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Enrolled Partied and States
Technical Workshop 2
March 19, 2021

Items from the Last Workshop

NERC Standard TPL-001-4 — Transmission System Planning Performance Requirements Table

Category	Initial Condition	Event [1]	Fault Type [2]	BES Level [3]	Interruption of Firm Transmission Service Allowed [4]	Non-Consequential Load Loss Allowed
P0 No Contingency	Normal System	None	N/A	EHV, HV	No	No
P1 Single Contingency	Normal System	Loss of one of the following: 1. Generator 2. Transmission Circuit 3. Transformer [5] 4. Shunt Device [6]	3Ø	EHV, HV	No[9]	No[12]
		5. Single Pole of a DC line	SLG			
P2 Single Contingency	Normal System	1. Opening of a line section w/o a fault [7]	N/A	EHV, HV	No[9]	No[12]
		2. Bus Section Fault	SLG	EHV	No[9]	No
				HV	Yes	Yes
		3. Internal Breaker Fault [8] (non-Bus-tie Breaker)	SLG	EHV	No[9]	No
				HV	Yes	Yes
		4. Internal Breaker Fault (Bus-tie Breaker) [8]	SLG	EHV, HV	Yes	Yes

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NERC TPL-001 Performance Requirements (cont.)

Category	Initial Condition	Event [1]	Fault Type [2]	BES Level [3]	Interruption of Firm Transmission Service Allowed [4]	Non-Consequential Load Loss Allowed
P3 Multiple Contingency	Loss of generator unit followed by System adjustments[9]	Loss of one of the following: 1. Generator 2. Transmission Circuit 3. Transformer [5] 4. Shunt Device [6]	3Ø	EHV, HV	No[9]	No[12]
		5. Single pole of a DC line	SLG			
P4 Multiple Contingency *(Fault plus stuck breaker[10])*	Normal System	Loss of multiple elements caused by a stuck breaker [10](non-Bus-tie Breaker) attempting to clear a Fault on one of the following: 1. Generator 2. Transmission Circuit 3. Transformer [5] 4. Shunt Device [6] 5. Bus Section	SLG	EHV	No[9]	No
				HV	Yes	Yes
		6. Loss of multiple elements caused by a stuck breaker[10] (Bus-tie Breaker) attempting to clear a Fault on the associated bus	SLG	EHV, HV	Yes	Yes

NERC TPL-001 Performance Requirements (cont.)

Category	Initial Condition	Event [1]	Fault Type [2]	BES Level [3]	Interruption of Firm Transmission Service Allowed [4]	Non-Consequential Load Loss Allowed
P5 Multiple Contingency *(Fault plus relay failure to operate)*	Normal System	Delayed Fault Clearing due to the failure of a non-redundant relay[13] protecting the Faulted element to operate as designed, for one of the following: 1. Generator 2. Transmission Circuit 3. Transformer [5] 4. Shunt Device [6] 5. Bus Section	SLG	EHV	No[9]	No
				HV	Yes	Yes
P6 Multiple Contingency *(Two overlapping singles)*	Loss of one of the following followed by System adjustments.[9] 1. Transmission Circuit 2. Transformer [5] 3. Shunt Device[6] 4. Single pole of a DC line	Loss of one of the following: 1. Transmission Circuit 2. Transformer [5] 3. Shunt Device [6]	3Ø	EHV, HV	Yes	Yes
		4. Single pole of a DC line	SLG	EHV, HV	Yes	Yes
P7 Multiple Contingency *(Common Structure)*	Normal System	The loss of: 1. Any two adjacent (vertically or horizontally) circuits on common structure [11] 2. Loss of a bipolar DC line	SLG	EHV, HV	Yes	Yes

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Transmission Flows Today

Panel discussion with Dave Cathcart, Bonneville Power Administration, and Rikin Shah, PacifiCorp

Moderator: Nadine Hanhan, Oregon Public Utility Commission

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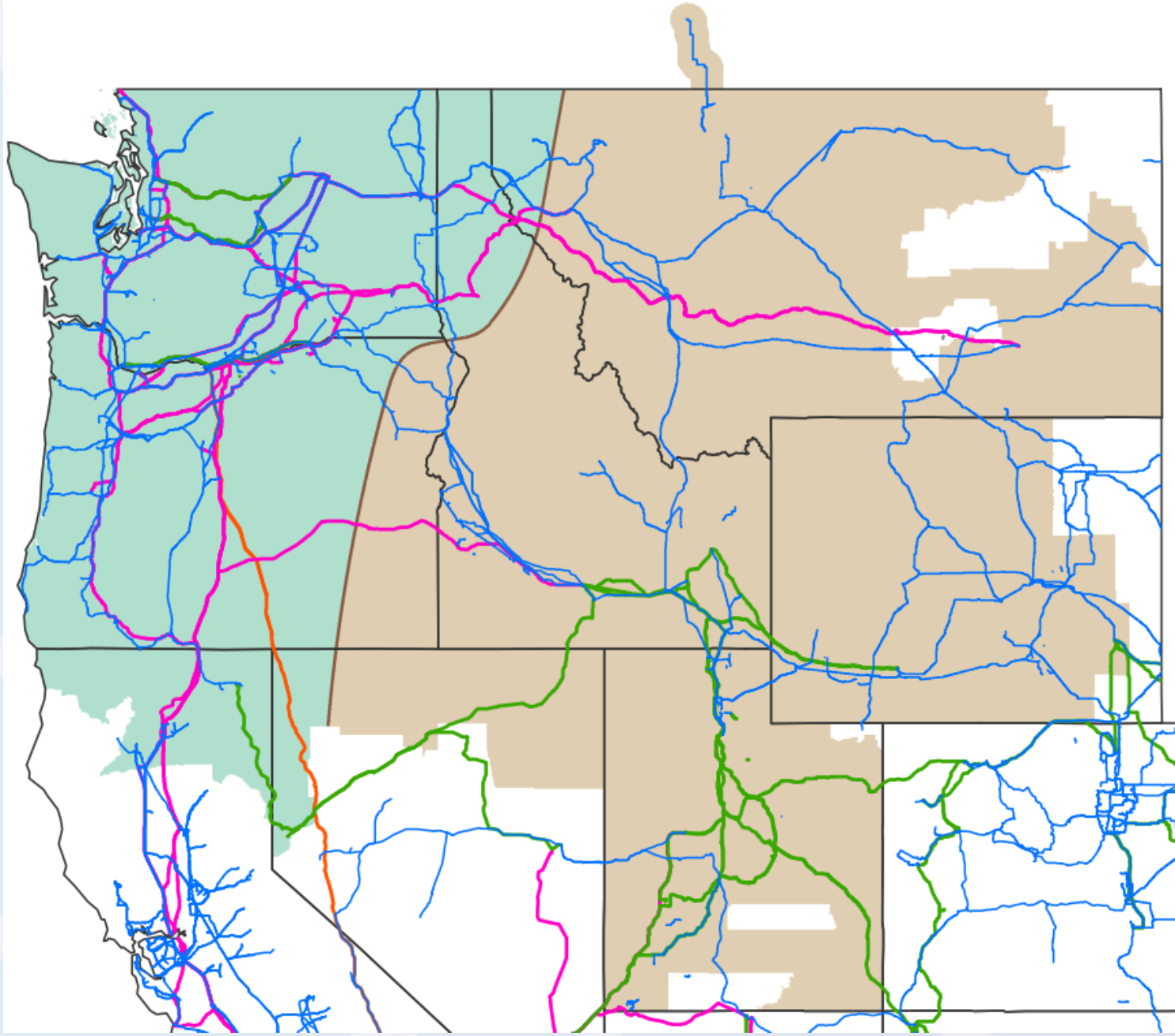
NorthernGrid Subregions

- Pacific Northwest
- Intermountain

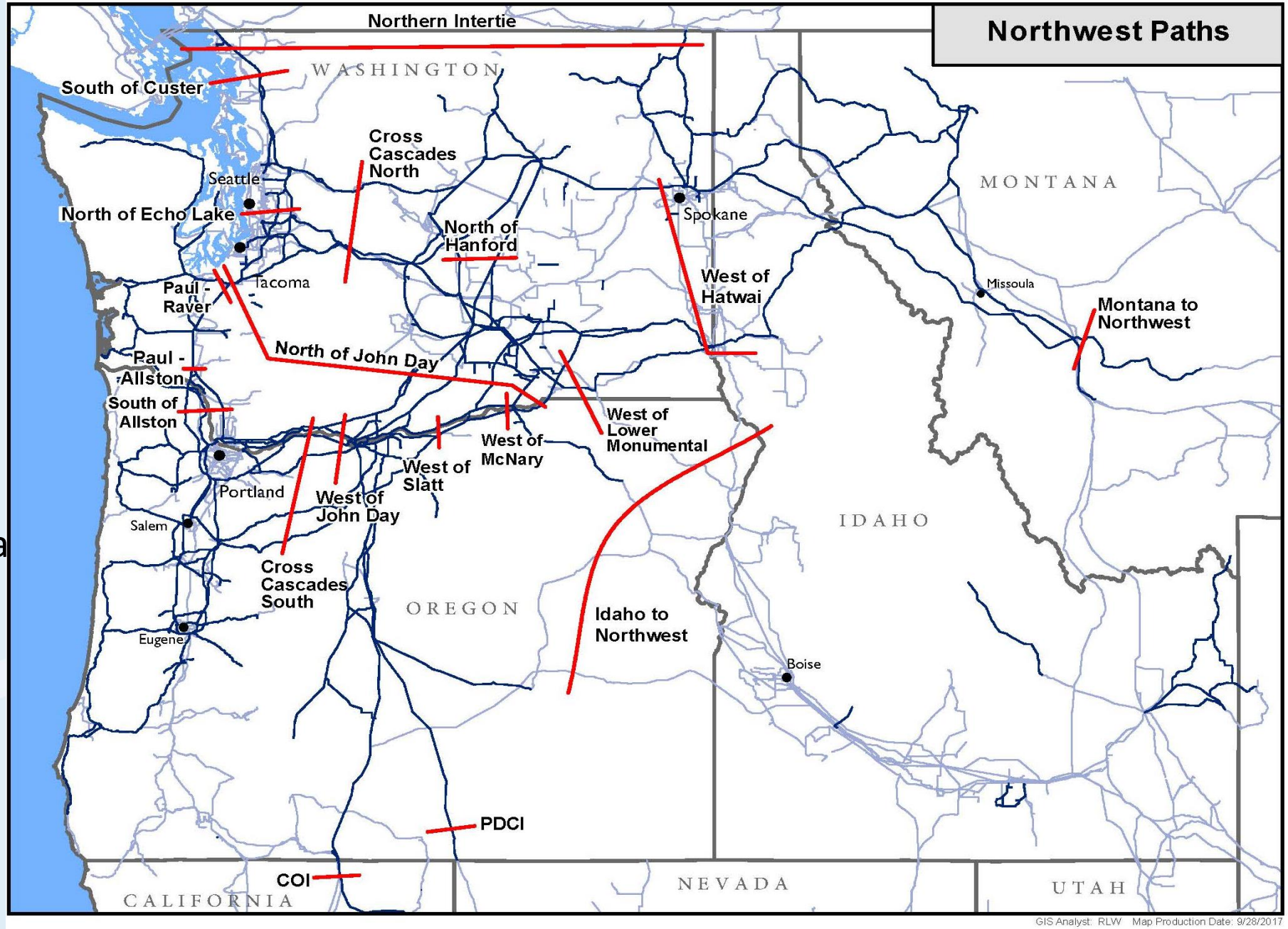


Transmission Flows Today (Dave Cathcart)

- The major paths, constraints, and usages
  - Paths covered in NG Region
  - Example of Path
- “Traditional” NW Flows: common worst-case conditions covered by Planners
- “Novel” NW Flows: new system usages covered by Planners today & in future

Northwest Transmission

- BPA plans for 18 paths or interties (excludes ID-NW)
- Notable Resource hubs: Upper/Mid/Lower Columbia, Lower Snake, Lower Basin Wind/Thermal, I-5 Corridor, Puget Sound Area
- Notable Load hubs: NW WA, Willamette Valley/SW WA, Spokane, C.OR, Tri-Cities, Boardman, Hood River/The Dalles
- BPA "load areas" covered previously



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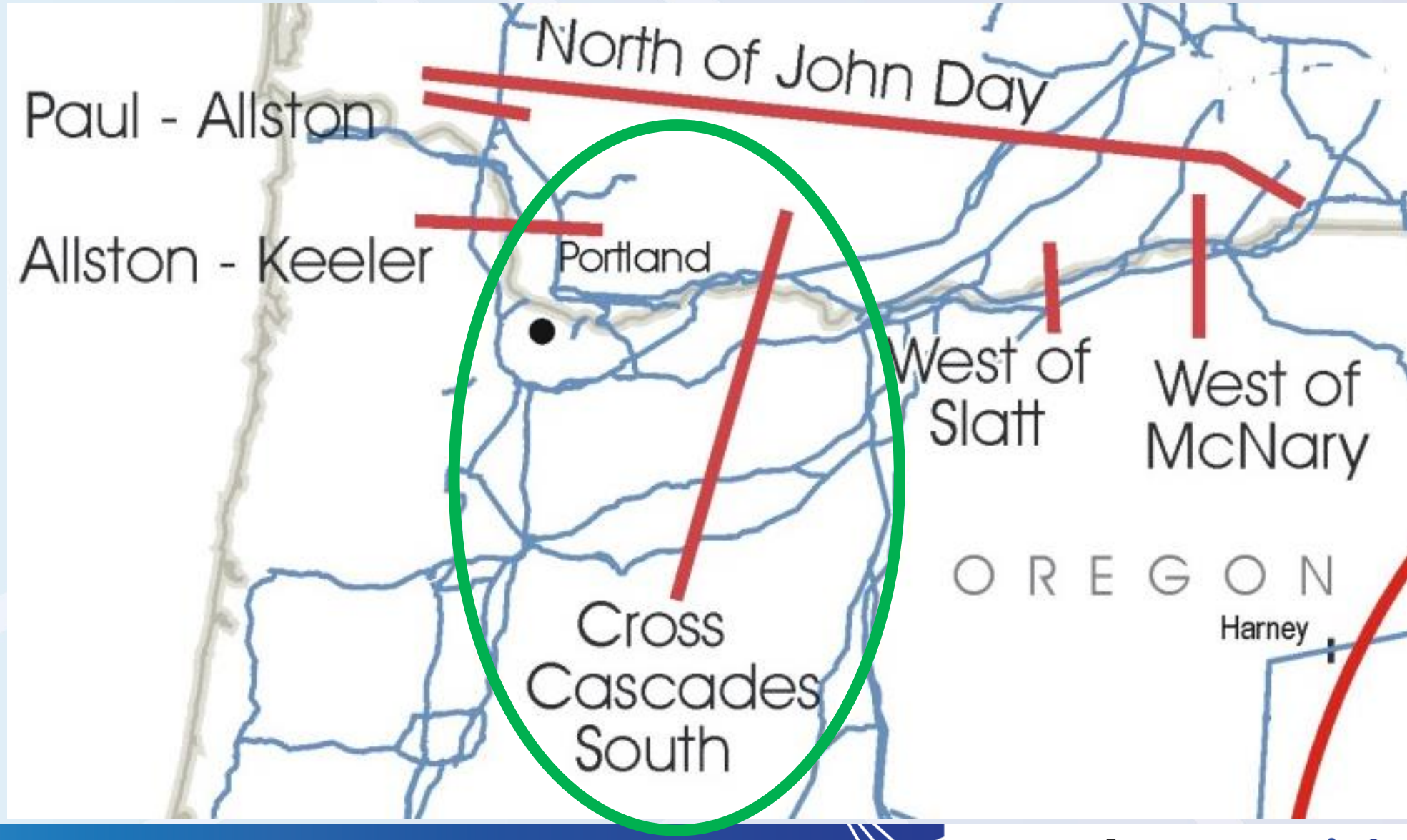
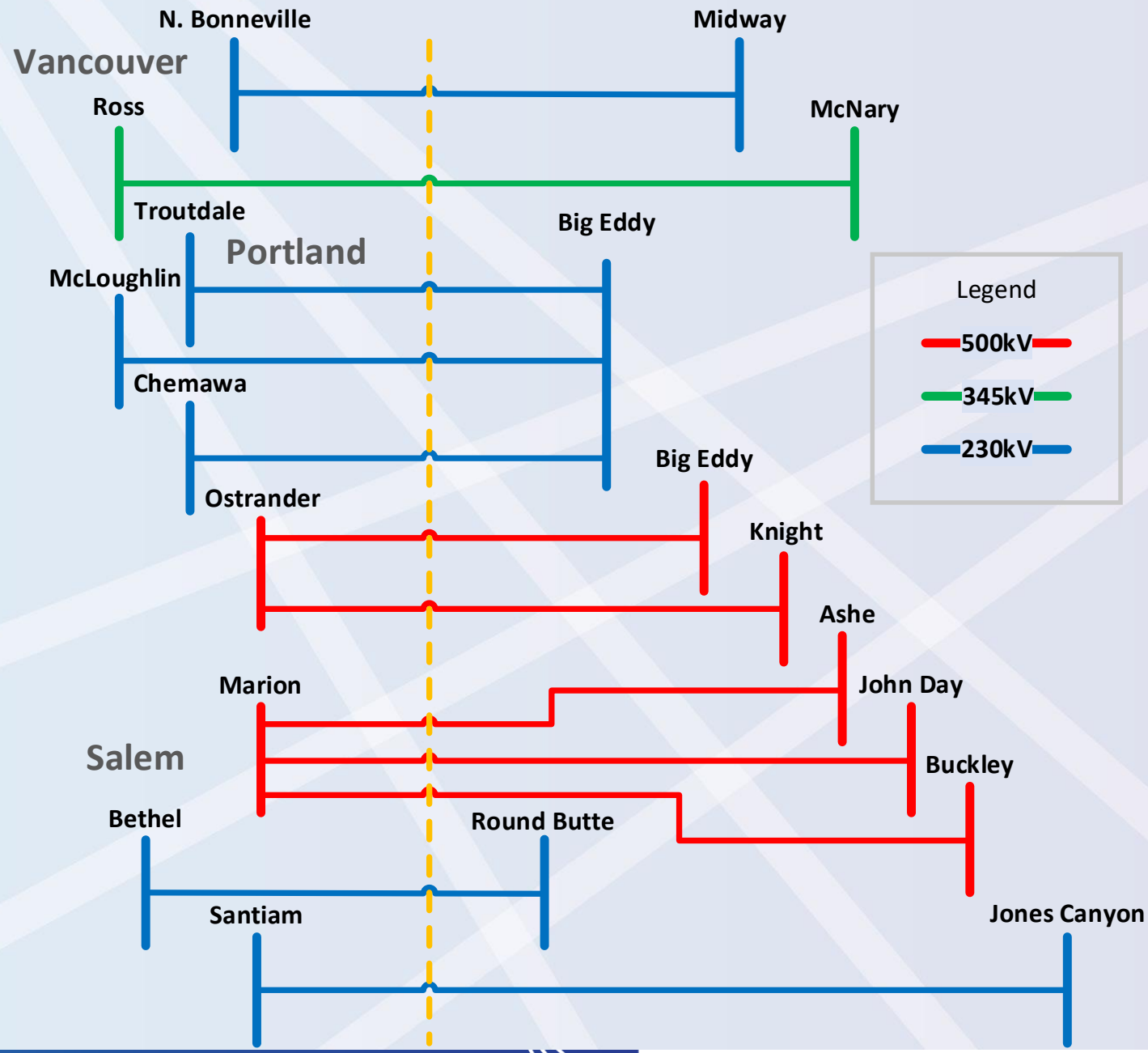
Cross Cascades South



Cross Cascades South Path

- Aggregate elements by geographic proximity for analysis
- Reliability is established by setting limits determined by studies
- Path limit is the highest total flow that can safely withstand loss of the most critical element(s), without exceeding facility ratings or uncontrollable system response



