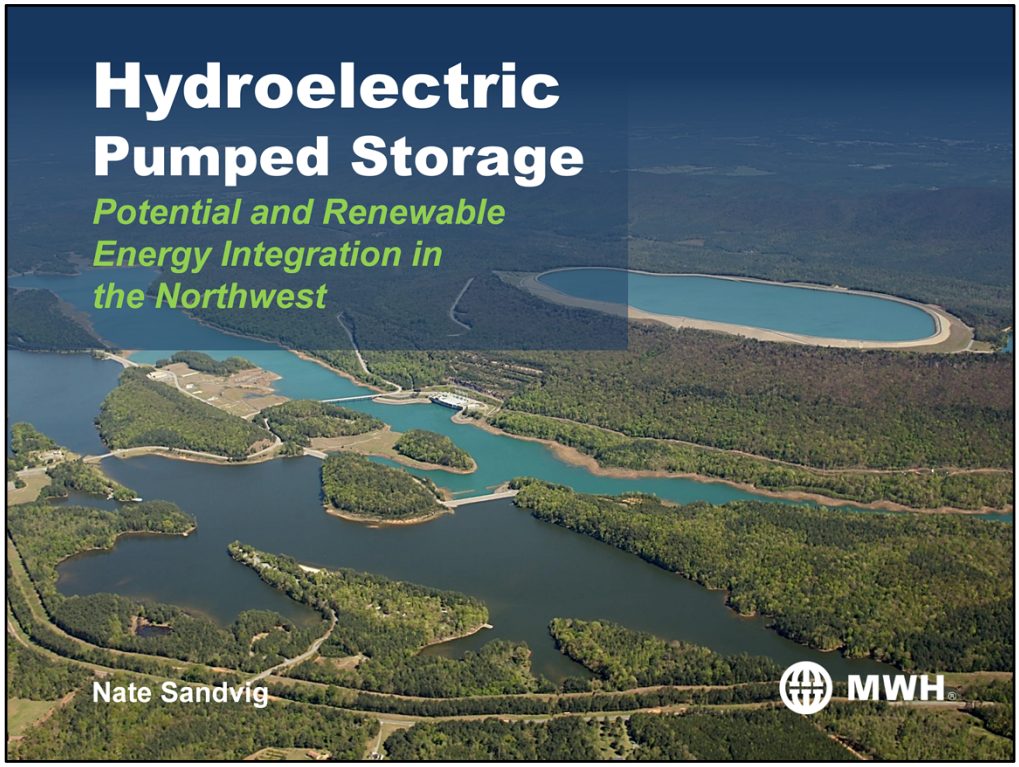
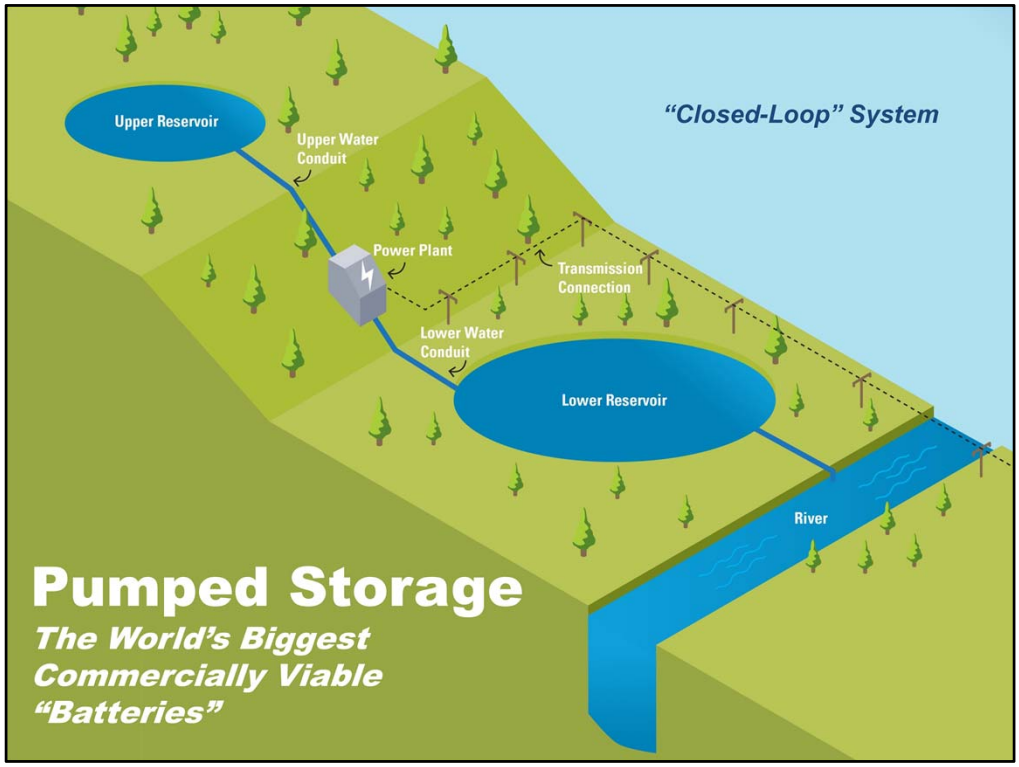

Hydroelectric
Pumped Storage
Potential and Renewable Energy Integration in the Northwest
Nate Sandvig
MWH

