NorthernGrid

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

NorthernGrid Member Planning Committee Approval Date: tbd

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 more cost effectively or efficiently meet the needs of the NorthernGrid members in a 10-year future.

The process started with a summary of transmission needs from each of the Members. For a 10-year future, each Member submitted their forecasted load, expected resource additions or retirements, 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 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. 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. 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. 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 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.

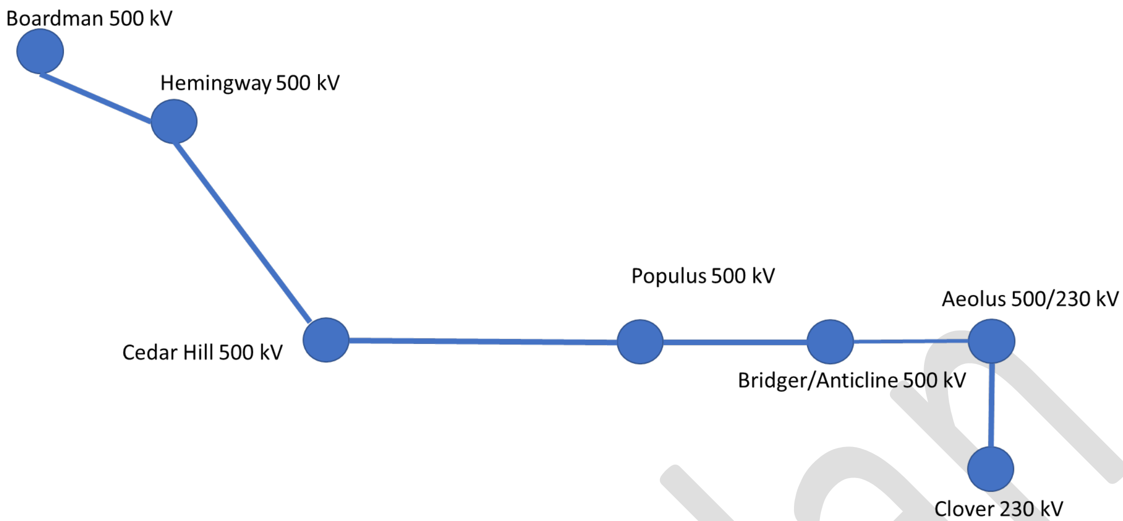

Figure 1: Regional Transmission Plan, regional combination {03}

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 cost-effective 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.

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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.

NorthernGrid Overview

The NorthernGrid is comprised of Avista (AVA), Bonneville Power Administration (BPA), Chelan PUD (CHPD), Grant County PUD (GCPD), Idaho Power Company (IPC), Berkshire Hathaway Energy (BHE, formerly 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.

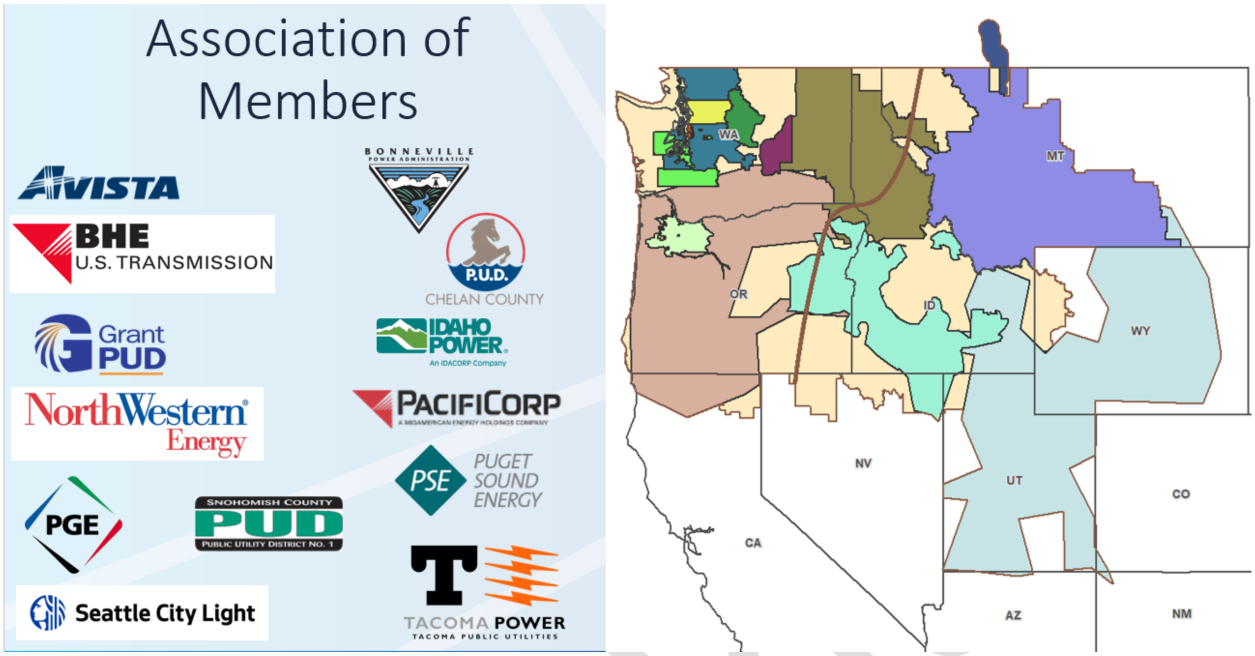

Figure 2: NorthernGrid footprint

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.

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 Western Electricity Coordinating Council (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 North American Electric Reliability Corporation (NERC) transmission planning criteria document, “TPL 001-04”. 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 001-04 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 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 stress 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 creating base cases 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 a spring condition will reflect more availability of hydro generation than do the base cases that represent a fall condition. The NorthernGrid Planning Committee discussed the stress conditions of interest and ultimately selected eight hours to model and study the regional transmission system. These eight hours, representing eight dispatch system conditions, 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.

