RTC+B: ESR SOC Accounting

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# Objective

This document is intended to provide a high-level overview of system changes required to account for State of Charge (SOC) of Energy Storage Resource (ESR) under the RTC+B Project.

For the RTC+B project, ESR SOC accounting is limited to RTC versions of RUC and SCED.

# Summary of proposed ESR SOC accounting changes

## Interim Period changes (NPRR 1186) carried over into the RTC+B Project

Additional fields in COP (MinSOC, MaxSOC, HourBegingingPlannedSOC) (used by RTC-RUC)

## Day-Ahead Market (DAM)

There are no changes proposed to RTC-DAM as part of the RTC+B project.

## RTC+B Reliability Unit Commitment

RTC-RUC will be the tool ERCOT will rely on to ensure that there is sufficient capacity (MW) and energy from ESRs (MWh), to meet demand (load forecast), Ancillary Service requirements and manage congestion.

The energy sufficiency checks on ESRs uses COP submissions of minSOC, maxSOC and Hour beginning planned SOC and includes the use of AS deployment factors.

The AS deployment factors are hourly parameters for each AS type that are values between 0 and 1 (or 0% to 100%) that indicate the expectation of deployment based on system conditions as new forecasts for demand and renewables are input to RUC.

For example, the AS deployment factor for Non-Spin may be set to a high value for time periods when the expected net load forecasted ramp over certain hours exceeds a certain MW/hour threshold.

RTC-RUC, will use the following new COP values and AS deployment factors to ensure that MW dispatch to an ESR for energy and AS are such that:

1. There is sufficient energy (SOC, MWh) available in the ESR to sustain the MW dispatch for energy and AS for their respective time durations and does not violate the COP values of minimum and maximum SOC for any given hour.
2. The study/simulated dispatch for energy and AS for a given hour are such that the resulting SOC accounting for the end of the given hour will be equal to the HourBeginningPlannedSOC of the next hour. In effect, RTC RUC will dispatch an ESR for energy and AS such that the ESR’s SOC accounting will track the submitted HourBeginningPlannedSOC for each hour as closely as possible (depending on violation costs).

The COP values related to SOC are;

1. Target SOC for the beginning of the Operating Hour for the ESR, (HourBeginningPlannedSOC), MWh
2. Minimum Operating State of Charge for the Operating Hour, (MinSOC), MWh and
3. Maximum Operating State of Charge for the Operating Hour (MaxSOC) MWh

With COP validation rules:

Check that the following condition is satisfied for given Hour Ending

1. MaxSOC is less than or equal to registered MaxSOC (similar to HSL check against HRL)
2. MinSOC is greater than or equal to registered MinSOC (similar to LSL check against LRL)

### RTC RUC setup

1. Input to Mid Term Load Forecast (MTLF) is setup such that MTLF does not include ESR charging load.
2. RUC study/simulation for ESR will be dispatched in RUC for both charging and discharging (change from current RUC where only ESR-GR is dispatched)
3. QSE: the QSE shall ensure that the Hour Beginning Planned SOC for any two consecutive hours shall be such that these values are operationally feasible.
4. RTC RUC preprocessing shall process the COP data and flag any ESR identified by hour(s) and amount where two consecutive Hour Beginning Planed SOC are not operationally feasible i.e., with a maximum basepoint (charging or discharging) in one hour, the next hour’s Hour Beginning Planned SOC in COP cannot be achieved.

For these ESRs, RTC RUC preprocessing will modify the COP submitted Hour Beginning Planned SOC value to a feasible value if the Hour Beginning Planned SOC value is not feasible.

For HRUC:

1. For RUC study hours (h=1,2,3,4, … last hour) initialize:
2. For 1st hour of RUC study (h=1):

Evaluate feasibility of ESR achieving the HourBeginngingPlannedSOC for the first hour of the RUC study using the telemetered ESR HSL, LSL and SOC at time of HRUC execution:

Check if the value of HourBeginningPlannedSOC is between the achievable min and max SOC. If not the RUC study will use the closest feasible value and potentially set the min and max SOC values to the closest feasible value (if needed):

1. For RUC study hours (h=2,3,4,… last hour):

From the 2nd hour till the last hour, evaluate sequentially (daisy chain), if the HourBeginningPlannedSOC for hour x is achievable from the previous hours SOC value that will be used by the RUC study. If the HourBeginngingPlannedSOC for an hour is not achievable, then the RUC study will use the closest feasible value for that hour and potentially set the min and max SOC values to the closest feasible value (if needed):

For DRUC and WRUC, the preprocessing check is the same as for HRUC with the exception that the first hour of the DRUC or WRUC study will assume that the COP SOC data is valid and no feasibility checks are required.

