2021 Regional Transmission Plan Scope and Process

Version 2.0

Document Revisions

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1. Introduction

The Regional Transmission Plan (RTP) is the result of a coordinated planning process, performed by ERCOT Staff with extensive review and input by NERC registered Transmission Planners (TPs), Transmission Owners (TOs), and other stakeholders. This process addresses reliability and economic transmission needs for the six-year planning horizon. This process produces a region-wide reliability and economic study of the transmission system in accordance with NERC and ERCOT planning requirements over a six-year transmission planning horizon. Results of this process include recommendations for upgrading and improving the existing system and proposals for new transmission projects that ensure transmission system reliability and relieve significant anticipated transmission system congestion. The 2021 RTP Scope and Process document captures the scope for planning studies conducted as part of the 2021 RTP. This document also briefly describes the process and various deliverables applicable for the 2021 RTP.

2. Scope

The 2021 RTP shall identify reliability needs and transmission upgrades and additions required to meet the system needs per criteria set in the ERCOT Planning Guide Sections 3 and 4 and the NERC TPL-001-4 Reliability Standard. The RTP study scope is limited to the steady state and short circuit portion of the reliability standards.

The 2021 RTP will study the following reliability cases.

- Summer peak load cases for years 2023, 2024, 2026, and 2027.
- Minimum load case for the year 2024.
- At a minimum, one sensitivity case each for years 2023 and 2026 summer peak, and 2024 minimum load.

For each study year, four sets of summer peak cases will be developed with each case representing one study region. The study regions are defined as follows.

- NNC study region: North and North Central weather zones.
- SSC study region: South and South Central weather zones.
- WFW study region: West and Far West weather zones.
- EC study region: East and Coast weather zones.

The 2021 RTP will also identify transmission projects that meet the ERCOT economic planning criteria as stated in Nodal Protocols Section 3.11.2. Economic analysis will be conducted for years 2023 and 2026.

To the extent practicable, projects identified in the 2021 RTP will be based on consensus between ERCOT Planning and the NERC registered TPs with input from other market participants.

All stakeholder communication regarding the RTP will be conducted through the monthly Regional Planning Group (RPG) meetings and mailing lists. Start cases and results of the analysis will be available for review via ERCOT's MIS Secure area.

3. Input Assumptions

Input assumptions used to prepare the RTP reliability base cases will be presented at the RPG meetings. Stakeholders are encouraged to provide feedback on the assumptions. ERCOT Planning will consider comments and feedback from stakeholders before finalizing these assumptions. The following section provides a high-level methodology used to develop assumptions for the RTP. The actual values used for the 2021 RTP can be found in the addendum which will be updated throughout the course of the RTP.

3.1 Transmission Topology

3.1.1 Start Cases

The Steady State Working Group (SSWG) summer peak cases for the years 2023, 2024, 2026, and 2027 will be used as start cases for reliability analysis. The SSWG minimum load case for the year 2024 will be used as the off-peak start case.

3.1.2 RPG Approved Projects

Per ERCOT Planning Guide Section 3.4.1.1, ERCOT Planning shall remove all Tier 1, 2, and 3 projects that have not undergone RPG Project Review from the most recent SSWG base cases. Projects receiving RPG acceptance concurrently with the RTP study will be reviewed for any material impact on the analysis. These, and any other model corrections, submitted by the TPs shall be documented and included in the study cases.

3.1.3 Transmission and Generation Outages

ERCOT will use Outage Scheduler to extract known generation or transmission facility outages with a duration of at least six months in addition to outages already modeled in the SSWG base cases. In addition, ERCOT will send out a Market Notice to collect known long-term outages with a duration of at least six months or longer. Those outages will be incorporated into the summer peak/off-peak cases accordingly. The list of generator outages will include the mothballed units as documented in the current Capacity, Demand, and Reserves report. Outages on seasonally mothballed units will also be included in the analysis of the appropriate study case. If issues or conflicts with planned outages are identified (IRO-017 R4), ERCOT will work with the affected TPs to jointly develop Corrective Action Plans (CAPs).

3.1.4 FACTS Devices

A data request will be sent out to TOs to understand the operation of FACTS devices in steady-state analysis, including base case and post-disturbance conditions. The information collected via the data request will be utilized to inform the use of FACTS devices in the RTP analysis.