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: Base Case Stress Conditions

Condition	Date	Hour Ending	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	June 4	18:00		

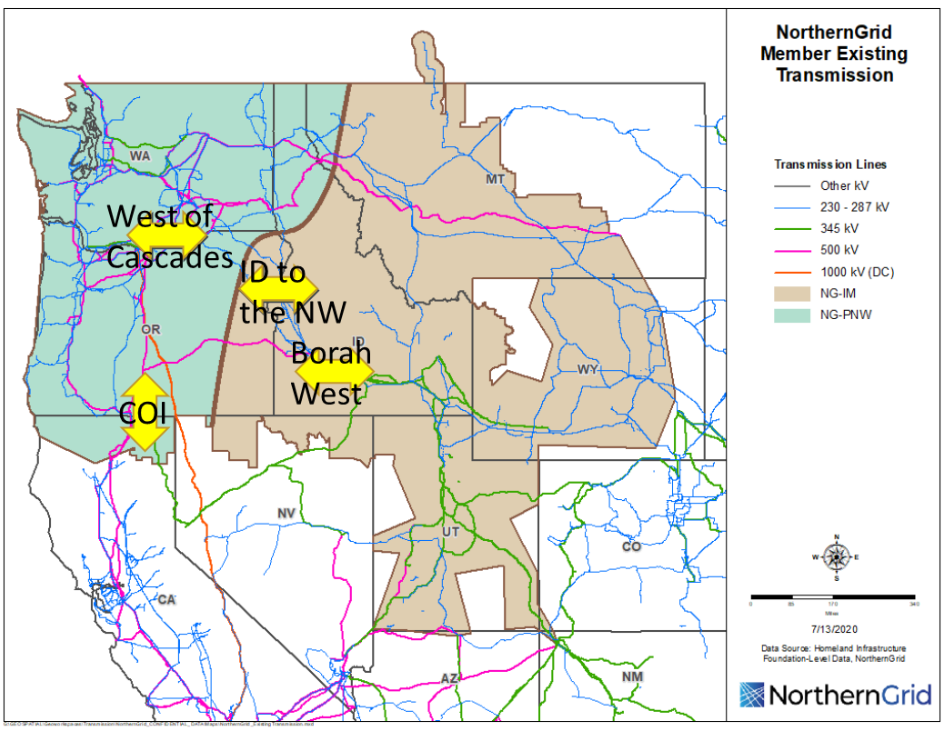

Figure 3: Paths of interest to the NorthernGrid footprint

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. 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.

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 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.

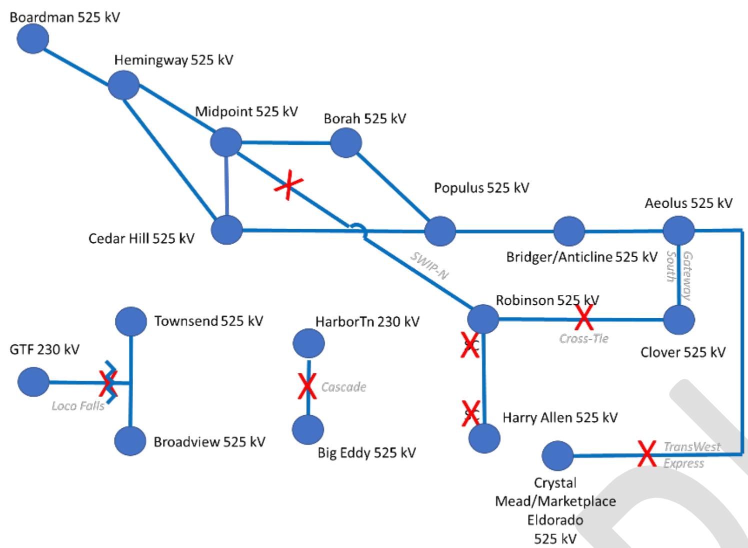

Figure 4: BLMP Example

Table 2: Table to demonstrate BLMP

Modeled Projects	Filter	B2H [H]	Gateway West Pop - Ced- Hem) [E]	Gateway West op - 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 Express DC 0 MW Schedule	TransWest Express DC 500 MW Schedule	TransWest Express C 1100 MW Schedule	Loco Falls Greenline	Cascade Renewable	Cascade Renewable DC 0 MW Schedule	Cascade Renewable DC 500 MW Schedule	Cascade Renewable C 1100 MW Schedule
BLMP	X	X	X	X	X	X	X	X											
Total	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0

Figure 4 and Table 2 provide a visual demonstration of the BLMP. None of the interregional or non-incumbent projects are selected in the BLMP. 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 525 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 regional combinations can be found in Appendix E. Table C.1 in Appendix C of the Study Scope lists all the combinations considered.

Given the large number of possible regional combinations that can be created from subsets of the BLMP, the members selected those regional combinations that were collectively determined as being of interest to the region. The BLMP gets naturally grouped into projects by their geographic locations. From west to east, the groupings are as follows:

1. Longhorn to Hemingway
   This project is often referred to as "B2H" as Boardman was the original terminus. This project now terminates at Longhorn.
2. Hemingway to Populus

There are two configurations of the Gateway West projects that form natural subsets of the Gateway projects: Hemingway to Cedar Hill to Populus and Hemingway to Midpoint to Borah to Populus.

3. Populus to Anticline to Aeolus

   Anticline to Aeolus is online and only added here for continuity.
4. Aeolus to Clover (Gateway South)

The regional combinations can be thought of as being built from the "inside out" from a regional combination perspective. Both main configurations of the Hemingway to Populus segment are tested, with the Hemingway to Cedar Hill segment including consideration of Midpoint to Cedar Hill. All the other natural groupings are then tested against the three main paths through Hemingway to Populus.

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 ranked violations for the BLMP and Regional Combination project combinations were presented and summarized using Excel Pivot Table features and charts. The selection of the regional projects in the Plan is determined by the combination of projects that results in a transmission system with a weighted reliability score that exceeds the reliability performance of the other combinations and offers a cost-effective solution for members.

