NorthernGrid

Regional Transmission Plan for the 2024-2025 NorthernGrid Planning Cycle

November 19, 2025

Photo: Courtesy of PacifiCorp

NorthernGrid Member Planning Committee (MPC)

Approval Date: November 19, 2025

Acknowledgements:

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NV Energy
PacifiCorp
Portland General Electric
Puget Sound Energy
Seattle City Light
Snohomish County PUD
Tacoma Power
Non-Incumbent Transmission Project Sponsors
PowerBridge – Cascade Renewable Transmission Project, Regional project
TransCanyon, LLC – Cross-Tie Transmission Line, Regional project
GridLiance, Sagebrush Project, Interregional project
ENGIE North America, Western Bounty Project, Interregional project
Neighboring Regional Entities
CAISO
WestConnect
Participating State Agencies
Idaho PUC
Idaho OER
Montana PSC
Montana Consumer Counsel
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Executive Summary

The NorthernGrid is an unincorporated association of entities that either own or operate, or that propose to own or operate, electric transmission facilities in the Western Interconnection. The NorthernGrid promotes coordinated, open, and transparent transmission planning and facilitates compliance with Federal Energy Regulatory Commission ("FERC") Orders No. 890 and 1000. The NorthernGrid is comprised of entities regulated by FERC and those that are not. The regional transmission planning process for the enrolled FERC jurisdictional Transmission Providers is defined in each provider's Open Access Transmission Tariff Attachment K – Regional Planning Process. The NorthernGrid entities that are not regulated by FERC participate in the regional transmission planning process through the NorthernGrid Planning Agreement for Planning Cycle 2024-2025.

The NorthernGrid 2024-2025 Regional Transmission Plan was developed according to the NorthernGrid regional planning process. The load and resource assumptions, transmission power flow conditions, analysis methods, and criteria used are described in the 2024-2025 Study Scope. A link to the Study Scope is provided in Appendix B: Study Scope. The objective of the planning process is to identify the projects that either cost-effectively or efficiently meet the needs of the NorthernGrid region in a 10-year horizon.

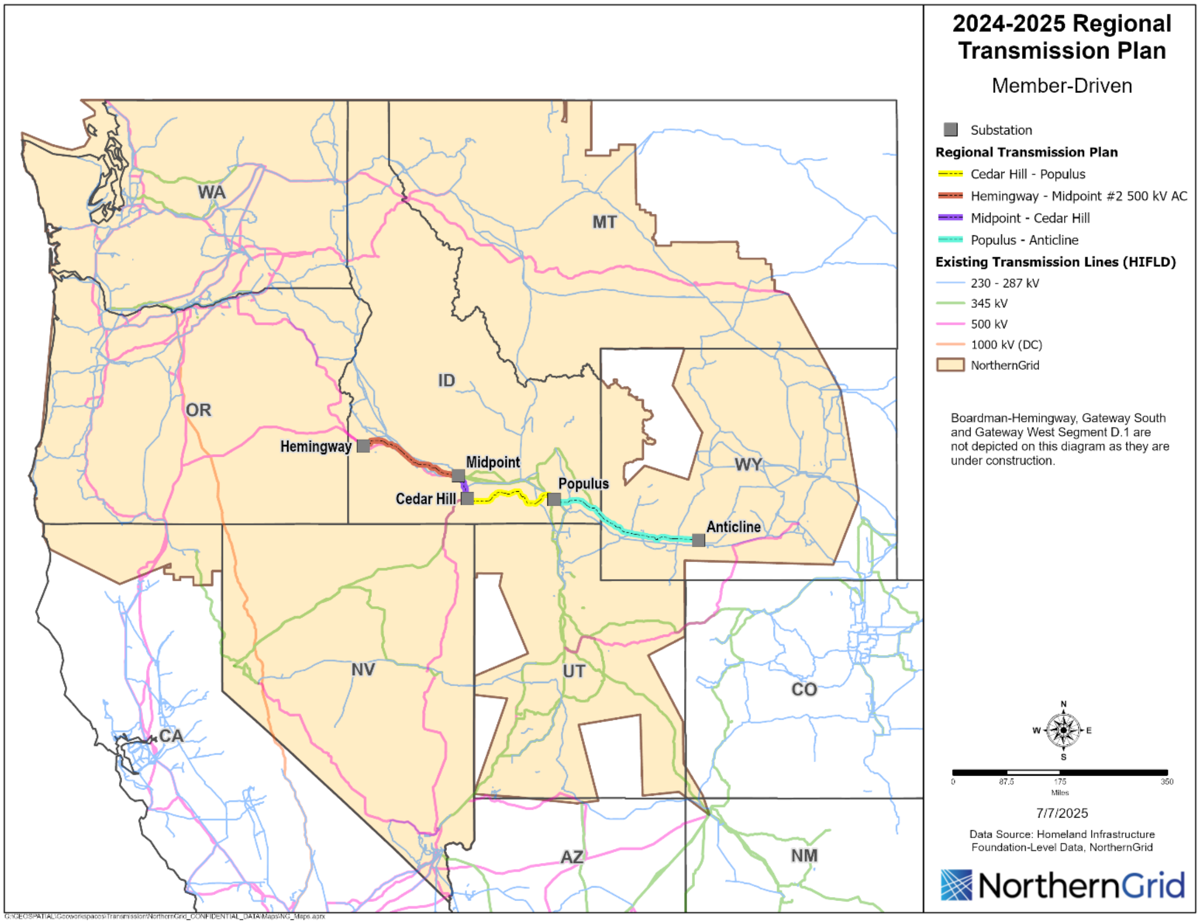

Figure 1: Regional Transmission Plan 2024-2025

The projects selected into the 2024-2025 Regional Transmission Plan for NorthernGrid comprise a connected, 500 kV system with terminuses in the Boadman/Longhorn and Anticline areas. This 500 kV system reinforces the local area transmission system, supports renewable generation from Wyoming to serve the larger load pockets in Seattle/Portland, and allows for larger deliveries into the Wyoming and Utah areas when generation is rich in the Pacific Northwest. The projects selected into the unapproved 2024-2025 Draft RTP are the same as those selected in 2022-2023; Longhorn to Hemingway is Committed for the 2024-2025 NorthernGrid RTP and was included as part of the base topology.