3.1.5 Ratings and Interface Limits

All System Operating Limits (SOLs), including Stability SOLs, shall be respected in accordance with the latest ERCOT System Operating Limit Methodology. All transmission lines and transformers (excluding generator step-up transformers) 60-kV and above shall be monitored for thermal overloads to ensure that they do not exceed their pre-contingency (Rate A) or post-contingency ratings (Rate B).

Dynamic ratings will be used for both the reliability and economic portions of the analysis. The ratings in reliability analysis will be based on the 90th percentile[1] temperature as determined for the weather zone associated with the transmission element.

For voltage analysis, all buses 100-kV and above shall be monitored to ensure that they do not exceed their pre-contingency and post-contingency limits. In addition to the voltage limits, ERCOT will also monitor the post-contingency voltage deviation for all buses 100-kV and above. This criterion is defined in Planning Guide Section 4.1.1.4

Requirement 3.3.1 of TPL-001-4 requires automatic tripping of elements where relay loadability limits are exceeded. These trip settings are submitted by TPs. If such ratings are not available from the TPs, or the ratings are lower than the emergency rating of the equipment, a default limit of 125% of the emergency rating of the equipment will be used.

Under Voltage Load Shed (UVLS) from TSPs, and Generator Over and Under Voltage trip settings from RARFs are modeled, when applicable. If the Generator Over and Under Voltage trip settings are not available, default values will be used. The default values are determined as follows:

- For renewable generators: 0.9 pu and 1.1 pu for Under Voltage and Over Voltage trip settings, respectively.
- For all other generators: the post-contingency voltage limits.

Appropriate stability limits, as identified by the latest planning studies, will be modeled in the economic cases if the total capacity of generation in the economic cases exceeds the interface limit.

3.1.6 Contingency Definitions

The most current SSWG Contingency Database will be used to create the contingency set for the RTP analysis. This database shall be supplemented by auto-inserting single element contingencies. All contingency categories P0-P7, as well as extreme events conditions, will be studied in the 2021 RTP. A detailed list of definitions can be found in Table 1 of NERC TPL-001-4. ERCOT may consider multiple generator outages due to a common cause failure as a first level contingency for P3 contingency analysis.

The contingencies defined in ERCOT Planning Guide Section 4.1.1.2 will also be studied in the 2021 RTP with the proposed label in the following table:

[1] Calculated based on the most recent 30-year historical data of annual peak temperatures for each weather zone

Table 3.1: Planning Guide Section 4.1.1.2 Contingencies

Initial Condition		Event	Facilities within Applicable Ratings and System Stable with No Cascading or Uncontrolled Outages	Non-consequential Load Loss Allowed	Proposed RTP Category Label
1	Normal System	Common tower outage, DC Tie Resource outage, or DC Tie Load outage	Yes	No	P7.1_ERCOT1 (for common tower outage) P1.5_ERCOT1 (for DC Tie outages)
2	Unavailability of a generating unit, followed by Manual System Adjustments	Common tower outage, DC Tie Resource outage, or DC Tie Load outage	Yes	No	P3_ERCOT2
3	Unavailability of a transformer with the high voltage winding operated at 300 kV or above and low voltage winding operated at 100 kV or above, followed by Manual System Adjustments	Common tower outage; or Contingency loss of one of the following: 1. Generating unit; 2. Transmission circuit; 3. Transformer; 4. Shunt device; 5. FACTS device; or 6. DC Tie Resource or DC Tie Load	Yes	No	P6.2_ERCOT3
4	Unavailability of a DC Tie Resource or DC Tie Load, followed by Manual System Adjustments	Common tower outage; or Contingency loss of one of the following: 1. Generating unit; 2. Transmission circuit; 3. Transformer; 4. Shunt device; 5. FACTS device; or 6. DC Tie Resource or DC Tie Load	Yes	No	P6.4_ERCOT4

3.2 Generation

3.2.1 Generation Additions and Retirements

All existing generation plants are retained from the SSWG start cases. Future generation resources will be added to the SSWG start cases using information from the Resource Integration and Online Operations – Interconnection Services (RIOO-IS) online system if the requirements from Planning Guide Section 6.9(1) are met. The RIOO-IS database will be used as the reference for the status of the future generation.