Regional Projects

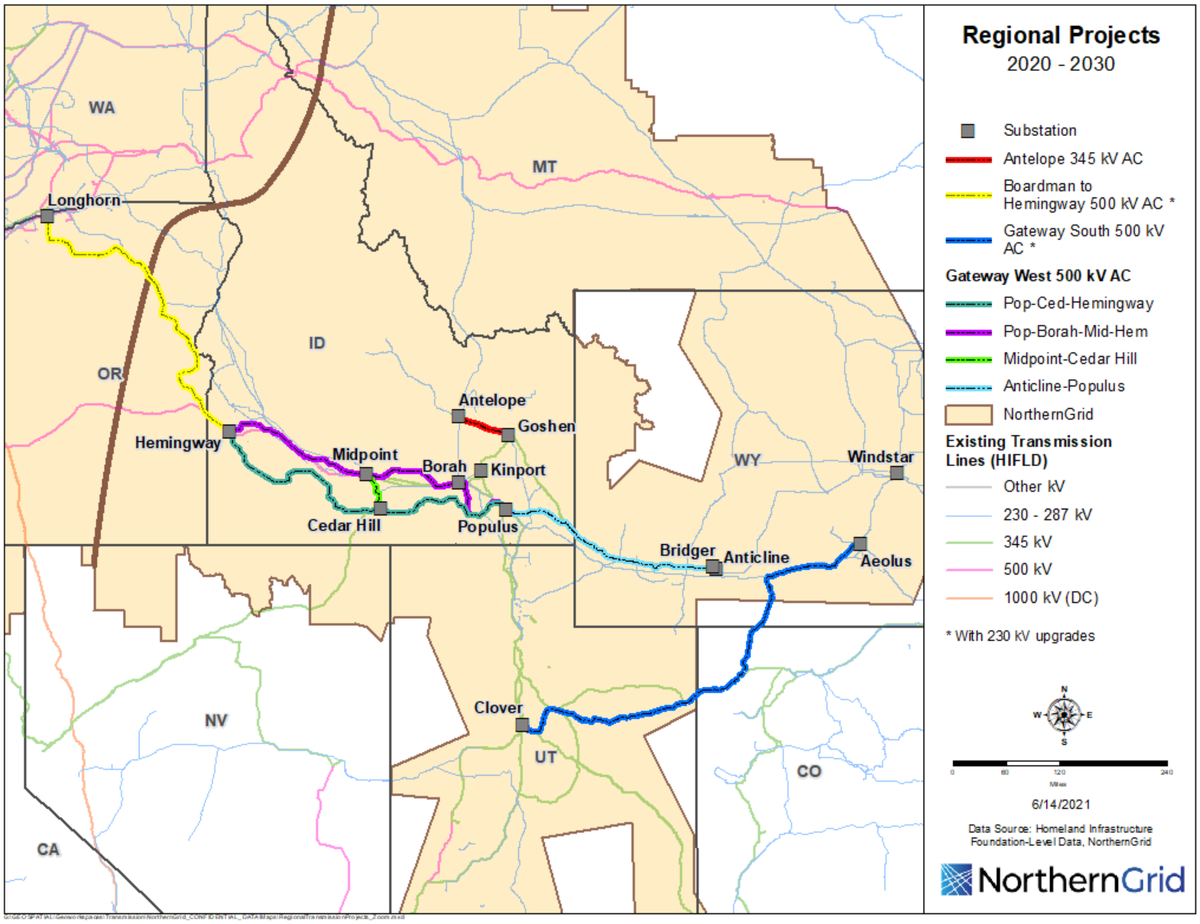

Figure 5: NorthernGrid footprint with regional project overlay

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.

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.

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.

Gateway West Transmission Project

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

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

Interregional Projects and Non-Incumbent Regional

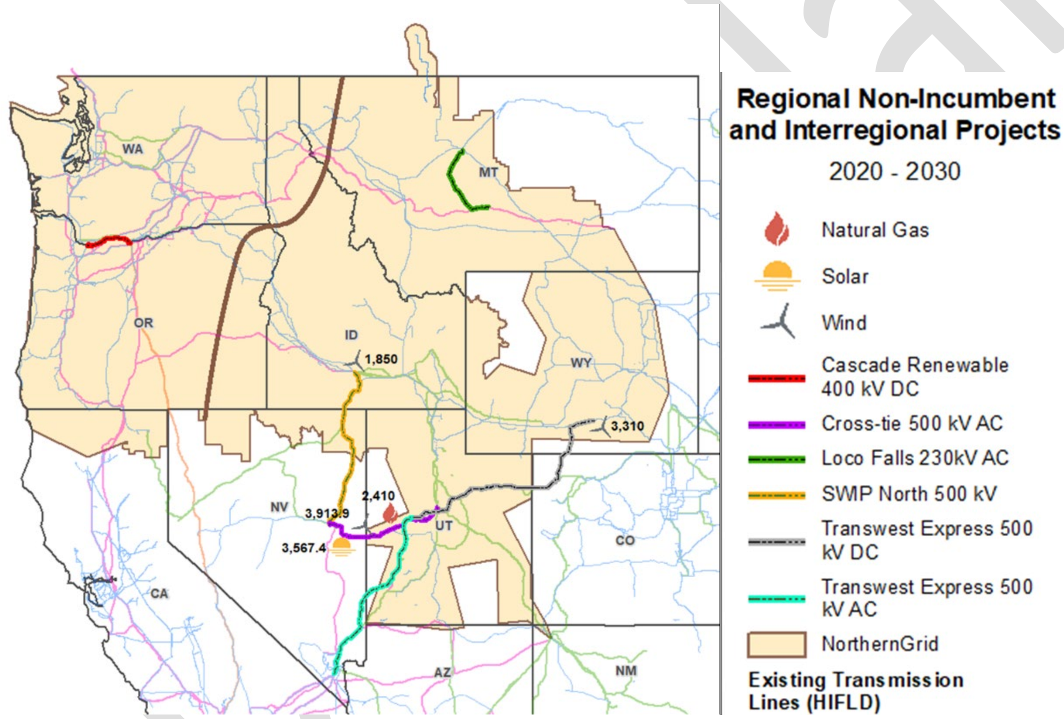

Figure 6: Interregional and Non-Incumbent Regional Projects

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 +/- 400 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 cause of the contingency and the impact of the contingency are vital to ascertaining the reliability of the transmission system. The cause and the impact 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. Altogether, the ranking factor for each of the three categories: voltage class, cause of the contingency, impact of the contingency was multiplied to produce an overall Ranking, an example is provided in Appendix C: Rankings.

