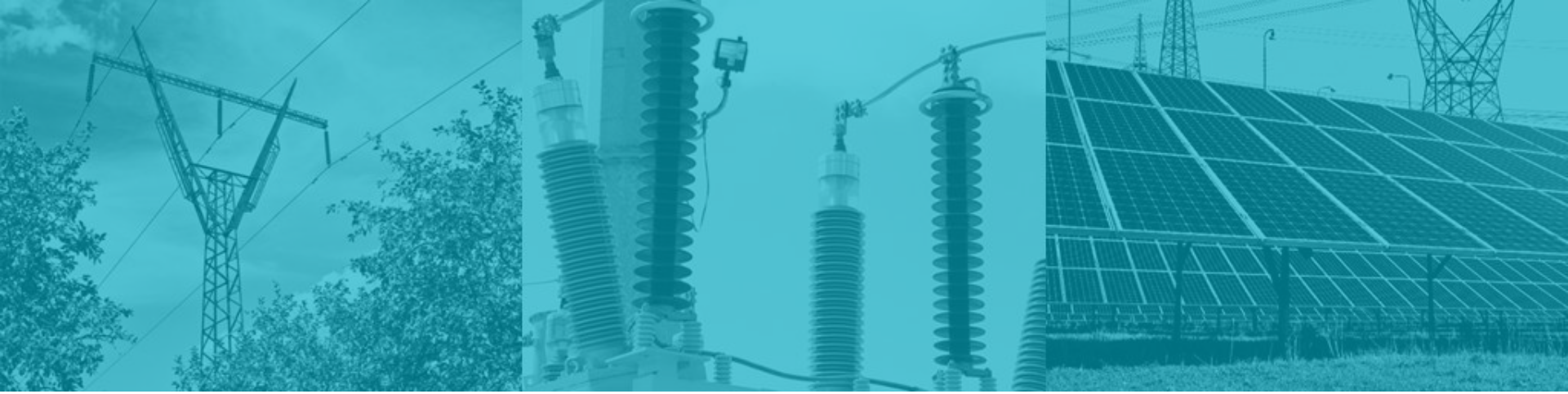


ERCOT Market Education

# Settlements 301

## Module 5: Reliability Unit Commitment

# Purpose of Reliability Unit Commitment (RUC)


It ensures:

- Enough capacity is committed to serve the forecasted load
- Committed capacity is in the right locations

## If ERCOT commits a Resource through RUC

- ERCOT provides QSE with a payment guarantee
- May provide Make-Whole Payment
- May clawback “excess revenues”

## Cost recovery

- Capacity-short QSEs responsible for Make-Whole (Up to a limit)
- Some costs may be socialized across all QSEs

# A QSE may Opt Out of RUC settlement

## Operational

- Update Telemetry – ONOPTOUT
- Must start resource if available
- May provide ancillary services

## Financial

- No RUC Make-Whole Payments
- No Clawback Charges

# Reliability Unit Commitment: Settlements

## RUC

Commitment
- Make-Whole
- Clawback

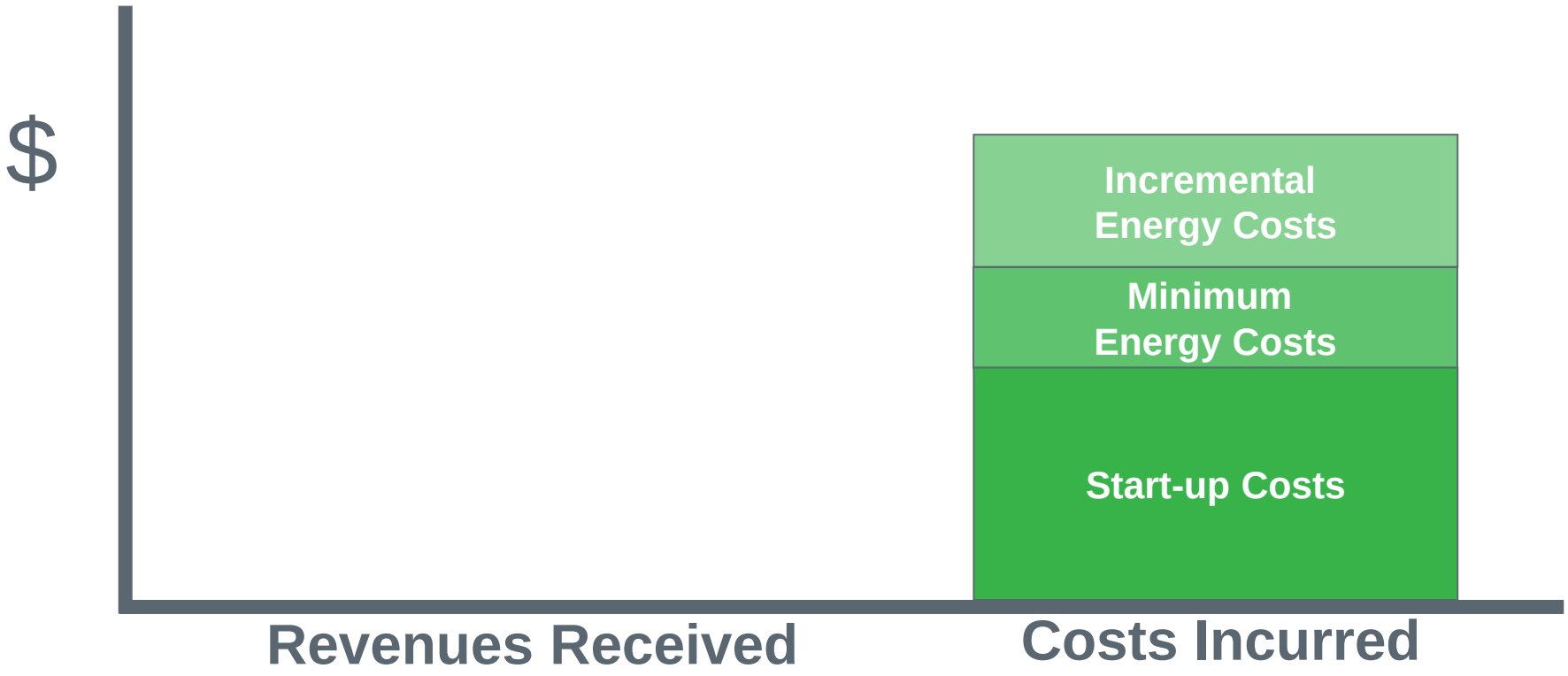

Decommitment

**Outcome #1**

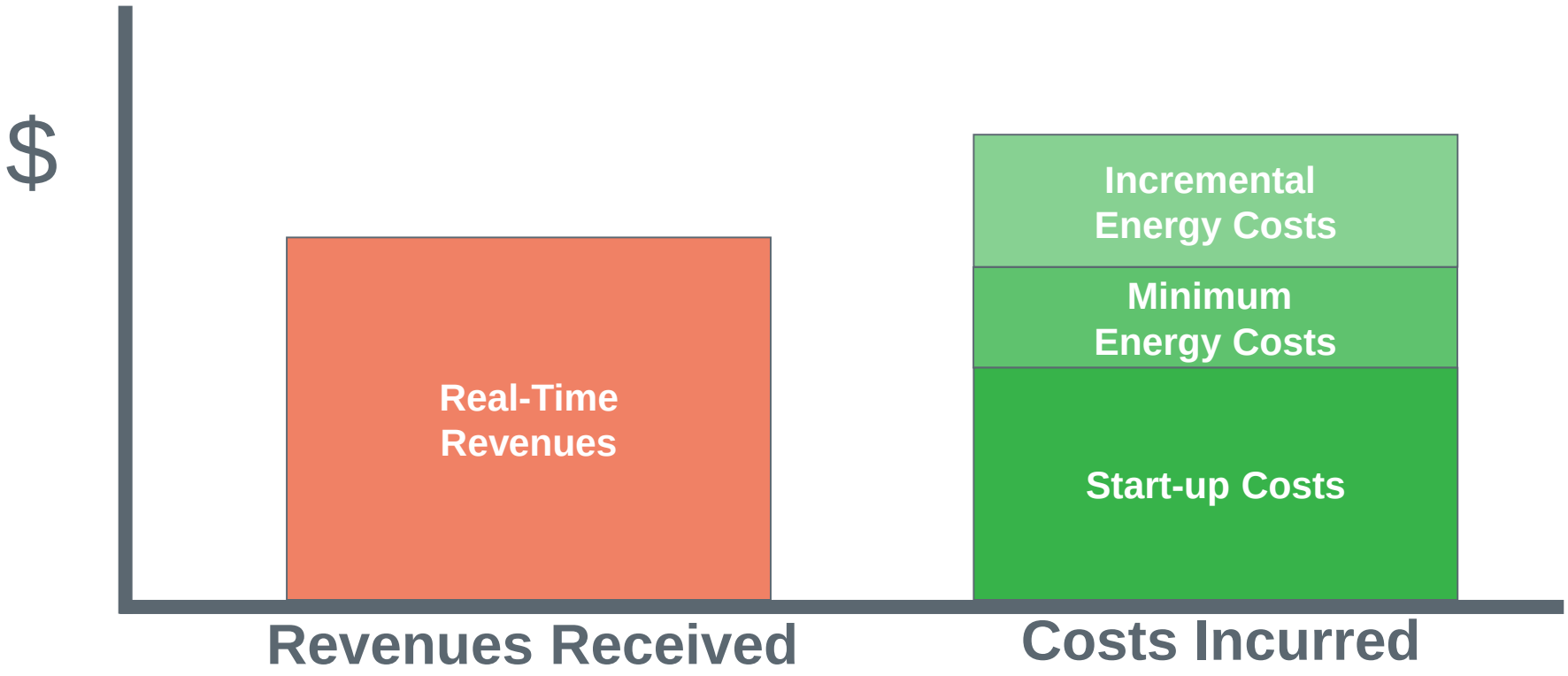

## QSE's Representing RUC committed resources may receive a Make-Whole payment

| | |
|---|---|
| **What:** | Payment when the Real-Time revenues are less than actual costs for a RUC-Committed Resource |
| **Why:** | To ensure that a QSE recovers its costs to run a RUC-Committed Resource |

