Regional Transmission Landscape

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Topics

• Electric Utility System Fundamentals
• Key Entities (Responsibilities/Roles)
• Western & Pacific Northwest Landscape
• Challenges and Opportunities
Transmission enables end-users to access cost-effective, clean, and diverse supply sources.

Transmission is necessary and important for keeping the lights on and getting to a low carbon energy future.
Pacific NW Transmission Grid
Electric Utility System Fundamentals

• 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
AC and DC Applications

- **Alternating Current (AC)**
  - Widespread high voltage power transmission and distribution technology because it is easier to transform between voltage levels
- **Direct Current (DC)**
  - Low voltage applications like consumer electronics, batteries, and solar PV
  - Limited to niche applications for high voltage transmission (several hundred miles without any connections in the middle)
  - Pacific Direct Current Intertie (PDCI) between The Dalles and Los Angeles
Flowgates and Paths

Flowgates and paths consist of one or more transmission facilities that are operated in a coordinated manner and are monitored for congestion management.
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
Key Entities: Roles and Responsibilities
Market Participants

• Federal power marketing administrations
  – BPA & WAPA

• Load-serving entities (LSE) and integrated Utilities
  – Publicly-owned
  – Investor-owned

• Independent power producers (IPP) and independent transmission companies (ITC)

• End-users
Regulators

• Federal Energy Regulatory Commission (FERC)
  – Independent United States government agency that regulates the interstate transmission and pricing of electricity, natural gas, and oil

• Electric Reliability Organization (ERO)
  – Consists of North American Electric Reliability Corporation (NERC) and seven Regional Entities, including Western Electricity Coordinating Council (WECC)
  – Mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid

• Public Utility Commissions
  – State agency charged with regulating investor-owned utilities and setting retail rates
Balancing Authorities

- Each Balancing Authority in the Western Interconnection ensures load/resource balance for its Balancing Authority Area in real time.
- Operating reserves are capacity set aside to deal with unforeseen variation in load and resources.
  - Providing reserves for variable resources (wind and solar) is an important consideration for renewable policy.
Balancing Authorities

Boundaries are approximate and for illustrative purposes only.
Northwest Power Pool

- Reserve sharing saves members an estimated $1 billion per year by spreading contingency reserve requirements over a larger footprint
- Seasonal reliability assessments with members focused on meeting summer and winter peak loads
Northwest Power and Conservation Council

• The 1980 Northwest Power Act authorized the states of Idaho, Montana, Oregon, and Washington to form the Council
• The Act requires the Council to develop, with broad citizen participation, a regional power plan and fish and wildlife program
  – The Council develops a 20-year power plan, which it revises every five years, to ensure the Northwest of an efficient and reliable power supply
    • Prioritizes cost-effective energy efficiency, followed by cost-effective renewable resources
    • The plan guides BPA’s resource decision-making, Council is required to approve any new BPA energy resource acquisition greater than 50 aMW
  – The Council’s Fish and Wildlife program recommends projects for BPA to fund
• Wholesale power revenues from BPA fund the Council
Reliability Coordinator Responsibility

- The Reliability Coordinator (RC) maintains the highest level of responsibility for reliable operations of the bulk electric system with:
  - Clear decision-making authority to act and direct actions to preserve the integrity and reliability of the system
  - Wide area view that enables system monitoring beyond that of other operators
  - Operating tools, process and procedures to prevent or mitigate emergency operating situations
Reliability Coordinator Services

- Each RC is NERC certified and provides the same core services required by NERC standards
  - Outage coordination
  - Day-ahead operation planning and analysis
  - Real-time assessment
  - Real-time monitoring and analysis
  - System restoration coordination
Reliability Coordinator Areas Today

NERC Reliability Coordinators
As of June 1, 2015
Expected RC Areas by Dec. 2019

Non-binding RC Footprints as of: 10/23/2018

BA - RC Mapping
- CAISO RC
- SPP RC
- AESO RC
- BCH RC
- Undeclared RC
- Gen-Only BAs

Based on draft, non-binding notifications to WECC
Boundaries are for illustrative purposes only
Regional Planning Organization (RPO)