Base Cases

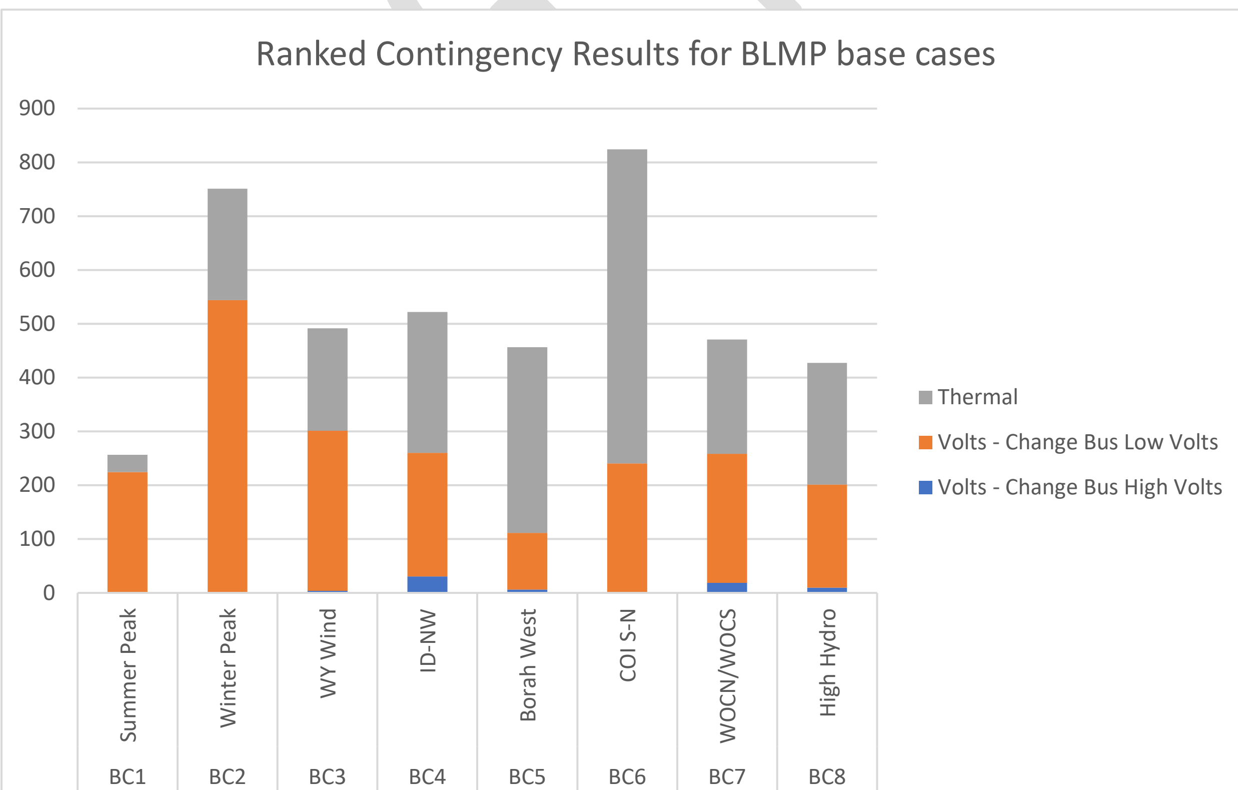

Figure 7: Ranked contingency results for the eight BLMP cases

Figure 7 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 PCM process.

Regional Combinations

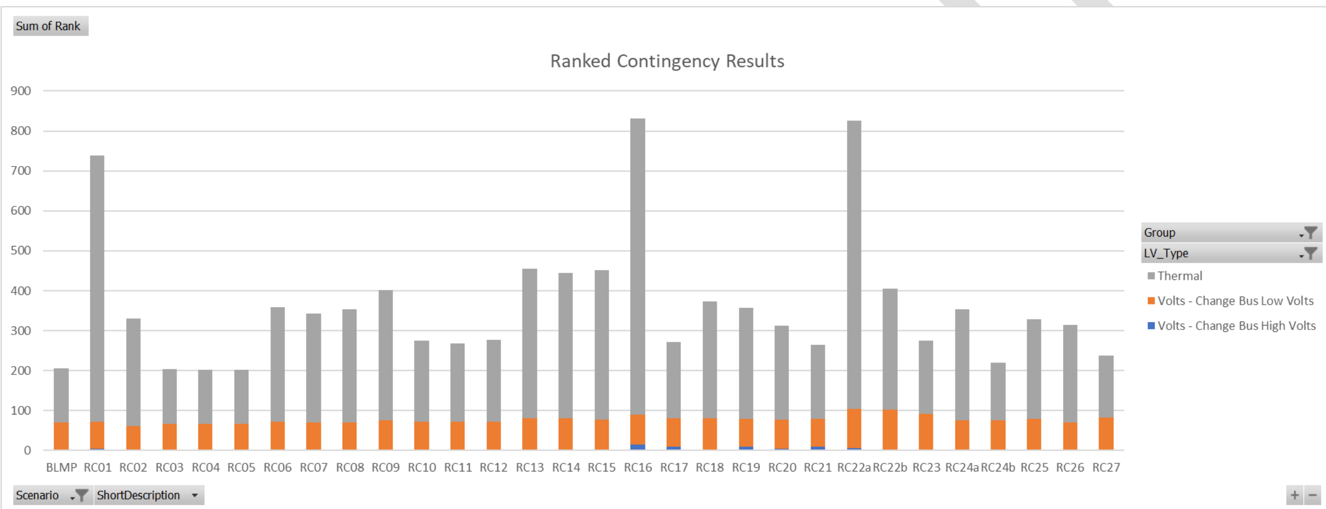

Figure 8: Ranked contingency results, all regional combinations with all cases

Figure 8 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 a subset of the entire set of possible regional projects. A few notable observations:

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 combinations {03, 04, 05} form a natural 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.
3. The only difference between regional combinations {03} and {04} is the presence of Midpoint to Cedar Hill.
4. Regional combination {24} has no upgrades between Populus and Midpoint but does have the addition of the SWIP North project. Regional combination was analyzed with and without Gateway South and it was found that with Gateway South yielded a more reliable system.

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 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.
7. Regional combinations {17, 21, 27} have results similar to those of regional combinations {10, 11, 12}. Of the three regional combinations, {17, 21, 27}, regional combination {17} is the only one that does not have the Boardman to Hemingway project.

Not all regional combinations are applicable to all base cases. Appendix D: Complete list of all RC combos lists which stress conditions are to be considered for each of the regional combinations. The best performing regional combinations {03, 04, 05, 10, 11, 12, 21, 23, 27} all have the same three stress conditions: Wyoming wind, Idaho to the Northwest, Borah-West. Additionally, regional combinations {03, 04, 05, 10, 11, 12} have the following two stress conditions: Heavy Summer and COI South to North. Consistent with the conclusions from all eight base cases, regional combinations {03, 04, 05} result in the fewest ranked contingency violations with regional combination {27} having the next fewest.

Figure 9 shows the details of the contingency analysis for regional combinations {03, 04, 05, 27}.

