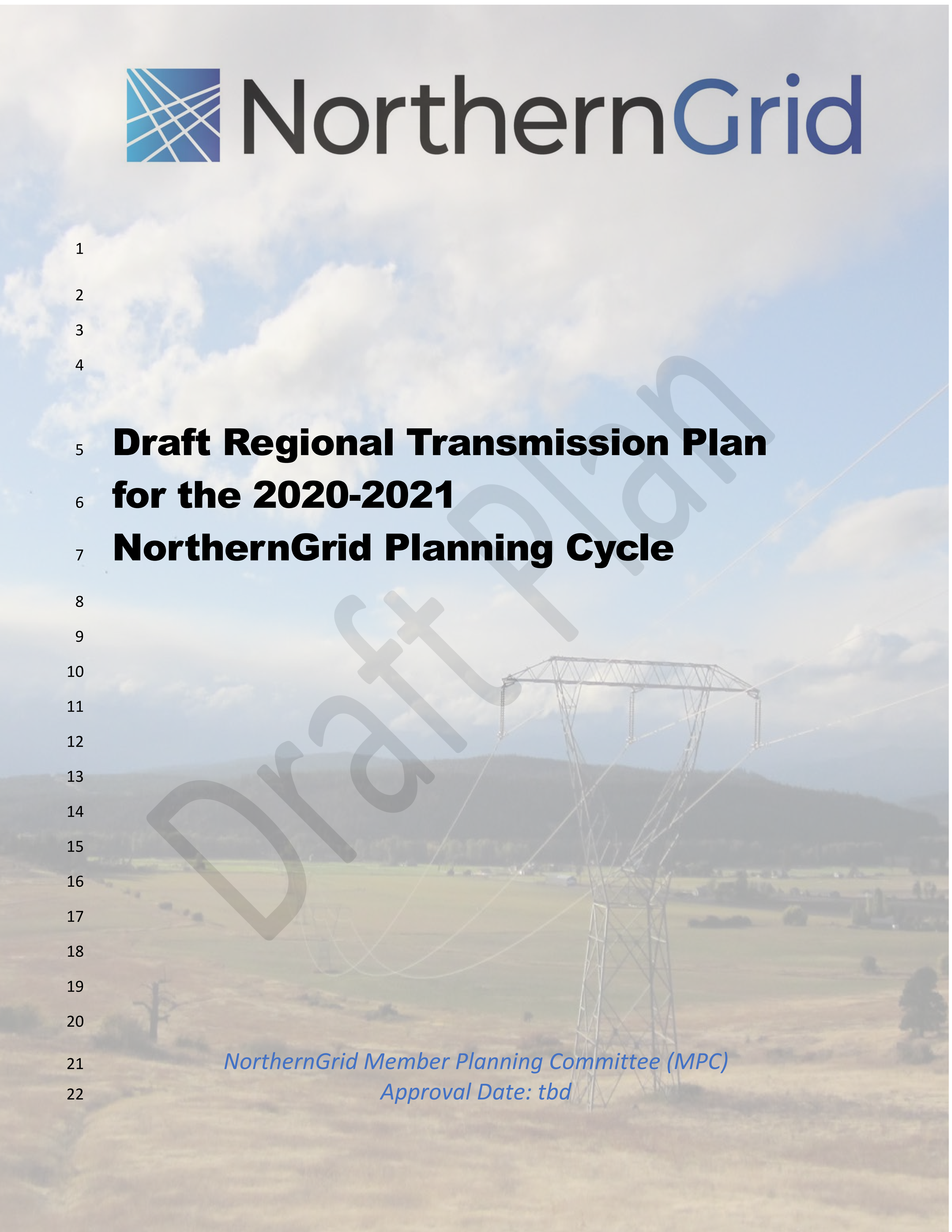

Draft Regional Transmission Plan for the 2020-2021 NorthernGrid Planning Cycle

NorthernGrid Member Planning Committee (MPC)
Approval Date: tbd

Acknowledgements:

NorthernGrid Members & Participants

Avista Corporation

Berkshire Hathaway Energy (BHE)

Bonneville Power Administration

Chelan County PUD

Grant County PUD

Idaho Power Company

NorthWestern Energy

PacifiCorp

Portland General Electric

Puget Sound Energy

Seattle City Light

Snohomish County PUD

Tacoma Power

Consultants and Other Contributors

Northwest Power Pool

Power Systems Consulting (PSC)

Old Saw Consulting

Harris PCM

CAISO

WestConnect

Interregional or non-Incumbent Transmission Project Sponsors

Fill in here…

State Commissions etc.

Fill in here…

Copies of this report are available from:

Northwest Power Pool

7505 NE Ambassador Place, Suite R, Portland, OR 97220

https://www.nwpp.org/

(503) 445-1074

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Executive Summary

The NorthernGrid 2020-2021 Regional Transmission Plan was developed per the Study Scope that outlines the NorthernGrid 2020-2021 regional planning process, as required under FERC Orders No. 890 and 1000, in accordance with each Enrolled Party's Open Access Tariff (OATT) Attachment K – Regional Planning Process and Northern Grid Planning Agreement, and the results are presented in this report. The objective of the planning process is to identify the projects that either cost-effectively or efficiently meet the needs of the NorthernGrid members in a 10-year future.

The process started with a data submittal of needs from each of the Members. For a 10-year future, each Member submitted their forecasted load, expected resource additions or retirements, public policy requirements, and expected transmission topology. All this information was then assimilated into the 2030 WECC Anchor Data Set (ADS). From that base case, a production cost model (PCM) analysis was performed to identify the stress conditions of interest for the NorthernGrid footprint. The stress conditions were selected to represent typical or expected operating conditions for the NorthernGrid footprint. Weather conditions have a large impact on system load. More megawatts are consumed on a hot summer day than on a cool autumn day due to things like industrial cooling loads. Similarly, more megawatts are consumed on a cold winter day than on a warm spring day due to keeping homes and businesses warm. Both summer and winter loading conditions were selected to capture these seasonal loading conditions. There is enough proposed wind generation in Wyoming to have a potential impact on the reliability of the NorthernGrid footprint; because of this, an hour representing high output from Wyoming wind resources was selected. Needs were also identified across southern Idaho, so a high Idaho to Northwest (west to east) case and Borah West (east to west) case were developed. Altogether, eight stress conditions for the NorthernGrid footprint were identified.

The results of the contingency analyses from those eight respective base cases formed the foundation for the selection of projects in the Regional Transmission Plan. Contingencies were submitted by the Members and focused on 230 kV and above electrical facilities. In general, the outage of facilities 100 kV and below do not significantly impact the reliability of the NorthernGrid transmission system. The NorthernGrid footprint along with adjacent neighboring regions were monitored.

The base cases contained all planned regional member projects. To identify the set of projects for the Regional Transmission Plan, portions of the planned regional projects were removed from the base cases to ascertain if a subset of the proposed regional projects would meet the needs of the transmission system more cost-effectively or efficiently than the entire set.

Consideration was also given to the interregional and non-incumbent regional projects that were submitted. The interregional projects and non-incumbent regional projects were first analyzed to determine if, without the addition of the proposed regional projects, they would meet the needs of the NorthernGrid footprint reliably. Further scrutiny was given to the interregional and non-incumbent regional projects to analyze their interplay with select regional projects if the interregional or non-incumbent regional project alone resulted in reliability violations.

Three developers, TransCanyon LLC, Great Basin Transmission, LLC, and PowerBridge met the criteria to be classified as Qualified Developers for this planning cycle. Ultimately, cost allocation analysis was not required as none of the interregional or non-incumbent regional projects were selected into the Regional Transmission Plan.

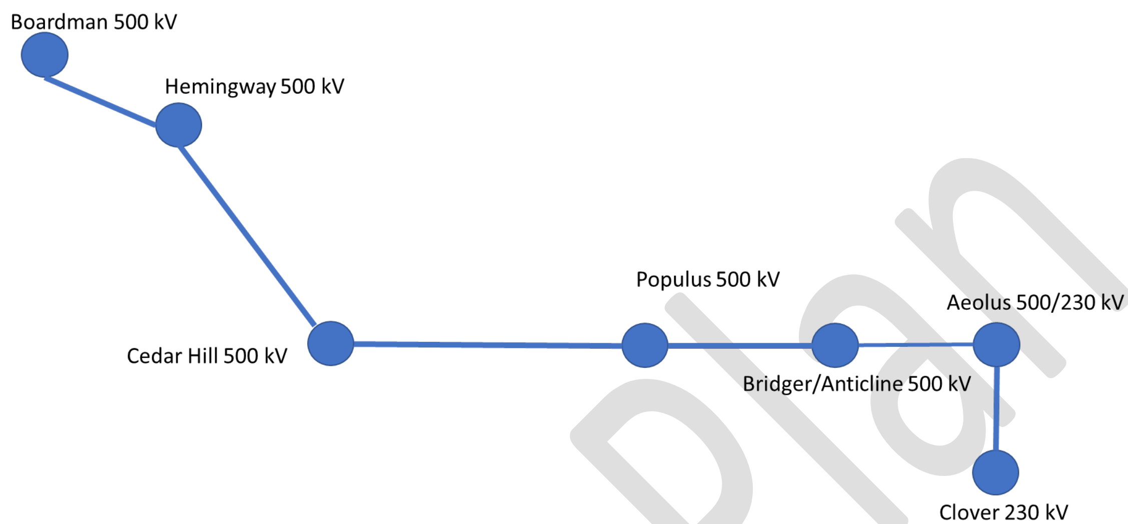

Figure 1: Regional Transmission Plan, regional combination {03}[1]

Figure 1 above provides a simplistic depiction of the regional projects that make up the Regional Transmission Plan. The Regional Transmission Plan projects were determined to be the most efficient solution to the NorthernGrid region given the parameters that were analyzed. The upgrades through the Cedar Hill bus increase the capacity of the transmission system between Populus and Hemingway. None of the interregional or non-incumbent projects met the needs of the region.

[1] This report adopts the common industry nomenclature that refers to facilities built to 525 kV specifications as "500 kV".

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Regional Planning Development

The Regional Transmission Plan is the result of the work performed as outlined in the study scope for the NorthernGrid 2020-2021 regional transmission planning process. Regional Planning is required under FERC Orders No. 890 and 1000 and was executed in accordance with each Enrolled Party's Open Access Tariff (OATT) Attachment K – Regional Planning Process and NorthernGrid Planning Agreement. The production of a Regional Transmission Plan satisfies FERC Order 1000 requirements for each region to produce a plan. To develop the Plan, the NorthernGrid members established the Baseline Projects which were then evaluated for inclusion in the final Regional Transmission Plan. NorthernGrid used steady state analysis to assess which projects could best meet system reliability performance requirements and transmission needs for the NorthernGrid footprint in a 10-year future. Enrolled Parties submitted updated Load and Resource information which was incorporated into the study effort. There were no Material Adverse Impacts noted for any of the solutions considered.

The regional planning process is designed to be a "bottom up" approach in that it begins with a compilation of the Members' local area plans which allows the planning emphasis to shift from the local to the regional footprint. The Transmission Providers, in conjunction with participation from stakeholders, public service commissioners, and interested parties have developed local area plans that meet the regulatory requirements for their respective areas. The projects that have been identified in the local area planning process are assumed to be in service for the regional planning effort.

This regional planning process is intended to focus on those projects that are of "regional significance". "Regional significance" is not a defined term in either the Members Planning Agreement or the OATT; rather, it is used to describe those projects whose presence, or lack thereof, would influence the overall reliability of the NorthernGrid footprint. A local project may improve the ability to serve native load or decrease the number of unplanned outages for a specified subsystem but typically is not going to influence larger transmission paths. A project that is more regional in nature may both increase the ability to serve native load as well as influence a larger transmission path.

NorthernGrid Overview

The NorthernGrid is composed of Avista (AVA), Bonneville Power Administration (BPA), Chelan PUD (CHPD), Grant County PUD (GCPD), Idaho Power Company (IPC), BHE U.S. Transmission as the owner of the Montana Alberta Tie Line (MATL), NorthWestern Energy (NWMT), PacifiCorp East and West (PACE and PACW), Portland General Electric (PGE), Puget Sound Energy (PSE), Seattle City Light (SCL), Snohomish PUD (SNPD), Tacoma Power (TPWR). The member Balancing Authority Areas are illustrated in Figure 2 below.