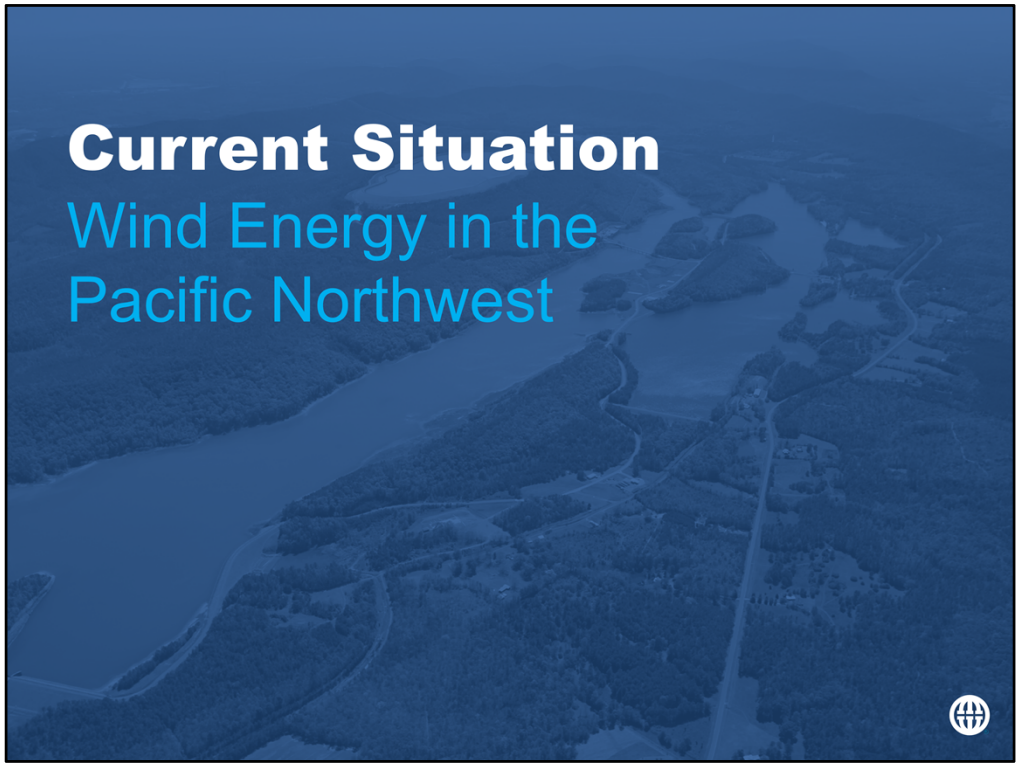
First, I'd like to start with a quick rundown on "*what is pumped storage*" as a common basis of understanding.



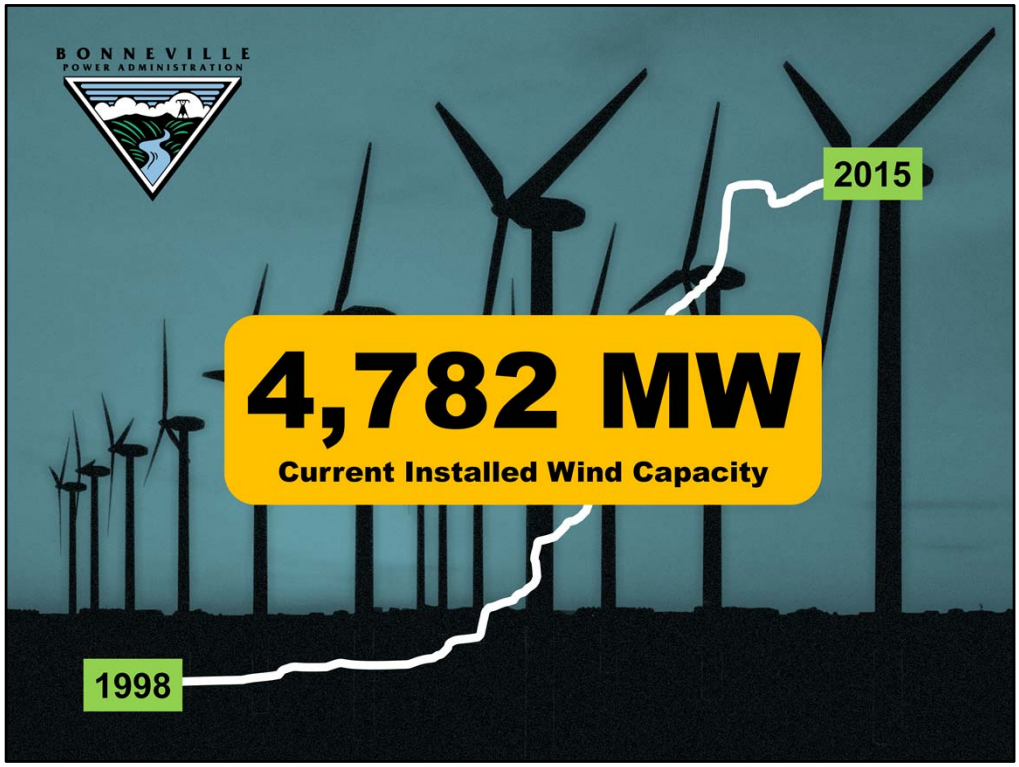
I'm going to assume most everybody in the room knows what a pumped storage project is and skip to the punch line – they are ultra-mature, proven, and essentially the biggest, cost-effective batteries on the planet.

When the elevation difference between the reservoirs is large – or more commonly known as head – more energy can be stored using smaller reservoirs, smaller water conveyances, and smaller physical equipment sizes, usually resulting in lower investment costs.

