Regional Transmission Plan for the 2020-2021 NorthernGrid Planning Cycle

NorthernGrid Member Planning Committee (MPC)
Approval Date: December 8, 2021

Acknowledgements:

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BHE U.S. Transmission (MATL)

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Chelan County PUD

Grant County PUD

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NorthWestern Energy

PacifiCorp

Portland General Electric

Puget Sound Energy

Seattle City Light

Snohomish County PUD

Tacoma Power

Interregional or non-Incumbent Transmission Project Sponsors

PowerBridge, Cascade Renewable Project

Absaroka, Loco Falls

TransCanyon, LLC, Cross-Tie

TransWest, TransWest Express

Great Basin Transmission, LLC, Southwest Intertie Project North

Neighboring Regional Entities

CAISO

WestConnect

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Idaho PUC

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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 Federal Energy Regulatory Commission (FERC) Orders No. 890 and 1000, in accordance with each Enrolled Party's[1] Open Access Transmission Tariff (OATT) Attachment K – Regional Planning Process and NorthernGrid 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 Path (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.

[1] Definition of Enrolled Party from the NorthWestern Energy OATT: Enrolled Party means a Person that has satisfied the eligibility requirements set forth in Section 4.2.1 of this Attachment K and completed the process set forth in Section 4.2.2 of this Attachment K to become enrolled in NorthernGrid. Enrolled Parties is a collective reference to each Enrolled Party.

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.

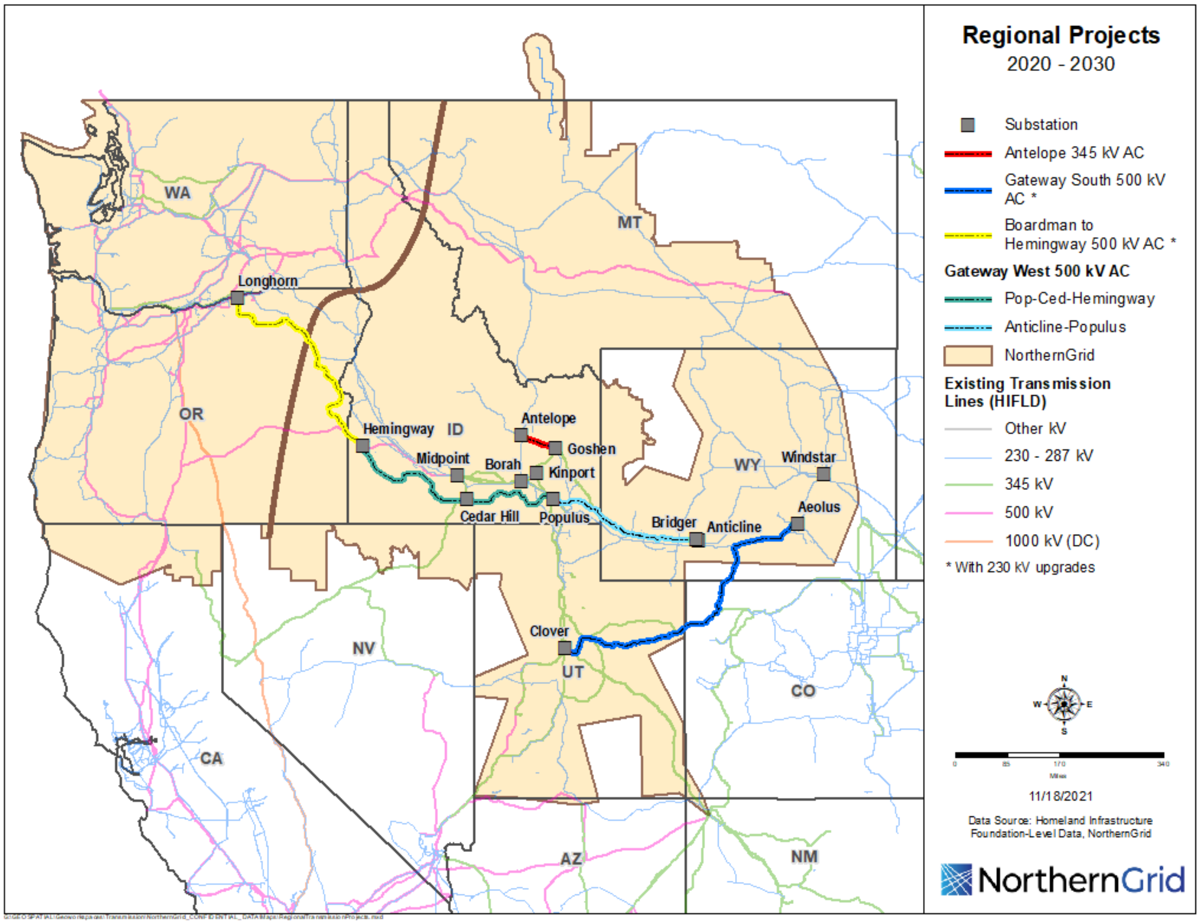

Figure 1: Regional Transmission Plan, regional combination {03}[2]

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 and were determined to be the most-efficient solution for the transmission system as they resulted in the fewest violations. The addition of the non-incumbent regional projects did reduce the reliability violations in the immediate vicinity of the respective projects. While this finding is promising, the cost of the projects did not justify adding them into the Regional Transmission Plan. Similarly, the interregional projects did not result in sufficient improvement of the transmission system to warrant including them in the Regional Transmission Plan.

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[2] 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 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 power flow contingency 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 commissions, 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; 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. However, 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.

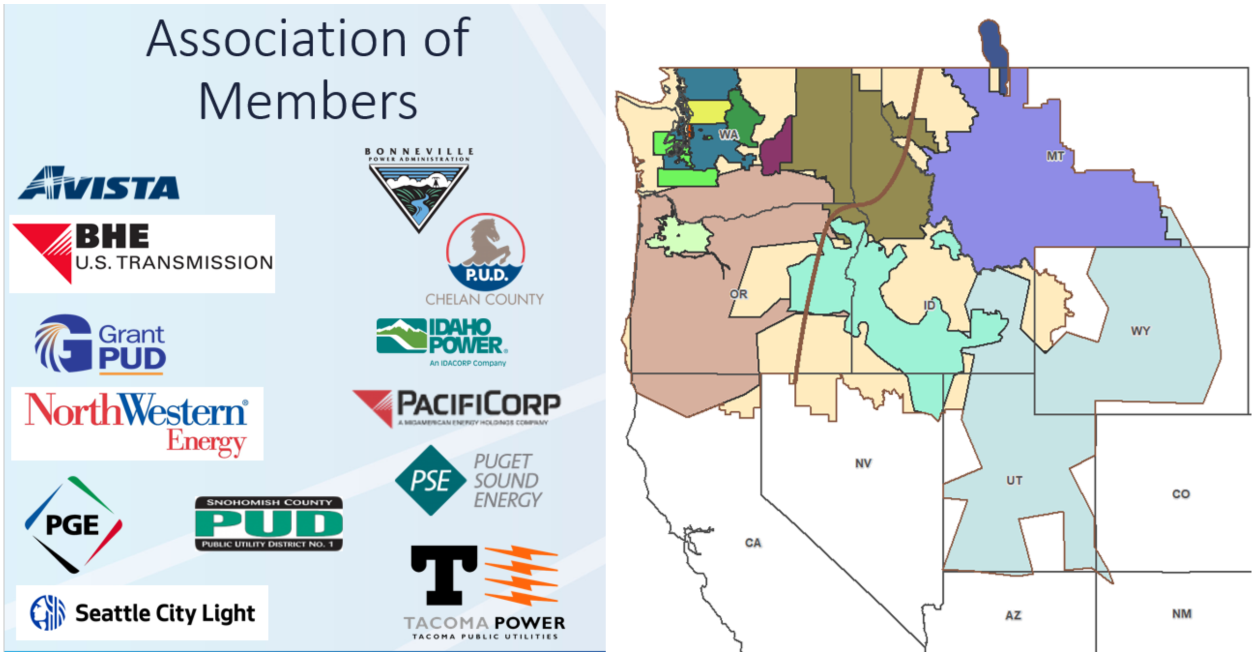

Figure 2: NorthernGrid footprint

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 Order No. 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.