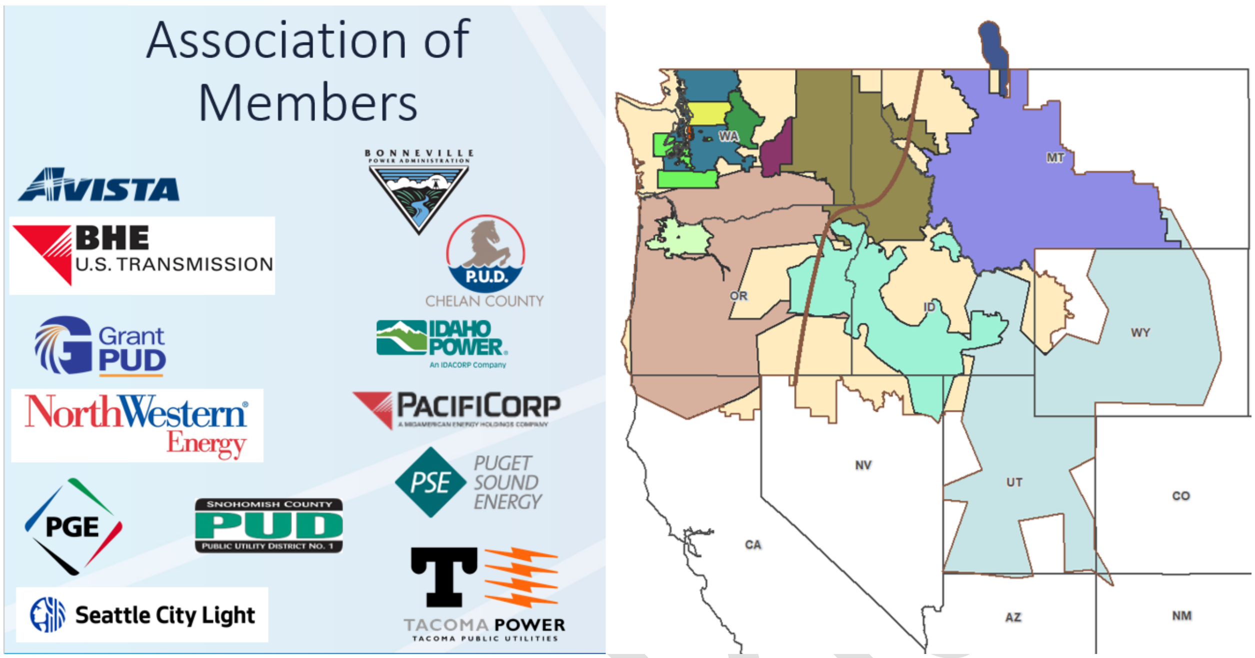


Figure 2: NorthernGrid footprint

Figure 2 shows the NorthernGrid footprint. For the purposes of the regional transmission plan data analysis and study case development, the NorthernGrid MPC divided the study area into the Pacific Northwest (NG-PNW) and Intermountain states (NG-IM) areas as shown by the brown line in Figure 2 above. The NorthernGrid footprint is a large, geographically diverse region that combines the needs of two previously separate regions. Some portions of the region may experience peak loading in the summer whereas other portions may experience peak loading in the winter. The Study Scope was developed to incorporate the ability to keep the region separated, should the results indicate that a separation is indeed useful. During the analysis, it was found that the separation of the NorthernGrid footprint was not needed. The brown line has been kept in this figure to help maintain consistency with the Study Scope and will not be specifically referenced hereafter.

Planning Development

The intent of FERC 1000 is to improve the regional planning process and identify opportunities for any transmission developer, incumbent or non-incumbent, to coordinate and develop solutions that are both beneficial to the developer as well as the region to which that developer interconnects. Given proper coordination and communication, only the necessary facilities would get identified, and those facilities become the RTP. The RTP is not a construction plan and the Members have no obligation to build the facilities identified in the RTP.

A few notables about the planning process: amongst other things, transmission needs are driven by reliability and by integrated resource planning. Reliability planning is driven by North American Reliability Council (NERC) criteria which provides utilities with a consistent methodology to identify facilities needed to support reliability. Integrated resource planning is driven by the market and resources are identified by the specific utility that is looking to build future generation. The member utilities combine the transmission needs driven by reliability with the transmission needs driven by the market to develop their overall transmission needs in the form of the Loads and Resources data submittal to the Western Electric Coordinating Council (WECC); that data gets consolidated and is the basis for building base cases. Member utilities are also tasked with ensuring that all public policies are reflected in their transmission needs. Public policies that initiate at the beginning of a planning cycle or make a shift during the planning cycle may not necessarily get reflected in the regional planning process. Member utilities need to decide how they are going to implement the changes to the transmission system that will result from a change to public policy and those decisions take some time to make. Similarly, not all generation or transmission projects driven by public policy changes can be reflected in a long-term planning study. While this RTP may not reflect the changes driven by public policy in this cycle, the process is such that there is the opportunity for those changes to get captured in the next planning cycle.

Study Process

Study Scope

The objective of the transmission planning study is to produce the NorthernGrid Regional Transmission Plan, through the evaluation and selection of regional and interregional projects that effectively satisfies all the transmission needs within the NorthernGrid region. The regional needs were sourced from member data submissions, including load forecasts, resource additions and retirements, projected transmission, and public policy requirements. The Study Scope in its entirety is provided in Appendix B: Study Scope.

Study Methodology and Criteria

To assess the 2030 loads and resources anticipated for the NorthernGrid footprint, a combination of power flow and production cost model techniques were used. A WECC base case was then put through a production cost modeling effort to identify stressed conditions on the NorthernGrid footprint based on the economic dispatch of planned resources. The stressed conditions were translated into base cases which became the basis for the analysis effort. The selected base cases were run through a contingency analysis using member-supplied contingencies. All contingencies were categorized per the NERC transmission planning criteria document, “TPL-001-4”. The NorthernGrid footprint as well as immediate neighboring regions were monitored. The analysis of the contingency results accounted for any area-specific Member Committee criteria, otherwise, NERC TPL-001-4 criteria was used.

Loads and Resources

Members submitted Loads and Resources data along with their current transmission plans in the first quarter; this data was consolidated and used to develop the Study Scope. The needs of the NorthernGrid footprint were identified through these submittals. No Loads and Resources data updates were submitted in the fifth quarter. All loads and resources characteristics are captured in the Study Scope which is available in Appendix B: Study Scope.

Base Case Development

The WECC 2030 Anchor Data Set (ADS) seed case was used as the starting point to produce the base cases used in the reliability analysis. The Anchor Data Set seed case was put through a production cost modeling effort to identify the stressed conditions of interest for the NorthernGrid footprint from 8760 potential hourly conditions. These operating conditions were created through modeling the economic dispatch of the resources combined with the expected loading conditions for the time of year and for each of the 8760 hours in a year. These models account for seasonal variations in load and resource availability. For example, base cases representing spring conditions will reflect more availability of hydro generation than do the base cases that represent fall conditions. The NorthernGrid Planning Committee discussed the conditions of interest and ultimately selected eight hours to model and study the regional transmission system. These eight hours were selected to represent known or expected operating conditions for the NorthernGrid footprint and are identified in Table 1. Members reviewed these cases and provided additional tuning and adjustments as appropriate for each scenario.

In the process of developing and selecting the stressed dispatch conditions, it was found that there are opportunities for improving the ADS. NorthernGrid worked closely with WECC to provide a list of topics where the ADS could be improved and WECC is actively working through those issues. A simple example of where the ADS could be improved is in the weather data that is being used: the data is based on years-old data and does not necessarily reflect current weather data. All topics are provided in Appendix H: Complete list of all ADS opportunities supplied to WECC.

The hours were selected for known or expected "stresses" on the NorthernGrid footprint. The NorthernGrid footprint spans a wide geographic area; because of this, heavy conditions for both summer and winter were selected. There is enough proposed wind generation in Wyoming to have a potential impact on the reliability of the NorthernGrid footprint; because of this, an hour representing high output from Wyoming wind resources was selected. Needs were also identified across southern Idaho, so a high Idaho to Northwest (west to east) case and Borah West (east to west) case were developed. The NorthernGrid Planning Committee voted on, and approved, the study hours identified in

Table 1.

Table 1: Base Case Stress Conditions

Condition	Date	Hour Ending, Pacific time	NorthernGrid Load (MW)	NorthernGrid Generation (MW)
NorthernGrid region summer peak load	July 30	16:00		
NorthernGrid region winter peak load	December 10	19:00		
High Wyoming Wind	February 1	1:00		
High Idaho to Northwest path [west to east]	July 20	17:00		
High Borah West path [east to west]	September 29	1:00		
High COI path [south to north]	March 10	15:00		
High West of Cascades paths [east to west]	April 3	11:00		
High COI and PDCI paths with high hydro [north to south]	June 4	18:00		

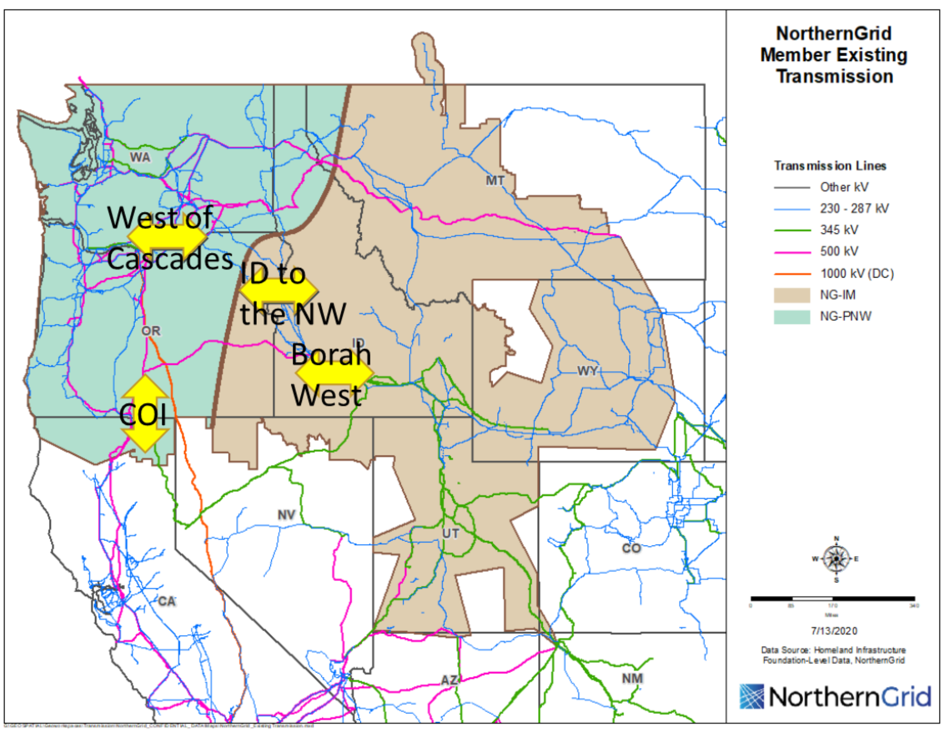


Figure 3: Paths of interest to the NorthernGrid footprint

Figure 3 above allows for identification of the four WECC paths of most interest to the NorthernGrid footprint for purposes of stressing the transmission system. Not all WECC paths relating to NorthernGrid are displayed. The California-Oregon Intertie (COI) is needed for inter-regional transfers between the California Independent System Operator (CAISO) and NorthernGrid. West of Cascades, Idaho to the Northwest, and Borah West are all crucial to the reliability of the NorthernGrid footprint and stresses may occur in both directions.

Contingencies and Criteria

Contingency analysis is the modeling of systematically removing specified pieces of equipment from service and measuring the resulting impact to the transmission system.

Thermal overloads occur when the electrons flowing through a piece of equipment exceed the capability of the equipment which causes heat to build up; excess heat occurs which can then damage the equipment. Typically, a thermal overload results from the loss of a transmission line or transformer, not necessarily from the loss of voltage control elements such as capacitor or reactor banks. Operationally, there are multiple ways to mitigate thermal excursions. For example, remedial action schemes are designed to respond to specific events on the transmission system to help preserve reliability and load service; these actions are programmed and the outcomes to the transmission are expected. Generators may be programmed to reduce their output in response to specific changes on the transmission system. These operational mitigation actions decrease the loading on the overloaded equipment by either reducing the number of electrons altogether or redirecting the electrons to pieces of equipment with larger capabilities. In instances where no pre-planned responses are in place, the transmission system is protected through standard protection devices including relays and breakers. As an example, the pieces of equipment experiencing the thermal overload would be disengaged from service through the actions of the relays and breakers and subsequently, changes the transmission topology naturally occur. This change in topology redirects the electrons which may or may not lead to further thermal excursions on the transmission system. Changes in transmission topology increase the need for Operator intervention and action as the transmission system is in a new state.

Voltage excursions occur when the reactive support of the transmission system changes, as can happen during the loss of a piece of equipment. Voltage excursions can be high or low, either of which causes undue stress on the equipment experiencing the excursion. Due to the interplay of all the pieces of equipment in a transmission system, the loss of any piece of equipment has the potential to cause a voltage excursion on the transmission system. Voltage excursions can be mitigated automatically through switching schemes on capacitor and/or reactor banks. These switching sequences do not add further stress or burden to the transmission system as they reduce the reactive need on the transmission system.

NorthernGrid Members submitted regionally significant contingencies used in the analysis for the development of the Plan. Contingencies on major WECC Paths relevant to the NorthernGrid footprint as well as contingencies on pieces of equipment in the 200 kV and above voltage classes were the primary focus. These regionally significant contingencies were selected for their criticality to the NorthernGrid footprint. The contingencies were categorized using Table 1 from NERC TPL-001-4. The post-contingency system analysis was performed using applicable NERC and WECC criteria while accounting for any member provided thermal or voltage criteria.

The NorthernGrid footprint as well as neighboring regions were monitored during the contingency analysis to determine if any negative impacts occur to the reliability of the transmission system due to the introduction of the regional projects. If negative impacts to the transmission system of neighboring regions could not be mitigated through operational changes for any regional combination, coordination would have to occur to identify the appropriate mitigation and the costs of that mitigation would be added to the cost of the regional project. No negative contingency results were observed in the neighboring regions and as such no Material Adverse Impacts were identified for any of the combinations considered.

