



Item 7.1: Real-Time Co-optimization Task Force (RTCTF) Update

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ERCOT Compliance Director

Board of Directors Meeting

ERCOT Public
December 10, 2019

RTCTF Update

- RTCTF Stakeholder Update
- TAC Voting Results on Key Principles (KPs)
- Examples of Real-Time Co-optimization (RTC) Issues
- Next Steps
- Appendix
 - RTC KPs
 - Procedural Processes

RTCTF Stakeholder Update

~~Thursday, April 4 (Initial meeting, Charter and Approach)~~

~~Monday, April 22 (RTC Orientation Session)~~

~~Tuesday, April 30 (Begin reviewing Key Principles)~~

~~Monday, May 13~~

~~Friday, June 7~~

~~Friday, June 21~~

~~Friday, July 12~~

~~Friday, Aug. 9~~

~~Tuesday, Aug. 27~~

~~Thursday, Sept. 19~~

~~Tuesday, Sept. 24 (Special meeting for ISO Lessons Learned)~~

~~Wednesday, Oct. 9~~

~~Wednesday, Oct. 30~~

~~Tuesday, Nov. 19~~

~~Tuesday, Dec. 3~~

Thursday, Dec. 19

Friday, Jan. 10

Wednesday, Jan. 22 > TAC Jan. 29 > Board Feb. 11

TAC Endorsement of Key Principles*

- At the October 23, 2019, TAC meeting, TAC endorsed the following KP subsections:

Unanimous Endorsement:

- KP1.1(5): Ancillary Service Demand Curves and Current Market Price Adders
- KP1.3(1) – (3), (4)(a) & (b), (5) – (8)(a) & (b), (10) & (11): Offering and Awarding Ancillary Services in Real-Time
- KP5(1) – (6): Day-Ahead Market

- At the November 20, 2019, TAC meeting, TAC endorsed the following KP subsections:

Unanimous Endorsement:

- KP1.3(8)(c), (9), (12) & (13): Offering and Awarding Ancillary Services in Real-Time
- KP2(1) – (6): Suite of Ancillary Services
- KP5(7): Day-Ahead Market

* Details of each endorsed KP are in the Appendix

Examples of RTC Issues

- As a follow up from the discussion at the October 8, 2019, Board meeting, the following issues below reflect examples of how RTCTF considered and agreed to resolution of design issues:
 - Maintaining Participation Factors;
 - Shape of AS Demand Curves; and
 - AS Proxy Offers Curves.

Examples of RTC Issues

- Maintaining Participation Factors

- Today, Qualified Scheduling Entities (QSEs) can continuously update “Participation Factors” with telemetry to ERCOT to indicate which Resources they will use to provide their Regulation Service portfolio requirement.
- ERCOT Proposal: ERCOT initially proposed Real-Time Ancillary Service awards and deployments be “Resource-specific” as part of KP1.5.
- Alternative (Participation Factor) Proposal: An alternative was proposed to combine both designs, where the initial dispatch would be Resource-specific, but then allow QSEs to continue to use Participation Factors for flexibility within the 5-minute interval to move Ancillary Services to other Resources.
- Both proposals were developed and presented to RTCTF.
 - TAC endorsed the ERCOT Proposal at its July 24th meeting.
 - The Alternative Proposal was added to KP8 as Out of Scope.

Examples of RTC Issues

- Shape of Ancillary Service (AS) Demand Curves
 - Today, the Operating Reserve Demand Curve (ORDC) represents scarcity pricing for reserves; The design objective for RTC is to align AS Demand Curves (ASDCs) with the ORDC.
 - ERCOT Proposal: ERCOT initially proposed that the ASDCs include some distribution of services into lower pricing on the curve to reflect a gradual increase in pricing (e.g., some amount of Regulation Up having some MW amounts exist below the Value of Lost Load (VOLL)).
 - Alternative Proposal: An alternative was proposed to not distribute certain services to lower pricing and deployment at lower levels, in order to protect the higher quality services (Regulation Service and Responsive Reserve) from being dispatched before all Non-Spin and ERCOT Contingency Reserve Service (ECRS) are deployed.
 - There was consensus at the RTCTF to move forward with the Alternative Proposal; the ERCOT Proposal was set aside.
 - RTCTF also agreed that ASDCs should be designed and implemented as parameters, to allow for minimal impacts if changed in the future.