There are many factors that get considered in a long-term planning process. Utilities are charged with maintaining the reliability of the transmission system as well as ensuring there are sufficient resources and/or transmission service arrangements to serve their respective loads. FERC No. 890 and No. 1000 mandate long-term, coordinated planning at both the local and regional levels. North American Electric

Reliability Corporation (NERC) planning standard TPL-001-4 provides criteria for performing contingency analysis on facilities 100 kV and above and is used in the FERC planning process.

Integrated resource planning is a complex process that each utility undertakes to identify and meet its respective generation portfolio needs. Resource planning may contemplate market-driven transmission sales, public policy requirements and/or considerations, environmental impacts, corporate business goals, resource adequacy, and/or any other slew of topics that consider or influence the relationship between the consumer and the utility.

The timelines for resource and reliability planning are not one and the same; each follows its own cycle according to its respective requirements. The timeline for reliability planning is prescribed, cyclical, and regular: in January of every even-numbered year, a twenty-four-month cycle is initiated for the purposes of producing a regional transmission plan by the end of December in every odd-numbered year. This twenty-four-month cycle is listed in the open access transmission tariffs of all the FERC-jurisdictional utilities and is specified in the Member Planning Committee agreement for those non-FERC-jurisdictional utilities that are members of the NorthernGrid planning process.

The cycle for resource planning is not necessarily "universal" in that all utilities adhere to the same schedule; the timelines for resource planning are not as prescribed or regular and may be dependent on external factors such as changes to public policy. Resource planning cycles that initiate at or near the beginning of a transmission planning cycle or make a shift during the two-year transmission planning cycle may not necessarily get reflected in the current transmission planning cycle. Once a new resource need is identified, utilities not only need to identify the public policy-driven resource need for their system, they also have to start an open and transparent bidding process to notify all of their need for resources. There are many mechanisms that drive the need for resource procurement; a change to public policy requirements is a simple example that illustrates the inherent complexity in any given resource procurement process.

There is a relationship between resource planning and reliability planning. Once the results of the resource bid are known, the reliability analysis needed to incorporate the results of the resource bid can begin. Transmission models can then be updated to analyze the impacts of the resources identified in the resource procurement process.

Because of all the intricacies involved in a resource procurement process, from the identification of the resource through to the identification of the transmission facilities needed to support the output of the selected resource, there is the opportunity that resources that are identified in a resource procurement process are not necessarily reflected in the current regional planning study.

Annually, the member utilities each compile their collective needs into the form of a Loads and Resources data submittal which gets submitted to Western Electric Coordinating Council (WECC) as part of WECC's base case building process. NorthernGrid uses those WECC base cases in the planning process.

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 utility 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. An 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. Another example is that of a resource being placed on a bus with insufficient capacity in which case that resource may cause violations in the base case. WECC is considering how to improve the model building process for the ADS with consideration given to those provided topics. 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; Appendix G also shows the Path Flows

Condition	Date	Hour Ending, Pacific time	NorthernGrid Generation (MW)	NorthernGrid Load (MW)
NorthernGrid region summer peak load	July 30	16:00	45781	42111
NorthernGrid region winter peak load	December 10	19:00	45981	43603
High Wyoming Wind	February 1	1:00	34174	30261
High Idaho to Northwest path [west to east]	July 20	17:00	45175	38256
High Borah West path [east to west]	September 29	1:00	27760	21634
High COI path [south to north]	March 10	15:00	26046	28812
High West of Cascades paths [east to west]	April 3	11:00	36812	34705
High COI and PDCI paths with high hydro [north to south]	June 4	18:00	45447	34855

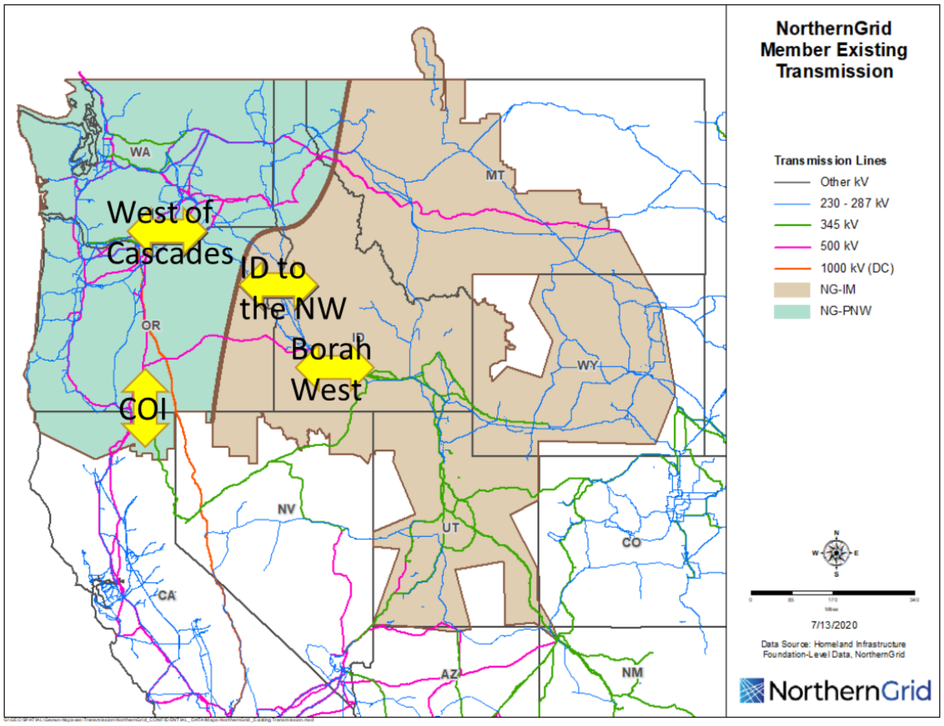

Figure 3: Paths of interest to the NorthernGrid footprint

Figure 3 above is a visual complement to Table 1 and 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, only those that are particularly useful in describing the flow patterns on the NorthernGrid transmission system for the different stressed conditions. The California-Oregon Intertie (COI) is needed for interregional 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.

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 power flowing through a piece of equipment exceeds 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. Operationally, there are multiple ways to mitigate thermal overloads. 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 power or redirecting the power to pieces of equipment with larger capabilities.

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. Inserting capacitor banks acts to increase the voltage and inserting reactor banks acts to reduce the voltage. These switching sequences do not add further stress or burden to the transmission system as they compensate for 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 meet 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. Planned future regional projects is an undefined term that generally refers to transmission projects that have been identified and possibly funded, but are typically not yet in construction. 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 or efficiently meet the needs of the NorthernGrid footprint while maintaining system reliability.