Selection of Projects

The objective of the regional transmission analysis is to identify a set of transmission projects that cost-effectively or efficiently meets the transmission service and reliability needs of the NorthernGrid footprint ten years in the future. To accomplish this goal, NorthernGrid started with base cases that include member planned future regional projects modeled as “in-service”, as displayed below in Figure 4. Collectively, these regional projects comprise the Baseline Member Projects, or the “BLMP”. Sensitivity cases based on combinations of various regional project components being systematically removed from the BLMP cases created a set of Regional Combination cases to test against the performance of the BLMP cases. While the BLMP includes the highest number of regional projects, the analysis will evaluate whether a subset of the BLMP may cost-effectively meet the needs of the NorthernGrid footprint while maintaining system reliability.

B2H [H]	Gateway West (Pop - Ced - Hem) [E]	Gateway West (Pop - Bor - Mid - Hem)	Gateway West (Mid - Ced)	Gateway West (Ant - Pop) [D.3]	Antelope	Gateway South [F]	SWIP-N	Cross-Tie	TransWest Express ACDC	Loco Falls Greenline	Cascade Renewable
							X	X	X	X	X

BLMP

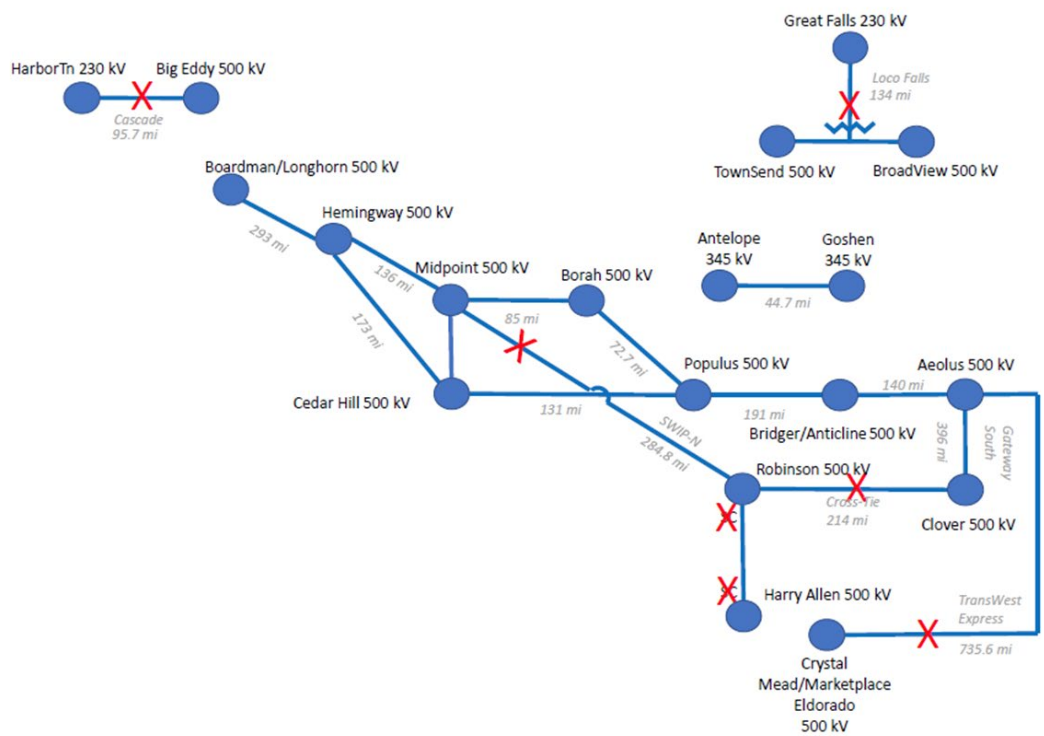


Figure 4: BLMP Example, "stick figure" representation

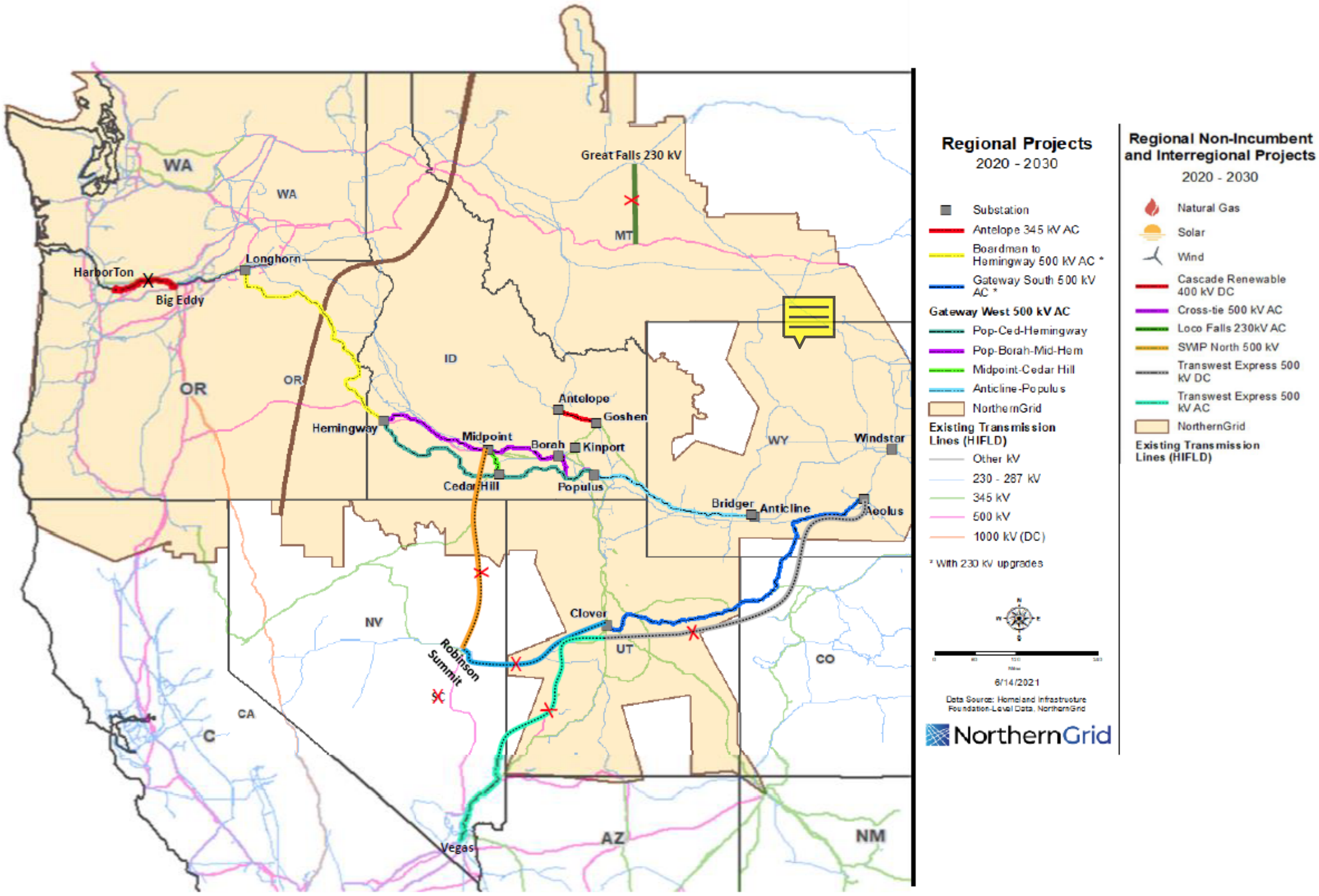


Figure 5: NorthernGrid geographical overlay with all Regional, Interregional, and Non-Incumbent Regional projects displayed

Figure 4 and Figure 5 provide a visual demonstration of all of the projects that have been submitted for consideration in the Regional Transmission Plan. In the top left-hand corner of Figure 4, a table is displayed to show which projects are included in the BLMP. The blue "stick figure" diagram on the left is the visual representation of the projects and each segment has a corresponding geographically aligned element depicted on Figure 5. This figure is not demonstrative of the entire set of upgrades associated with any main portion of the regional combinations, rather it is intended to help the reader understand in general the topology of interest. Boardman 500 kV is listed as the terminating point of the Boardman to Hemingway project to help preserve continuity with the naming convention; in actuality, the project terminates at Longhorn. Visual Aides for all the combinations can be found in Appendix E.

After the contingencies were run, the raw counts of violations were ranked using weighting criteria developed by the NorthernGrid Member Planning Committee. The rankings give less weight to those contingency categories that either have system adjustments available, can be addressed locally – such as reconfiguring a station to avoid a breaker failure issue, or have been determined to be less likely to occur. The results were further ranked by voltage class and severity of the violation; Appendix C: Rankings lists the full complement of ranking factors used.

The selection of the regional projects in the Plan is determined by the combination of projects that results in a transmission system that most cost-effectively or efficiently exceeds the reliability performance of the other possible combinations of submitted projects.

Regional Projects

The following projects were submitted by the Members and are identified as having the potential to impact the reliability of the NorthernGrid region.

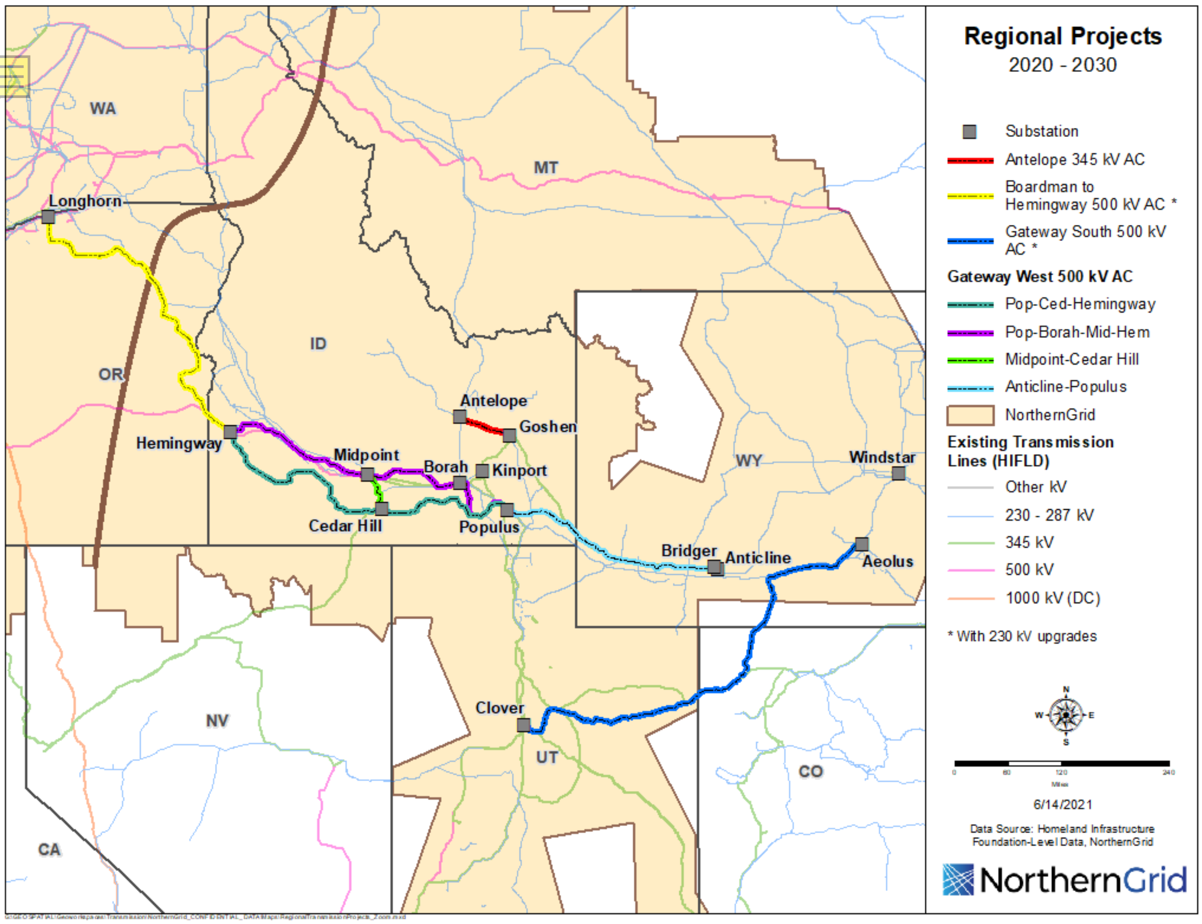


Figure 6: NorthernGrid footprint with regional project overlay. Proposed 345 kV and 500 kV facilities are displayed.

Antelope to Goshen 345 kV Transmission Line

The transmission facilities submitted to NorthernGrid for modeling the UAMPS generation addition near Antelope substation are preliminary in nature as detailed technical studies have not been completed. One of the keys assumptions to the single 345 kV line addition between Antelope and Goshen is that UAMPS has indicated that the proposed generation can be tripped for outage of the Antelope – Goshen 345 kV line. The Antelope to Goshen 345 kV line was selected into the Northern Tier transmission plan for the 2018-2019 cycle. The Technical Subcommittee determined that the Antelope to Goshen line should be included in all models as “in-service”.

