Western Power Pool 20-Year Low Carbon Study

November 23, 2022

Objective

The 20-year (2042) low carbon study ("Study") is effort by a group of transmission owners and transmission planners operating in eight western U.S. states to evaluate issues of common interest, which can best be studied jointly. The objective of the Study is to identify whether long-term transmission constraints exist under low carbon resource requirements. If constraints exist, the Study will identify solutions that may be implemented over the 20-year planning horizon.

The participants initiated this Study as a way to facilitate joint sharing of information, development of common scopes, assumptions, data and methodology for a long-term 20-year planning horizon. The Study aims to increase the efficiency of the planning process in addressing longer-term outlook transmission requirements and communicate to impacted utility planners and regional stakeholders any identified concerns and potential solutions.

Relationship to Other Study Efforts

The purpose of the Study is to evaluate specific conditions and scenarios that are not otherwise already studied through other coordinated efforts. While the participants may freely utilize the Study results to inform other planning analyses, the Study is not intended to fulfill or replace any other transmission planning or resource planning requirements. Specifically, this Study will not address the full suite of NERC TPL-001-4 / TPL-001-5 requirements and Study results are provided in addition to, but not replacing, the participants' FERC Order 890 and 1000 regional planning requirements and NorthernGrid Enrolled Party tariffs. This Study in no way obligates NorthernGrid members to perform future studies as described in this Study scope document.

This Study is not a resource adequacy or economic congestion study. While a goal of the Study is to provide a long-term conceptual plan for the 20-year future and additional context around transmission and resource issues arising in the long-term planning horizon, the Study is informational in nature only, will likely identify open-ended solutions that require additional future evaluation, and will not result in a regional transmission, local transmission, action, or construction plan.

Study Participants

The Study Participants are Avista, Bonneville Power Administration, Chelan PUD, Idaho Power, NorthWestern Energy, NV Energy, PacifiCorp, Portland General Electric, Puget Sound Energy, Seattle City Light, Snohomish PUD and Tacoma Power. **Figure 1** shows a map of the Study participant footprint.