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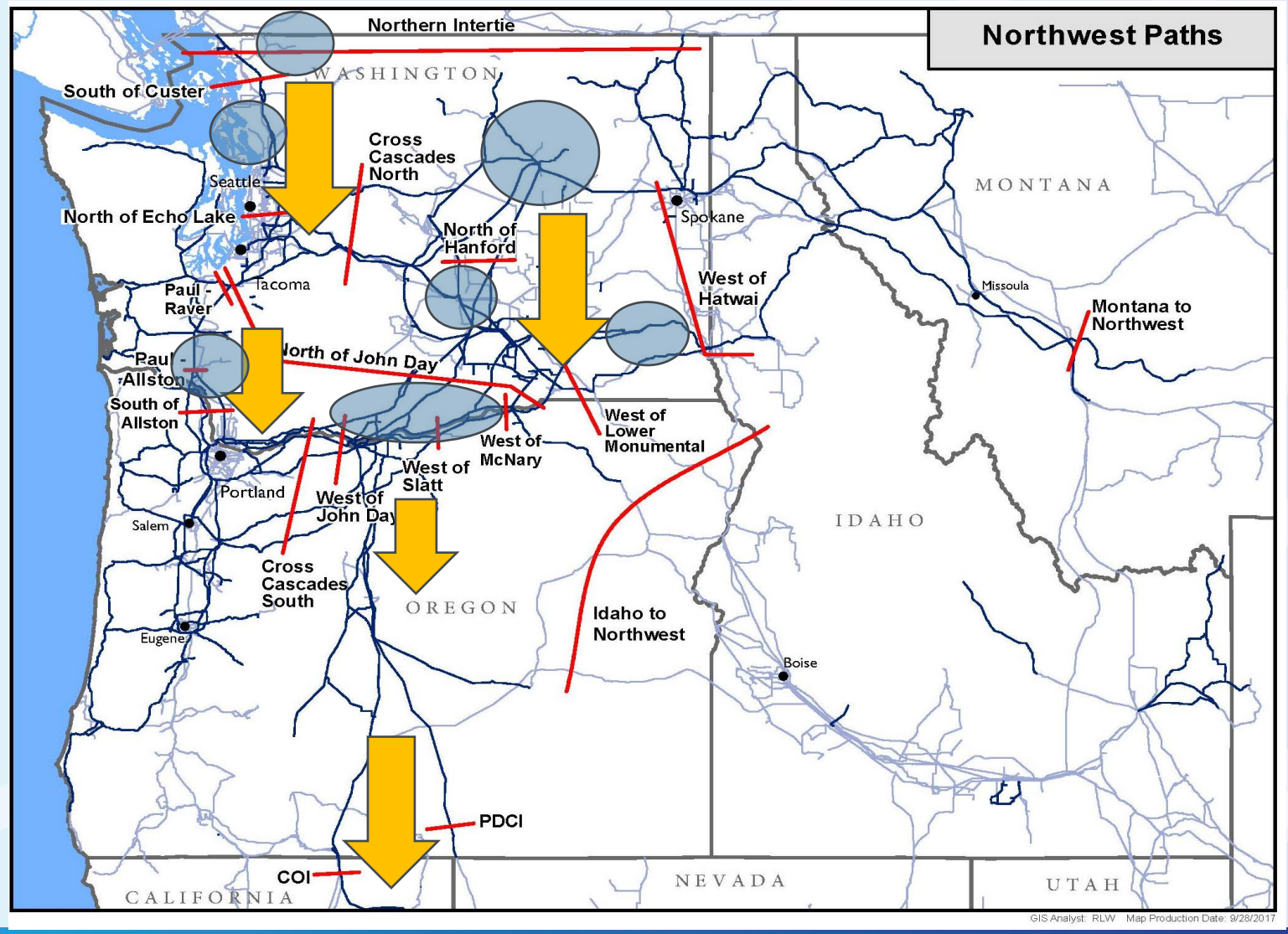
Demonstration

- PowerWorld demonstration of a transmission line outage impact on the Cross Cascade South path

Some “Traditional” NW Flows & Conditions

- 1. Peak N-S: Heat-wave for WECC-wide loads, surplus NW resources exporting to California
- 2. Peak E-W: Heat-wave OR Cold-snap for NW loads, NW thermal & hydro high
- 3. Off-Peak E-W: <75% of NW annual peak loads (any season), surplus hydro from run-off conditions, maintenance seasons for some thermal plants
- 4. Dual Export: <75% of NW annual peak loads, surplus NW resources, simultaneously exporting North to Canada AND South to California

Summer Peak N-S



- Characterized by heat-wave NW loads, moderate-to-high COI/PDCI flows.
- Depending on dispatch pattern, limiting paths include: NOH, COI, PDCI, SOA and SOC.
- Surplus Resources can come from Canada, CRPS, NW Wind, or I-5 Corridor thermals

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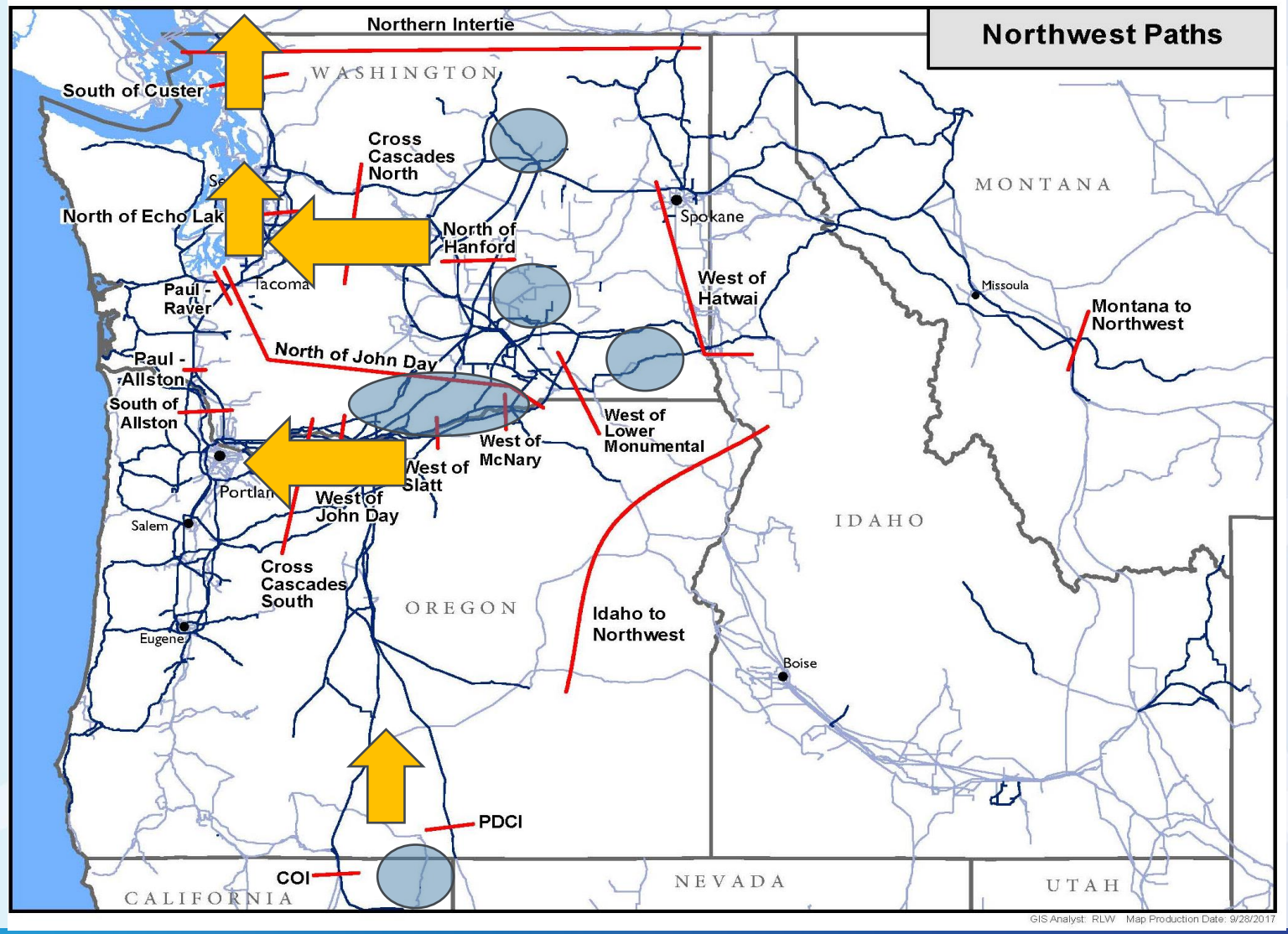
2. NW Peak Load E-W



- Characterized by high west side peak loads. Usually cold-snap or heat-wave event
- High NW resource outputs (Hydro, thermal)
- limiting paths include: WOCN, WOCS, NOEL
- Exports to Canada as BC loads peak and hydro availability tapers.
- Historically, California imports to NW only occur in winter months (more on that later)

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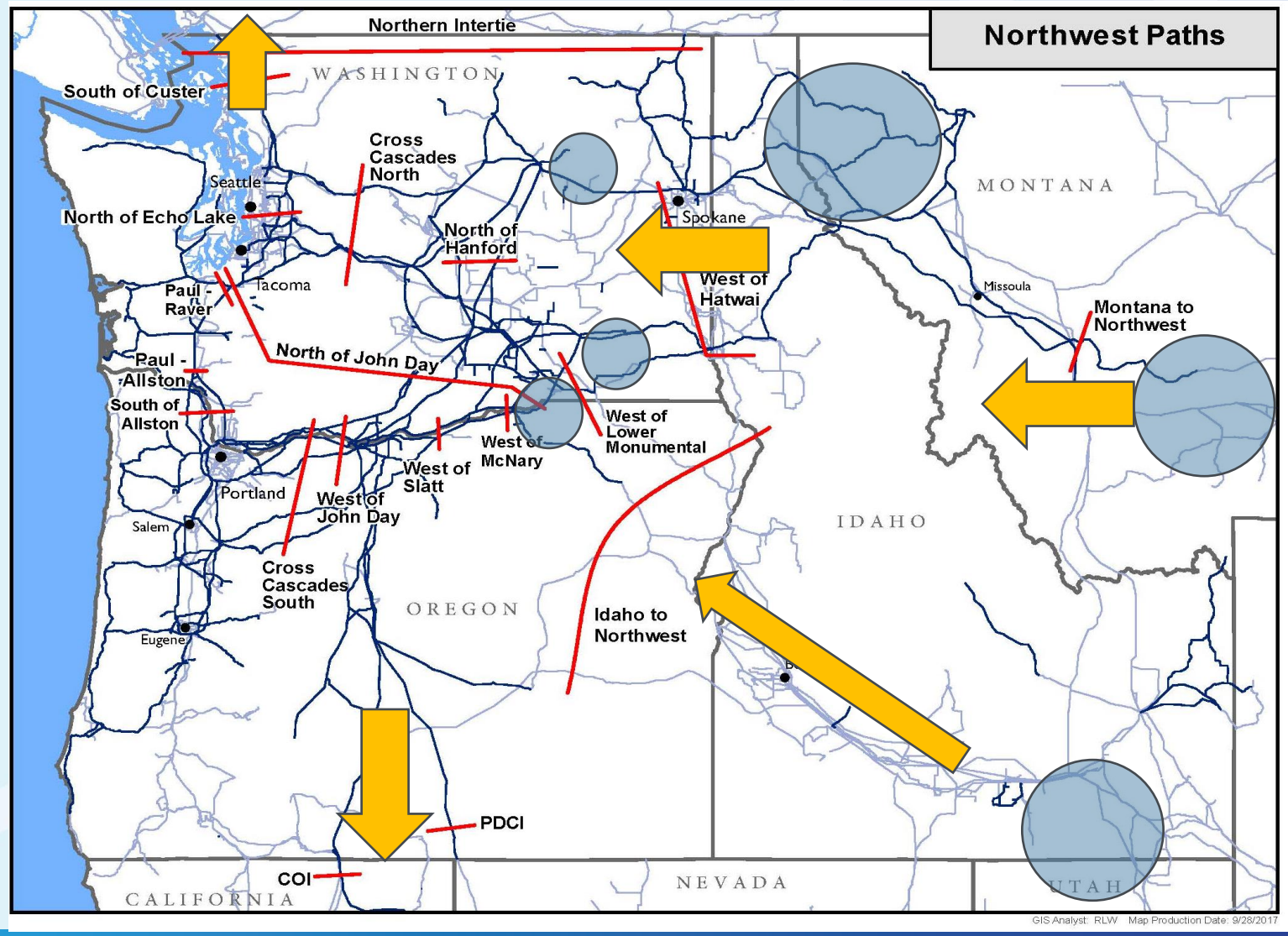
3. NW Off-Peak E-W



- Characterized by light NW loads, upper & mid Columbia hydro low, and surplus MT/ID resources (spring/Fall, light summer)
- Many west-side thermal plants offline, NW wind moderate-to-high
- Limiting paths include: WOH, MT-NW
- Usually exporting to Canada & California

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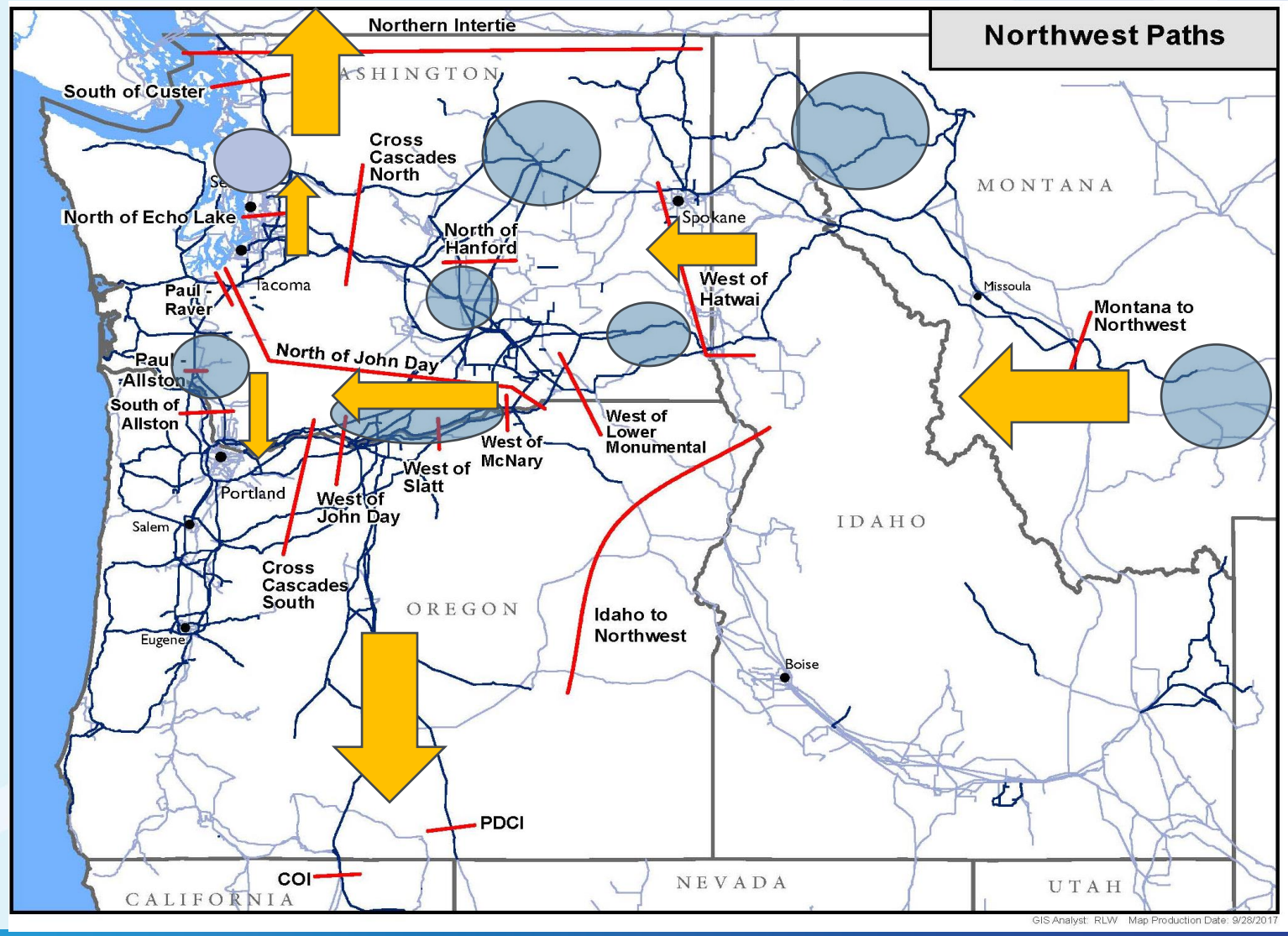
4. NW Dual Export



- Characterized by light NW loads, lots of surplus NW resources
- Simultaneous High exports North to Canada & South to California
- Limiting paths include: COI/PDCI, NI/NOEL, MT-NW, WOM/WOS/WOJ.
- Moderate-to-High E-W flows, usually less than peak load conditions

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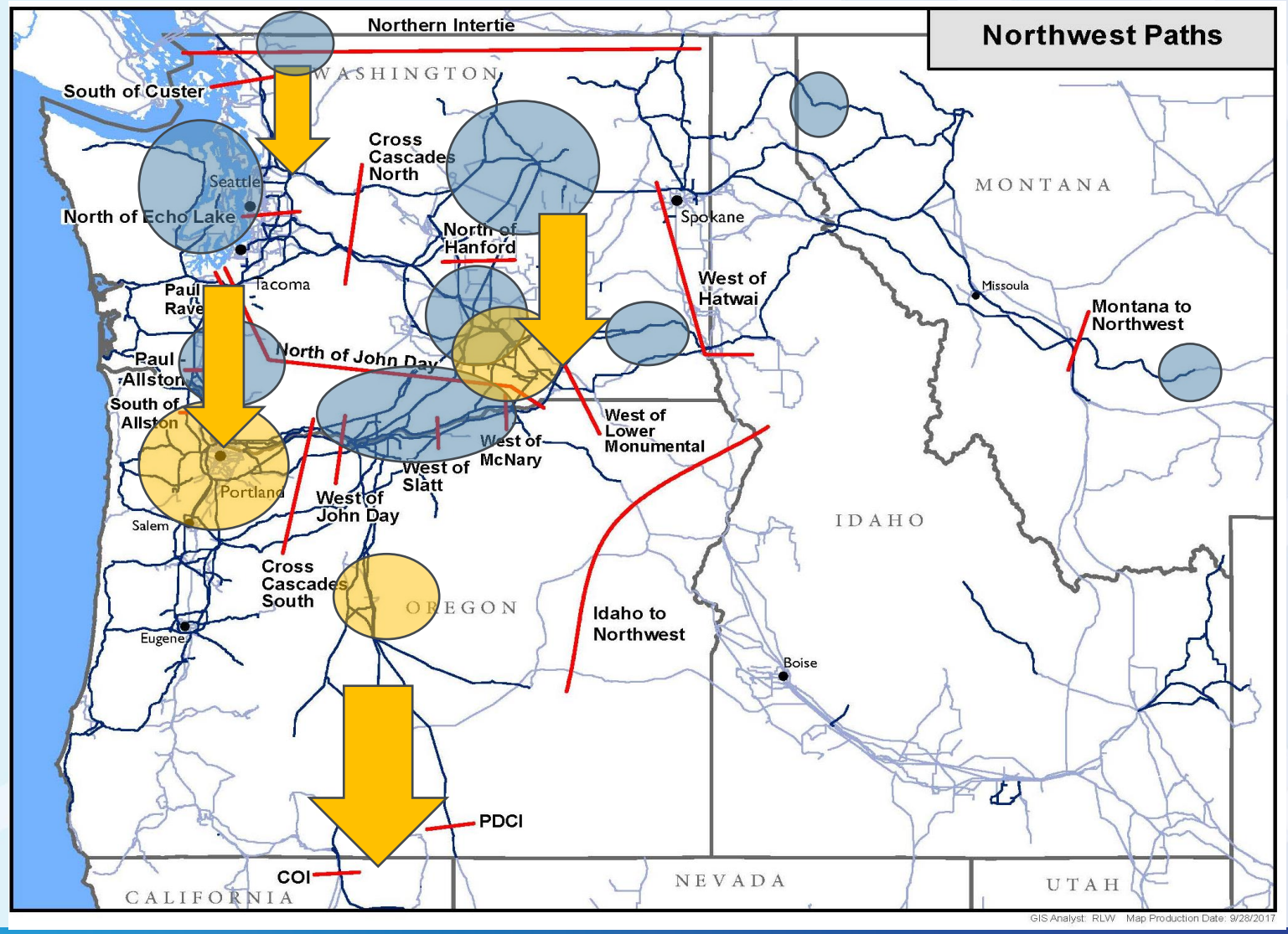
Some “Novel” NW Flows & Conditions