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Transmission Planning Requirements

The Federal Energy Regulatory Commission ("FERC") requires, through orders 890 and 1000, each Transmission Provider ("TP") to publish local and regional transmission plans on a periodic basis using open and transparent processes. FERC requires that each Transmission Provider develop and file their transmission planning processes for FERC's acceptance. Once accepted, the processes are published in the provider's Open Access Transmission Tariff Attachment K – Transmission Planning Process.

Additionally, FERC requires all TPs to participate in transmission planning regions to develop these regional transmission plans. For the NorthernGrid, TPs who meet certain requirements may enroll in the region to become an Enrolled Party. The regional transmission planning process for the Enrolled Parties is defined in each Enrolled Party's Open Access Transmission Tariff Attachment K.

Federal, municipality, and public utility district electric utilities are not subject to FERC regulation, but also perform local and regional transmission planning to meet their load, resource, and transmission requirements. These entities voluntarily participate in regional transmission planning with the TPs through the NorthernGrid Planning Agreement for Planning Cycle 2024-2025.

NorthernGrid Overview

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

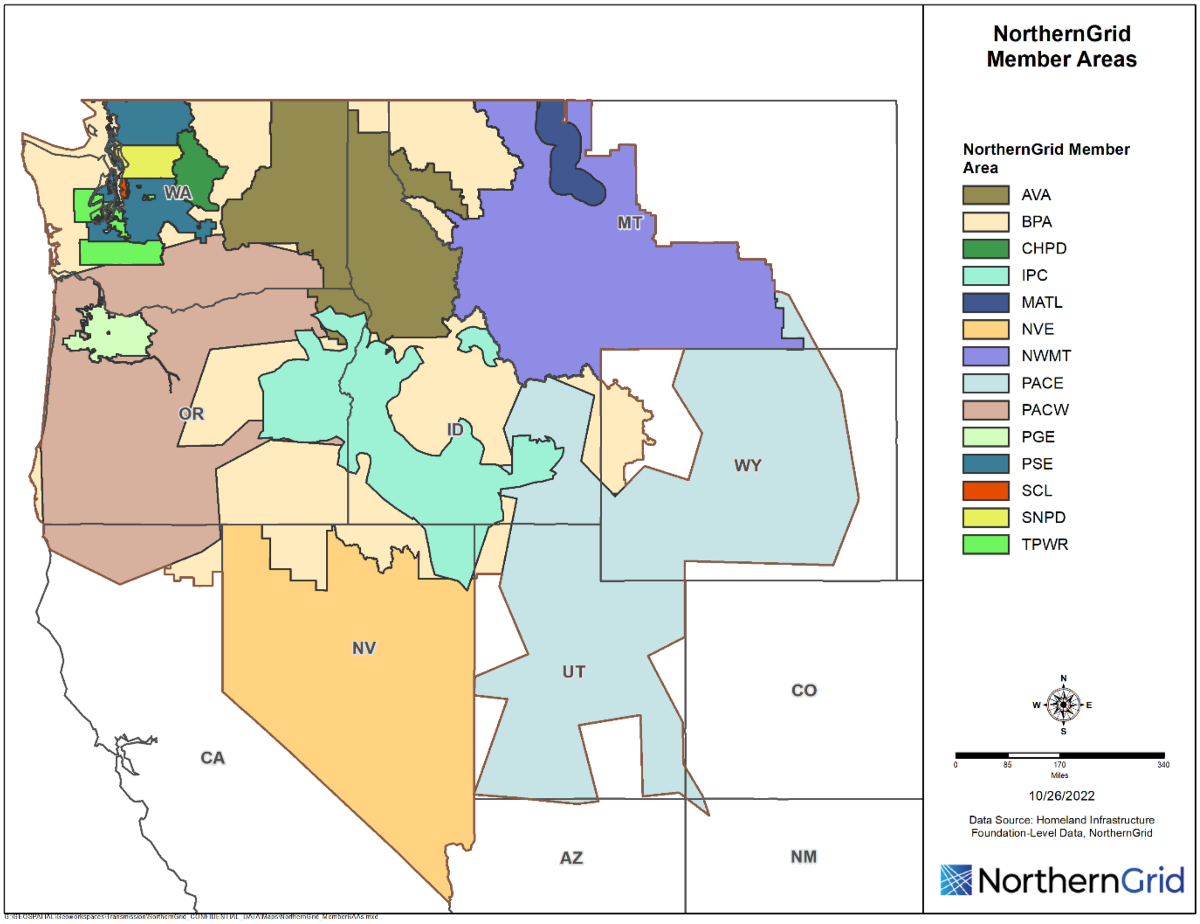


Figure 2: NorthernGrid region

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 regional system to which that developer interconnects. Given proper coordination and communication, only the necessary facilities would get identified, and those facilities would become the Regional Transmission Plan ("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 standards TPL-001-4 and 5.1 provide 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, load growth 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 NorthernGrid Planning 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 often 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.

The resource procurement process involves many intricacies. 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 possibility that resources that are identified in a resource procurement process are not necessarily yet 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.

Interregional Coordination

NorthernGrid met with WestConnect and CAISO to coordinate power flow cases, assumptions, and methodologies at the Annual Interregional Information Exchange. Three projects were submitted to the Regions for interregional consideration. The Sagebrush Project electrically connects with NorthernGrid and CAISO; the Western Bounty Project electrically connects with all three Regions. Neither WestConnect nor CAISO identified any Interregional Needs and have since removed the Sagebrush Project and Western Bounty Project from consideration. NorthernGrid considered the interregional projects as part of the Regional Combinations as specified in the Study Scope. Neither of the interregional projects were selected into the 2024-2025 Draft RTP.

Representatives from the regions met on a near-monthly basis with some of them being on-site to discuss study efforts, inform one another on any new developments, and identify opportunities for stakeholder engagement.

State Agency Engagement

Several state agencies participated in the planning process through the Enrolled Parties and States Committee (EPSC). The EPSC reviewed and actively participated in the development of the Study Scope. All EPSC members are encouraged to attend NorthernGrid's monthly public meetings as well as any public EPSC meetings that are held to help further support the efforts of the EPSC.

Stakeholder Engagement

Stakeholders are invited to participate in the public meetings and comment periods. They will also have active involvement in the development of the RTP. The first period for stakeholder comments begins with the publishing of the Draft Study Scope. There are three main opportunities to provide Comment, and they are in response to the following publications: the proposed Study Scope, the Draft Regional Transmission Plan, and the Draft Final Transmission Plan. Members of the public are invited to Subscribe to NorthernGrid activities through the subscription feature on the northerngrid.net website.