Examples of RTC Issues

- AS Proxy Offer Curves

- Today, if a complete Energy Offer Curve (EOC) is not available, EOCs can be created and cover the full range of a Resource. These are called proxy EOCs.
- ERCOT Proposal: ERCOT initially proposed methods of proxy AS Offers that would:
 - If an incomplete AS Offer, extend same price across range of Resource.
 - If no AS Offer, set the Proxy Offer at some minimum value (e.g., value of \$0/MWh).
- RTCTF and the Independent Market Monitor (IMM) thoroughly discussed these scenarios.
- Ultimately a design framework was adopted that addressed the proxy offer logic and proxy offer floors in a manner that would allow ERCOT to move forward with Protocols and system development.
- In parallel to system development, stakeholders will be able to vet and adopt proxy offer floors prior to RTC go-live, which can be defined in the Protocols as TAC-approved values for each AS product and sub-product.

Next Steps

- It is anticipated that at the next Board meeting, February 11, 2020, and in accordance with the RTCTF Charter:
 - RTCTF will present the Board with the comprehensive list of KPs needed to implement RTC, and identify any policy issues beyond the scope of the RTC project.
 - RTCTF will respectfully request that the Board instruct ERCOT staff to develop the requisite Nodal Protocol Revision Requests (NPRRs) and applicable Other Binding Documents (OBDs) based on the KPs needed for RTC’s implementation.
- Reminder of Posted Key Principles on RTCTF Homepage:
 - [“Key Principles Library”](#): RTCTF discussion organized by KP
 - [“TAC Approved RTCTF Key Principles”](#): Zipped file of documents reflecting cumulative version of TAC-approved KPs.

APPENDIX

Key Principle 1.1: Ancillary Service Demand Curves and Current Market Price Adders

- KP 1.1 The pricing of reserves and energy with RTC) will reflect the use of demand curves based on the Operating Reserve Demand Curve (ORDC) while continuing to adjust for defined out-of-market actions taken by ERCOT to maintain reliability.
- KP 1.1 (5) (summarized)
 - 5) ERCOT will implement parameters to represent the disaggregation of Ancillary Service Demand Curves (ASDCs) so that potential future changes in values and distribution will not require system changes. To disaggregate single ORDC into individual ASDCs, the following requirements are necessary:
 - a) Place Reg-Up at the highest priced MWs on the aggregate ORDC;
 - b) Place RRS at the highest priced open MWs on the aggregate ORDC;
 - c) Place ERCOT Contingency Reserve Service (ECRS) at the highest priced open MWs on the aggregate ORDC;
 - d) Place Non-Spinning Reserve (Non-Spin) at the highest priced open MWs on the aggregate ORDC; and
 - e) Fill remaining MWs on the aggregate ORDC priced at \geq \$0.01 as NSRS.
- Meetings and discussion:
 - RTCTF discussion Aug 9, Aug 27, Sep 19.
 - October 9 RTCTF confirmed consensus of KP 1.1(5) proposal by Crescent Power.



Key Principle 1.3: Offering and Awarding Ancillary Services in Real-Time

- KP 1.3 Defines offers and awards of Ancillary Services (AS) in Real-Time by outlining the key mechanisms and timelines for submitted AS Offers, as well as the Ancillary Services considered and awarded under RTC.
- KP 1.3 (1), (2), (3), (4) (a & b), (5), (6), (7), (8), (10), and (11) (summarized)
 - 1) QSEs will have ability in Real-Time to indicate whether a Resource is temporarily unable to provide AS due to operational constraints.
 - 2) High-Set Under Frequency Relay (UFR) Load Resources will be able to self-provide Responsive Reserve UFR and ECRS; the amount of which will be based on Day-Ahead Market (DAM) and AS trades.
 - 3) On-Line hydro Generation Resources not operating in Synchronous Condenser Fast-Response mode will be able to maintain RRS, Non-Spin, and ECRS on those Resources through modification of the Mitigated Offer Cap (MOC).
 - 4) RTC will account for frequency responsive capacity of a Combined Cycle Generation Resource (CCGR) when awarding AS that is required to be frequency responsive.
 - a) QSEs will supply real-time data on the portion of the total output that is being provided from the CCGR's frequency responsive capacity, and the high and low limits of that capacity.
 - b) Utilizing the CCGR's frequency responsive parameters, RTC will limit frequency responsive AS awards to be within the frequency responsive capability limits.