- 5. Summer Off-peak “Sunset”: 75-90% of summer peak WECC-wide, high NW wind/high NW hydro, low CA solar conditions
- 6. Light NW load “high renewables”: <70% of typical peak NW loads, WECC-wide renewables high, WECC-wide thermals offline
- 7. Near-Peak NW summer load “high renewables”: 70-90% of typical NW peak load, WECC-wide renewables high, I-5 corridor gen low/offline
- 8. Near-Peak NW winter load “high renewables”: 70-90% of typical NW peak load, WECC-wide renewables high, I-5 corridor gen low/offline

5. Summer Off-Peak "Sunset"



- Characterized by evening following a WECC-wide heat wave, high COI/PDCI flows.
- Depending on NW resource pattern, limiting paths include: COI/PDCI, NOH, R-P, SOA, or SOC.
- Load area "sub-grids" also become limiting (PDX, Tri-C, C.OR)
- CA/AZ/NV solar offline, WECC thermal plants low, sending NW surplus resources to California.
- MT/ID resource surplus can also contribute

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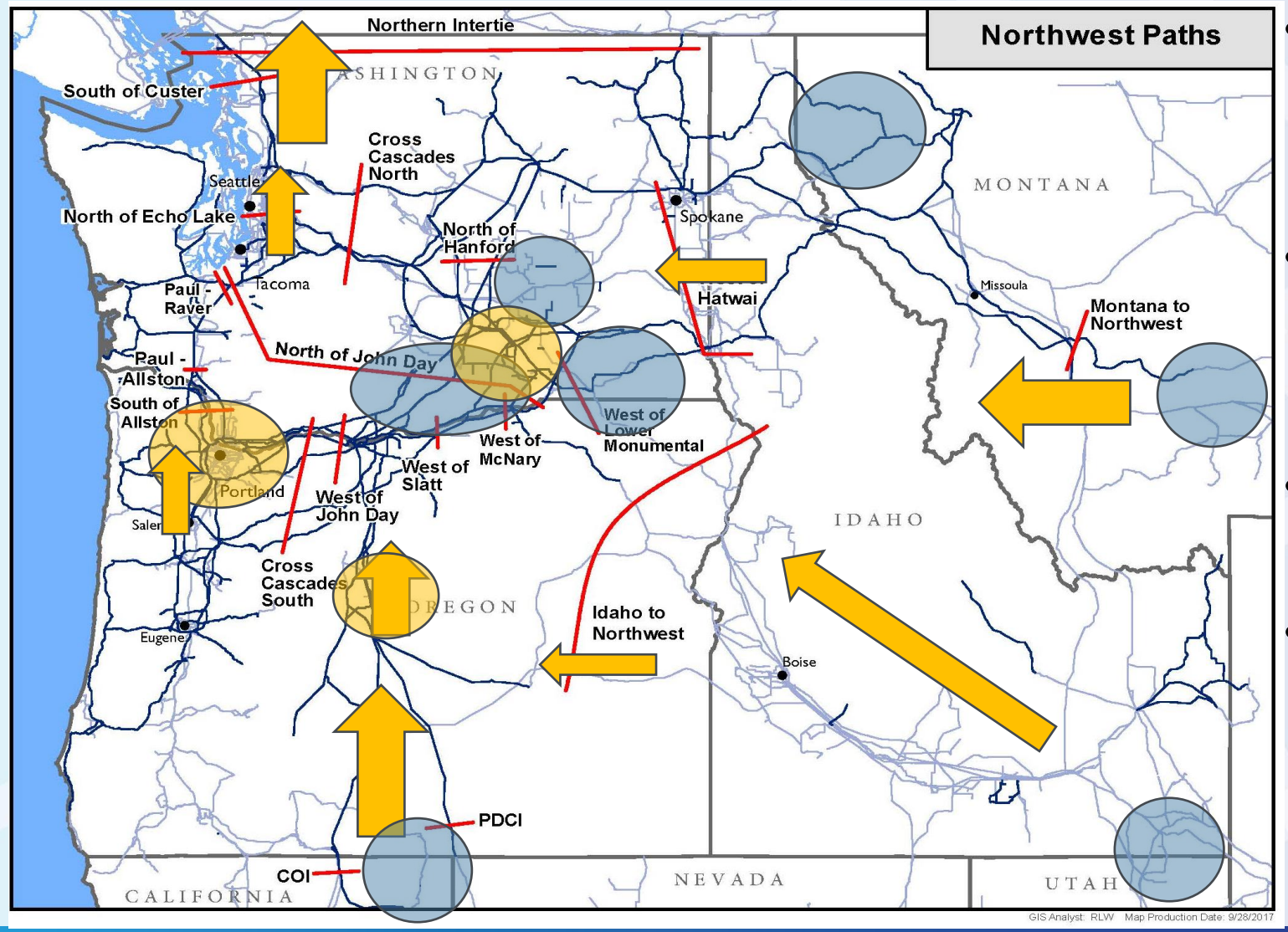
6. Light NW Load, High Renewables



- Characterized by light-to-moderate NW loads, WECC-wide renewables high, WECC-wide thermals offline
- <75% of NW annual peak loads, surplus hydro from run-off conditions, maintenance seasons for some thermal plants
- Limiting paths include: WOH, MT-NW, various load area “sub-grids”
- Importing from California, Max Exports to Canada, moderate E-W flows on WOCS/WOCN

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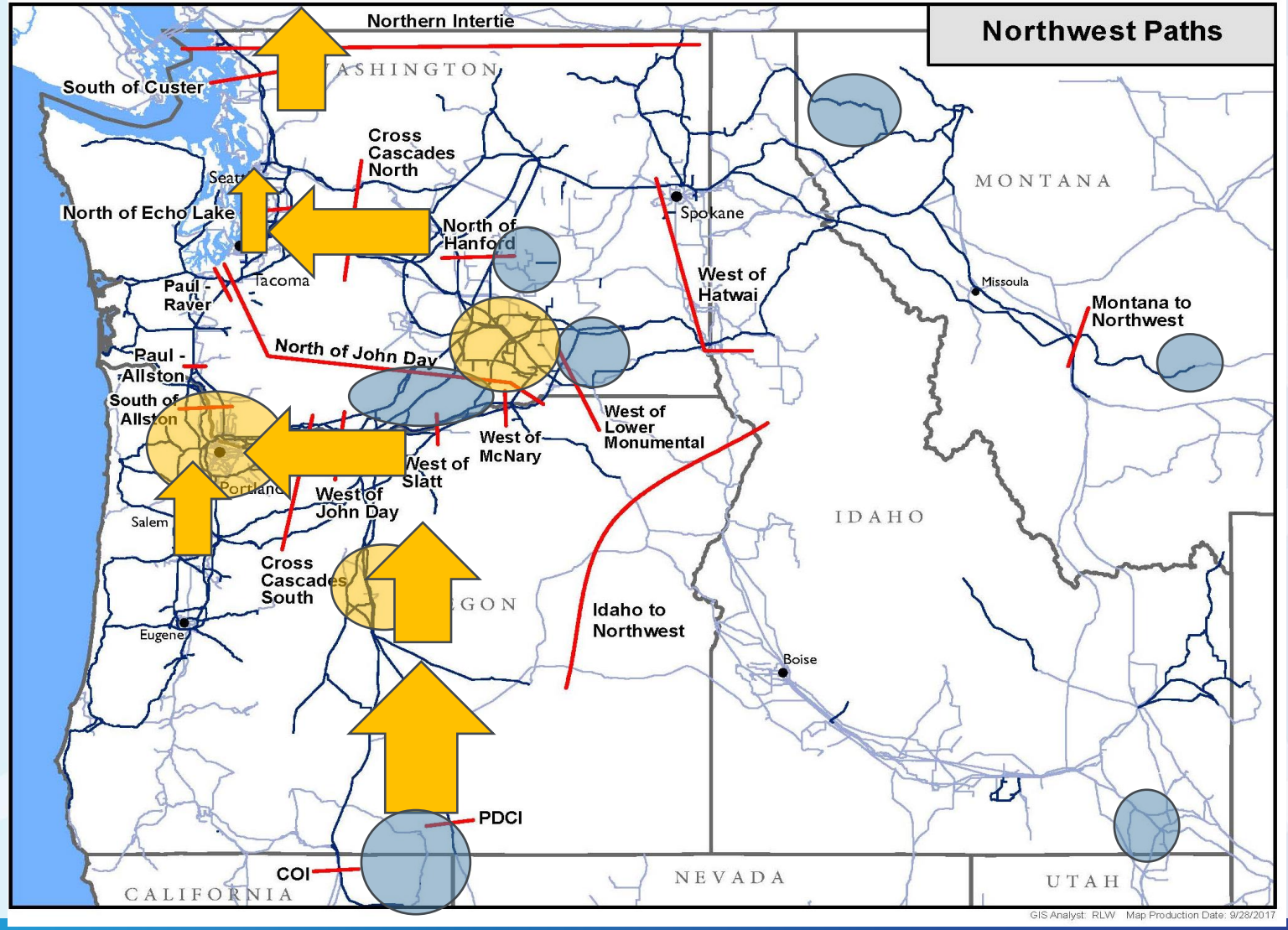
7. Near-Peak NW Load, High Renewables



- Characterized by moderate-to-high NW **summer loads**, WECC-wide renewables high, WECC-wide thermals offline
- Limiting paths include: WOCN, WOCS, NOEL, load area "sub-grids"
- Moderate-to-high Exports to Canada, depending on BC loads and hydro output
- Maximum imports from California due to solar
- Moderate NW renewable output in E.OR/E.WA

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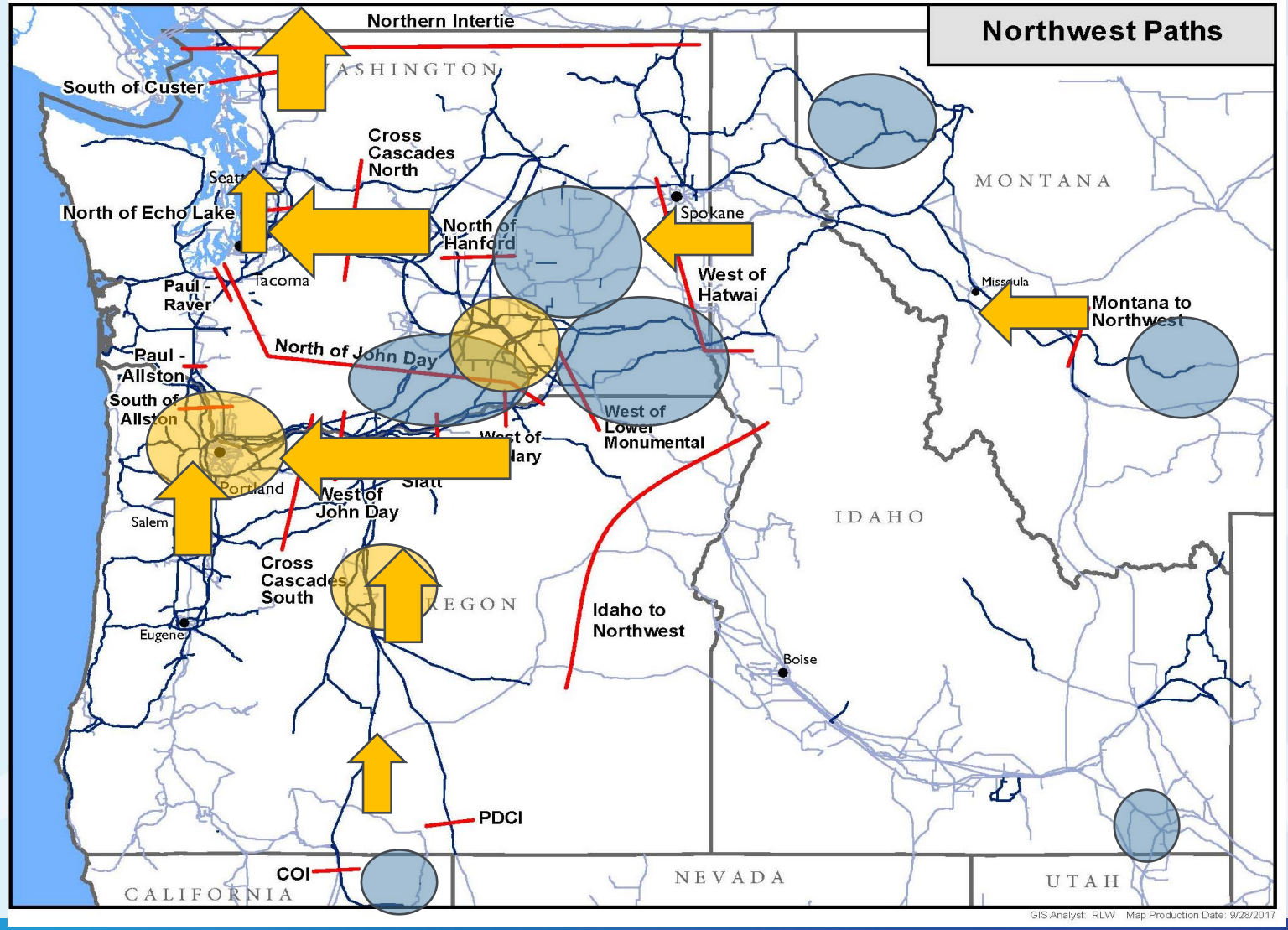
8. Near-Peak NW Load, High Renewables



- Characterized by moderate-to-high NW **winter loads**, moderate WECC-wide renewable output, WECC-wide thermals offline
- Limiting paths include: WOCN, WOCS, NOEL, load area "sub-grids"
- Moderate-to-high Exports to Canada, depending on BC loads and hydro output
- Moderate imports from California
- High NW renewable output in E.OR/E.WA/N./ID/MT

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Q&A Break

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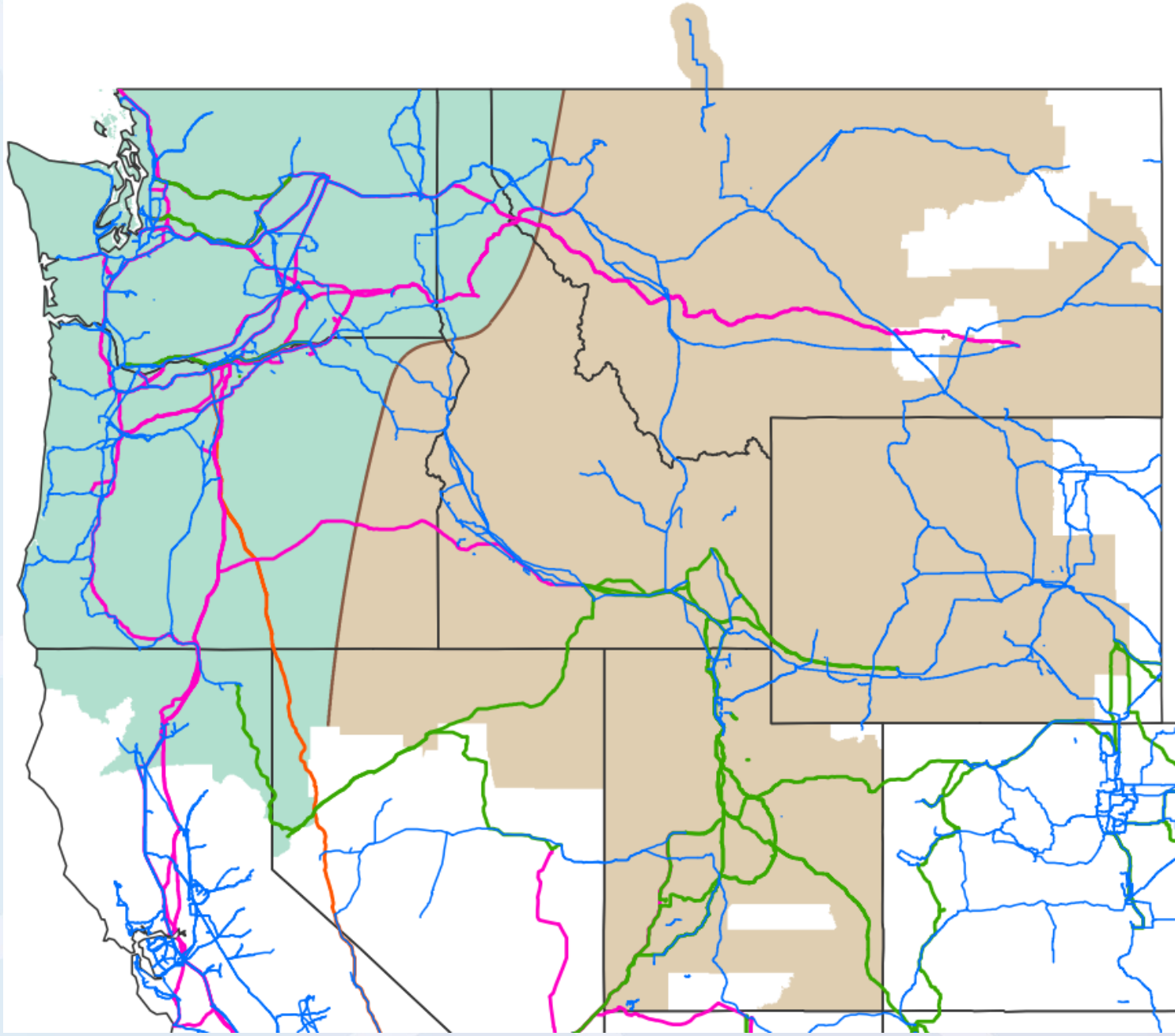
Transmission Flows Wyoming to Idaho and Southern Utah Tie Lines



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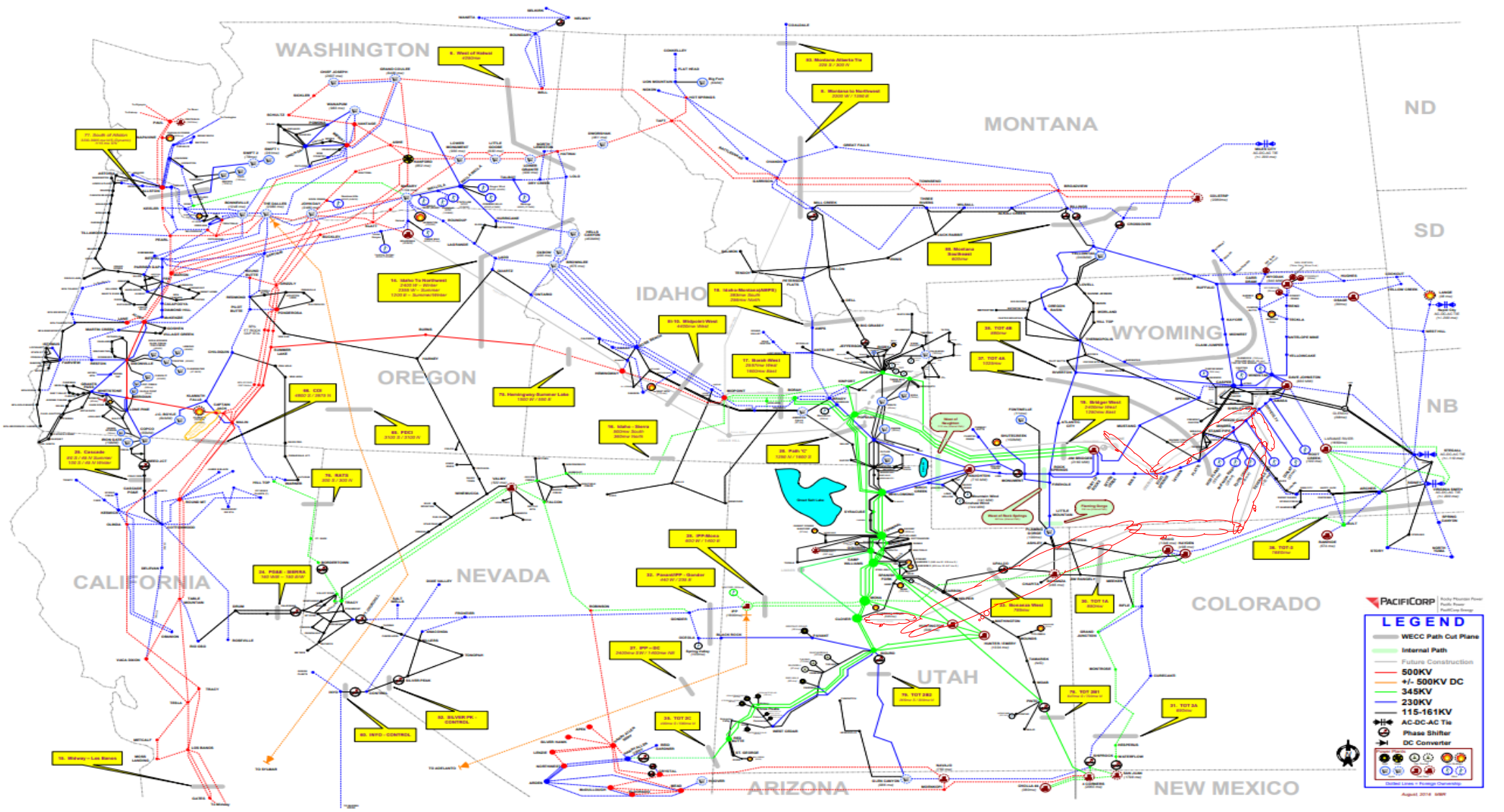
WECC Transmission Paths



