



2018 Regional Transmission Plan Scope and Process

Version 2.0

Document Revisions

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3/22/2018	2.0	Updated section on economic analysis start case selection and added clarification on some reliability analysis assumptions	Ping Yan, Tim McGinnis

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1. Introduction

The Regional Transmission Plan 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 2018 RTP Scope and Process document captures the scope for planning studies conducted as part of the 2018 RTP. This document also briefly describes the process and various deliverables applicable for 2018 RTP.

2. Scope

The 2018 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 NERC TPL-001-4 reliability standard. The RTP study scope is limited to the steady state portion of the reliability standards.

The 2018 RTP will study the following reliability cases.

- Summer peak load cases for years 2020, 2021, 2023, and 2024.
- Minimum load case for the year 2021.
- At a minimum, one sensitivity case each for years 2020 and 2023 summer peak, and 2021 minimum load.

The 2018 RTP will also identify transmission projects that meet the ERCOT economic planning criteria as stated in the Protocol Section 3.11.2. Economic analysis will be conducted for years 2020 and 2023.

To the extent practicable, projects identified in the 2018 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.

3. Input Assumptions

Input assumptions used to prepare the RTP reliability base cases will be presented at the Regional Planning Group meetings. Stakeholders are encouraged to provide feedback on the assumptions. ERCOT Planning will consider comments and feedback from stakeholders before finalizing these assumptions. This section provides a high level methodology used to develop assumptions for the RTP. The actual values used for the 2018 RTP can be found in the addendum which will be updated through 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 2020, 2021, 2023, and 2024 will be used as start cases for reliability analysis. The SSWG minimum load case for the year 2021 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

All known generation or transmission facility outages with duration of at least six months are assumed to be modeled in the SSWG base cases. 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.

3.1.4 FACTS Devices

A data request will be sent out to TOs to confirm the list of FACTS devices which are not available for steady-state voltage support. Such FACTS devices will be turned off for the RTP analysis since they are not expected to contribute during steady-state system conditions.

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 percentile¹ 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, the 2018 RTP will also monitor the post-contingency voltage deviation for all buses 100-kV and above. This criterion is defined in the 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 collected from TPs via the SSWG process. If such ratings are not available from the TPs, a default limit will be used. This default limit is determined to be the lower of 1) 115% of their emergency ratings and 2) 150% of normal ratings. Under Voltage Load Shed (UVLS) from TSPs, Generator Over and Under Voltage trip settings from RARF are modeled when applicable.

Appropriate Panhandle export interface limits and other **Generic Transmission Constraint (GTC)** 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 contingencies, namely for P2-1 and P6 planning events. All contingency categories P0-P7, including the extreme events conditions, will be studied in the 2018 RTP. A detailed list of definitions can be found in Table 1 of NERC TPL-001-4.

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 Asset Registration Form (RARF) if the requirements from Planning Guide Section 6.9 are met. If the future generation resource meets all requirements of Planning Guide Section 6.9 except all of the data required in the Resource Registration Glossary are not available as per Planning Guide Section 6.9(1) (a) then other sources such as Interconnection Agreements may be used to model these generators. The ERCOT Generation Interconnection Status (GIS) database will be used as a reference list containing 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.

3.2.2 Renewable Generation Dispatch

In the summer peak reliability cases, the wind plants located inside the study region will be dispatched based on the 15th percentile output based on vendor supplied profiles sampled for the top 20 peak load hours for each of the ten preceding years. Hydro-electric Generation Resources and solar plants in the reliability cases are dispatched up to the

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

Hydro Unit Capacity and the Solar Unit Capacity respectively as defined in Protocol 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 (typically three years) capacity factors and dispatch levels for Hydro units.

3.2.3 Switchable Generation and Exceptions

Per ERCOT Protocol 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 (typically three years) 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 cost will be modeled at \$0/MWh in the economic analysis. ERCOT will review available sources for fuel price forecast for the 2018 RTP, these sources include but are not limited to the Energy Information Agency's (EIA) Current Annual Energy Outlook (AEO), SNL, and NYMEX etc. ERCOT will also review available sources for emission cost for the 2018 RTP, these sources include but are not limited to SNL, EPA etc.

3.2.7 Distributed Generators

Distributed generators identified in the SSWG start cases as a negative Load are assumed to be unavailable for the reliability cases and will be modeled offline.

3.3 Demand

The load in the RTP cases is organized and evaluated by weather zones. The RTP summer peak reliability cases will use a weather zone non-coincidental peak forecast. The load in the reliability cases will be set per the methodology detailed in the 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. The minimum load cases will use the load from the minimum load SSWG base cases.