BLMP

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

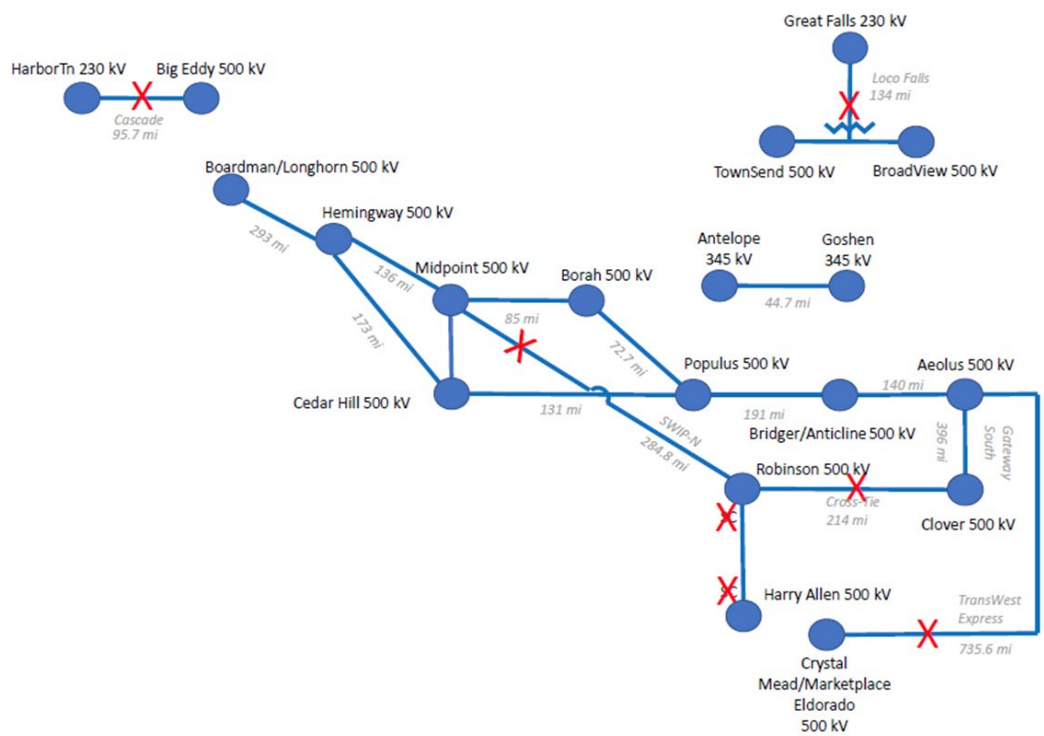

Figure 4: "Stick figure" representation of the BLMP, a red "X" denotes an element that is NOT a part of the BLMP

The displayed connection between Robinson 500 kV and Harry Allen 500 kV is related to the SWIP North project and not indicative of existing facilities.

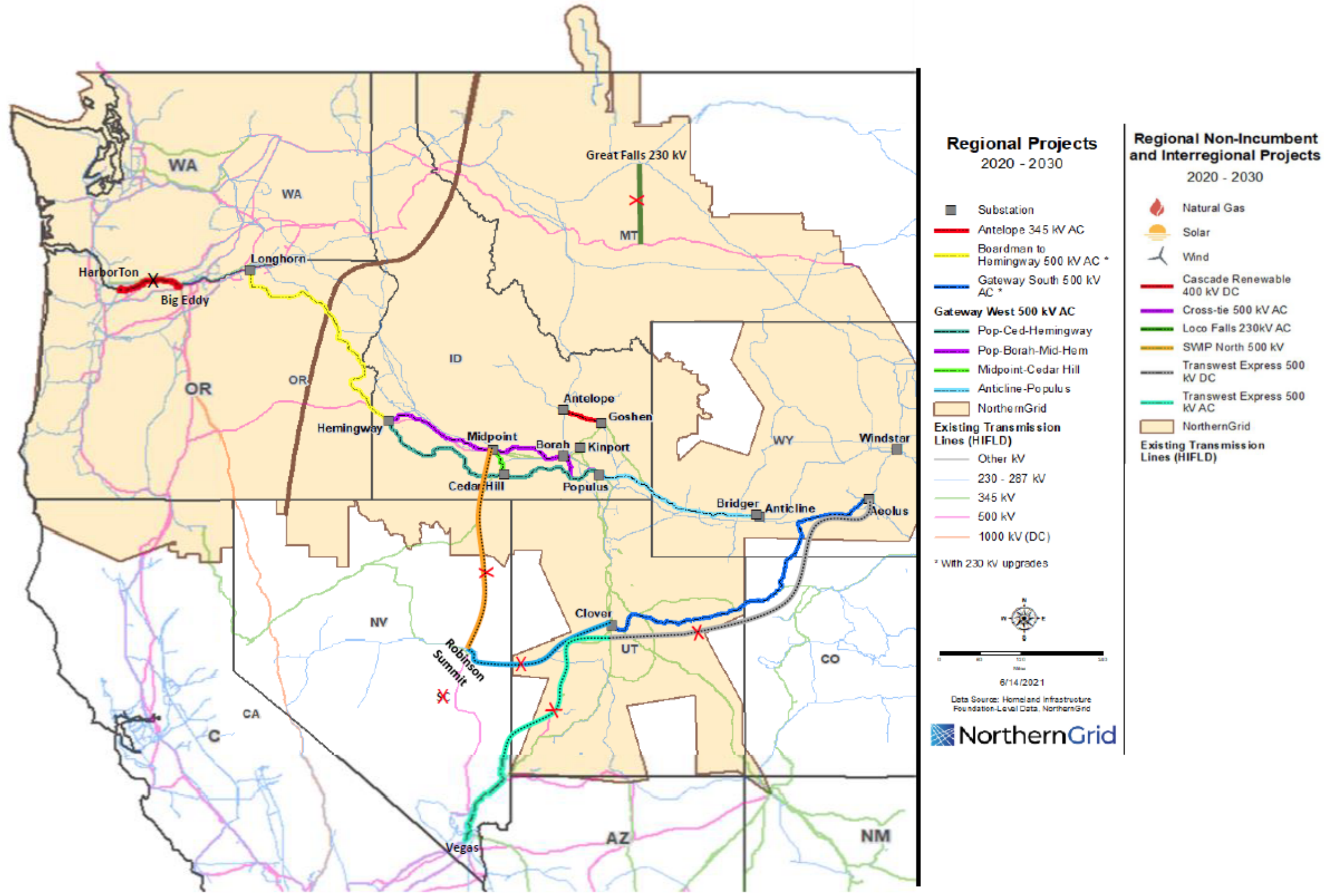

Figure 5: NorthernGrid geographical overlay with all Regional, Interregional, and Non-Incumbent Regional projects displayed

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 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.