- An RPO supports reliability of the grid and facilitates efficient expansion
- Coordination within a region & between regions
  - FERC Orders 890 and 1000
Western & Pacific NW Landscape

• Traditional power flow patterns
  – High E->W flows in winter across Cascades to serve local load
  – High N->S flows in spring and summer through WA and OR to CA related to exports, but S->N from CA is very rare
  – Flows respond to hydro, wind, and solar availability

• Emerging patterns
  – High exports to CA around sunset have pushed peak N->S flows to a couple hours later in recent years
  – S->N transfers of surplus solar expected (duck curve)
  – More bidirectional transfers between coastal and mountain states to take advantage of load / resource diversity
Pacific NW Transmission Grid
Western Energy Imbalance Market (EIM)

- Voluntary market that optimizes sub-hourly economic dispatch of participating resources for balancing supply and demand every five minutes
- Transmission and reliability constraints are honored
- Every participant must enter the trading hour fully balanced
- Larger footprint allows for resource diversity
- CAISO is the market operator
EIM with BPA

- BPA is currently determining how and under what conditions it could join the EIM, with a potential implementation date of April 2022
Challenges and Opportunities

- Safety and reliability
- Keeping costs low while meeting public policy objectives to reduce emissions
- Coal generation replacement
- Path to zero emissions
- Congestion management
Safety and Reliability

• The transmission system is planned and operated so that it can withstand the impacts of normal equipment outages without interrupting service to end-users
  – Prevention of all outages is not possible

• Multiple layers of defenses keep the public and workers safe
  – Detect and isolate short circuits quickly
  – Manage flows within system operating limits
  – Standards, best practices, training
Transmission Reliability Standards

• NERC and WECC Standards define specific performance requirements for the high voltage transmission system
  – Interruption of firm demand is only permitted as a corrective action in limited circumstances

• Transmission providers must annually demonstrate that their system can reliably serve projected loads and resources through the next ten years
Resource Adequacy vs. Transmission Reliability

• Resource Adequacy: demonstrate that there will be enough resources to serve loads
  – Address uncertainties in both supply and demand (weather, outages, growth, etc.)

• Transmission reliability: demonstrate that resources can be delivered to load under expected conditions (peak and off-peak)
  – Stress test
Keeping Customer Costs Low

• Scale solution to match need
  – Remedial action schemes (RAS)
  – Power flow control devices
  – Distributed energy resources (EE, DR, etc.)
  – Efficient redispatch
  – Conditional Firm transmission service
  – Transmission reinforcements

• Joint ownership by multiple utilities has been successful for decades
  – California – Oregon Intertie (COI)
Load Changes

• Load growth
  – Energy efficiency and shifts in the economy have offset demand growth in WA and OR over the last decade
  – Data center loads are attracted to the PNW’s reliable, low cost electricity supply (hundreds of MW can show up at a rural location)

• Loads and resources connected through a power electronics interface can behave differently during disturbances than the traditional devices that they replace
  – Coordination between stakeholders (utilities, plant operators, equipment manufacturers) is important to prevent unintended operations
  – Inverter connected resources (solar PV, batteries, newer wind turbines) are a growing share of resource mix
  – Loads with a power electronic interface (computers, LED lights, variable speed drives) are a growing share of demand
Coal Generation Replacement

- Coal generation is being retired due to a combination of public policy and economic considerations
  - Boardman and Centralia Unit 1 by the end of 2020
  - Colstrip 1 & 2 by July 2022
  - Centralia Unit 2 by the end of 2025
  - Other plants in Mountain states within the next 10-15 years
- Multiple challenges and opportunities associated with replacing capacity, energy, and essential reliability services attributes while reducing emissions
  - Location of resources impacts transmission flows
  - Availability and cost of transmission impacts resource choices
  - Variable resources replacing dispatchable resources
  - Optimize transmission capacity utilization
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
Congestion Management

- Congestion occurs when demand for transmission across a path exceeds available capacity
  - Outages can cause or exacerbate congestion
- Transmission providers curtail transmission schedules by priority order and on a pro-rata basis when needed to keep flows within limits
  - Non-firm is curtailed before firm
  - Conditional firm can be curtailed at a lower priority under defined system conditions or for a specified number of hours per year