Transmission Planning
Past, Present, and Future

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Disclaimer

This presentation is a personal point of view of the presenter
Topics

- About ColumbiaGrid
- A quick overview of power industry
- Transmission planning
  - Past, present, and future
  - FERC Order 1000 (and 890)
  - Moving forward
- Q&A

This presentation represents presenter personal view of the industry - it does not represent ColumbiaGrid's position.
ColumbiaGrid

- One of 4 planning regions in the Western Interconnection
  - Primary focus on the Northwest
- Independent staff
- Focus on transmission planning
- Open stakeholder process
- Planning and Expansion Functional Agreement (PEFA) and Order 1000 (O1K)
- Conducts reliability, economic studies and other studies focused on specific issues
- Cost allocation
ColumbiaGrid Planning

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Members and Planning Participants

- Avista Corporation
- MATL (formerly Enbridge)*
- Puget Sound Energy
- Bonneville Power Administration
- Chelan County PUD
- Cowlitz County PUD*
- Douglas County PUD*
- Grant County PUD
- Seattle City Light
- Snohomish County PUD
- Tacoma Power

* Non-Member PEFA Planning Participants

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Have you noticed the changes during the past 10 years (and their future trends)?

Supply side (resources)
Transmission planning & operation
Demand side (load)
Market operation
Rules & Regulatory
Technologies, etc

Imagine how these will impact transmission planning?
Power Industry: The Western Interconnection

- Hydro power-rich area
- Lots of Wind
- Almost coal-free
- Majority of transmission system owned & operated by federal entity
- Unique organization structure
- Winter peaking
- Major exporter
- Lower rates

- High potential for wind power
- Potential for solar
- Sizable amount of coal power plants
- Majority of transmission system owned & operated by utilities

- Lots of renewable
- Aggressive & more energy policies
- Most transmission system owned by IOUs but operated by CAISO
- Summer peaking (mostly)
- Low/moderate load growth
- High penetration of DER
- Full function market under CAISO
- Biggest load center in the west
- Rates are higher

- Large amount of solar power
- High potential of additional solar & wind
- More coal power plants
- Majority of bulk transmission system owned & operated by utilities

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Resource mixes, procurement, and operation are changing:

- Several large & conventional resources have been retired
- Significant amount of renewable penetration
  - ~8,000 MW of wind in NW
  - >9,000 MW of wind and solar in CA
  - Similar trend in other areas
  - They are different from conventional resources!
- The booming of Distribution-side resources
  - Net Energy Metering (NEM), Renewable Auction Mechanism (RAM)
  - Others e.g. DR, market-driven
- Part of existing resources are also changing
Power Industry: Supply changes

- Example: Wind power in the Northwest

~7000 MW of wind in NW only!
Observation #1: CA renewable output has significant amount and seems to have “pattern”

Source: California ISO
Power Industry: Supply changes

- 1-week historical output 4/5/15 – 4/12/15

Source: California ISO
Observation #2: NW renewable output is also significant but not so much “pattern”

Source: BPA’s website from the 1st week of June 2015
Observation #3: NW has large hydro capability but the output is also varied & weather dependent

* This graph represents only part of entire system from Coulee to Bonneville)
Observation #4: Distribution-side resources may be difficult to detect from transmission side

Source: Western Electricity Coordination Council
Power Industry: Supply changes

- Future rules & policies
  - CA storage mandate (1.3 GW by 2020) and market-driven storage
  - California 50% RPS
  - Section 111(d) of the clean air act
  - Procurement such as Long Term Procurement Plan (LTPP)
  - etc

- Other new technologies & Initiatives
Power Industry: Transmission changes

Policies, technologies, and because roles of “Transmission”

- Most of the changes are driven by the needs to accommodate supply, demand, and other changes
- New issues are continue to be identified
  - Our transmission system is being operated differently from its design
  - Technical issues e.g. ramp rates, inertia, freq responses
  - Policies issues
- Implementation of rules, regulatory requirements, e.g.
  - FERC Orders e.g. 890, 1000
  - Mandatory standards e.g. NERC TPL, FAC, etc
  - Permits, land uses
Power Industry: Transmission changes

- New technologies are being deployed. Examples:
  - New equipment & procedures e.g. PMU, VTL, Dynamic ratings
  - Node-breaker modeling, west-wide system model
  - Efforts to maximize existing facilities

- More involvement from the policy makers
  - Transmission investment can be costly and takes a long time

- It is more and more complex to perform long-term planning!