# Calculating RUC Make-Whole Payment

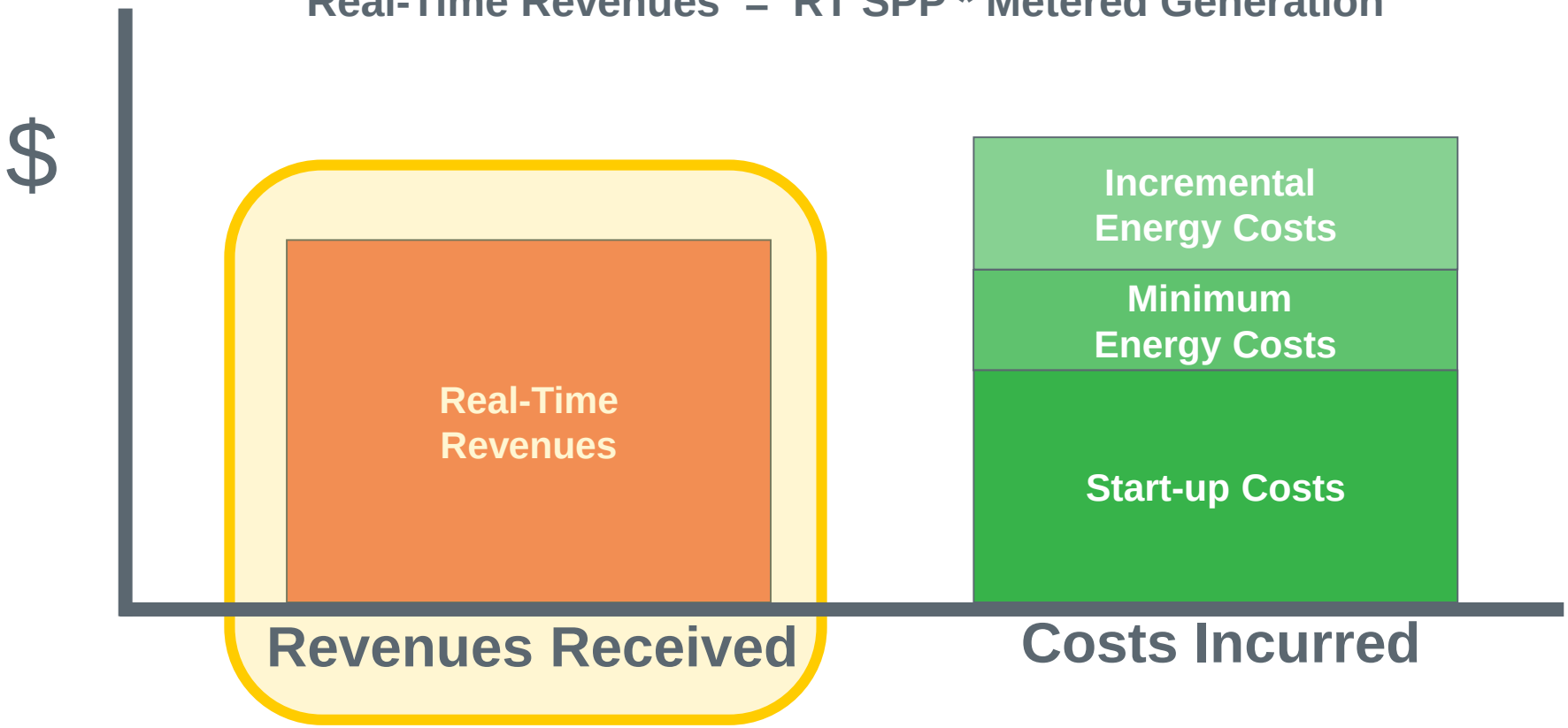


# Calculating RUC Make-Whole Payment

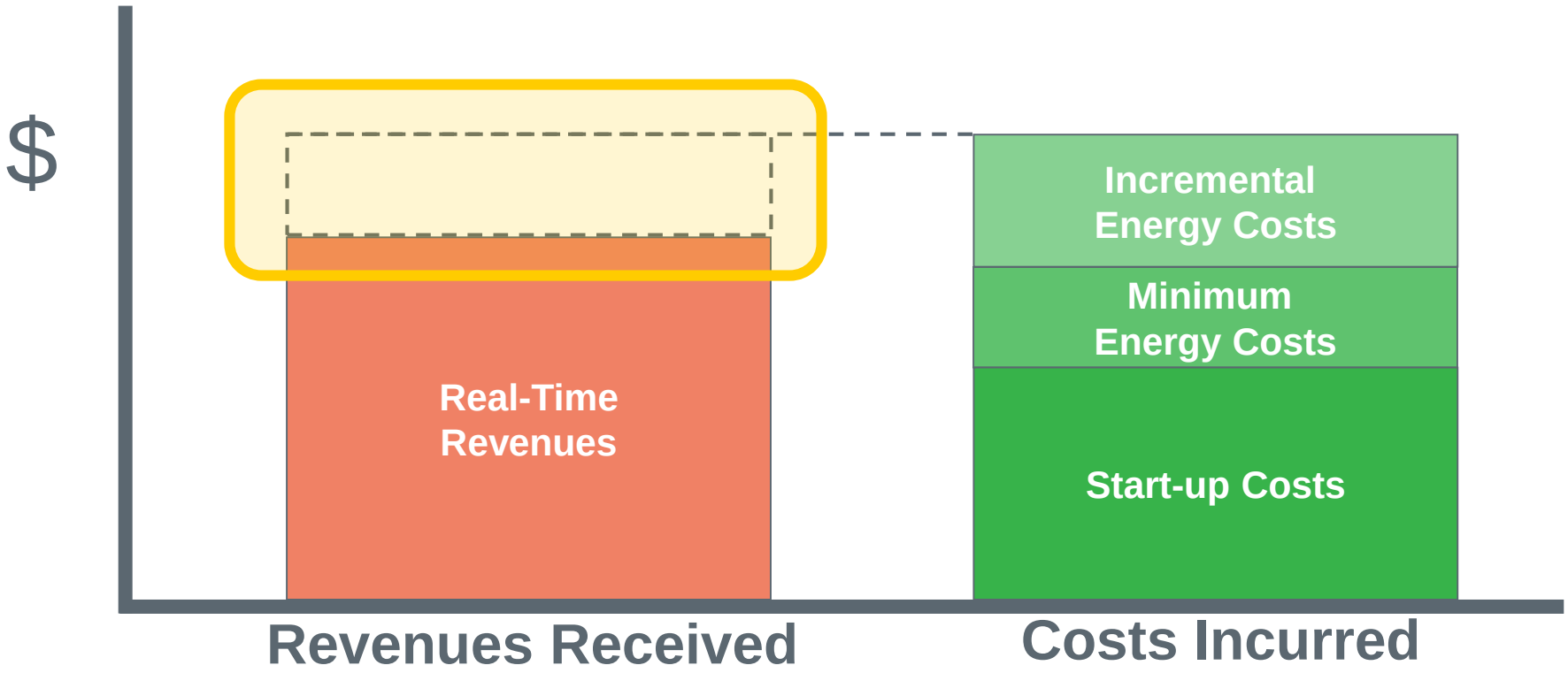


# Calculating RUC Make-Whole Payment

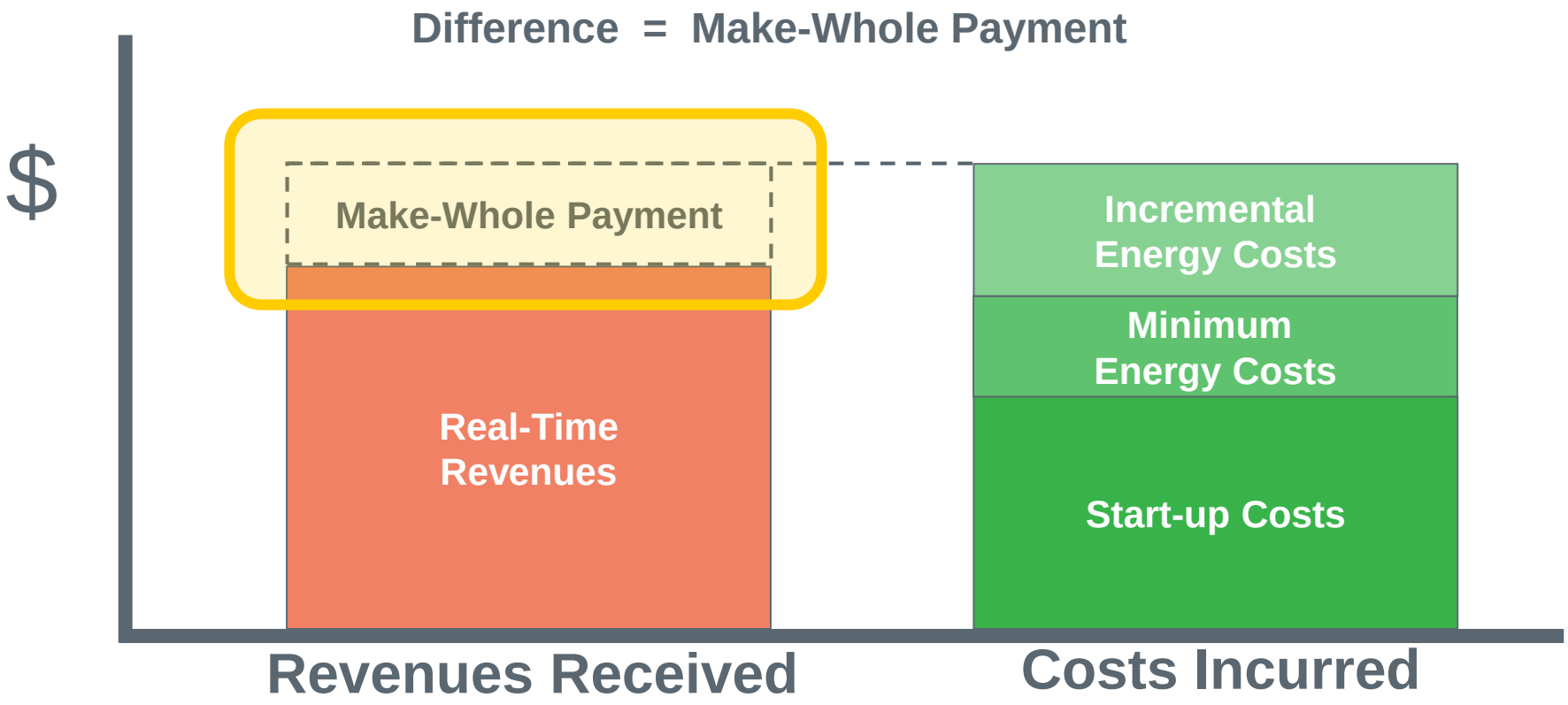
**Real-Time Revenues = RT SPP * Metered Generation**



## What if revenues are less than cost?

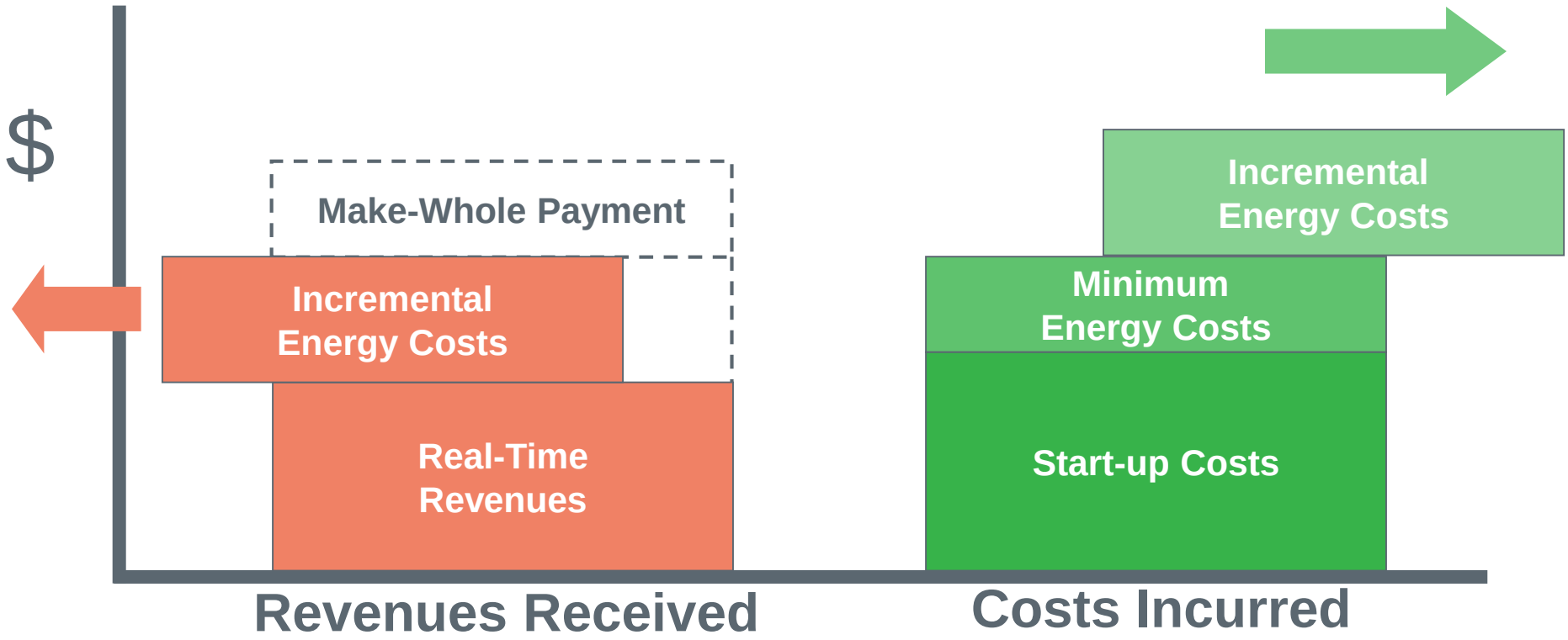


## What if revenues are less than cost?



## Now we re-arrange the balance sheet slightly ...

Subtract Incremental Energy Costs from *both columns*

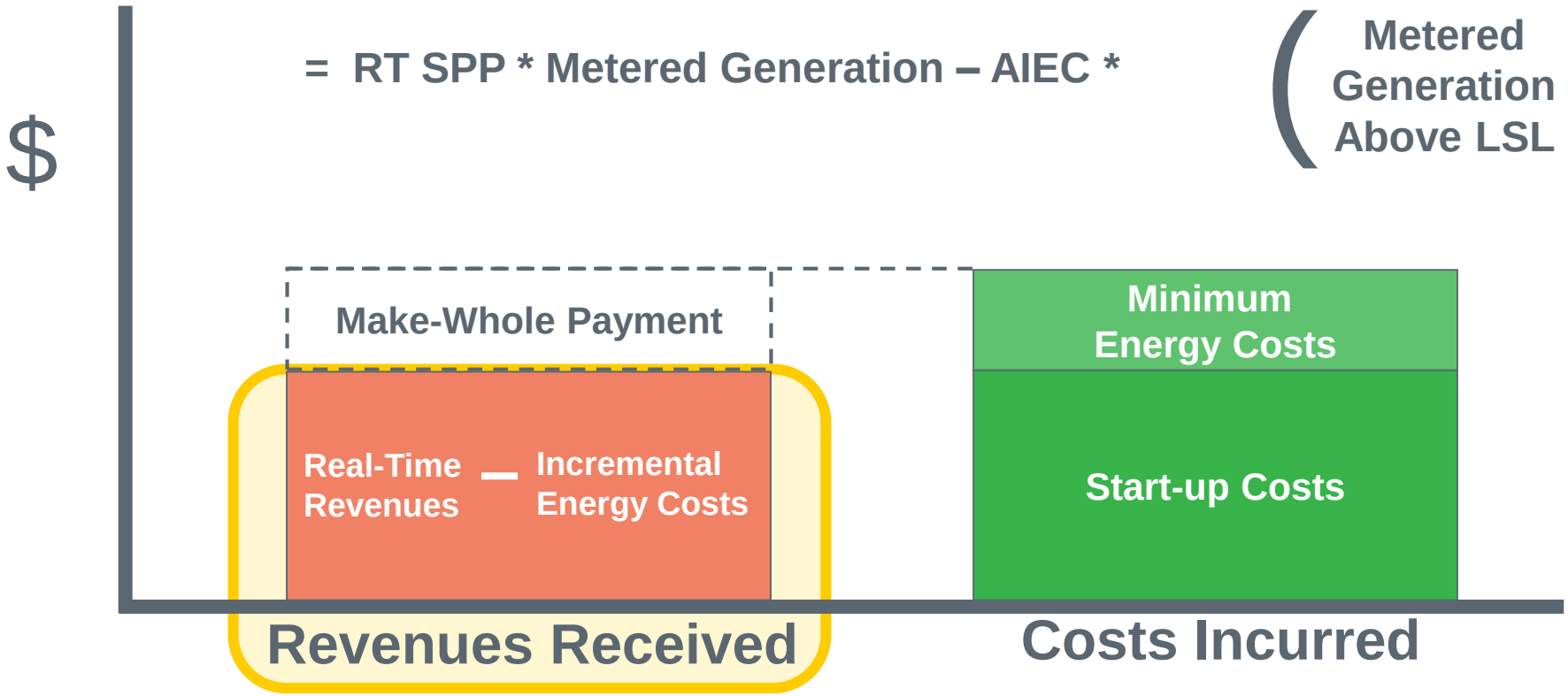


## What if revenues are less than cost?

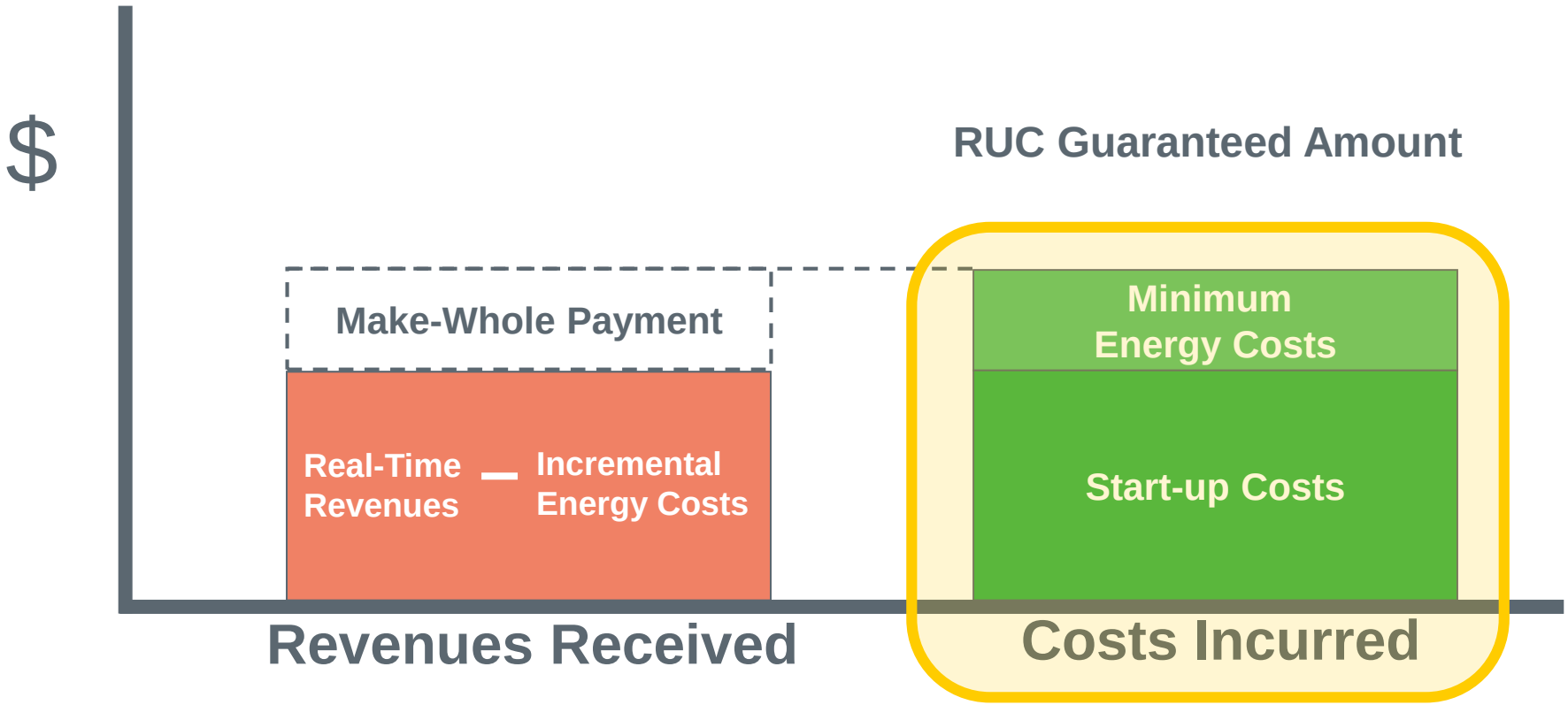
Real-Time Revenues – Incremental Energy Costs

= RT SPP * Metered Generation – AIEC *

(Metered Generation Above LSL)



## What if revenues are less than cost?



# RUC Make-Whole Payment

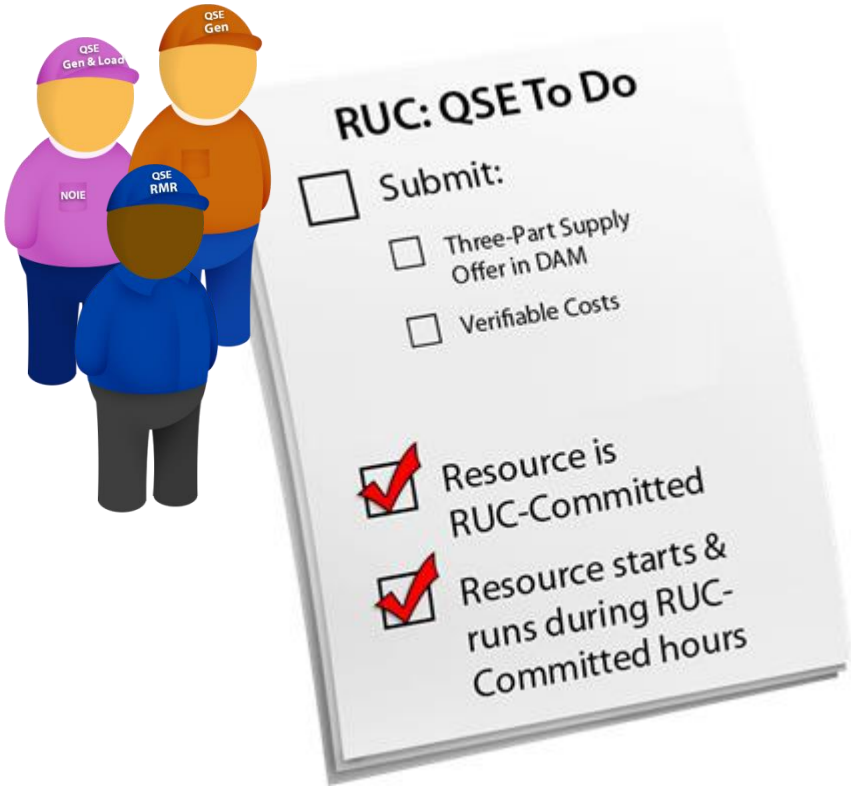

(Resource Revenues) < (RUC Guaranteed Amount)

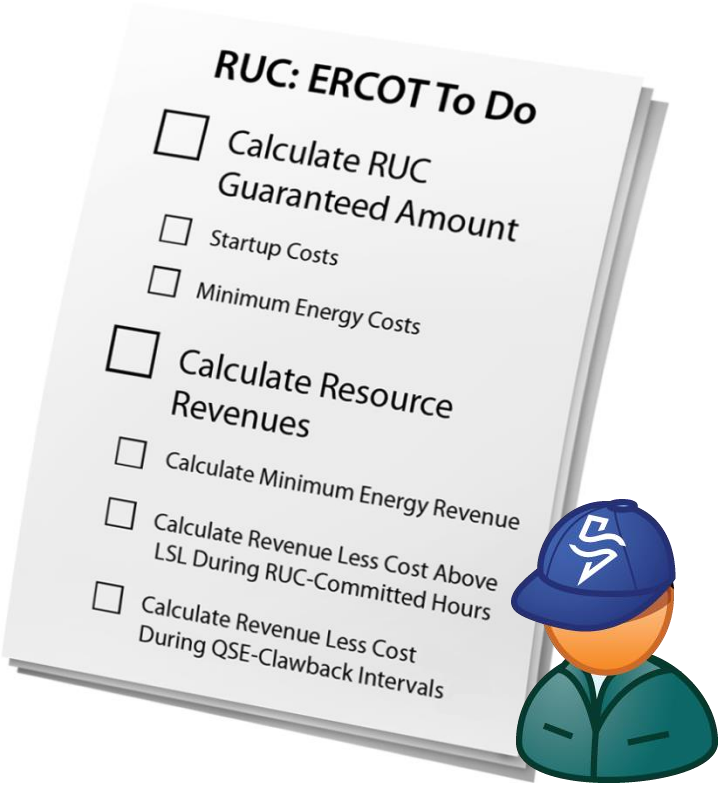
A QSE is paid the Real-time Settlement Point Price for all energy produced by its Resource

A QSE will also receive a Make-Whole Payment if its Resource's net revenues are less than its Startup and Minimum Energy Costs