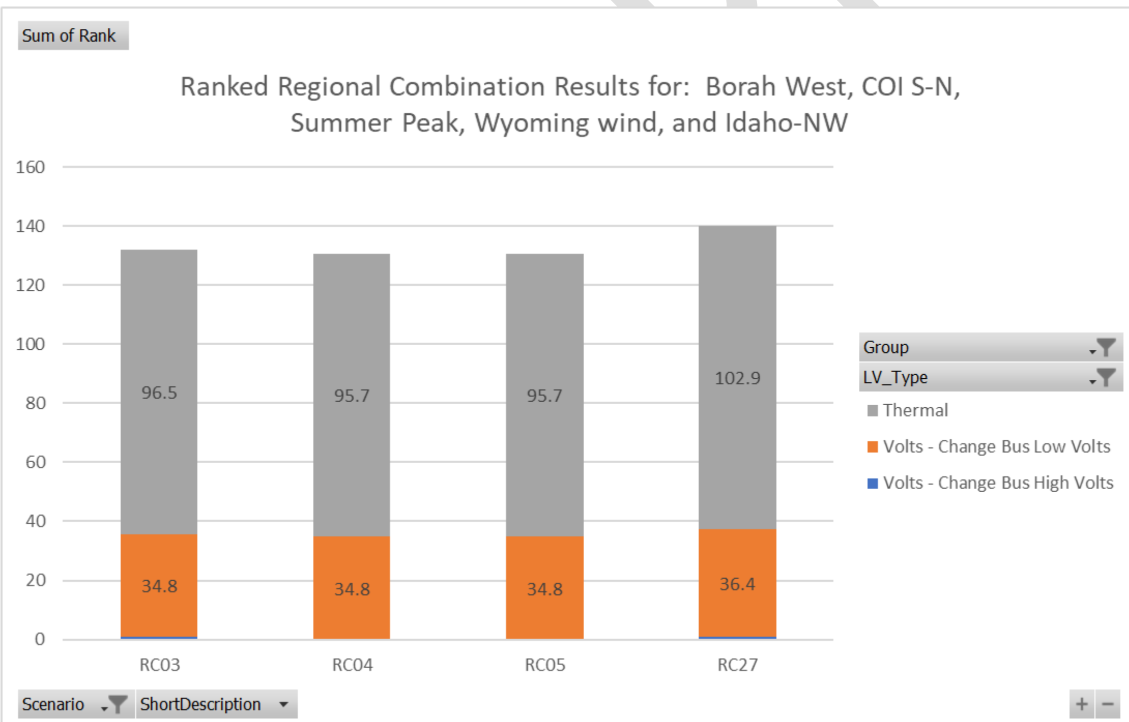

Figure 9: Ranked contingency results for regional combinations {03, 04, 06, 27} with 5 base case conditions

There is negligable difference in the performace of regional combinations {03} and {04}; regional combination {03} has fewer pieces of equipment to install than regional combination {04} and for that reason, regional combination {03} will be given preference.

Figure 10below shows regional combination {03} and Figure XXXX shows regional combination {05}. These figures do not detail the entire transmission system between Boardman and Clover, rather, they are intended to visually depict the segments under consideration that yield the fewest reliability violations for the NorthernGrid footprint.

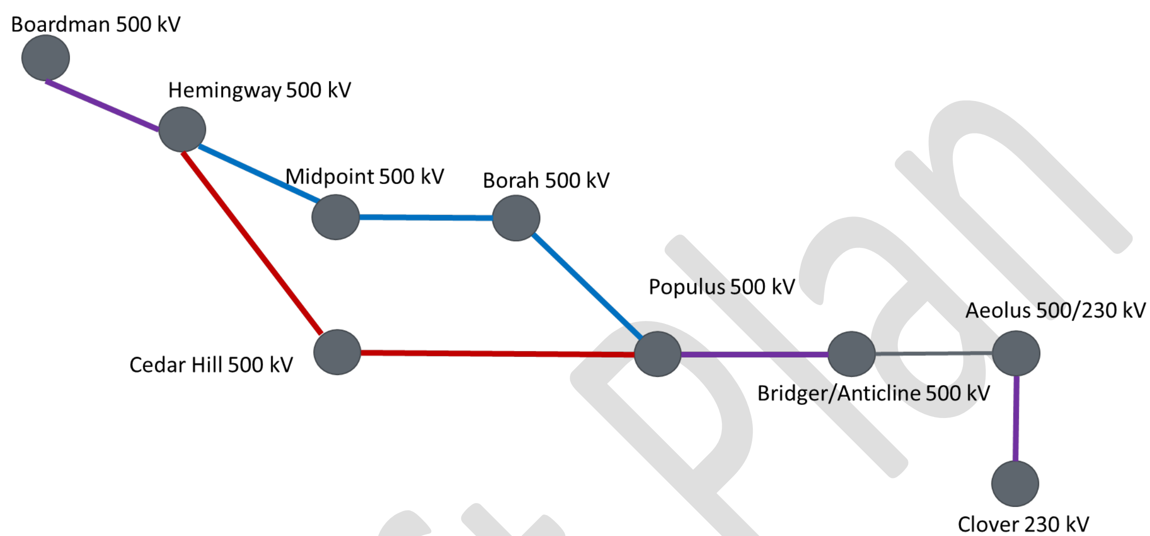

*Figure 10: Regional Projects **{03}** and **{05}***

Figure 10 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 combionation {05}, and purple segments belong to both. As can be seen in XXXX 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 1500 MW can be gained in capacity for the Cedar Hill facilities.

Interregional and Non-Incumbent Regional

Three interregional and two non-incumbent regional projects were then analyzed to see if alone, without the presence of the regional projects, any of the interregional or the non-incumbent projects would meet the needs of the NorthernGrid region.

There were no voltage excursions that were introduced by any of the projects in Figure 11 which is why only thermal violations are displayed. There are significantly more thermal overloads in the cases that have only an interregional or non-incumbent regional project than the case that has the full complement of regional projects.

