CETA: Market Workgroup
How Transmission Works

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Long Term Transmission Planning

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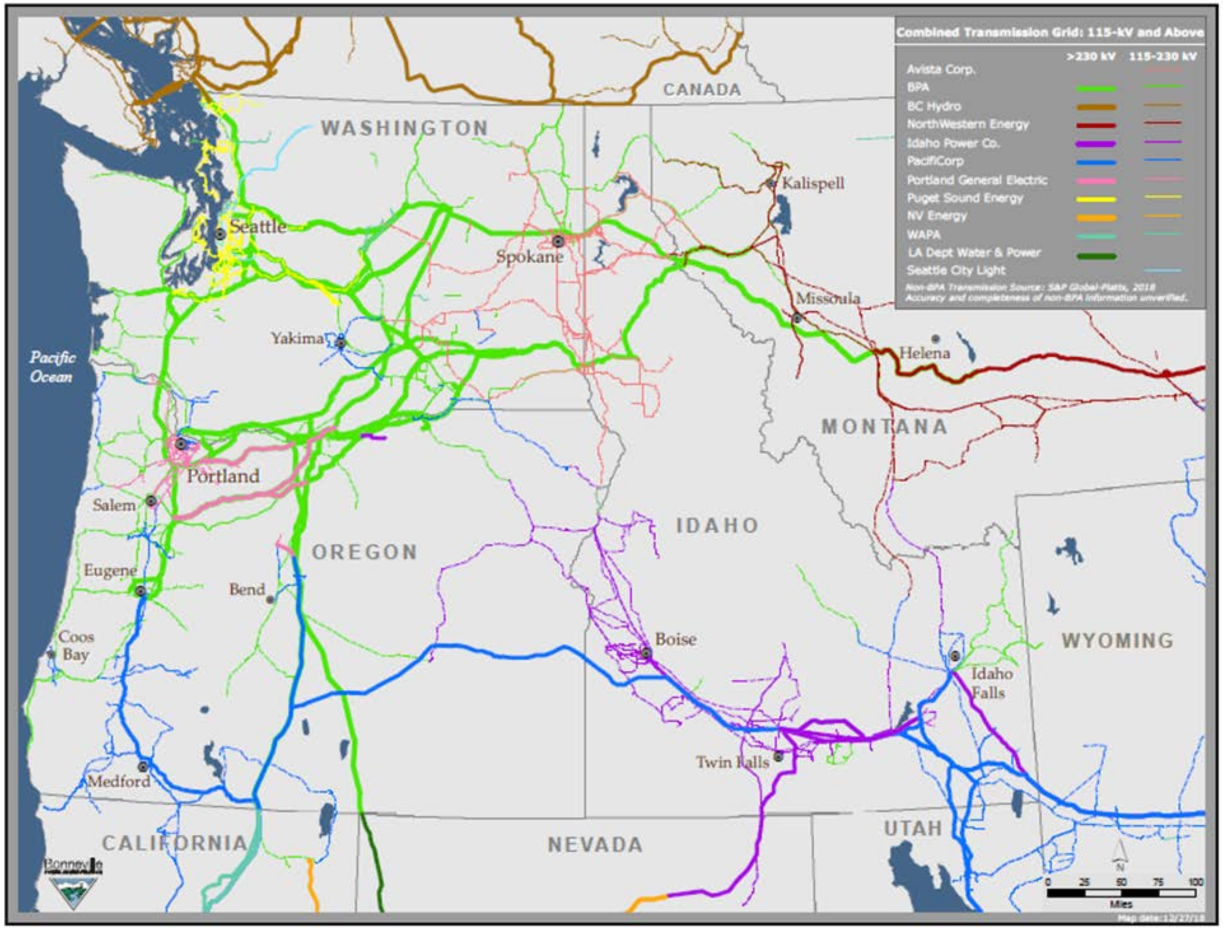
Introduction

- BPA markets power from 31 Federal Hydropower plants (21 Corps/10 Reclamation) (6,909 avg. MW), the Columbia Generating Station Nuclear Plant, and several small non-Federal power plants.
- BPA owns no power generators.
- About 80% of the power BPA sells is hydroelectric.
- The federal Columbia River hydropower system produces enough carbon-free power in an average water year to serve seven cities the size of Seattle. The Columbia River acts as a giant battery for intermittent power generated by wind and solar. The reservoirs have the ability to store power for hours and some for days or weeks. Federal hydro has helped the region meet its peak load demands as well as integrate renewable resources.