Boardman to Hemingway Transmission Line Project (B2H)

Boardman to Hemingway 500 kV line, Hemingway to Bowmont and Bowmont to Hubbard 230 kV lines. This includes two sections of series compensation. The Oregon end of the line was terminated at the Longhorn station, which is near the town of Boardman, Oregon. While Figure 5 does not visually display the 230 kV facilities associated with the B2H project, the 230 kV facilities are included in the model for B2H. The B2H project was selected into the Northern Tier Transmission Plan for the 2018-2019 cycle.

Gateway South Transmission Project

Aeolus to Clover 500 kV Line. Based on guidance from PacifiCorp, the Windstar-Shirley Basin 230 kV line (part of Gateway West) was treated as part of the Aeolus-Clover project. The Gateway South transmission project was selected into the Northern Tier Transmission Plan for the 2018-2019 cycle.

Gateway West Transmission Project

A suite of four project segments were evaluated for Gateway West. These are:

1. Populus-Cedar Hill-Hemingway 500 kV
2. Populus-Borah-Midpoint-Hemingway 500 kV
3. Midpoint-Cedar Hills 500 kV
4. Anticline-Populus 500 kV

Of the Gateway West projects, neither the Midpoint to Cedar Hill nor the Populus to Borah segments were selected into the 2018-2019 Northern Tier Transmission Group Plan.

Interregional Projects and Non-Incumbent Regional

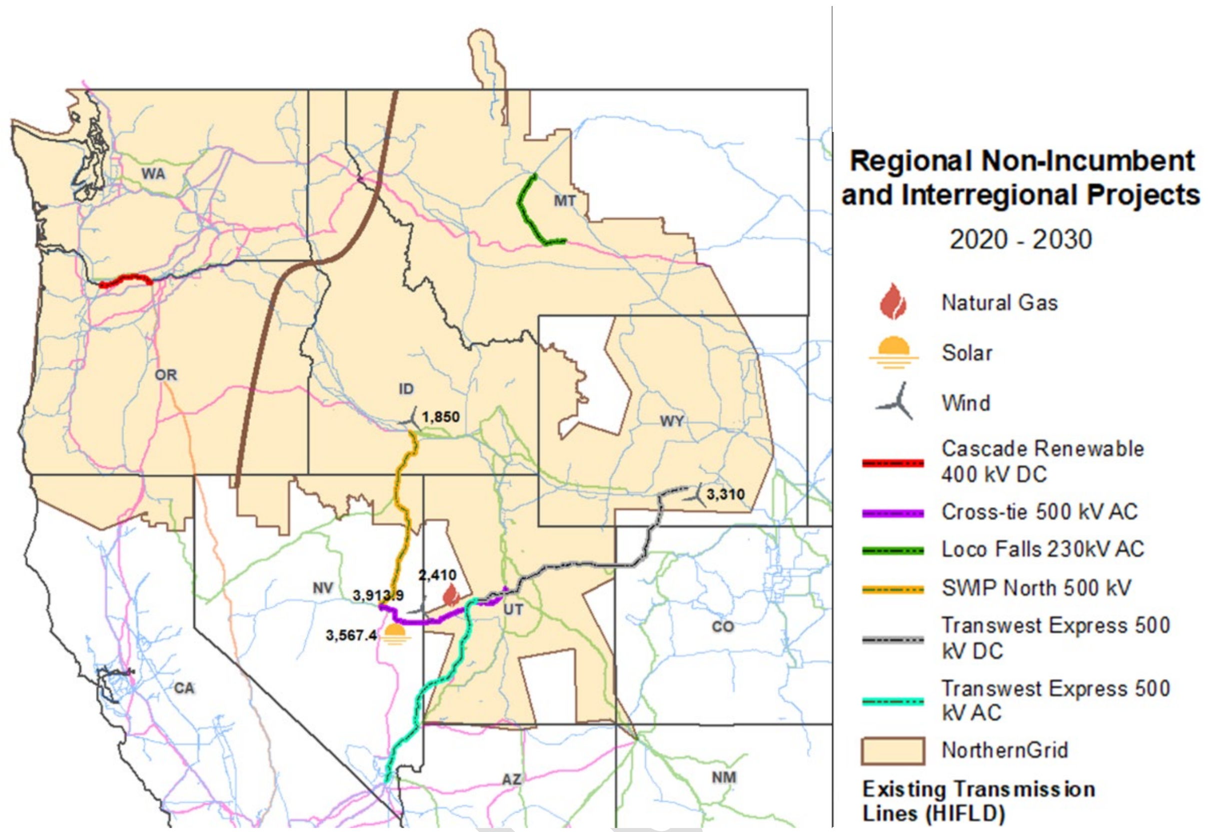


Figure 7: Regional Non-Incumbent and Interregional Projects

All interregional projects considered in this planning cycle have been submitted by Non-Incumbent Transmission Developers.

Cross-Tie Transmission Project

Interregional Evaluation Plan: https://www.northerngrid.net/resources/cross-tie-itp-evaluation-plan-2020-21

TransCanyon LLC is proposing the Cross-Tie Project, a 1,500 MW, 500 kV single circuit transmission project that will be constructed between central Utah and east-central Nevada. The project connects PacifiCorp's planned 500 kV Clover substation (in the NorthernGrid planning region) with NV Energy's existing 500 kV Robinson Summit substation (in the WestConnect planning region).

Cross-Tie has proposed 9,891 MW of total cumulative resource additions (3,567 MW Solar, 3,914 MW Wind, and 3,410 MW Natural Gas) as a result of the proposed transmission line. These resources are located in the states of Wyoming and Utah. Please see the appendix for a data table of proposed generation associated with the Cross-Tie project.

Southwest Intertie Project North (SWIP)

Interregional Evaluation Plan: https://www.northerngrid.net/resources/swip-north-itp-evaluation-plan

Great Basin Transmission, LLC ("GBT"), an affiliate of LS Power, submitted the 275-mile northern portion of the Southwest Intertie Project (SWIP) to the California ISO and NorthernGrid. SWIP-North was also submitted into WestConnect's planning process by the Western Energy Connection (WEC), LLC, a subsidiary of LS Power. The SWIP-North Project connects the Midpoint 500 kV substation (in NorthernGrid) to the Robinson Summit 500 kV substation (in WestConnect) with a 500 kV single circuit AC transmission line. The SWIP is expected to have a bi-directional WECC-approved path rating of approximately 2000 MW.

SWIP North has proposed 1,850 MW of new wind generation resources located in Idaho as a result of the transmission line. Please see the appendix for a data table of proposed generation associated with the SWIP North project.

TransWest Express

Interregional Evaluation Plan: https://www.northerngrid.net/resources/transwest-express-itp-evaluation-plan

TransWest Express is a 500 kV DC and 500 kV AC transmission project proposed by TransWest. The TransWest Express (TWE) Transmission Project consists of three discrete interconnected transmission segments that, when considered together, will interconnect transmission infrastructure in Wyoming, Utah, and southern Nevada. TransWest has submitted each of the following TWE Project segments as separate ITP submittals:

A 405-mile, bi-directional 3,000 MW, ±500 kV, high voltage direct current (HVDC) transmission system with terminals in south-central Wyoming and central Utah (the WY-IPP DC Project).

A 278-mile 1,500 MW 500 kV alternating current (AC) transmission line with terminals in central Utah and southeastern Nevada (the IPP-Crystal 500 kV AC Project.

A 50-mile, 1,680 MW 500 kV AC transmission line with terminals in southeastern Nevada, and southwestern Nevada (the Crystal-Eldorado 500 kV AC Project).

Transwest Express has proposed 3,310 MW of wind generation as a result of the transmission line. Please see the appendix for a data table of proposed generation associated with the transmission project.

Non-Incumbent Projects

Cascade Renewable Transmission System

PowerBridge is proposing to construct the Cascade Renewable Transmission System Project. This Project is an 80-mile, 1,100 MW transfer capacity +/- 440 kV HVDC underground cable (95 percent installed underwater) interconnecting with the grid through two +/- 1100 MW AC/DC converter stations interconnecting with the AC grid at Big Eddy and Harborton substation. There is no proposed generation resource associated with the transmission line.

Loco Falls Greenline

Absaroka is proposing a merchant transmission project connecting Great Falls 230 kV substation to the Colstrip 500 kV Transmission System. The project consists of two 230 kV transmission circuits and a new

Loco Mountain Substation with 230 to 500 kV transformation. There are no proposed generation resources associated with the transmission line.

Analysis Results

Once the base cases were created to reflect the topology and loading conditions of interest, they were run through contingency analysis. When running contingency analyses, both the type of the contingency and the impact of the contingency are vital to ascertaining the reliability of the transmission system. The type and the impact of the contingency are considered in conjunction with the voltage class of the equipment. In general, losses of higher voltage equipment have more of an impact on the transmission system than do the losses of lower voltage equipment. From a NorthernGrid perspective, the contingencies that result in the loss of large amounts of load or the inability to honor transmission arrangements are those that are regionally significant and warrant further scrutiny.

Initially, the results were compiled and the total number of violations from each contingency summed together, regardless of the voltage level of the piece of equipment lost, the voltage of the piece of equipment impacted, or the extremity of the event. Appendix C: Rankings shows a figure of the unranked results of the contingency analysis.

To help identify regionally significant contingencies, each contingency result was multiplied by ranking factors: voltage class, type of the contingency, and impact of the contingency, to produce an overall Ranking for that contingency. The larger the resulting ranking, the more regionally significant the contingency. Voltage class refers to the kV rating of the equipment: the larger the rating, the larger the ranking factor. Type of the contingency refers to the NERC TPL-001-4 criteria which is the guiding document used to classify all contingencies analyzed. The contingencies in NERC TPL-001-4 contain scenarios that range from outages of single pieces of equipment to severe faults that impact multiple pieces of equipment. It is quite common for a transmission system to have a single piece of equipment out of service, either planned or unplanned, and it is less common for a transmission system to experience fault events that result in the loss of multiple pieces of equipment. Because of this, single outage contingencies were given a larger ranking factor than severe contingencies. The impact of a contingency refers to what happens to the transmission system when a contingency occurs. Contingencies that caused minor violations were given a smaller ranking factor than those that led to major violations. From a NorthernGrid perspective, a minor violation is one that can be readily mitigated operationally with no anticipated damage to equipment. A major violation may cause cascading outages or equipment damage. Each contingency from each base case was ranked per the ranking factors; all contingency results displayed in this report are ranked contingency results. Ranked contingency results have no known unit. An example calculation of ranking a contingency as well as a comparison of the ranked versus the un-ranked results is provided in Appendix C: Rankings.

Base Cases

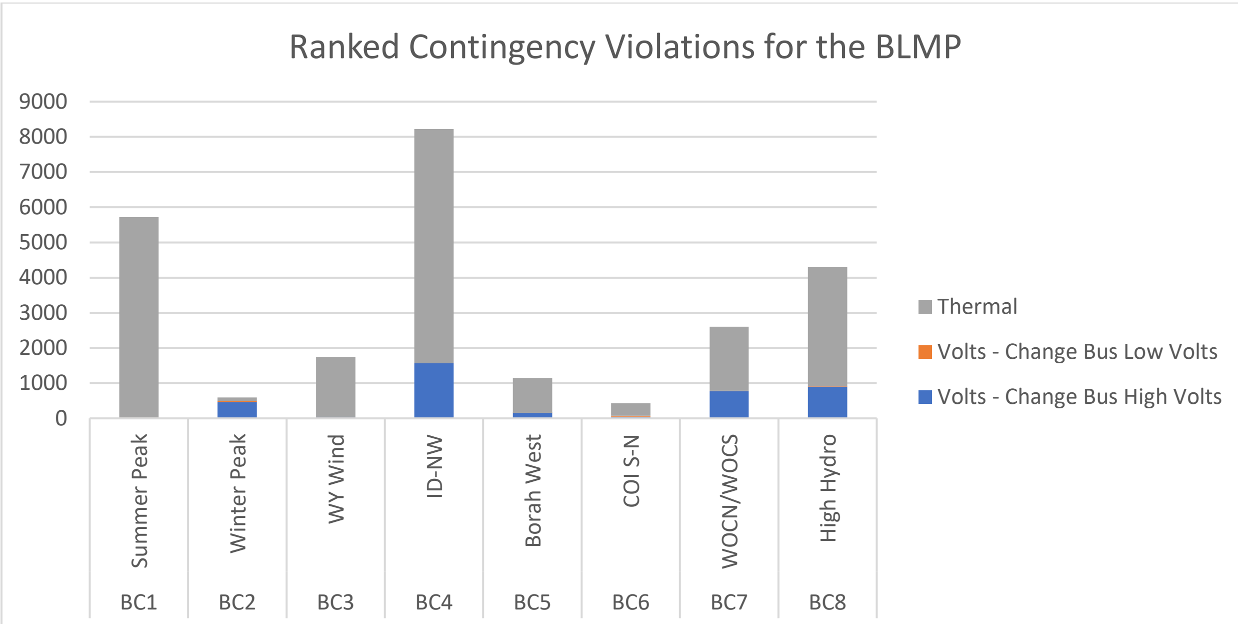


Figure 8: Ranked contingency results for the eight BLMP base cases

Figure 8 displays the ranked contingency violations for the eight base cases developed to represent the different stress conditions of interest. All eight base cases are derived from the BLMP and their only differences stem from the varying load and resource combinations that resulted from the production cost model analysis. Thermal excursions identify the portions of the system that may need infrastructure improvement to support the movement of electrons whereas voltage changes identify the portions of the transmission system that may need reactive equipment to support the overall voltage. By emphasizing the change in volts, either high or low, the analysis effort is well situated to identify those contingencies that led to changes in the transmission system and to put less emphasis on voltage excursions that may be present in the BLMP due to the initial conditions of the case selected through the PCM process.