Generation identified as retired or mothballed based on the most recent information available to ERCOT at the time of case building and analysis will be modeled as offline for appropriate cases. ERCOT has the discretion to turn off units if the Resource Entity notifies ERCOT of its intent to retire/mothball the Generation Resource and/or makes a public statement of its intent to retire/mothball the Generation Resource. ERCOT will provide reasonable advance notice to the RPG of any proposed Generation Resource retirements/mothballs and allow an opportunity for stakeholder comments.

3.2.2 Renewable Generation Dispatch

In the summer peak reliability cases, the wind plants located inside the study region will be dispatched at 15th percentile output based on the historical wind resource data during peak load hours. Hydro-electric Generation Resources and solar plants in the reliability cases are dispatched up to the Hydro Unit Capacity and the Solar Unit Capacity, respectively, as defined in Nodal Protocols Section 3.2.6.2.2, Total Capacity Estimate.

For the Off-Peak reliability case, the historical data of wind resources during the minimum load conditions will be analyzed to determine maximum wind dispatch output level. All hydro and solar generation in the minimum load reliability case will be modeled offline.

In economic analysis, vendor-supplied 8,760-hour profiles will be used to dispatch wind and solar generation units. Hydro dispatch will be based on a review of historical capacity factors and dispatch levels for Hydro units.

3.2.3 Switchable Generation and Exceptions

Per ERCOT Nodal Protocols Section 16.5.4, upon receipt of a written notice, Switchable Generation Resource parameters used in the RTP cases will be updated to appropriately reflect the amount of switchable generation available to ERCOT for the study cases.

3.2.4 DC Ties

All of the existing DC ties, including those connecting to the *Comisión Federal de Electricidad* (CFE), will be set based on a review of historical DC tie import/export information and any changes in the capacity of the DC ties.

3.2.5 Reserve Requirements

The reserve requirements in RTP reliability and economic analysis will be based on a review of ERCOT's ancillary services Responsive Reserve and Regulation Up requirements.

3.2.6 Fuel Price and Other Considerations

Wind and solar production costs will be modeled at $0/MWh in the economic analysis. ERCOT will review available sources for fuel price forecast for the 2021 RTP, these sources include, but are not limited to, the Energy Information Agency's (EIA) Current Annual Energy Outlook (AEO), SNL, and NYMEX. ERCOT will also review available sources for emission costs for the 2021 RTP. These sources include, but are not limited to, SNL, EPA, etc.

3.2.7 Distribution Generation Resources, Settlement Only Distribution Generators, and Unregistered Distributed Generation

Distribution Generation Resources (DGRs) and Settlement Only Distribution Generators (SODGs) that are not included in the SSWG base cases will be modeled as a simple model generator. SODGs and unregistered Distributed Generation (DG) modeled as negative load in the SSWG base cases will be taken offline. DGRs will be dispatched similarly to other Generation Resources (GRs) of the same resource type. SODGs will be kept offline.

3.2.8 Energy Storage

Battery energy storage will be modeled in the 2021 RTP economic and reliability analysis using data provided in response to requests for information (RFI) in addition to that available in RIOO. The following assumptions will be made for battery energy storage for which data is not available from RFIs or other available sources:

- An energy to power ratio (E/P) of 2 will be assumed to determine the MWh Nameplate Rating
- Roundtrip efficiency will be assumed to be 86%

Transmission-connected battery energy storage will be assumed online to provide reactive power support for the reliability portion of the 2021 RTP. Battery energy storage, except those registered as SODG, with a duration of 4 hours or greater will be dispatched up to their maximum discharging capacity for summer peak cases, and all battery energy storage, except those registered as SODG, will be assumed to charge up to their maximum charging capacity for the minimum load case. Both charging and discharging will be subject to Security-Constrained Optimal Power Flow (SCOPF).

3.3 Demand

The load in the RTP cases is evaluated by weather zone. The load in the reliability cases will be set per the methodology detailed in Planning Guide Section 3.1.7. A boundary threshold of 5% will be used to compare the SSWG load forecast with the ERCOT 90th percentile load forecast for all weather zones except for the Far West weather zone, where a boundary threshold of 7.5% will be used. All loads not identified as self-served load will be scaled to achieve the approved weather zone load levels. The minimum load cases will use the load from the SSWG minimum load base case unless ERCOT load review identifies the need for adjustment.

The ERCOT load forecast for the 2013 weather year, plus self-serve load, will be used for the economic portion of the analysis. Economic analysis may be supplemented by sensitivities for the 2007, 2008, 2011, and 2015 weather years.

