# Integrated Resource Planning

## Roundtable Meeting #20-2

April 14, 2020

# MEETING LOGISTICS

- **Participants:**
  - Electronic version of presentation: *portlandgeneral.com/irp*
- Teams Live event
  - Please click the invite link sent to your email/calendar that says “Join Live Event”
  - A browser window will open. Click on the button that says “watch via internet browser”.
  - In the new pop up click “Join anonymously”
  - You can fully participate via computer (visual and audio) if you have a built in microphone.
  - If you call in using your phone in addition to joining via the online link please make sure to mute your computer audio
  - When we start we will have the all presenters muted but during the presentations we want you to be able to ask questions, please mute yourself when you are not speaking and be aware of background noise

# SAFETY MOMENT

- Computer work: Neck pain
  - Make sure your monitor is eye level, that means you are looking straight ahead at the top third of your screen
  - Stretch and/or strengthen your neck muscles
  - Stay well hydrated to nourish the disks and tissue in your spine
  - Use a headset for long calls to avoid tilting or jutting your head

# AGENDA

- Transmission
  - Stakeholder input for design/scoping
- Integration cost drivers enabling study
  - Initial ideas to propose, input for design and scoping
- Climate adaptation enabling study
  - Stakeholder input for design/scoping

# Transmission

Seth Wiggins

# Incorporating transmission into IRP

- Previous IRPs assumed generic off-system resources selected were able to acquire all necessary transmission to deliver to PGE
  - The associated costs were set at BPA tariff rates
  - MT Wind transmission costs came from MRDAP and recent BPA and PSE tariff filings
- Wood Mackenzie's WECC-wide model (run in Aurora) limited zone-to-zone transfers based on physical transmission capacity limits
- We are proposing that the IRP include a more detailed incorporation of the current transmission landscape
  - Using BPA data, off-system resource additions will be constrained during the Action Plan window by what long-term posted transmission capacity is available

# Transmission in the IRP

## Our capacity expansion model ROSE-E sets constraints for MW additions of each resource in each year

- Users can set both minimum and maximum MW additions per resource per year

| Annual Resoure Constraints | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 |
|---|---|---|---|---|---|---|---|
| **Minimum Addition (MW)** | | | | | | | |
| New_LMS100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_SCCT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_CCCT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Recips | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Biomass | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Geothermal | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_PumpedHydro | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Wind_Ione | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Wind_Gorge | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Wind_WA | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Wind_MT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Solar | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_SolarPlusStorage | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Bat_2h | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Bat_4h | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Bat_6h | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Maximum Addition (MW)** | | | | | | | |
| New_LMS100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_SCCT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_CCCT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Recips | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Biomass | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_Geothermal | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_PumpedHydro | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_Wind_Ione | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_Wind_Gorge | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_Wind_WA | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_Wind_MT | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_Solar | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_SolarPlusStorage | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_Bat_2h | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_Bat_4h | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_Bat_6h | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |

## We propose limiting the maximum resource MW additions in the 2-4 year 'Action Plan window'

- After, resource additions will be unconstrained by transmission

| Annual Resoure Constraints | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 |
|---|---|---|---|---|---|---|---|
| **Minimum Addition (MW)** | | | | | | | |
| New_LMS100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_SCCT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_CCCT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Recips | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Biomass | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Geothermal | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_PumpedHydro | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Wind_Ione | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Wind_Gorge | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Wind_WA | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Wind_MT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Solar | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_SolarPlusStorage | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Bat_2h | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Bat_4h | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Bat_6h | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Maximum Addition (MW)** | | | | | | | |
| New_LMS100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_SCCT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_CCCT | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Recips | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New_Biomass | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_Geothermal | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_PumpedHydro | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_Wind_Ione | 410 | 250 | 275 | 9999 | 9999 | 9999 | 9999 |
| New_Wind_Gorge | 580 | 612 | 650 | 9999 | 9999 | 9999 | 9999 |
| New_Wind_WA | 320 | 320 | 400 | 9999 | 9999 | 9999 | 9999 |
| New_Wind_MT | 200 | 450 | 450 | 9999 | 9999 | 9999 | 9999 |
| New_Solar | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_SolarPlusStorage | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_Bat_2h | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_Bat_4h | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| New_Bat_6h | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |

This will the current characteristics of the transmission system while not over-constraining resource additions given long-term uncertainties in the transmission system