# RUC Make-Whole Payment

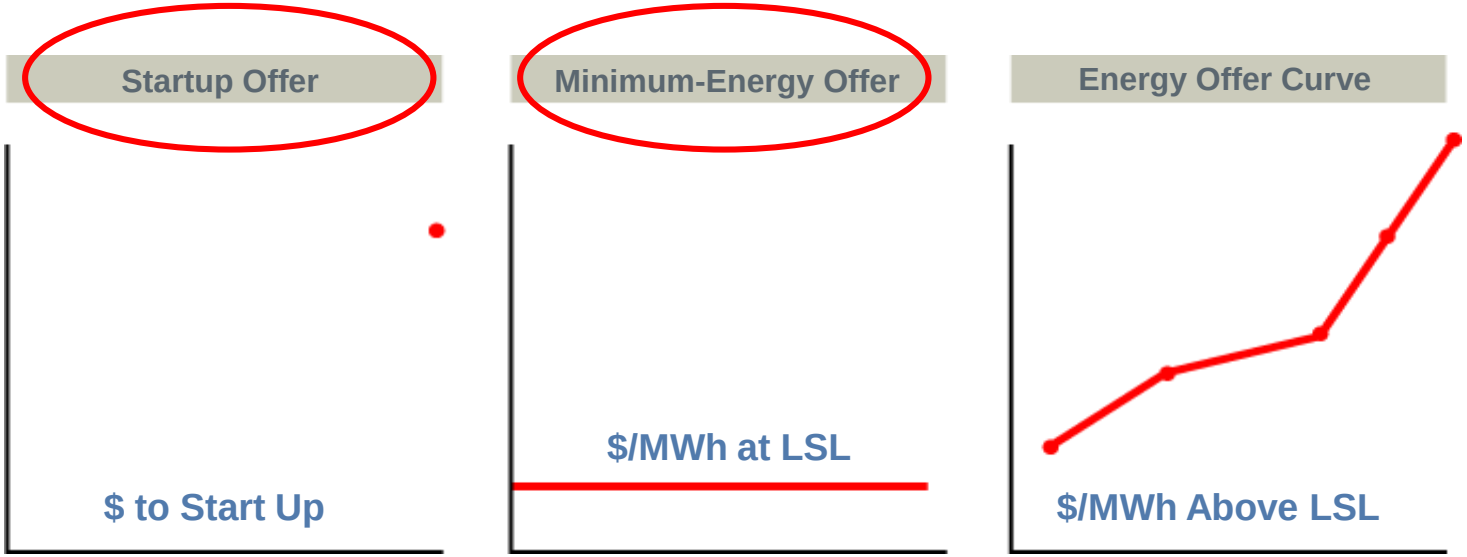

(Resource Revenues) < (RUC Guaranteed Amount)



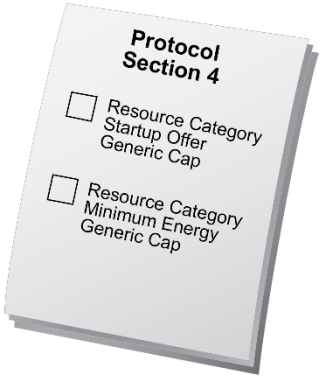



# Calculate RUC Guaranteed Amount

RUC Guaranteed Amount = ( Startup costs + Minimum energy costs )



# Startup and Minimum Energy costs subject to caps


| If ERCOT has Verifiable Costs | | | Otherwise | | |
|---|---|---|---|---|---|
| Startup Cap | = | Verifiable Startup Costs | Startup Cap | = | Resource Category Startup Offer Generic Cap |
| Minimum Energy Cap | = | Verifiable Minimum-Energy Costs | Minimum Energy Cap | = | Resource Category Minimum-Energy Generic Cap |

## If QSE submitted valid Three-Part Supply Offer,

SUPR = Min(SUO, SUCAP)

MEPR = Min(MEO, MECAP)

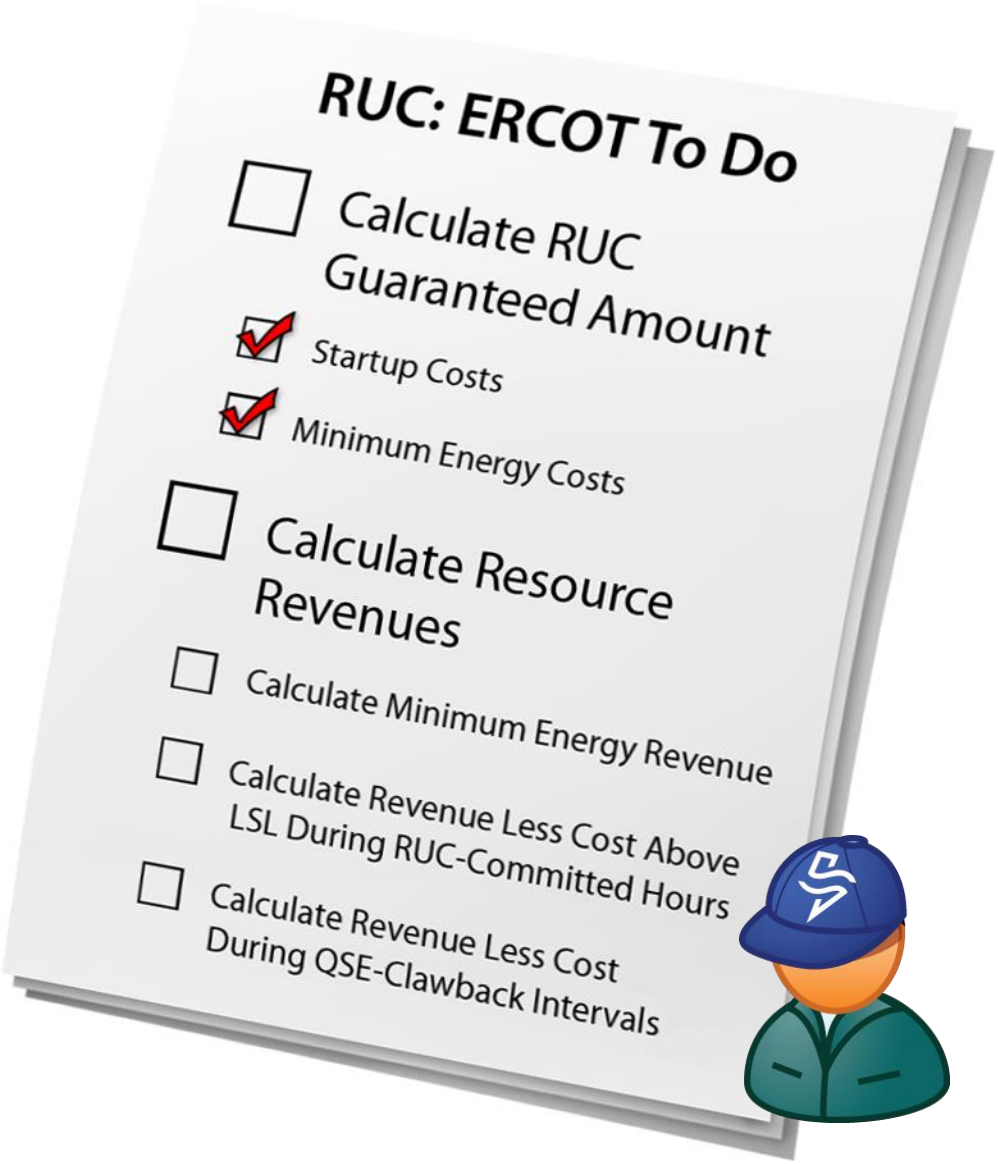
## Otherwise,

SUPR = SUCAP

MEPR = MECAP


| |
|---|
| Startup Price (SUPR) |
| Startup Offer (SUO) |
| Startup Cap (SUCAP) |
| Minimum Energy Price (MEPR) |
| Minimum Energy Offer (MEO) |
| Minimum Energy Cap (MECAP) |

# RUC Make-Whole Payment



# RUC Make-Whole Payment


(Resource Revenues) < (RUC Guaranteed Amount)

$$RUCG_{q,r,d} = \sum_{s} (SUPR_{q,r,s} * RUCSUFLAG_{q,r,s}) + \sum_{i} (MEPR_{q,r,i} * \text{Min}((LSL_{q,r,i} * (1/4)), RTMG_{q,r,i}))$$

| | |
|---|---|
| Startup Price (SUPR) | $ 5000 |
| RUC Startup Flag (RUCSUFLAG) | 1 |
| Minimum Energy Price (MEPR) | $10/MWh |
| Low Sustained Limit (LSL) | 20MW |
| Real-Time Metered Generation (RTMG) | 50MWh |


QSE4's Resource is committed for 5 hours

# RUC Make-Whole Payment


(Resource Revenues) < (RUC Guaranteed Amount)

**RUCG = (SUPR * RUCSUFLAG) + ∑(MEPR * Min ((LSL * (¼)), RTMG ))**

---

**RUCG = ($5000 * 1) + ($10/MWh * Min(20MW * ¼h, 50MWh) * 4i/h * 5h)**

**= $5000 + ($10/MWh * (20MW * ¼h) * 4i/h * 5h)**

**= $5000 + ($10/MWh * 100MWh)**

**= $6000**

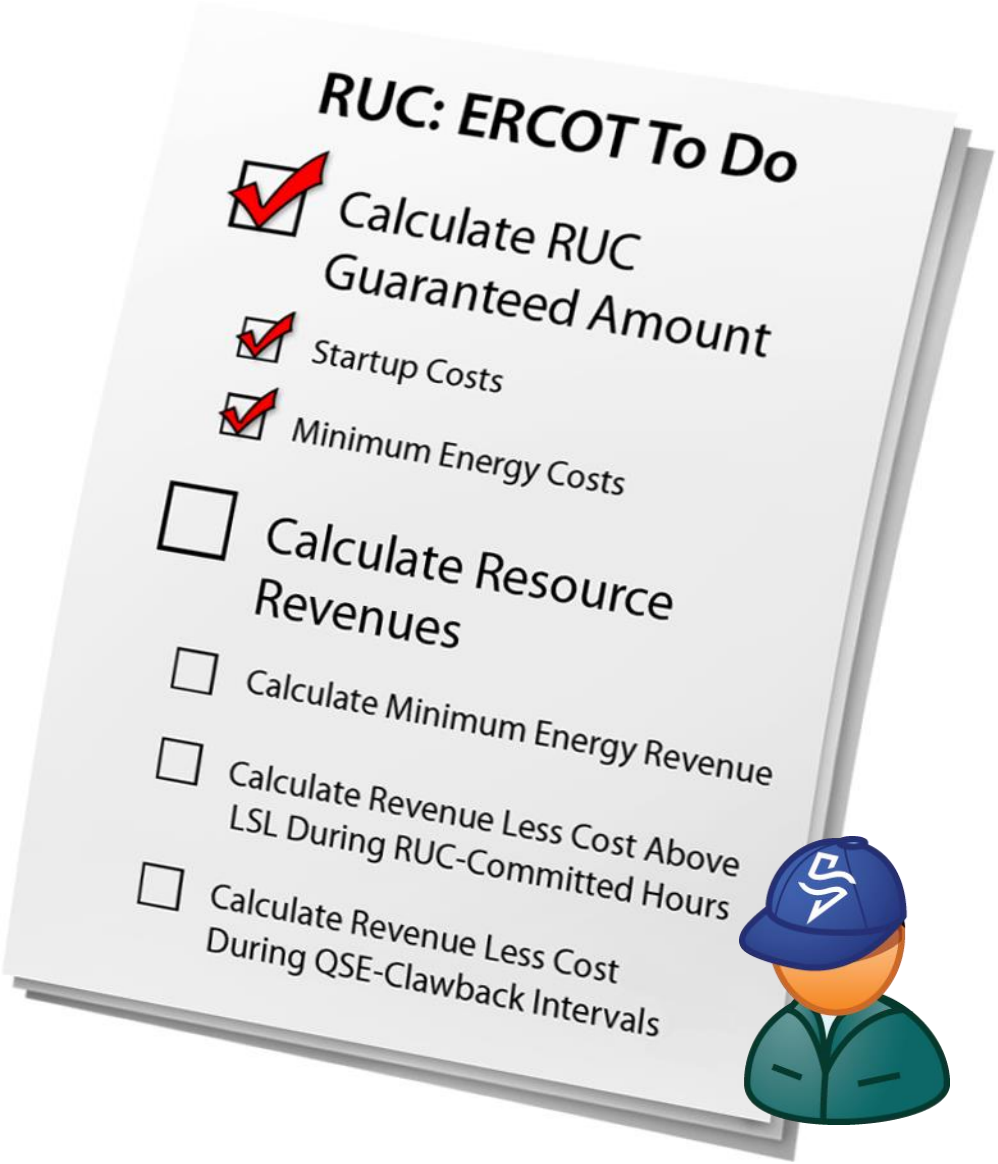
# RUC Make-Whole Payment


( Resource Revenues ) < ( RUC Guaranteed Amount )

| | RUC Guaranteed Amount |
|---|---|
| QSE1 | $4,000 |
| QSE4 | $6,000 |
| QSE6 | $8,000 |

- Per QSE
- Per Resource
- Per Operating Day with RUC Commitment

# RUC Make-Whole Payment



# RUC Make-Whole Payment

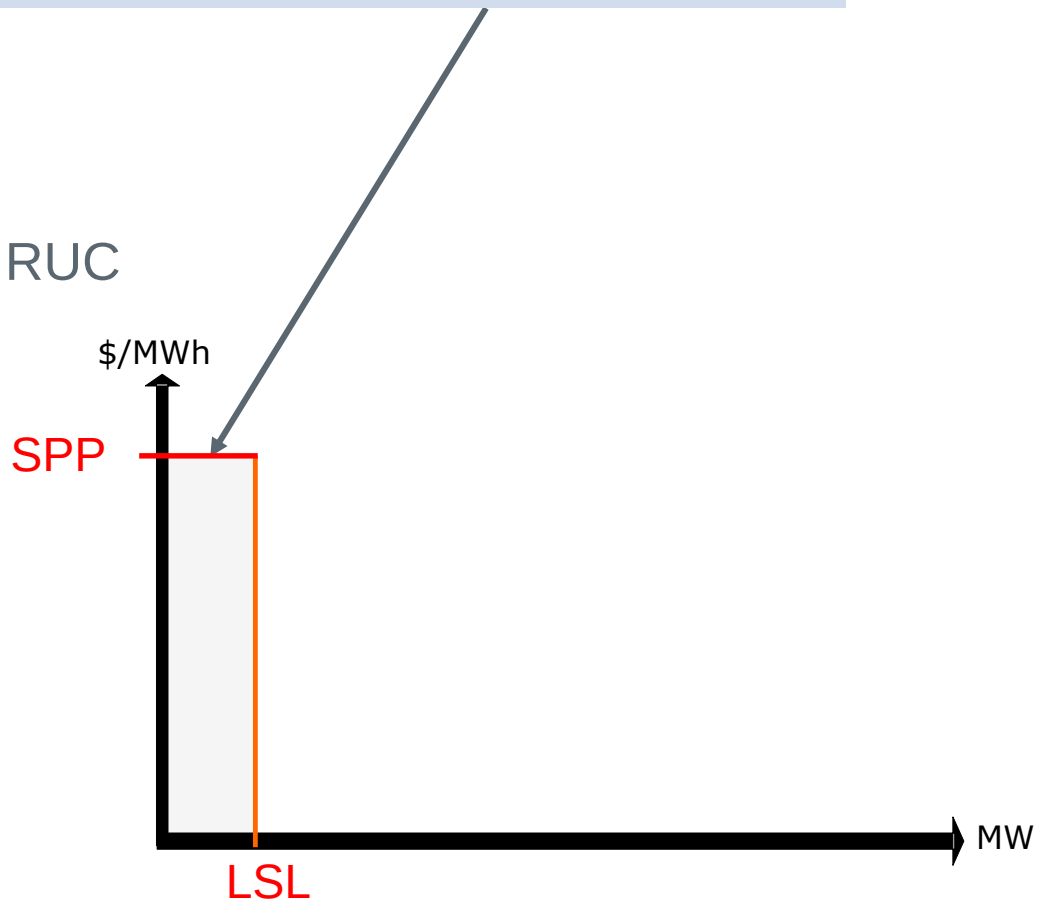

(Resource Revenues) < (RUC Guaranteed Amount)

Resource Revenues = (Minimum-Energy Revenue up to LSL + Revenue Less Cost above LSL + Revenue Less Cost during QSE-Clawback intervals)

# Calculate Resource Revenues

**Minimum-Energy revenue up to LSL**

- Per QSE
- Per Resource
- Per Operating Day with RUC Commitment

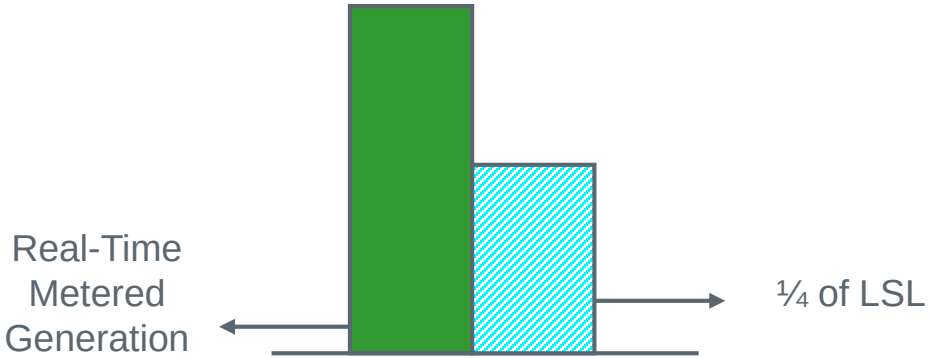


# Calculate Resource Revenues

**Minimum-Energy revenue up to LSL**

**RUC Minimum Energy Revenue**
**= (Price)* (Quantity)**

**Quantity = Minimum of:**



# Calculate Resource Revenues

**Minimum-Energy revenue up to LSL**

$$RUCMEREV_{q,r,d} = \sum (RTSPP_{p,i} * \text{Min}(RTMG_{q,r,i}, (LSL_{q,r,i} * (1/4))))$$

| Determinants |
| --- |
| RUC Minimum-Energy Revenue |
| Real-Time Settlement Point Price |
| Real-Time Metered Generation |
| Low Sustained Limit |

