<u>Wind Power and Clean Energy Policy Perspectives</u>

Washington Wind Farms Rated Lowest for Effective Capacity in Winter

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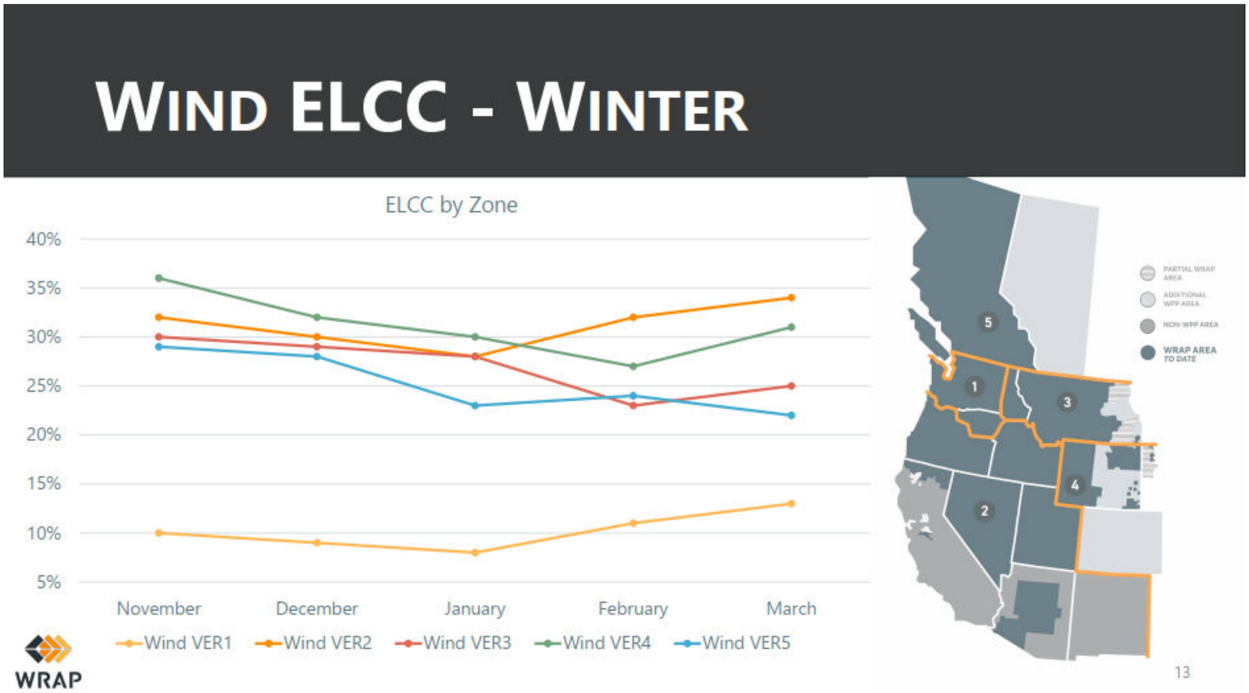
When you think of electricity in the pacific northwest and Washington state, you think hydropower. Representing as much as 60% of Washington's annual electricity fuel mix, hydro is the foundation of a nearly 70% non-emitting and abundant electricity portfolio unlike anywhere else in the United States. And hydro is the single technology we rely on most to keep the lights on throughout the northwest.