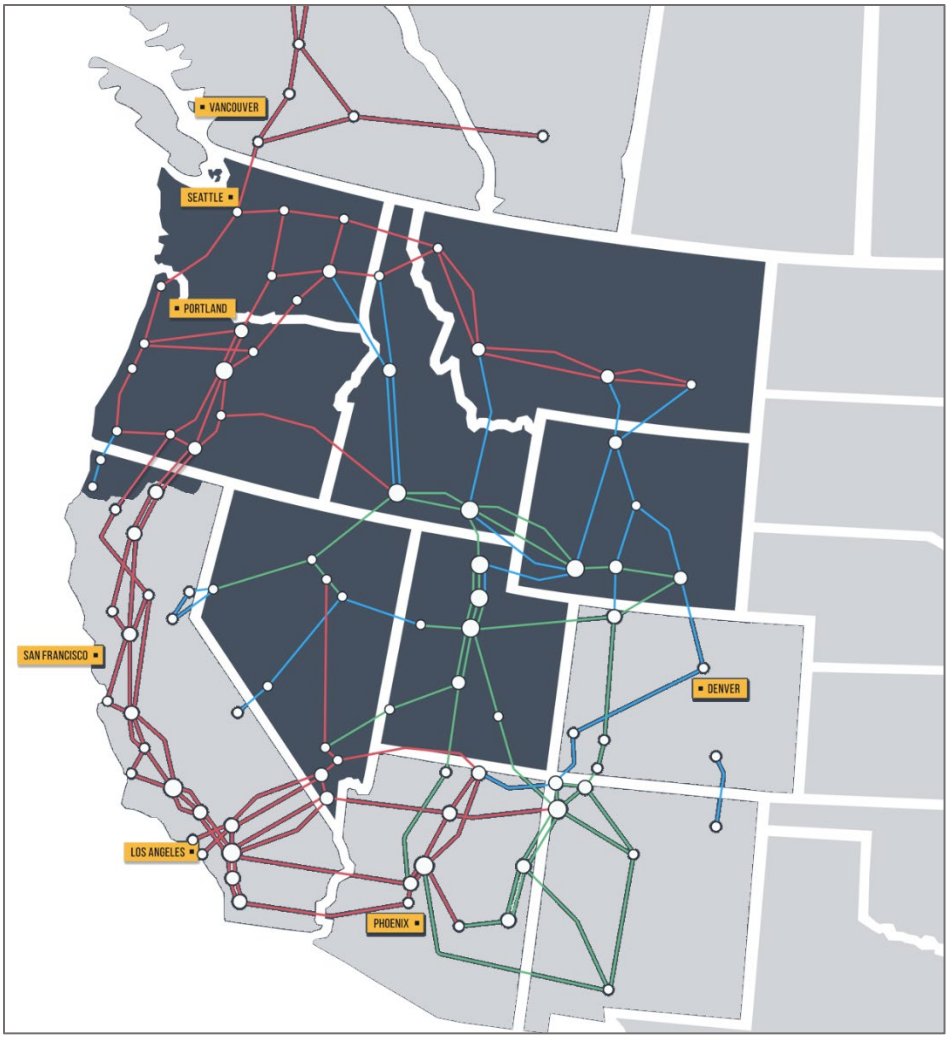

Figure 1: Study Participant Footprint

Stakeholder Participation

Study participants seek to engage state utility commissions, neighboring utilities and other stakeholders in scope development, assumptions, draft results and proposed solutions through multiple workshops. The goal of stakeholder participation is to help focus, inform and enhance the Study. Four primary workshops have been identified, but additional workshops or requests for stakeholder input may be needed as study work progresses:

1. Initial study scope development
2. Top-down review of bottom-up study inputs to help align and describe study assumptions
3. Initial study results and solutions
4. Draft final study results and reporting

Meetings will be formally noticed and posted on the Western Power Pool's Transmission Planning Committee Special Studies website: https://www.westernpowerpool.org/about/programs/tpc-studies.

Study Horizon

The Study will encompass a twenty-year horizon to include expected clean energy public policy requirements and expected public policy driven electrification of carbon emitting sectors such as, water and space heating along with transportation. Load forecasting assumptions will include any known or expected customer preference assumptions (e.g. electric ferries, buses, aviation). The Study will also incorporate best estimates of demand side management, time of use pricing and smart charging that are anticipated to be implemented.

Existing Data Analysis

Relevant reports from members Integrated Resource Plans (IRP), WECC, Northwest Power and Conservation Council, neighboring regions national labs, states, WIRED and others will be analyzed to create a range of expected load, resources, and fuel prices prior to modeling and simulation. The Study will seek to balance historical data and forecasts from these multiple data sets to derive a common set of study assumptions. All data used will be the latest available as of November 1, 2022.

Data sources for historic and forecasted loads and resources may include all or some of the following:

- Production Cost Model (PCM) data for high coincidence conditions
- SCADA, PI-historian and other historical data records from participants
- Northwest Power and Conservation Council 2021 Power Plan
- Bureau of Reclamation RMJOC climate scenarios
- Temperature data from NOAA and other national weather data sources
- U.S. Department of Energy National Transmission Planning Study
- Pacific Northwest National Labs and Oregon Department of Energy Off-shore Wind Studies

Based on the common set of assumptions WPP will request and combine detailed load and resource forecasts, planned projects and associated data from participants. WPP will work with participant representatives to support their organization supplementing data as needed, including providing references on assumptions used in other participant 20-year forecasts if the participant does not already have 20-year data available.

Adjustments may need to be made to existing IRP derived forecasts to model a lower carbon assumption based on expected public policy considerations. Emissions prices and availability of carbon emitting resources will be developed based on expected public policies.

Study Methods and Tools

PCM software will be used to generate a future resource dispatch and power flow analysis will be deployed to assess the system reliability for the future resource dispatch and loading scenarios. The primary tools used for the analysis are Hitachi Gridview PCM and PowerWorld Simulator power flow analysis software. WECC approved PCM and power flow cases will be used as the basis for the analysis. WECC is also currently developing a 2040 model for both PCM and power flow, but the case is not anticipated to be complete within the Study timelines. Accordingly, assumptions for the WECC 2040 model and the Study models will be coordinated with WECC staff and stakeholders in an effort to improve the quality of both the WECC model and this Study.

Transmission Topology and Planned Transmission Projects

Transmission projects with a need identified in a Regional Transmission Plan and projects already under construction as of November 1, 2022 will be considered in-service and included in the 20-year study base case. Existing planned or proposed transmission projects not in a Regional Transmission Plan or already under construction and with in-service dates prior to 2042 will be evaluated for inclusion or exclusion from the initial case by the utility or utilities most impacted by the project. No preference will be given to incumbent or independent projects. If planned projects are modeled as not being in-service initially, the Study may evaluate the ability to bring such projects online if the Study shows a need. Known projects from neighboring utilities outside of the Study footprint will be similarly evaluated. Projects with in-service dates of 2042 or later will be initially offline or removed from cases and evaluated as potential mitigation.