Study Process

The Regional Transmission Plan ("RTP") is the result of the work performed as outlined in the study scope for the NorthernGrid 2024-2025 regional transmission planning process.

The regional planning process is a "bottom up" approach that begins with a compilation of the Members' loads, generation resources, local area plans, and regional transmission projects. The Members who are 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.

To develop the Plan, the NorthernGrid members ("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 region in a 10-year future. Members submitted updated Load and Resource information which was incorporated into the study 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 region. 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, it is possible that 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 does not strive to resolve all of the violations seen in the contingency analysis. The technical team supporting the NorthernGrid analysis work identified conditions on the NorthernGrid footprint that would allow for regional-level stress patterns. These regional stress patterns sometimes resulted in violations which were subsequently considered by the technical team to determine if they were local or regional in nature. Remnant local issues were assumed to be mitigated operationally and not factored into the overall selection of projects; they are listed for clarification to the utility that regionally based stress patterns may require operational intervention.

NorthernGrid considers Regional and Interregional Non-Incumbent submissions with the same degree of respect and reverence that the Member projects are treated. All Member, Regional Non-Incumbent, and Interregional Non-Incumbent projects are analyzed to identify the set of projects that best serves the NorthernGrid footprint in a 10-year future. The Regional Combination table (Appendix C in the Study Scope) illustrates how the Regional Combinations were selected with engineering expertise and with disregard to ownership status. In this manner, any Regional Transmission Plan selected for NorthernGrid is based on the reliability benefits achieved from the inclusion of the selected transmission projects.

The production of a Regional Transmission Plan satisfies FERC Order 1000 requirements for each region to produce a 10-year transmission plan on a two-year cycle.

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, generation resource additions and retirements, projected transmission additions, and public policy requirements. The study scope identifies different power flow conditions and different regional transmission project combinations to assess and develop the RTP. A link to the Study Scope is provided in Appendix B: Study Scope.

Study Methodology and Criteria

To assess the 2034 loads, resources, and transmission projects anticipated for the NorthernGrid region, 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 region 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 region as well as immediate neighboring regions were monitored. The analysis of the contingency results accounted for any area-specific member utility criteria, otherwise, the Western Electric Coordinating Council's (WECC) and NERC TPL-001-4 criteria was used.

Submitted Loads and Resources

Table 1: NorthernGrid Loads, 2034

	NG Study Cycle 2022-2023 (MW)	NG Study Cycle 2024-2025 (MW)	%Increase
Jan	49,264	57,951	18%
Feb	47,454	56,361	19%
Mar	44,994	52,707	17%
Apr	42,608	50,773	19%
May	44,277	51,179	16%
Jun	51,652	61,809	20%
Jul	54,887	64,583	18%
Aug	53,900	63,960	19%
Sep	47,818	57,206	20%
Oct	43,769	52,190	19%
Nov	45,409	55,274	22%
Dec	49,564	58,503	18%

Table 1: NorthernGrid Loads represents the cumulative non-coincident peak load for each of the utilities that make up the NorthernGrid footprint. Overall, the NorthernGrid footprint load for 2034 is expected to be approximately 13% higher than the updated load prediction for 2032. The peak loading condition for NorthernGrid occurs in the summer which is consistent with the 2022-2023 cycle.

Member-Driven Transmission Projects

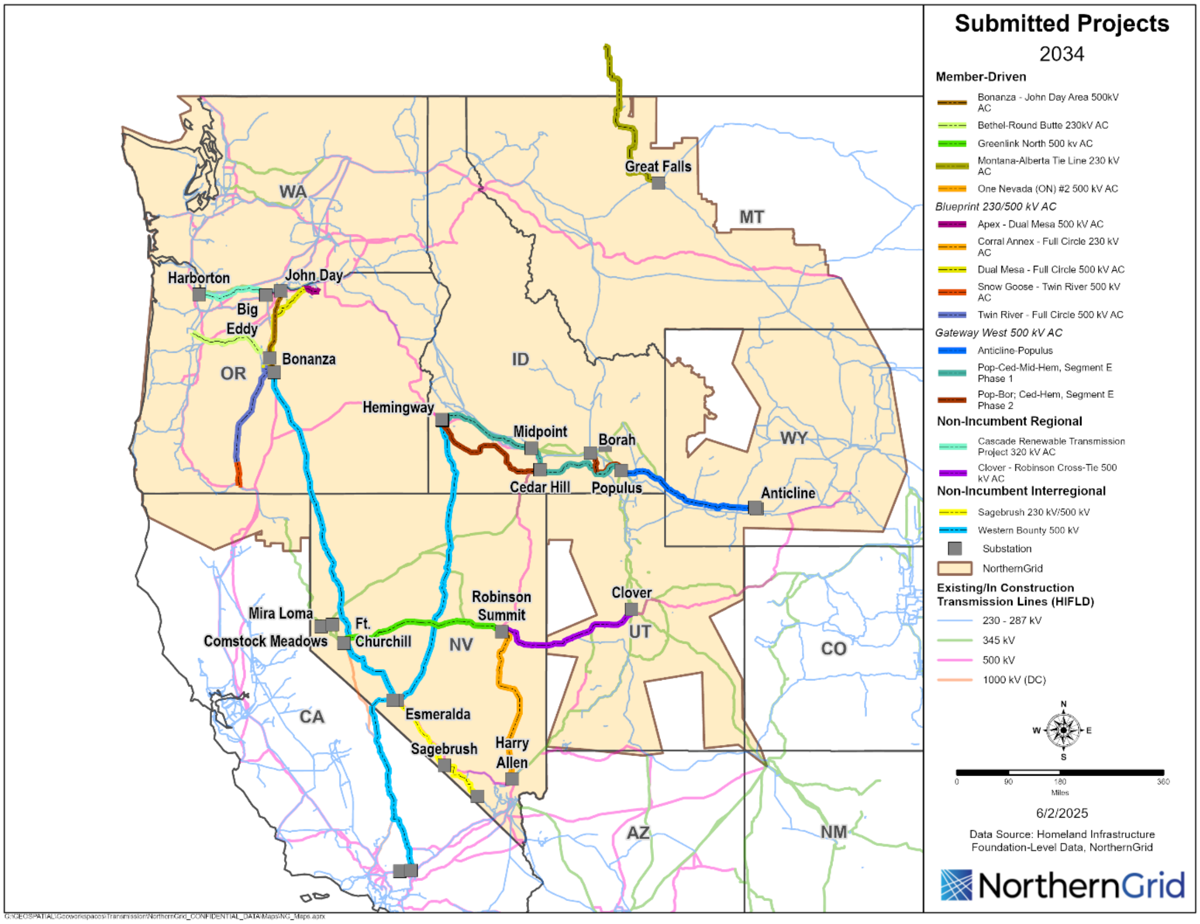


Figure 3: Submitted Projects for the 2024-2025 NorthernGrid Cycle

The projects submitted by the Enrolled Parties are as follows:

- Gateway West- A suite of seven project segments will be evaluated for Gateway West. These projects are:
    a. Populus – Cedar Hill 500 kV
    b. Cedar Hill – Hemingway 500 kV
    c. Populus – Borah 500 kV
    d. Borah – Midpoint 500 kV
    e. Midpoint – Hemingway #2 500 kV
    f. Midpoint – Cedar Hill 500 kV
    g. Anticline – Populus 500 kV

  For analysis, the Gateway West segments west of Populus (Segments E) will be grouped into two phases:
  Gateway West Segment E Phase 1: Populus – Cedar Hill 500 kV, Cedar Hill – Midpoint 500 kV, and Midpoint – Hemingway #2 500 kV

Gateway West Segment E Phase 2: Populus – Borah 500 kV, Borah – Midpoint 500 kV, and Cedar Hill – Hemingway 500 kV

- Gateway Central – Limber Area (local transmission needs)
  Addition of Limber 500 kV, 345 kV, & 138 kV substation
  Limber – Terminal #1 and #2 345 kV lines
- One Nevada #2- 500 kV #2 from Harry Allen to Robinson Summit. Also includes upgrades to the 345 kV system.
- Greenlink North projects.500 kV from Fort Churchill to Robinson Summit.
- MATL- MATL proposed a conversion of the MATL to direct current. The rating will increase to a maximum of 500 MW.
- Bonanza/John Day Bonanza- New 500 kV Bonanza substation in Central Oregon and 500kV connection to the John Day Area. [1]
- Blueprint 500 kV Projects- Construct approximately 170 miles of new 500 kV transmission between Snow Goose substation near Klamath Falls, Oregon and the new Full Circle substation near Redmond, Oregon. Construct approximately 150 miles of new 500 kV transmission between Full Circle substation near Redmond, Oregon and Apex substation near Boardman, Oregon.
- Bethel – Round Butte Rebuild and expand existing 98 mile Bethel – Round Butte 230 kV transmission line to 500 kV, connecting the new Lambert substation near Salem, Oregon to the new Mountain View substation near Madras, Oregon.

Non-Incumbent Transmission Projects

The NorthernGrid regional planning process allows non-incumbent and merchant transmission developers to submit projects for analysis. Several non-incumbent or merchant transmission projects were received during the submission period. They are further classified into regional and interregional transmission projects based on whether the project terminals are within the region or interconnect between regions, i.e. interregional.

Cascade Renewable Transmission System- PowerBridge is proposing to construct the Cascade Renewable Transmission System Project. This Project is a 100-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 substations. There are no proposed generation resources associated with the transmission line. PowerBridge is a Qualified Developer seeking Regional Cost Allocation.
Cross-Tie Transmission Project- TransCanyon LLC is proposing the Cross-Tie Project, a 1,500 MW, 500 kV single circuit HVAC transmission project that will be constructed between central Utah and east-central Nevada. The project connects PacifiCorp's planned 500-kV Clover substation with NV Energy's existing 500 kV Robinson Summit substation; both substations reside in the NorthernGrid footprint. TransCanyon is a Qualified Developer seeking Regional Cost Allocation.

Western Bounty Project- ENGIE North America is proposing the Western Bounty Transmission System project, which is an interregional, +/- 525 kV HVDC transmission system that would enable 12 gigawatts of transmission capacity between the central 'hub' in Nevada and the project's 4 termination points:

[1] This project is part of the BPA Evolving Grid projects. The full set of models was not available during the study preparation of this study and will be included in the future study cycles to determine the full regional impact.

SCE's Lugo-Vincent 500 kV line and LADWP's Adelanto Substation in California, BPA's Grizzly Substation in Oregon, and Idaho Power's Hemingway Substation in Idaho. ENGIE North America is not seeking Interregional Cost Allocation.
SageBrush Project- GridLiance is proposing an interregional project with upgrades in the southern portion of Nevada between Nevada and California. GridLiance is not seeking Interregional Cost Allocation.

Alternative Projects

The Enrolled Parties Planning Committee did not identify any Alternative Projects: no Alternative Projects were carried over from the 2022-2023 cycle and no new Alternative Projects were submitted at the beginning of the 2024-2025 planning cycle.

Power Flow Case Development

NorthernGrid started with the data from the 2024 Quarter 1 Data Submittal and incorporated that data into the 2034 Anchor Data Set. This incorporation primarily included ensuring the topology, loading, and generation were expected for a 2034 future. From that modified 2034 Anchor Data Set, an 8760 hour production cost model was run to represent each hour in 2034. The 8760-hour representation allowed for scrutiny into overall regional stress conditions through examination of hourly system loading, path flows, and resource dispatch by fuel type.

Once the hours were selected from the production cost model 8760 hour run, they were transformed back into solve-able power flow cases. This transformation from production cost model to power flow tool was developed to support the NorthernGrid effort; the transformation tool is automated, transparent, and replicable.

Power Flow Case Conditions

The technical team concluded the following hours as those that represent varying stress conditions for the NorthernGrid footprint:

1. Heavy system loading, lower renewable generation output 1/2/34, 22:00
2. North to South, East to West interface flows 2/13/34, 20:00
3. Low Hydro/End of Summer conditions 8/11/34, 17:00
4. East to West interface flows 11/16/34, 15:00
5. West to East interface flows 5/13/34, 24:00
6. South to North interface flows 4/8/34, 17:00
7. Summer peak loading condition 7/9/34, 14:00
8. Winter peak loading condition 12/6/34, 10:00
9. West of Cascades, North 6/18/34, 16:00

Contingencies and Criteria

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

Thermal overloads occur when the power flowing through a facility exceeds the capability of the facility which causes heat to build up; excess heat occurs which can then damage the facility. 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 system 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 facility by either reducing the power or redirecting the power to facilities with larger capabilities.