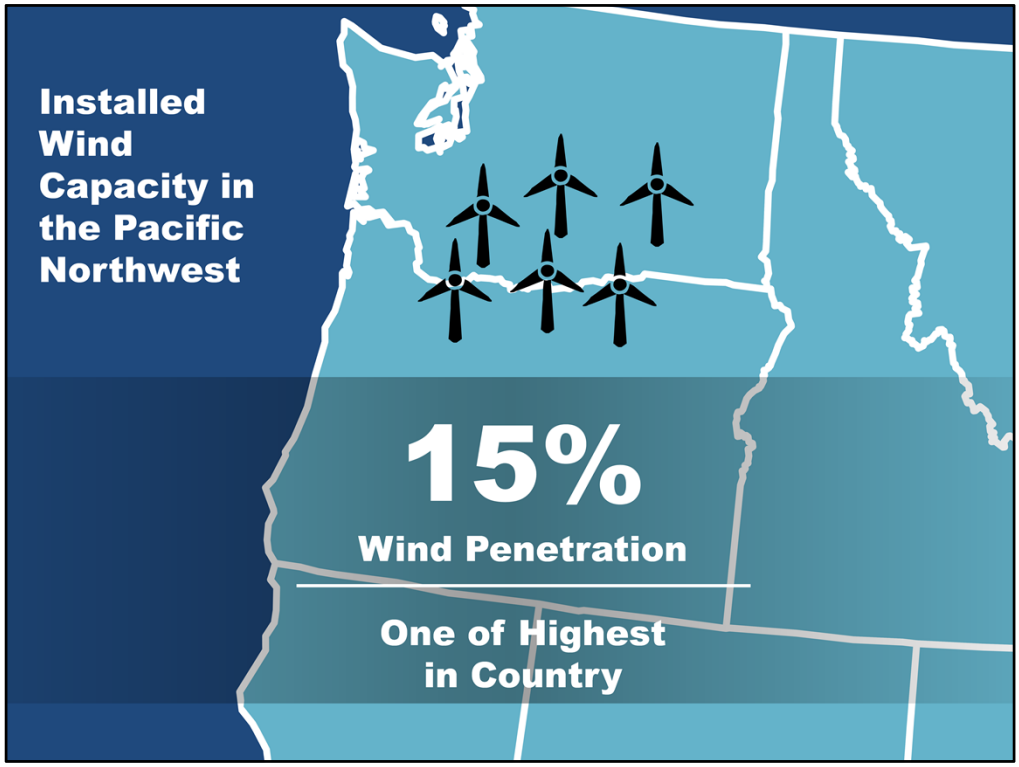
A dedicated off-river or "closed loop" pumped storage project does not have the operational restrictions imposed such as those that occur on the Columbia River, and hence, can freely start, stop, reverse, and fluctuate as needed by the power system without negatively impacting the aquatic species, or adversely impacting other demands such as food control, fish passage, navigation, irrigation and recreation.



So where are we today with wind energy in the Northwest?

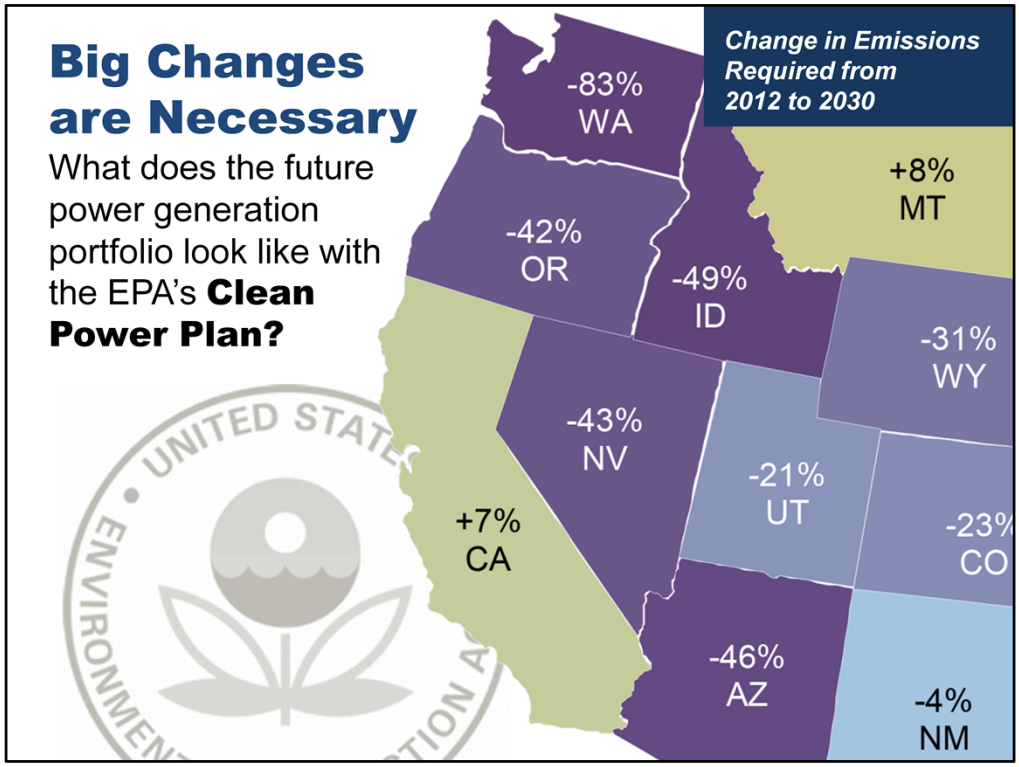


Over the past decade, the Northwest has seen explosive growth in wind generation. Wind generation on BPA's balancing authority in the Northwest grew from almost nothing in 1998, to over 4,700 MW in 2015.
One note, this chart doesn't include what is in BPA's geographical footprint but accounted for in other control areas such as PacifiCorp and Puget Sound Energy.