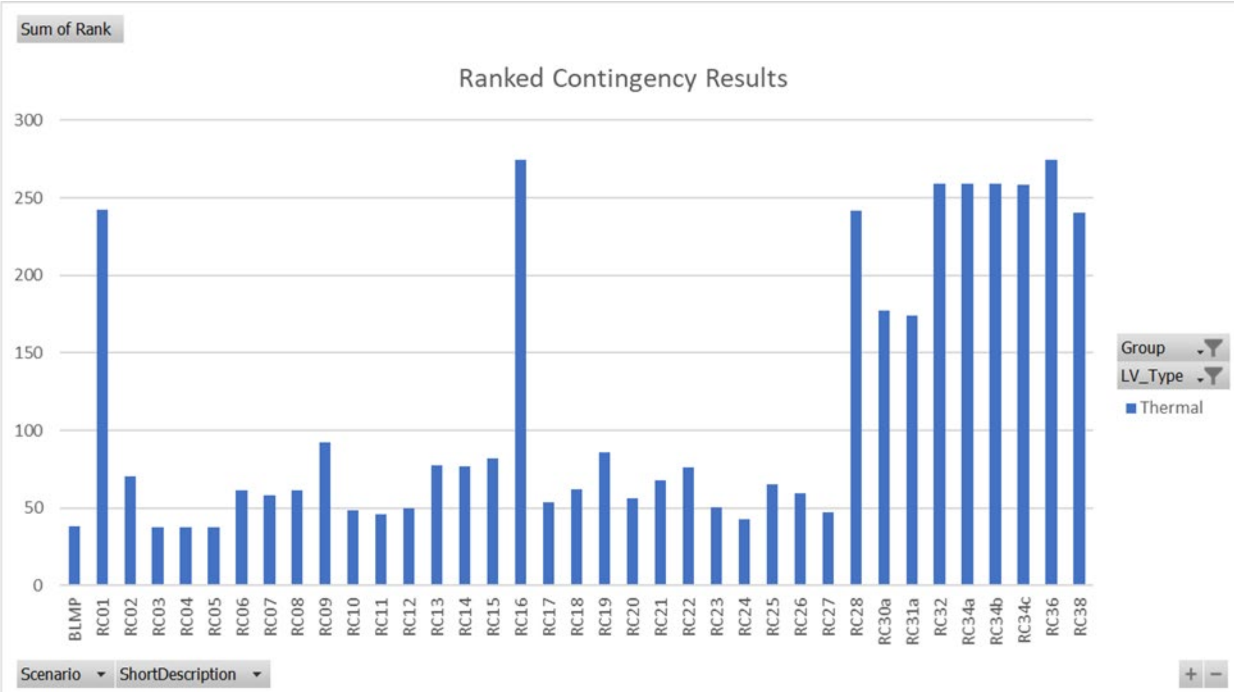

Figure 11: Interregional or non-incumbent regional project with no regional upgrades

Odd-numbered regional combinations {29, 31, 33, 35, 37, 39} were developed based off the stand-alone analyses and Appendix D: Complete list of all RC combos provides the final list of combinations.

1. Regional combinations {03, 04, 05} yield the fewest violations.
2. The interregional and non-incumbent projects start at RC{28}; there are significantly more violations in regional combinations {28+} than in regional combinations {03, 04, 05}.

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.

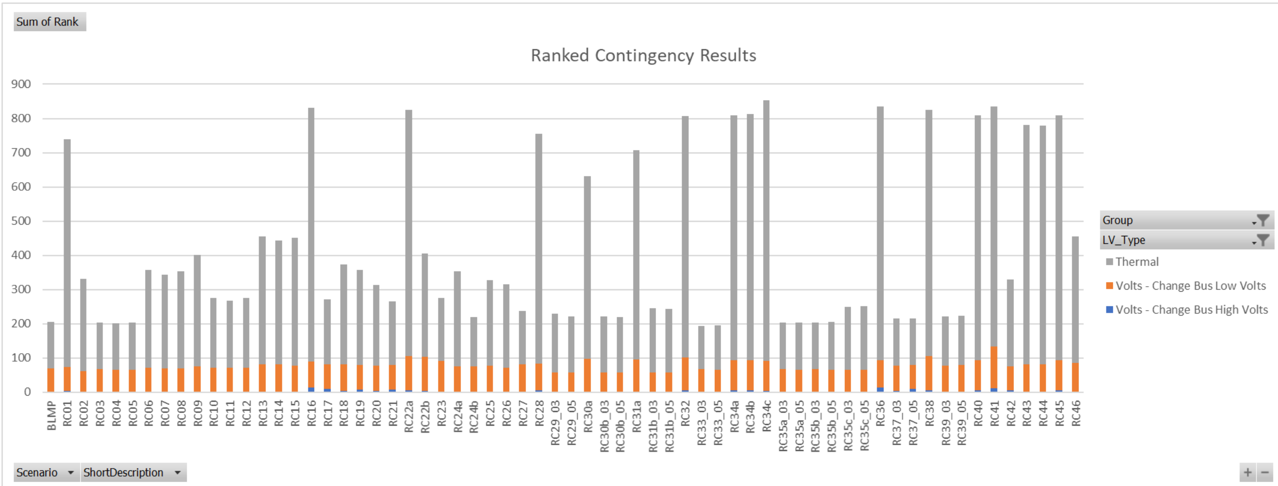

Figure 12: Ranked continency results for select combinations

Figure 12 above shows the entire set of results for the majority of the combinations considered. Starting with regional combination {28} are those combinations that take interregional projects into consideration.

1. Regional combinations {03, 04, 05} as well as {33_03, 33_05} all appear to have the fewest violations. Regional combination {33_03} is simply regional combination {03} with the addition of the Loco Falls project. The Loco Falls project alone is insufficient to meet the needs of the region. Loco Falls in conjunction with regional combination {03} performs well but would be more expensive to build than just regional combination {03} by itself.
2. Interregional projects by themselves, without the addition of regional projects, are insufficient to meet the needs of the NorthernGrid region as they lead to significantly more violations.

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

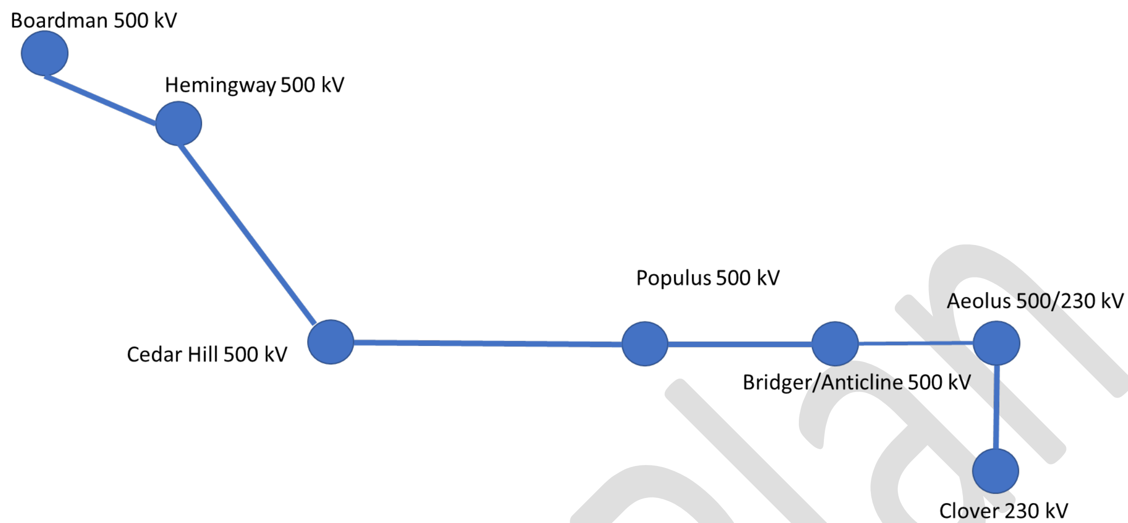

Figure 13: The Regional Transmission Plan for the 2020-2021 NorthernGrid cycle

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 1500 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 reliable.