A few observations about the results from the BLMP analysis:

1. It makes sense that there are fewer thermal excursions in the winter case than the rest of the loading conditions. Many entities allow for extra loading on transmission elements in the winter due to the cooling effect of the lower temperatures associated with winter conditions. The cooling effect of the temperature allows for an increase of electrons to transfer without damaging equipment.
2. Northbound flows on the COI resulted in the fewest violations for these 8 cases.
3. The Summer Peak operating condition resulted in a large number of thermal overloads.

The projects in the BLMP have been identified to resolve the reliability concerns and meet the transmission obligations of the entities on an individual level and do not necessarily resolve all the potential operating conditions or stressed conditions that may occur in the larger NorthernGrid footprint.

Regional Combinations

After the initial analysis was performed on the BLMP, the contingency analysis was then extended to looking into different subsets of the BLMP. The Technical Subcommittee of the Member Planning Committee convened to determine the subsets, or regional combinations, of the BLMP to analyze.

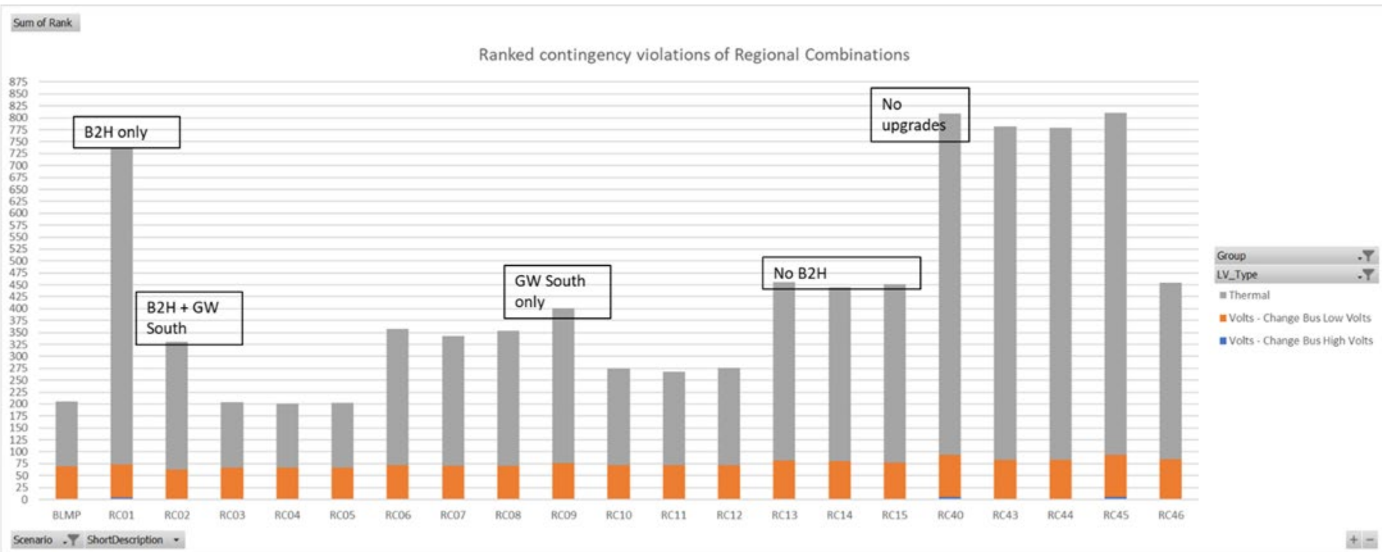


Figure 9: Ranked contingency results, all regional combinations with all cases

Figure 9 above displays the ranked contingency results for the regional combinations of projects. The BLMP case represents the case that has all the regional projects modeled as "in-service". The rest of the combinations are composed of subsets of the entire set of possible regional projects. The Gateway West and Gateway South projects upgrade the transmission system by adding transmission facilities to enhance the system between Boardman and Mona, with a parallel path between Hemingway and Populus. The subsets are intended to help determine if all of the Gateway projects are needed or if a subset will suffice to meet the needs of the NorthernGrid footprint. Appendix E displays all the combinations considered.

A few notable observations on the ranked contingency results:

1. The BLMP case has fewer violations than most of the other regional combinations. This result is expected as the BLMP case has the largest number of transmission upgrades compared to the regional combinations.
2. Regional combination {01} has only the Boardman to Hemingway upgrade, and in general, no upgrades between Hemingway and Populus.
3. Regional combinations {03, 04, 05} form a group and result in the fewest ranked violations. These three regional combinations all have the Boardman to Hemingway, Gateway South, and the Anticline to Populus branch of the Gateway West projects.
4. The only difference between regional combinations {03} and {04} is the presence of Midpoint to Cedar Hill.

5. Regional combinations {06, 07, 08} are a subset of regional combinations {03, 04, 05} in that they do not have the Gateway South project and they yield a larger number of violations.
6. Regional combination {09} has only the Gateway South and no other regional project.
7. Regional combinations {10, 11, 12} are a subset of regional combinations {03, 04, 05} in that they do not have the Boardman to Hemingway project and they yield a larger number of violations.
8. Regional combinations {13, 14, 15} do not have the Boardman to Hemingway project, but they do have subsets of the Gateway projects.
9. Regional combination {40} has no upgrades beyond the Antelope project and resulted in the most ranked violations. This regional combination tests the current NorthernGrid transmission system against a ten-year future and the results suggest that upgrades of some form are needed to support the needs of the NorthernGrid region.
10. Regional combinations {43, 44, 45, 46} systematically tested individual sections of the Gateway projects.

Regional combinations {03, 04, 05} resulted in the fewest violations and warrant further scrutiny.

Figure 10 shows the details of the contingency analysis for regional combinations {03, 04, 05}.

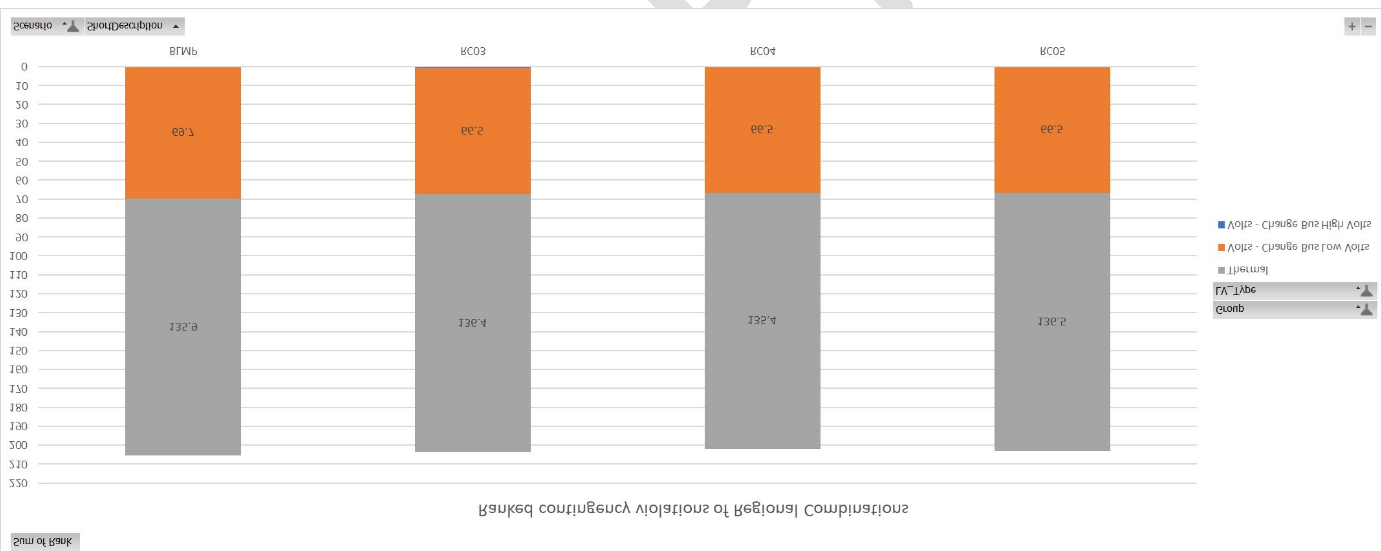


Figure 10: Ranked contingency results for regional combinations {03, 04, 05}

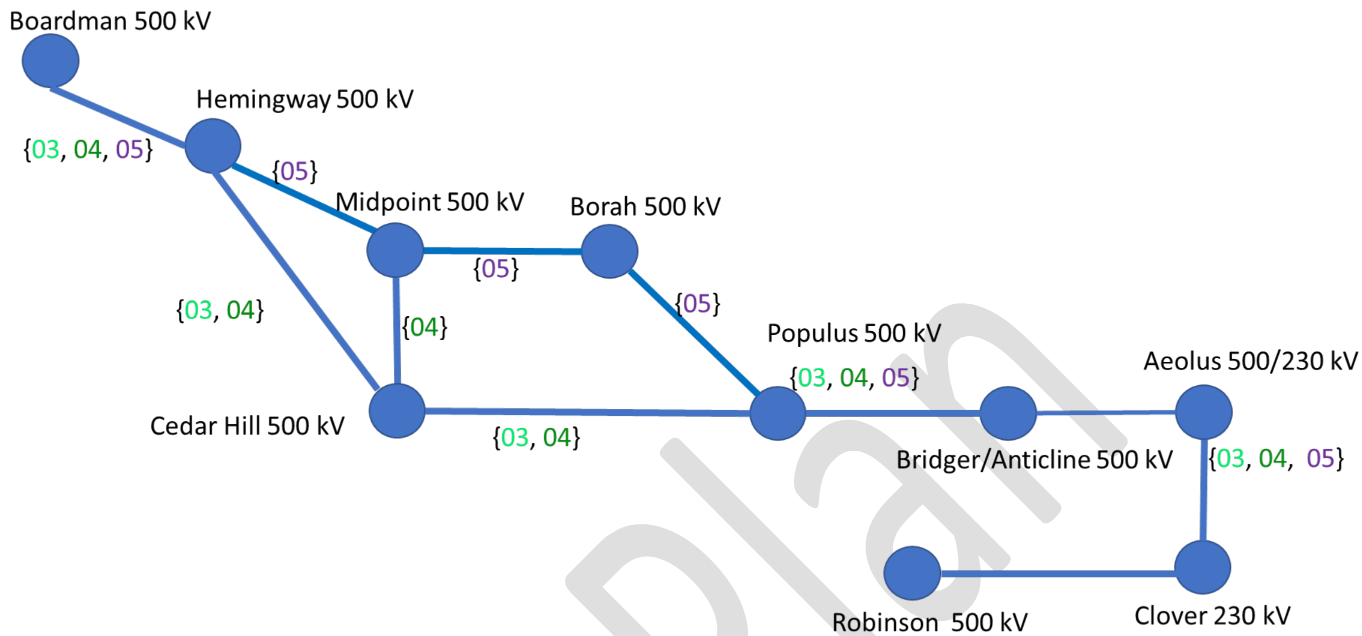


Figure 11: Regional combinations {03, 04, 05}

In all regional combinations of interest, the upgrade from Bridger/Anticline to Aeolus will not be specifically mentioned as construction is already complete.

As can be seen in Figure 11, there are multiple subsets of the BLMP that perform similiarly to the BLMP, and further considerations are warranted. The following section provides more discussion and introduces some of the merits and demerits of each of these five regional combinations.

Regional combination {03} is a new line that connects Hemingway to Populus via Cedar Hill. Regional combination {03} increases the west-bound capacity from Populus to Hemingway because it adds a new, independent path for electrons to flow. Regional combination {03} also mitigates the limiting contingency; currently, the limiting contingency for megawatts flowing between Populus and Hemingway is a loss on the Hemingway-Midpoint-Borah-Populus line.

Regional combination {04} takes regional combination {03} and adds in the Midpoint to Cedar Hill segment. The Midpoint to Cedar Hill segment does not fundamentally improve the reliability results over regional combniation {03} as can be seen in the results in Figure 11. The change in reliability results from regional combinations {03} to {04} does not warrant the cost incurred to construct Midpoint to Cedar Hill in this analysis; therefore, regional combination {04} will be removed from further scrutiny.

Regional combination {05} rebuilds existing facilities and does not create a new path for electrons to flow. the loss of any of the line segments: Hemingway to Midpoint, Midpoint to Borah, Borah to Populus, could lead to the reduction of west-bound schedules; regional combination {05} does not ameliorate this situation. Regional combination {05}, however, re-builds existing faciliites and the monetary efficiency gained by re-building facilities instead of building "greenfield" facilities should not be dismissed and regional combination {05} will be further scrutinized.