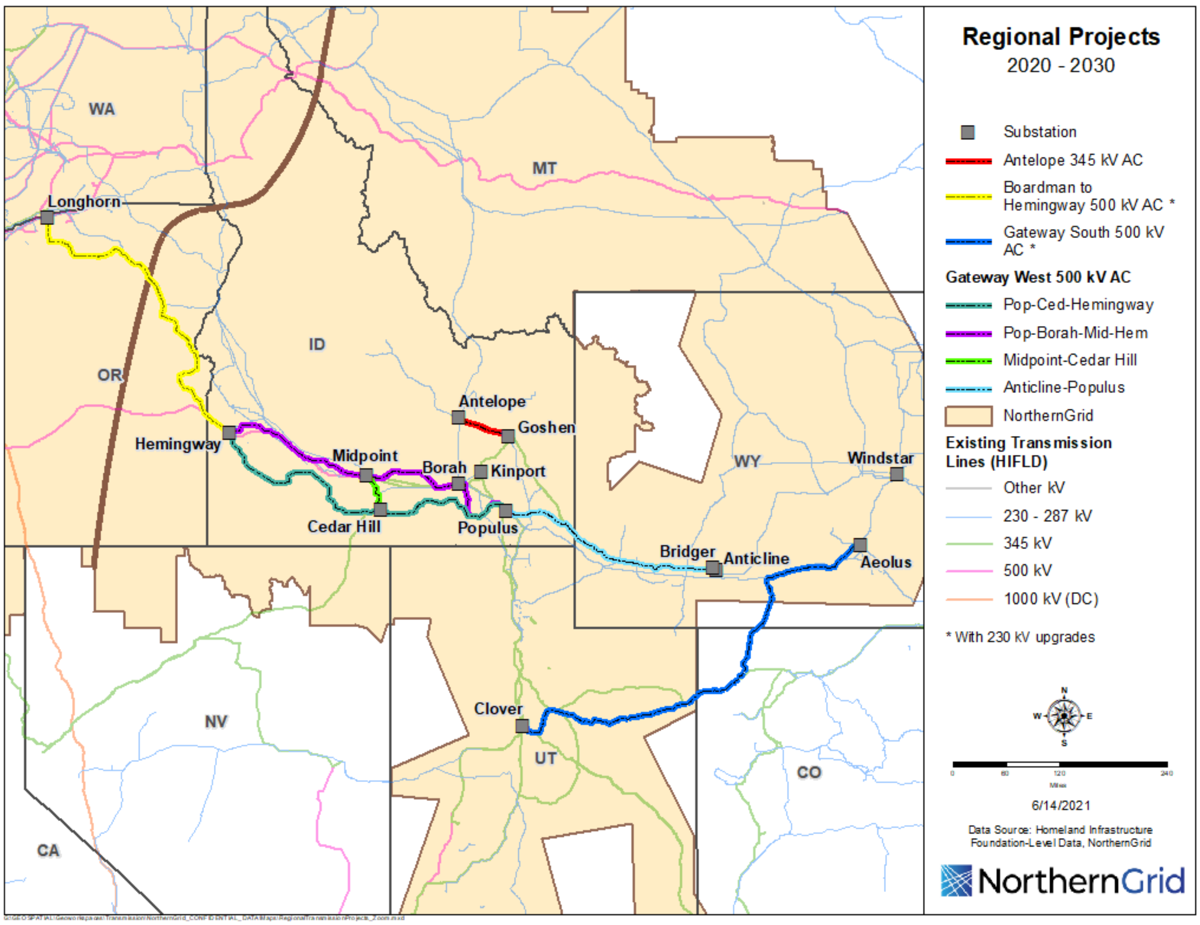

Figure 6: NorthernGrid footprint with regional project overlay. Proposed 345 kV and 500 kV facilities are displayed.

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 as they are needed to integrate B2H into Idaho Power's system. 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) has the same in-service date as the Aeolus-Clover project for simplicity. 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, only the Populus-Cedar Hill-Hemingway and Anticline-Populus 500 kV lines were selected into the 2018-2019 Northern Tier Transmission Group Plan.

Interregional and Non-Incumbent Regional Projects

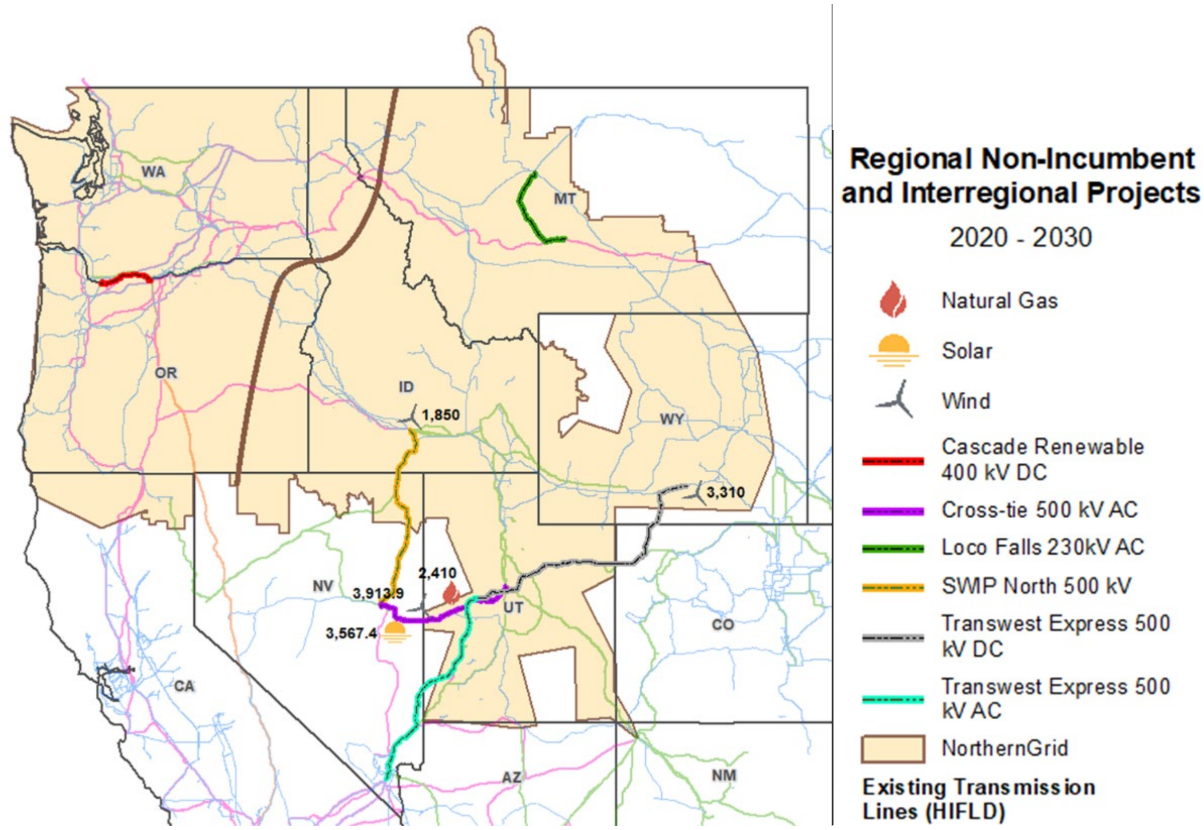

Figure 7: Regional Non-Incumbent and Interregional Projects

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.

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 outages 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 events that result in the loss of multiple pieces of equipment. Because of this, single outage contingencies were given a larger ranking factor than multi-outage 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

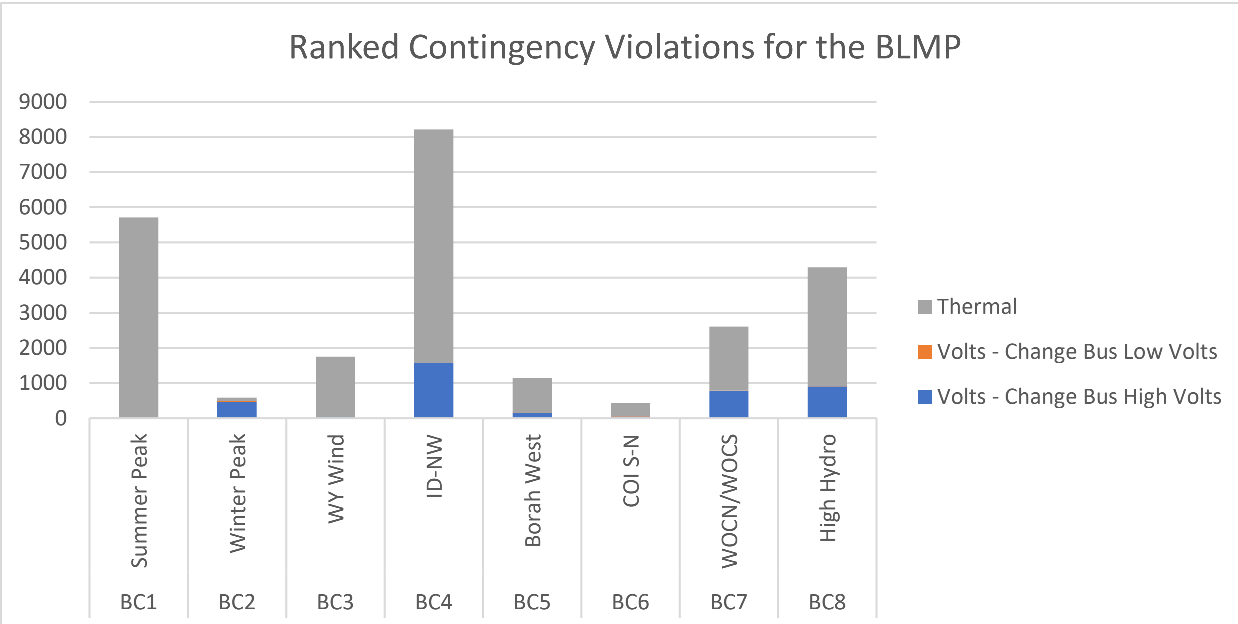

Figure 8: Ranked contingency results for the eight BLMP base cases

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 overloads identify the portions of the system that may need infrastructure improvement to support the movement of power whereas voltage changes identify the portions of the transmission system that may need reactive equipment (capacitors or reactors) 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. There are fewer thermal overloads 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 power flow through equipment without causing damage.
2. Northbound flow conditions on the California-Oregon Intertie (COI) resulted in the fewest violations of the 8 cases.
3. The Summer Peak operating condition resulted in many 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.