Appendix A: Definitions and Terms

Attachment K from NorthWestern Energy is provided here for reference to the process or definitions.

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

Final Study Scope for the 2020- 2021 NorthernGrid Planning Cycle

Member Planning Committee Approval Date: September 30, 2020

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Appendix C: Rankings

Table 3: 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 4: 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 5: 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 caused by a P1 event is:

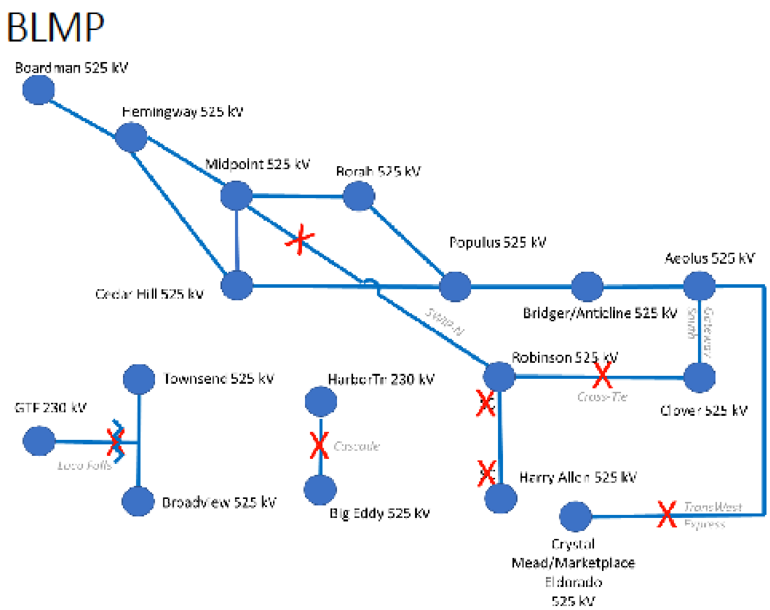
$$(1) * (0.5) * (0.5) = 0.25$$

Appendix D: Complete list of all RC combos

Table 6: Working version of the Regional Combinations Table

Placeholder for Regional Combinations Table

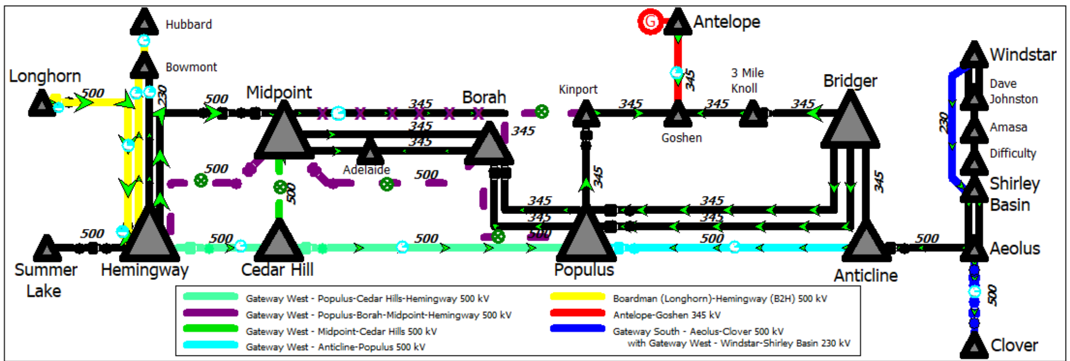
Appendix E: Visual Aides for the Regional Combinations



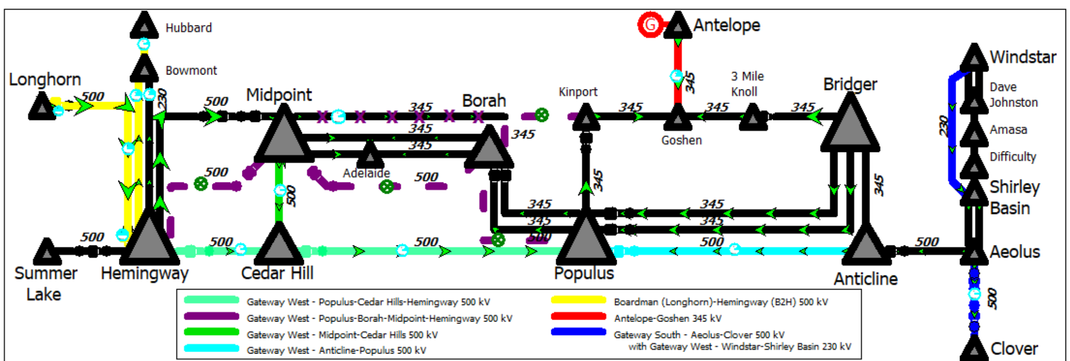
Modeled Projects	Filter	B2H [H]	Gateway West Pop - Ced- Hem) [E]	Gateway West op - Bor - Mid - Hem)	Gateway West (Mid - Ced)	Gateway West (Ant - Pop) [D.3]	Antelope	Gateway South [F]	SWIP-N	Cross-Tie	TransWest Express ACDC	TransWest Express DC 0 MW Schedule	TransWest Express C 500 MW Schedule	TransWest Express C 1100 MW Schedule	Loco Falls Greenline	Cascade Renewable	Cascade Renewable DC 0 MW Schedule	Cascade Renewable C 500 MW Schedule	Cascade Renewable C 1100 MW Schedule
BLMP	X	X	X	X	X	X	X	X											
Total	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0

Here's ZZ's recommended graphics for the best performing RCs (03-05) and 2nd best (10-12) (next page)