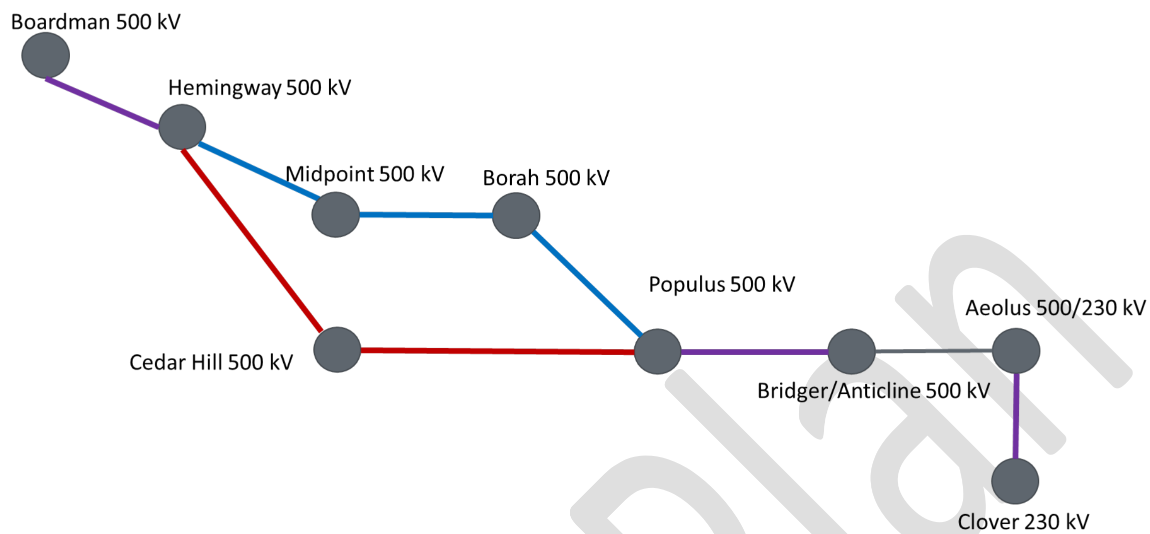


*Figure 12: Regional Projects **{03}** and **{05}***

Figure 12 depicts major segments of the regional projects and does not constitute their entirety. Red segments belong to regional combination {03}, blue segments belong to regional combination {05}, and purple segments belong to both. As can be seen in Figure 16, not all the portions of the Gateway West project are needed to support the reliability of the NorthernGrid footprint. Electrons flowing between Populus and Hemingway need only one path; either south through Cedar Hill or north through Borah.

The Cedar Hill route increases the capacity on the transmission system between Populus and Hemingway. The segments associated with the Cedar Hill substation are new whereas the segments associated with Midpoint and Borah are upgrading existing facilities. The main contingency for the Midpoint-Borah segments is the loss of the line that is getting upgraded, which does not increase the capacity of the system from a contingency perspective. The Cedar Hill facilities provide an alternate route for electrons to flow, which increases the capacity of the system. Conservative estimates suggest that upwards of 850 MW can be gained in capacity for the Cedar Hill facilities.

Interregional and Non-Incumbent Regional Projects

Interregional projects connect two planning regions and non-incumbent regional projects are projects that fall within a planning region. Interregional projects are sponsored by Interregional Transmission Project Proponents and are typically designed to take generation from one region and transmit it to a load pocket in another region. Non-incumbent regional projects are projects that have been sponsored by either a transmission developer that does not have a retail distribution service or a utility that is proposing a project outside their retail distribution service. For this cycle, both non-incumbent regional projects have been submitted by Merchant Transmission Developers.

The interregional projects that have been submitted to the NorthernGrid region for consideration in the 2020-2021 regional transmission process are designed to take the output from renewable generation and deliver it to a load in a neighboring region.

Three interregional and two non-incumbent regional projects were incorporated and analyzed to determine if either alone or in conjunction with the leading regional combinations, they would create a more cost-effective or efficient NorthernGrid transmission system.

The first stage of the analysis was designed to ascertain if the interregional or non-incumbent regional project would meet the needs of the NorthernGrid region alone, without the presence of the other planned projects. The second stage of the interregional and non-incumbent regional analysis was to determine if there was any benefit in adding the interregional or non-incumbent regional project to subsets of the BLMP. The third phase of the interregional and non-incumbent regional analysis allowed for increased flows on the interregional or non-incumbent projects and the opportunity to determine if the interregional or non-incumbent project with megawatts flowing on them was better for the NorthernGrid footprint than just the projects alone.

Figure 13 below shows the ranked contingency results for the first stage of the interregional and non-incumbent regional analysis. Each interregional or non-incumbent regional project was first modeled alone with no regional upgrades.

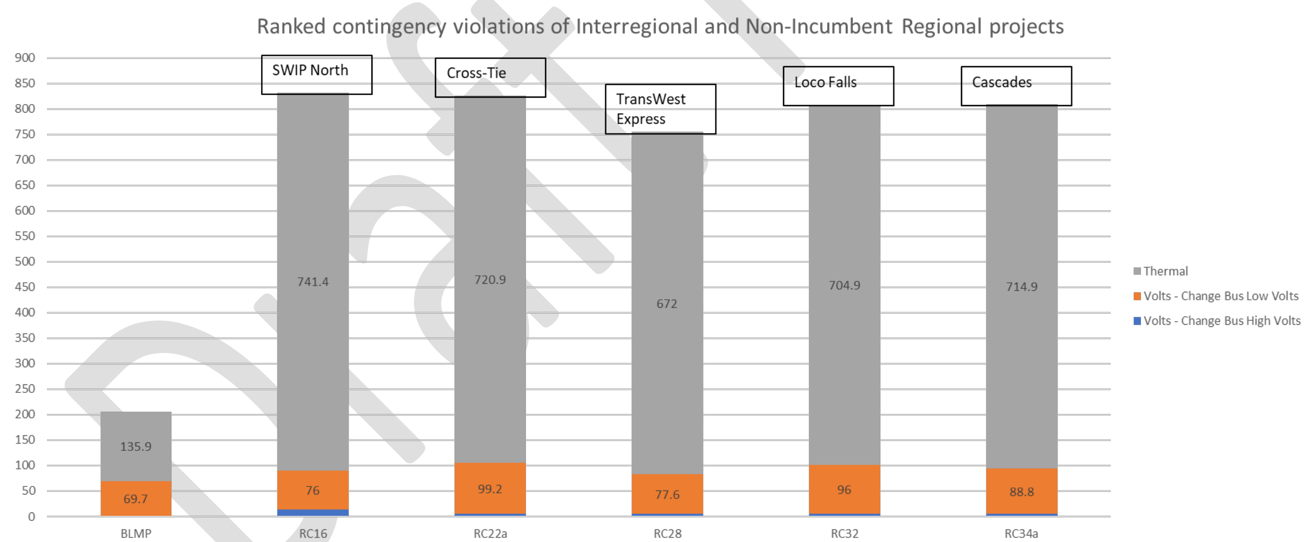


Figure 13: Each interregional or non-incumbent regional project with no regional upgrades

Each interregional or non-incumbent regional project alone results in significantly more ranked contingency violations than the BLMP.

The second stage of the analysis explored the interaction of the interregional and non-incumbent projects with various regional projects.

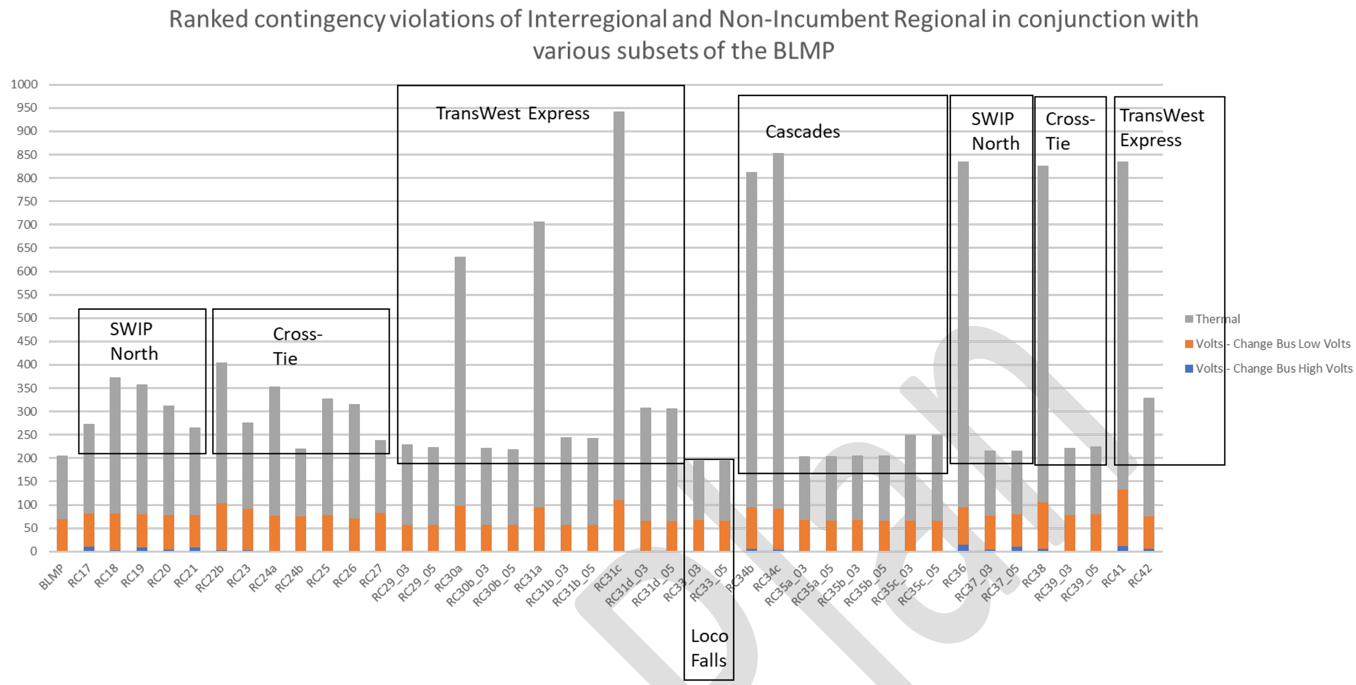


Figure 14: Second stage of interregional and non-incumbent regional analysis

Any project that ends with an "_03" or "_05" is that interregional or non-incumbent regional project in conjunction with the leading regional combination {03} or {05}.

1. Each of the interregional projects in conjunction with the leading regional combinations {03} and {05} result in fewer ranked violations than without the leading regional combinations.
2. Loco Falls in conjunction with regional combinations {03} and {05} perform similarly to the BLMP. The increase in reliability performance does not outweigh the increase in cost that would result in adding the Loco Falls project to the Regional Transmission Plan and therefore the Loco Falls project will not be selected into the Regional Transmission Plan.

The last stage of the interregional analysis examined how changes to the AC portion of the interregional and non-incumbent regional projects impacted how those projects interplayed with the NorthernGrid footprint. The generation associated with these interregional and non-incumbent projects was not identified in the Loads and Resources data submitted by the Members and so consequently, was not included in the production cost modeling run used to create the base cases of interest. Changes to the generation dispatch of the NorthernGrid footprint subsequently changed the inherent loading conditions in the base cases and so the generation portion of this interregional and non-incumbent regional analysis is more informational than instructional to the Plan.

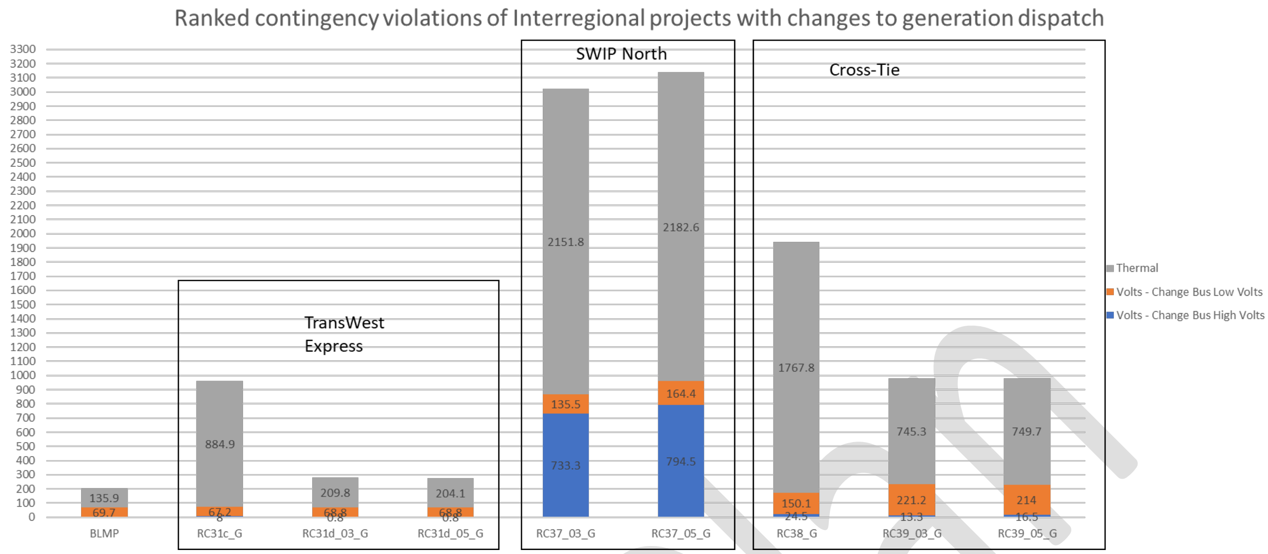


Figure 15: Interregional and Non-Incumbent with generation changes

SWIP North by itself and with generation changes yielded a ranked contingency result near 25,000 and is not depicted in Figure 14 as it throws the entire scale off.

Consistent with previously seen results, all projects perform better when coupled with the leading regional combinations. Also consistent, the improvement to the reliability of the region is not so significantly improved when the leading regional combinations are considered with the interregional or non-incumbent regional projects to justify adding the costs of those projects to the NorthernGrid Plan.