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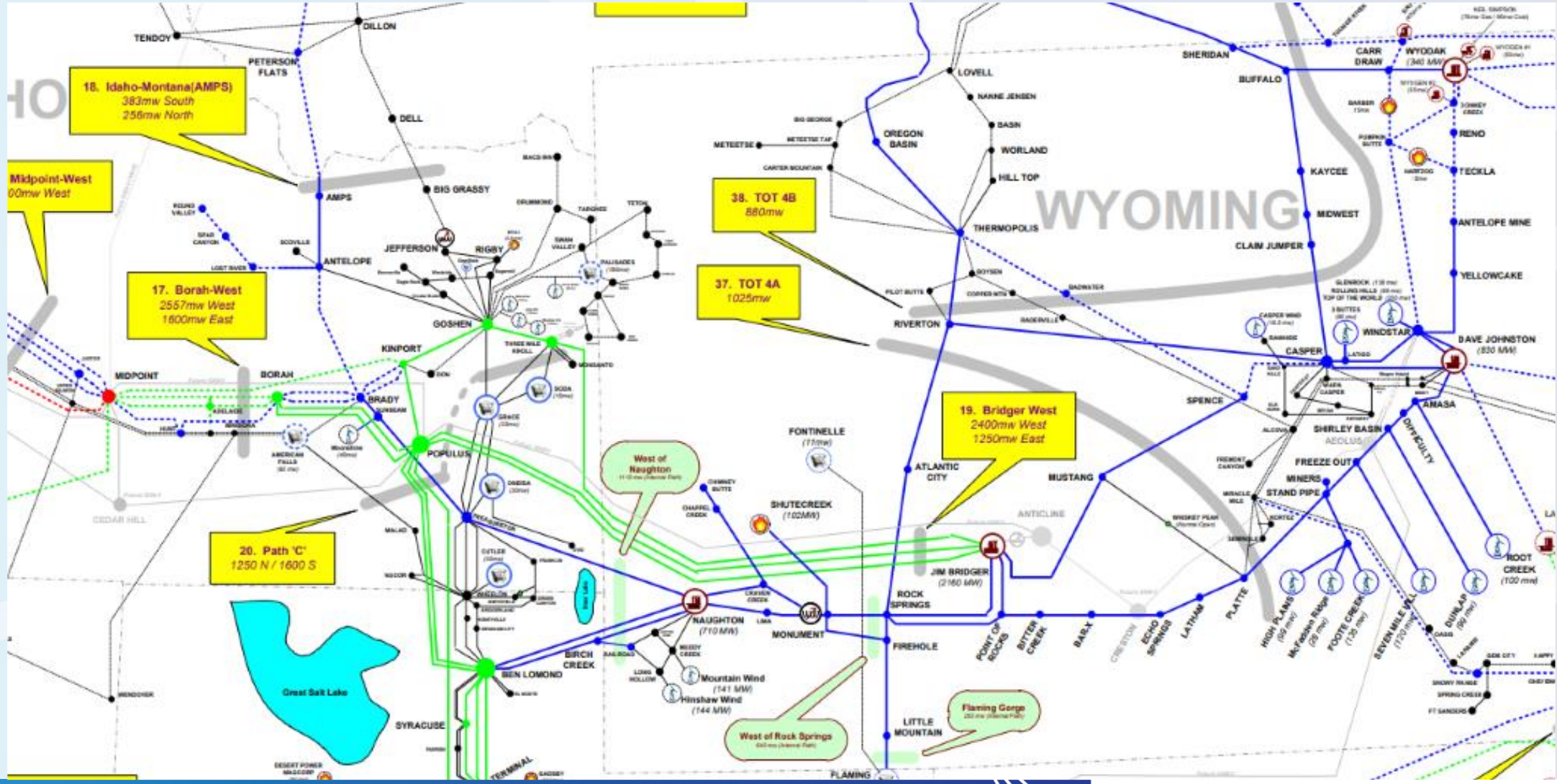
Bridger West, Populus West & Path C



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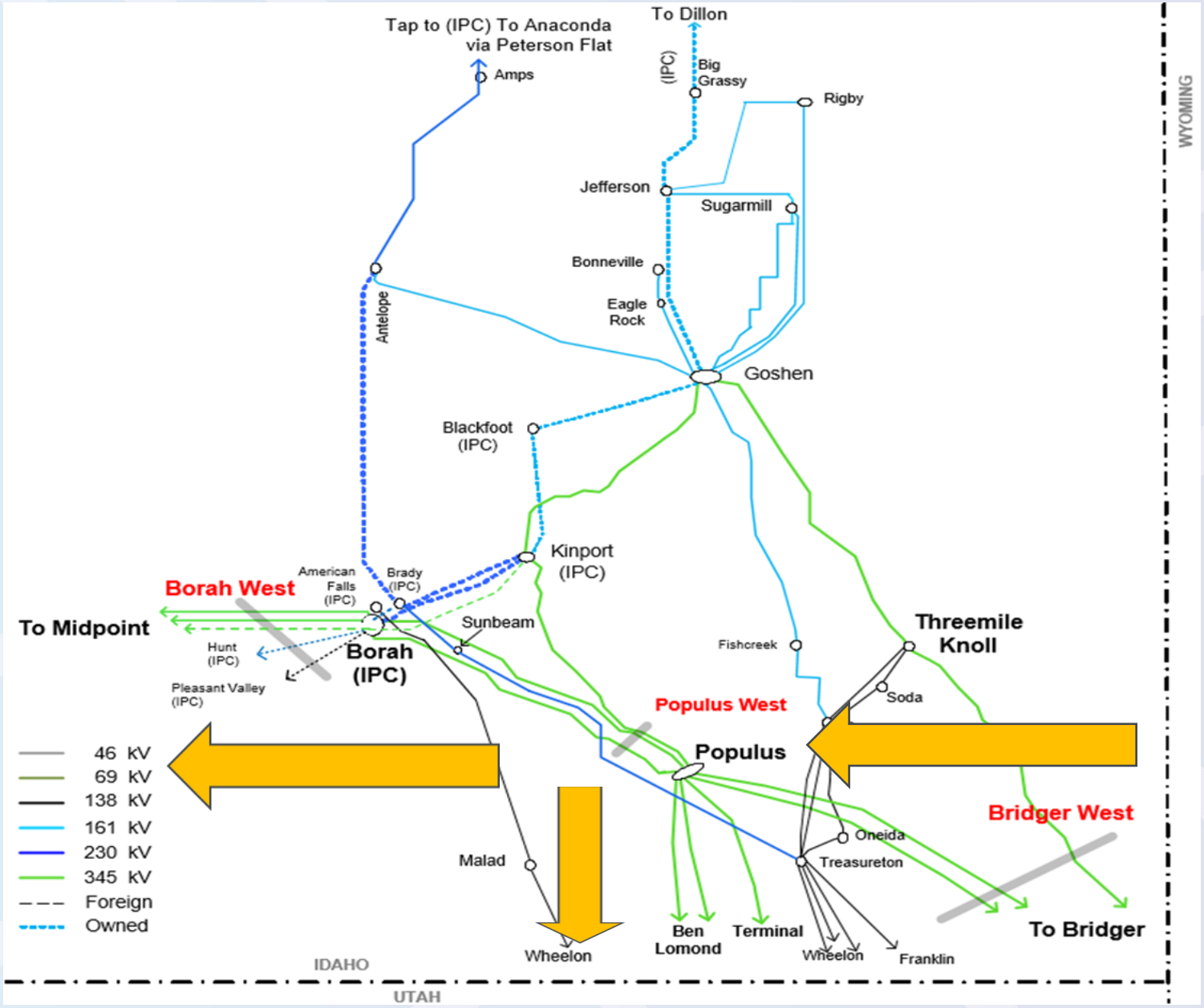
Bridger West, Populus West & Path C



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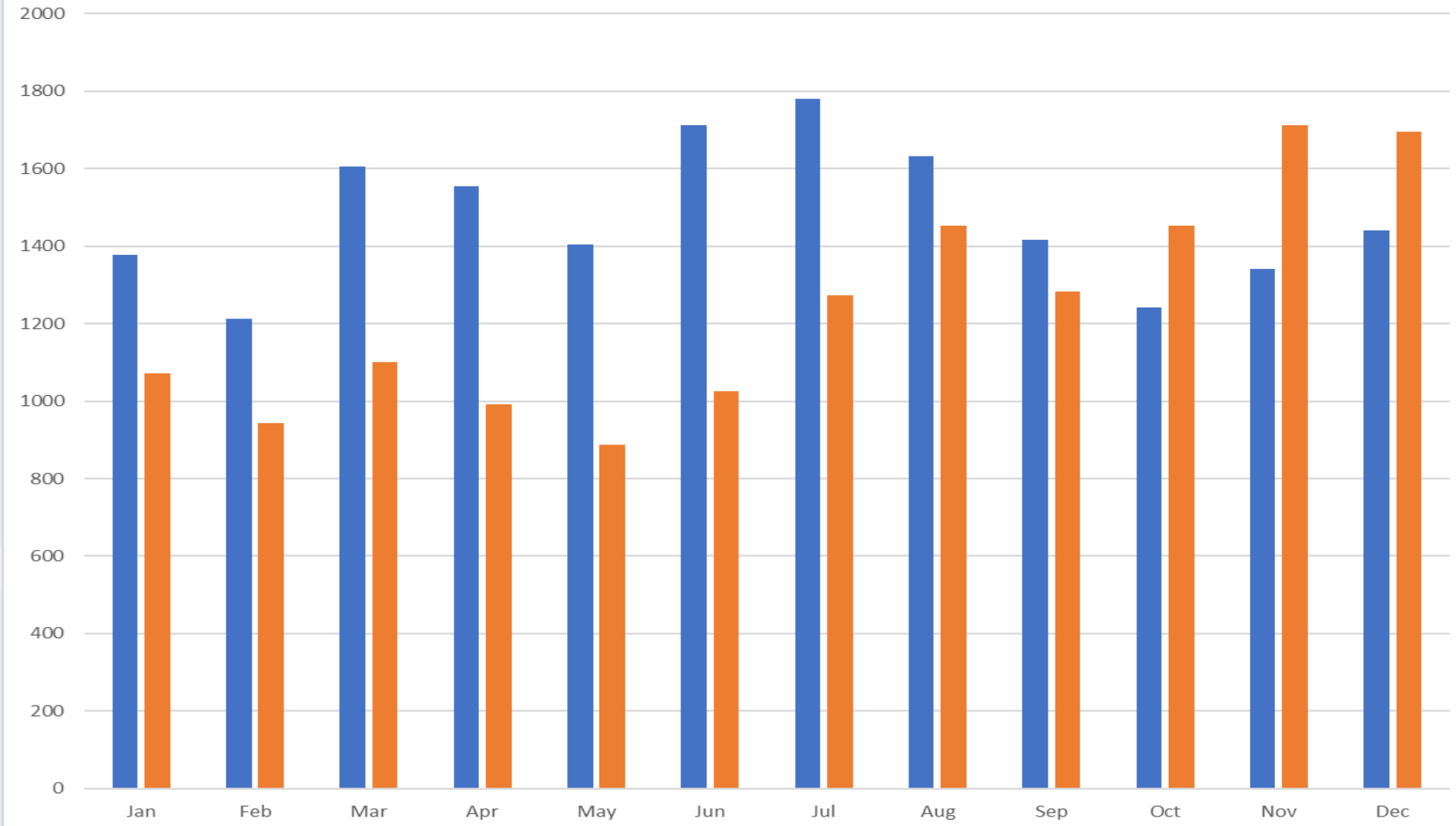
Bridger West Power Flow Changes

- Bridger, WY to Goshen/Populus, ID
- Wyoming generation being transmitted to the Northwest & Utah.



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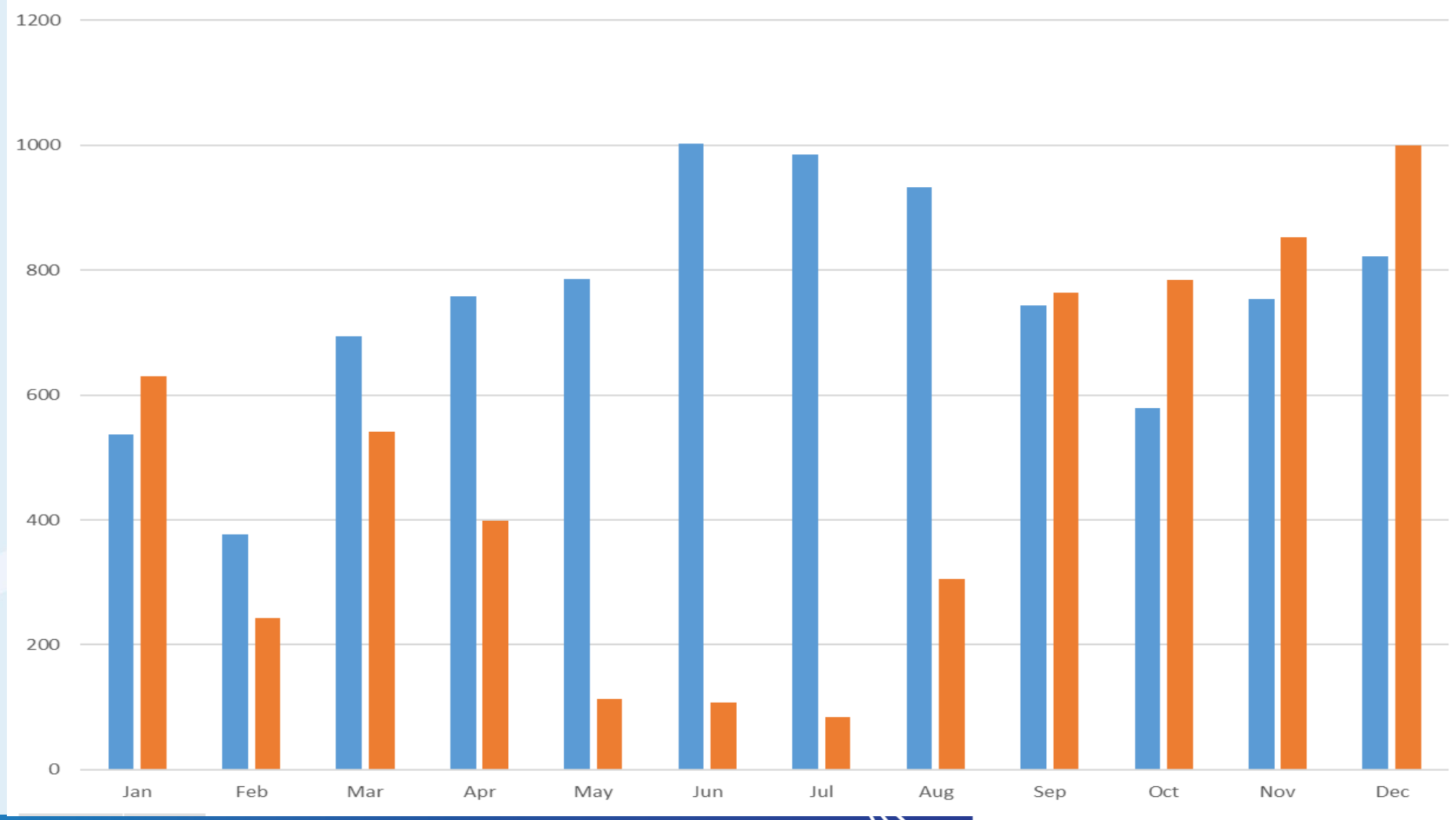
Populus West Power Flow Changes

- Populus, ID to Borah/Kinport, ID
- Under heavy load conditions, more north-to-south flows as compared to east-to-west flows.



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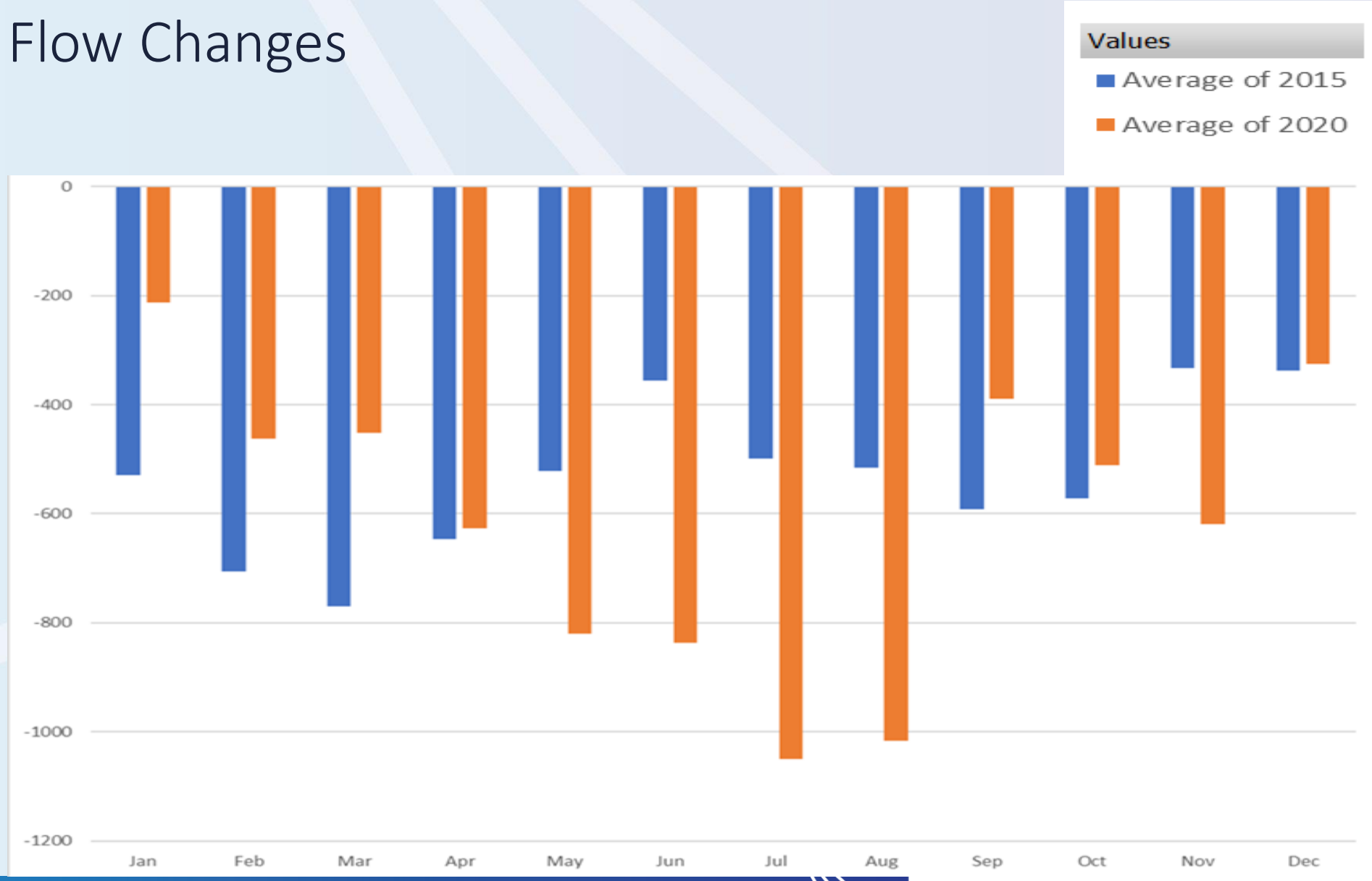
Path C Power Flow Changes

- Populus (ID) to Terminal (UT)
- Under heavy load conditions, more north-to-south flows as compared to east-to-west flows.