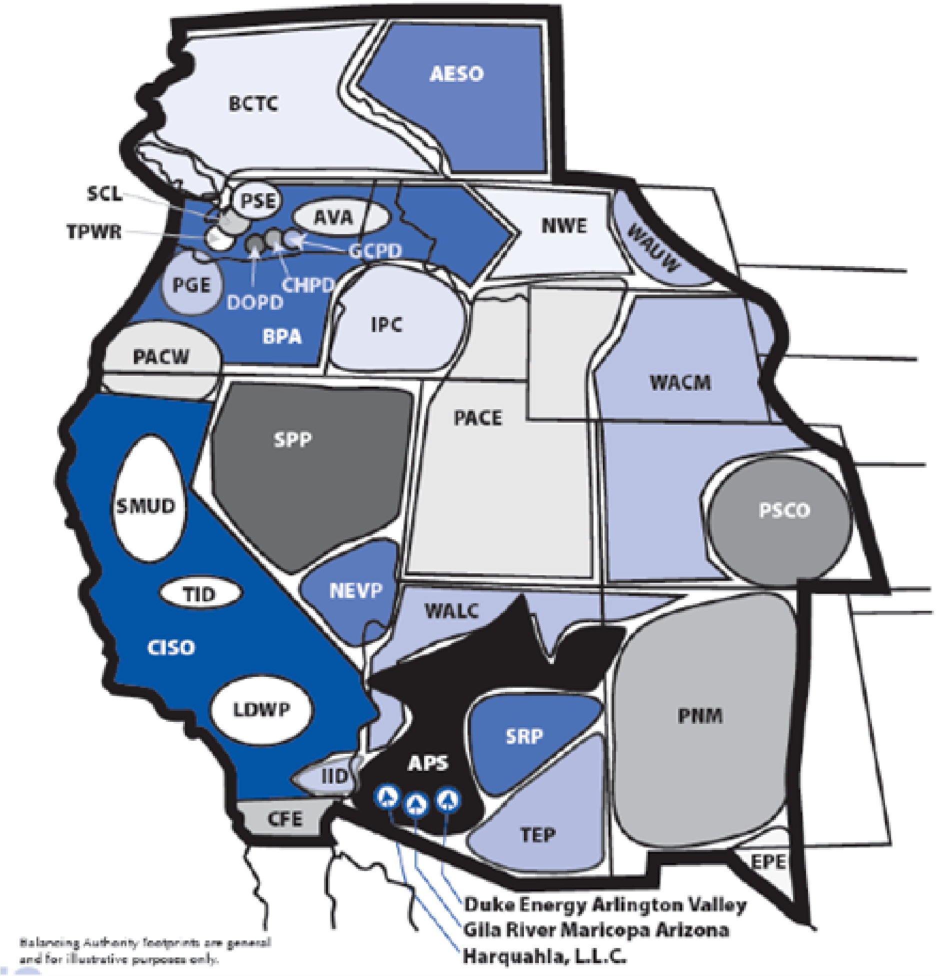
# Transmission in IRP

- Off-system resources generally rely on BPA transmission to bring energy to PGE's Balancing Authority (BA)
- While there are constraints in the system*, BPA has not moved forward with recently considered plans to expand transmission**

* Defined here as more capacity demanded than currently available

** Recent examples of improvements considered by BPA but not pursued include BPA's I-5 Project, Montana to Washington (M2W), and Garrison to Ashe

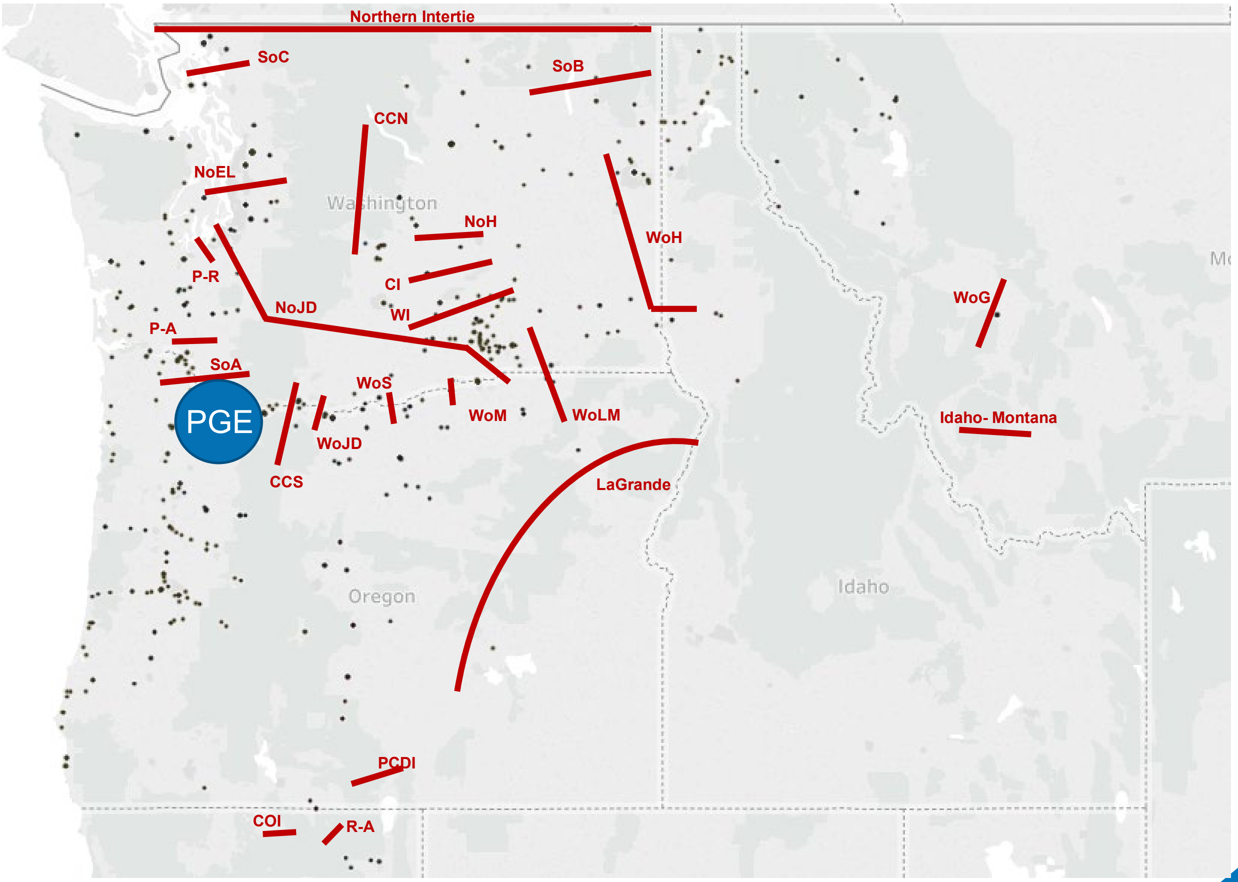
WECC Balancing Authorities



# BPA Transmission

- There are 261 substations on BPA's system
- Network paths are defined as the method energy moves between two substations
  - Each network path has a Source (where the generation will enter BPA's system) and a Sink (where the power will leave)
- BPA measures the impact (relative to current conditions) of additional capacity between source and sink over 14 network flowgates
- This impact is expressed as a Power Transfer Distribution Factor (PTDF), a percent of the total capacity added
  - This value can be negative – which is counted as no impact (rather than an increase in ATC)

## BPA network and intertie flowgates:




substations

# BPA Transmission

To calculate the impact of a transmission service request (TSR) over a specific network path, we need:

- **Source** (which substation the power will enter BPA's system)
- **Sink** (which substation the power will exit BPA's system)
- **Total MW demanded**