At this point, the analysis suggests that either interregional or non-incumbent projects by themselves, in the absence of any regional upgrades, are insufficient to meet the needs of the NorthernGrid footprint.

Interregional Coordination Process

NorthernGrid met with WestConnect and CAISO to coordinate base cases, assumptions, and methodologies at the Annual Interregional Information Exchange. None of the interregional projects were selected into regional Plans for the neighboring regions.

Cost Allocation

The interregional projects submitted for consideration in the NorthernGrid footprint were not selected into the Plans of the other regions. For this cycle, there are no projects that meet the criteria for cost allocation. The Study scope in

Appendix **B: Study** provides the complete list of developers who pre-qualified through the Northern Tier Transmission Group 2018-2019 planning process.

Regional Transmission Plan

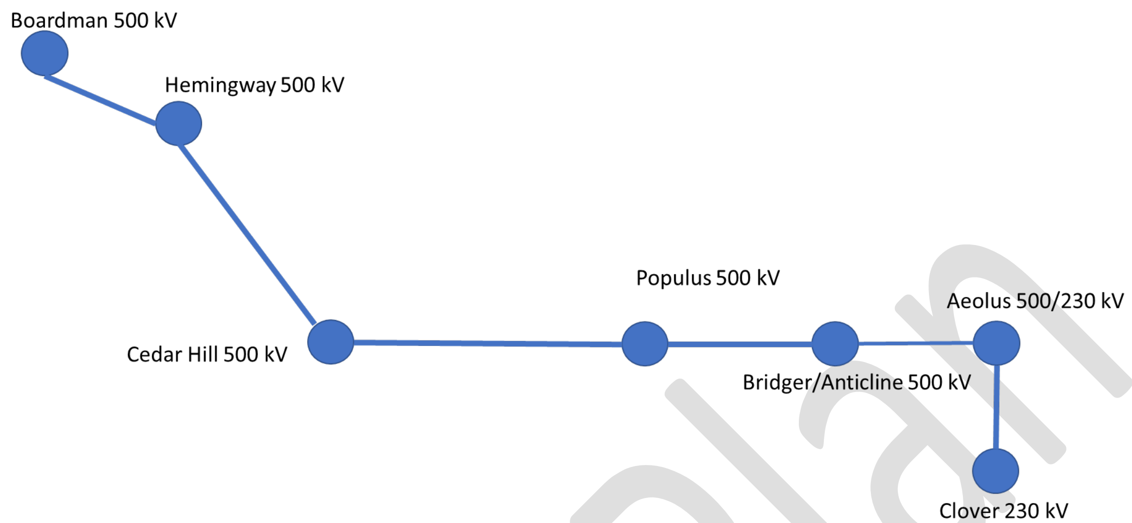


Figure 16: The Regional Transmission Plan for the 2020-2021 NorthernGrid cycle

Regional combination {03} forms the basis of the Regional Transmission Plan. This selection of projects supports the NorthernGrid system for a 10-year future and is less expensive to build than the entire set of projects that comprise the BLMP. The Cedar Hill route conservatively increases the capacity of the transmission system by 850 MW. None of the interregional or non-incumbent regional projects resulted in as few violations as regional combination {03} and while there is merit in considering the construction of regional combination {03} along with interregional or non-incumbent regional projects, the costs would be significantly higher than constructing just regional combination {03} and the reliability results suggest that regional combination {03} results in a system that is as or more efficient.

Appendix A: Definitions and Terms

Attachment K from NorthWestern Energy is provided here for reference to the process or definitions and can be accessed by double-clicking on the icon.

Accepted, effective April 1, 2020,
NorthWestern Corp., 170 FERC ¶ 61,298 (Mar. 31, 2020)

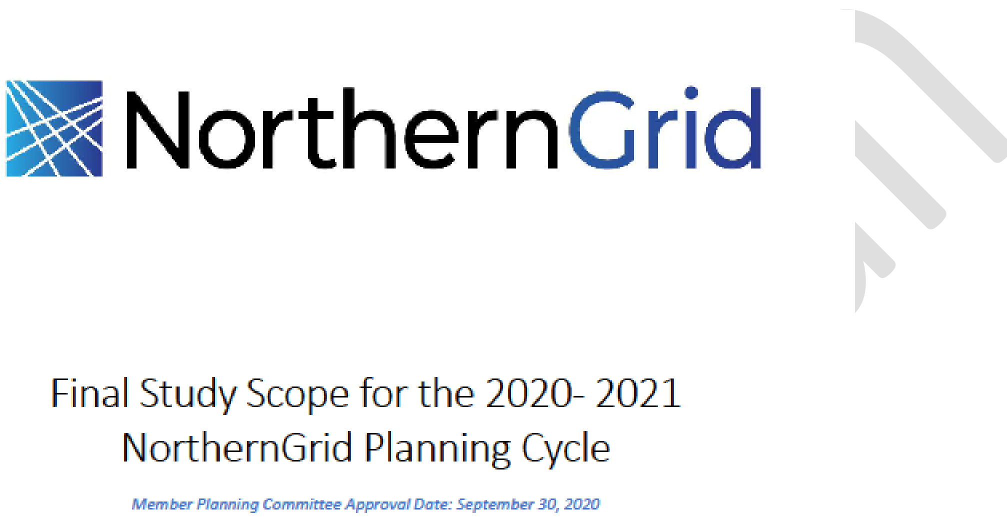
NorthWestern Corporation
Montana OATT

ATTACHMENT K

Transmission Planning Process

Appendix B: Study Scope

The entire study scope for the 2020-2021 cycle can be accessed by double-clicking the icon below.


NorthernGrid

Final Study Scope for the 2020- 2021 NorthernGrid Planning Cycle

Member Planning Committee Approval Date: September 30, 2020

Appendix C: Rankings

Table 2: Voltage Class for Ranking

From	To	Rank
0 kV	50 kV	0.1
50 kV	100 kV	0.1
100 kV	200 kV	0.3
200 kV	300 kV	0.5
300 kV	400 kV	0.8
400 kV	1000 kV	1

Table 3: NERC TPL Category for Ranking

Category	Rank	Description
P0	1	All lines in service
P1	0.5	N-1
P2	0.1	Multiple outages
P3	0.075	N-1-1
P4	0.1	Multiple outages
P5	0.1	Multiple outages
P6	0.075	N-1-1
P7	0.1	Multiple outages

Table 4: Violations for Ranking

LV_Type	Rank	Description
Interface MW	0.5	Mild overload of path rating.
Interface MW	1	Heavy overload of path - potential stability problems.
Branch Amp	0.5	Mild overload of line.
Branch Amp	1	Heavy overload of line. Possibility of automated tripping.
Branch MVA	0.5	Mild overload.
Branch MVA	1	Heavy overload.
Unsolved	1	
Bus High Volts	0.5	
Bus High Volts	1	
Bus Low Volts	0.5	
Bus Low Volts	1	
Change Bus Low Volts	0.5	
Change Bus Low Volts	1	
Change Bus High Volts	0.5	
Change Bus High Volts	1	

Example: The ranking factor for a Heavy Overload on a 230 kV piece of equipment resulting from a P1 event is:

$$(1) * (0.5) * (0.5) = 0.25$$

The rankings didn't fundamentally change the results, rather, they help emphasize them. Figure 20 below shows the raw contingency violations for the BLMP. Consistent with the results from Figure 21, the Summer Peak, ID-NW, and High Hydro stressed conditions prevail with ID-NW leading in number of thermal excursions. As mentioned in the body of the report, the ranking process gives a larger rank to thermal excursions than voltage violations, and that can be seen in the comparison below. The contingencies from the Winter Peak and WY Wind conditions resulted in primarily voltage violations, which is why the bars for Winter Peak and WY Wind are significantly shorter in the ranked results.