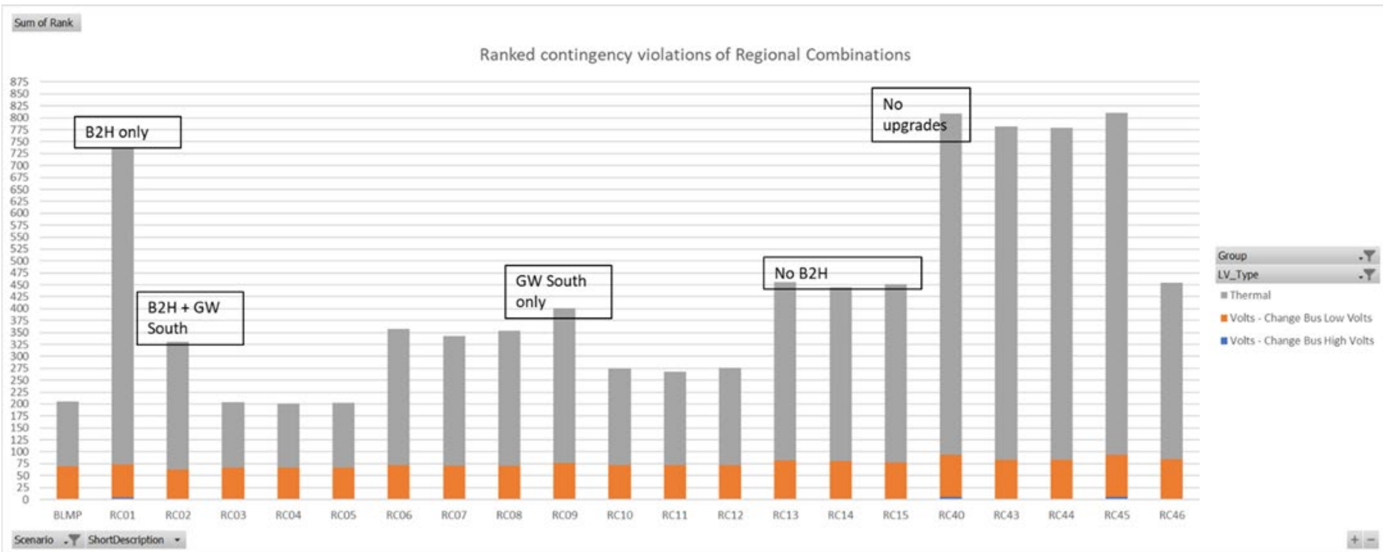

Figure 9: Ranked contingency results, all regional combinations with all cases

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 Boardman to Hemingway , Gateway West and Gateway South projects upgrade the transmission system by adding transmission facilities to enhance the system between Oregon, Idaho, Wyoming, and Utah, with a parallel path across Idaho between Hemingway and Populus. The subsets are intended to help determine if all of the Gateway projects (Segment E) 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.

In summary, 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}.

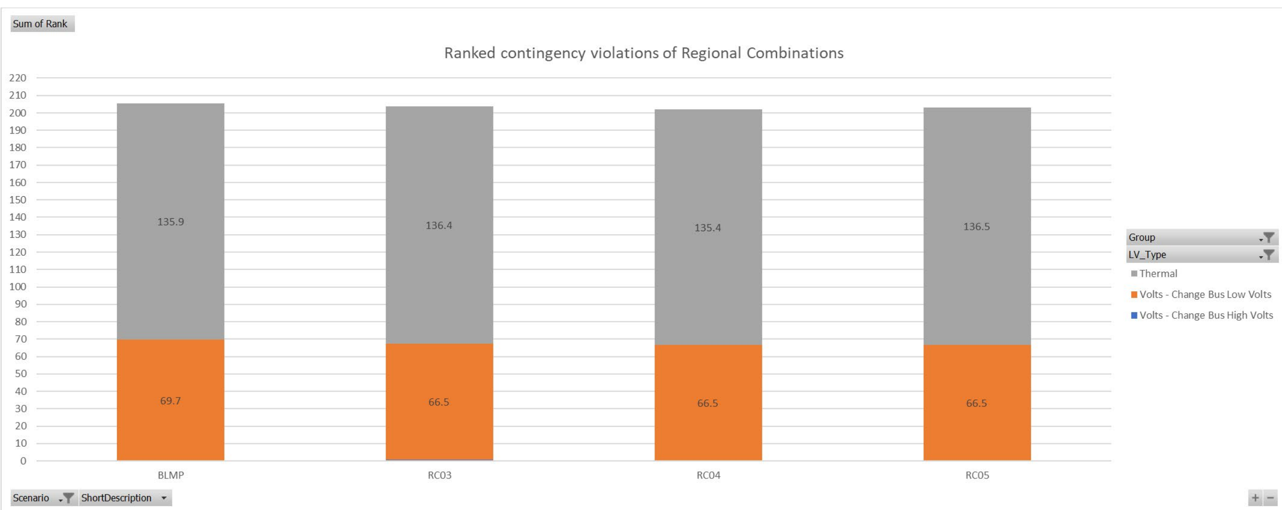

Figure 10: Ranked contingency results for regional combinations {03, 04, 05}

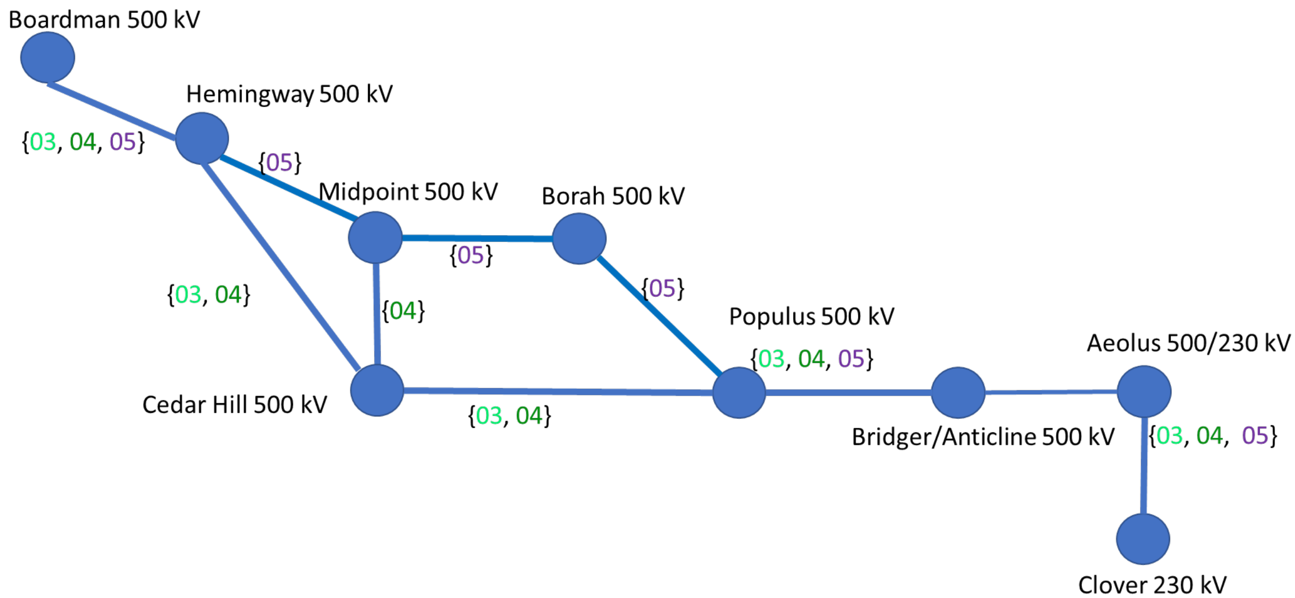

Figure 11: Regional combinations {03, 04, 05}

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 power to flow. Regional combination {03} also mitigates the limiting contingency; currently, the limiting contingency for power transfers 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 appear to fundamentally improve the reliability results over regional combniation {03} as can be seen in the results in Figure 11; therefore, regional combination {04} will be removed from further scrutiny.

