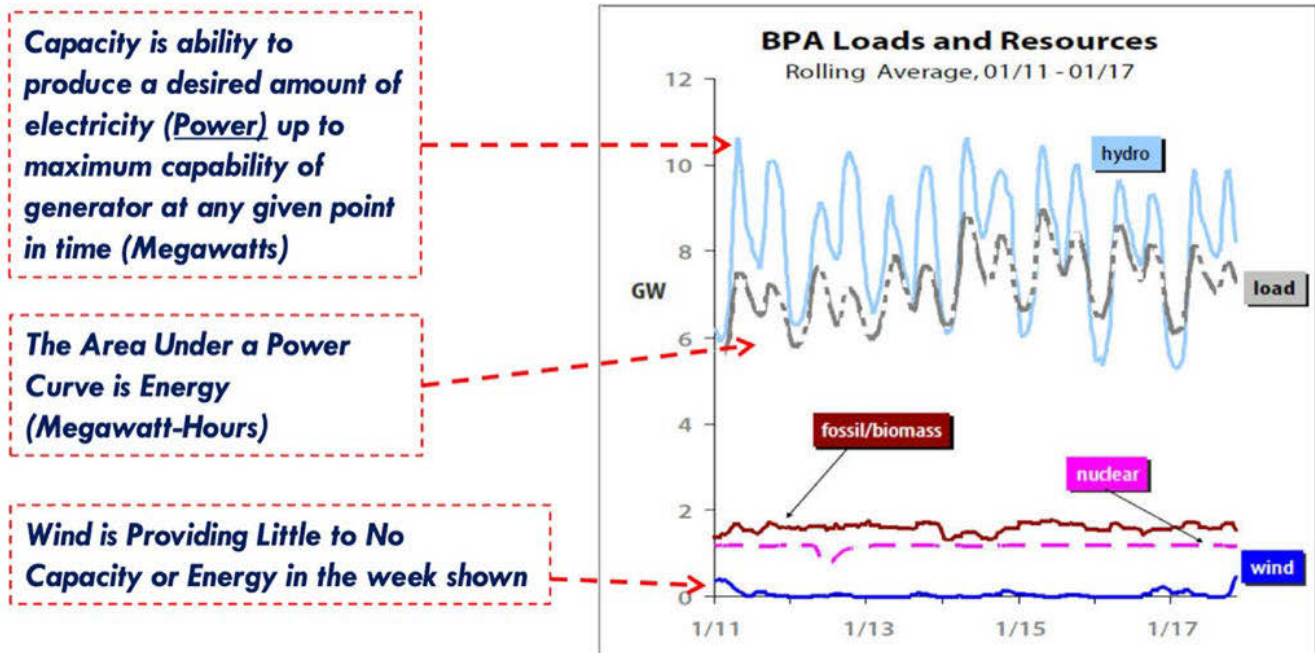


Fig. 4. The NWPCC considers an outage risk of less than 5 percent to be safe, but they warned back in 2019 that the state faces a 26 percent probability of outages beginning in 2025, when Washington’s last coal plant shuts down.



further strain on the grid by removing over 8 billion kilowatt-hours per year of reliable green energy. To replace the loss would require over 7,000 MW of new wind turbines with storage (as many as presently exist in the entire state, although they have no storage), or two new gas plants, or one new pack of small modular nuclear reactors.

CETA requires utilities to gradually shift toward clean energy sources like wind. However, these lack the reliability and predictability of resources like nuclear and natural gas and require backup sources for when they fail to generate. Hydro presently provides that backup in the PNW, while gas provides it almost everywhere else in America. It's not that CETA prohibits the use of natural gas, but it does strongly discourage it through punitive financial penalties, effectively eliminating investment in new gas.

The weekly load map from the Bonneville Power Administration (Fig. 4) shows how the PNW grid operates over any seven-day period, this one specifically for within BPA's system, but most everywhere the basics are the same. The gray line is load, or draw, on the grid, and it shows the daily double-hump shape made from everyone getting up in the morning, going to work, taking lunch, going home, and going to sleep.