# Calculate Resource Revenues

**Minimum-Energy revenue up to LSL**

$$RUCMEREV = \sum (RTSPP * Min (RTMG, (LSL * (1/4))))$$

$$\begin{aligned} RUCMEREV &= \$50/MWh * Min (50MWh, (20MW * 1/4h)) * 4i/h * 5h \\ &= \$50/MWh * (20MW * 1/4h) * 4i/h * 5h \\ &= \$50/MWh * 100MWh \\ &= \$5000 \end{aligned}$$

# RUC Make-Whole Payment

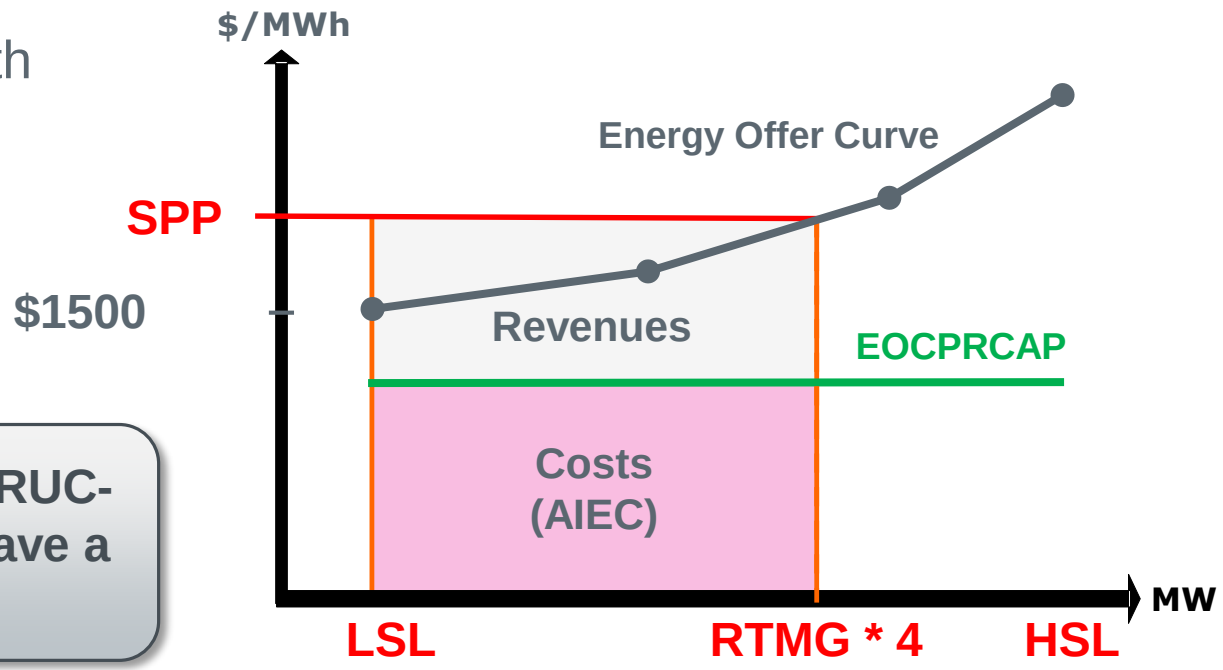

(Resource Revenues) < (RUC Guaranteed Amount)

| | RUC Guaranteed Amount | Minimum-Energy revenue up to LSL | Revenue Less Cost Above LSL During RUC-Committed Hours | Revenue Less Cost During QSE-Clawback Intervals |
|---|---|---|---|---|
| QSE1 | $4,000 | $2,000 | | |
| QSE4 | $6,000 | $5,000 | | |
| QSE6 | $8,000 | $4,000 | | |

# Calculate Resource Revenues

**Revenue Less Cost Above LSL During RUC-Committed Hours**

- Per QSE
- Per Resource
- Per Operating Day with RUC Commitment




**Energy Offer Curves for RUC-Committed Resources have a $1500 floor price**

# Calculate Resource Revenues

**Revenue Less Cost Above LSL During RUC-Committed Hours**

| Revenues | Costs |
|---|---|
| Energy Revenue above LSL | Average Incremental Energy Cost above LSL |
| Voltage Support Service | |
| Emergency Power Increase | |

# Calculate Resource Revenues

**Revenue Less Cost Above LSL During RUC-Committed Hours**

$$
\begin{aligned}
\mathbf{RUCEXRR}_{q,r,d} = \; & \mathrm{Max}\{0, \sum [\mathbf{RTSPP}_{p,i} * \mathrm{Max}(0, \mathbf{RTMG}_{q,r,i} - (\mathbf{LSL}_{q,r,i} * (1/4))) \\
& + (-1) * (\mathbf{VSSVARAMT}_{q,r,i} + \mathbf{VSSEAMT}_{q,r,i}) \\
& + (-1) * \mathbf{EMREAMT}_{q,r,i} \\
& - \mathbf{RTAIEC}_{q,r,i} * \mathrm{Max}(0, \mathbf{RTMG}_{q,r,i} - (\mathbf{LSL}_{q,r,i} * (1/4)))]\}
\end{aligned}
$$

| Additional Determinants |
|---|
| Revenue Less Cost Above LSL (**RUCEXRR**) |
| **V**oltage **S**upport **S**ervice **VAR Am**oun**t** |
| **V**oltage **S**upport **S**ervice **E**nergy **A**mount |
| **Em**ergency **E**nergy **Am**oun**t** |
| **R**eal-**T**ime **A**verage **I**ncremental **E**nergy **C**ost |

# Calculate Resource Revenues

**Revenue Less Cost Above LSL During RUC-Committed Hours**

$$
\begin{aligned}
RUCEXRR_{q,r,d} = \; & \text{Max}\{0, \sum [RTSPP_{p,i} * \text{Max}(0, RTMG_{q,r,i} - (LSL_{q,r,i} * (1/4))) \\
& + (-1) * (VSSVARAMT_{q,r,i} + VSSEAMT_{q,r,i}) \\
& + (-1) * EMREAMT_{q,r,i} \\
& - RTAIEC_{q,r,i} * \text{Max}(0, RTMG_{q,r,i} - (LSL_{q,r,i} * (1/4)))]\}
\end{aligned}
$$

| | |
|---|---|
| Real-Time Metered Generation (RTMG) | 50MWh |
| Average Incremental Energy Cost (RTAIEC) | $20/MWh |
| RT Settlement Point Price (RTSPP) | $50/MWh |

# Calculate Resource Revenues

**Revenue Less Cost Above LSL During RUC-Committed Hours**

$$\text{RUCEXRR} = \text{Max}\{0, \sum[\text{RTSPP} * \text{Max}(0, \text{RTMG} - (\text{LSL} * (1/4))) - \text{RTAIEC} * \text{Max}(0, \text{RTMG} - (\text{LSL} * (1/4)))]\}$$

---

$$\text{RUCEXRR} = \text{Max}\{0, [\$50/\text{MWh} * \text{Max}(0, 50\text{MWh} - (20\text{MW} * (1/4))) - \$20/\text{MWh} * \text{Max}(0, 50\text{MWh} - (20\text{MW} * (1/4)))] * 4\text{i/h} * 5\text{h}\}$$

$$= \text{Max}\{0, [\$50/\text{MWh} * \text{Max}(0, 45\text{MWh}) - \$20/\text{MWh} * \text{Max}(0, 45\text{MWh})] * 4\text{i/h} * 5\text{h}\}$$

$$= \text{Max}\{0, 45\text{MWh} * (\$50/\text{MWh} - \$20/\text{MWh})] * 4\text{i/h} * 5\text{h}\}$$

$$= \$1350 * 4\text{i/h} * 5\text{h}$$

$$= \$27{,}000$$

# RUC Make-Whole Payment


(Resource Revenues) < (RUC Guaranteed Amount)

| | RUC Guaranteed Amount | Minimum-Energy revenue up to LSL | Revenue Less Cost Above LSL During RUC-Committed Hours | Revenue Less Cost During QSE-Clawback Intervals |
|---|---|---|---|---|
| QSE1 | $4,000 | $2,000 | $1,000 | |
| QSE4 | $6,000 | $5,000 | $27,000 | |
| QSE6 | $8,000 | $4,000 | $4,000 | |

# Calculate Resource Revenues

**Revenue Less Cost During QSE Clawback Intervals**

- QSE-Committed Interval
- Contiguous block with one RUC-Committed hour
- QSE-Committed AFTER RUC-Commitment

# Calculate Resource Revenues

**Revenue Less Cost During QSE Clawback Intervals**

| Revenues | Costs |
|---|---|
| Energy Revenue | Minimum Energy Costs |
| Voltage Support Service | Average Incremental Energy Cost above LSL |
| Emergency Power Increase | |

# Calculate Resource Revenues

## Revenue Less Cost During QSE Clawback Intervals

$$
\begin{aligned}
RUCEXRQC_{q,r,d} = \; & \text{Max}\{0, \sum [(RTSPP_{p,i} * RTMG_{q,r,i}) \\
& + (-1) * (VSSVARAMT_{q,r,i} + VSSEAMT_{q,r,i}) \\
& + (-1) * EMREAMT_{q,r,i} \\
& - [MEPR_{q,r,i} * \text{Min}(RTMG_{q,r,i}, (LSL_{q,r,i} * (1/4)))] \\
& - RTAIEC_{q,r,i} * \text{Max}(0, RTMG_{q,r,i} - (LSL_{q,r,i} * (1/4)))]\}
\end{aligned}
$$

| Additional Determinants |
| --- |
| Revenue Less Cost (**RUCEXRQC**) |

# Calculate Resource Revenues

**Revenue Less Cost During QSE Clawback Intervals**

$$
\begin{aligned}
RUCEXRQC_{q,r,d} = \; & \text{Max}\{0, \sum [(RTSPP_{p,i} * RTMG_{q,r,i}) \\
& + (-1) * (VSSVARAMT_{q,r,i} + VSSEAMT_{q,r,i}) \\
& + (-1) * EMREAMT_{q,r,i} \\
& - [MEPR_{q,r,i} * \text{Min}(RTMG_{q,r,i}, (LSL_{q,r,i} * (1/4)))] \\
& - RTAIEC_{q,r,i} * \text{Max}(0, RTMG_{q,r,i} - (LSL_{q,r,i} * (1/4)))]\}
\end{aligned}
$$

| | |
|---|---|
| Real-Time Metered Generation (RTMG) | 50MWh |
| Average Incremental Energy Cost (RTAIEC) | $20/MWh |
| RT Settlement Point Price (RTSPP) | $50/MWh |

# Calculate Resource Revenues

**Revenue Less Cost During QSE Clawback Intervals**

$$\text{RUCEXRQC} = \text{Max}\{0, \sum[(\text{RTSPP} * \text{RTMG}) - [\text{MEPR} * \text{Min}(\text{RTMG}, (\text{LSL} * (1/4)))] - \text{RTAIEC} * \text{Max}(0, \text{RTMG} - (\text{LSL} * (1/4)))]\}$$

$$\text{RUCEXRQC} = \text{Max}\{0, [(\$50/\text{MWh} * 50\text{MWh}) - [\$10/\text{MWh} * \text{Min}(50\text{MWh}, (20\text{MW} * (1/4)))] - \$20/\text{MWh} * \text{Max}(0, 50\text{MWh} - (20\text{MW} * (1/4)))] * 4\text{i/h} * 2\text{h}\}$$

$$= \text{Max}\{0, [(\$50/\text{MWh} * 50\text{MWh}) - [\$10/\text{MWh} * 5\text{MWh}] - (\$20/\text{MWh} * 45\text{MWh})] * 4\text{i/h} * 2\text{h}\}$$

$$= \text{Max}\{0, [\$2500 - \$50 - \$900] * 4\text{i/h} * 2\text{h}\}$$

$$= \$1550 * 4\text{i/h} * 2\text{h} = \$12{,}400$$

# RUC Make-Whole Payment


(Resource Revenues) < (RUC Guaranteed Amount)

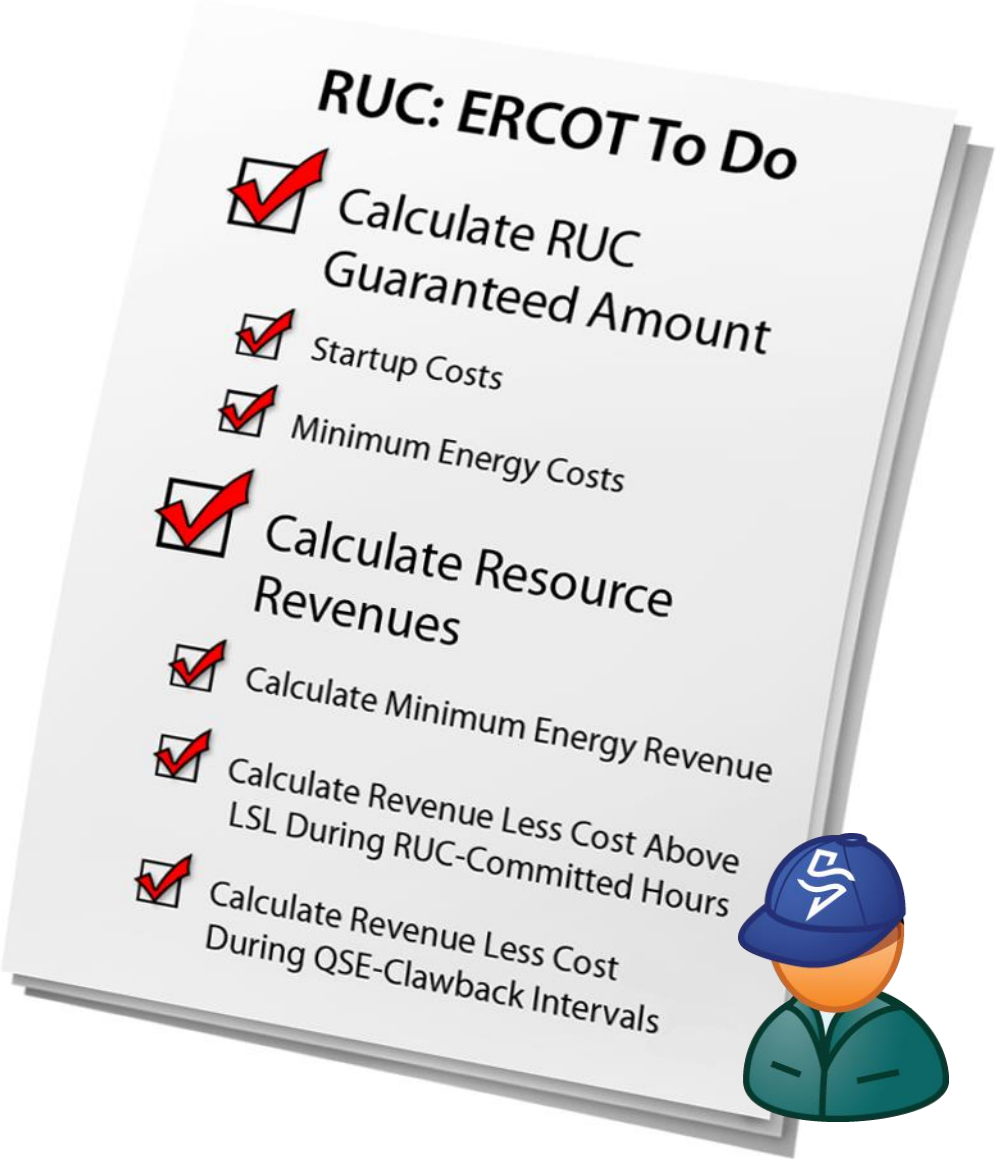
| | RUC Guaranteed Amount | Minimum-Energy revenue up to LSL | Revenue Less Cost Above LSL During RUC-Committed Hours | Revenue Less Cost During QSE-Clawback Intervals |
|---|---|---|---|---|
| QSE1 | $4,000 | $2,000 | $1,000 | $0 |
| QSE4 | $6,000 | $5,000 | $27,000 | $12,400 |
| QSE6 | $8,000 | $4,000 | $4,000 | $8,000 |

# RUC Make-Whole Payment


(Resource Revenues) < (RUC Guaranteed Amount)

| | RUC Guaranteed Amount | Resource Revenues |
|---|---|---|
| QSE1 | **$4,000** | $2,000 + $1,000 + $0 = **$3,000** |
| QSE4 | **$6,000** | $5,000 + $27,000 + $12,400 = **$44,400** |
| QSE6 | **$8,000** | $4,000 + $4,000 + $8,000 = **$16,000** |

# RUC Make-Whole Payment



# RUC Make-Whole Payment

**Trigger #1**

( Resource Revenues ) < ( RUC Guaranteed Amount )

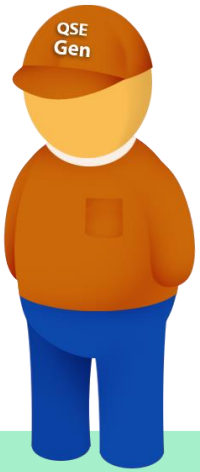
**Outcome #1**


| | RUC Guaranteed Amount | Resource Revenues | Eligible for Make-Whole Payment? |
|---|---|---|---|
| QSE1 | $4,000 | $3,000 | ? |
| QSE4 | $6,000 | $44,400 | ? |
| QSE6 | $8,000 | $16,000 | ? |