The study will use the WECC 2032 Anchor Data Set (ADS) as a primary data source for development of the 20-year models. Any path rating changes included in the 2032 ADS will be used in the study. For newly identified WECC Major Path modifications, the WECC Path Rating Process requires detailed studies to identify and confirm ratings. As a result the study may need to estimate future path ratings changes and document the assumptions for those ratings estimates.

Load Forecast Assumptions

The twenty-year load forecast will be derived from the member IRPs as well as IRPs from neighboring entities. Participating members will review their IRP forecasts, update as needed and provide a list of key assumptions used in those forecasts such as climate assumptions, system stress and exceedance probability used in the forecast. These “bottom-up” inputs will be consolidated and then a Stakeholder Workshop will be held to provide a “top-down” discussion to help define and align assumptions while documenting uncertainties in those assumptions.

Scenarios, both high and low, will consider state and national lab reports which forecast the electrification of other carbon emitting sectors. Battery and pumped storage (hydrologic, compressed air, etc.) charging profiles will be generated from national lab reports and PCM simulation where charging will be adjusted to non-ramping and off-peak conditions along with consideration of establishing a full charge for ramp periods.

Forecasts for customer-driven and industrial loads, non-participating Load Serving Entities and utilities outside the footprint will be based on the best available data but may be less certain for the 20-year horizon.

Resource Additions, Retirements and Placement

Future resource assumptions will be gathered from IRPs and the amount or capacity will be adjusted if the expected loss of load exceeds industry established goals. Participant IRP preferred portfolio resources, including resource additions and retirements, will be evaluated for inclusion or exclusion from the initial case by each respective participant. The assumed initial case resources will be documented in the Study report. Future resources without specific siting locations in IRPs will be located in the model based on input from the respective utility using geographic zones, knowledge of existing transmission system topology and commercial interest reflected in member interconnection queues. Any such model assumptions used in the Study will not be indicative of preferred siting, ease of interconnection or feasibility of interconnection.

Any planned generation facility retirements or modifications included in utility IRPs by 2042 will be included in the Study. If the Study identifies system constraints resulting from these planned generation

facility retirements or modifications, the constraints will be documented and potential mitigation options identified.

Batteries and other energy storage solutions will be collocated with renewable resources and at other locations as identified in member IRPs. Battery and pumped storage dispatch will be determined from the PCM and may need to consider model improvements or augmentation to account for future long-term storage charging and discharging capabilities.

Resource Dispatch and Area Interchange Assumptions

The Study will utilize the latest available hydraulic Hydsim and HOSS models and results of Bonneville Power Administration Environmental Impact Statement assessments to supplement and replace PCM hydro assumptions. These supplemental hydro assumptions may also need to consider river flow modeling based on USBR RMJOC climate scenarios and the work done in the Northwest Power and Conservation Council 2021 Power Plan.

The Study will also consider appropriate interchanges with California and British Columbia based on long-term historic data and entitlement requirements. This may include reduced exports in line with historic peak conditions and any expected changes due to continued energy policy needs. The area interchange assumptions and adjustments made to areas external to the Study footprint will be documented in the Study.

While this is not a resource adequacy study, the Study will seek to identify transmission constraints driven by resource availability internal to the Study footprint. Any potential need for increased reliance on neighboring systems will be documented and mitigation options internal to the Study footprint will be identified as alternatives to this increased reliance. While this Study is regionally focused, it is anticipated that interregional coordination will be an integral part of the long-term planning process going forward. The Study will seek to identify where future interchange capability deficiencies may exist but anticipates the evaluation of feasibility and cost of increasing use of interchange between neighboring regions and expanding interregional connections will require additional study efforts beyond the scope of this Study.

The Study will develop assumptions for emissions pricing and hurdle rates at borders for use in PCM using any available materials and literature. If during the literature review, the Study is unable to establish an adequate basis for these assumptions, additional workshops with resource planners and industry stakeholders may be utilized to develop assumptions around barriers and pricing within the bilateral markets in the study footprint to model decarbonization policies.