Regional combination {05} rebuilds existing facilities and does not create a new path for power 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.

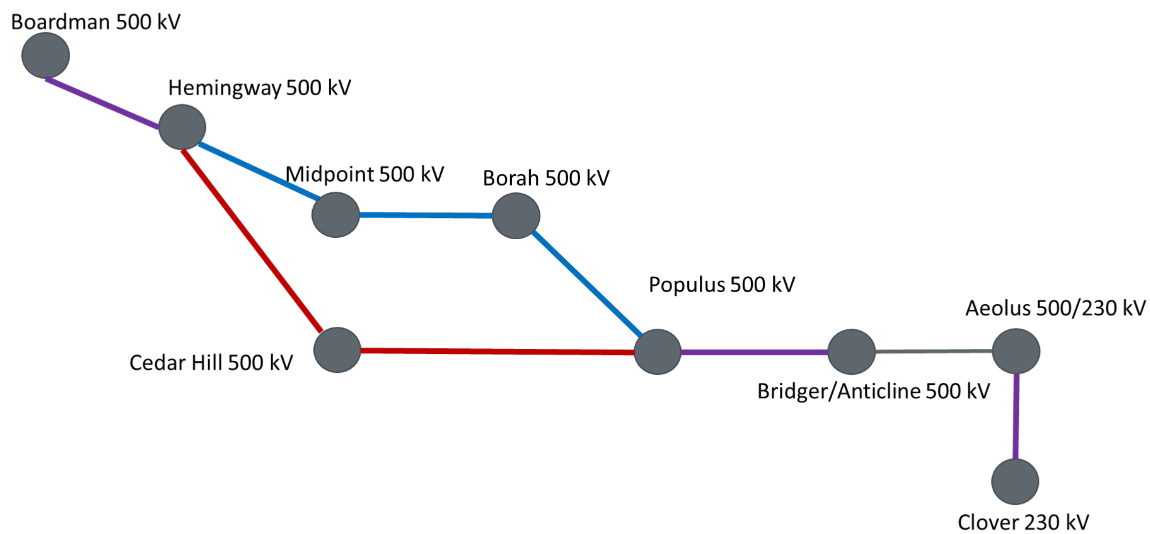

Figure 12: Regional Projects ***{03}*** *and* ***{05}***

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 (Segment E) project are needed to support the reliability of the NorthernGrid footprint in the 10-year planning horizon. Only a single upgraded path is required between Populus and Hemingway; either south through Cedar Hill or north through Borah.

The Populus-Cedar Hill-Hemingway route increases the capacity on the transmission system between Populus and Hemingway. The segments associated with the Populus-Cedar Hill-Hemingway line are new whereas for the Populus-Borah-Midpoint-Hemingway line, only the Populus-Borah and Midpoint-Hemingway segments are new. The Borah-Midpoint segment is an upgrade to an existing facility. The main contingency for the Populus-Borah-Midpoint-Hemingway segment is the loss of the line that is getting upgraded, which results in a lesser system capacity upgrade. The Populus-Cedar Hill-Hemingway facilities provide an alternate route for power to flow, which increases the capacity of the system. Conservative estimates suggest that upwards of 850 MW of transmission capacity can be gained through the addition of the Populus-Cedar Hill-Hemingway facilities over the Populus-Borah-Midpoint-Hemingway upgrades.

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.

Three interregional and two non-incumbent regional projects were evaluated to determine if their inclusion in the plan 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.

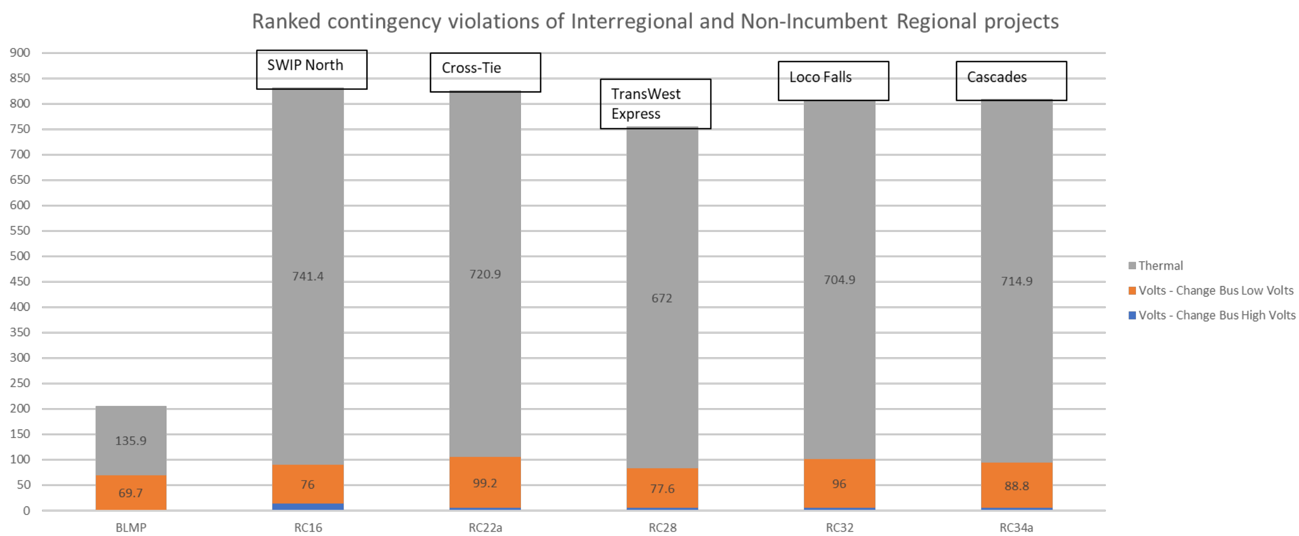

Figure 13: Each interregional or non-incumbent regional project with no regional upgrades

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.