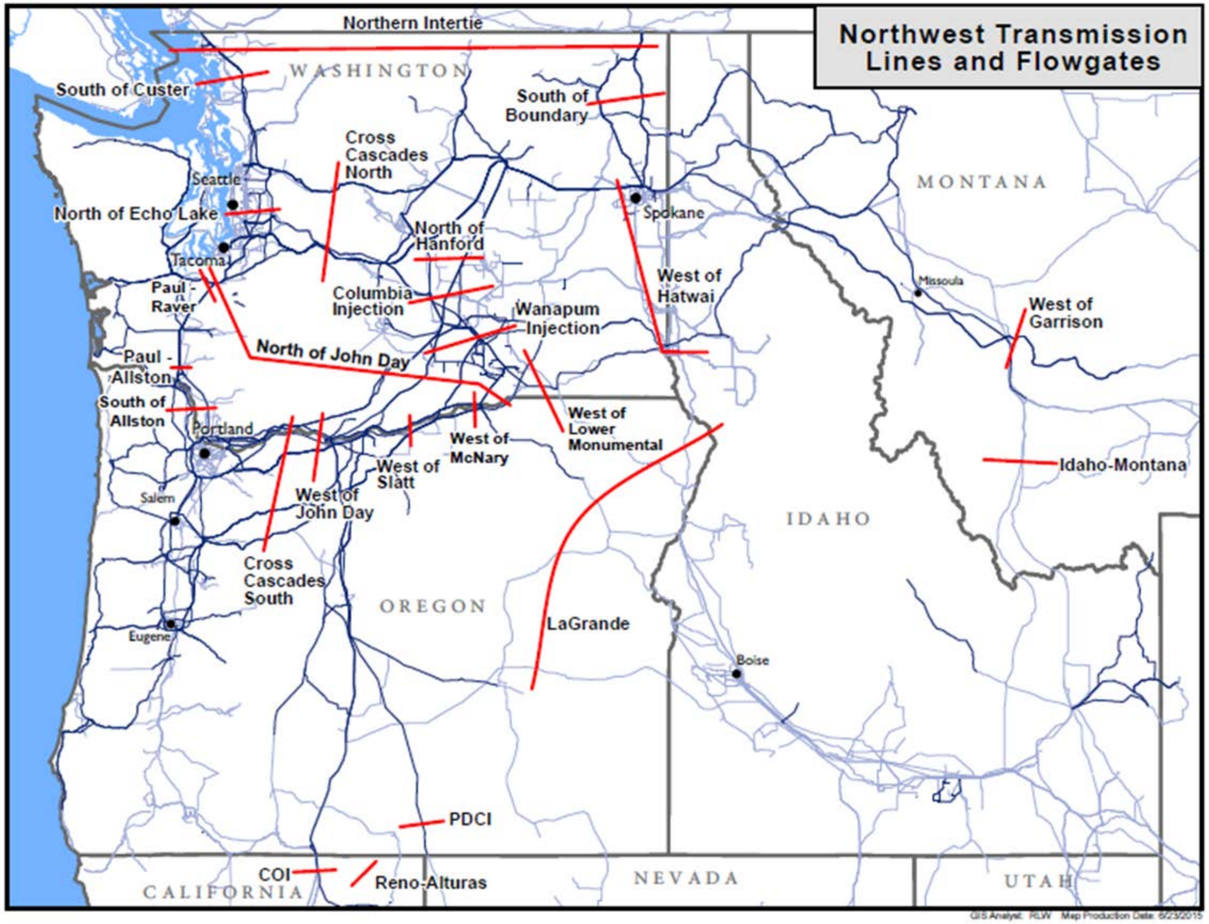
Bonneville Power Administration

- BPA accounts for about 28% of the electric power consumed within the PNW. Serves 40-43% of power loads in Washington.
- BPA owns and operates 15,000 miles of transmission lines = 75% of PNW transmission.
- 2,900 Federal FTE employees; approximately one-half in Washington.
- BPA receives no congressional appropriations. If we are spending money, we are earning it from selling power or transmission services.
- BPA, with the Corps and the Bureau, invests $250 to $300 million a year since 2008 in new Fish and Wildlife programs across the Columbia River basin. Likely the biggest F&W program in the country. It's a responsibility; we partner with tribes, states, non-profits like The Nature Conservancy