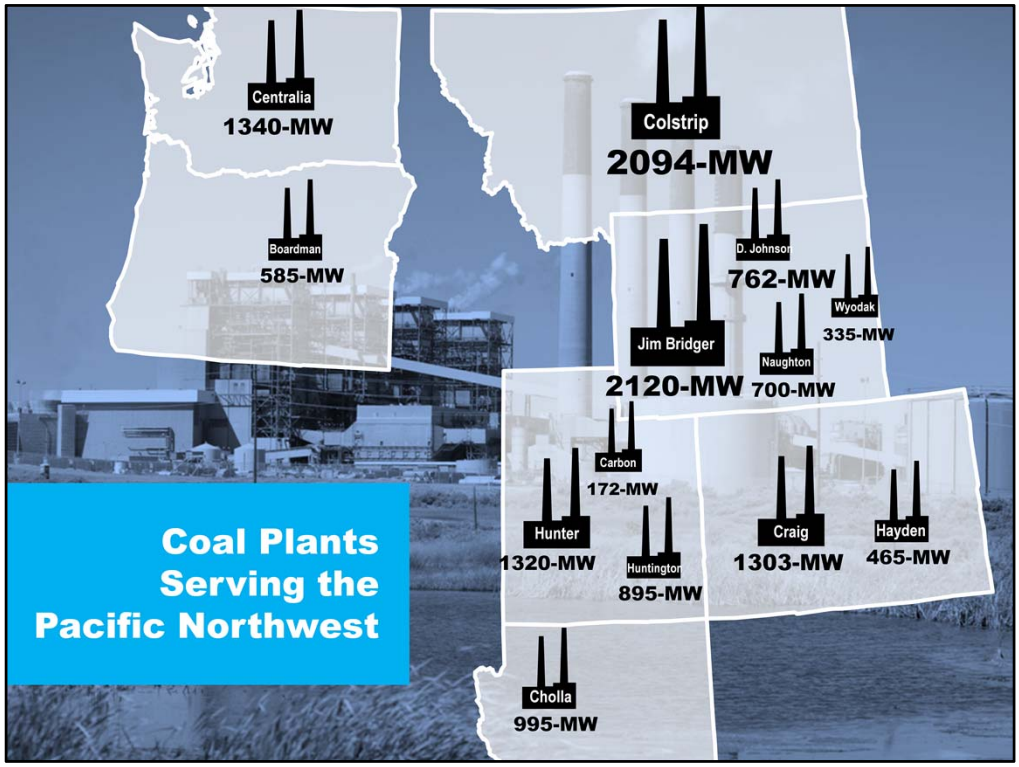


As a result of this exponential growth, the installed operating wind energy capacity in the Northwest is one of the highest in the country as a percentage of load with the majority located in the Columbia River Gorge just east of here representing a $6 Billion clean energy investment.

But this doesn't come without challenges and changes ahead.



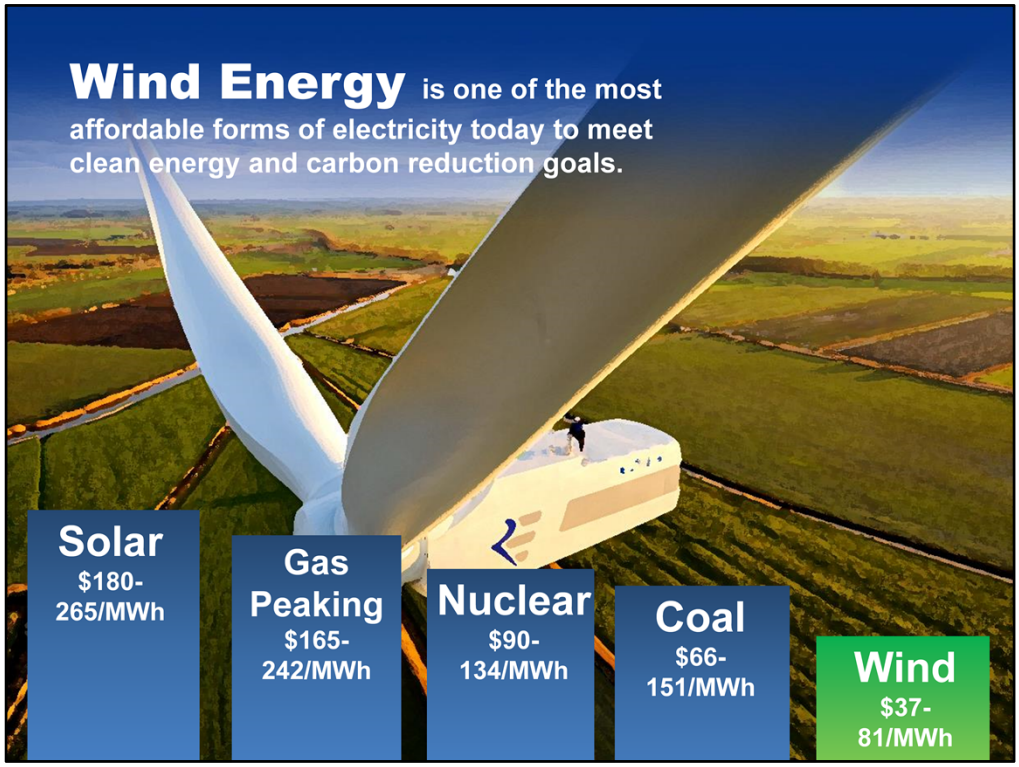
The EPA has announced rules to curb carbon dioxide emissions in a big way over a number of years with their Clean Energy Plan.
The proposed rules target coal plants, impacting some states far greater than others. Washington State, for example, would need to reduce its emissions by nearly 83% – more than any other state. It's not without saying that big changes regionally will be necessary to meet these goals.