Voltage excursions occur when the reactive support of the transmission system changes, as can happen during the loss of a facility. Voltage excursions can be high or low, either of which causes undue stress on the facility experiencing the excursion. Due to the interplay of all the facilities in a transmission system, the loss of any facility 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.

Members submitted regionally significant contingencies used for reliability analysis to develop the Plan. Contingencies on major WECC Paths relevant to the NorthernGrid region as well as contingencies on facilities in the 200 kV and above voltage classes were the primary focus. These regionally significant contingencies were selected for their criticality to the NorthernGrid region. 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 region 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.

Evaluation of Regional Transmission Project Combinations

To determine whether transmission needs within the NorthernGrid may be satisfied by regional transmission projects, NorthernGrid evaluates the proposed regional and interregional (if any) transmission projects independently and in regional combinations. The regional combinations are determined by the MPC based on their knowledge of the NorthernGrid Region. The regional combinations are shown in the 2024-2025 NorthernGrid Study Scope.

Impacts on Neighboring Regions

As stated above, the power flow cases represent the entire western interconnection. Therefore, during the power flow analysis NorthernGrid will monitor for NERC standard and WECC criterion violations occurring in the neighboring regions. Upon identification of a violation in a neighboring region, NorthernGrid will coordinate with the region to confirm validity and whether the violation is due to an existing condition. Mitigation plans for a violation will be determined in accordance with the NorthernGrid Member tariffs and planning agreement.

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 region 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”. 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 region while maintaining system reliability.

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 lists the full complement of ranking factors used.

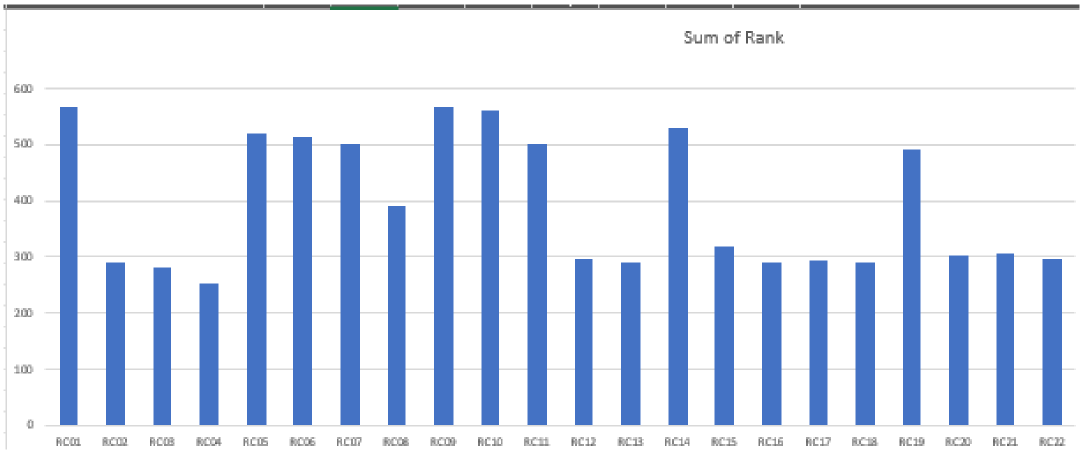
The selection of the regional projects in the Plan is determined by the combination of projects that results in a transmission system that most cost-effectively or efficiently exceeds the reliability performance of the other possible combinations of submitted projects.

Analysis Results

Once the base cases were updated to include the submitted loads, resources, and projects along with adjusting the generation dispatch to match the regional transmission flows described above, they were run through contingency analysis. When running contingency analyses, both the type of 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 facility. In general, an outage of higher voltage facilities has a greater impact on the transmission system than the loss of lower voltage facilities. 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.

To help identify regionally significant contingencies, each contingency result was multiplied by ranking factors: voltage class, type of contingency, and the severity of contingency impact. An overall contingency ranking is the product of the sum of each ranking factor. The larger the resulting ranking, the more regionally significant the contingency. Voltage class refers to the kV rating of the facility: 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 facilities to severe outages that impact multiple facilities. It is quite common for a transmission system to have a single facility 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 facility. 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 facility. A major violation may cause cascading outages or facility damage. Each contingency from each base case and each regional combination was ranked per the ranking factors. Ranked contingency results are unitless and are only used as a comparison of performance between power flow cases. The ranks are listed in Appendix C.



Regional Combination	RC01	RC02	RC03	RC04	RC05	RC06	RC07	RC08	RC09	RC10	RC11	RC12	RC13	RC14	RC15	RC16	RC17	RC18	RC19	RC20	RC21	RC22
Greenlink North		X	X	X			X	X	X	X	X					X	X	X	X	X	X	X
MATL		X	X	X													X	X		X	X	X
One Nevada #2		X	X	X			X	X	X							X	X	X		X	X	X
Gateway West, Anticline-Populus		X	X	X								X	X	X	X	X	X	X	X	X	X	X
Gateway West, Populus-Cedar Hill-Midpoint-Hemingway		X	X	X								X	X		X	X	X	X		X	X	X
Gateway West, Populus-Borah-Midpoint, Cedar Hill-Hemingway		X	X	X									X		X	X	X	X		X	X	X
Cascade Renewable Transmission System			X	X	X													X				
Clover-Robinson (Cross-Tie)			X	X		X	X	X			X						X		X			
Sagebrush (Interregional)				X				X														
Western Bounty (Interregional)				X				X							X							
Blueprint		X	X	X																X		
Bonanza/John Day Area to Bonanza		X	X	X																	X	
Bethel Round Butte (Lambert Mountain View)		X	X	X														X				X
Robinson Phase Shifter		X	X	X		X	X	X			X						X		X			
One Nevada #1 Series Comp		X	X	X		X	X	X			X						X		X			

Figure 4: Ranking results, Thermal Overloads and Unsolved for the NorthernGrid footprint

Figure 4 shows the results of the contingency analysis for any thermal overloads or unsolved cases observed. The NorthernGrid ranking total captures the rank for the entirety of the contingency for each of the Regional Combinations for all the cases analyzed.