The ERCOT load forecast for the 2009 weather year, plus self-serve load, will be used for the economic portion of the analysis. The load forecast will be based on a weather

zone 8760-hour forecast. The economic analysis may be supplemented by additional weather-year sensitivities. 2007 and 2010 are two additional weather-years that may be included in the 2018 RTP economic analysis.

ERCOT will use the “scalable load” information from the SSWG cases to identify non-conforming loads to be used in the RTP cases. When loads are scaled in a weather zone, all loads, except those identified as non-conforming within the weather zone, 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.

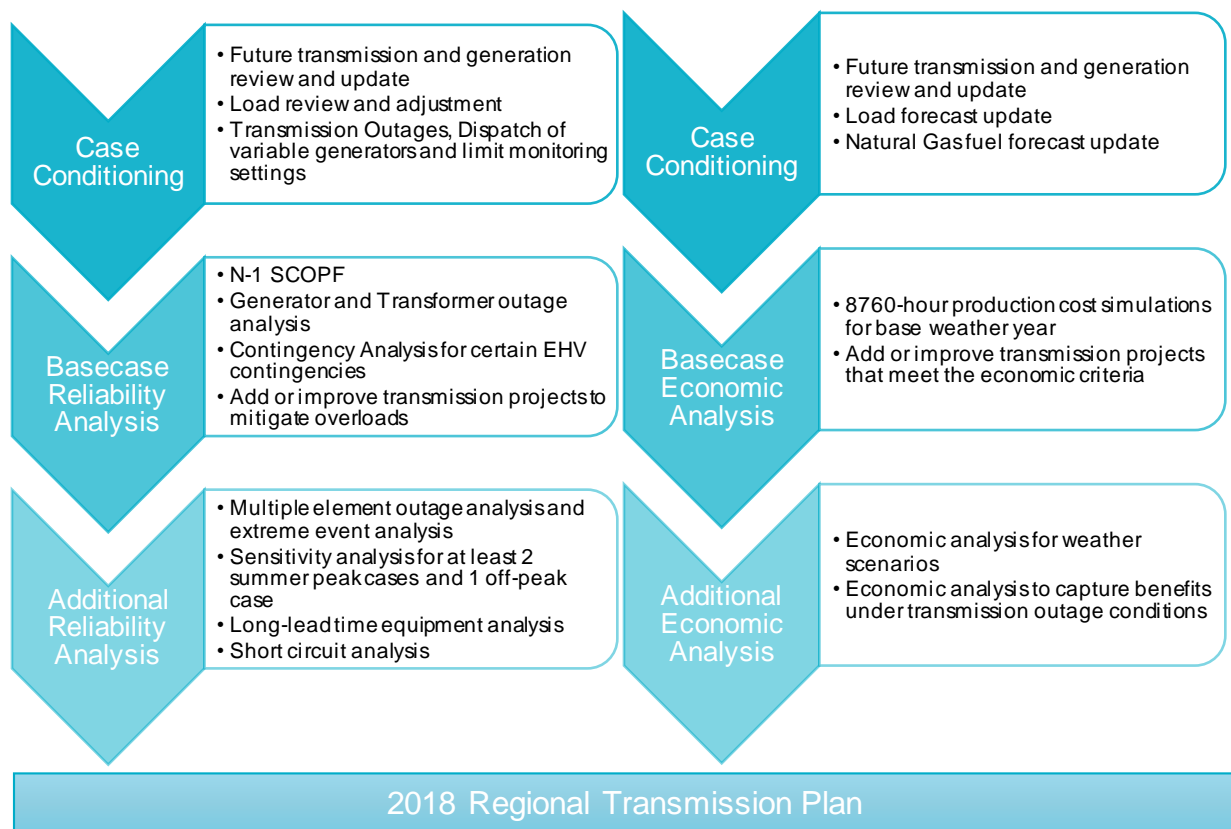


Figure 4.1: The Regional Transmission Plan Process

5.1 Case Conditioning

A data request will be sent out to the TSPs to review and update information to be used in the 2018 RTP cases. This request will include, but will not be limited to, the following information.

- Review the list of FACTS devices which will not be used as voltage support devices.
- Review the list of Tier 1, 2, and 3 projects in Model-On-Demand (MOD) that have not completed RPG review.
- Review the list of future generation to be added or removed, as well as existing generation to be retired or mothballed from the 2018 RTP cases.
- 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.
- Review the relay-loadability limits and provide any updates to the existing set of ratings.

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 MIS.