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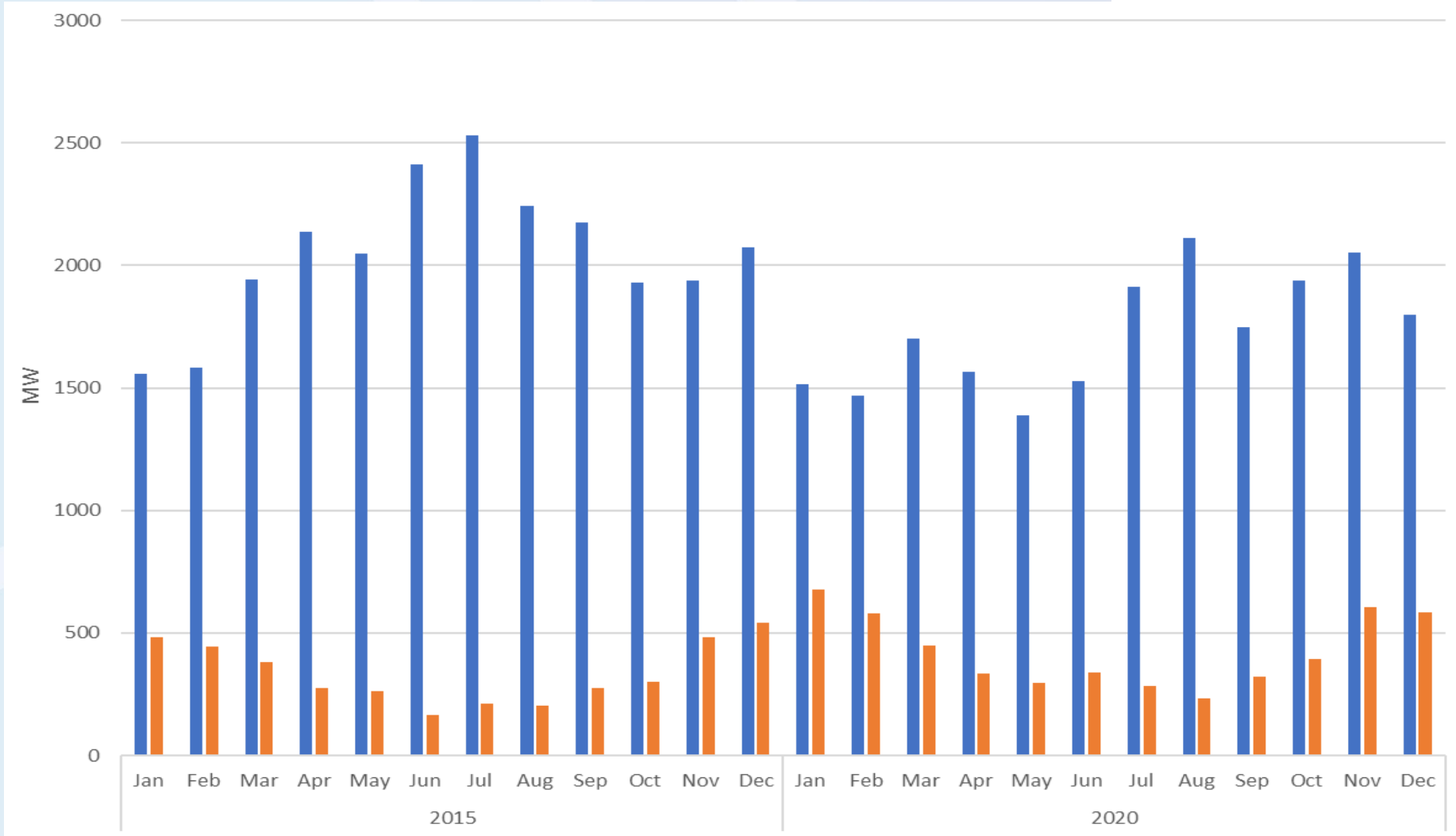
Coal versus Wind across Wyoming



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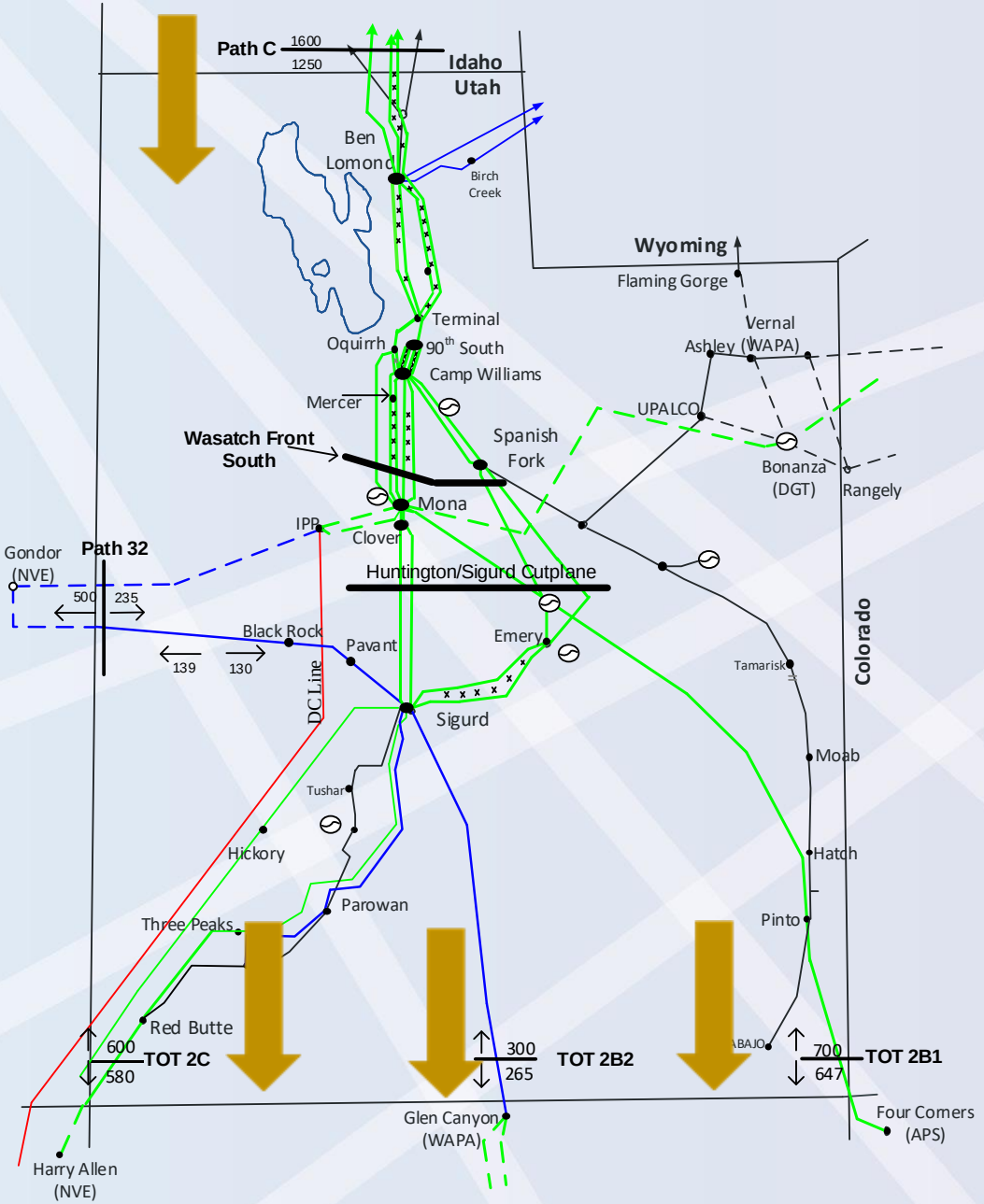
Southern Utah Transmission Paths



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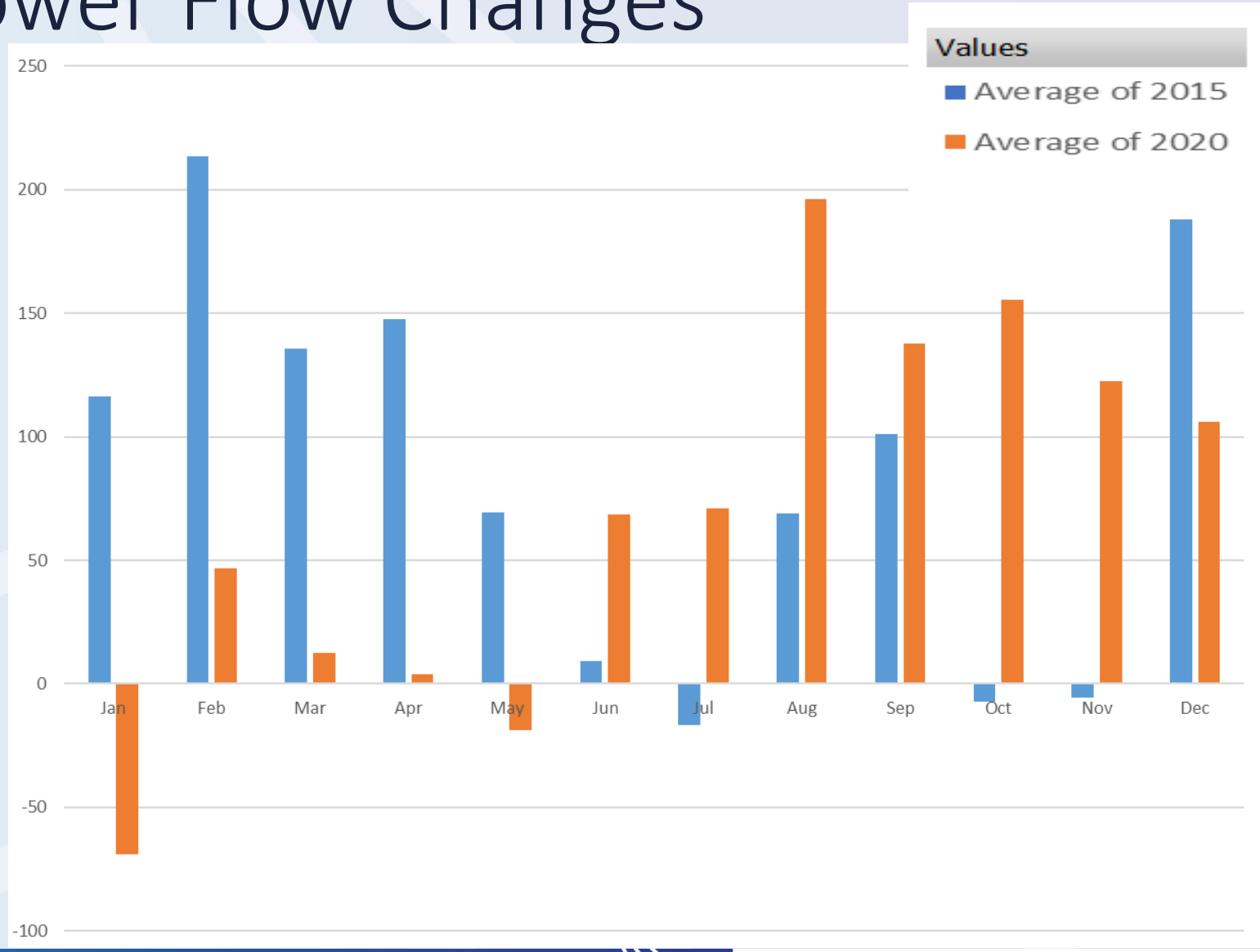
Southern Utah Power Flow Changes

- Pinto (UT) to Four Corners (AZ)
- Heavy north-to-south flows during summer months during heavy load conditions
- Very few instances of south-to-north flows on the paths



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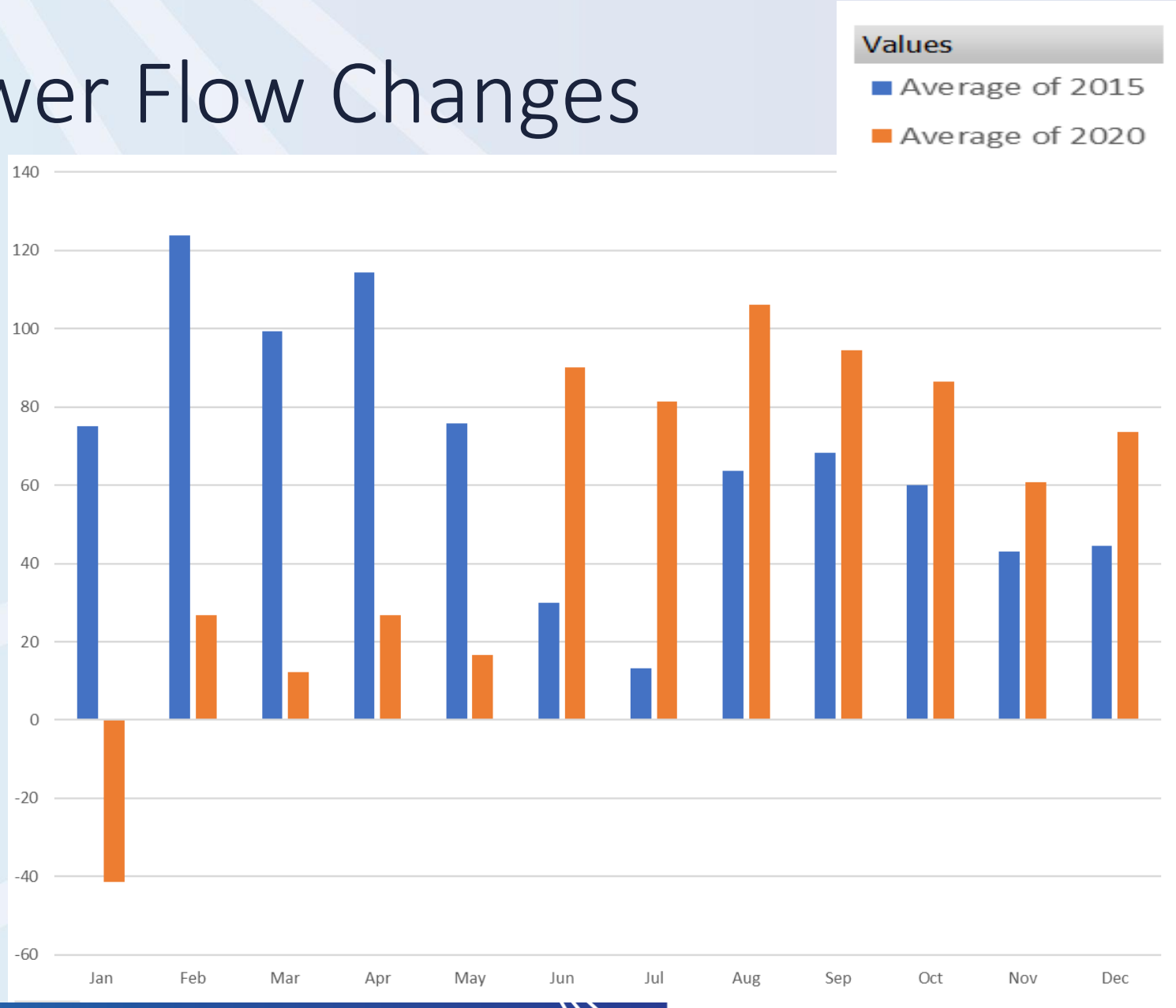
Southern Utah Power Flow Changes

- Sigurd, UT to Glen Canyon, AZ
- Heavy north-to-south flows during summer months during heavy load conditions
- Very few instances of south-to-north flows on the paths



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Q&A Break

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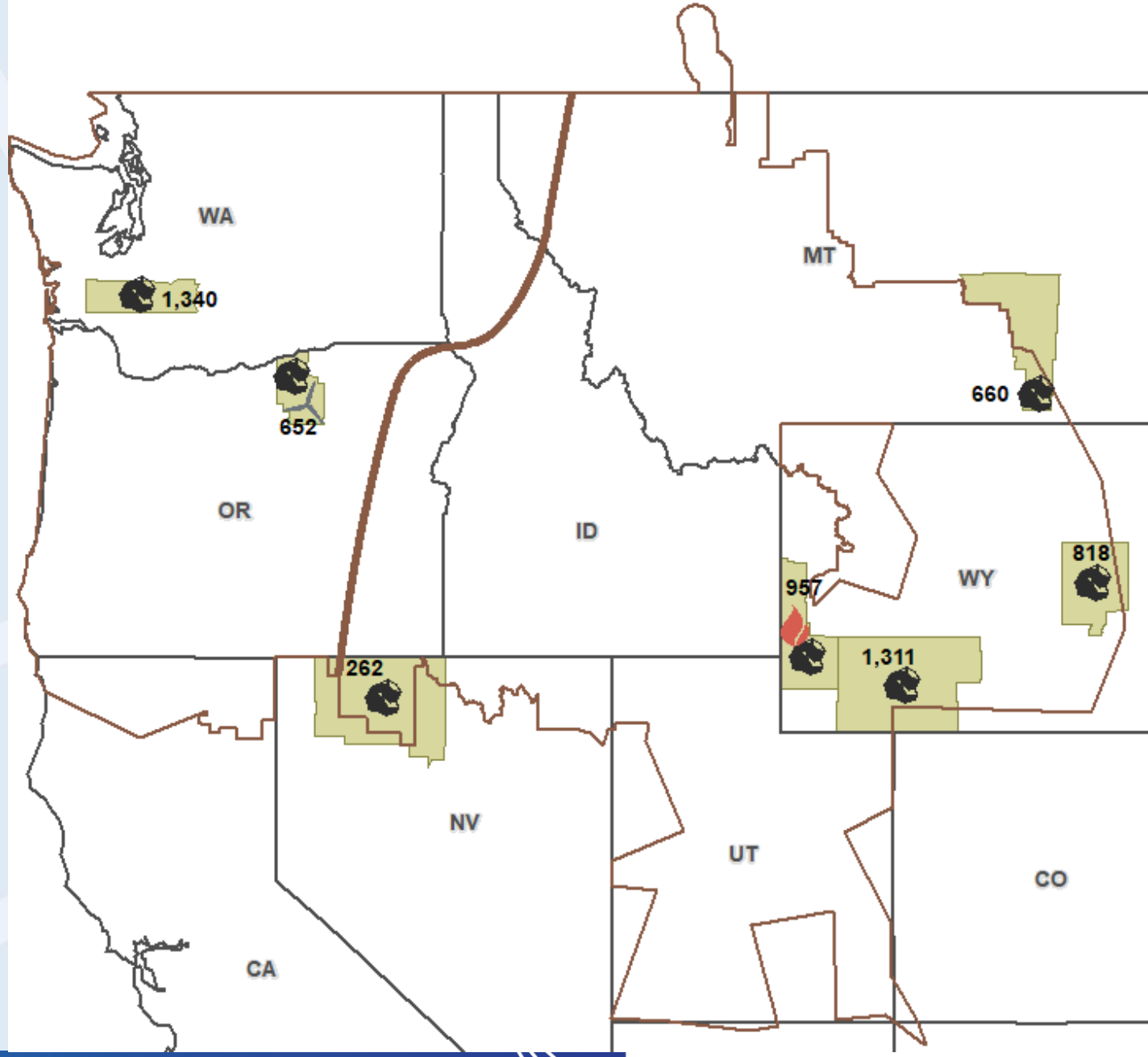
Resource Retirements