SOC accounting related parameters:

 : Time duration required to sustain MW energy dispatch (analogous to Real-Time Base Point)

 : Time duration required to sustain MW Regulation Up/Down dispatch (analogous to Real-Time Regulation Up/Down MW award )

 : Time duration required to sustain MW RRS-PFR dispatch (analogous to Real-Time RRS-PFR MW award )

 : Time duration required to sustain MW RRS-FFR dispatch (analogous to Real-Time RRS-FFR MW award )

 : Time duration required to sustain MW ECRS dispatch (analogous to Real-Time ECRS MW award )

 : Time duration required to sustain MW Non-Spin dispatch (analogous to Real-Time Non-Spin MW award )

 : Deployment Factor for Regulation Up in hour *h*

 : Deployment Factor for Regulation Down in hour *h*

 : Deployment Factor for RRS-PFR in hour *h*

 : Deployment Factor for RRS-FFR in hour *h*

 : Deployment Factor for ECRS in hour *h*

 : Deployment Factor for Non-Spin in hour *h*

###  RTC RUC: Objective function change related to ESR

ESR energy dispatch costs (Bid/Offer) and AS offer costs not included in the RTC-RUC objective function. i.e., ignore energy dispatch costs and AS offer costs of ESR. The SOC constraint violation costs are included in the objective function. *(Note that ERCOT is open to feedback on whether AS Offer costs should be included or not in the objective function)*

### RTC RUC: Additional SOC accounting related constraints

RTC-RUC will attempt to track the COP HourBeginningPlannedSOC for each hour of the RUC study period. As written below, there is no coupling between intervals as the violations of target SOC in one interval do not influence the starting SOC of the next interval. With this approach the penalty costs for violating the target SOC become important. With no temporal coupling, the performance of RTC RUC should not be adversely impacted by the introduction of binary variables due to SOC accounting.

Note that the equations below use RUCHourBeginningPlannedSOC, RUCMinSOC, RUCMaxSOC. If the COP submitted values for HourBeginningPlannedSOC, MinSOC and MaxSOC are feasible, then the values used in the RUC study are the same as the values in COP.

1. For hour h of RTC-RUC Study:
2. *(ESR has discharge energy dispatch)*

Ensure that, with a discharging energy dispatch, if all upward AS (RegUp, RRS-PFR, RRS-FFR, ECRS, NonSpin) are fully deployed (duration requirements for energy and AS), that there is sufficient SOC so that the ESR is not discharged below its COP minimum operating SOC value:

Ensure that, with a discharging energy dispatch, if downward AS (RegDown) is fully deployed (duration requirements for energy and AS), that the ESR’s calculated SOC is not above its COP maximum operating SOC value:

The starting SOC for the next interval (hour h) is known beforehand from COP (HourBeginningPlannedSOCi,h+1) (or closest feasible value). The energy and AS awards for the current interval must be such that the ESR SOC trajectory from one interval to the next will track as closely as possible (subject to violation penalty costs) the COP SOC values. Also, the change in SOC during an interval is based on how much SOC was depleted due to discharging energy dispatch and likely RegUp deployment and boosted by likely RegDown deployment (taking into account regulation deployment factors).

 and are the Regulation Up and Regulation Down deployment factors respectively (value between 0 and 1 for the interval/hour h). In addition, RRS-PFR, RRS-FFR, ECRS and NSPIN deployment factors are considered. and are the RRS-PFR, RRS-FFR, ECRS and NSPIN deployment factors respectively (value between 0 and 1 for the interval/hour h).

This constraint ensures that this calculated change in SOC matches the difference between the COP SOC values in adjacent intervals as closely as possible (HourBeginningPlannedSOCi,h+1 - HourBeginningPlannedSOCi,h):

1. *(ESR has a charge energy dispatch)*

Ensure that, with a charging energy dispatch, if all upward AS (RegUp, RRS-PFR, RRS-FFR, ECRS, NonSpin) are fully deployed (duration requirements for energy and AS), that there is sufficient SOC so that the ESR is not discharged below its COP minimum operating SOC value:

Ensure that, with a charging energy dispatch, if downward AS (RegDown) is fully deployed (factoring safety margin, duration requirements for energy and AS), that the ESR’s calculated SOC is not above its COP maximum operating SOC value:

The starting SOC for the next interval (hour h) is known beforehand from COP (TargetBeginSOCi,h+1). The energy and AS awards for the current interval must be such that the ESR SOC trajectory from one interval to the next will match as closely as possible (subject to violation penalty costs) the COP target begin SOC values. Also, the change in SOC during an interval is based on how much SOC was boosted due to charging energy Base Point and likely RegDown deployment and depleted by likely RegUp deployment (taking into account statistical regulation deployment factors).

 and are the Regulation Up and Regulation Down deployment factors respectively (value between 0 and 1 for the interval/hour h). In addition, RRS-PFR, RRS-FFR, ECRS and NSPIN deployments must be factored in. and are the RRS-PFR, RRS-FFR, ECRS and NSPIN deployment factors respectively (value between 0 and 1 for the interval/hour h).