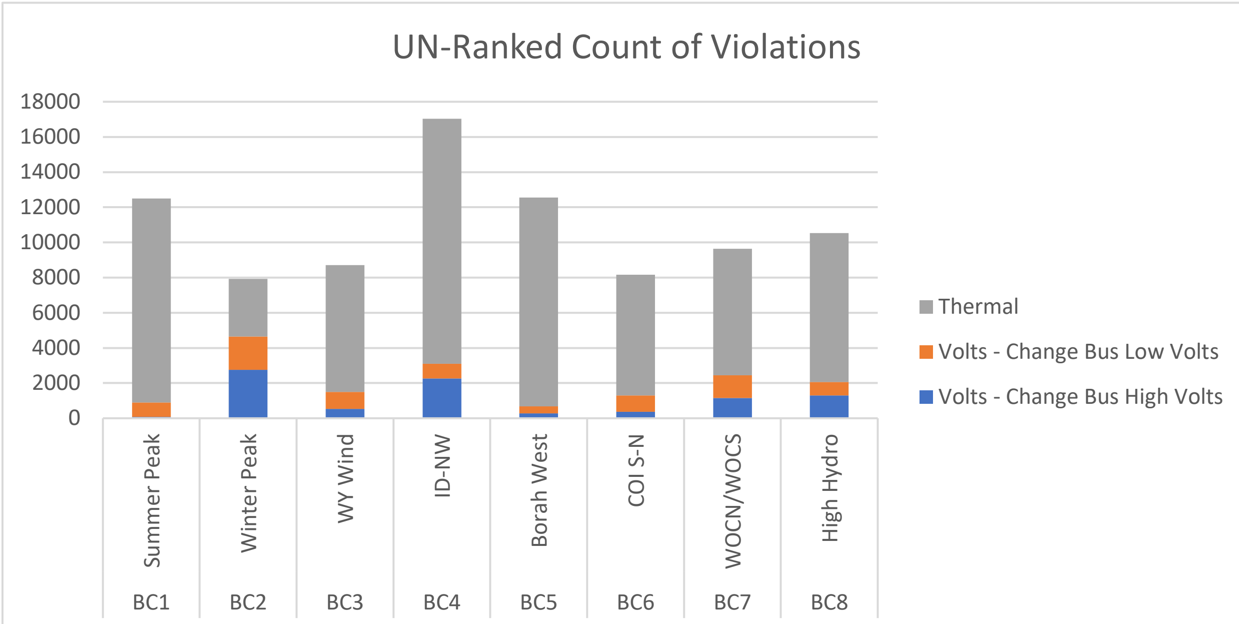


Figure 17: Un-Ranked contingency results for the BLMP

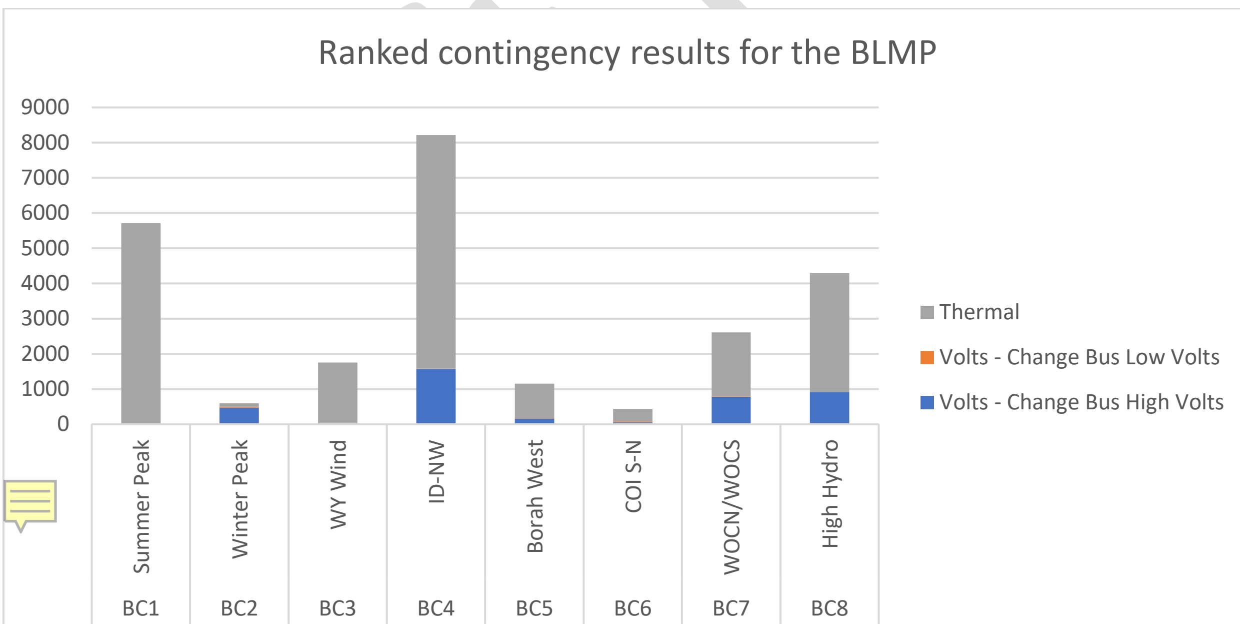


Figure 18: Ranked contingency results for the BLMP

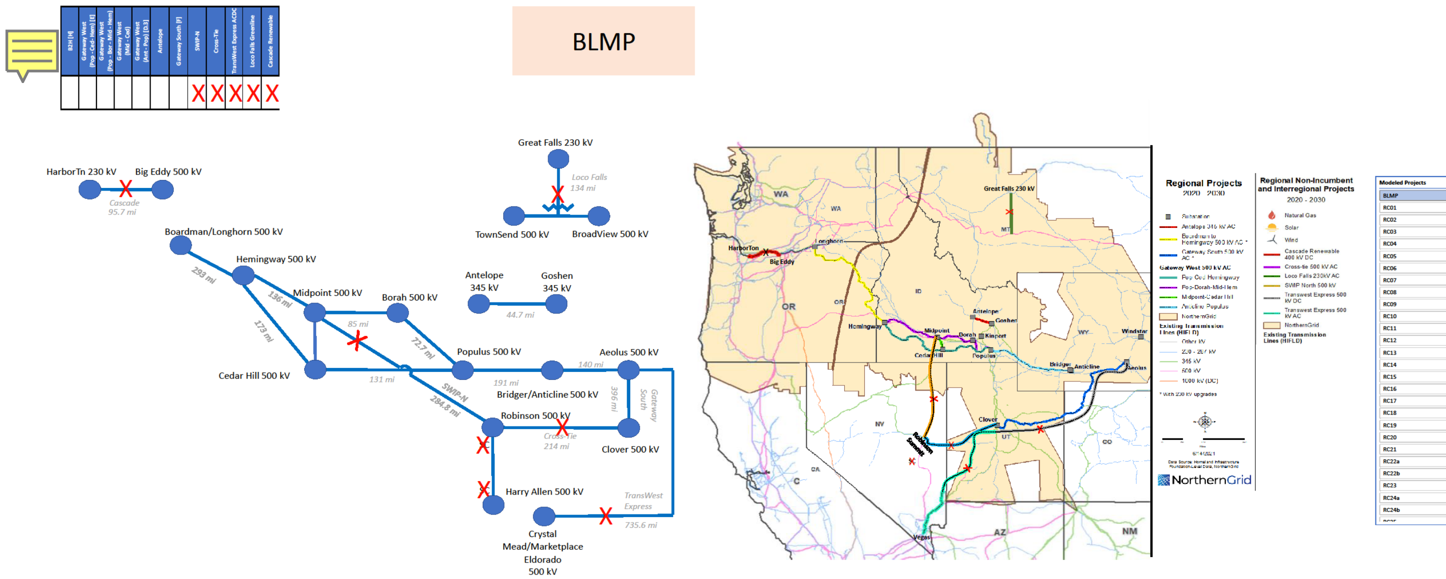
722 # Appendix D: Complete list of all RC combos

723 *Table 5: Working version of the Regional Combinations Table*

Modeled Projects	Filter	B2H [H]	Gateway West (Pop - Ced- Hem) [E]	Gateway West (Pop - Bor - Mid - Hem)	Gateway West (Mid - Ced)	Gateway West (Ant - Pop) [D.3]	Antelope	Gateway South [F]	SWIP-N	Cross-Tie	TransWest Express ACDC	TransWest ExpressDC 0 MW Schedule	TransWest Express DC 500 MW Schedule	TransWest Express DC 1100 MW Schedule	TransWest Express DC 1500 MW Schedule	Loco Falls Greenline	Cascade Renewable	Cascade Renewable DC 0 MW Schedule	Cascade Renewable DC 500 MW Schedule	Cascade Renewable DC 1100 MW Schedule	SWIP-N Gen	Cross-Tie Gen	TWE 1500 MW Gen
BLMP		X	X	X	X	X	X	X															
RC01		X					X																
RC02		X					X	X															
RC03		X	X			X	X	X															
RC04		X	X		X	X	X	X															
RC05		X		X		X	X	X															
RC06		X	X			X	X																
RC07		X	X		X	X	X																
RC08		X		X		X	X																
RC09							X	X															
RC10			X			X	X	X															
RC11			X		X	X	X	X															
RC12				X		X	X	X															
RC13			X			X	X																
RC14			X		X	X	X																
RC15				X		X	X																
RC16							X		X														
RC17			X			X	X	X	X														
RC18		X	X			X	X		X														
RC19		X					X	X	X														
RC20		X	X				X	X	X														
RC21		X				X	X	X	X														
RC22a							X			X													
RC22b							X	X		X													
RC23			X			X	X	X		X													
RC24a		X	X			X	X			X													
RC24b		X	X			X	X	X		X													
RC25		X					X	X		X													
RC26		X	X				X	X		X													
RC27		X				X	X	X		X													
RC28							X				X	X											
RC29 03		X	X			X	X	X			X	X											
RC29 05		X		X		X	X	X			X	X											
RC30a							X				X		X										
RC30b 03		X	X			X	X	X			X		X										
RC30b 05		X		X		X	X	X			X		X										
RC31a							X				X			X									
RC31b 03		X	X			X	X	X			X			X									
RC31b 05		X		X		X	X	X			X			X									
RC31c							X				X				X								
RC31d 03		X	X			X	X	X			X				X								
RC31d 05		X		X		X	X	X			X				X								
RC32							X									X							
RC33 03		X	X			X	X	X								X							
RC33 05		X		X		X	X	X								X							
RC34a							X										X	X					
RC34b							X										X		X				
RC34c							X										X			X			
RC35a 03		X	X			X	X	X									X	X					
RC35a 05		X		X		X	X	X									X	X					
RC35b 03		X	X			X	X	X									X		X				
RC35b 05		X		X		X	X	X									X		X				
RC35c 03		X	X			X	X	X									X			X			
RC35c 05		X		X		X	X	X									X			X			
RC36							X		X														
RC37 03		X	X			X	X	X	X														
RC37 05		X		X		X	X	X	X														
RC38							X			X													
RC39 03		X	X			X	X	X		X													
RC39 05		X		X		X	X	X		X													
RC40							X																
RC41							X		X	X	X			X		X	X			X			
RC42		X	X	X	X	X	X	X	X	X	X			X		X	X			X			
RC43			X				X																
RC44				X			X																
RC45					X		X																
RC46						X	X																
RC31c G	//						X				X				X								G
RC31d 03 G	//	X	X			X	X	X			X				X								G
RC31d 05 G	//	X		X		X	X	X			X				X								G
RC36 G	//						X		X												G		
RC37 03 G	//	X	X			X	X	X	X												G		
RC37 05 G	//	X		X		X	X	X	X												G		
RC38 G	//						X	X		X												G	
RC39 03 G	//	X	X			X	X	X		X												G	
RC39 05 G	//	X		X		X	X	X		X												G	

Appendix E: Visual Aides for the Regional Combinations

Each combination is visually depicted in the document which can be accessed by double-clicking the icon below.



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Appendix F: NorthernGrid Contingencies

The entire list of contingencies analyzed can be accessed by double-clicking the icon below.

Area Name	Category	Name	kV Class
APS	P6	Double Palo Verde	
NORTHWEST	P1.1/P1.2(GENTIE)	Thornton-Palouse Wind 230 kV	230
NORTHWEST	P1.1/P1.3(GSU)	Cabinet Gorge GSU (12) 230/13.8 kV	230
NORTHWEST	P1.1/P1.3(GSU)	Cabinet Gorge GSU (34) 230/13.8 kV	230
NORTHWEST	P1.1/P1.3(GSU)	Noxon #1 230/13.8 kV	230
NORTHWEST	P1.1/P1.3(GSU)	Noxon #2 230/13.8 kV	230
NORTHWEST	P1.2	Beacon-Bell #4 230 kV	230
NORTHWEST	P1.2	Beacon-Bell #5 230 kV	230
NORTHWEST	P1.2	Beacon-Boulder 230 kV	230
NORTHWEST	P1.2	Beacon-Rathdrum 230 kV	230
NORTHWEST	P1.2	Bell-Westside 230 kV	230
NORTHWEST	P1.2	Benewah-Boulder 230 kV	230
NORTHWEST	P1.2	Benewah-Moscow 230 kV	230
NORTHWEST	P1.2	Benewah-Pine Creek 230 kV	230
NORTHWEST	P1.2	Benewah-Thornton 230 kV	230
NORTHWEST	P1.2	Boulder-Lancaster 230 kV	230
NORTHWEST	P1.2	Cabinet-Noxon 230 kV	230
NORTHWEST	P1.2	Cabinet-Rathdrum 230 kV	230
NORTHWEST	P1.2	Coulee-Westside 230 kV	230
NORTHWEST	P1.2	Dry Creek-Lolo 230 kV	230
NORTHWEST	P1.2	Dry Creek-North Lewiston 230 kV	230
NORTHWEST	P1.2	Dry Creek-Talbot 230 kV	230
NORTHWEST	P1.2	Hatwai-Lolo 230 kV	230
NORTHWEST	P1.2	Hatwai-Moscow 230 kV	230
NORTHWEST	P1.2	Hatwai-North Lewiston 230 kV	230
NORTHWEST	P1.2	Hot Springs-Noxon #1 230 kV	230
NORTHWEST	P1.2	Hot Springs-Noxon #2 230 kV	230
NORTHWEST	P1.2	Lancaster-Noxon 230 kV	230
NORTHWEST	P1.2	Lancaster-Rathdrum 230 kV	230
NORTHWEST	P1.2	Libby-Noxon 230 kV	230
NORTHWEST	P1.2	North Lewiston-Shawnee 230 kV	230
NORTHWEST	P1.2	Noxon-Noxon Reactor 230 kV	230
NORTHWEST	P1.2	Noxon-Pine Creek 230 kV	230
NORTHWEST	P1.2	Shawnee-Thornton 230 kV	230
NORTHWEST	P1.2	Walla Walla-Saddle Mountain 230 kV	230
	P1.2	Wanapum-Saddle Mountain 230 kV	230
NORTHWEST	P1.2	Latah Junction-Moscow 115 kV (LAT-GAR)	115
NORTHWEST	P1.2	Latah Junction-Moscow115 kV (M23-GAR)	115
NORTHWEST	P1.2	Moscow-Orofino 115 kV	115

Appendix G: BLMP BC1-8 Case Load, Generation, and Path Summary OR WECC bubble diagrams for NorthernGrid footprint

(RESERVED)

Appendix H: Complete list of all ADS opportunities supplied to WECC

Document is accessible by double-clicking the image below.

PCM to PF Data Quality Issues			
Item	**Issue**	**Discussion**	**Data Issue; Software Solution**
1	GCPD loads - The loads in the NorthernGrid PCM cases appear to have been derived using the WECC *L&R forecast, rather than the NorthernGrid forecast*	JA - loads in the NorthernGrid PCM cases appear to have been derived using the WECC L&R forecast, rather than the NorthernGrid forecast March 2020 WECC L&R "Monthly" forecast should equal NorthernGrid forecast. Should be BA level load forecast, and not planning area forecast.	* NorthernGrid Data issue * BPA have loads for planning area and also for BA; working with BPA to confirm which forecast was submitted to the L&R * This is Tacoma, DPUD, BPA, IPC, PACE had BA mapping issues; populating BAs is required in the DPM but not all entities are populating them in WECC base cases. * Add to resource data repository * Requirements already listed in DPM
2	Bus mismatches' tab contains a sample of the extremely large bus mismatches present in the PCM case immediately in the EPC export (no Ron S. magic yet) – this is part of the solution difficulty, overcoming such large mismatches in the exported powerflow	The export from PCM to a powerflow case snapshot has some significant bus mismatches (worst in the example case was 4,762,977 MVA; 28 buses > 40,000 MVA mismatch); finding a way in PCM to reduce these on export would greatly help the solvability of the Powerflow cases – right now it takes a 'wizard' level engineer an hour and a half to make one case solve-able out of PCM. Ideally, we'd like to skip the wizard step and have the cases solvable upon export.	* Issue has to do with not having the right voltage angle when adding a new bus. we've been using 1. Pu. * Power Flow uses "Angle Smoothing"; use voltage and angle averages on adjacent busses. If new bus is on a radial branch, use the voltage and angle on the connecting bus. WECC staff will do this edit (add instruction in DDVM) * ABB will look into a potential software solution * Run data sanity check in GridView to determine the extent of the issue; use up to 30 degrees check. Apply check to branches. * All generators should be exported. * Generators on parked busses; appear to be dispatching in PCM but not in power flow * ABB – Jin will validate * Tyler – have posted a new PF, AC solved where
3	Do NOT modify topology in any way	GridView can do what it needs to do behind the scenes but literally the imported power flow and exported power flow topology need to match exactly	Agree. The issue has to do with tracking topology changes and reflect that in the reference case. Develop a process to apply edits in the power flow reverence case: * Topology – read in from epc file * DC lines- sending end power, rectifier, inverter (alpha, gama) * Phase shifters * Negative load * Generators – voltage control, Pmax, Pmin, Qmax, Qmin, technology
4	Addition of speculative generation might be allowable but there is no reason why that can't be manually added in the process of reading in the import power flow case	Agree – initial changes to generators should be applied in power flow	
5	Well bounded load profiles and generation dispatch are the only allowable parameters that the PCM should modify	ZZ - think Tracy would support PCM modifying DC line flow/direction and phase shifter adjustments in support of matching the PCM internal model with the exported PowerFlow case, based on other correspondence.	
6	What generator representations are in which of the three models	This check spoke to the generator mapping challenges – I see this as a WECC data management piece, not a software piece provided review tables for the generators e.g., 1) heat rate for generator limit 2) PF limits want to see PF limits honored.	* Data issue; conversation ongoing at WECC. * Need more than one season PF gen rating in the PCM; perhaps also model winter PF case in addition to summer PF

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