and Lower Columbia Estuary Partnership to restore habitat, purchase conservation easements, build hatcheries, buy-back water, open up stream miles, etc.
- 1980 Northwest Power Act includes the Residential & Small Farm Exchange. It provides residential and small farm customers of PNW utilities a form of access to low-cost Federal power.

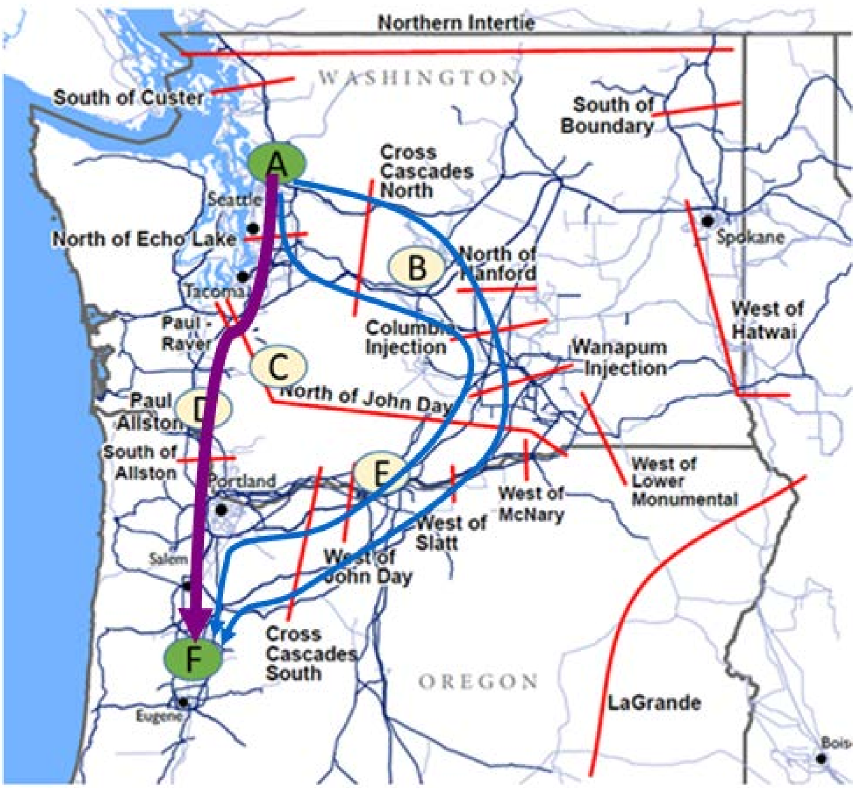
Pacific NW Transmission Grid



Flowgates and Paths



Contracts vs. Physics



Example:

- A seller near Seattle wants to sell generation to a buyer with load near Eugene
- They enter a transmission service contract for the right to move power from a point of receipt (A) to a point of delivery (F)
- Physical power flow is more complicated. It automatically splits across multiple paths