*Total flowgate impact (MW) =*
*(Source PTDF – Sink PTDF) * MW Demanded*

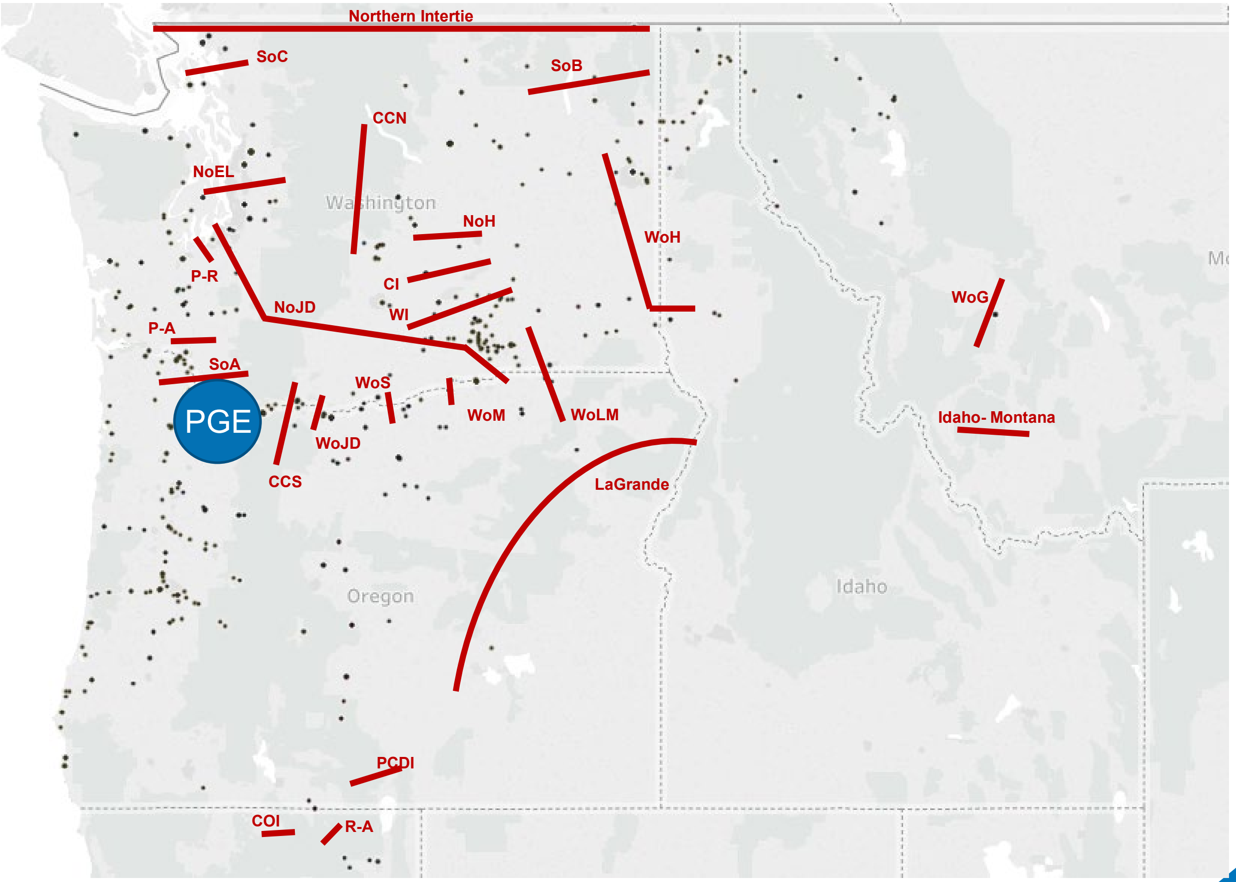
Generally, a TSR will only be granted if the impact on a flowgate is less than the associated ATC, for ***every*** impacted flowgate*

BPA also evaluates whether an impact can be considered "*de minimus*"

- If so, BPA can grant the TSR even without ATC

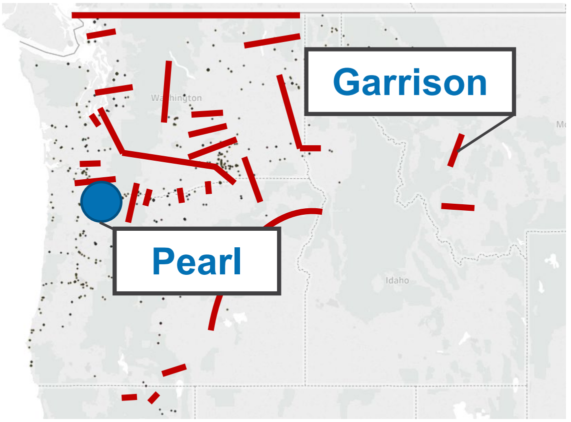
** Ignoring any subgrid impacts, which can be a reason for TSR denial*

## BPA network and intertie flowgates:




* *substations*

# Submitting a hypothetical TSR to BPA




100 MW of transmission capacity from Garrison230 to Pearl230

- Using BPA data, we can determine whether BPA will grant the request*

First, use BPA PTDF calculator** to determine individual flowgate impacts

Second, evaluate whether any impact is greater than the applicable ATC (LTF, LTF+CF, etc.)***

| Flowgate | Source: GARRISON230 | Sink: PEARL230 | Impact |
|---|---|---|---|
| CROSS CASCADES NORTH E>W | -0.1292 | -0.3214 | 19.22 |
| CROSS CASCADES SOUTH E>W | 0.033 | -0.6186 | 65.16 |
| NORTH OF HANFORD N>S | -0.3057 | -0.4758 | 17.01 |
| NORTH OF JOHN DAY N>S | -0.1004 | -0.7555 | 65.51 |
| PAUL TO ALLSTON N>S | -0.0467 | -0.2676 | 22.09 |
| RAVER TO PAUL N>S | -0.0375 | -0.2107 | 17.32 |
| SOUTH OF ALLSTON N>S | -0.0548 | -0.3096 | 25.48 |
| WEST OF JOHN DAY E>W | 0.0461 | -0.2028 | 24.89 |
| WEST OF SLATT E>W | -0.0022 | -0.1411 | 13.89 |
| WEST OF LOWER MONUMENTAL E>W | 0.2488 | -0.067 | 31.58 |
| SOUTH OF CUSTER N>S | 0.0703 | -0.0046 | 7.49** |
| NORTH OF ECHO LAKE S>N | -0.0223 | 0.0428 | 0* |
| WEST OF MCNARY E>W | 0.0417 | -0.1255 | 16.72 |
| WEST OF HATWAI E>W | 0.7985 | 0.0425 | 75.6 |