Key Principle 1.3: Offering and Awarding Ancillary Services in Real-Time (continued)

- Cont.
 - 5) RTC will not change limitations on sub-categories of AS products (e.g., FRRS, FFR, and RRS and ECRS provided via UFR).
 - 6) Off-Line Resources providing Non-Spin that are in startup due to manual deployment by ERCOT will continue to be eligible for being awarded Non-Spin for the first 25 minutes following the deployment. The eligible capacity will be based on the High Sustained Limit (HSL) of the Resource less its Base Point instruction.
 - 7) Resources operating in quick-start mode that are in startup due to a deployment from ERCOT will continue to be eligible for being awarded ECRS and Non-Spin. The eligible capacity will be based on the HSL of the Resource less its base point instruction.
 - 8) During each execution, RTC awards for energy (Base Points) and AS will be based on taking a fresh look at the pool of Resources available to provide energy and AS.
 - a) Energy awards (Base Points) will be relative to Resource capability (limits, ramp rates).
 - b) AS awards will be relative to Resource capability (limits, ramp rates, etc.) and the ASDCs irrespective of the quantity of AS already being deployed.

Key Principle 1.3: Offering and Awarding Ancillary Services in Real-Time (continued)

- Cont.
 - 10) RTC will utilize the AS Offer structure that will be in place with the implementation of Nodal Protocol Revision Request (NPRR) 863.
 - 11) The AS Offer submission window will be consistent with the Energy Offer Curve (EOC) submission window.
- Meetings and discussion:
 - RTCTF discussion June 21, July 12, Aug 9, Aug 27, Sep 19.
 - October 9 RTCTF reviewed KP 1.3(1) - (15), and reached consensus on the following: KP(1), (2), (3), (4) (a & b), (5), (6), (7) (8), (10), and (11).

Key Principle 5: Day-Ahead Market

- KP 5 Identifies necessary changes for the DAM to bring Day-Ahead AS procurement into alignment with implementation of RTC.
- KP 5(1) – (6) (summarized)
 - 1) ASDCs will be added to the DAM optimization, and used as an input affecting AS quantity procured and Market Clearing Price for Capacity (MCPC).
 - 2) The same ASDCs that are used in Real-Time will be used in DAM.
 - 3) The current DAM AS insufficiency process will be eliminated by removing:
 - a) The process of reopening submission window for more offers;
 - b) The AS penalty costs; and
 - c) The current pricing run used when AS Offers are insufficient to meet the AS Plan.
 - 4) AS Obligation quantities posted by 06:00 in the Day-Ahead will become an advisory-only number based on the AS Plan and will be used to validate self-arranged AS transactions. This validation will include any AS subtype limitations, e.g., RRS being provided via UFR.

Key Principle 5: Day-Ahead Market

- Cont.
 - 5) Minimum AS Obligation quantity will be 0.1 MW.
 - 6) After DAM is published, updated AS Obligation quantities will be calculated and published based on the actual DAM AS requirement. These quantities may differ from the 06:00 posting, and are the quantities that will be used for DAM Settlement.
 - a) “DAM AS requirement” means the sum of the DAM AS awards plus any self-arrangement.
 - b) In the event that a QSE’s self-arranged quantity exceeds the final AS Obligation, the remainder will be paid to the QSE at the DAM MCPC. Self-arranged AS transactions will not be allowed to be submitted or updated after DAM.
- Meetings and discussion:
 - RTCTF discussion Aug 27, Sep 19, and Oct 9.
 - October 9 RTCTF reviewed KP 5(1) - (6), and reached consensus for the entire KP.