When loads are scaled outside of a study region, conforming loads will be scaled by the same percentage and the P/Q ratio at each load will be kept constant.

Non-conforming loads will be extracted from the weather zone load and will not vary on an hourly basis in the economic portion of the analysis.

Load modeling changes (including shifting loads between substations) and corrections provided by TPs during the course of the analysis will be documented and included in the study cases.

4. The RTP Process and Method of Study

Figure 4.1 shows the RTP study process.

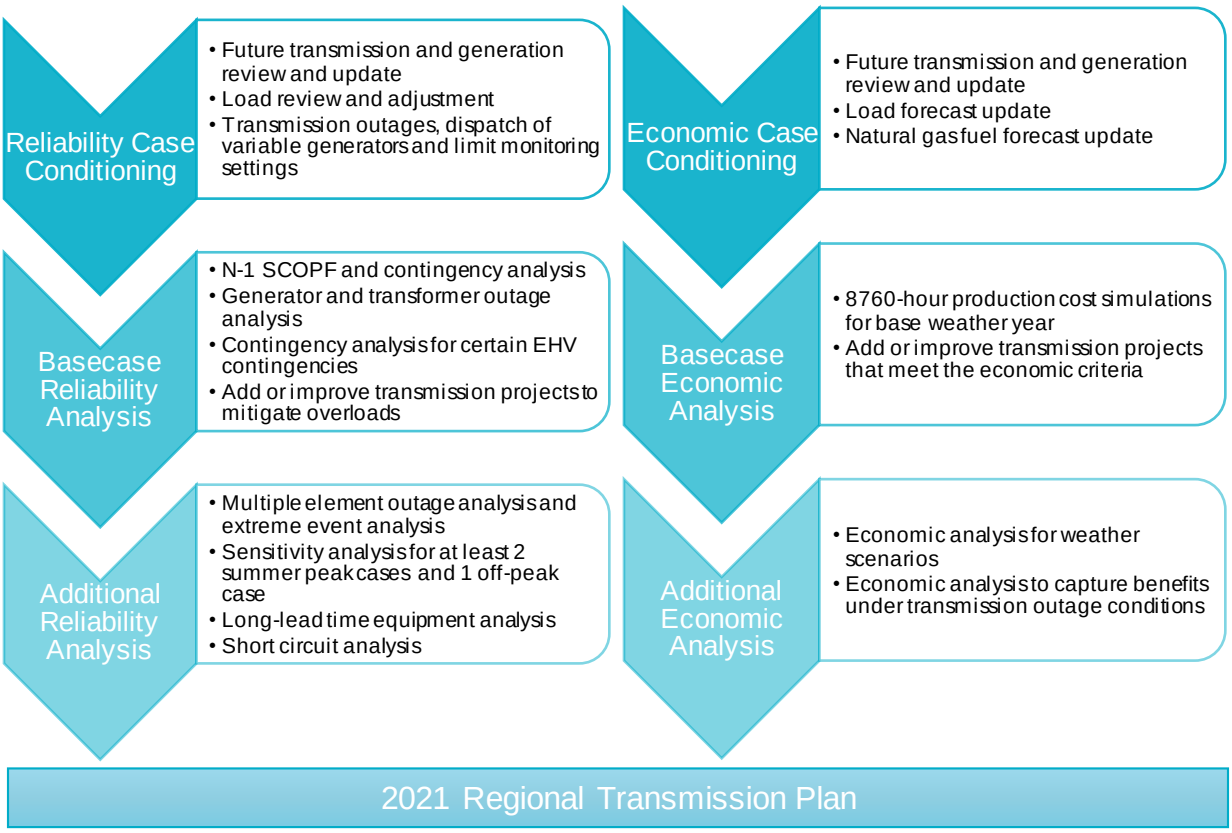

Figure 4.1: The Regional Transmission Plan Process

4.1 Case Conditioning

A data request will be sent out to the TSPs to review and update information to be used in the 2021 RTP cases. This request will include, but will not be limited to, the following information.