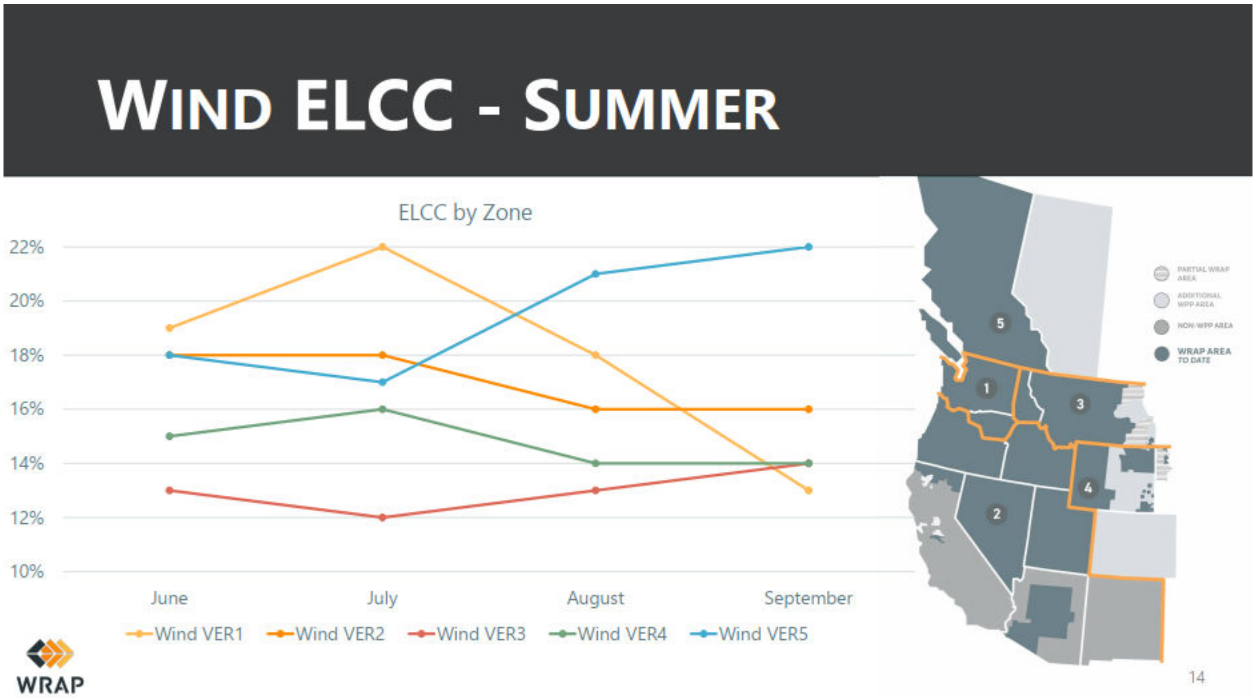
While hydropower is clearly the foundation of northwest power grid reliability, it is a variable generating resource limited by the timing and volume of water flows. So, when hydropower comes up short, other technologies need to be standing by to carry the load. And while **hydrocarbon-based electricity** production has historically represented only **one third of the nameplate capacity** of generators connected to the greater pacific northwest power grid (includes four northwest states, western Wyoming, and Utah), **coal and natural gas** have provided about **half of the region's effective capacity**. In simple terms, effective capacity is the percentage of the maximum generating capability of a particular technology that can be expected to be available when maximum electricity demand occurs on the coldest and hottest days of the year. To put things in perspective thermal power plants with predictable fuel supplies like **coal, natural gas and nuclear** have an **effective capacity in the northwest of around 98% or better** when considering the diversity of generation plants and electricity demand across a geographically large and interconnected power grid.

In response to **increasing risk of northwest power grid blackouts** driven by rapid retirement of coal plants combined with crippling financial penalties and restrictions on new natural gas power plant development included in Washington and Oregon clean energy legislation, a consortium of utilities organized by the Northwest Power Pool started an effort called the **Western Resource Adequacy Program (WRAP)**. One of the major objectives of the WRAP was to adopt common power grid reliability planning standards for participating utilities which included calculating the effective capacity of intermittent and variable wind power throughout different geographical zones across the western U.S. and into British Columbia, Canada; see graphic below. What the WRAP team determined was **Washington based wind** power (Zone 1) provides the **lowest effective capacity in the winter months of December through February of any region**, with effective load-carrying capability (ELCC) **ranging between 8% to 11%** as shown by the "Wind VER1" graph. This is not surprising to us who live through winters in eastern Washington where we experience many days of high-pressure inversions resulting in deeply cold and windless days. Clearly the WRAP assessment shows **not all wind farms are created equal**. And when it comes to Washington wind, the science of power grid physics and analysis shows a stark difference in performance compared to other regions and should be a serious consideration, especially when wind farm development results in significant environmental and ecological impacts.



Washington wind is expected to perform better in the summer months with ELCC ranging between a high of 22% in July and a low of 13% in September; see figure below. But in the northwest, hydropower is usually operating at maximum levels in June and July and the power grid doesn't need as much help from other generating technologies. The greatest need in summer for high effective capacity usually occurs in August and September when hot summer temperatures are still in play and the hydro system water flows have petered out. These are also the months when Washington wind ELCC begins a summer decline to its lowest levels of 18% and 13% respectively.

So, **<u>if you are trying to replace 98% effective coal and natural gas capacity with 8% to 22% effective wind power you can see there are significant gaps to make up depending on the month</u>**. This is where the overbuilding of wind farms across an expansive geographical area becomes necessary to try and improve its total capacity contribution. Of course, developers are more than happy to leverage federal and state tax subsidies to build more and more wind farms regardless of the vast amounts of land required.