Key Principle 1.3: Offering and Awarding Ancillary Services in Real-Time

- KP 1.3 Defines offers and awards of Ancillary Services (AS) in Real-Time by outlining the key mechanisms and timelines for submitted AS Offers, as well as the Ancillary Services considered and awarded under RTC.
- KP 1.3 (8)(c), (9), (12), (13) (summarized)
 - 8) (c) All Resources providing FFR shall be considered during the RTC runs following an automatic deployment of FFR, including continued awarding of FFR and economic dispatch of the Resource up to the Resource's limits.
 - 9) ERCOT operators will have the ability to manually reduce the amount of AS being awarded to Resources that, when deployed, may violate transmission constraints. ERCOT will notify QSE in Real-Time of any AS capability that has been derated by ERCOT including unit's new AS limit in MW. ERCOT will exclude any such manually reduced AS amounts from the AS imbalance calculation.
 - 12) Proxy AS Offers will be created for Resources that do not have a valid AS offer curve for the entire operating range of the Resource for use in the Real-Time Market (see *next slide for more details*).
 - 13) Proxy AS Offers will not be created for Resources for use in the DAM.

Key Principle 1.3: Offering and Awarding Ancillary Services in Real-Time (continued)

- Details of Proxy Offers (12):

- a. The proxy offer will be a linked AS Offer across all AS products for which a Resource is qualified to provide. For Resources that are not Load Resources, the proxy offer MW will be equal to the Resource's telemetered HSL. For Load Resources, the proxy offer MW will be equal to the Resource's telemetered Maximum Power Consumption (MPC).
- b. For each AS, the price in the proxy AS Offer for that AS for the Resource will be set equal to:
 - i. For Reg-Up and RRS, the maximum of a proxy offer price floor for that AS, the Resource's highest submitted offer price for that AS, the Resource highest price offer for ECRS (submitted or proxy), and the Resource's highest price offer for Non-Spin (submitted or proxy).
 - ii. For ECRS, the maximum of a proxy offer price floor for ECRS, the Resource's highest submitted offer price for ECRS, and the Resource's highest price offer for Non-Spin (submitted or proxy).
 - iii. For Non-Spin, the maximum of a proxy offer price floor for Non-Spin and the Resource's highest submitted offer price for Non-Spin.
 - iv. For Reg-Down, the maximum of a proxy offer price floor for Reg-Down and the Resource's highest submitted offer price for Reg-Down.
- c. Each of the AS proxy offer price floors will be a separate configurable parameter that can be set equal to a defined \$/MWh value.
- d. The system will be designed to allow different proxy offer price floors for instances in which the same AS can be provided by either Off-Line or On-Line Resources (i.e., the proxy offer price floor for an offline Non-Spin offer may be different than the proxy offer price floor for an online Non-Spin offer). It will also be designed to allow different proxy offer price floors for different subcategories of AS (i.e., the proxy offer price floor for a PFR-type RRS offer may be different than the proxy offer price floor for a UFR-type RRS offer).
- e. The RTC optimization will enforce various Resource specific AS constraints to ensure the AS awards are feasible, considering both QSE submitted AS offers and RTC created proxy AS Offers.

- Meetings and discussion:

- RTCTF discussion Sep 19, Oct 9, Oct 30.
- October 30th reached consensus on the following: KP 1.3 (8)(c), (9), (12), (13).



Key Principle 2: Suite of Ancillary Service Products

- KP 2 Analyze necessary changes (if any) on the suite of Ancillary Service (AS) products with the implementation of Real-Time Co-Optimization (RTC)
- KP 2(1) – (6):
 - 1) AS products under RTC will be the products finalized with the approval NPRR863.
 - 2) For all AS, the qualification process will determine the maximum MW amount the Resource is qualified to provide. ERCOT will limit awards the qualified quantity.
 - 3) Regulation Service continues with current qualification methodology. The MW qualified to provide Regulation Service (excluding Fast Responding Regulation Service (FRRS)) how much Resources can sustain for 15 minutes.
 - 4) Responsive Reserve (RRS) for a Generation Resource or Controllable Load Resource, continue with current qualification methodology and include the provision to sustain the qualified MW for 15 minutes. For a Generation Resource operating in synchronous condenser fast-response mode, continue with current qualification methodology. For a Load Resource controlled by high set UFR set at 59.7 Hz, continue with current qualification methodology. For a Resource providing Fast Frequency Response (FFR) including under-frequency relay Controlled Load Resources, ERCOT deployment signal and high-speed site-level data to verify the 15-cycle response along with the sustained 15-minute output.