- Review the list of FACTS devices to inform the use of FACTS devices in the RTP analysis.
- Review the list of Tier 1, 2, and 3 projects in Model-On-Demand (MOD) that have not completed RPG review.
- List of generic equipment with long lead time requirements in the TSP footprint. TPL-001-4 R2.1.5 defines the equipment to be studied in this analysis as having a lead time of one year or longer.
- Provide known long term outages with a duration of at least six months or longer that are applicable to the summer peak and off peak study cases of the 2021 RTP.

Following the response to the above data request, the generation, transmission, and load data in the SSWG start cases will be updated using the input assumptions discussed in this scope document. The summer peak and the minimum load cases will be prepared in this step. The reliability start cases and initial N-1 criteria violations will be shared with stakeholders via the MIS Secure area.

4.2 Reliability Analysis

SCOPF will be run to identify unresolvable constraints in the Year 6 conditioned case. Loading on elements 60 kV and above will be monitored for P0, P1, P2-1, P3, P6-2 (where the initial condition is the loss of a 345/138-kV transformer), and P7 events. Per TPL-001-4, manual system adjustments following the first outage are allowed for P3 and P6 planning events. These system adjustments may include, but are not limited to, curtailment of DC tie flows, transmission configuration changes, and re-dispatch of Generators, if feasible. For P0, P1, P2-1, and P7 events, DC tie curtailment will be utilized to resolve reliability criteria violations before proposing reliability projects. Furthermore, loading on BES elements and voltage violations on BES buses will be monitored for all other contingency events, including Extreme Events. CAPs will be developed per NERC and ERCOT reliability criteria.

CAPs will be studied in collaboration with TPs to find solutions to constraints under different contingency events per TPL-001-4 and ERCOT Planning Guide Section 4. Following a contingency where non-consequential load shed is acceptable, ERCOT will conduct a load shed and cascading analysis to identify contingencies that have a severe impact on the ERCOT BES network. A severe impact includes, but is not limited to, 1) 300 MW or more load shed required to mitigate the impact of contingency; 2) non-convergence resulting from a system-wide voltage stability issue; or 3) cascading outages. When investigating the need for a transmission improvement project for these conditions, ERCOT may decide to not recommend a project based on the consideration of the likelihood and impact of the event occurrence and the cost and public impact of a transmission improvement project.

Once all reliability projects have been identified (i.e. no unresolvable constraints remain) projects will be reevaluated to determine if each project is needed. The above analysis will be repeated for other cases described in the scope section of this document.

4.2.1 Cascading Outage Analysis

All contingency events where non-consequential load shed is allowed will be screened to detect potential cascade events for more detailed analysis. The simultaneous loss of the North and East DC ties will be included as an extreme event in the analysis.

The screening to detect a cascade event will begin by simulation of events that may result in tripping of system elements as follows:

- Transmission facilities (100 kV and above) overloaded beyond the lower of their relay loadability limits and 125% of their emergency ratings.
- Generator buses where voltage on the low side of the Generator Step Up (GSU) transformer are less than known or assumed minimum generator under-voltage trip limits.
- Generator buses where voltage on the low side of the Generator Step Up (GSU) transformer exceed known or assumed maximum generator over-voltage trip limits.
- Buses with known UVLS protection schemes where voltages go below the under-voltage triggering level.

If an initiating event results in any one of the following conditions, the event will be selected as a potential cascade event for more detailed analysis:

- The total load loss as a result of system cascading is 2000 MW[2][3] or greater; or
- The power flow does not converge - which may be a result of a potential voltage collapse condition, subject to additional confirmation.

ERCOT may simplify the above tripping criteria and process further to more effectively identify cascading events.

The events identified as potential cascade conditions will be studied further in co-ordination with associated TPs. In the detailed analysis, an event will be defined as cascading if the total load loss as a result of system cascading is 2000 MW or greater. Appropriate CAPs will be developed in accordance with Table 1 of NERC Reliability Standard TPL-001-4. Possible corrective measures, including potential mitigation plans, generator re-dispatch, and controlled load shed, or a transmission improvement project will be considered.

4.2.2 Sensitivity Analysis

NERC TPL-001-4 R2.1.4 requires transmission planners to study the impact of changes to basic assumptions via Sensitivity Analysis. ERCOT will present the sensitivities selected for the 2021 RTP to the RPG. The assumptions for the sensitivity analysis will be detailed in the reliability input assumptions appendix.