* No flowgate impact
** *De minimus*

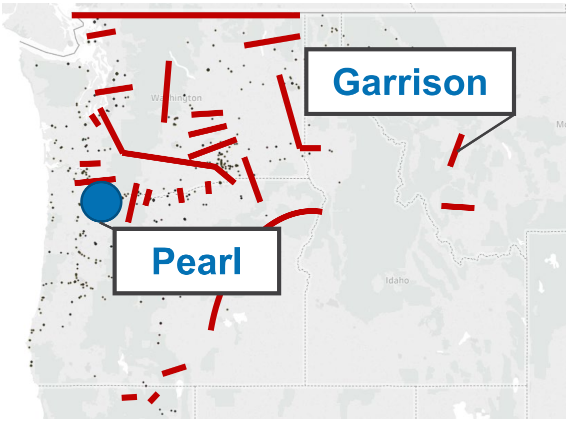
| LTF ATC - pending TSRs | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|
| South of Allston N>S | 0 | 0 | 0 | 0 | 0 | 0 |
| Cross Cascades North E>W | 0 | 0 | 0 | 0 | 0 | 0 |
| West of Lomo E>W | 500 | 893 | 903 | 913 | 645 | 655 |
| Cross Cascades South E>W | 420 | 0 | 0 | 0 | 0 | 0 |
| North of Hanford N>S | 447 | 1281 | 1257 | 1161 | 627 | 584 |
| North of John Day N>S | 356 | 1137 | 1106 | 1001 | 387 | 343 |
| Paul-Allston N>S | 524 | 702 | 673 | 643 | 609 | 585 |
| Raver-Paul N>S | 43 | 0 | 0 | 0 | 0 | 0 |
| West of McNary E>W | 345 | 2273 | 2292 | 2171 | 2110 | 2130 |
| West of Slatt E>W | 211 | 1537 | 1559 | 1548 | 1545 | 1564 |
| West of John Day E>W | 0 | 621 | 461 | 325 | 180 | 124 |
| South of Custer N>S | 0 | 202 | 205 | 207 | 210 | 212 |
| North of Echo Lake S>N | 0 | 36 | 0 | 0 | 0 | 0 |

For ***individual*** flowgates, the associated impact ***exceeds*** the flowgate's LTF ATC less pending TSRs:

- This TSR ***will not be granted****

* These calculations are only generally indicative of BPA's determinations
** Available here: https://www.bpa.gov/transmission/Reports/TransmissionAvailability/Documents/LT-Original-Calculator.xlsx
*** ATC: https://www.bpa.gov/transmission/Reports/TransmissionAvailability/Documents/long_term_atc.xlsx
ATC minus pending TSRs: https://www.bpa.gov/transmission/Reports/TransmissionAvailability/Documents/atc_less_pending.xlsx

# Submitting a hypothetical TSR to BPA




100 MW of transmission capacity from Garrison230 to Pearl230

- Using BPA data, we can determine whether BPA will grant the request*

First, use BPA PTDF calculator** to determine individual flowgate impacts

Second, evaluate whether any impact is greater than the applicable ATC (LTF, LTF+CF, etc.)***

| Flowgate | Source: GARRISON230 | Sink: PEARL230 | Impact |
|---|---|---|---|
| CROSS CASCADES NORTH E>W | -0.1292 | -0.3214 | 19.22 |
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| WEST OF HATWAI E>W | 0.7985 | 0.0425 | 75.6 |

* No flowgate impact
** *De minimus*

| LTF+CF ATC | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|
| South of Allston N>S | 208 | 211 | 211 | 211 | 211 | 211 |
| Cross Cascades North E>W | 1815 | 1815 | 1815 | 1815 | 1815 | 1815 |
| West of Lomo E>W | 814 | 814 | 814 | 814 | 814 | 814 |
| Cross Cascades South E>W | 1849 | 1849 | 1849 | 1849 | 1849 | 1849 |
| North of Hanford N>S | 1453 | 1453 | 1453 | 1453 | 1453 | 1453 |
| North of John Day N>S | 1036 | 1036 | 1036 | 1036 | 1036 | 1036 |
| Paul-Allston N>S | 678 | 678 | 678 | 678 | 678 | 678 |
| Raver-Paul N>S | 355 | 355 | 355 | 355 | 355 | 355 |
| West of McNary E>W | 1446 | 1446 | 1446 | 1446 | 1446 | 1446 |
| West of Slatt E>W | 1644 | 1644 | 1644 | 1644 | 1644 | 1644 |
| West of John Day E>W | 1762 | 1762 | 1762 | 1762 | 1762 | 1762 |
| South of Custer N>S | 993 | 993 | 993 | 993 | 993 | 993 |
| North of Echo Lake S>N | 0 | 0 | 0 | 0 | 0 | 0 |

For ***every*** flowgate, the associate impact ***does not exceed*** LTF ATC less pending TSRs + CF:

- This TSR ***will be granted****

* These calculations are only generally indicative of BPA's determinations
** Available here: https://www.bpa.gov/transmission/Reports/TransmissionAvailability/Documents/LT-Original-Calculator.xlsx
*** ATC: https://www.bpa.gov/transmission/Reports/TransmissionAvailability/Documents/long_term_atc.xlsx
ATC minus pending TSRs: https://www.bpa.gov/transmission/Reports/TransmissionAvailability/Documents/atc_less_pending.xlsx

# Modeling Transmission Capacity per Pathway

Define “***Passable Impact***” as the largest TSR that would generally be granted by BPA based on posted ATC*

- Can be calculated for each source/sink/year permutation in two steps:

1. Determine the total *Passable Impact* for each flowgate:

*(Source PTDF – Sink PTDF) * MW Demanded = Total flowgate impact (MW)*

Redefine and rearrange*:*

***Total Passible Impact (MW)*** *=Total* ***available*** *flowgate impact (MW) / (Source PTDF – Sink PTDF)*

2. Calculate the total *Passible Impact* for each flowgate on path:

- Take the smallest *Passible Impact* among all flowgates
  - Example: Total *Passible Impact* for pathway in 2020 = 10 MW

| Total Passable Impact (hypothetical) | 2020 |
|---|---|
| South of Allston N>S | 528 |
| Cross Cascades North E>W | 623 |
| West of Lomo E>W | 42 |
| Cross Cascades South E>W | 345 |
| North of Hanford N>S | 756 |
| North of John Day N>S | 8345 |
| Paul-Allston N>S | 10 |
| Raver-Paul N>S | 355 |
| West of McNary E>W | 24 |
| West of Slatt E>W | 263 |
| West of John Day E>W | 34 |
| South of Custer N>S | 993 |
| North of Echo Lake S>N | 500 |



* *Assuming no subgrid or other complications*

# Modeling Transmission Capacity per Pathway

- Even if there is no ATC posted on a given flowgate, capacity can be granted if the impact is considered "*de minimus*".* There are two conditions:
  1. The total impact on the flowgate must be less than 10 MW
  2. The impact on the flowgate must be less than 10%. Binary test, 1 if true 0 otherwise *[.1 > (Source PTDF – Sink PTDF)]*

- Define "**Total *de minimus* MW**" as the maximum qualifying request that can be considered *de minimus* over an individual flowgate. *Calculate as:*

*Total* de minimus *MW = [9.99999 / (Source PTDF – Sink PTDF)] * (1 or 0 from condition #2 test)*

- Similar to before, the smallest flowgate value is the total MW available over a specific path

- The larger of the **Total Passible Impact** and **Total *de minimus* MW** can be modeled as the total MW capacity over each pathway each year.