Speaking of subsidies. Yes, all generating technologies are (or have been) subsidized. But it's important to differentiate the gross dollar subsidies from the dollar per unit of energy delivered. Based on 2018 data we gleaned from a presentation by energy expert Robert Bryce, wind power in the U.S. has received 44 times more in subsidies per megawatt-hour produced than fossil-fuels and 157 times more subsidies than nuclear. **And after nearly two decades and billions of dollars of subsidies, wind power currently provides only 9.2% of U.S. electricity and less than 3.4% of total U.S. primary energy.** You see, the energy density (how much electricity you can produce in a square foot of land) matters if you are cognizant of the scale of energy needed and care about minimizing land use impacts. And that's why we continue to argue for a more balanced approach where perhaps the most environmentally responsible thing we can do is generate the most electricity possible, on the smallest piece of land possible, and as close to where the electricity will be consumed as possible. And if carbon dioxide emission reductions are your goal or mandate, then natural gas and nuclear power are the rational near and long-term answers.

The next time you are driving by Hermiston or Boardman in Oregon, keep in mind the three natural gas power plants you can see from the interstate occupy around 15 to 20 acres each and are providing between 474 and 635 megawatts of 98% effective capacity with carbon dioxide emission rates between 50% and 60% less than coal. In contrast, a 500-megawatt wind farm in Washington would on average impact an area of 45,000 acres and would only be credited by the WRAP for 40 megawatts of January effective capacity at an 8% ELCC. It's instructive to recognize a **utility would have to build more than twelve 500-megawatt Washington wind farms impacting around 560,000 acres to get 500 megawatts of January effective capacity** credit from the WRAP.

This is illustrative of why a myopic focus on carbon reduction through a deepening dependence on energy dilute, intermittent, and variable wind power must ultimately come to terms with the laws of physics and the high financial and environmental cost of achieving a reliable power grid with this technology. It may be argued it's worth every penny based on concerns with climate change. Fair enough and we should have that discussion, but at least politicians should level with people and stop promising a grid with ever cheaper wind and solar power will deliver a reliable and lower cost power grid with inconsequential environmental impacts. It hasn't happened yet and there are no indications as far as we can see that it will. Just look at Germany and California where blackout risks have increased, and electricity rates have risen to over 30 cents per kilowatt-hour (kWh). This contrasts with the U.S. average of 12 cents and Washington's 8 cents per kWh. And we do not subscribe to the often parroted "all of the above" strategy to make up for wind power deficiencies. We're in the camp of "always the best" technology as utilities try to balance the three-legged stool of providing affordable, reliable, and environmentally responsible electricity, with a full cradle-to-grave lifecycle consideration of all technologies.

It is worth considering Washington state's 2021 Energy Strategy (SES) indicates a near doubling of electricity consumption will be required by 2050 to significantly decarbonize the state transportation sector and natural gas end uses. So, what is the end in mind if wind power is considered essential to meeting state decarbonization goals? Given Washington's annual electrical energy consumption was recently 10,700 average megawatts, the SES vision would require more than 35,000 megawatts of wind power to generate an equivalent amount of annual energy without considering the overbuild required due to its low effective capacity (which in previous calculations was demonstrated to be on the order of twelve times for January capacity). Of course, no single technology is being proposed as a solution but when you consider wind farms on average require about 140 square miles of land for every 1,000 megawatts of installed capacity, **a land area equivalent to sixty Seattle's would have to be covered with industrial wind turbines to achieve just the incremental energy envisioned by Washington's clean energy strategy**. And when you consider the extremely low effective capacity of Washington wind, the number of Seattle sized wind farms goes up by a factor of 5 to 10 which we recognize is impractical and cannot happen. It is a fool's errand to think citizens in rural Washington and adjacent states will welcome and have endless patience for the level of sacrifice to natural landscapes required for wind farms to be a primary contributor to a clean energy future. Particularly when citizens most impacted by wind farm development realize their sacrifices have delivered an inconsequential and fractional contribution to net reductions in global carbon dioxide emissions while simultaneously increasing retail electricity rates and degrading power grid reliability.

To provide further perspective it is important to recognize nearly 4,000 megawatts of coal-fired power plant capacity will be retired in the northwest by 2025 and that coal power is prohibited from Washington utility portfolios after 2025. In Benton County, a developer is proposing to build an **expansive and controversial 850-megawatt wind farm** in the iconic Horse Heaven Hills. Using the ELCC values produced by the WRAP team, a utility off taker of the Horse Heaven project would receive an **effective capacity credit** of **68 megawatts for January** and **187 megawatts for July** which doesn't go far toward making up for the dependable capacity lost through coal plant retirements and the future impacts of Washington and Oregon clean energy policies that aim to shut down natural gas plants in the future. From a utility planning perspective, it's clear **Washington based wind farms should be low on the list of alternatives if you are trying to balance CO2 emission reductions, grid reliability and land-use impacts in the most cost-effective manner possible**.