Low Carbon Public Policy and Customer Preference Assumptions

The Study will incorporate Public Policy requirements and goals such as Washington CETA and Oregon HB 2021, along with individual utility IRP goals and Load & Resource Forecasts, to represent a low carbon future for 2042. As a result of the combined requirements and goals, it is anticipated that electrification of vehicles and heating sources will have a significant impact on load profiles and distribution, as well as changing the coincidence of load peaks across the wider system. The assumptions used in the Study will also incorporate increased inverter-based resource interconnections, distributed energy resources, energy efficiency and demand-side management.

Performance Criteria

The power flow simulations will be monitored for compliance with the North American Electric Reliability Corporation (NERC) Reliability Standard TPL-001-4, WECC Criterion TPL-001-WECC-CRT-

3.2 and TOP specific standards. The Reliability Standard requires transmission facilities to operate within normal and emergency limits. Then the criterion further defines the default base planning criteria for steady-state, post-contingency, transient dip, and recovery voltage along with oscillation dampening. The WECC criteria also allow for transmission planners to apply a more or less stringent criterion for their own system provided they gain agreement or allowance, respectively as described in the criterion.

Any unserved load in an all lines in service optimized PCM simulation should be closely scrutinized as an indicator that the modeled system was insufficient for that scenario.

Scenarios and Identification of Transmission and Resource Mitigations and Solutions

The Study will seek to identify reliability deficiencies during peak summer, peak winter and light load conditions as well as congestion magnitude and duration through the full year 2042 load and resource profile. Due to the large geographic footprint of the Study with participants covering portions of eight western states, the power flow scenarios will be selected to include stressed path conditions such as heavy exports from Oregon and Nevada into California during peak load conditions and moderate to high exports from California during off-peak conditions. These power flow case conditions will be developed from the PCM data set.

The participants will propose transmission and resource solutions to resolve reliability issues, transmission congestion and transmission availability constraints. These solutions are not intended to be bound by existing planned projects or individual utility IRP preferred portfolios and may identify new projects and/or resource locations with the potential to optimize benefits of resource additions, transmission utilization and expansion in a more cost-effective manner when looking at the larger Study footprint.

Mitigations available by 2042 may include, but are not limited to, transmission to reinforce areas and corridors with identified congestion; transmission to facilitate integration of new resource development areas with the bulk power system; grid-enhancing technologies to enhance flow control and system performance; and transmission to increase the load serving capability of areas with increased load serving requirements. Additionally, demand response and increased integration of distribution-connected distributed energy resources with transmission-level operations may be considered as mitigation options.

Where information is available, emerging technologies will be considered as possible mitigations while noting where uncertainties may need resolution prior to implementation in long-term plans.

The Study may also identify planned resource retirements or modifications that could result in reliability issues during the evaluated conditions. Additionally, the ability to charge energy storage solutions will be evaluated to determine if the transmission system is adequate to both deliver power during peak times and supply storage resources during other hours.

Consideration may be given to external factors such as minimizing environmental impact and maximizing resiliency. These factors will be considered by the Study participants and clearly documented for stakeholder input. Possible examples include optimizing use of existing transmission corridors to reduce environmental impact and considering geographic diversity of solutions to increase resiliency to earthquakes, wildfire and extreme weather events.

The proposed mitigations and solutions will be evaluated in the power flow and production cost model scenarios for effectiveness and limitations. Stakeholder input will be sought on the proposed solutions and used to form the Study results and reporting. The Study results will be informational in nature only and will not constitute a regional transmission plan, resource plan, local transmission plan or other action or construction plan.

Major Study Milestones

The Study will focus first on evaluation of the extreme heat and extreme cold scenarios and will use the results of those analyses to inform the model assumptions of the wildfire scenario.

Scoping

- Initial Stakeholder Engagement Workshop: September 23, 2022
- Draft Scope: October 7, 2022
- Stakeholder Scoping Workshop: October 25, 2022
- Finalize Study Scope: November 8, 2022

Analysis

- Begin Gathering Data Inputs and Scenario Assumptions: December 2022
- Initial PCM Case Development: January 2023
- Power Flow Case Development: February 2023
- Initial Results: April 2023
- Develop Initial Mitigation Solutions: May 2023
- Stakeholder Workshop on Initial Results and Proposed Solutions: June 2023
- Analysis with Proposed Solutions: August 2023
- Draft Final Results and Report Workshop: September 2023
- Final Report: October 2023