The light blue line is hydro. It—and only it—mirrors and balances the load. The pink line is Washington's one nuclear plant, Columbia Generating Station, which never varies except for refueling every two years. The brown line is coal, gas, and a little biomass, also not varying much. The dark blue line is wind. It comes and goes, but every time it comes onto the grid, hydro must be dumped. Very little water can be stored in these run-of-the-river dams. Only Grand Coulee can store appreciable amounts of water.

One zero-carbon source replacing another zero-carbon source is, well, stupid, and I use that term in a scientific sense. The \$14 billion or so spent on emplacing wind in this region has resulted in merely dumping hydro, losing about \$1.4 billion of electricity per year. It has not reduced carbon emissions at all. It has not added to our effective capacity at all. And

Capacity Factor and Effective Capability



...that is, only 500 MW of wind power, out of 7,100 MW, can be expected to show up on the coldest or warmest days in the region.

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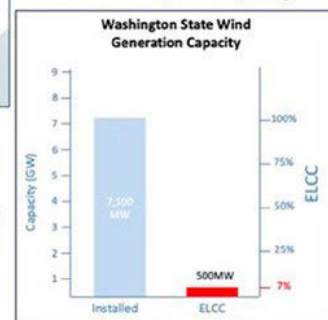


Fig. 5. While the average capacity factor for wind is about 35 percent across the country, it is only 27 percent in Washington state, and the effective capacity is only 7 percent. Since wind cannot be relied on when it is really needed, investing more in wind is a Sisyphean task.

wind turbines have added to the beauty of the landscape only if you're looking through green-colored glasses.

On an annual basis, wind power plants generate energy equivalent to about 25 percent to 30 percent of what they would if the wind blew constantly and the generators were producing at their maximum nameplate rating. By comparison, Washington's nuclear plant generates over 95 percent of its maximum nameplate rating—often 98 percent.

But it's even worse. According to the most recent Northwest resource adequacy study by Energy + Environmental Economics, the effective capacity contribution of Washington's 7,100 MW of wind power in the region was determined to be only 7 percent of its nameplate capacity, that is, only 500 MW of wind power out of 7,100 MW can be expected to show up on the coldest days (Fig. 5). It doesn't matter if you put in more wind—or overbuild as it's called—it will still be only 7 percent.

As Dunn quipped, praying for mild weather and abundant snow and rain isn't an adequate plan when it comes to keeping the lights on.

There is a way to make wind useful in this region, and that is to emplace pumped hydro

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storage facilities, about one 20 MW/500 MWh facility for every 2,000 MW of wind. Then wind could be stored for the times it is needed and we wouldn't have to just dump hydro every time the wind blows. Pumped hydro is about as efficient as lithium batteries, requires little maintenance and operations, is relatively quick to build, and doesn't degrade over time—there are still ones from the 1950s operating great. But plans generally get shot down by the public.

Dunn sees SMRs as the important energy source as the state transitions away from coal, but the Washington State Department of Commerce's *2021 Energy Strategy* envisions a ramp-up in wind only. In one scenario, electricity demand grows 90 percent from 2020 to 2050. Dreams of attracting big agricultural facilities like fertilizer plants or big data centers, both of which take over 200 MW of reliable continuous generation each, will not be realized in the present plan for the region. But rolling blackouts and grid failure certainly will—not to mention at least doubling the price of electricity.

It's a no-brainer deciding which party will

be blamed by an angry voting public after these blackouts start rolling.

For the long term, emplacing just two full SMR packs totaling about 1,800 MW by 2030–2032 and three 20 MW/500 MWh pumped hydro facilities by 2026 would solve Washington's reliability problems, and a few more SMRs would solve problems for the rest of the PNW. We used to plan pretty well in the past for future energy crises when all we had to do was be sure we had enough energy at a reasonable price. We weren't hamstrung by a rapid push to decarbonize or the irrational fear of nuclear. It is not enough to just put up wind and solar without planning for the infrastructure needed to efficiently employ them, or without the pumped hydro and SMRs that should be backing them up instead of gas or the dream of sufficient batteries and tons of precious metals that are decades away.

If this kind of problem can happen in Washington state, which has one of the lowest carbon footprints and one of the most aggressive decarbonization plans in the world, then other states had better beware. ☒

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