- Additional adjustment for capacity beyond what is listed on BPA's website
  - Third parties in the market hold some quantity of transmission capacity

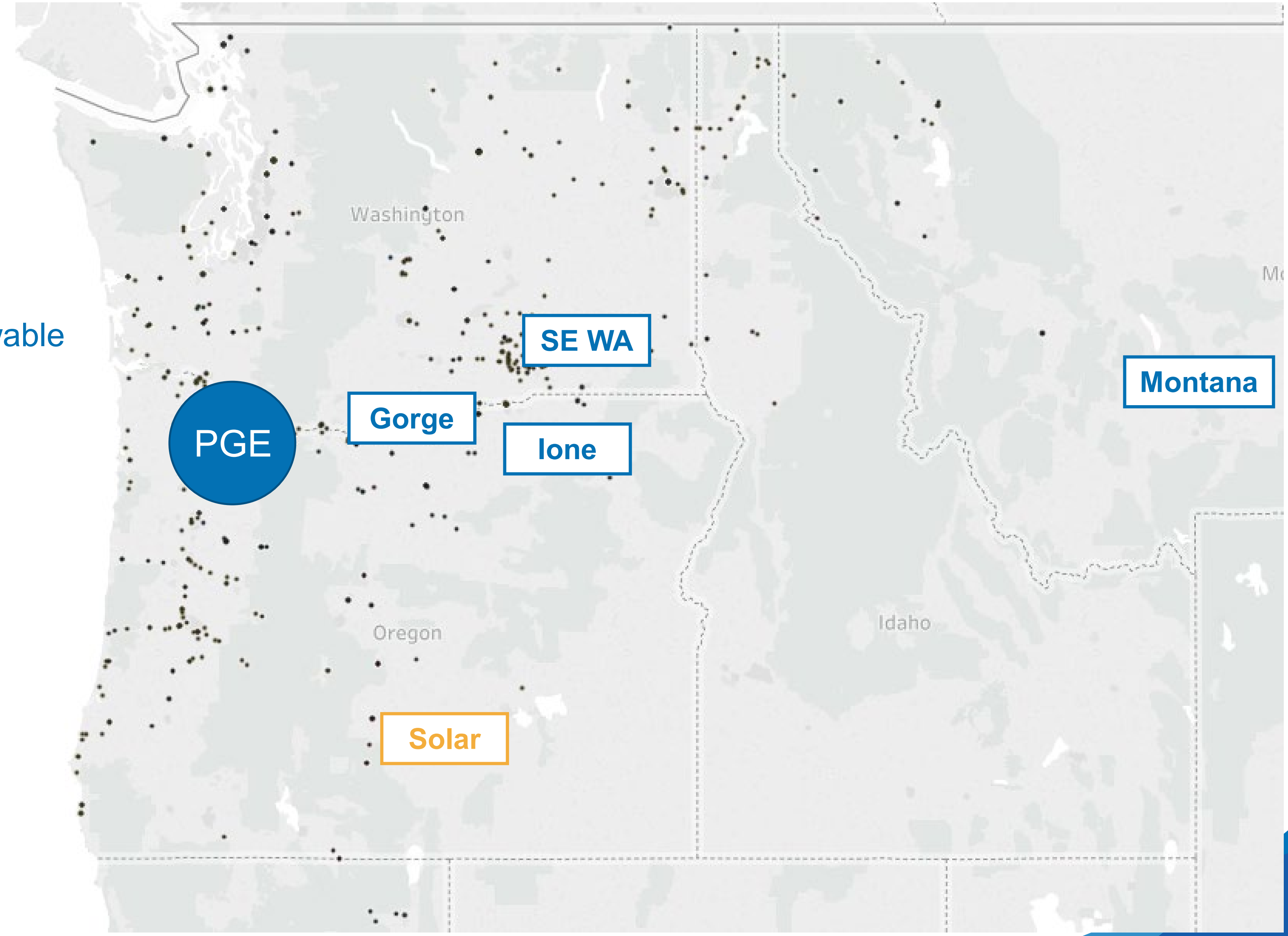


** For more detail:* https://www.bpa.gov/transmission/Doing%20Business/ATCMethodology/Documents/ATCID.pdf

# Determining Resource Zones

The 2019 IRP evaluated proxy renewable resources from specific locations:

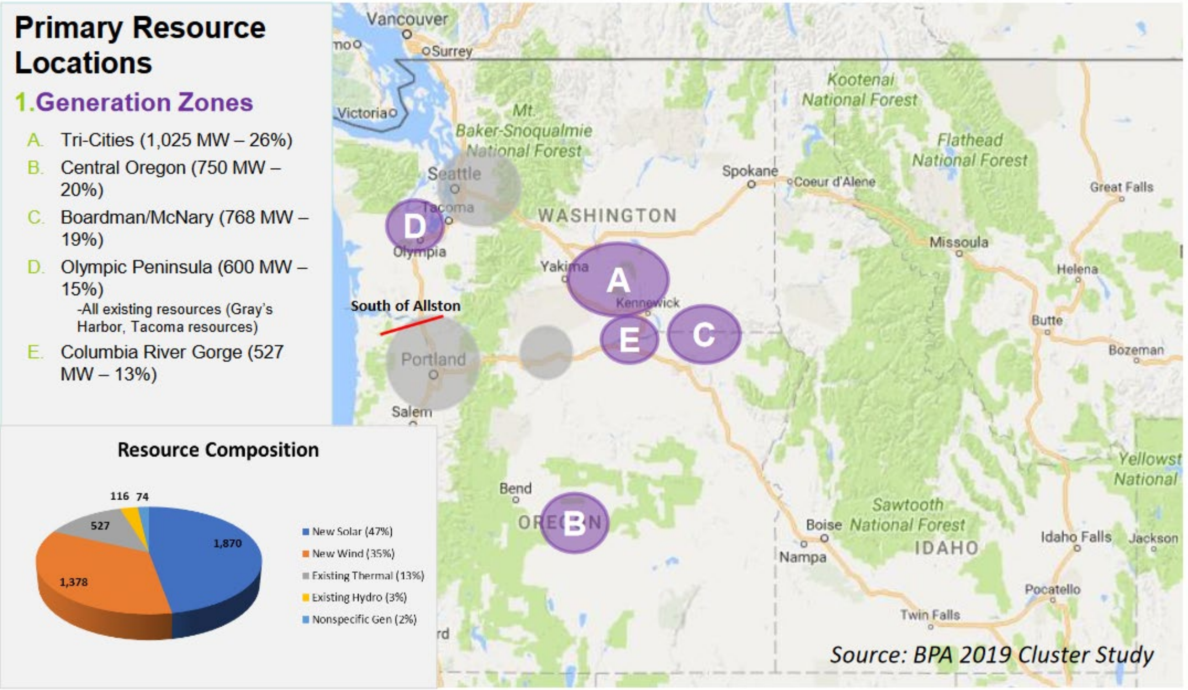
- Gorge Wind: Columbia Gorge, OR
- Ione Wind: Ione, OR
- SE WA: Columbia County, WA
- Montana Wind: Loco Mountain, MT
- Solar: Christmas Valley, OR