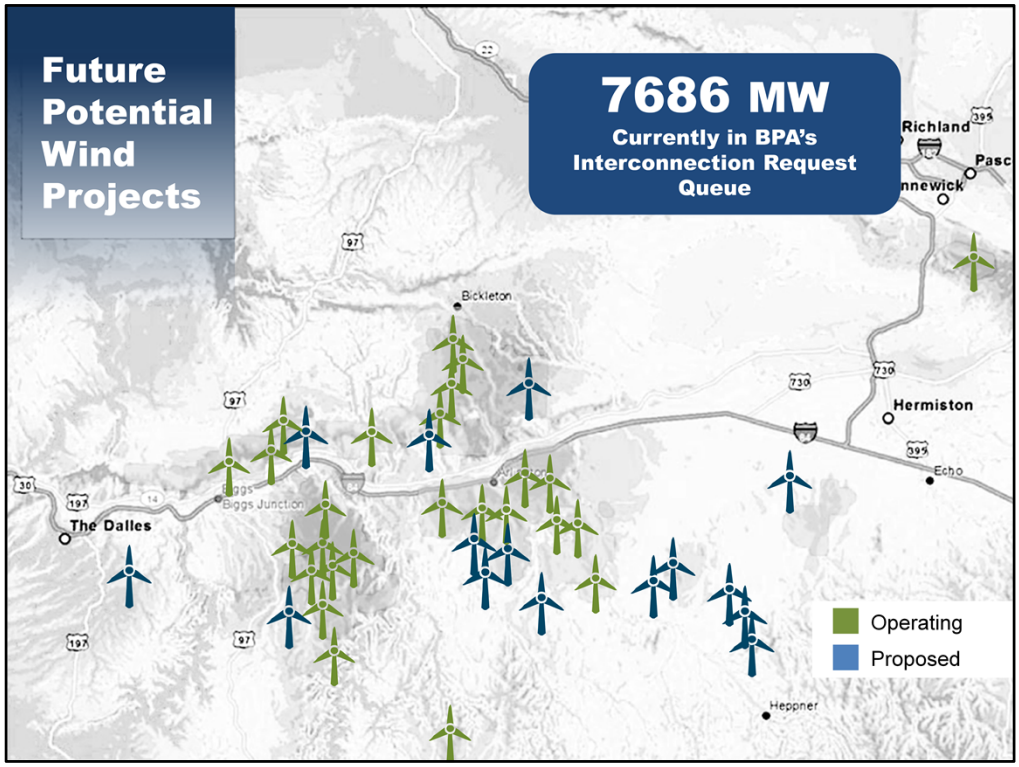
By just looking at the coal plants serving the Northwest, there will be a considerable need for low-carbon replacement capacity.

Over the next 20 years, PacifiCorp alone is planning to take down 2,800 MW of coal-fired generation in the West. Aging infrastructure is another driving factor for retirement, with the average age of all these coal plants being over 43 years old.

So, the $64,000 question – what does the region's future power generation portfolio look like with the EPA's Clean Power Plan?



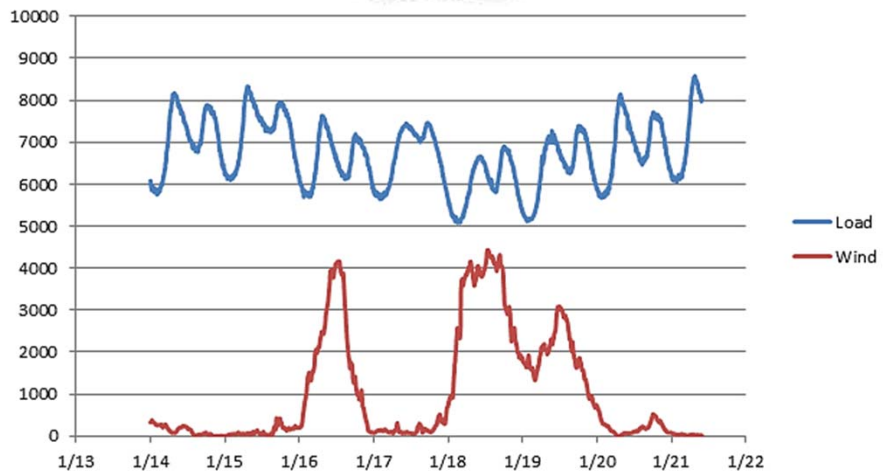
With the procurement options available for new generation on an unsubsidized and levelized cost of energy basis, assuming new hydropower is largely built out, wind energy is one of the most affordable forms of electricity today to meet clean energy and carbon reduction goals.
Additionally, with the drought-stricken conditions across the West, wind energy can also reduce or avoid the consumption of water.