1. The Regional Combination (RC) with the highest rank/worst results for thermal overloads and unsolved contingencies has no upgrades. RC01 tests today's topology against the loads and resources submitted for a ten-year future. It is not surprising that the case with the fewest upgrades results in the highest overall ranked score.
2. Similarly, the RC with the fewest thermal overloads and unsolved contingencies is the combination with all submitted regional and interregional projects, both member and non-incumbent. RC04, or the "Bugatti" case, results in the lowest thermal contingency ranking, but would also result in the greatest overall cost.
3. There are no unsolved contingencies for any of the Regional Combinations studied.

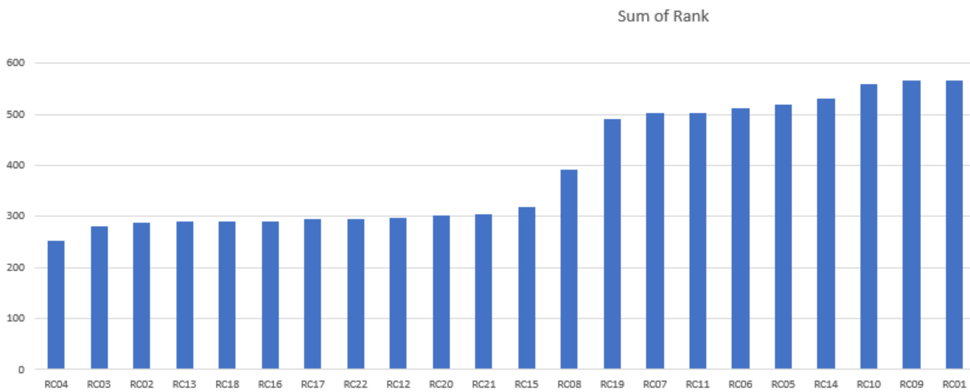


Figure 5: Sorted Rankings for the NorthernGrid footprint

Figure 5: Sorted Rankings for the NorthernGrid footprint shows the sorted rankings for all the RCs. RCs with scores totaling 300 points or more were removed from further consideration.

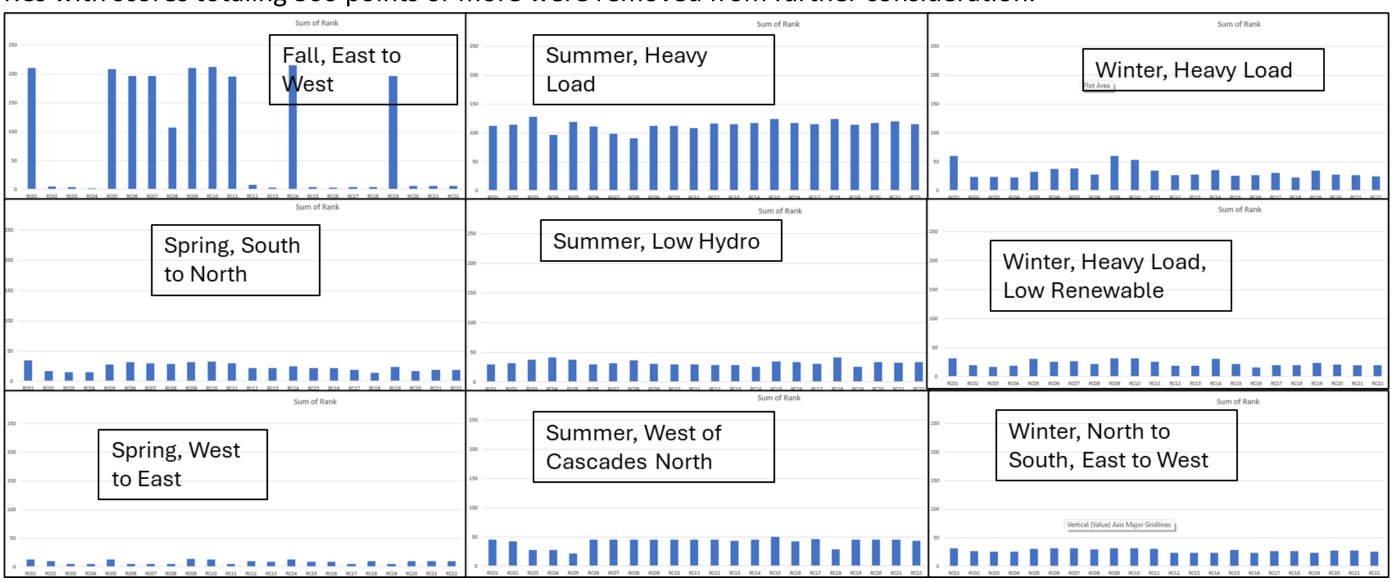


Figure 6: NorthernGrid Thermal Rankings by Stressed Condition

The impact of the different RCs for the different stressed conditions is illustrated in Figure 6. The NorthernGrid footprint responds differently to the studied stressed conditions; for example, focusing on the RC1 combination with no new projects the Fall, East to West scenario resulted in a high amount of thermal violations. The NorthernGrid Technical Team used these graphics to help determine the impact of RCs resolving violations for different flow scenarios.

Further examination of the data culminated in the following general conclusions:

1. The MATL project tended to impact the Montana area and has negligible impact on the rest of the NorthernGrid footprint. RCs 16 and 17 were chosen as demonstrative examples of the impact of MATL. The two RCs are topologically similar with the exception of MATL, the Robinson Phase Shifter, and One Nevada #1 Series Comp. The Robinson Phase Shifter and One Nevada #1 Series Comp projects support local service in Nevada and are electrically disparate from MATL such that conclusions drawn in the Montana/Alberta area will likely be due to the topological differences in Montana. The only topological difference in Montana is the modification to MATL.
   Increased flows on MATL results in increased flows through Montana; this effect can be seen in Table 2 where the maximum thermal loading on branches in Montana/Alberta tends to be higher with MATL than without.