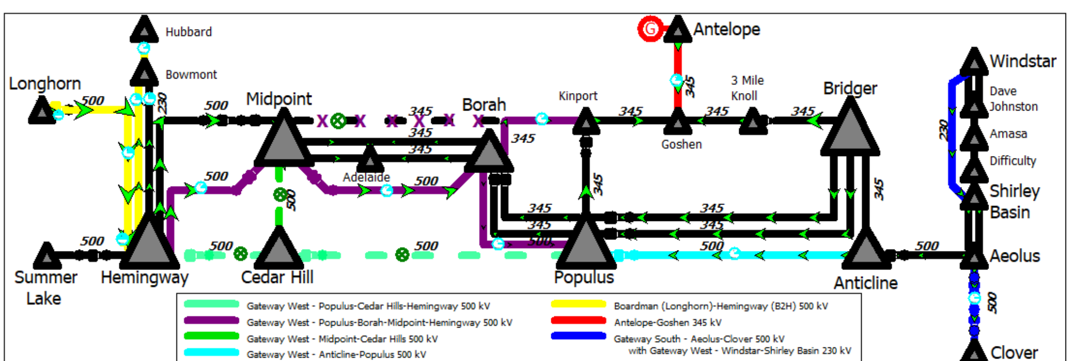
Case	B2H [H]	Gateway West (Pop - Ced- Hem) [E]	Gateway West (Pop - Bor - Mid - Hem) [E]	Gateway West (Mid - Ced)	Gateway West (Ant - Pop) [D.3]	Antelope	Gateway South [F]	SWIP-N	Cross-Tie	TransWest Express DC	TransWest Express DC/AC	Loco Falls Greenline	Cascade Renewable Transmission
RC3	X	X			X	X	X						
RC4	X	X		X	X	X	X						
RC5	X		X		X	X	X						



NorthernGrid BC1 Case - Heavy Summer RC03



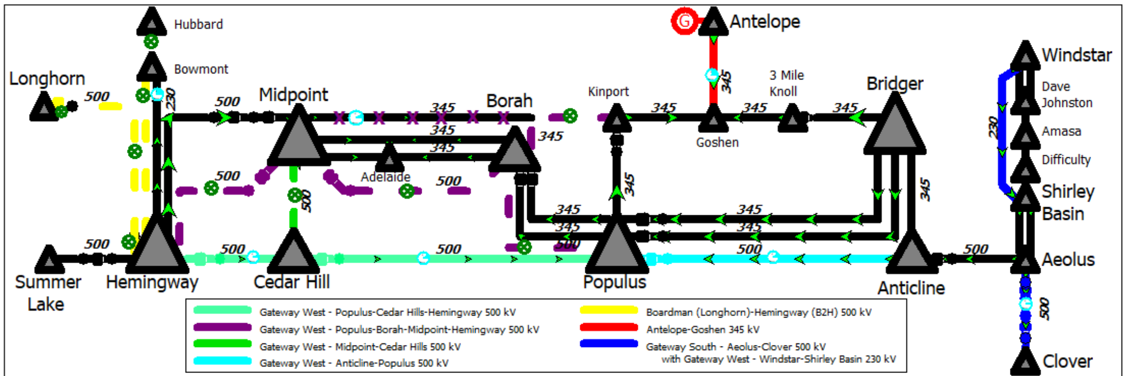
NorthernGrid BC1 Case - Heavy Summer RC04



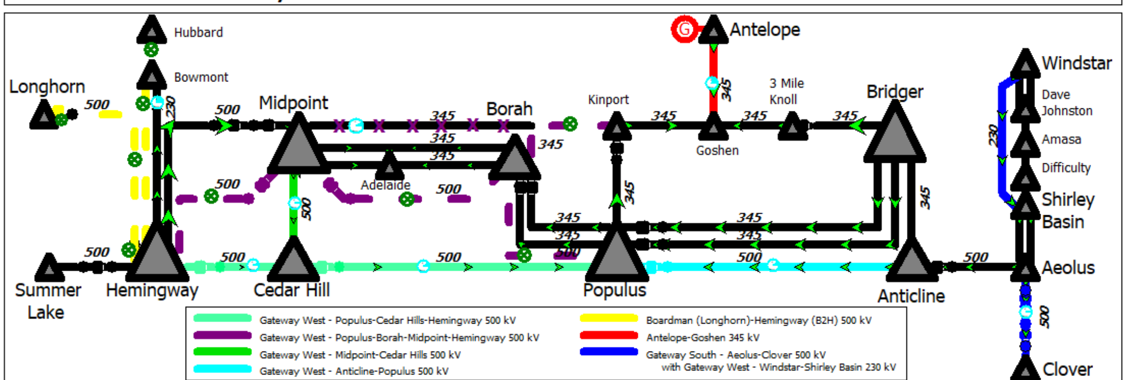
NorthernGrid BC1 Case - Heavy Summer RC05

2nd best group of performers – RC 10-12 – no B2H

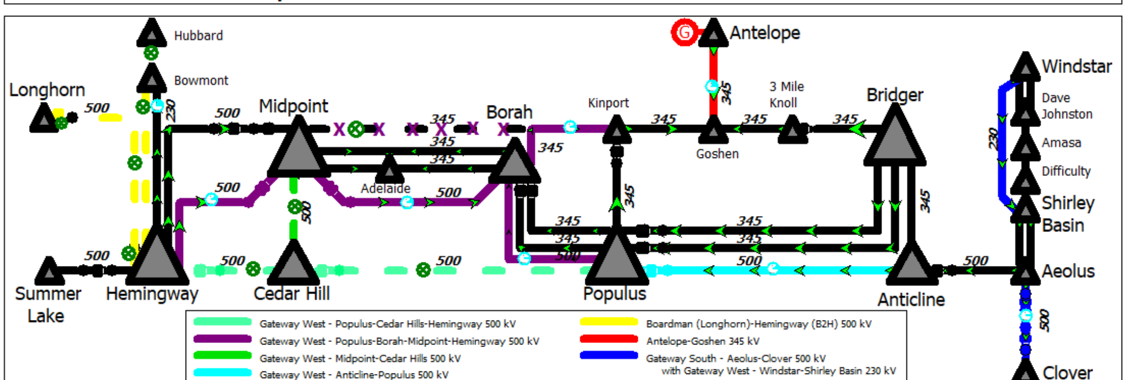
Case	B2H [H]	Gateway West (Pop - Ced- Hem) [E]	Gateway West (Pop - Bor - Mid - Hem) [E]	Gateway West (Mid - Ced)	Gateway West (Ant - Pop) [D.3]	Antelope	Gateway South [F]	SWIP-N	Cross-Tie	TransWest Express DC	TransWest Express DC/AC	Loco Falls Greenline	Cascade Renewable Transmission
RC10		X			X	X	X						
RC11		X		X	X	X	X						
RC12			X		X	X	X						



NorthernGrid BC1 Case - Heavy Summer RC10



NorthernGrid BC1 Case - Heavy Summer RC11



NorthernGrid BC1 Case - Heavy Summer RC12