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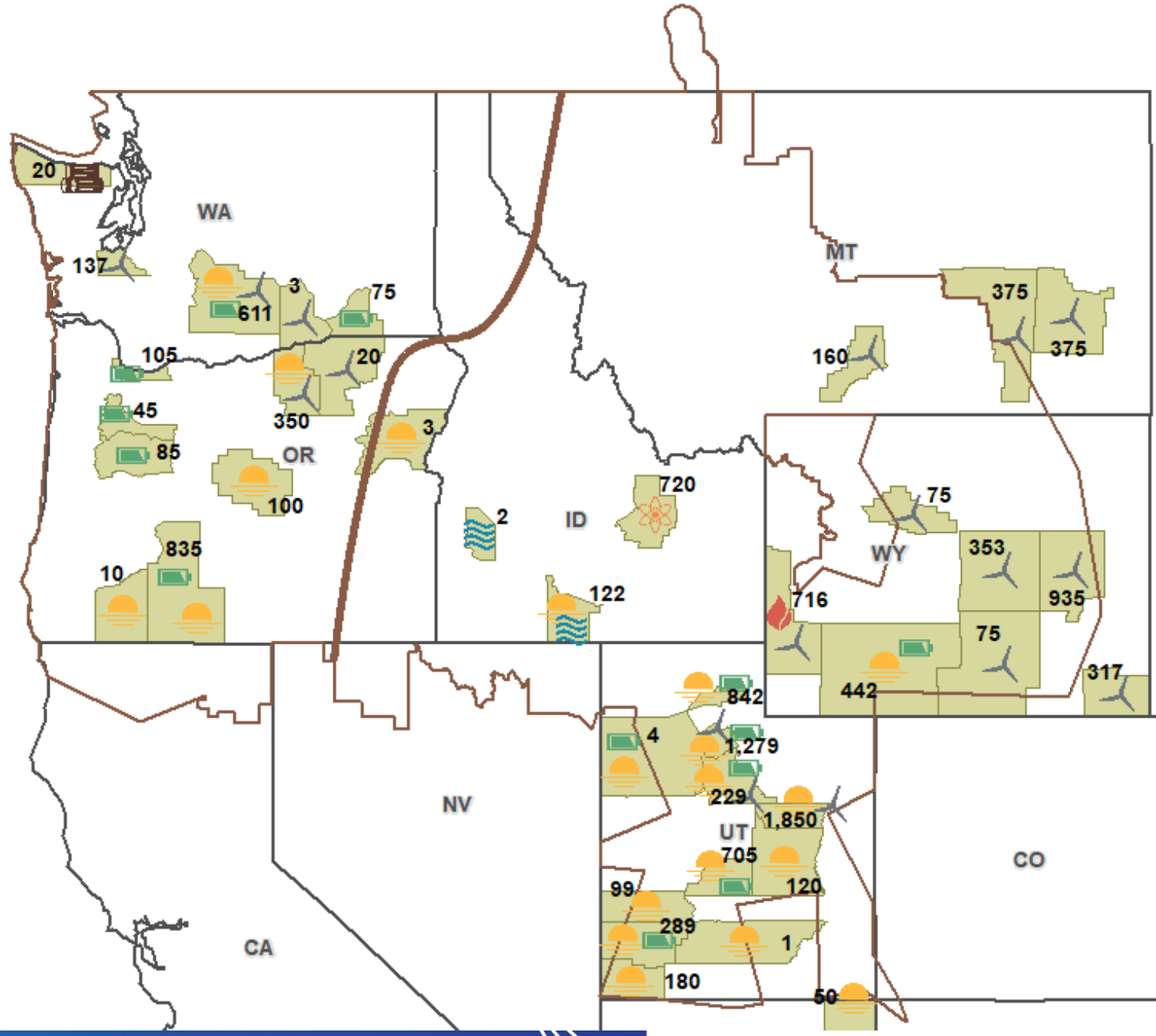
Resource Additions



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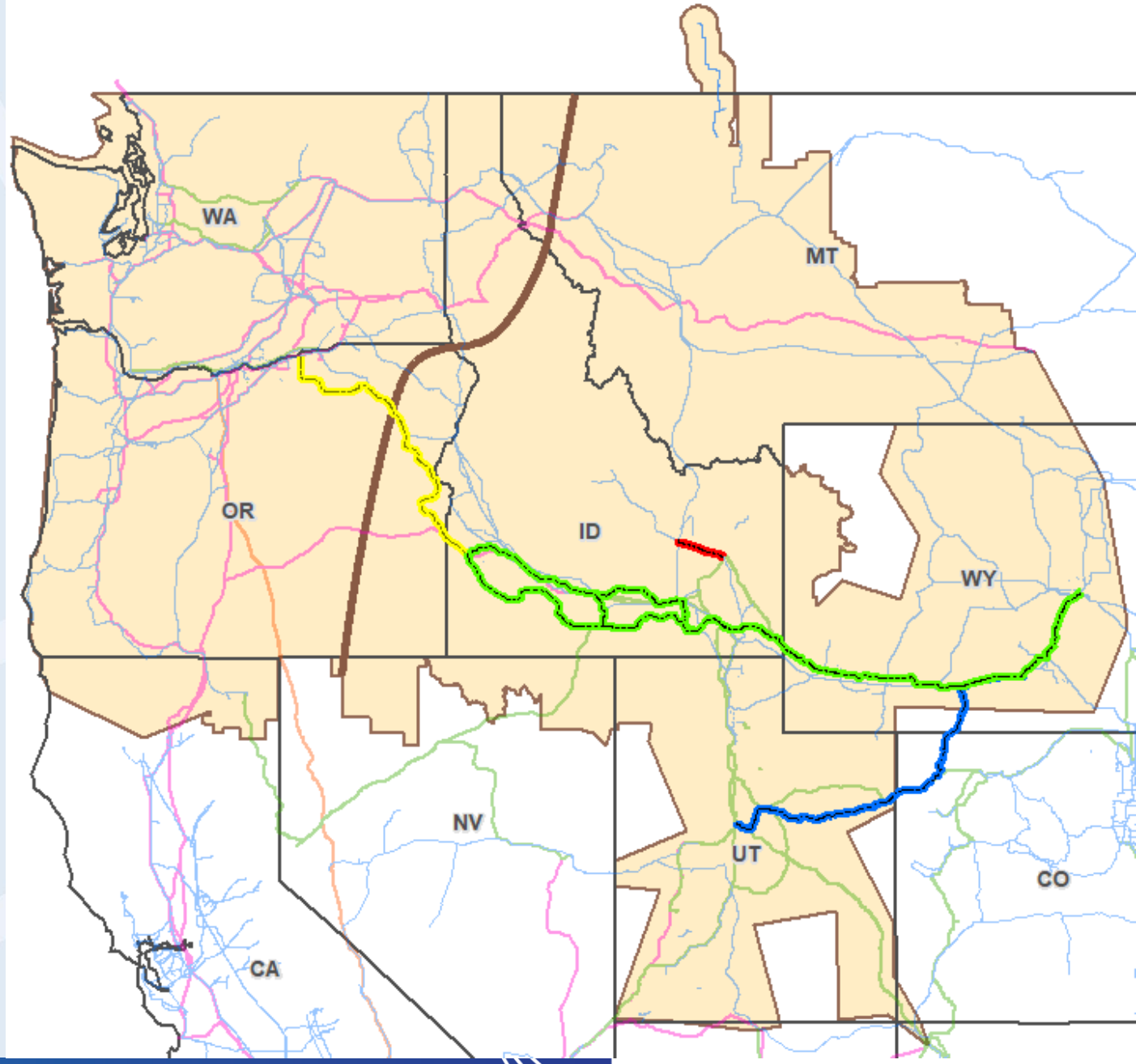
Regional Transmission Additions



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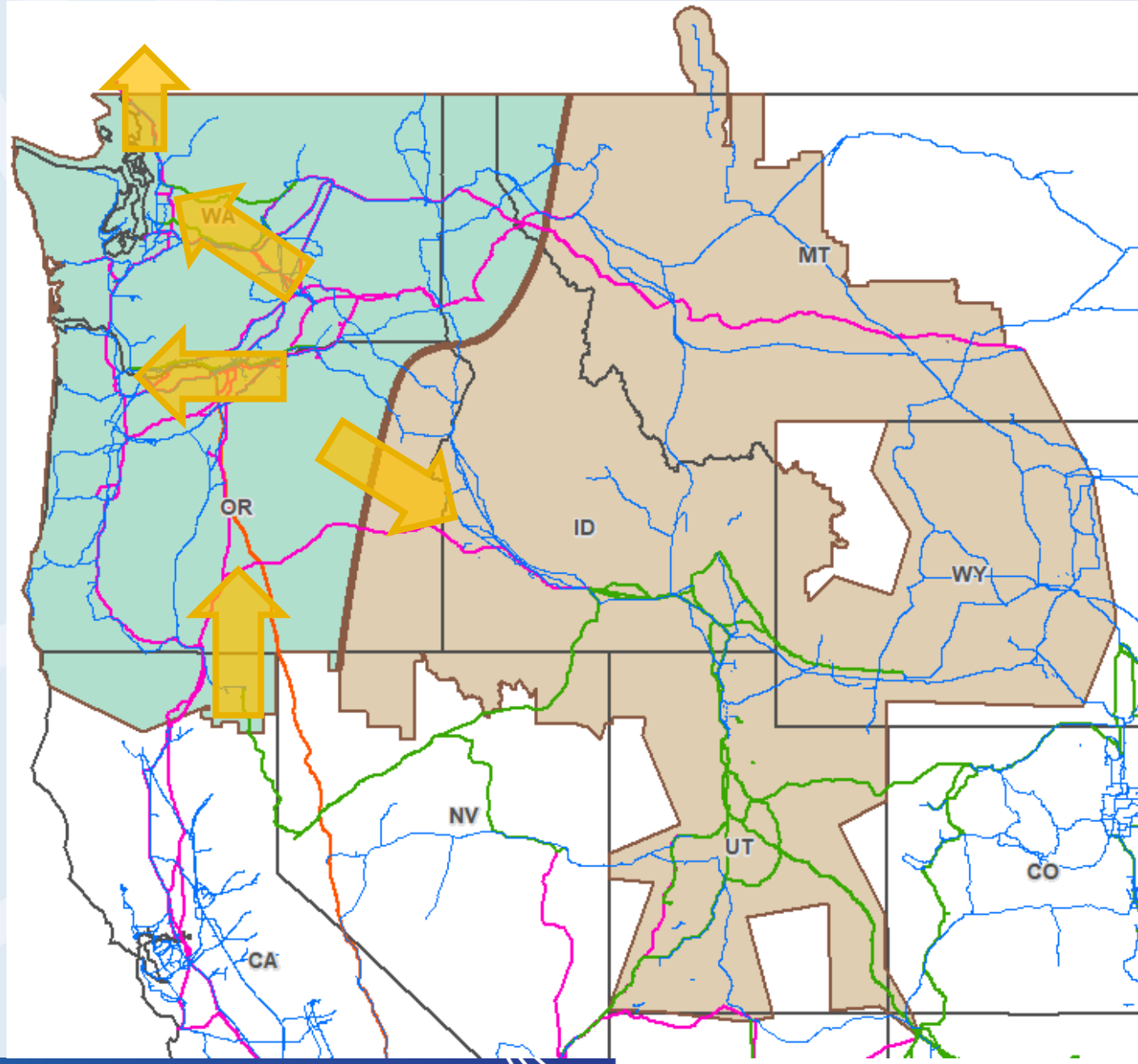
Potential Future Peak Summer Flows with High Renewable Generation



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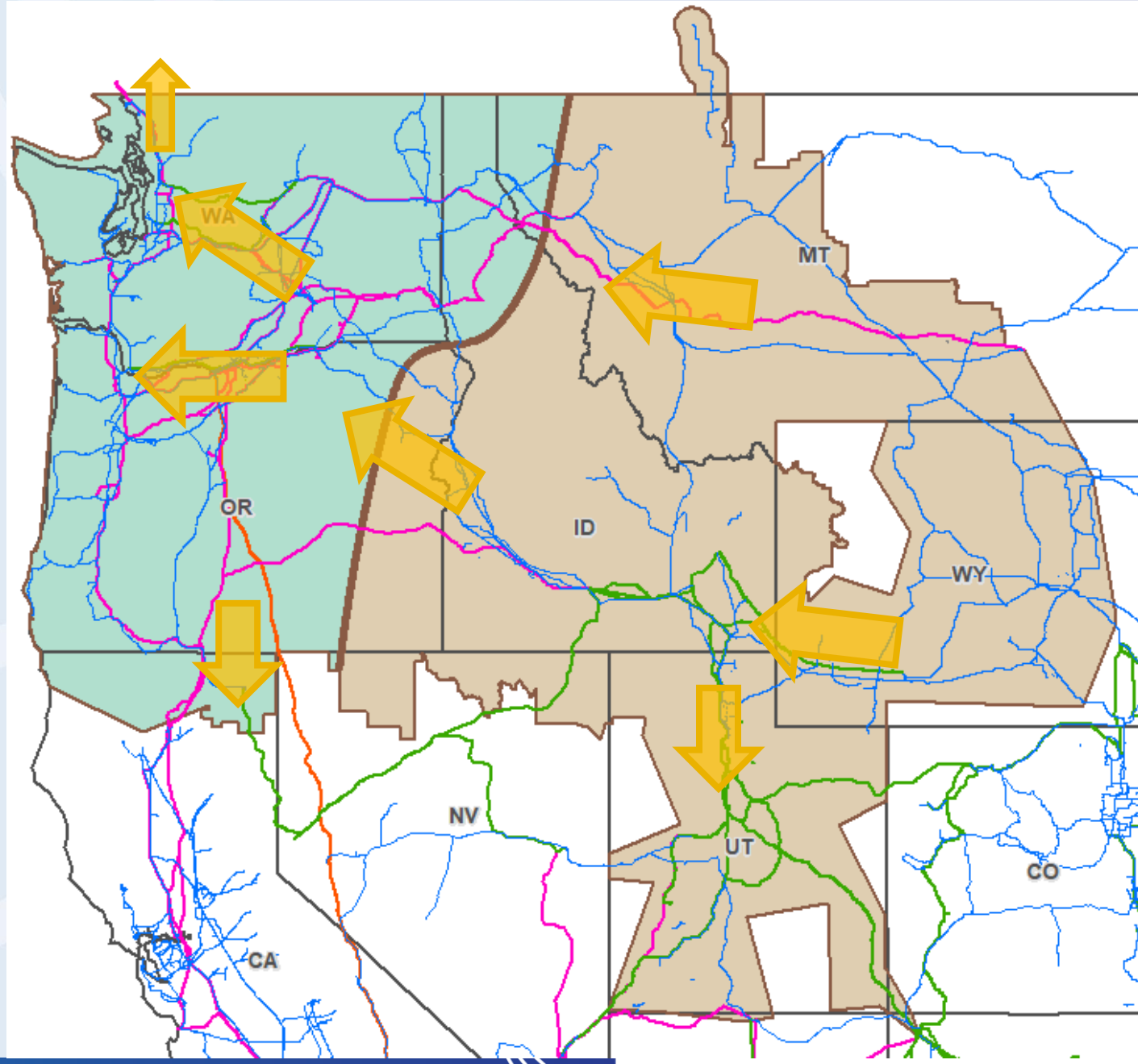
Future Peak Wyoming Flows with High Renewable Generation



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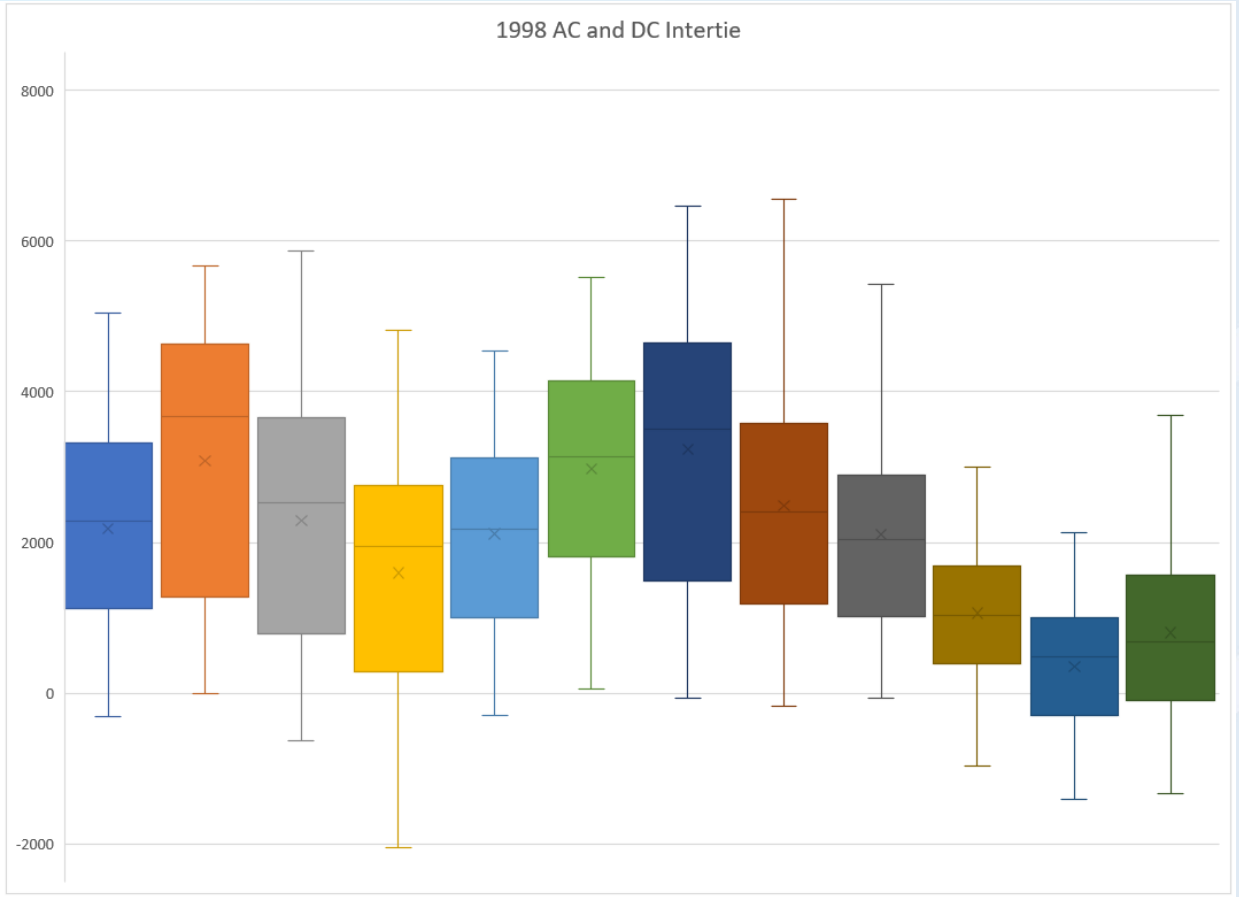
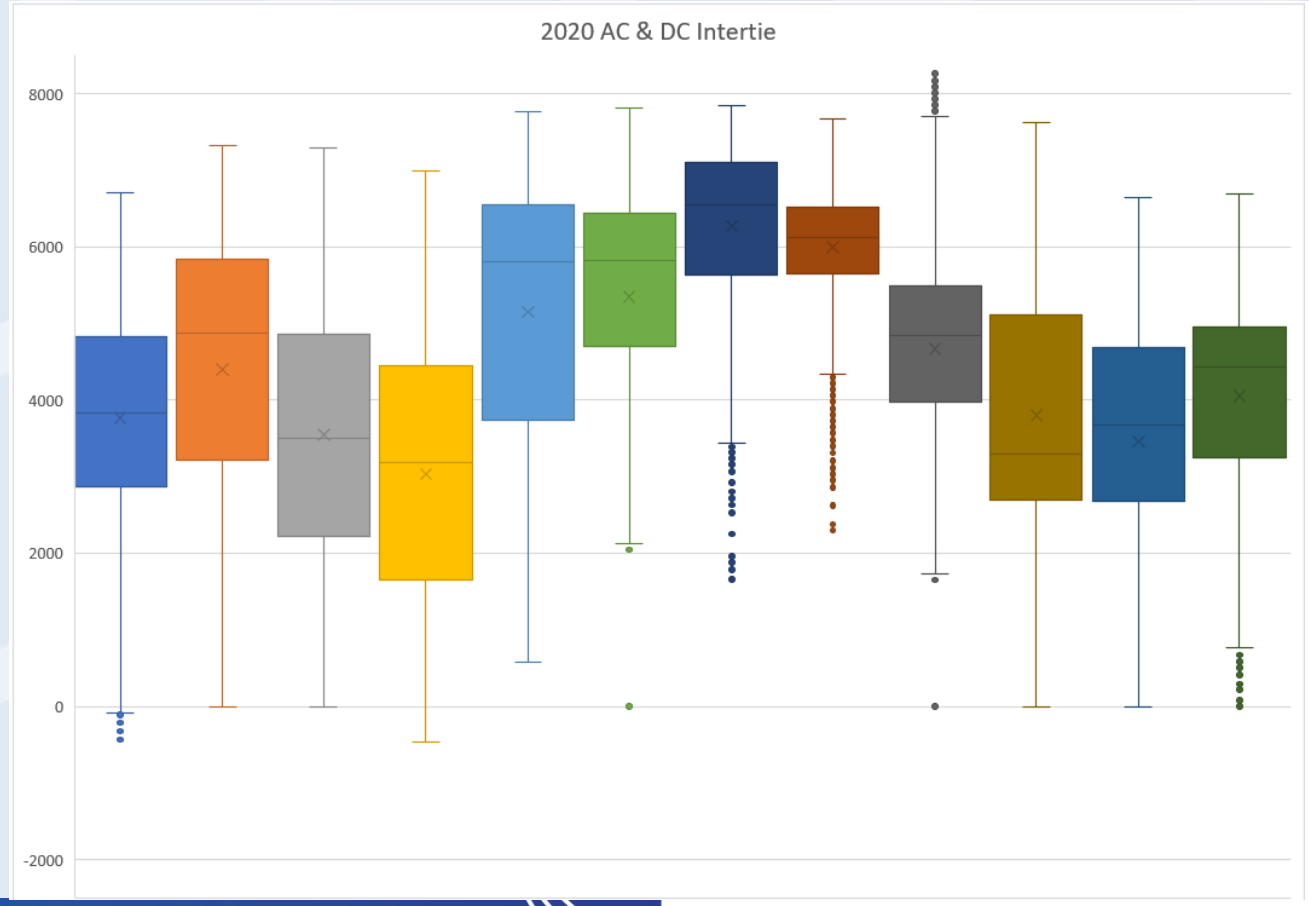
AC and DC Intertie Monthly Transfers