# Determining Resource Zones

- The 2016 and 2019 IRPs used multiple wind locations to evaluate the benefits associated with different generation timing and intensity portfolios
  - Varying capacity factors, coincidence with peak, etc.
- How should PGE determine resource zones in the next IRP?
  - Ideally capture the geographic similarities in resource generation while reflecting transmission realities of that region
- Possible options:
  - Use geographic distance to 2019 IRP resource locations
  - Use general BPA areas depicted to the right
  - Others?

BPA found geographical similarities in requests to PGE's system in 2018:



# IRP Transmission Workflow

- **BPA ATC Data** — *Acquire BPA substation-substation PTDF data*
- **Substation Calculation** — *Determine total Passible Impact from each substation to PGE*
- **Resource Zone Aggregation** — *Aggregate substation Passible Impact to resource zones*
- **Interim Transmission Solution Parameters** — *Increase totals given ITS characteristics*
- **Extra-Market Capacity Assumption** — *Increase totals given assumption about what is held outside of BPA data*
- **Total MW Capacity per Zone**

| Hypothetical Scenario | |
|---|---|
| **Inputs** | **Outputs** |
| All substations have a PTDF of .8 on the most constrained flowgate | - |
| Each substation has 25 MW LTF and 25 MW CF ATC to PGE, no *de minimus* option | (25+25) / .8 = 62.5 MW / substation |
| Specific resource zone has 5 relevant substations | 62.5 * 5 = 312.5 MW |
| Allow the use of CF, projects are only required to have 80% of nameplate | 312.5 / .8 = 390.6 MW |
| There is an extra 5% capacity not listed in BPA's data | 390.6 * 1.05 = 410.2 MW |
| Total amount available of specific resources in the given year | 410.2 MW |

# Incorporating transmission into IRP

Several important questions remain

- Which sources of data should be used?
- How should we determine resource zones?
- How should we select the substations associated with each resource zone?
- How to determine total amount of ATC from each resource zone?
- How much ATC should be modeled after what is posted?
- Is it appropriate to limit the Action Plan additions but not longer-term expansion paths?
- Anything else?

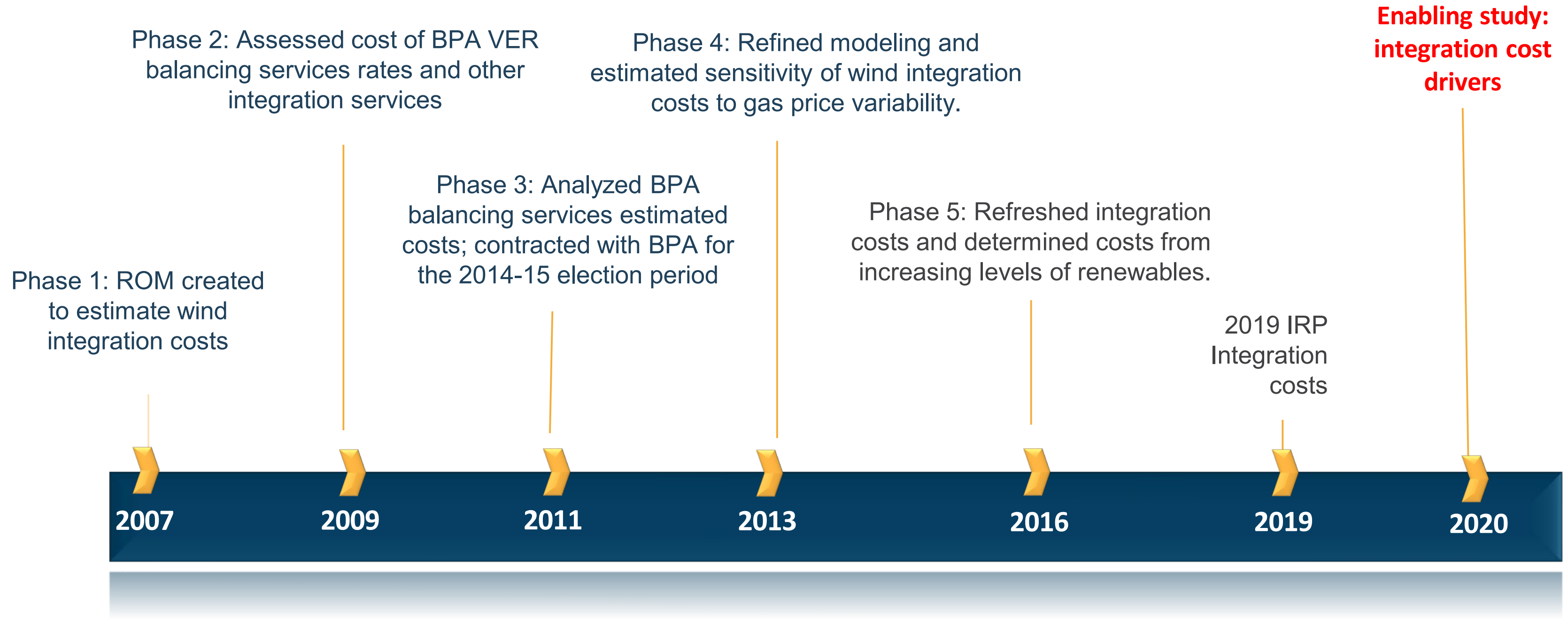
# Integration Cost Drivers Enabling Study