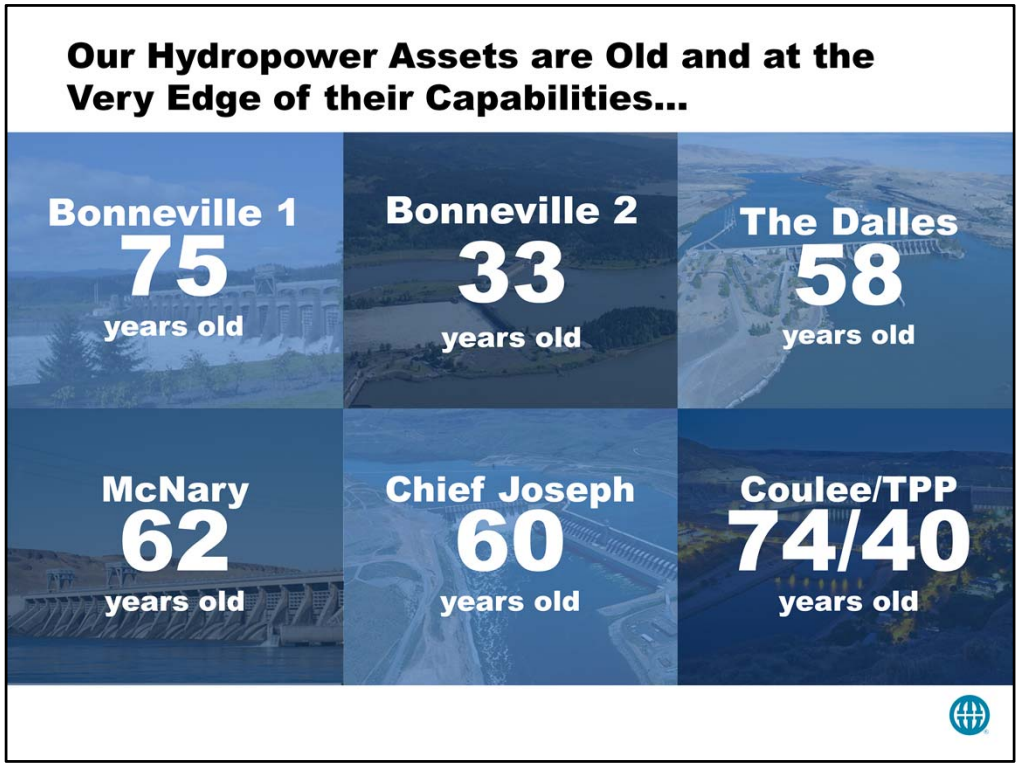
As I mentioned before, the majority of wind developed in the Northwest is in the Columbia River Gorge, with a substantial amount of additional projects proposed in this rich wind resource area.
BPA's transmission interconnection queue has over 7,600 MW in study with over 8,000 MW likely on BPA's system by 2024.

Challenge:

How to make energy created by wind and other renewable intermittent resources available on demand to match load?

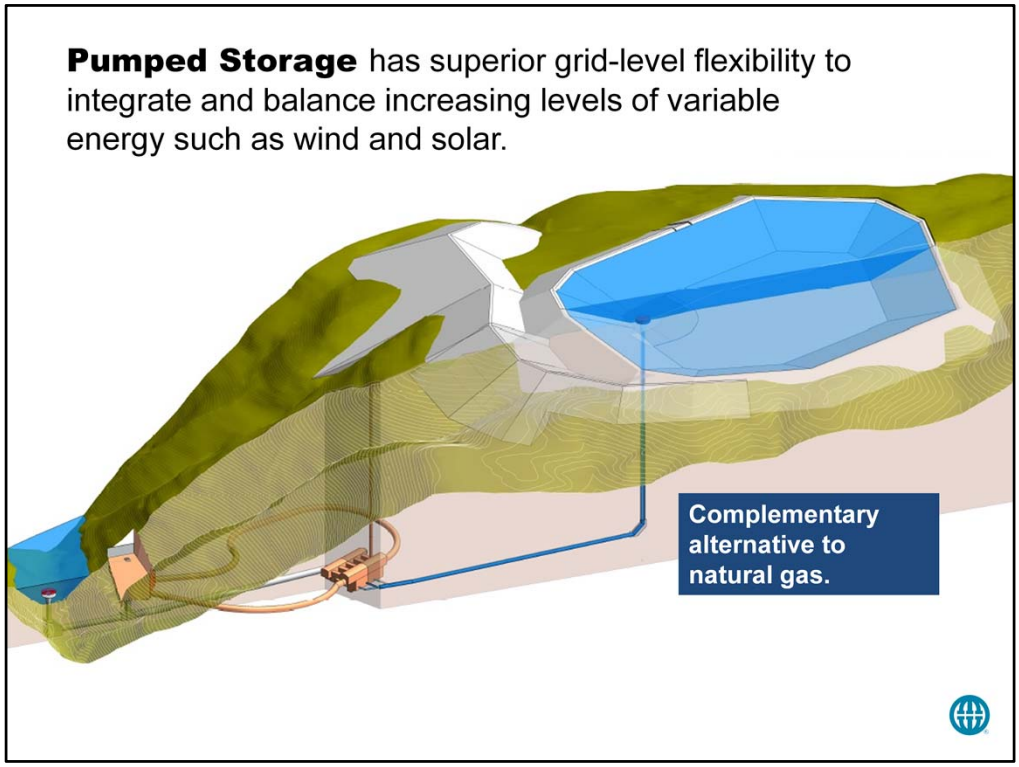


However, the Achilles' heel of wind integration lie in the intra-hour variability and uncertainty of wind, making this resource difficult to dispatch.
The challenge is to find a way to make wind energy and other intermittent resources in synch and balanced with load on a real-time basis.