1998



2020



January February March April May June July August September October November December

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AD and DC Intertie Daily Transfers

ACDC 4/19/1998

AC and DC 4/19/2020

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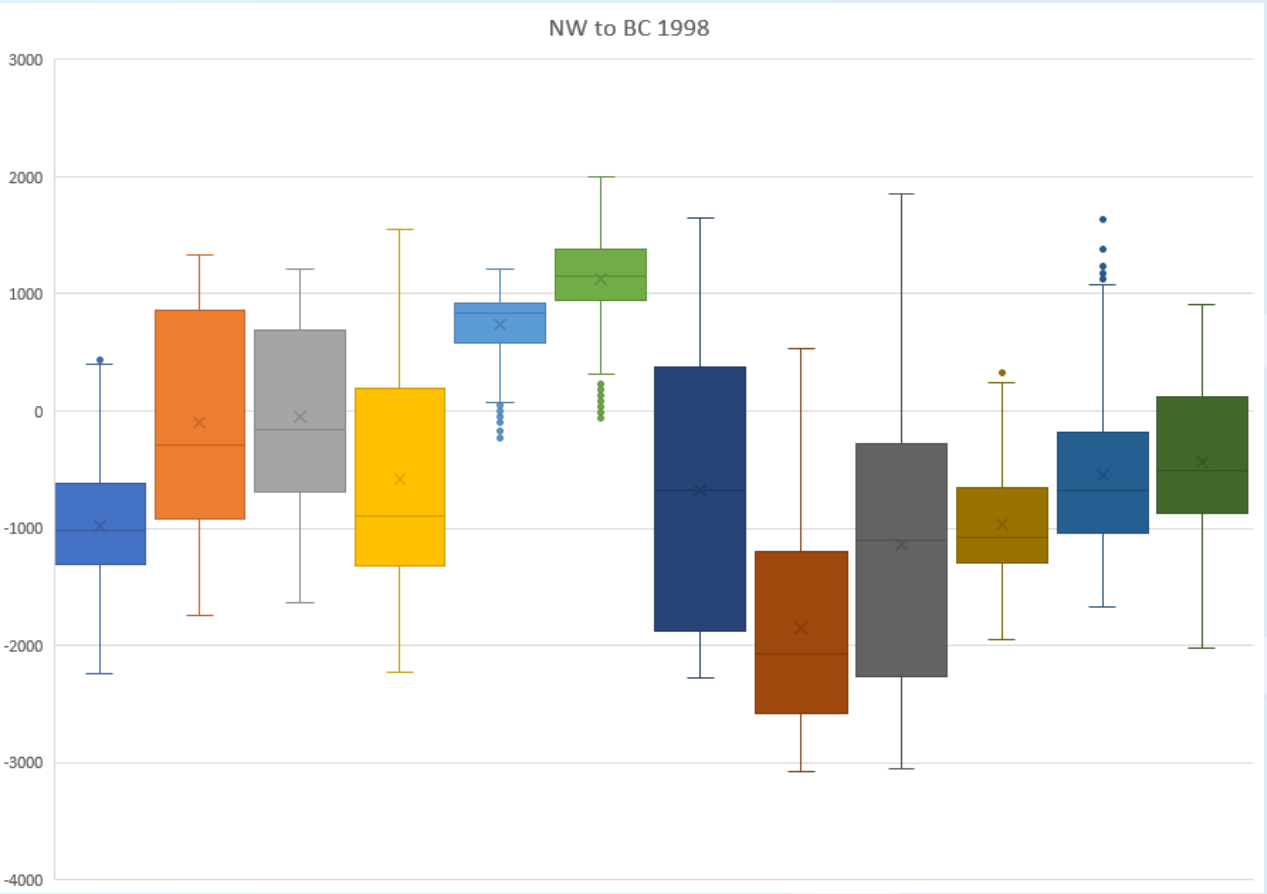
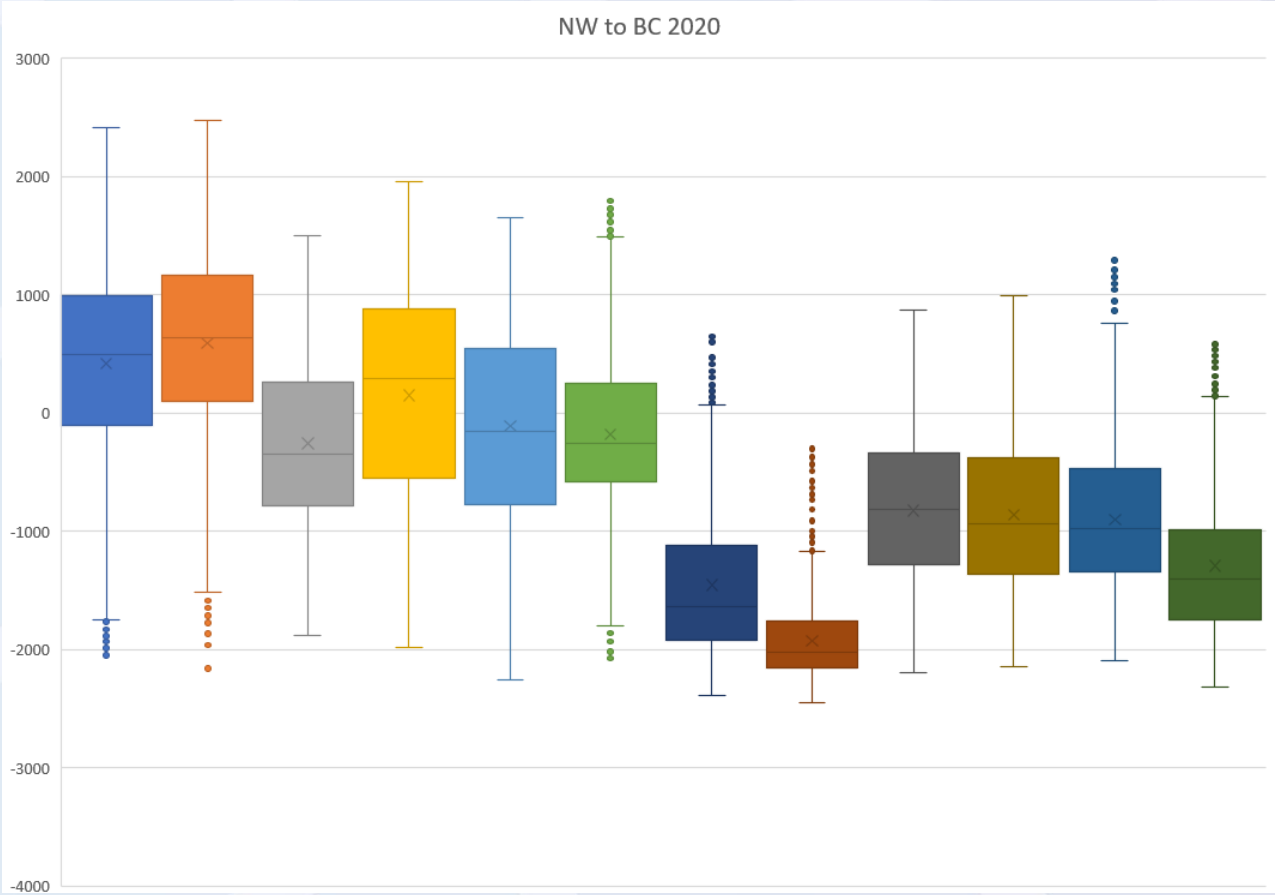
NW to BC Monthly Transfers

1998



2020



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NW to BC Daily Transfers

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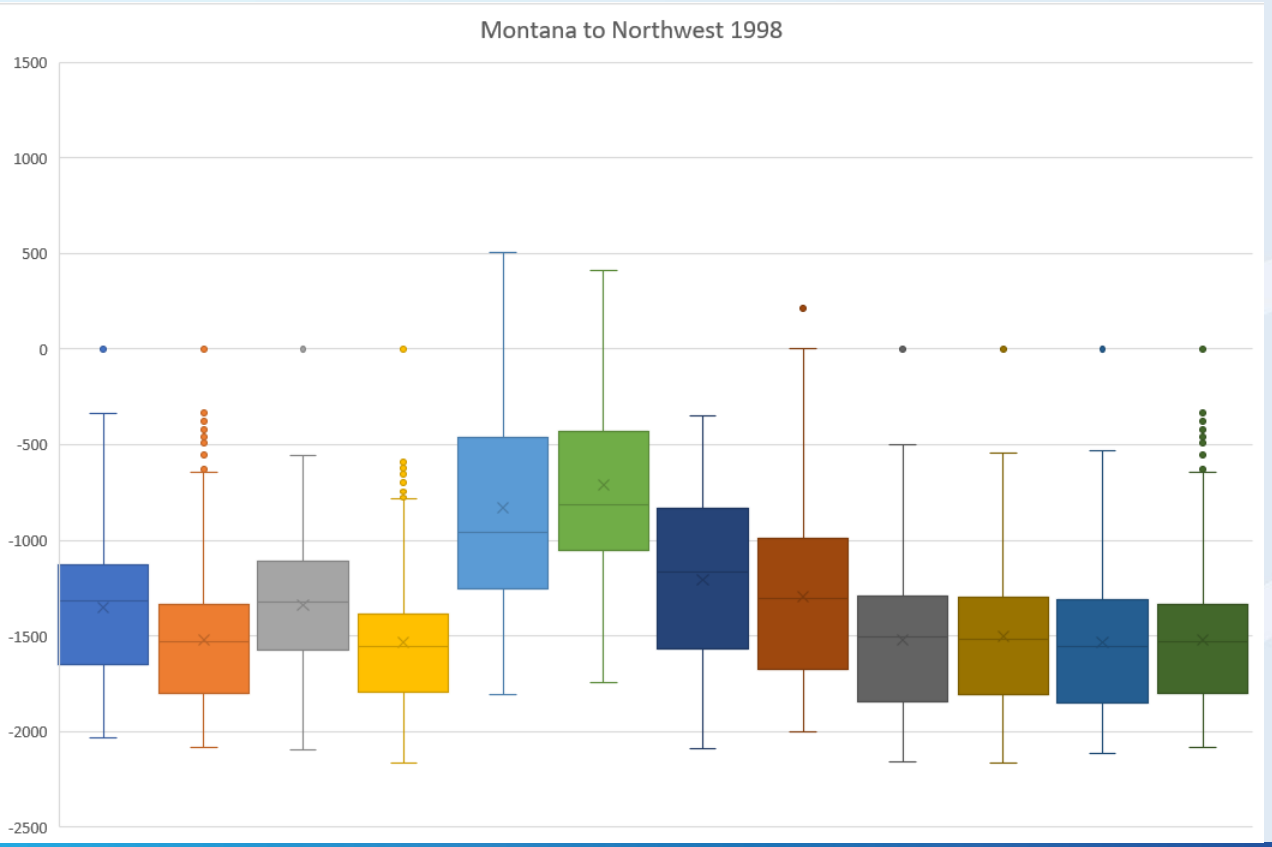
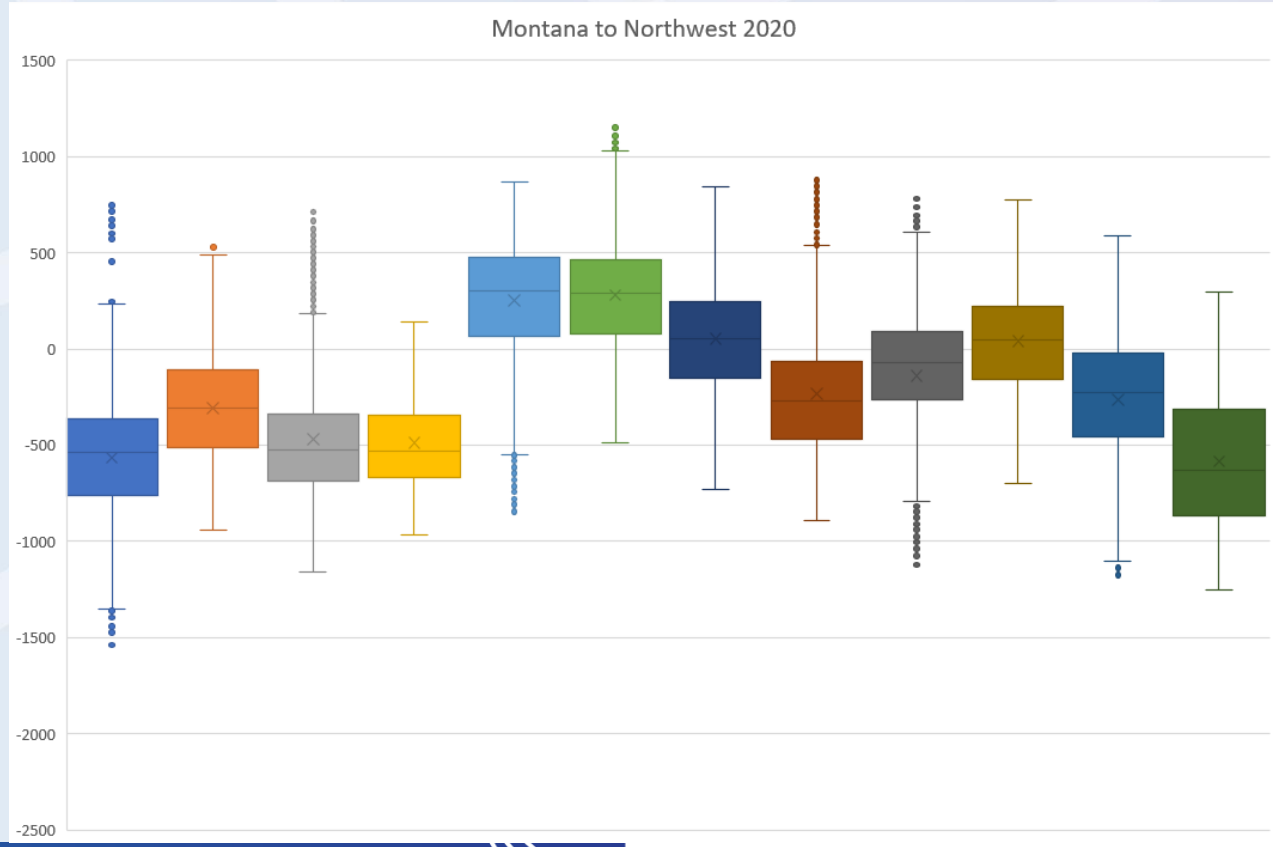
Montana to NW Monthly Transfer

1998



2020



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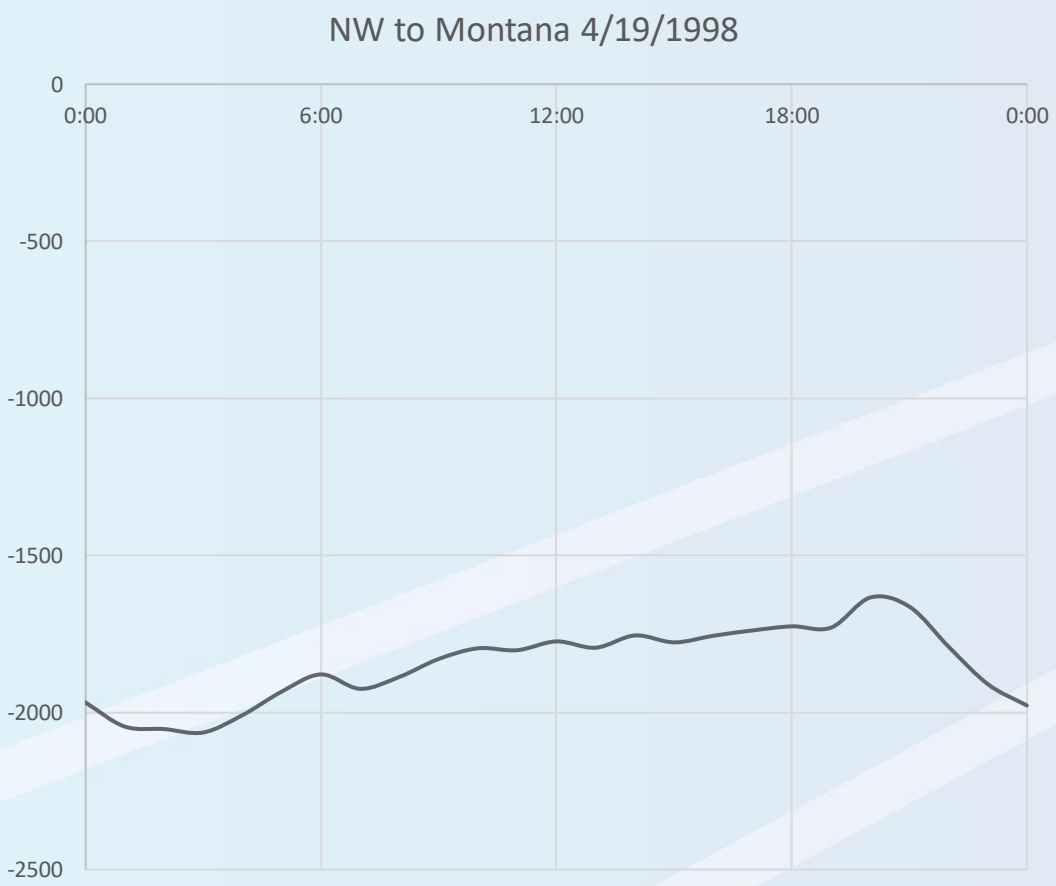
NW to Montana Daily Transfers