Nora Xu

# VER Integration Costs

- Past IRPs included estimates of the cost associated with integrating new renewable resources into the PGE system
- Simulated system dispatch and costs in the Resource Optimization Model (ROM)
- Post-2019 IRP – plan for integration cost study investigating main driving components behind the solar integration cost

## VER integration cost analysis using ROM



# 2019 IRP VER Integration Costs

- Integration costs in the 2019 IRP were estimated for three wind regions and one solar region for a 2025 test year
  - 100 MWa of each renewable resource added to the system

| | Renewable Integration Cost (2020$/MWh) |
|---|---|
| Gorge Wind | 0.33 |
| Ione Wind | 0.33 |
| MT Wind | 0.07 |
| WA Wind | 0.31 |
| Central OR Solar | 1.36 |

- Current ROM version and methodology underwent public review and an external Technical Review Committee in 2016 IRP
- Integration cost for each new renewable resource addition is calculated as follows:

  [(System cost with integration of new renewables) – (System cost without integration of new renewables)] / (Renewable energy addition)

PGE

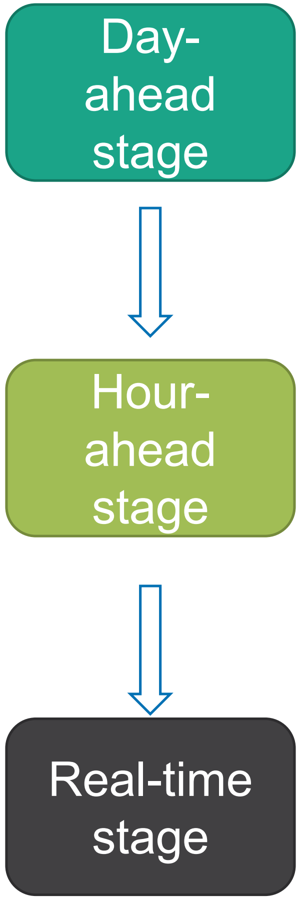
# Compare to 2016 IRP VER Integration Costs

- Integration costs in the 2016 IRP were estimated for one wind region and one solar region for a 2021 test year
  - Run 2. PGE self-integrates existing VERs (Biglow Canyon and Tucannon River)
  - Run 3. PGE self-integrates existing VERs and additional 318 MW (111 Mwa) Gorge resource
  - Run 4. PGE self-integrates existing VERs, additional 318 MW (111 Mwa) Gorge resource and 135 MW (30 MWa) central Oregon solar resource

| Scenario | VER Capacity (MW) | VER Energy (GWh) | Integration Cost ($/MWh) |
|---|---|---|---|
| Run 2 | 717 | 1,973 | $0.99 |
| Run 3 | 1035 | 2,947 | $0.91 |
| Run 4 | 1160 | 3,210 | $0.92 |

# Resource Optimization Model (ROM)

- What is ROM?
  - Mixed integer programming optimal commitment and dispatch model
  - Multi-stage: DA (hourly), HA (15-min), RT (15-min)
  - Includes generator representations, fuel constraints, market availability, regulation and load following reserve requirements
- What resources can be represented in ROM?
  - Current PGE generation portfolio
  - Potential new additions (thermal, storage, renewables)
- ROM does not model capital costs, revenue requirement modeling, loss of load expectation



# ROM Stage Descriptions

| | DA Scheduling Stage | HA Scheduling Stage | RT Scheduling Stage |
|---|---|---|---|
| Granularity | Hourly | 15 minute | 15 minute |
| Load | DA forecast | HA forecast | RT actuals |
| Renewables | DA forecast | Persistence forecast | RT actuals |
| Reserves | Load following up and down, regulation up and down for load and renewables | Load following up and down, regulation up and down, imbalance up and down for load and renewables | Load following up and down, regulation up and down for load and renewables |
| Commitment | Decisions made | DA stage decision | DA stage decision |

# 2019 IRP VER Integration Costs

- 2019 IRP inputs for year 2025 summarized below:

| Input | Comments |
|---|---|
| Time frame | Updated to 2025 |
| Existing contracts | Updated |
| Gas prices | Reference |
| Carbon prices | Reference |
| Electricity prices | Reference (RRRR) |
| Load | Updated to 2025, average year |
| VER generation | Updated to 2025, average year |
| Reserves | Load following, regulation, spin, non-spin |
| Capacity Availability | Day-ahead, block capacity that is more expensive than existing system generation available depending on study |
| Market Availability | Unconstrained |

# Enabling Study: Integration Cost Drivers
# Proposed Study Methodology

## Proposed categories of investigation

| Forecast error | Variability | Renewable generation levels | Reserves |
|---|---|---|---|
| Test bookend of removing imbalance reserves | Test effects of reductions in subhourly, hourly variability | Test impact of lower generation levels | Review reserve calculations |

## Proposed Exploratory and Bookend Scenarios

1. Smaller solar resource addition (25 aMW)
2. Hold fewer reserves for VER forecast error
3. Remove solar resource's sub-hourly variability
4. Additional requests to consider?

# Enabling Study: Integration Cost Drivers

Comments? Suggestions? Questions?