# RUC Make-Whole Payment

**Trigger #1**

- QSE1 Resource is RUC-Committed
- QSE1 is eligible for a Make-Whole Payment




**Outcome #1**

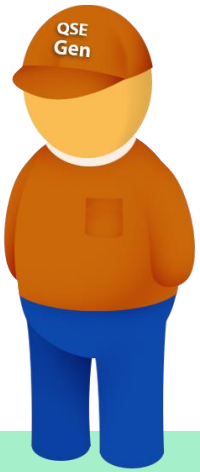

$$RUCMWAMT = (-1) * Max(0, RUCG - RUCMEREV - RUCEXRR - RUCEXRQC) / \sum RUCHR$$

**RUCHR will be set to 1 for each RUC-Committed hour of the day.**

# RUC Make-Whole Payment

**Trigger #1**

- QSE1 is RUC-Committed
- QSE1 is eligible for a Make-Whole Payment




**Outcome #1**


**RUCMWAMT = (-1) * Max (0, RUCG – RUCMEREV – RUCEXRR – RUCEXRQC) / ∑ RUCHR**

**RUCMWAMT = (-1) * Max(0, $4000–$2000–$1000– 0) / 5**

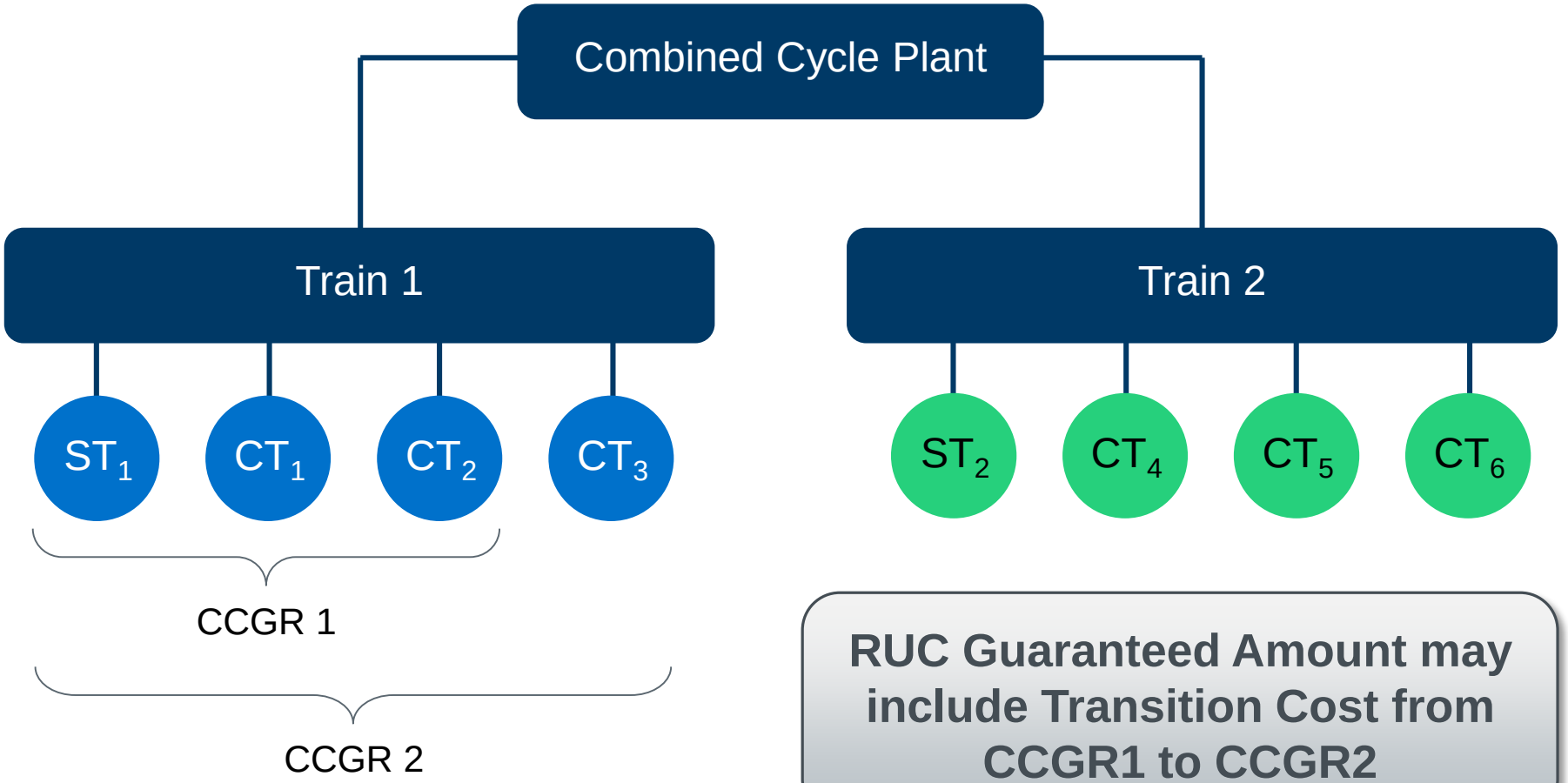
**= - $200 per hour**

## What if the RUC-committed Resource is part of a Combined Cycle Plant?

- Make-Whole is paid at the Train level
- RUC Guaranteed Amount
  - Start-up Costs
  - Minimum Energy Costs
  - May include Transition Cost

**RUC may start any offered CCGR and transition from one offered CCGR to another**

# RUC Make Whole - Combined Cycle Resources

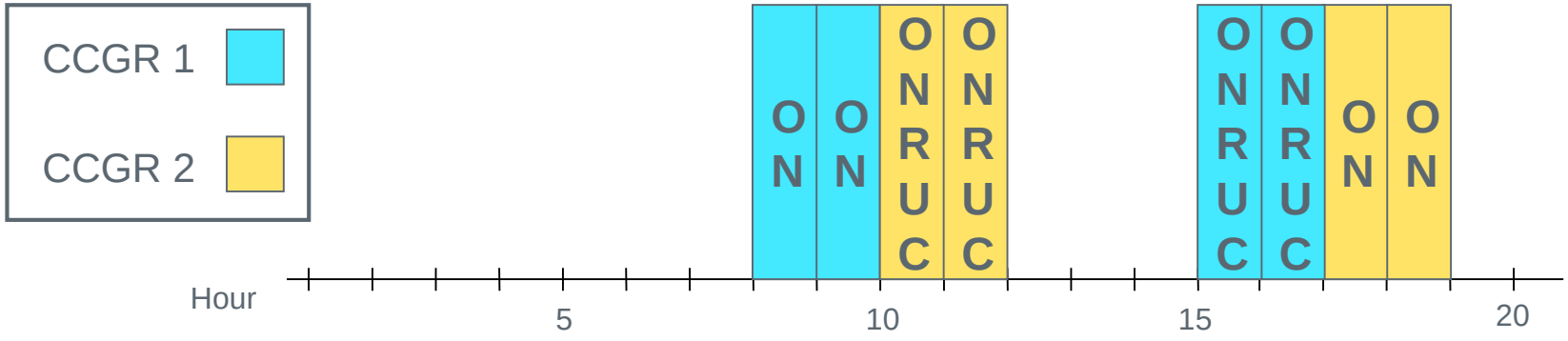



**RUC Guaranteed Amount may include Transition Cost from CCGR1 to CCGR2**

## Eligible Transitions:

- ON to RUC
- RUC to RUC
- RUC to ON

**Train must be in RUC-Committed configuration for at least 1 minute**



# RUC Make Whole - Combined Cycle Resources


( Resource Revenues ) < ( RUC Guaranteed Amount )

$$RUCG_{q,r,d} = \sum(SUPR_{q,r,s} * RUCSUFLAG_{q,r,s})$$
$$+ \sum(\text{Transition costs})$$
$$+ \sum(MEPR_{q,r,i} * \text{Min}((LSL_{q,r,i} * (1/4)), RTMG_{q,r,i}))$$

**Transition costs:**

$$\text{Max}(0, SUPR_{afterCCGR} - SUPR_{beforeCCGR})$$

*Transition to RUC*

--and--

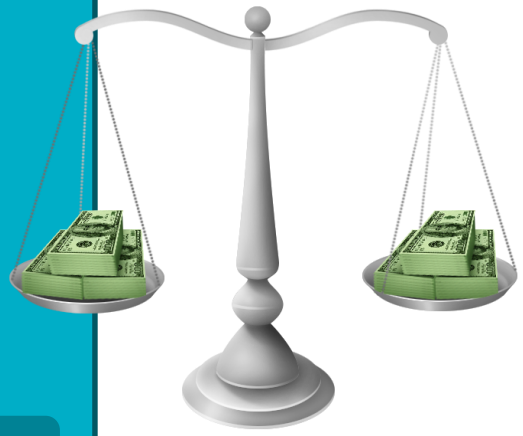
$$\text{Max}(0, SUPR_{beforeCCGR} - SUPR_{afterCCGR})$$

*Transition from RUC*

# Reliability Unit Commitment: Settlements

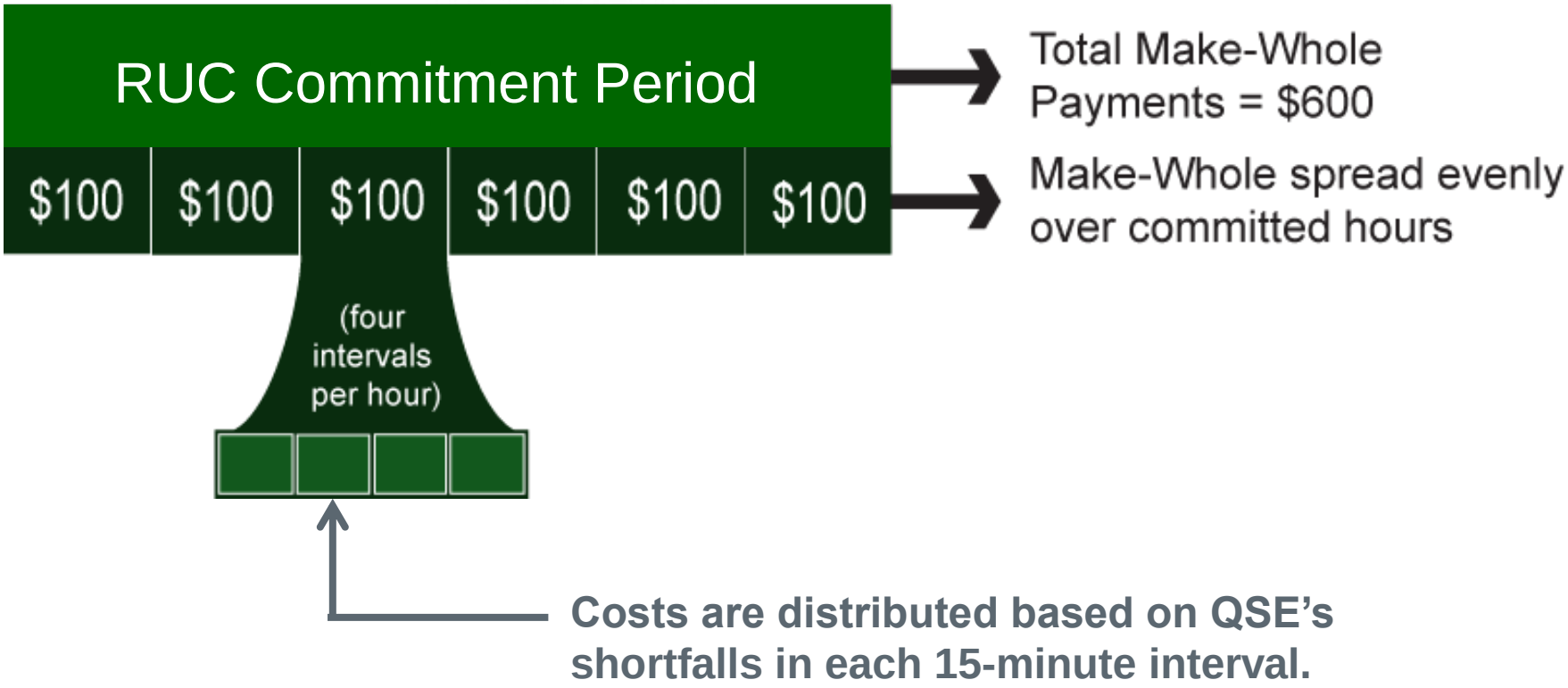
## RUC

Commitment
- Make-Whole
- Clawback

Decommitment

## To remain revenue neutral, ERCOT will first try to directly assign all costs incurred for Make-Whole Payments.



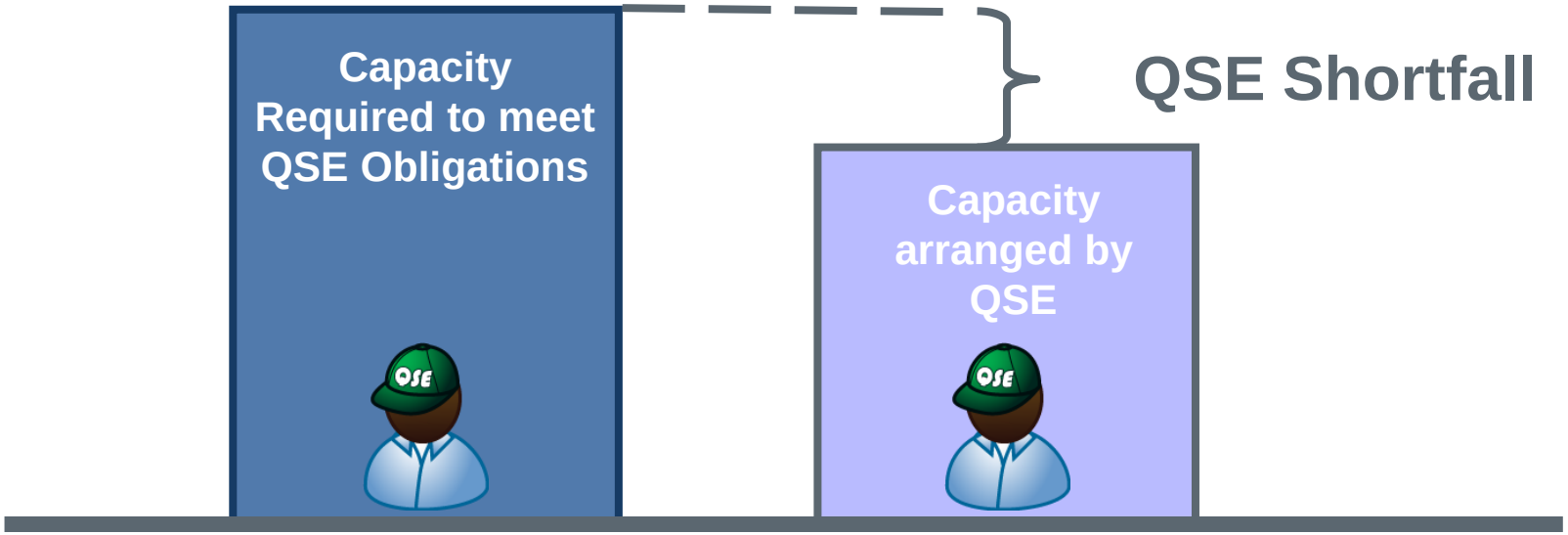
**Outcome #1**


## Charge to a QSE that was capacity-short in a RUC

| | |
|---|---|
| **What:** | Charge to QSEs that are capacity short |
| **Why:** | Collect funds to pay the Make-Whole Payments to eligible QSEs |

## RUC Capacity Short Charge

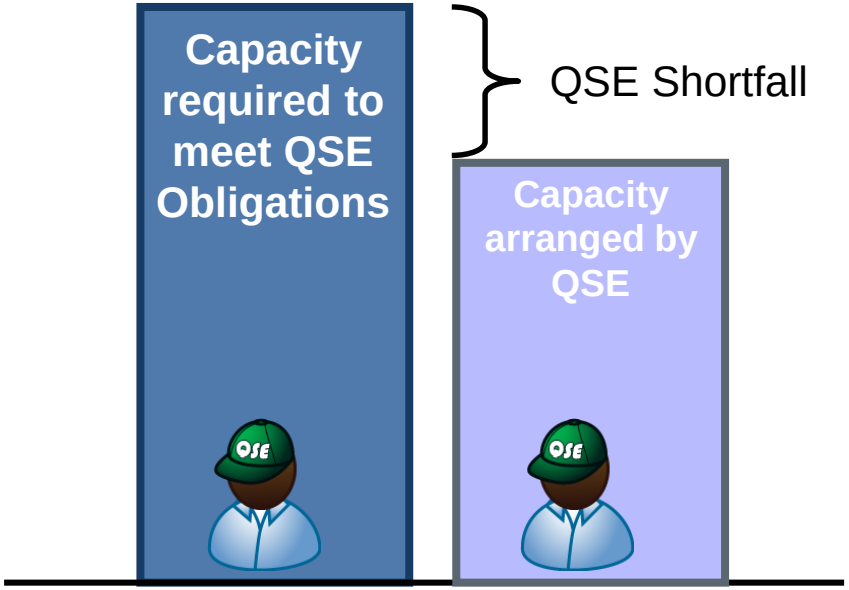
When a QSE does not provide enough capacity to meet its obligations, it may be assessed a Capacity Short Charge



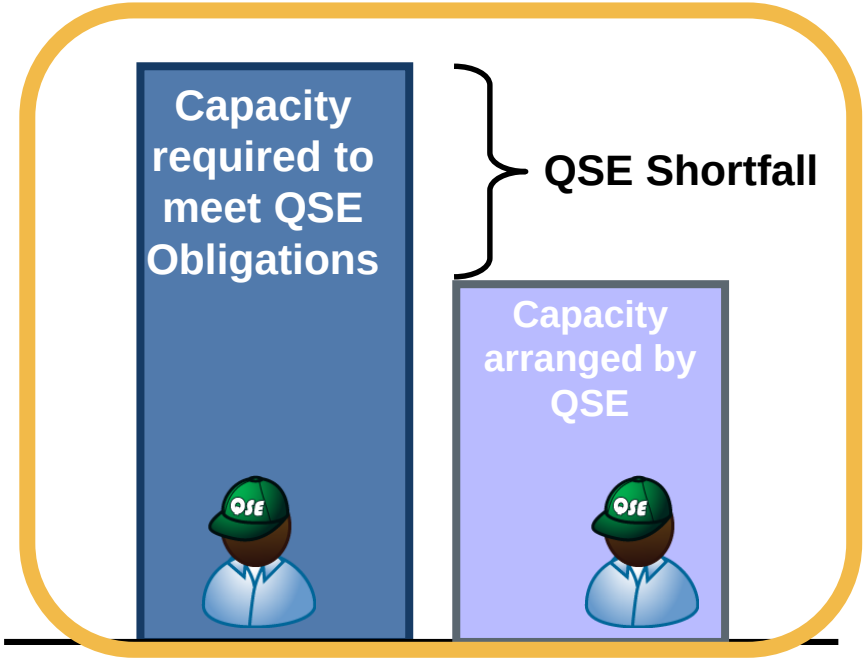
## Measure QSE Shortfall twice for each hour:

- Execution of RUC
- End of Adjustment Period

***Worst case wins!***




**RUC (DRUC / HRUC)**




**Adjustment Period**

## RUC Capacity Short Charge

All QSEs who were capacity short in each RUC will pay a portion of the RUC Make Whole Payments for that particular RUC:

**RUC Capacity Short Charge** = **RUC Capacity Shortfall Ratio Share** * ( **RUC Make Whole Total** )

***by 15-Minute Settlement Interval***

## Short Charge Cap

The charge to each QSE is capped at

$$2 * \text{RUC Capacity Shortfall} * \frac{\text{RUC Make Whole Total}}{\text{RUC Capacity Total}}$$

*. . . which is the same as*

$$2 * \text{RUC Capacity Shortfall} * \left( \text{Price / MW of RUC Procurement} \right)$$

## RUC Capacity Short Charge

A QSE with a capacity shortfall will pay the lesser of

**RUC Capacity Shortfall Ratio Share * ( RUC Make Whole Total )**

or their cap

**2 * RUC Capacity Shortfall * ( Price / MW of RUC Procurement )**

# RUC Capacity Short Charge

$$RUCCSAMT = (-1) * Max\,[(RUCSFRS * RUCMWAMTRUCTOT),\ (2 * RUCSF * (RUCMWAMTRUCTOT / RUCCAPTOT))] / 4$$

| | |
|---|---|
| RUCCSAMT $_{ruc,\ i,\ q}$ | RUC Capacity Shortfall Amount |
| RUCSFRS $_{ruc,\ i,\ q}$ | RUC Shortfall Ratio Share |
| RUCMWAMTRUCTOT $_{ruc,\ h}$ | RUC Make Whole Amount Total per RUC |
| RUCSF $_{ruc,\ i,\ q}$ | RUC Shortfall |
| RUCCAPTOT $_{ruc,\ h}$ | RUC Capacity Total |

## RUC Shortfall Ratio Share

- Per RUC process
- Per QSE
- Per 15-minute Interval

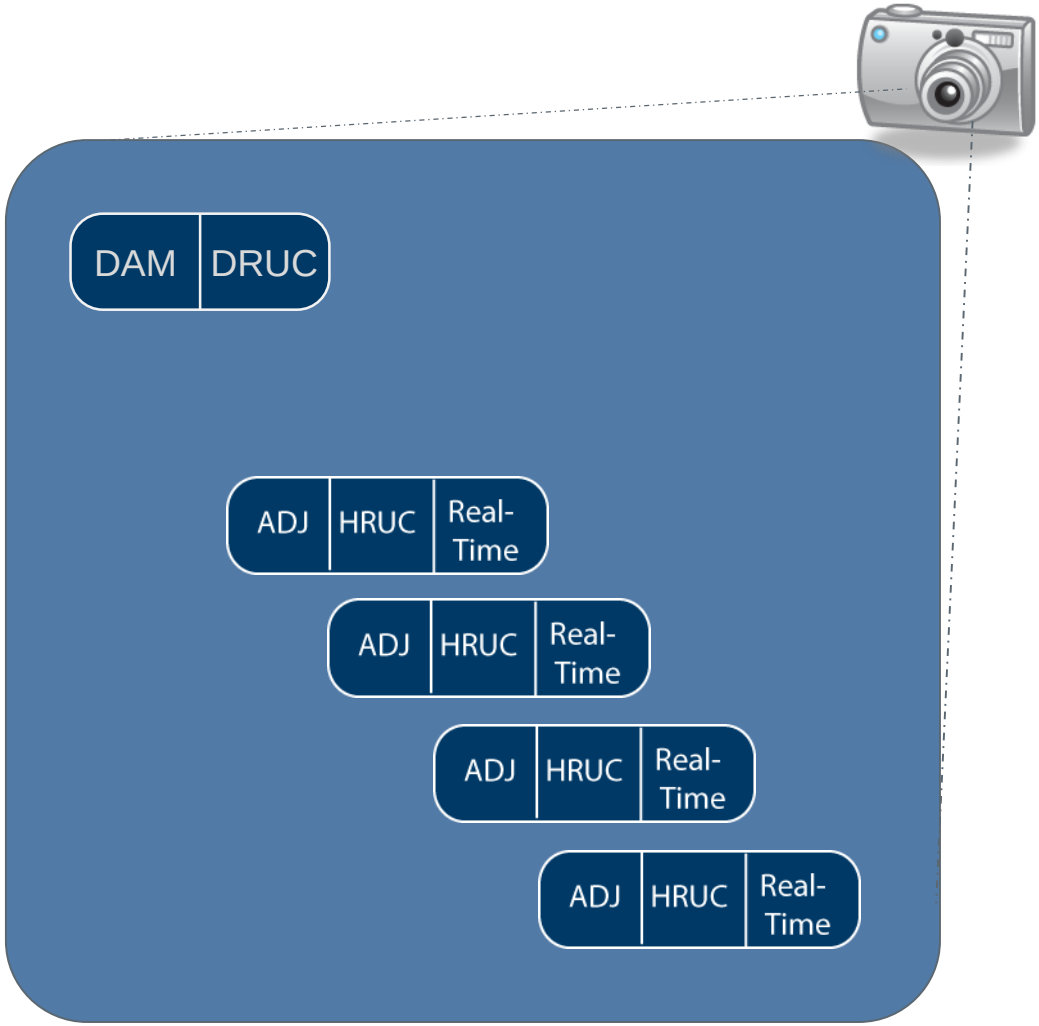
$$RUCSFRS_{ruc,i,q} = RUCSF_{ruc,i,q} / RUCSFTOT_{ruc,i}$$

| Determinants |
| --- |
| **RUC S**hort**f**all **R**atio **S**hare |
| **RUC S**hort**f**all |
| **RUC S**hort**f**all **Tot**al |

# Determining a QSE's RUC Shortfall

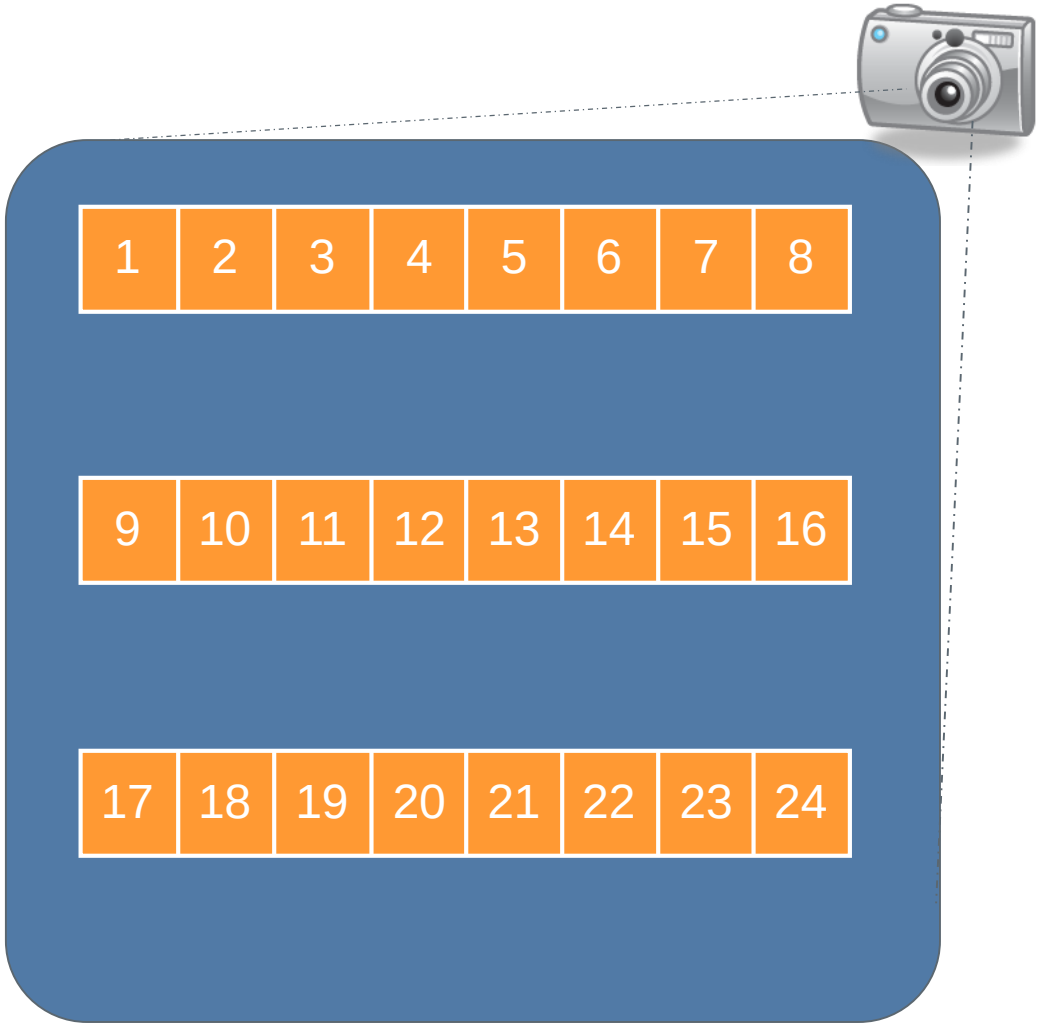
## ERCOT takes Snapshots:

- QSE's market position each time RUC is executed
- QSE's market position at end of each Adjustment Period



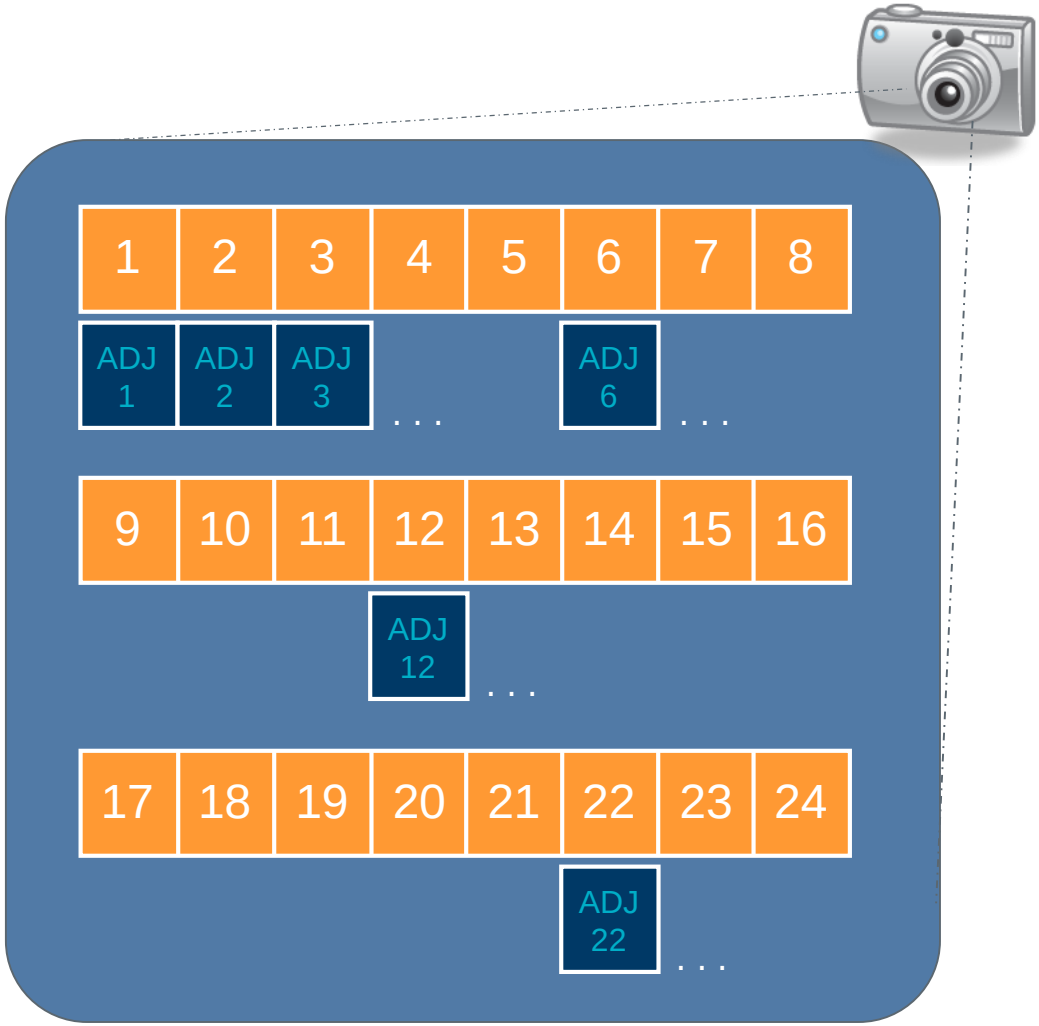
## RUC Snapshot (DRUC)

Looks at QSE's market position for each hour during the RUC Study Period



## Adjustment Period Snapshot

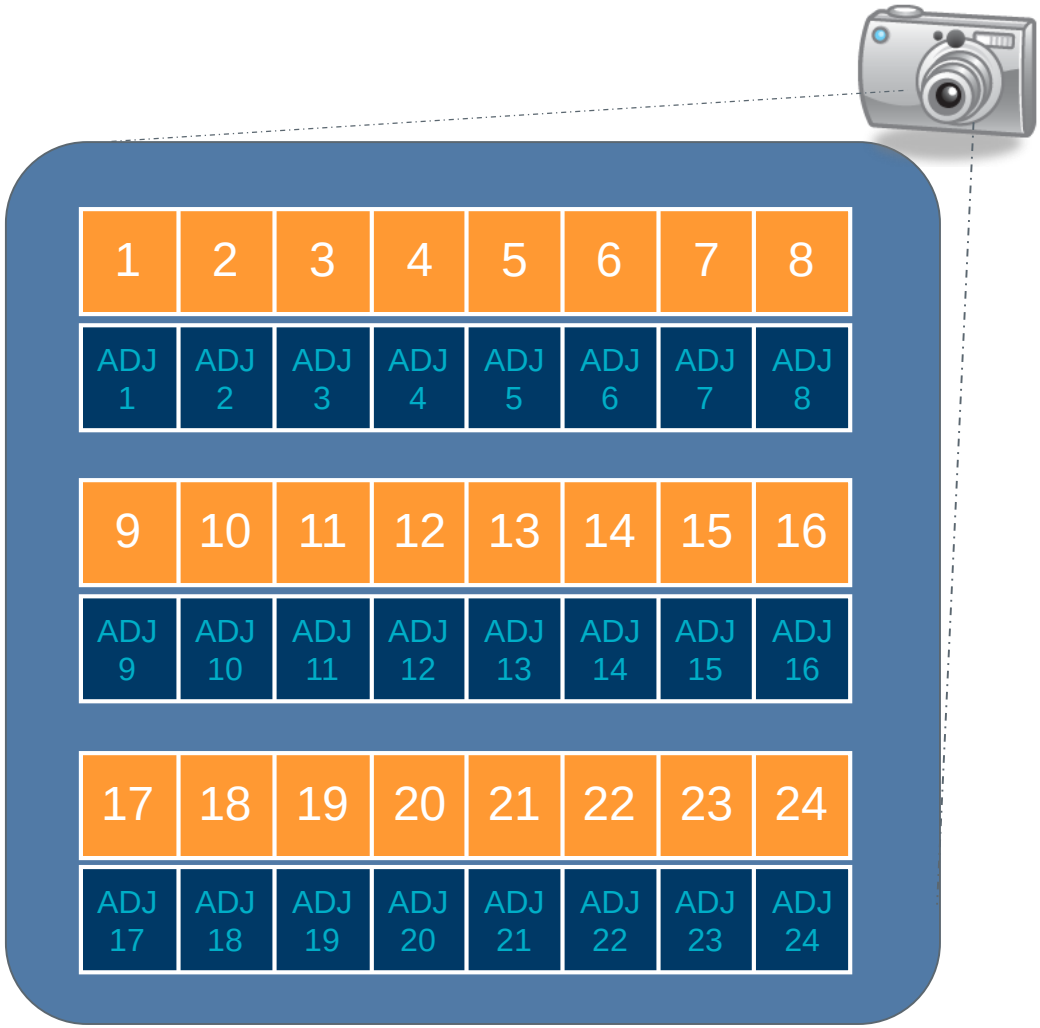
Looks at QSE's market position at the end of each Adjustment Period



# Determine QSE's RUC Shortfall

## For each hour:

- ERCOT compares the Adjustment Snapshot with the corresponding hour in the RUC Snapshot
- The QSE's RUC shortfall is based on the snapshot that is the most short



# RUC Shortfall

$$RUCSF_{ruc,i,q} = Max\,(0, Max\,(RUCSFSNAP_{ruc,q,i}, RUCSFADJ_{ruc,q,i}) - \sum_{\substack{Prior\\RUCs}} RUCCAPCREDIT_{q,i,z})$$

RUCSFSNAP

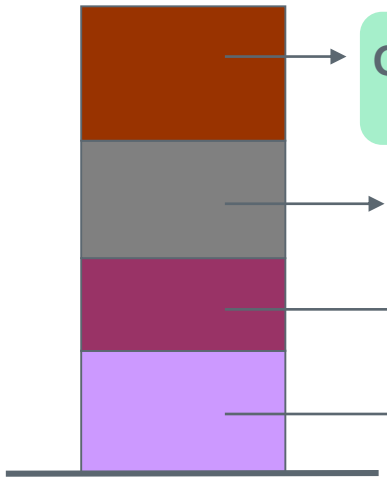
- Snapshot of the QSEs market position each time a RUC is executed
- Different RUCSNAP for each RUC

| Determinants |
| --- |
| **RUC S**hort**f**all |
| **RUC S**hort **F**all at **Snap**shot |
| **RUC S**hort **F**all at **Adj**ustment Period |
| **RUC Cap**acity **Credit** |