This constraint ensures that this calculated change in SOC matches the difference between the COP target begin SOC values in adjacent intervals as closely as possible (HourBeginningPlannedSOCi,h+1 - HourBeginingPlannedSOCi,h):

Simultaneous upward and downward AS deployment scenario is not considered for either charging or discharging scenarios as the above constraints are more conservative and will ensure that the COP minimum and maximum operating SOC values are not violated with simultaneous upward and downward AS deployment.

### RTC+B RUC: RUC Capacity Short Calculations

The RUC capacity short calculations will factor in the COP value of HourBeginningPlannedSOC for each hour of the RUC study horizon to determine capacity available to meet the QSE’s energy and AS position.

## RTC+B Real-Time Market

In Real-Time, for an ESR, RTC-SCED will use the currently SOC related telemetered values (that became required telemetry for ESRs in 2018)

1. Telemetered State of Charge [SOC\_Telem], “SOC”, MWh
2. Telemetered Minimum Operating State of Charge ([SOC\_OperMin], “MNOS”, MWh; and
3. Telemetered Maximum Operating State of Charge [SOC\_OperMax], MXOS”,MWh

to:

1. perform telemetry validation to ensure telemetered min, max, and current SOC values are within bounds, i.e.,
2. Modify RTC-SCED to incorporate SOC related constraints such that there is sufficient energy to sustain the MW awards for energy (Base Points) and AS for their respective time duration and does not violate the telemetered minimum and maximum SOC values.

### RTC SCED: Additional SOC related constraints

This section describes the proposed additional RTC SCED constraints for SOC accounting. The purpose of these constraints is to ensure that there is sufficient stored energy (MWh) available to sustain RTC-SCED MW awards for energy and AS.

SOC accounting related parameters:

 : Time duration required to sustain MW energy award (Base Point)

 : Time duration required to sustain MW Regulation Up/Down award

 : Time duration required to sustain MW RRS-PFR award

 : Time duration required to sustain MW RRS-FFR award

 : Time duration required to sustain MW ECRS award

 : Time duration required to sustain MW Non-Spin award

1. ESR with status of ON, ONOS, ONEMR
2. (ESR has a Base Point to Discharge)

Ensure that, with a discharging Base Point, if all upward AS (RegUp, RRS-PFR, RRS-FFR, ECRS, NonSpin) are fully deployed (duration requirements for energy and AS), that there is sufficient SOC so that the ESR is not discharged below is telemetered minimum operating SOC value:

Ensure that, with a discharging Base Point, if downward AS (RegDown) is fully deployed (duration requirements for energy and AS), that the ESR is not in a state where the calculated SOC is not above its telemetered maximum operating SOC value:

1. *(ESR has a Base Point to Charge)*

Ensure that, with a charging Base Point, if all upward AS (RegUp, RRS-PFR, RRS-FFR, ECRS, NonSpin) are fully deployed (duration requirements for energy and AS), that there is sufficient SOC so that the ESR is not discharged below is telemetered minimum operating SOC value:

Ensure that, with a charging Base Point, if downward AS (RegDown) is fully deployed (duration requirements for energy and AS), that the ESR is not in a state where the calculated SOC is not above its telemetered maximum operating SOC value:

Simultaneous upward and downward AS deployment scenario is not considered as the above constraints (for discharging and charging) are more conservative and will ensure that the telemetered minimum and maximum operating SOC values are not violated with simultaneous upward and downward AS deployment.

Where;

 is the roundtrip efficiency (dimensionless) value being between 0 and 1

1. ESR with status of ONTEST, ONHOLD

Do not enforce SOC constraints.

### RTC SCED: Preprocessing

To eliminate the use of penalty variables in SCED SOC constraints, perform preprocessing to ensure feasibility of SOC constraints. If LDL<0 and HDL >0, then there is no issue of SOC constraint infeasibility. However, there are infeasibilities that can occur when LDL and HDL are such that RTC-SCED cannot give a ESR Base Point of 0.

The assumptions are:

1. The system that calculates LDL and HDL, will always provide LDL, HDL values such that LDL<=HDL.
2. RTC-SCED can always give an AS award =0

Below are the preprocessing rules:

1. LDL>0: If giving a minimum discharge energy Base Point of LDL violates MinSOC limit then:
2. Do not enforce SOC constraints.
3. Constrain Base Point to LDL
4. Do not award any AS

1. HDL<0: : If giving a maximum charge energy Base Point of HDL violates MaxSOC limit then:
2. Do not enforce SOC constraints.
3. Constrain Base Point to HDL
4. Do not award any AS