Table 2: Branch Amp %Overloads for Montana, Montana and Alberta, All of WECC

		Montana, 230 kV	Montana and Alberta, 230+ kV	WECC, 230+ kV
Spring South to North	RC 16	3%	16%	42%
	RC 17	0%	30%	47%
Heavy Summer Load	RC 16	21%	0%	90%
	RC 17	15%	0%	90%
Summer, West of Cascades North	RC 16	0%	0%	88%
	RC 17	40%	40%	88%
Heavy Winter Load, Low Renewable	RC 16	19%	24%	87%
	RC 17	45%	49%	85%
Heavy Winter Load	RC 16	0%		161%
	RC 17	44%	44%	161%
Winter, North to South, East to West	RC 16	49%	54%	54%
	RC 17	68%	68%	68%
Fall, East to West	RC 16	0%	0%	53%
	RC 17	1%	0%	53%
Spring, West to East	RC 16	15%	0%	82%
	RC 17	14%	0%	82%
Summer, Low Hydro	RC 16	0%	0%	92%
	RC 17	0%	0%	92%

2. Greenlink North, One Nevada #2, Robinson Phase Shifter, and One Nevada #1 Series Comp projects are all 230+ kV projects and therefore meet the criteria for regional consideration. These projects primarily bolster the local area; this is demonstrated in Figure 7; the data for Figure 7 is a subset of that shown in Figure 4. RC15 has no Nevada area upgrades and results in the largest ranking; this finding suggests that Nevada benefits from these upgrades, but the overall ranking gain is insufficient for selection into the overall RTP.

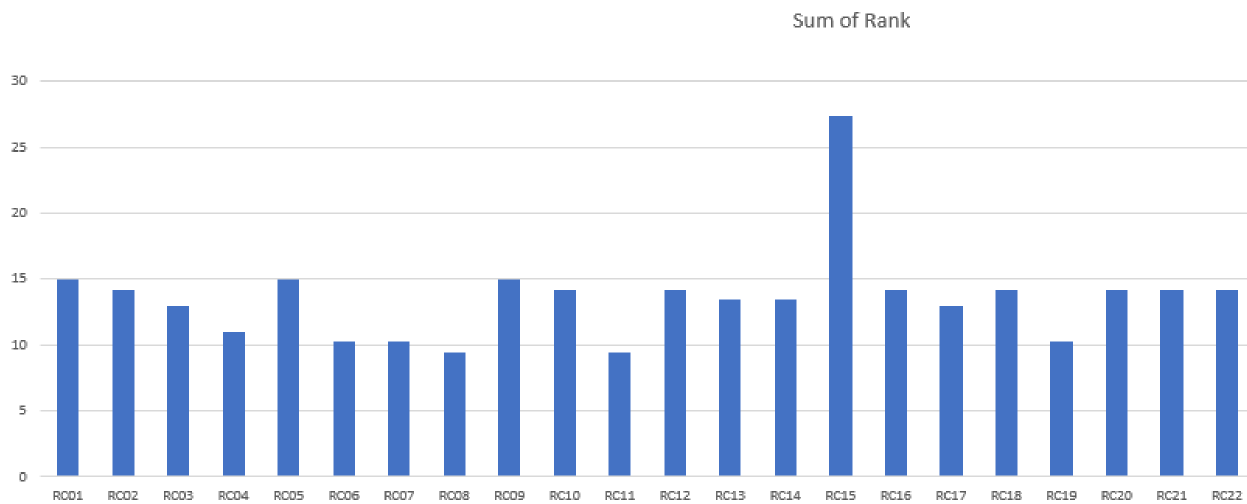


Figure 7: Nevada thermal rankings

3. The Cross-Tie project primarily resolves an N-2 contingency which was deemed to have minimal regional impact.
4. The Bonanza project did not significantly contribute to the reduction of the overall regional ranking scores compared to other RCs for the studied scenarios. This project has other nonregional drivers that are not part of this study and a full inclusion of the BPA Evolving Grid projects in future studies may impact this result. The RCs with Bonanza also have in common both paths through Gateway, MATL, and the One Nevada #2 line.
5. The Western Bounty project helps to resolve some regional area issues, however, the cost incurred with the interregional project is not substantiated with a corresponding and commensurate increase in reliability benefits.

Further examination of the regional combinations yield RC12 and RC13 as the leading contenders. The RC12 and RC13 combinations do not have any projects that primarily resolve a local area issue and the RC12 and RC13 combinations more cost effectively mitigate reliability violations with a smaller portfolio of transmission projects than competing combinations.

Table 3: Sampling of three base cases, comparison of RC12 and RC13, NorthernGrid footprint Results

	Fal_EW-RC12		Fal_EW-RC13		Spr_SN-RC12		Spr_SN-RC13		Sum_LHydro-RC12		Sum_LHydro-RC13	
	Count	Max	Count	Max	Count	Max	Count	Max	Count	Max	Count	Max
Branch MVA	7	13.0%	1	13.0%	7	84.1%	7	84.0%	9	71.8%	9	71.3%
Branch Amp												
P1					16	42.4%	16	40.6%	20	40.9%	20	40.5%
P2	7	40.0%	3	40.0%	8	31.1%	8	31.1%	3	20.6%	3	20.4%
P7									3	32.6%	3	32.7%
unknown	3	3.3%	3	3.3%	9	24.8%	10	25.1%	4	12.6%	4	12.9%

Table 3: Sampling of three base cases, comparison of RC12 and RC13 indicates that the two regional combinations respond similarly for the sampling of base cases selected for this table: the remaining base cases show similar responses. RC12 is a subset of RC13, and therefore RC12 is the set of projects that comprises the Draft Regional Transmission Plan for the 2024-2025 cycle.