Key Principle 2: Suite of Ancillary Service Products (continued)

- Cont.

- 5) For Off-Line Non-Spin, continue with current qualification methodology. All SCED-dispatchable Resources are qualified to provide On-Line Non-Spin based on their 30 minute blended ramp rate.
- 6) Off-Line ERCOT Contingency Reserve Service (ECRS) can only be provided by Resources that have met the Quick Start Generation Resources (QSGR) qualification. All SCED-dispatchable Resources are qualified to provide On-Line ECRS based on their 10-minute blended ramp rate. For ECRS from a Load Resource other than a Controllable Load Resource, the same qualification process used today to test manual deployment of Load Resources for RRS, excluding requirements for under-frequency relay response will be used.

- Meetings and discussion:

- RTCTF discussion Sep 19, Oct 9, Oct 30.
- October 30th reached consensus on the following: KP 2 (1)-(6)

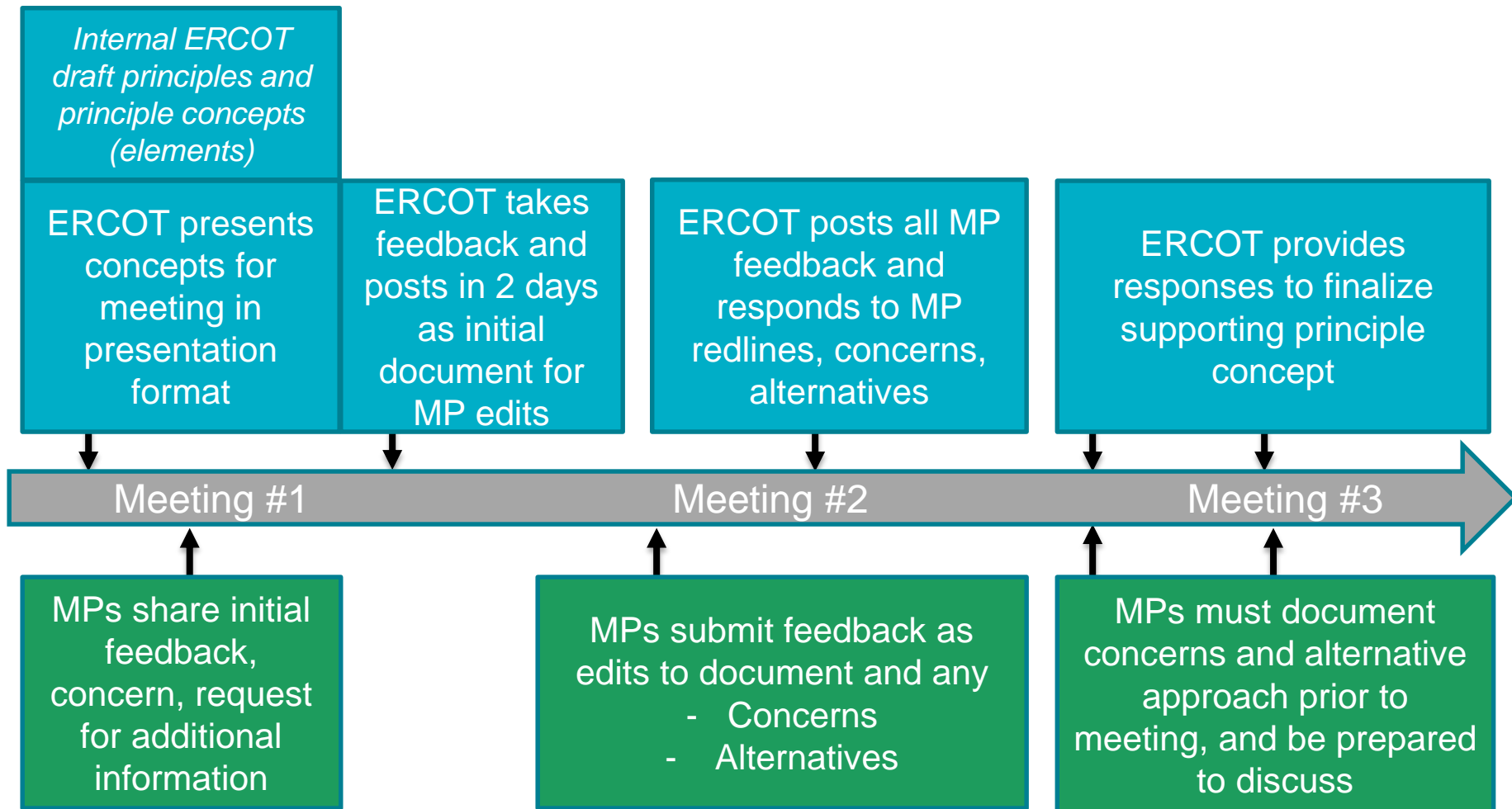
Key Principle 5: Day-Ahead Market

- KP 5 Identifies necessary changes for the DAM to bring Day-Ahead AS procurement into alignment with implementation of RTC.
- KP 5 (7) (summarized)
 - 7) AS Virtual Offers
 - a) Allow one part, unlinked offers of AS that do not represent an offer from a physical Resource from Qualified Scheduling Entities (QSEs). The general purpose of adding this new transaction is convergence bidding, in contrast to conventional Resource-specific AS Offers.
 - b) If awarded, the QSE will be paid the DAM price for the capacity times the quantity awarded. The awarded QSE will pay the Real-Time price times the quantity awarded, via the AS Imbalance calculation.
 - c) This proposal does not change the quantity of capacity purchased for each AS. ERCOT will attempt to procure the quantity from its AS Plan from Resource-specific offers as well as virtual offers against respective ASDCs.
 - d) Virtual offers can only be submitted for Conventional Regulation (not Fast Frequency Response Service); RRS – Primary Frequency Response type; ECRS – dispatchable; and Non-Spin.
 - e) The capability to self-arrange AS in excess of a QSE’s AS Obligation will no longer be needed and can be removed.