## RUC Shortfall

$$RUCSFSNAP_{ruc,q,i} = Max\ (0, ((\sum RTAML_{q,p,i} * 4) + \sum RTDCEXP_{q,p,i} - RUCCAPSNAP_{ruc,q,i}))$$

Capacity at snapshot:



- QSE-to-QSE Energy Purchases – QSE-to-QSE Energy Sales (Energy Trades)
- Day-Ahead Energy Purchases – Day-Ahead Energy Sales
- Capacity Purchase – Capacity Sales (Capacity Trades)
- High Ancillary Service Limits + DC Tie Imports

## RUC Shortfall

$$RUCSFSNAP_{ruc,q,i} = Max\,(0, ((\sum RTAML_{q,p,i} * 4) + \sum RTDCEXP_{q,p,i} - RUCCAPSNAP_{ruc,q,i}))$$

$$RUCCAPSNAP_{ruc,q,i} = \sum HASLSNAP_{q,r,h} + (RUCCPSNAP_{q,h} - RUCCSSNAP_{q,h}) + (\sum DAEP_{q,p,h} - \sum DAES_{q,p,h}) + (\sum RTQQEPSNAP_{q,p,i} - \sum RTQQESSNAP_{q,p,i}) + \sum DCIMPSNAP_{q,p,i}$$

| Determinants |
| --- |
| **R**eal-**T**ime **DC** Tie **Exp**ort (Oklaunion Exemption) |
| **RUC Cap**acity **Snap**shot at time of RUC |
| **H**igh **A**ncillary **S**ervice **L**imit at **Snap**shot |
| **RUC C**apacity **P**urchase |
| **RUC C**apacity **S**ale |
| **D**ay-**A**head **E**nergy **P**urchase |
| **D**ay-**A**head **E**nergy **S**ale |
| **Q**SE-to-**Q**SE **E**nergy **P**urchase |
| **Q**SE-to-**Q**SE **E**nergy **S**ale |
| **DC Imp**ort at **Snap**shot |

# RUC Shortfall

$$RUCSF_{ruc,i,q} = Max\,(0, Max\,(RUCSFSNAP_{ruc,q,i}, RUCSFADJ_{ruc,q,i}) - \sum_{\substack{Prior\\RUCs}} RUCCAPCREDIT_{q,i,z})$$

**RUCSFADJ**

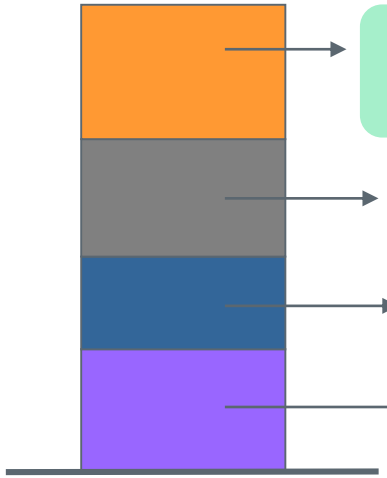
- Snapshot of the QSEs market position at the end of the Adjustment period
- Built over time
- Complete at the end of the last Adjustment period of the day

| Determinants |
| --- |
| **RUC S**hort**f**all |
| **RUC S**hort **F**all at **Snap**shot |
| **RUC S**hort **F**all at **Adj**ustment Period |
| **RUC Cap**acity **Credit** |

## RUC Shortfall

$$RUCSFADJ_{ruc,q,i} = Max\left(0, \left(\left(\sum RTAML_{q,p,i} * 4\right) + \sum RTDCEXP_{q,p,i} - \sum_{IRRs} HASLSNAP_{ruc,q,r,h} - RUCCAPADJ_{q,i}\right)\right)$$

Capacity at Adjustment Period:



- QSE-to-QSE Energy Purchases – QSE-to-QSE Energy Sales (Energy Trades)
- Day-Ahead Energy Purchases – Day-Ahead Energy Sales
- Capacity Purchase – Capacity Sales (Capacity Trades)
- High Ancillary Service Limits + DC Tie Imports

## RUC Shortfall

$$RUCSFADJ_{ruc,q,i} = Max\left(0, \left(\left(\sum RTAML_{q,p,i} * 4\right) + \sum RTDCEXP_{q,p,i} - \sum_{IRRs} HASLSNAP_{ruc,q,r,h} - RUCCAPADJ_{q,i}\right)\right)$$

$$RUCCAPADJ_{q,i} = \sum HASLADJ_{q,r,h} + (RUCCPADJ_{q,h} - RUCCSADJ_{q,h}) + \left(\sum DAEP_{q,p,h} - \sum DAES_{q,p,h}\right) + \left(\sum RTQQEPADJ_{q,p,i} - \sum RTQQESADJ_{q,p,i}\right) + \sum DCIMPADJ_{q,p,i}$$

| Determinants |
| --- |
| **R**eal-**T**ime **DC** Tie **Exp**ort (Oklaunion Exemption) |
| **RUC Cap**acity Snapshot at **Adj**ustment Period |
| **H**igh **A**ncillary **S**ervice Limit at **Adj**ustment Period |
| **RUC C**apacity **P**urchase |
| **RUC C**apacity **S**ale |
| **D**ay-**A**head **E**nergy **P**urchase |
| **D**ay-**A**head **E**nergy **S**ale |
| **Q**SE-to-**Q**SE **E**nergy **P**urchase |
| **Q**SE-to-**Q**SE **E**nergy **S**ale |
| **DC Imp**ort at **Adj**ust. Period |

## Refer to your Settlements Workbook


**In a small group, respond to the questions that relate to Scenario #RUC1**

**You have 10 minutes to complete your questions.**

*If you cannot complete all questions, don't worry – all questions will be reviewed as a class.*

# RUC Shortfall

$$RUCSF_{ruc,i,q} = Max\,(0, Max\,(RUCSFSNAP_{ruc,q,i}, RUCSFADJ_{ruc,q,i}) - \sum_{\text{Prior RUCs}} RUCCAPCREDIT_{q,i,z})$$

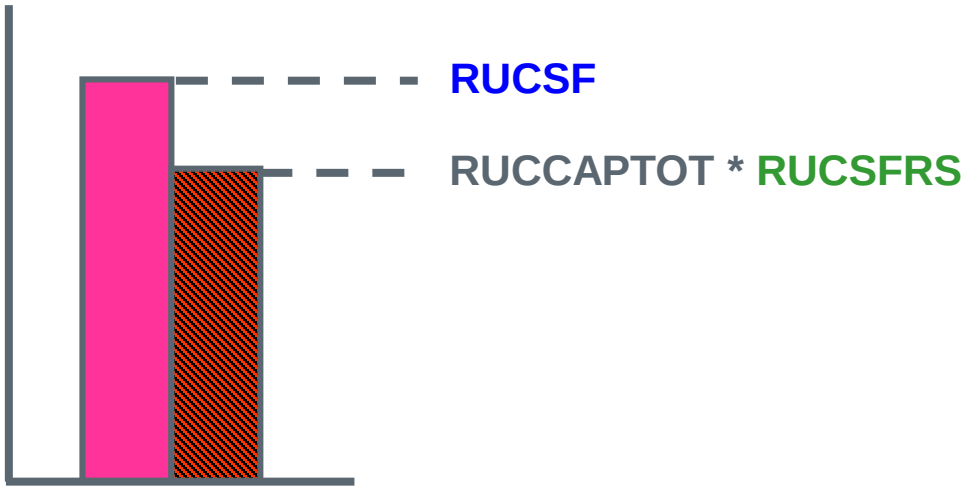
**Capacity Credit**

- Credit to QSEs to ensure not charged twice for the same capacity shortage

| Determinants |
| --- |
| **RUC S**hort**f**all |
| **RUC S**hort **F**all at **Snap**shot |
| **RUC S**hort **F**all at **Adj**ustment Period |
| **RUC Cap**acity **Credit** |

# RUC Shortfall

$$RUCCAPCREDIT_{ruc,i,q} = \text{Min}\left[RUCSF_{ruc,i,q}, \left(RUCCAPTOT_{ruc,h} * RUCSFRS_{ruc,i,q}\right)\right]$$




| Determinants |
| --- |
| **RUC Cap**acity **Credit** |
| **RUC S**hort**f**all |
| **RUC Cap**acity **Tot**al |
| **RUC S**hort**f**all **R**atio **S**hare |

## Refer to your Settlements Workbook

**In a small group, respond to the questions that relate to Scenario #RUC2.**


**You have 5 minutes to complete your questions.**

*If you cannot complete all questions, don't worry – all questions will be reviewed as a class.*

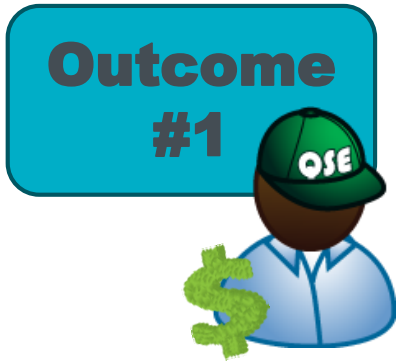

## RUC Shortfall Ratio Share

QSE3 is capacity-short for a RUC process

- 20 MW

Total short is

- 100 MW


**RUCSFRS = RUCSF / RUCSFTOT**

**= 20 MW / 100 MW**

**= 0.20**

# RUC Capacity-Short Charge


- QSE3:
  - RUC Shortfall: 20 MW
  - RUC Shortfall Ratio Share of: 20 %
- ERCOT-wide Values
  - Total RUC Make-Whole Payments: -$800
  - RUC Capacity Total: 400 MW


**RUCCSAMT = (-1) * Max [(RUCSFRS * RUCMWAMTRUCTOT),**
**(2 * RUCSF * (RUCMWAMTRUCTOT / RUCCAPTOT))] / 4**

---

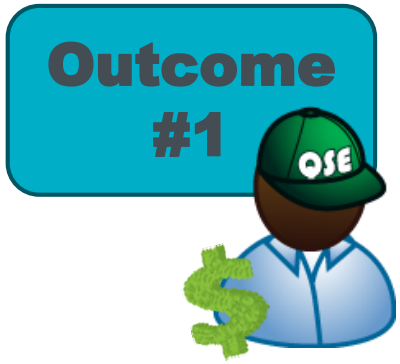
**RUCCSAMT = (-1) * Max [(.20 * $-800), (2 * 20 MW * ($-800/400 MW))] / 4**

**= (-1) * Max [(-$160), (-$80)] / 4**

**= $20**

# RUC Capacity-Short Charge

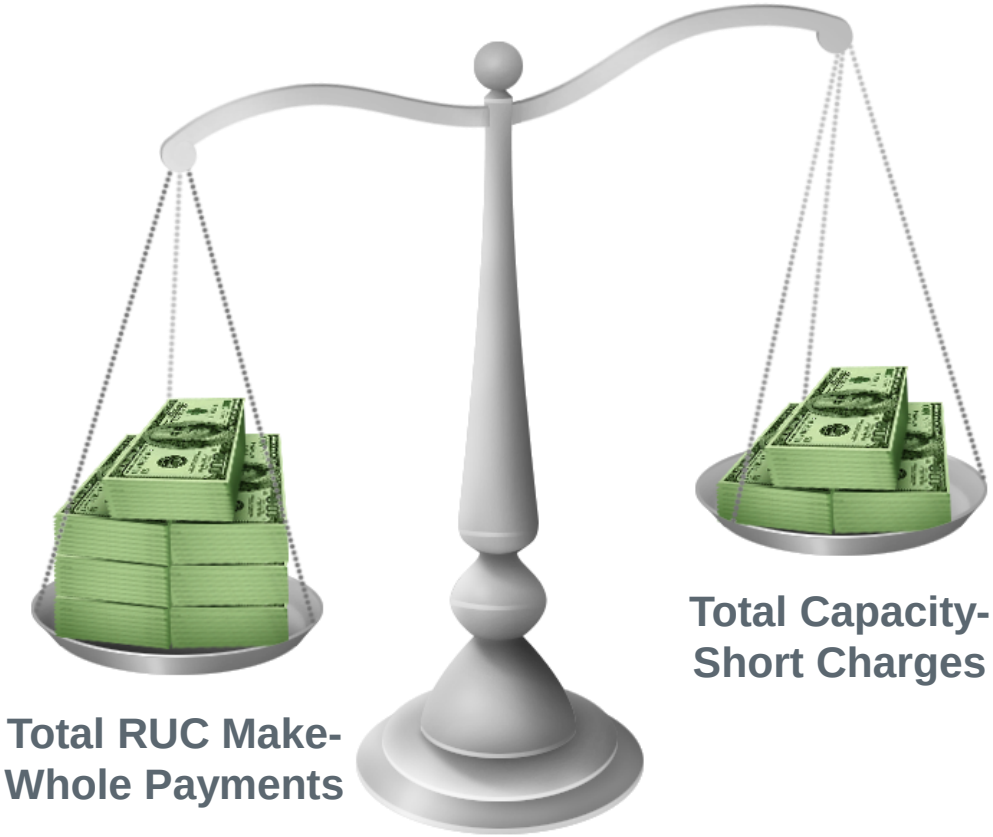

- QSE3:
  - RUC Shortfall: 20 MW
  - RUC Shortfall Ratio Share of: 20 %
- ERCOT-wide Values
  - Total RUC Make-Whole Payments: -$800
  - RUC Capacity Total: 400 MW


**RUC Capacity Short Charge is limited to $20 by the Short Charge Cap.**

**Without cap, charge would have been $40.**

## If after all the Capacity-Short charges have been collected ...




## ... then ERCOT needs additional funds for Make-Whole Payments.

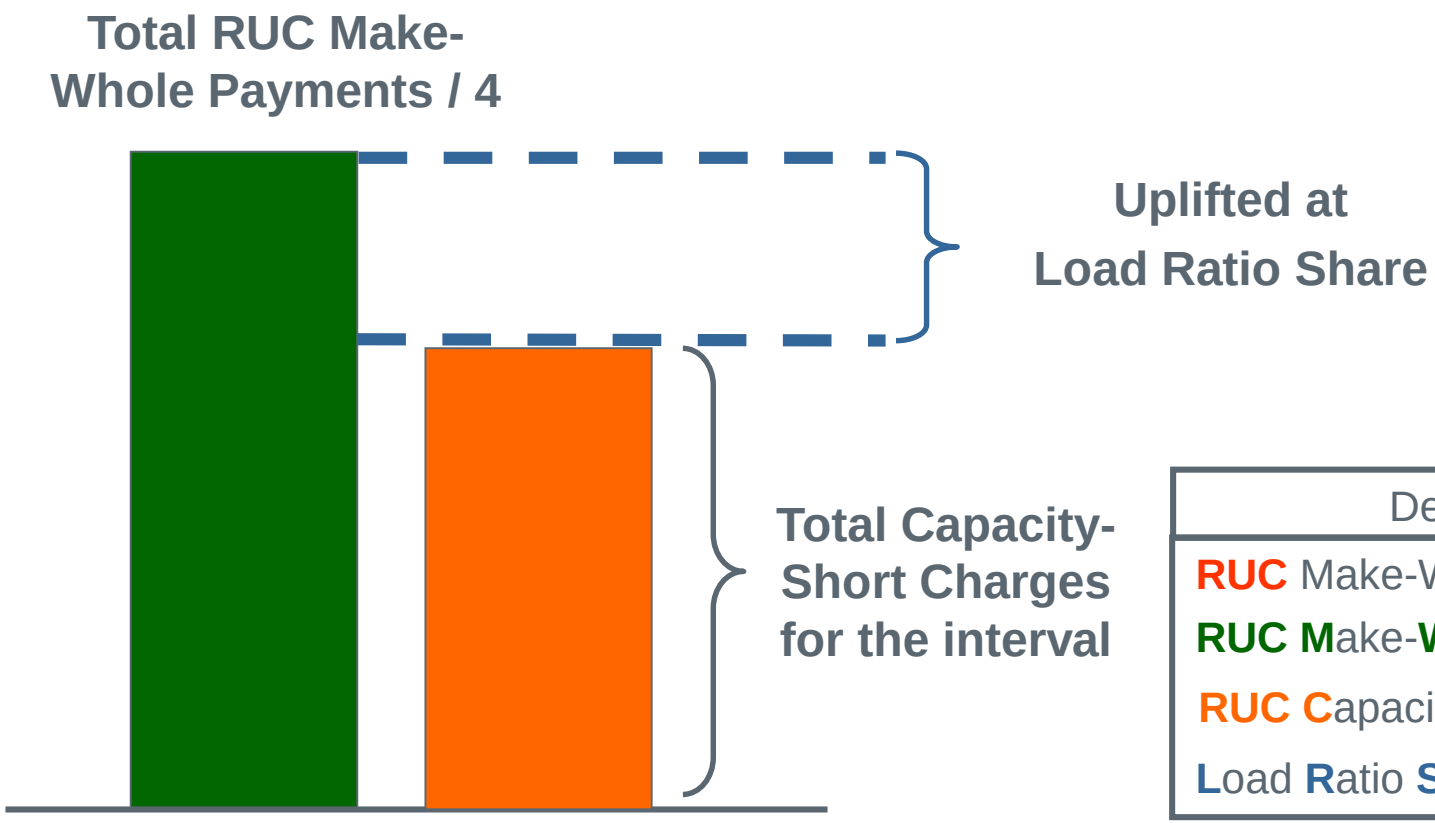
**Outcome #1**


## Charge to all QSEs to collect enough funds to pay the RUC Make-Whole Payments

| | |
|---|---|
| **What:** | If the revenues from the Capacity-Short Charge don't cover all RUC Make-Whole Payments then additional funds will be uplifted to QSEs on a Load Ratio Share basis |
| **Why:** | Keep ERCOT revenue neutral |