Proposed Regional Transmission Plan

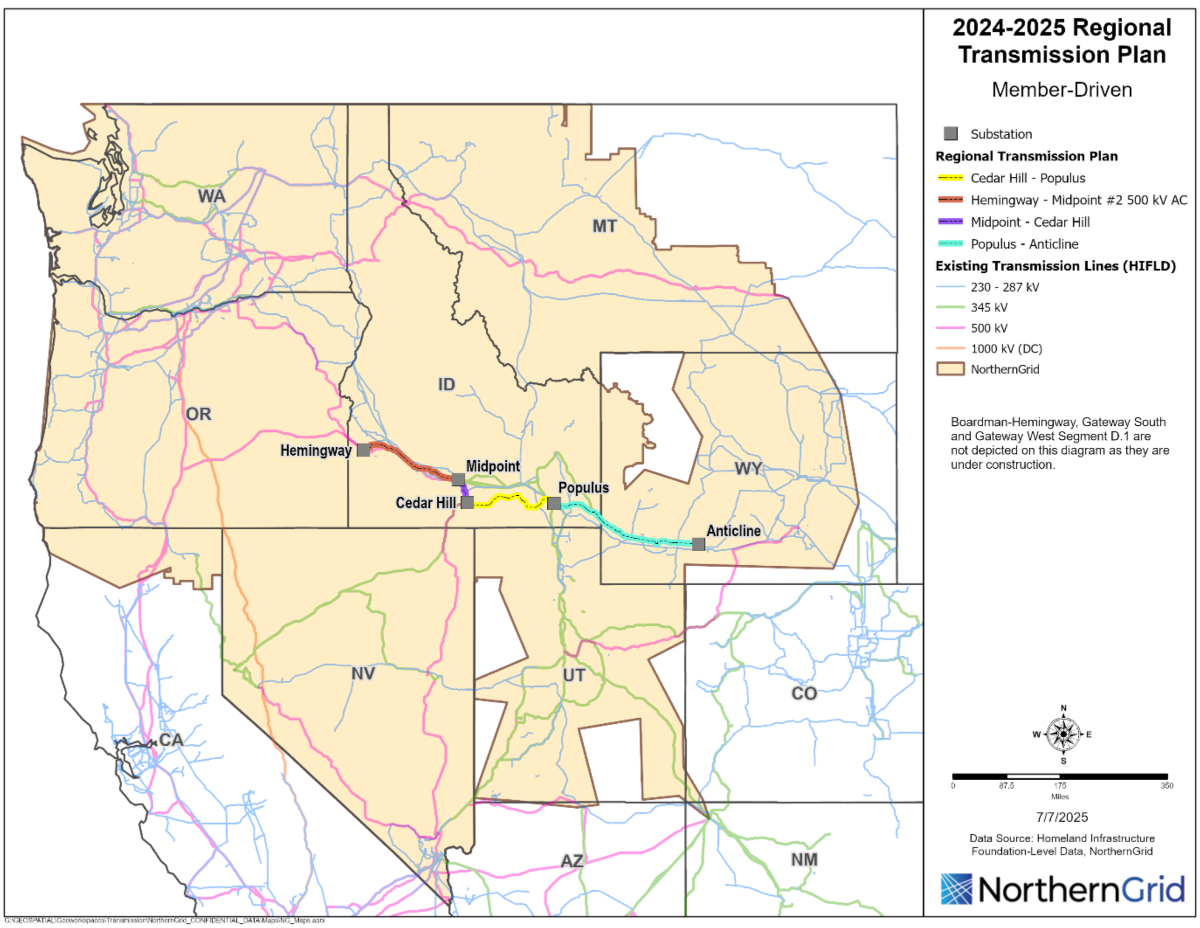


Figure 8: 2024-2025 Draft Regional Transmission Plan

The draft 2024-2025 RTP is a single path connecting Hemingway through Midpoint, Cedar Hill, Populus, and on to Anticline. Interestingly, this path is the same path that was selected for the 2022-2023

NorthernGrid RTP without the Longhorn/Boardman to Hemingway project. The Longhorn/Boardman to Hemingway project was included as part of the base transmission system for the 2024-2025 cycle due to its update to Committed Project status from the 2022-2023 cycle.

Impacts on Neighboring Regions

There were no Material Adverse Impacts within neighboring regions identified for any of the projects evaluated.

Cost Allocation

The projects submitted for cost allocation consideration in the NorthernGrid region were not selected into the RTP. For this cycle, there are no projects that meet the criteria for cost allocation.

Conclusion

Every Cycle, the NorthernGrid team gathers up their best predictions of what the 10-year future looks like. The NorthernGrid technical team takes that information and uses their technical expertise to perform a thorough and thoughtful analysis that takes into account the expected load, generation, and transmission for the 10-year future. For this 2024-2025 cycle, the NorthernGrid technical team analyzed nine cases that were based on back-transformations from a production cost model run. These nine cases, 22 different Regional Combinations, and hundreds of contingencies were simulated and coalesced into a pivot table that accounts for all components of the analysis, from contingency type and voltage level through to which zone was impacted. The NorthernGrid technical team fully scrutinized the data and identified the Regional Combination that met the reliability expectations for the NorthernGrid footprint for a 10-year future at the least cost. These reliability and cost drivers resulted in the same set of projects as the 2022-2023 NorthernGrid RTP, sans Boardman/Longhorn to Hemingway. The Boardman/Longhorn to Hemingway project achieved its Rights of Way for construction before the beginning of the 2024-2025 planning cycle and was consequently treated as “in-service” or part of the base transmission system for NorthernGrid.

Appendix A: Definitions and Terms

Attachment K from NorthWestern Energy is provided here for reference to the process or definitions and can be accessed through this website:

https://www.oasis.oati.com/woa/docs/NWMT/NWMTdocs/Att_K_-_Transmission_Planning_Process.pdf

Appendix B: Study Scope

The approved 2024-2025 NorthernGrid Study Scope is located here:

https://www.northerngrid.net/private-media/documents/2024_2025_Approved_Study_Scope.pdf

Appendix C: Ranks

Each contingency gets a Ranking, the multiplicative result of each of the three categories.

Category	Rank	Description
P0	1	All lines in service
P1	0.8	N-1
P2	0.5	Multiple outages
P4	0.3	Multiple outages
P5	0.3	Multiple outages
P7	0.8	Multiple outages
P3	0.1	N-1-1
P6	0.1	N-1-1
unknown	0.5	

Figure 9: Ranking for Contingency Type

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

Figure 10: Ranking for Voltage Level, measured at the high-side of the equipment

LV_Type	From	To	Rank	Description
Interface MW	0%	10%	0	Mild overload of path rating.
Interface MW	10%	9999999999999%	0	Heavy overload of path - potential stability problems.
Branch Amp	0%	15%	1	Mild overload of line.
Branch Amp	15%	9999999999999%	1.5	Heavy overload of line. Possibility of automated tripping.
Branch MVA	0%	15%	1	Mild overload.
Branch MVA	15%	9999999999999%	1.5	Heavy overload.
Unsolved	0%	9999999999999%	1	
Bus High Volts	0%	10%	1	
Bus High Volts	10%	9999999999999%	1.5	
Bus Low Volts	0%	10%	1	
Bus Low Volts	10%	9999999999999%	1.5	
Change Bus Low Volts	0%	10%	1	
Change Bus Low Volts	10%	9999999999999%	1.5	
Change Bus High Volts	0%	10%	1	
Change Bus High Volts	10%	9999999999999%	1.5	
WECC TPL CRT WR1.1.2	0%	9999999999999%	1	

Figure 11: Ranking for the Level of Impact