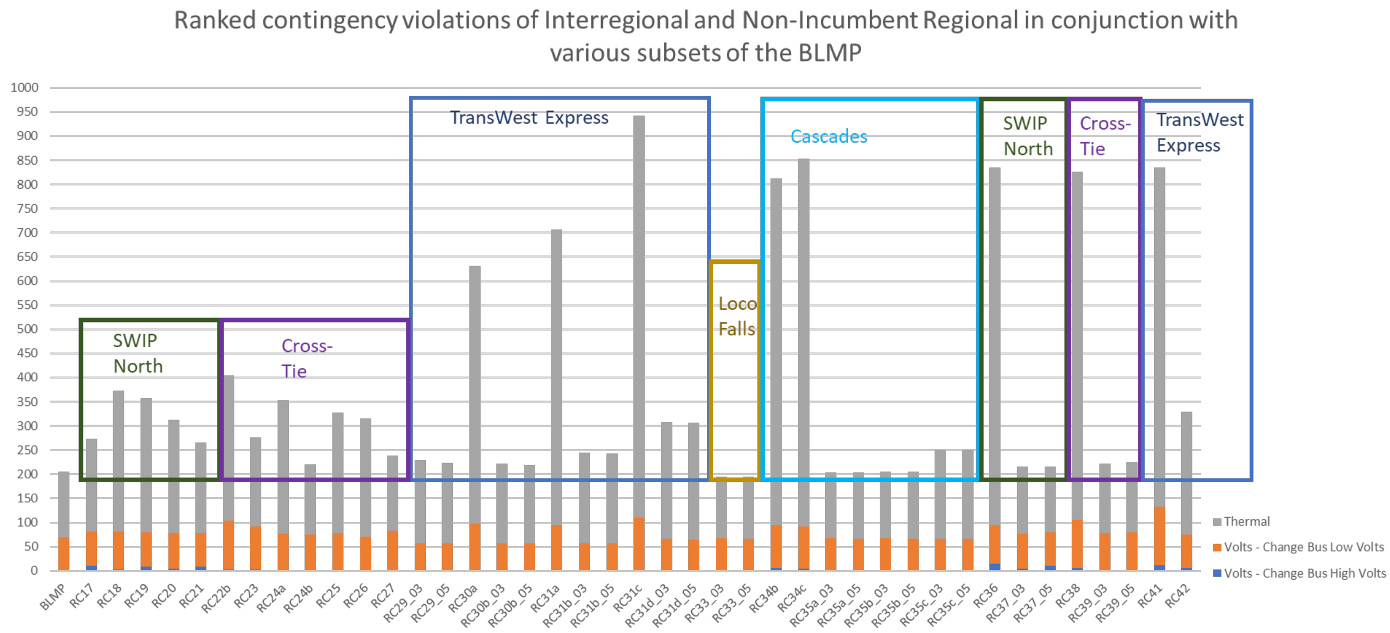

Figure 14: Second stage of interregional and non-incumbent regional analysis; the colors are only to help visualize the groupings

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}.

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.

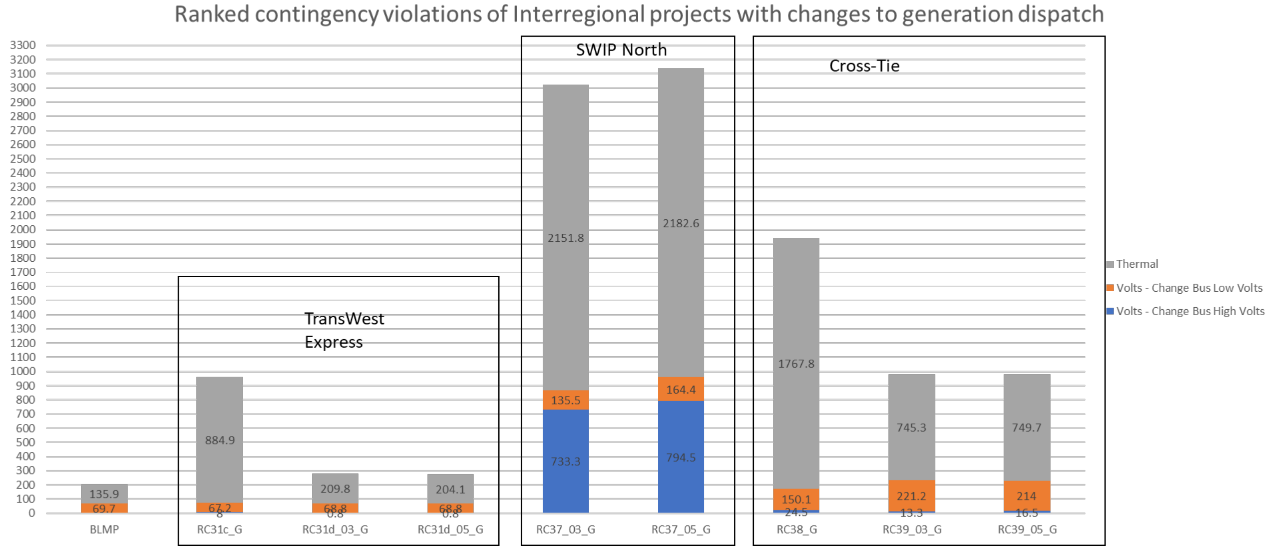

Figure 15: Interregional and Non-Incumbent with generation changes

SWIP North by itself and with generation changes yielded a ranked contingency result near 25,000 and is not depicted in Figure 14 due to scaling issues.

Consistent with previously seen results, when interregional and non-incumbent projects are coupled with the leading regional combinations, the combined set has performance comparable to the leading regional combinations without the interregional or non-incumbent project. Therefore, the interregional and non-incumbent projects are unnecessary to meet NorthernGrid's needs, and will not be included in the NorthernGrid Plan.

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 Scope provides the complete list of developers who pre-qualified through the Northern Tier Transmission Group 2018-2019 planning process.

Regional Transmission Plan

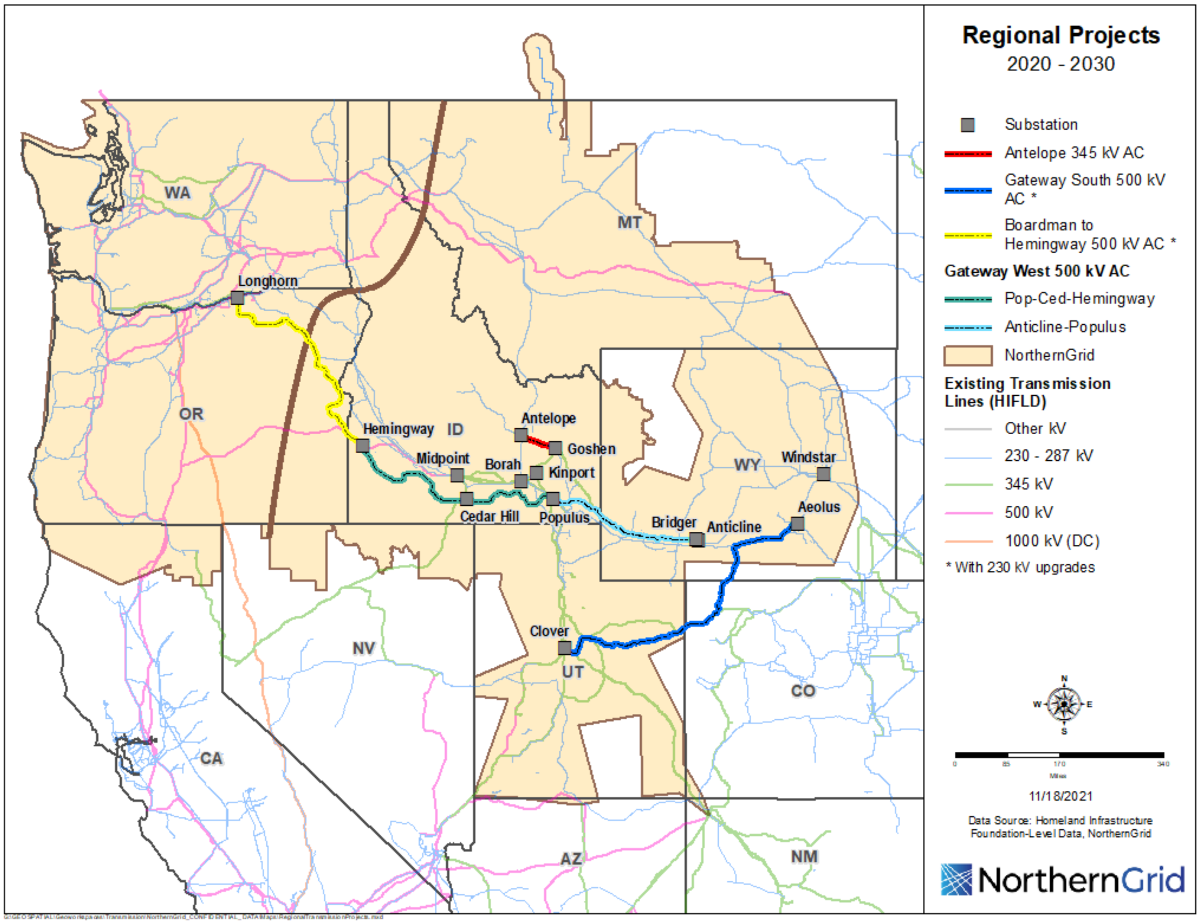

Figure 16: The Regional Transmission Plan for the 2020-2021 NorthernGrid cycle

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 more efficient to build than the entire set of projects that comprise the BLMP.