5.2 Reliability Analysis

A SCOPF, Security Constrained Optimal Power Flow, 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, P3, P6-2 (where the initial condition is the loss of a 345/138 kV transformer), and P7 events. Per the TPL-001-4, manual system adjustments following the first outage is 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. Furthermore, loading on BES elements and voltage violations on BES buses will be monitored for all other contingency events, including Extreme Events. Corrective Action Plans will be developed per NERC and ERCOT reliability criteria.

Corrective Action Plans 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, 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.

5.2.1 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 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 their relay loadability limits (defined in section 3.1.4)
- Generator buses where voltage on the low or high 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 or high 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 potential cascade event for more detailed analysis:

- The total load loss as a result of system cascading is greater than 6% of the total initial system load²
- 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 coordination 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 greater than 6% of the total initial system load. Appropriate corrective action plans will be developed in accordance with Table 1 of the 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.

5.2.2 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 2018 RTP to the RPG. The assumptions for the sensitivity analysis will be detailed in the input assumptions appendix.

The sensitivity analysis will be performed with all reliability solutions identified from the base case analysis to evaluate the effectiveness and robustness of the base case

² Based on Section 3.7 of the SOL Methodology for Operating and Planning Horizon

solutions under the stressed system conditions. For any new constraints found in the sensitivity analysis, ERCOT will identify potential Corrective Action Plans which will be shared with stakeholders as a reference to guide analysis of future system conditions.

5.2.3 Short Circuit Analysis

ERCOT will perform a short circuit analysis based on three-phase to ground fault and single-line to ground (SLG) fault. The study will be conducted using the 2021 and 2023 summer peak reliability base cases with all projects identified in the 2018 RTP. All generators modeled in each case will be turned online except those determined to be not in service (e.g. mothballed units or units with the notice of Suspension of Operations of a Generator Resource).

Faults will be tested at all BES buses (typically, 100 kV and above) and all point of interconnection (POI) buses associated with generators. For sequence impedance data required for the study, ERCOT will use the following assumptions and methodology.

- For transmission facilities in the RTP cases, positive sequence impedance will be based on the impedances in the RTP cases. Negative sequence impedance is identical to positive sequence impedance. For zero sequence impedance, the database built for ERCOT System Protection Working Group (SPWG) will be used. If zero sequence impedance data of a transmission line is not available, ERCOT may use a default value (typically, three times greater than positive sequence impedance). If zero sequence impedance of a transformer is not available in the SPWG database, ERCOT may use the data of similar transformer in the system or contact TSPs to obtain sequence impedances.
- For generators in the RTP cases, the database of SPWG will be used to obtain sequence impedance data. If the data of a generator is not available in the SPWG database, ERCOT may use either Resource Asset Registration Form (RARF) database or data of a similar generator in the system. For the purpose of this study Inverter based generators are assumed to have nominal contribution to the fault current and hence are modeled with high sub-transient reactance.
- Load level will be consistent with the RTP cases.

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 on MIS for GO and TO review. Within 30 calendar days from ERCOT email notification sent to the NERC Registered TOs and GOs, TOs and GOs will complete the review of study results and provide a list of over-dutied circuit breaker and corresponding Corrective Action Plans.

5.2.1 Long-lead Time Analysis

The impact of unavailability of long-lead time equipment will be studied as part of the 2018 RTP per R 2.1.5 of the NERC Reliability Standard TPL-001-4. Long lead time equipment analysis is performed to study the impact of an outage of a transmission elements which will be unavailable for a longer period of time. 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 Transmission Owners (TO) s. 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 Corrective Action Plans for issues identified in long-lead time analysis.

5.2.1 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 2018 RTP analysis.

5.3 Economic Analysis

The transmission network from the final summer peak 2017 RTP reliability cases for 2020 and 2023 will be uploaded into UPLAN as the starting economic cases. Updates to the transmission network include projects that have recently received approval through the Regional Planning Group process. The UPLAN database will be updated using input assumptions relevant to economic analysis discussed in this document. The economic analysis may include weather scenarios performed on three weather years in which wind, solar and load profiles are based on 2007, 2009 and 2010 weather years. Transmission outage sensitivity may also be included in RTP economic project evaluation. After completing a production-cost simulation run, the congestion in each case will be organized by its rank and shadow price. 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 is 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 case to ensure that the reliability case is 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 at yearly peak including all reliability and economic projects for each case.
 - Summer peak load cases for years 2020, 2021, 2023, and 2024
 - Minimum load case for the year 2021.

- Each sensitivity case each for years 2020 and 2023 summer peak and 2021 minimum load.
- A final congestion table will be posted for each study year in the economic analysis.

Appendix

Addendum A: [2018 RTP input assumptions](#)