Electric Utility System Fundamentals

- Balancing Authority (Transmission) Obligation: Supply must equal demand at all times
  - Generation + Imports = Load + Exports
- Power flows are dictated by the laws of physics
  - Power automatically distributes based on electrical characteristics (path of least resistance)
  - Contract path (point A to point B) is an approximation
- Safety and reliability are the priorities
  - Electricity is an essential public service that needs to be very reliable
  - Safety-conscious decisions protect customers, employees, and the public
- Interconnected system benefits everyone
  - Increases system stability, reliability, and diversity across a large footprint

Western & Pacific NW Landscape

- Traditional power flow patterns
  - High E->W flows in winter across Cascades to serve local load (flows consistently E to W all months)
  - High N->S flows in spring and summer through WA and OR to CA related to exports, but S->N from CA was very rare (e.g. dry water year)
  - Flows respond to hydro, wind, and solar availability
- Emerging patterns
  - Higher exports to CA around sunset have pushed peak N->S flows to a couple hours later in recent years (July: 4,300 MW flowing south at noon; 7,000 MW flowing south at 7:45 pm after solar stopped producing.)
  - S->N California is exporting power mid-day to the north this past winter and spring. (NW peak loads early morning and evening.)
  - More bidirectional transfers between coastal and mountain states to take advantage of load / resource diversity

Factors That Changed Transmission Planning

- Major Blackouts in the US
- National Regulation and Standards
- State Renewable Portfolio Standards
- Renewable Generation has become a major generation resource
- Use of demand side management
- Coal, Nuclear, Oil, and Gas plant retirements
- New Storage Capability (batteries, etc.)
- Use of Electric Vehicles
- Use of Variable Transfer Path Limits
- Longer build times for transmission additions
- Aging Infrastructure
- Real-time monitoring that allows seasonal and time-of-day ratings for transmission equipment
- Market Changes

Moving Forward

- Public policies, technology availability, and household/business preferences are accelerating shift toward carbon-free electricity.
- There may be more than one way to achieve reduced emissions targets but implementation details affect relative performance of resource and transmission portfolios.
- Transmission assets have a very long useful life.
- Robust consideration of uncertainties necessary to minimize the cost of being wrong.
  - There are no perfect forecasts.

Challenges

- Transmission Planning will be more complex in the future
- Regional Loss of Load Probability (LOLP) expected to exceed 5% target in the early 2020s, increasing post 2025
  - Coal is retiring without committed replacement by resources with comparable capacity.
  - Relatively low energy prices don't encourage new entry of capacity resources
- Wholesale power markets may be insufficiently liquid.
- Transmission is very difficult, very expensive, and time consuming to plan, site, permit and build. A complex line can take 14-22 years from design to activation.
- Need for a reliable, flexible, and resilient transmission system and distribution network

Path to Zero Emissions in the PNW

- Wind, solar PV, and battery energy storage costs have dropped significantly in the last 5 years
- PNW winter peak load and resource characteristics present a challenge to get to 100% zero emissions
  - Two daily load peaks in winter (morning before sunrise, evening after sunset)
  - Will a cost-effective and scalable technology that can efficiently store days or weeks of energy emerge?
- Dispatchable resources still needed for flexibility and capacity
  - Explore opportunities to make load more dispatchable
- Effective coordination within the region and with other regions
- Location of retiring generation and of new renewables impacts transmission flows.

Questions?

APPENDIX

Dynamic Transfer Capability

- Dynamic Transfer Capability (DTC) is the amount of within-hour change in power flows (up or down) a system or facility can tolerate over short periods of time (such as over a five minute period) without causing an unacceptable voltage excursion or some other adverse system condition
- New use of DTC is accomplished through dynamic and pseudo-tie schedules, which are an acceptable usage of transmission rights.
- DTC limits are expressed in MW; thus, for example, 50 MW of DTC means power flows may increase or decrease 50 MW from current operating levels over, say, five minutes without causing an adverse system condition
- DTC limits are set to respect limiting increased device switching and dispatcher workload due to DTC use - Changes in power results in changing in voltage (minimize voltage variances)