# RUC Make-Whole Uplift Charge

$$LARUCAMT_{q,i} = (-1) * (RUCMWAMTTOT_h / 4 + RUCCSAMTTOT_i) * LRS_{q,i}$$




| Determinants |
| --- |
| **RUC** Make-Whole Uplift Charge |
| **RUC M**ake-**W**hole **Am**oun**t Tot**al |
| **RUC C**apacity **Am**oun**t Tot**al |
| **L**oad **R**atio **S**hare |

# RUC Make-Whole Uplift Charge


QSE5 represents Load

- Load Ratio Share = .25

ERCOT-wide Values

- Total RUC Make-Whole Payments: -$800
- RUC Capacity-Short Charge Total: $100

ERCOT needs additional funds to pay Make-whole Payments



**LARUCAMT = (-1) * ( RUCMWAMTTOT / 4 + RUCCSAMTTOT ) * LRS**

---

**LARUCAMT = (-1) * (- $800 / 4 + $ 100) * .25**

**= (-1) * ( - $100 ) * .25**

**= $25**

# Reliability Unit Commitment: Settlements

## RUC

Commitment
- Make-Whole
- Clawback

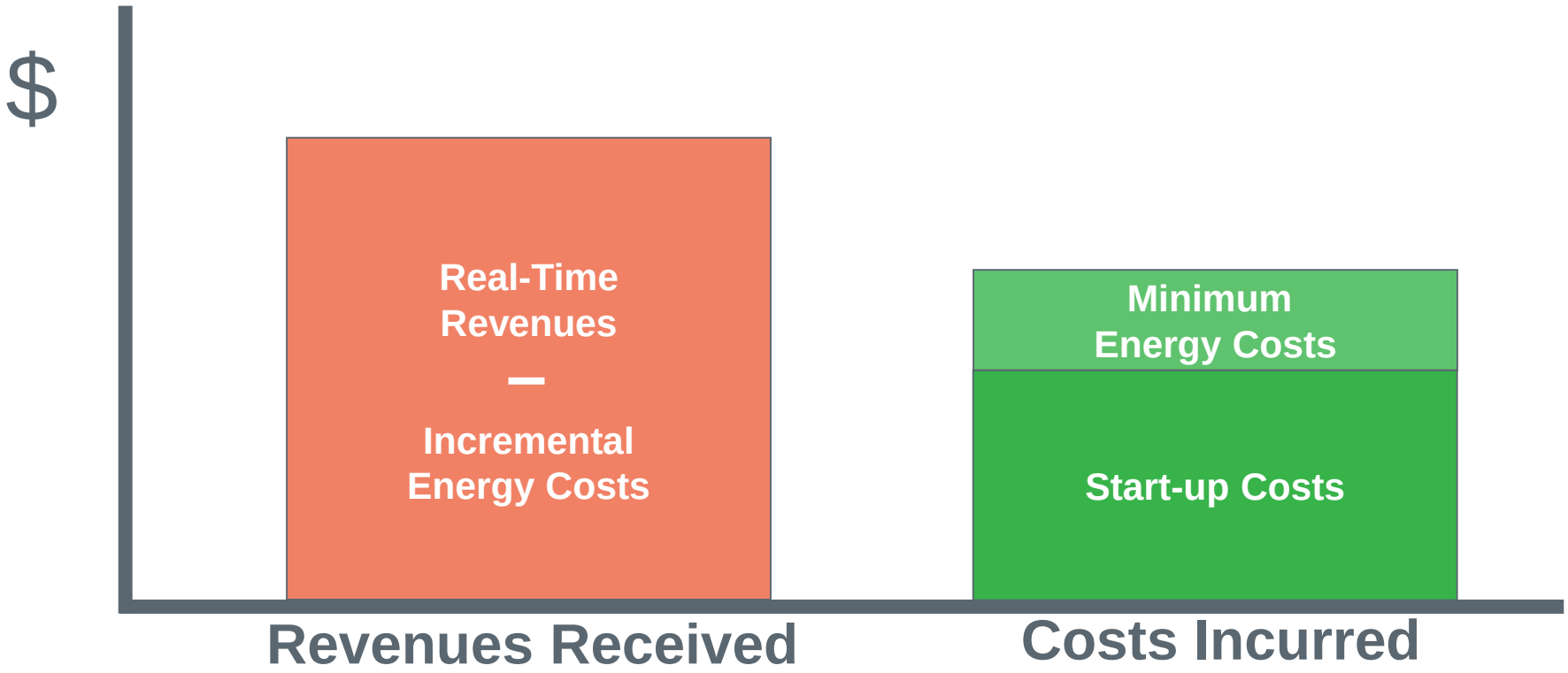

Decommitment

**Outcome #1**


## Charge to all QSEs whose revenues exceed the RUC Guarantee

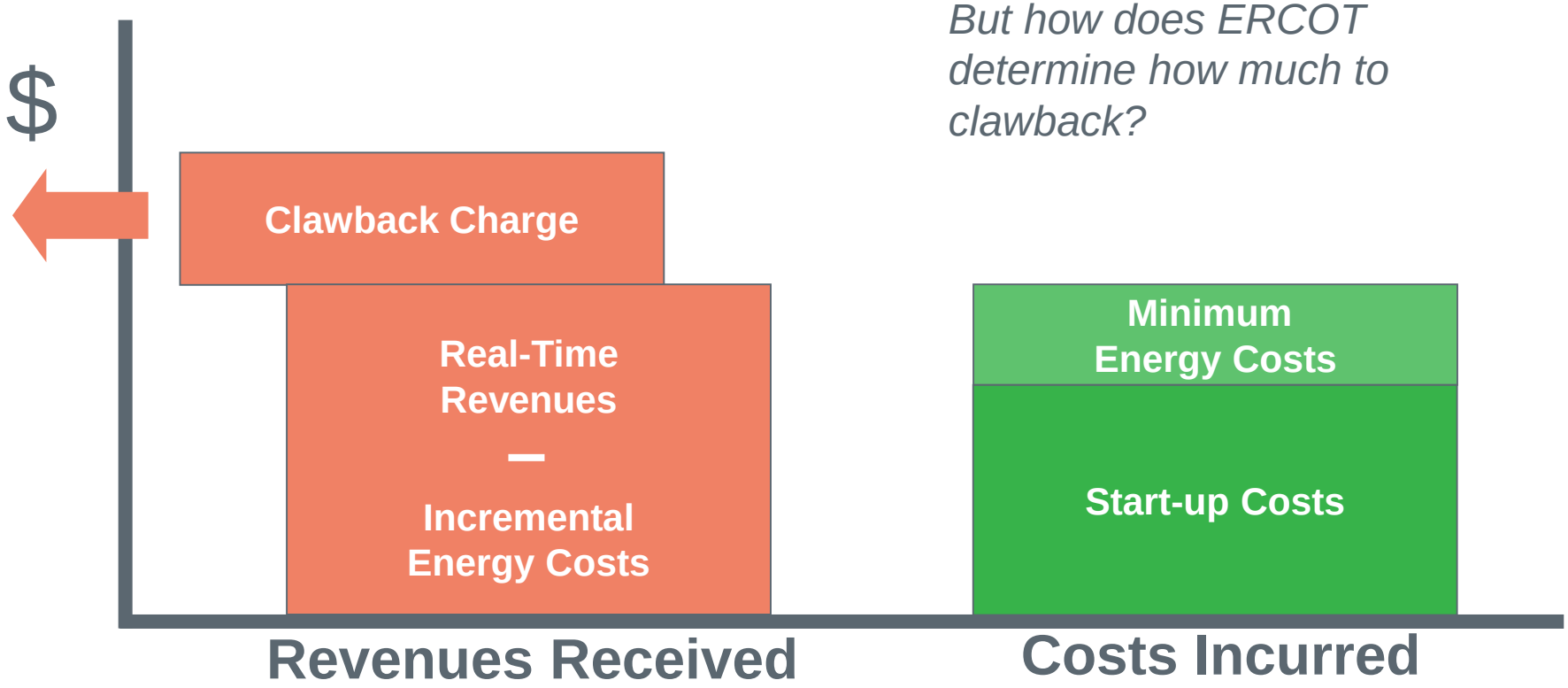
| | |
|---|---|
| **What:** | Collects a portion of revenue above costs |
| **Why:** | Resource was committed for reliability. Excess revenue should be returned to Load |

## What if revenues are greater than cost?



## What if revenues are greater than cost?

*But how does ERCOT determine how much to clawback?*



# Clawback Factors

| | Three-Part Supply Offer in DAM | No Three-Part Supply Offer in DAM |
|---|---|---|
| RUC Clawback Factor for RUC hours | 50% | 100% |
| RUC Clawback Factor for QSE hours | 0% | 50% |


# RUC Clawback Charge

**Trigger #1**

(Resource Revenues) > (RUC Guaranteed Amount)

**Outcome #1**


| | RUC Guaranteed Amount | Resource Revenues | Receive a RUC Clawback Charge? |
|---|---|---|---|
| QSE1 | $4,000 | $3,000 | ? |
| QSE4 | $6,000 | $44,400 | ? |
| QSE6 | $8,000 | $16,000 | ? |

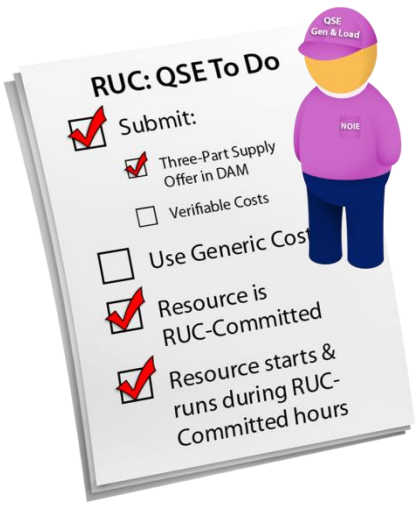
## Calculate Clawback Amount

$$RUCCBAMT = [(RUCMEREV + RUCEXRR - RUCG) * RUCCBFR + (RUCEXRQC * RUCCBFC)] / \sum RUCHR$$

| | |
|---|---|
| $RUCCBAMT_{q, r, h}$ | **RUC C**lawback **C**harge **Am**oun**t** |
| $RUCMEREV_{q, r, d}$ | **RUC M**inimum-**E**nergy **Rev**enue |
| $RUCEXRR_{q, r, d}$ | Revenue Less Cost Above LSL from RUC Hours |
| $RUCG_{q, r, d}$ | **RUC G**uarantee |
| $RUCEXRQC_{q, r, d}$ | Revenue Less Cost from QSE Clawback Intervals |
| $RUCCBFR_{q, r, d}$ | **RUC C**law**b**ack **F**actor for **R**UC-Committed Hours |
| $RUCCBFC_{q, r, d}$ | **RUC C**law**b**ack **F**actor for QSE **C**lawback Intervals |
| **RUCHR** | **RUC H**our |

# RUC Clawback Charge

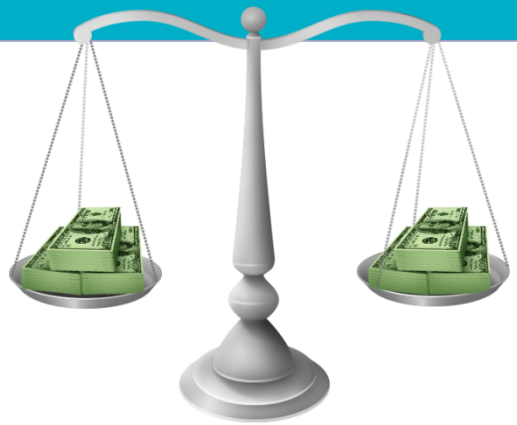

- QSE4's Resource Revenues are greater than its RUC Guaranteed Amount
- QSE4's Resource was committed with a Three-Part Supply Offer
- QSE4's Resource was offered in DAM




**RUCCBAMT = [(RUCMEREV + RUCEXRR – RUCG) * RUCCBFR**
**+ (RUCEXRQC * RUCCBFC)] / ∑ RUCHR**
**= [($5,000 + $27,000 – $6000) * 0.5**
**+ ($12,400 * 0)] / 5**
**= [$26,000 * 0.5] / 5**
**= $2600 per hour**

**Outcome #1**

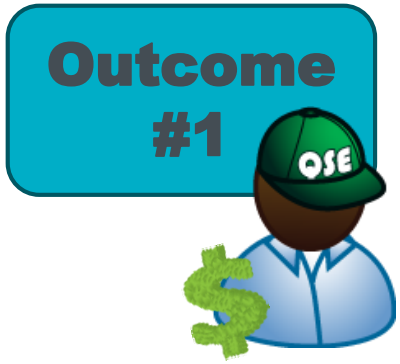

## Payment to all QSEs that represent Load



| | |
|---|---|
| **What:** | Revenue collected above costs through Clawback charge |
| **Why:** | Keep ERCOT revenue neutral |

# RUC Clawback Payment


- ERCOT receives funds from Clawback charges
- QSE5 represents Load
  - Load Ratio Share (LRS) of 30%


**RUC Clawback Payment**

= (-1) * (Hourly RUC Clawback * (¼) * QSE's LRS)

---

**LARUCCBAMT** = (-1) * (RUCCBAMTTOT * (¼) * LRS)

= (-1) * ($2600 * (¼) * 0.30)

= (-1) * ($650 * 0.30)

= -$195

# Reliability Unit Commitment: Settlements

## RUC

Commitment
- Make-Whole
- Clawback


Decommitment

## Outcome #1


## Payment to QSE for a QSE-committed Resource that the RUC process decommitted


**If all criteria met:**

- ERCOT pays QSE for decommittment
- Payment occurs only for Operating Day of decommitment
- QSE gets RUC Capacity Credit

## Decommitment of a QSE-Committed Resource

**RUC Decommitment Payment**

- Start-up Cost (SUPR)
- Less cost savings (MEPR – RTSPP), if any
- Distributed across Decommitted Hours (NCDCHR)

**Where,**

SUPR = Min(SUO, SUCAP)

MEPR = Min(MEO, MECAP)

| |
|---|
| Startup Price (SUPR) |
| Startup Offer (SUO) |
| Startup Cap (SUCAP) |
| Minimum Energy Price (MEPR) |
| Minimum Energy Offer (MEO) |
| Minimum Energy Cap (MECAP) |

# RUC Payment for Decommitment

**Trigger #1**

- ERCOT decommits QSE1 Unit 1
  - QSE-Committed Resource
  - Resource is NOT scheduled to shutdown within the Operating Day


**Outcome #1**


**RUCDCAMT**

$$= (-1) * \text{Max}\{0, [\text{SUPR} - (\text{Max}(0, \text{MEPR} - \text{RTSPP}) * (\text{LSL} * (1/4)))]\} / \text{NCDCHR}$$

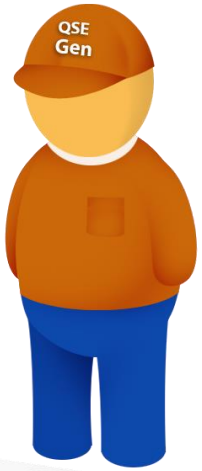
**RUCDCAMT**

$$= (-1) * \text{Max}\{0, [\$1200 - (\text{Max}(0, \$30 - \$40) * (10\text{MW} * (1/4)))]\} / 6$$

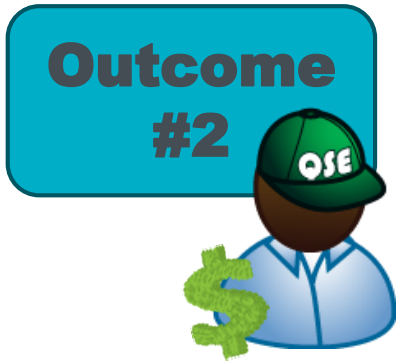
$$= (-1) * \$1200 / 6 = -\$200$$

# RUC Payment for Decommitment


- ERCOT decommits QSE1 Unit 1
  - QSE-Committed Resource
  - Resource IS scheduled to shutdown within the Operating Day



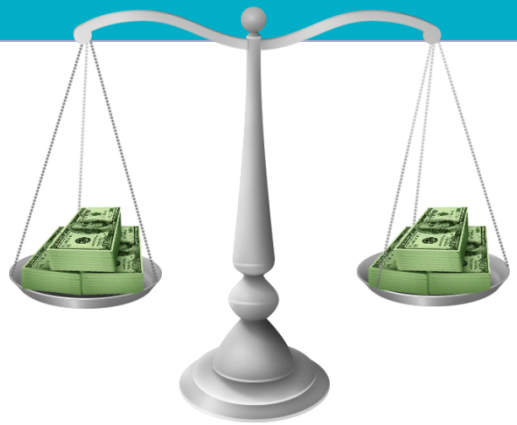





**QSE will not receive payment for decommitment**

## Outcome #1


## Charge to QSEs that represent Load



| | |
|---|---|
| **What:** | Charge to fund Decommitment Payments |
| **Why:** | Keep ERCOT revenue neutral |

# RUC Decommitment Charge


- Resource are decommitted by the RUC process and are eligible to receive a decommitment payment
- QSE5 represents Load
  - Load Ratio Share of 30%



**RUC Decommitment Charge**

**= (-1) * [(RUC Decommitment Payments / 4 ) * LRS]**

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$$LARUCDCAMT_{q,i} = (-1) * [(RUCDCAMTTOT_h / 4) * LRS_{q,i}]$$

$$= (-1) * [(-\$200 / 4) * 0.30]$$

$$= (-1) * [-\$50 * 0.30]$$

$$= \$15$$

# Module Conclusion

## CRR Auction

Charges & Payments for CRRs


Revenue Distribution

## CRR Balancing Account


Reconcile CRR Short payments

## DAM


Participation in DAM
- Energy
- AS
- PTP Obligations

DAM Commitment
- Make-Whole

Settlement of CRRs purchased in the Auction

## RUC

Commitment
- Make-Whole
- Clawback


Decommitment

## Real-Time

Real-Time Activities
- Imbalances
- Base Point Deviations
- Other odds & ends

Settlement of PTP Obligations purchased in the DAM

Real Time Ancillary Service Settlements

Revenue Neutrality