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## Power Industry: Transmission changes

### Some Examples

<table>
<thead>
<tr>
<th>No.</th>
<th>Project Name</th>
<th>Service Area</th>
<th>Estimated Cost</th>
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<tbody>
<tr>
<td>1</td>
<td>Hemingway-Boardman 500 kV Line</td>
<td>Idaho/PAC/BPA</td>
<td>$840 M</td>
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<td>2</td>
<td>Cascade Crossing Project</td>
<td>PGE, PAC, BPA</td>
<td>$610-825 M</td>
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<td>3</td>
<td>South Cowlitz County Project</td>
<td>Cowlitz</td>
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<td>Celilo Terminal Replacement (PDCI Upgrade to 3220 MW)</td>
<td>BPA</td>
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<td>5</td>
<td>Castle Rock-Troutdale 500 kV Line (I-5 Corridor Reinforcement Project)</td>
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<td>6</td>
<td>MATL Project</td>
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<td>7</td>
<td>Denny Substation (Phase 1)</td>
<td>SCL</td>
<td>$180 M</td>
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<tr>
<td>8</td>
<td>Big Eddy-Knight 500 kV line and Knight Substation</td>
<td>BPA</td>
<td>$124 M</td>
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<td>9</td>
<td>Montana to Washington Project</td>
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<td>10</td>
<td>Central Ferry-Lower Monumental 500 kV Line Project</td>
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<td>11</td>
<td>Eastside Project: Lakeside 230/115 kV Transformer and Sammamish-Lakeside-Talbot Line Rebuilt to 230 kV</td>
<td>PSE</td>
<td>$65-$80 M</td>
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<td>Upgrade Denny Substation Transmission</td>
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<td>13</td>
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Load characteristics e.g. shapes, amount are changing

- “Total or Net” and “Actual” load
- Total load seen from transmission side may not reflect actual load
  - Actual load may be growing but look flat from transmission side
- Total load amount & shapes also driven by supply changes
  - Large-scale on transmission side
  - Distribution side
  - Behind the meters
- Information from behind the meters activities may not be always available
Power Industry: Demand changes

Introducing the California “Duck” curves

*Source: California ISO
Power Industry: Demand changes

Examples of CA seasonal load curves

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Power Industry: Demand changes

No “Duck” in the Northwest!

Jan 2015

May 2015

Jul 2015

Oct 2015

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Power Industry: Market operation changes

Driven by the regulation and market forces

- **Market products and operation changes**
  - Sub-hourly dispatch e.g. FERC 764
  - Energy Imbalance Market (EIM)

- Dynamic Transfer, etc
Shifting to more initiatives & world of compliance

Major incidents also like to result in new standards

NERC standards e.g.
- TPL (transmission planning)
- CIP-014 (Physical Security)
- GMD (TPL-007)

FERC Orders e.g.
- Order 764
- Order 888
- Order 890
- Order 1000
All these & future changes will impact Transmission Planning

- What the system conditions in 10 or 20 years will be like?
- How to identify the issues?
- How to create study assumptions?
- How to comply with the rules & policies?
- What are additional tools & techniques that will be needed?
- How to come up with reasonable solutions?
- How to justify the solutions?
- And... more!
Transmission Planning: Past, Present, and Future

Past

- Mostly Reliability-based
- Known technical issues
- Less complicated to determine assumptions & study scenarios
- Easier to build, justify
- Could Economic consideration
- Right of First Refusal (ROFL) or Right to Construct
- Mostly utilities build, owned, & operated
- Almost no competition from demand side
- May include market operation in the scope

Future

- Need to include flexibility and other operation/market driven
- New issues continue to be identified
- Much more complex to define future assumptions
- More scrutiny & difficult to build new projects, NIMBY
- Economic consideration are more important
- ROFL went away in most part
- 3rd party can build, owned & operated
- More competition from demand side & influence from the Market
- More open and transparency process

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Closely related to Order 890 that was issued in 2008
Attempt to improve transparency, coordination, and competition in transmission business
Transmission Planning: Key contents in O1K

- Regional and Interregional requirements
- Cost Allocation
- Non-incumbent Transmission Developers
  - Independent Transmission Developer can build and own new transmission projects
  - New business opportunity for both utilities and non-utilities
- Facilitate public policies
- Bolster coordination among planning regions

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Transmission Planning: In the West

- Four planning regions are comply with O1K
  - CAISO
  - ColumbiaGrid
  - NTTG
  - WestConnect

- Their planning processes are open to public
  - Interregional compliance started October 1, 2015
  - Stakeholders can participate and access to more information

- The first window for Non-incumbent transmission providers to submit their projects is Jan 1 – Mar 31, 2016
Transmission Planning: Moving forward

- It is no longer about “building” new facilities
- Consideration of both technical and policy issues
- Interactions with stakeholders & participants
- New technical issues
- More tools, techniques will be needed
- Consideration of market operations
- Any other challenges & comments?
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