Conclusion

The NorthernGrid planning effort for the 2020-2021 cycle culminated in the identification of a regional plan that is more efficient than a plan composed of a simple concatenation of all the Members' proposed projects. The transmission needs of the NorthernGrid transmission system: loads, resources, regional, and interregional projects including expected transmission arrangements, were provided by the members which collectively formed the basis for the Study Scope. For the 2020-2021 planning cycle, the base cases stemmed from the Anchor Data Set produced and maintained by WECC. The Anchor Data Set is relatively new and subject for improvement; NorthernGrid provided a list of specific improvement opportunities for WECC to consider. There were no economic studies requested in the

2020-2021 cycle and the projects submitted for cost allocation consideration were not selected into the Regional Transmission Plan. NorthernGrid analyzed well over 600 different base cases where each base case represented a selected hour combined with a selected set of transmission projects. Altogether, the set of transmission projects that resulted in a more efficient transmission system is that identified as regional combination {03}.

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.

Adobe Acrobat Document

Appendix B: Study Scope

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

Adobe Acrobat Document

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	Single element loss results in single element outage
P2	0.1	Single element loss results in multiple element outage
P3	0.075	Loss of generator followed by system adjustments
P4	0.1	Stuck breaker results in multiple element outage
P5	0.1	Delayed fault clearing results in multiple element outage
P6	0.075	Loss of single element followed by system adjustments
P7	0.1	Multiple element loss results in multiple element outage

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.

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 did not 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.

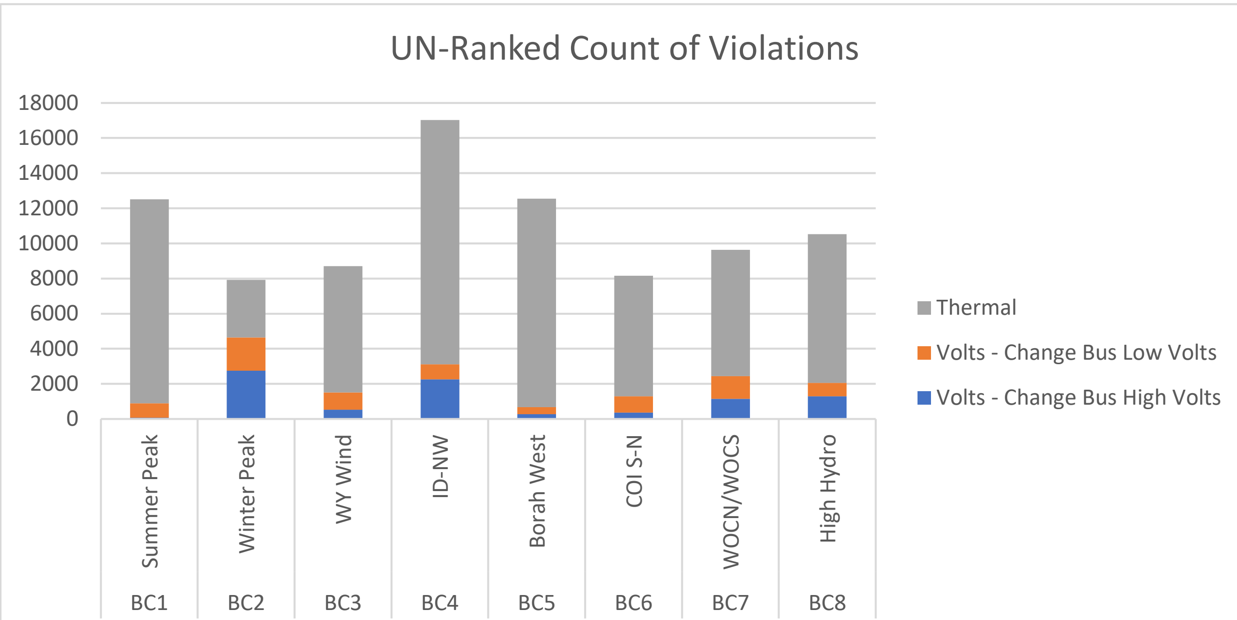

Figure 17: Un-Ranked contingency results for the BLMP

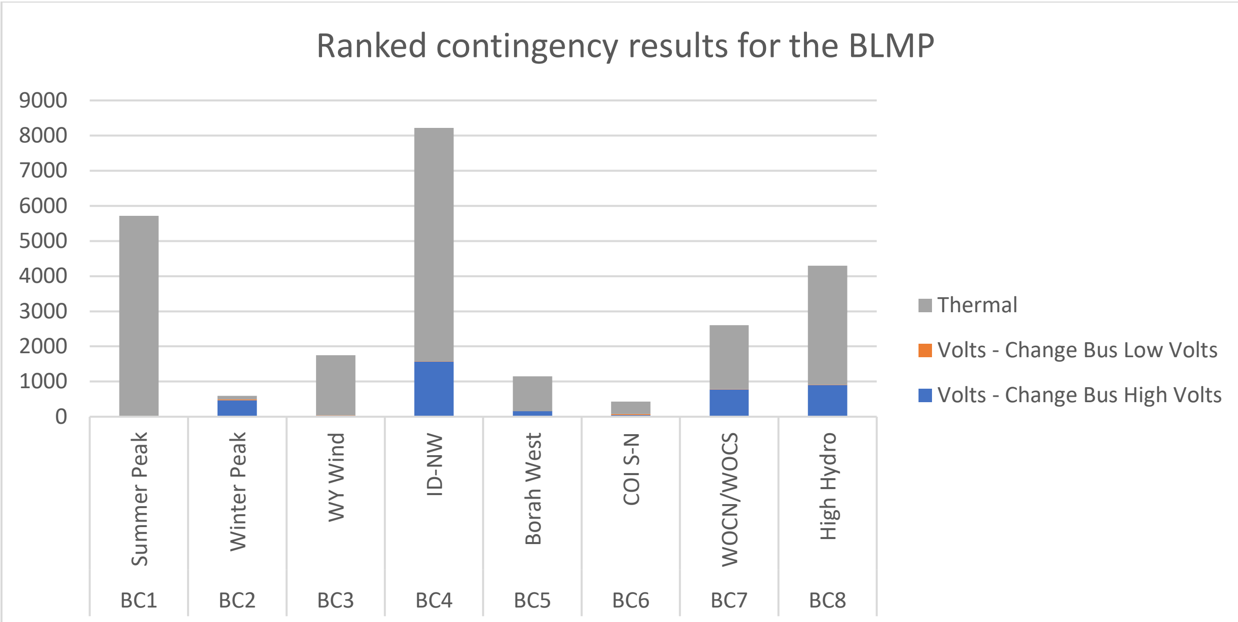

Figure 18: Ranked contingency results for the BLMP

Appendix D: Complete list of all RC combos

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.

Adobe Acrobat Document

Appendix F: NorthernGrid Contingencies

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

Adobe Acrobat Document

Appendix G: Base Case Summary

Base Case Name	Base Case Description	Generation (MW)	Load (MW)	West of Cascades-North, Path 4 (MW)	West of Cascades-South, Path 5 (MW)	Idaho-to-Northwest, Path 14 (MW)	Borah West, Path 17 (MW)	Pacific DC Intertie (PDCI), Path 65 (MW)	California-Oregon Intertie (COI), Path 66 (MW)
BC1	Summer Peak	45781	42111	3600	4141	-327	-43	147	3640
BC2	Winter Peak	45981	43603	5949	4512	1145	1771	1	1779
BC3	WY Wind	34174	30261	3973	3236	1470	2244	1	1794
BC4	ID-NW	45175	38256	3664	3691	-2431	-788	1309	4709
BC5	Borah West	27760	21634	2434	2490	2245	2616	627	3458
BC6	COI S-N	26046	28812	6251	4294	324	794	-2689	-3257
BC7	WOCN/WOCS	36812	34705	7693	5260	-1726	-1600	2800	484
BC8	High Hydro	45447	34855	6096	4011	-1334	-375	2151	4682

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

Document is accessible by double-clicking the image below.

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