Key Principle 5: Day-Ahead Market

- (Cont.)
 - 7) AS Virtual Offers (cont.)
 - f) Virtual AS Offers will automatically expire at the close of the DAM.
 - g) The QSE will have the award included in the calculation of the QSE's position regarding any RUC Capacity-Short Charge.
 - h) The credit calculation for Real-Time Liability Estimate (RTLE) will also need to be modified to include this capacity in a fashion similar to the DAM energy short calculations.
 - i) The DAM credit exposure calculations will be modified to validate the virtual AS Offers against the available credit limit, similar to how DAM Energy-Only Offers are treated (evaluating the potential DAM/RT price risk). This will take the form of the 90th percentile of any positive hourly difference between the RT MCPC and the DAM MCPC over the previous 30 days.
- Meetings and discussion:
 - RTCTF discussion Sep 19, Oct 9, Oct 30.
 - October 30th reached consensus on the following: KP 5 (7)

Procedural Processes: RTCTF Review Process



Procedural Processes: TAC and Board Review Process

- TAC serves as the stakeholder body that reviews and endorses design principles (Key Principles) from the RTCTF.
- RTC Key Principles are non-binding and will not go directly to the Board after TAC consideration.
 - Procedures set forth in Protocol Section 21 do not apply to discussions, opinions or approvals by TAC with respect to RTC Key Principles.
 - Section VIII of the ERCOT Board Policies and Procedures does not apply to discussions, opinions or unofficial approvals by TAC with respect to RTC Key Principles.
- After TAC endorsement of all RTC Key Principles, ERCOT will compile the RTC Key Principles into a single package, and submit it to TAC for a courtesy review prior to Board review. The package will contain a full record of TAC votes.
- Following TAC review of the complete RTC Key Principles package, ERCOT will submit it to the Board for discussion and consideration.
 - Any stakeholder opposed to an RTC Key Principle may, at this time, request Board consideration in accordance with Section VIII of the ERCOT Board Policies and Procedures.