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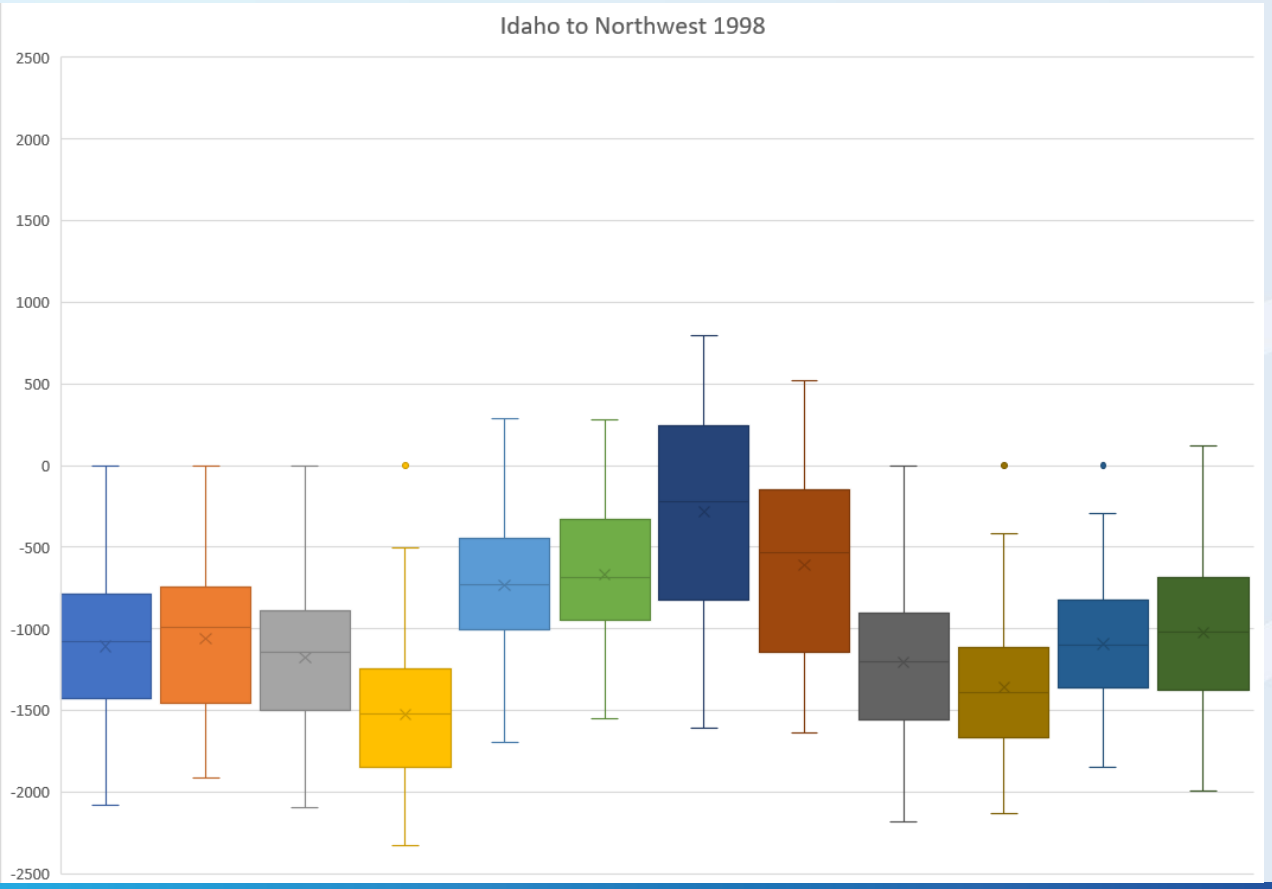
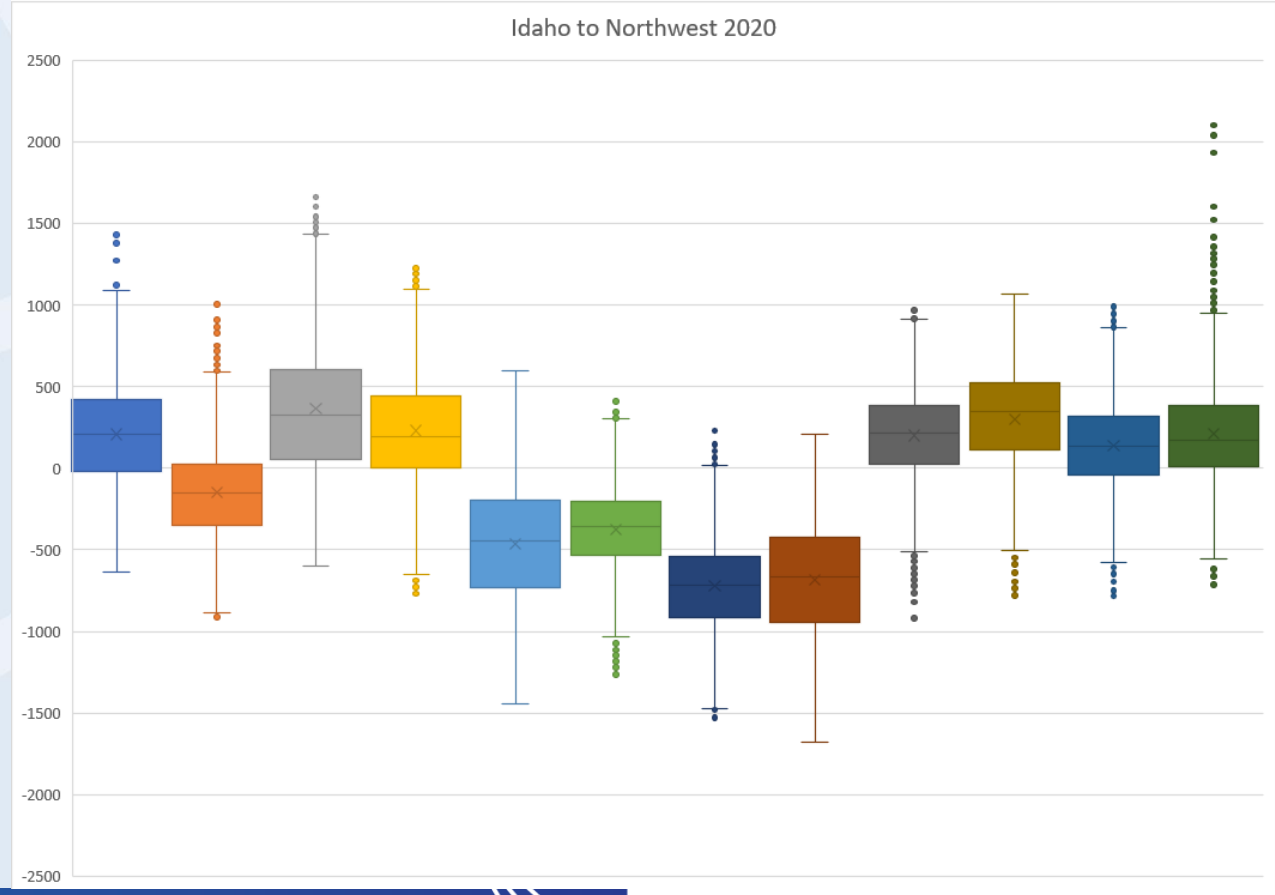
Idaho to NW Monthly Transfers

1998



2020



January February March April May June July August September October November December

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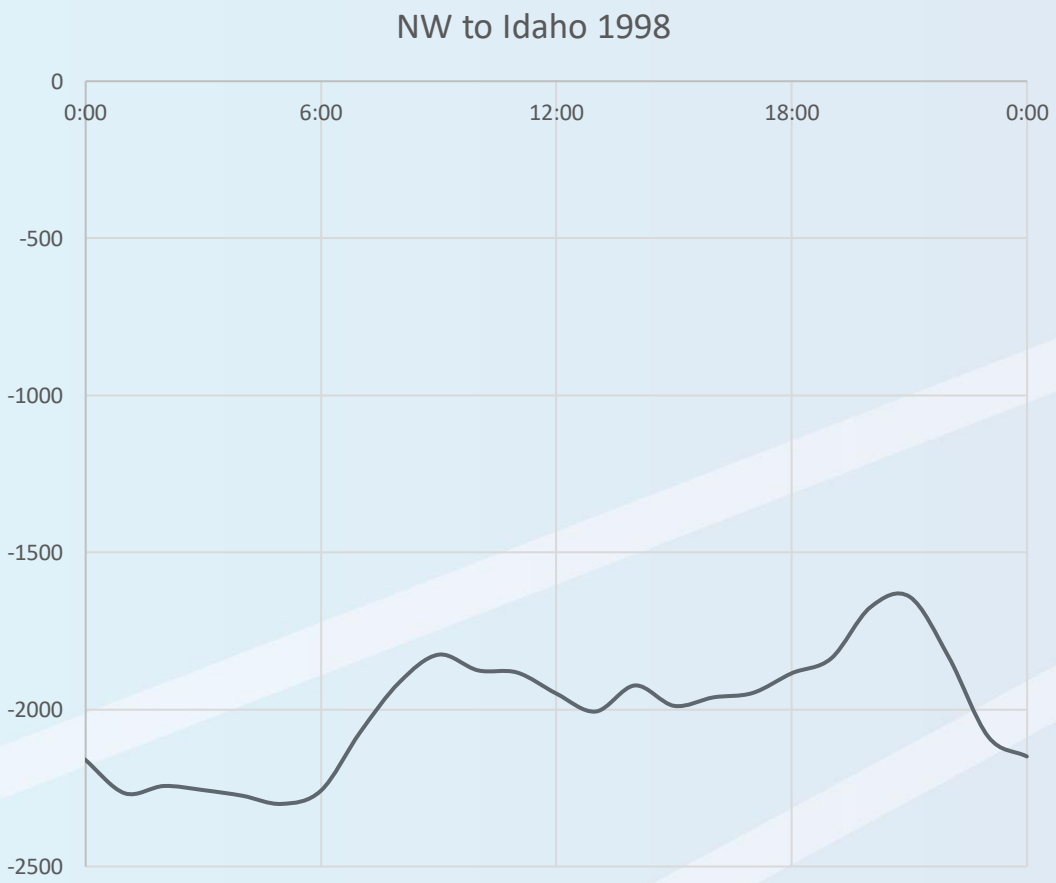
NW to Idaho Daily Transfers



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Power Flow Analysis

Chelsea Loomis, Northwestern Energy

Curtis Westhoff, Idaho Power

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Demo Key Takeaways

- Approaches for mitigation using a local and regional perspective
- How corrective action plans are developed and how utilities meet compliance through the plans
- Impact of regional projects

Terms Explained

- Base Case
- Bus
- Line
- Contingency
- Thermal overload
- Voltage excursion: high, low, difference
- Mitigation

Power Flow Analysis Example

- Idaho to Northwest Path and the Boardman to Hemingway Project

Q&A Break

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Transmission Service and Types

- Transmission customers reserve MWs of capacity
  - The right to transmit power on the transmission lines/paths of a transmission provider (TP)
- Two primary types of transmission service
  - Point-to-point
    - Used to move power from one area to another over a posted transmission path
      A path can be a single line or a group of specific lines
  - Network
    - Used to serve load by load serving entities
      - utility merchant function groups and other suppliers
    - Requires the designation of both loads and resources to establish transmission
    - Uses entire TP transmission network

Types of Transmission

- Point-to-point (PTP) transmission service
  - Long term Firm
  - Short term Firm
  - Non-Firm
- PTP transmission capacity is reserved in both quantity of power and quantity of time

Types of Transmission

- Network Transmission Service
  - Network Integration Transmission Service – often referred to as NITS
    - Requires the designation of loads and resources
    - Resources can either be located “on-system” or “off-system”
      - interconnected to another TP
  - Secondary Network Service
    - Allows a network transmission customer to serve their designated load from non-designated resources
    - Only on an as-available basis

Transmission Service Reservation Priorities

Priority	Acronym	Transmission Service Reservation Description
0	NX	Next-hour Market
1	NS	Secondary receipt and delivery points
2	NH	Hourly
3	ND	Daily
4	NW	Weekly
5	NM	Monthly
6	NN	Network Integration Transmission Service from resources that are not designated
7	F	Firm Point-to-Point Transmission
	FN	Network Integration Transmission Service from Designated Resources

Transmission Capacity and Paths

- PTP transmission is made available over posted paths.
  - A path can be a single line or many lines
- Key Transmission Capacity Terms
  - TTC – Total Transfer Capability
  - ETC – Existing Transmission Commitment
  - ATC – Available Transfer Capability (ATC = TTC-ETC)
- TTC is based on system modeling under simulated stressed conditions using reasonable load and generation dispatch scenarios in order to find the maximum theoretical flow on a path

Transmission Service Payments

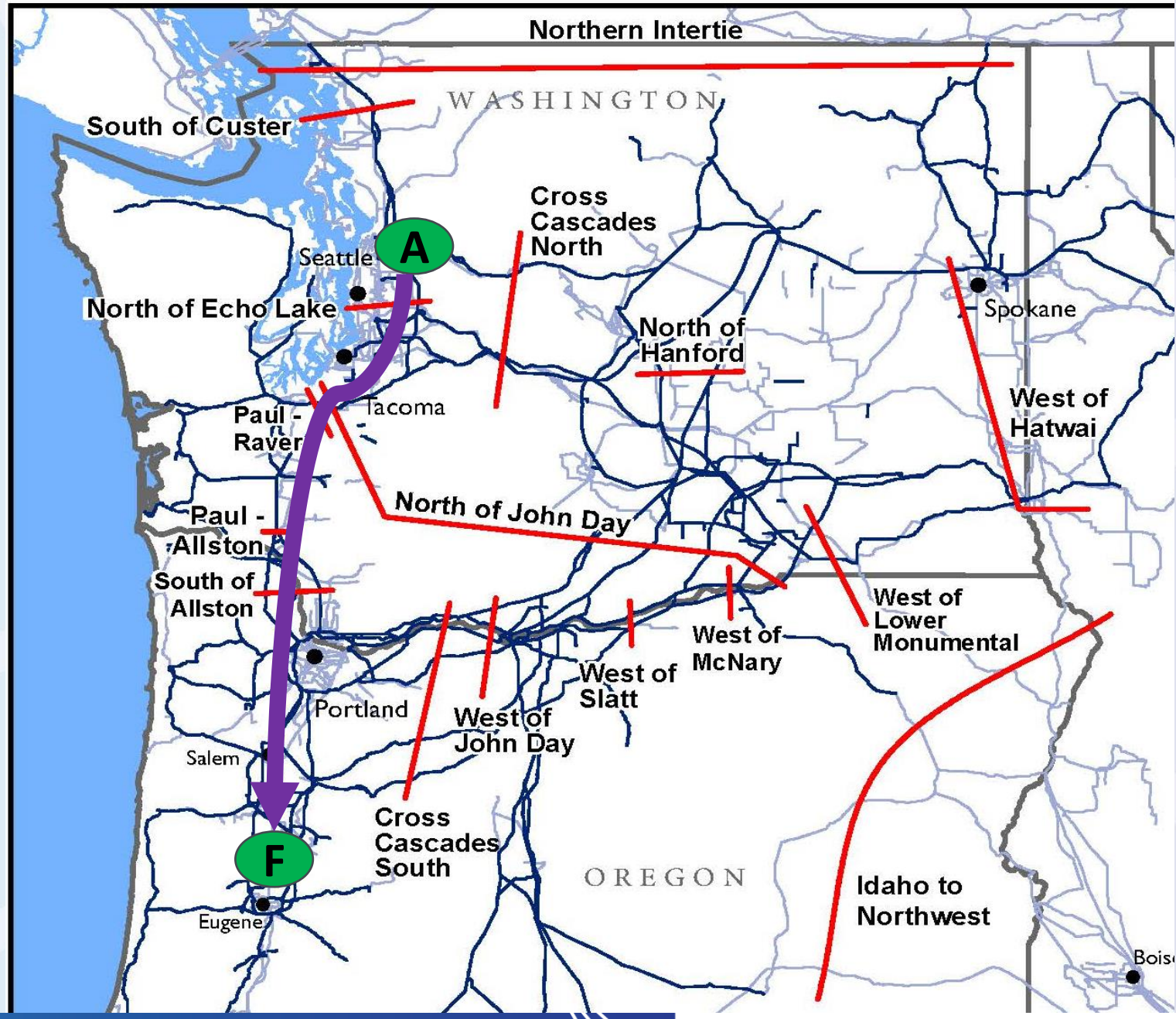
- Customer pays for firm transmission service whether used or not
- Transmission service use must be scheduled through OASIS website
- If customer doesn't use the purchased transmission, TP can remarket as non-firm capacity
- Unsubscribed transmission capacity can be used by TP for participation in EIM, if a member

Transmission Capacity and Paths

- Outside of the CAISO organized market, the west generally uses the contractual path methodology for establishing TTC and ATC on Paths
- Electrons do not follow contracts
- When paths get close to fully subscribed, they can become constrained
  - South of Allston or the California-Oregon Intertie
- Constraints can be limiting factors in the development of new resources.

Contract versus Flow

- Customer requests transmission to sell generation from location **A** near Seattle, WA to buyer accepting serving load at location **F** near Eugene, OR
- A transmission service contract is executed to move power from the point of receipt **A** to the point of delivery **F**



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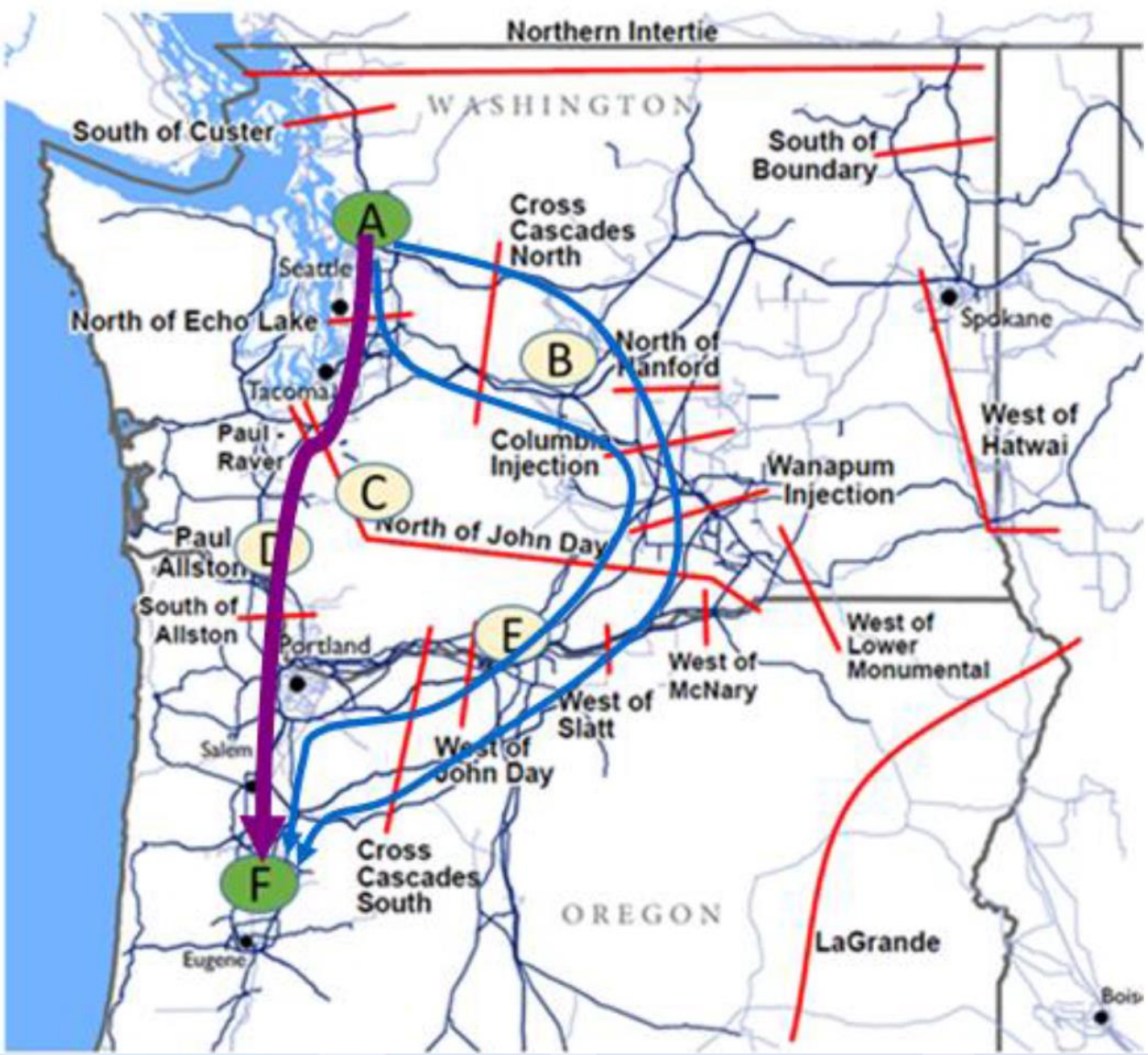
Contract versus Flow

- Actual power flow follows laws of physics and automatically splits across multiple paths connecting **A** to **F**
- Paths not explicitly included in transmission service contract see a change in actual flow as a result of the contract



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Thank you!

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