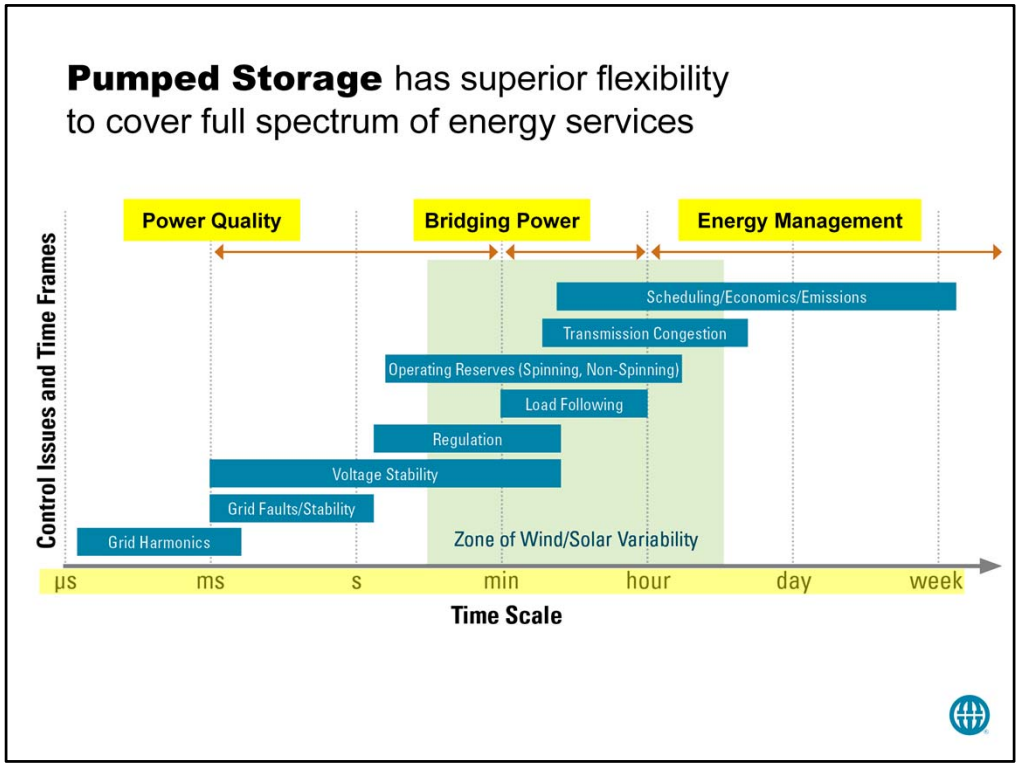


In the Northwest, wind and hydro have been the ideal marriage to integrate all this "must take" wind.
However, these hydropower assets are old and at the very edge of their capabilities, needing significant capital to rehabilitate and modernize in curbing their deterioration.
The average age of these main stem Columbia dams are almost 60 years old.
Plus, these leviathans weren't designed to ramp at the speed and frequency wind calls for which is akin to "putting grandma on a treadmill."
So, what's the solution?