The sensitivity analysis will be performed with all reliability solutions identified from the base case analysis included to evaluate the effectiveness and robustness of the base case solutions under the stressed system conditions. For any new constraints found in

[2] Based on NERC Methods for Establishing IROLs Task Force (MEITF) recommendation: https://www.nerc.com/comm/PC/Methods%20for%20Establishing%20IROLs%20Joint%20Task%20Force%20ME/MEITF_IROL_Framework_Assessment_-_2018-08-21.pdf

[3] This threshold is consistent with the updated ERCOT System Operating Limit (SOL) Methodology (http://www.ercot.com/gridinfo/planning) effective October 1, 2020

the sensitivity analysis, ERCOT will identify potential solutions which will be shared with stakeholders as a reference to guide analysis of future system conditions.

4.2.3 Short Circuit Analysis

ERCOT will perform a short circuit analysis based on three-phase-to-ground and single-line-to-ground (SLG) faults. The study will be conducted using the 2024 and 2026 summer peak system protection future year base cases from the System Protection Working Group (SPWG). All generators modeled in each case will be turned online except those determined to not be in-service.

Faults will be tested at all point of interconnection (POI) buses associated with generators.

ERCOT will use PTI PSS/E software to conduct the short circuit study using the classical flat start (e.g. FLAT, CL in PSS/E) method for the conditioning of the pre-fault conditions.

The results of short circuit analysis will include the magnitude of short circuit current and source impedance associated with each fault. The results will be posted to the MIS Secure area for GO review. After ERCOT email notification sent to the NERC Registered GOs, GOs will complete the review of study results and provide a list of over-dutied circuit breakers and corresponding CAPs.

4.2.4 Long Lead Time Analysis

The impact of unavailability of long lead time equipment will be studied as part of the 2021 RTP per R2.1.5 of NERC Reliability Standard TPL-001-4. Long-lead time equipment analysis is performed to study the impact of an outage of a transmission elements, identified by the TO per its review of its spare equipment strategy. For the purposes of this study the long lead time criteria is defined as one year. A market notice requesting a list of long lead time equipment will be sent out prior to the study. The study results are communicated with respective TOs. Each responsible TO is encouraged to review and update its spare equipment strategy to prepare for an outage of such an equipment. The RTP is not expected to develop CAPs for issues identified in long lead time analysis.

4.2.5 LTSA Alignment

Large projects (e.g., 345 kV) will be further evaluated using most recent Long-Term System Assessment (LTSA) cases to ensure project robustness and long-term effectiveness. Project concepts identified in the LTSA will be reviewed as an aid to identifying project recommendations that will provide long-term benefits either as part of a long-term plan for the development of the system or as an alternative to recommending a series of smaller incremental projects over time. Areas identified in the LTSA as requiring a significant number of system upgrades will be evaluated on a long-term basis if upgrade needs are identified in the area during the 2021 RTP analysis.

4.3 Economic Analysis

The transmission network from the final summer peak 2020 RTP reliability cases for 2023 and 2026 will be uploaded into UPLAN as the starting economic cases. The start cases will be updated to reflect new projects that have recently received approval through the RPG review process. The UPLAN database will also be updated using input assumptions included in the economic input assumptions addendum. The economic analysis may

include weather scenarios performed on five weather years in which wind, solar, and load profiles are based on the 2013, 2007, 2008, 2011, and 2015 weather years. Transmission outage sensitivity analysis may also be included in RTP economic project evaluation. After completing a production-cost simulation run, economic projects will be studied in collaboration with the TPs for the highest congested elements. Once all economic projects have been identified, a project back-out analysis will be performed to determine if each project is still economically justified when tested in combination with other economic projects. The final set of economic projects will be tested in the summer peak reliability cases to ensure that the reliability cases are still N-1 secure.

5. Deliverables

In the course of the analysis, the following information, at a minimum, will be shared with the stakeholders via MIS:

- Initial conditioned start cases and a list of binding constraints
- Intermediate cases and binding constraints, and proposed reliability and economic projects as they become available
- Steady-State AC base cases including all reliability and economic projects for each case
    - Summer peak load cases for years 2023, 2024, 2026, and 2027
    - Minimum load case for the year 2024
    - Each sensitivity case for years 2023 and 2026 summer peak and 2024 minimum load
- A final congestion table will be posted for each study year in the economic analysis

Appendix

Addendum A: 2021 RTP reliability input assumptions
Addendum B: 2021 RTP economic input assumptions