# QUESTIONS/ DISCUSSION?

# Climate Adaptation Enabling Study

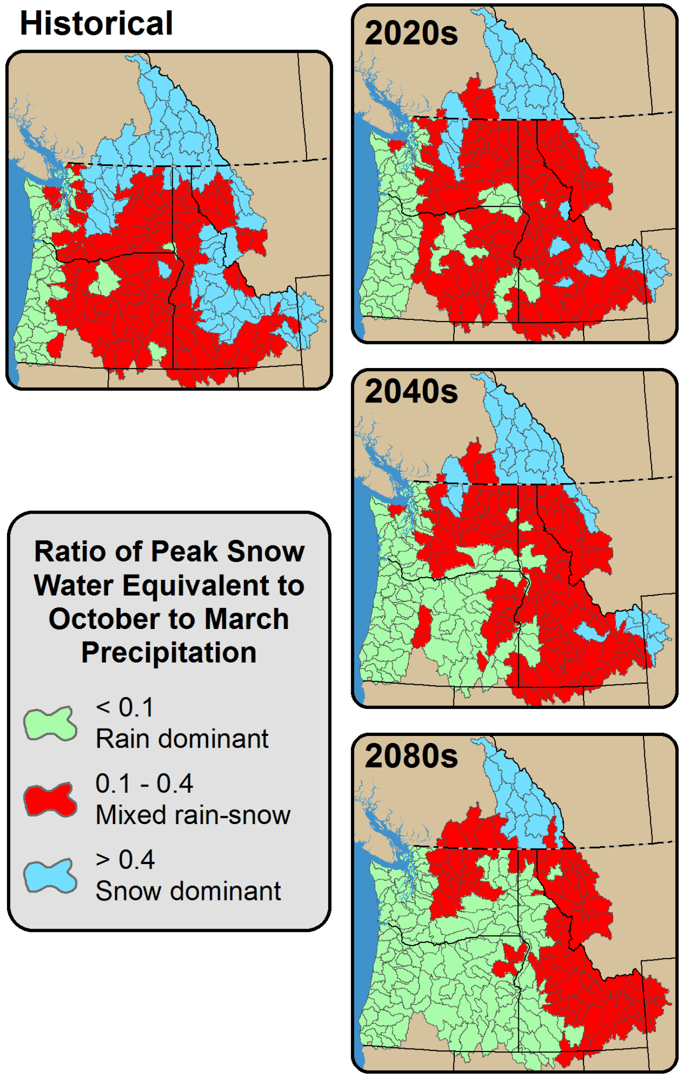
Elaine Hart

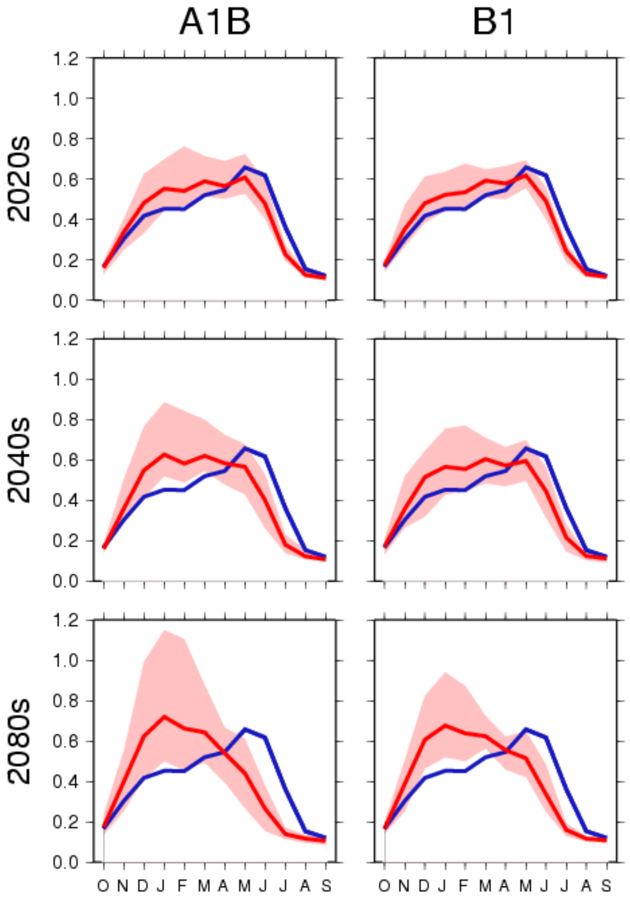
# Prior Work – 2015 Climate Study

**Study conducted by the Oregon Climate Change Research Institute, Oregon State University**

**Scope:**

- Regional impacts to weather drivers, including temperature and precipitation and potential impacts to streamflows.
- High level discussion of potential impacts to other factors including cloud cover, wind speeds, wildfire risk
- The 2015 Climate Study did not go as far as to estimate specific impacts to PGE loads and resources nor to investigate climate adaptation options



# What's next?

## PGE plans to engage an external consultant to support the Climate Adaption Study

At this stage, we welcome feedback on the scope of the study. Potential items in scope:

- Research best practices?
- Quantify potential impacts to customer loads?
- Quantify potential impacts to assets?
    - Reliability risk?
    - Hydro resource availability?
    - Variable resource availability?
    - Others?
- Engage in climate resilience planning?
    - Consider actions to improve the resilience of PGE's system to climate change-related circumstances?

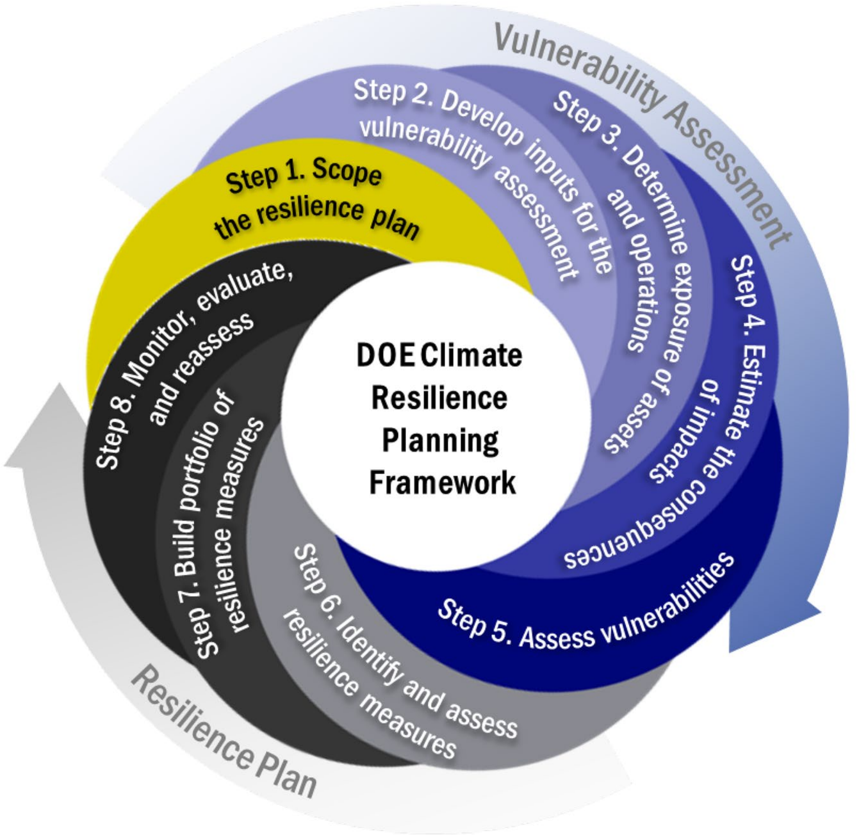



**Figure ES.1**. Steps for conducting a vulnerability assessment and developing climate resilience solutions

US DOE, "Climate Change and the Electricity Sector: Guide for Climate Change Resilience Planning," 2016.

# QUESTIONS/ DISCUSSION?

# THANK YOU

Contact us at:

IRP@pgn.com

Next Roundtable: April 30, 2020