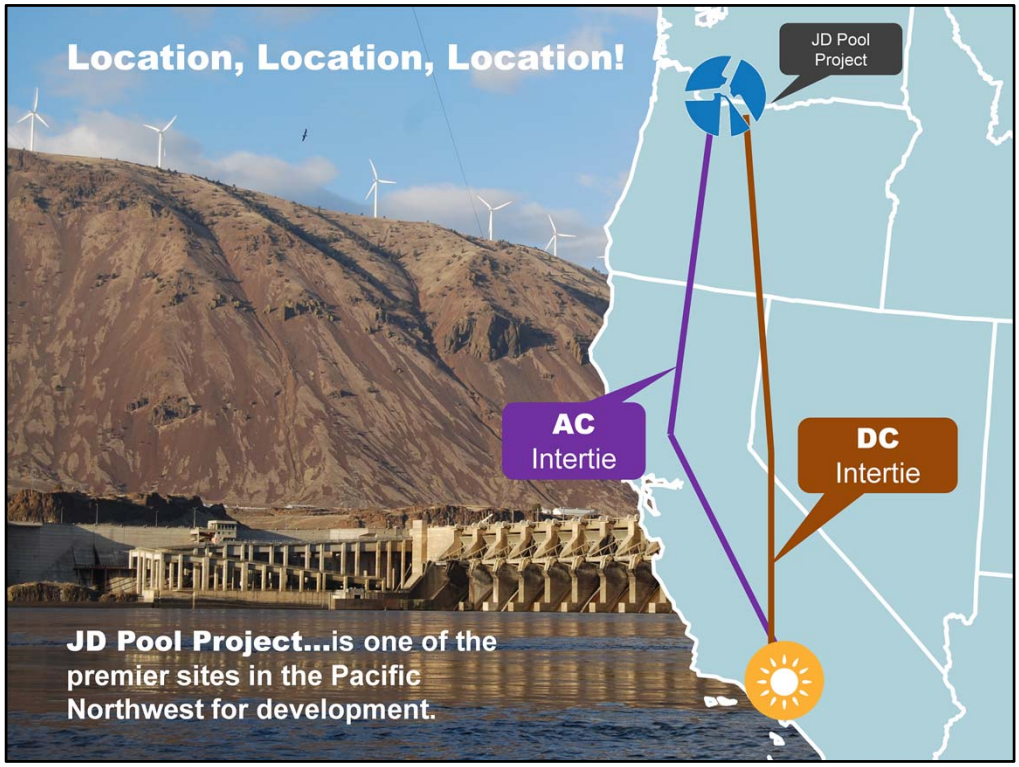
Pumped Storage



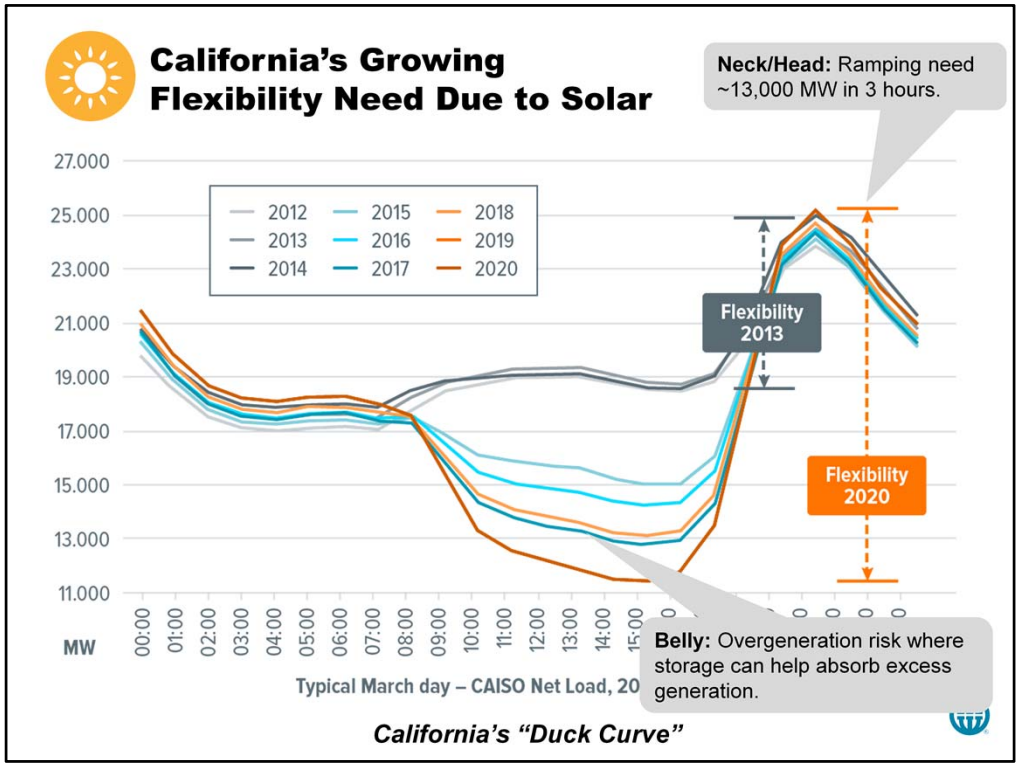
Combining energy storage with intermittent renewables holds great promise for the wind industry in the Northwest and the next quantum leap in market growth.
Pumped storage can unlock the greater value of existing and future renewables by integrating them with no carbon emissions.
Unfortunately, the current utility "default option" is natural gas for flexibility – it's cheap and easy now. However, this "bridge fuel," turning into the "destination fuel," is analogous to giving up the donut and trading it for a bagel in terms of carbon content.
What is needed is carbon-free storage with high operability and flexibility to not only respond quickly when power is needed, but to absorb excess energy in overgeneration conditions.



Pumped can respond to load changes within seconds and can operate across a broad range of time scales, from seconds through hours, to days and months, to ensure that sufficient generation will always be available to meet load and match changes in generation and demand on a real-time basis, and on an hour-to-hour and sub-hour time-frame.



As with real-estate – location, location, location.
While there are many proposed projects in the US, the JD Pool Project in the Columbia River Gorge is one of the most attractive, premier high-head sites in the Northwest for development.
Not only is JD Pool co-located next to significant amounts of existing and future wind, but it is in the middle of BPA's robust high-voltage transmission system at the northern terminus of the AC-DC Interties – a West Coast electron superhighway stretching from the Northwest to the Desert Southwest.
The project can also be developed in an environmentally benign manner. It is "closed-loop" with a sizable water right for the specific purpose of pumped storage by state law.
As they say in the West, especially with our persistent drought and fire-prone conditions, "whiskey is for drinking and water for fighting."



Lastly, while this presentation is focused on the Northwest, the region has major interconnections with California built in the 1960s as a result of the Columbia River Treaty vis-à-vis the AC-DC Interties.

With 8,600 MW of export-import transfer capacity, California could be a looming crisis and nightmare for the Northwest or a bold opportunity.

With everyone including "rock star" Elon Musk flogging this now legendary "duck curve" and the need for storage, it's worth analyzing how a pumped storage project at the northern terminus of the interties could provide inter-regional exchanges to solve California's growing oversupply problem.

Just recently, California has become the first state in the nation to top 10,000 MW of installed solar capacity, in addition to 3,000 MW on rooftops. Currently, utility-scale solar is regularly peaking daily at 6,000 MW.

Under a 40% California RPS in 2024, renewables curtailments could reach as high as 13,000 MW or more in April. Many other curtailments could occur in the several 1000's of MW range, particularly in March through June.

The reality is pumped storage projects require a long-view to realize and tenacious champions. They are long-lead time projects and very capital intensive – 10 plus years and several billion dollars. Additionally, while there has been a lot of talk and ink, a large pumped storage project hasn't been built in the US in almost 2 decades.
So, what's needed?
"Telling the story" and evangelizing – what is pumped storage, why it's good, and why we need more of it.
This message needs to reach the ***right*** leaders such as utility executives and planners, public service & utility commissions, policymakers, environmental and industry groups.
At the tip of the spear for "barriers to overcome" is the economic analysis and modeling of sub-hourly energy grid services and environmental benefits at a regional level to capture the revenue and cost savings pumped storage bring both as generation and load.