

# Issue #5 – Simultaneous Use of Ramping – Examples

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PUBLIC

- Show some feasible, illustrative schedules for 3x ramp rate without modifications to the constraint equations.
- Show some feasible, illustrative schedules for 3x ramp rate with modifications to the constraint equations .
- Show that the modification is required so that market prices are always based on the 3x ramp rate.

$$a. \quad Generation_g + \sum_{c \in RESERVECLASSES} Reserve_{r(g),c} \leq GenerationMaximum_g$$

This constraint ensures that a generation facility is not scheduled for energy and operating reserve beyond the maximum MW offered quantity.

$$b. \quad Generation_g + \sum_{\substack{r \in RESERVEOFFERS, \\ c \in \{RS10, RNS10\}}} Reserve_{r(g),c} \leq Generation_g^{start} + ReserveMaximum10_g$$

$$c. \quad Generation_g + \sum_{\substack{r \in RESERVEOFFERS, \\ c \in RESERVECLASSES}} Reserve_{r(g),c} \leq Generation_g^{start} + ReserveMaximum30_g$$

These constraints ensure that a generation facility is not scheduled to provide energy and operating reserve beyond its offered ramping capability.

- Generator Starting Output = 200MW
- Generation Maximum = 500MW
- Ramp Rate Energy = 5MW/min
- Ramp Rate OR = 5MW/min
  
- Assume constraint equation a. is non-binding
- 10M OR is limited to 50MW (5MW/min x 10 minutes)
- Total OR is limited to 150MW (5MW/min x 30 minutes)

1. RTU (with no modification): **All three limits must be met for a feasible schedule**

Energy ramped is limited to 75MW (5MW/min x 5 minutes x 3x ramp rate)

b. Energy ramped + 10-minute OR is limited to 50MW (5MW/min x 10 minutes)

c. Energy ramped + total OR is limited to 150MW (5MW/min x 30 minutes)

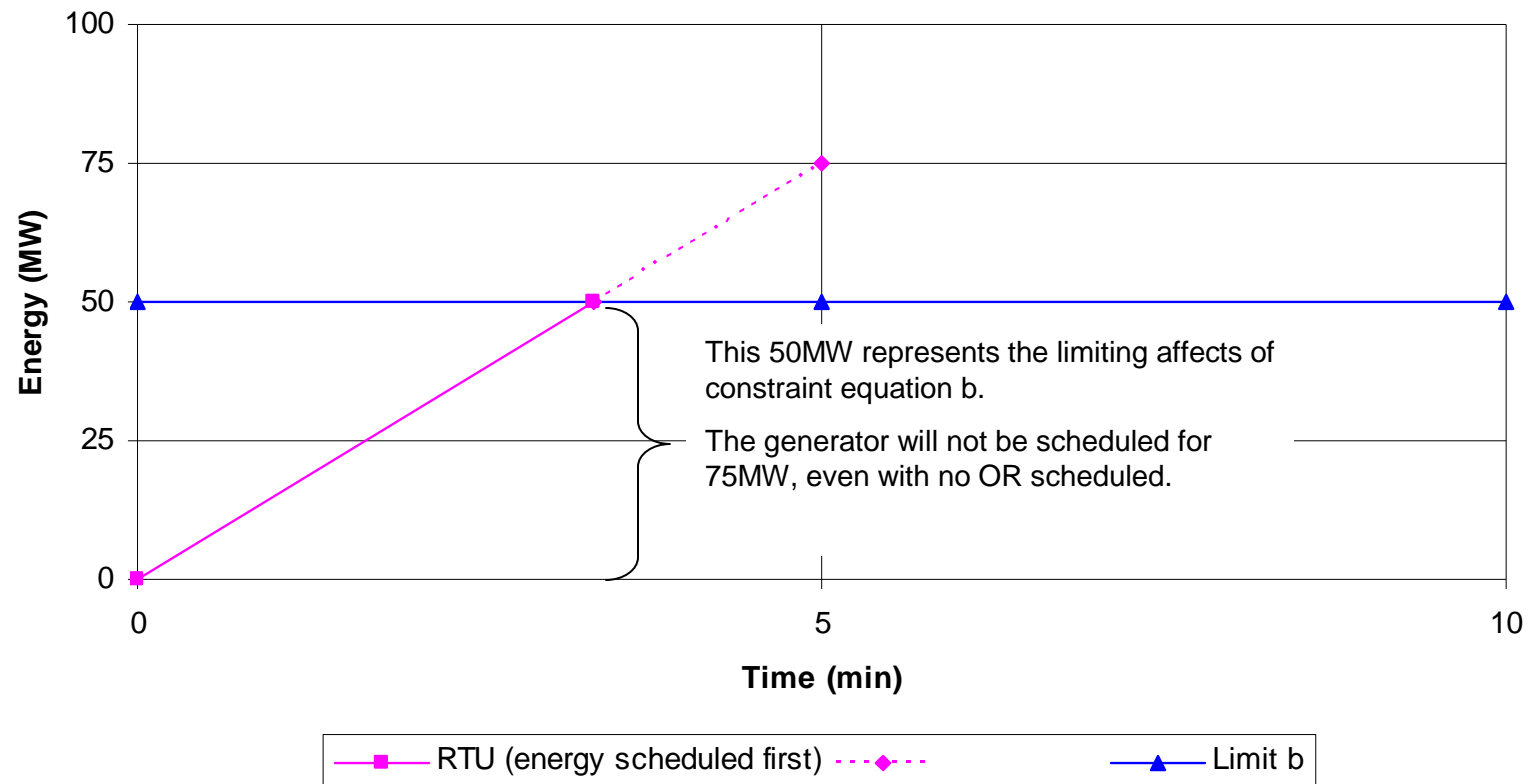
Some Feasible and Illustrative Schedules:

- E: 200, 10M: 50, 30M: 100
- E: 200, 10M: 0, 30M: 150
- E: 200, 10M: 25, 30M: 125
- E: 250, 10M: 0, 30M: 100

**NOTE: E: 275, 10M: 0, 30M: 0 IS NOT A FEASIBLE SCHEDULE (because of limit b).**

**The OR limits are restricting the amount of energy scheduled.**

## RTU with No Modifications



## 2. RTU (with modification): **All three limits must be met for a feasible schedule**

Energy ramped is limited to 75MW (5MW/min x 5 minutes x 3x ramp rate)

b. Energy ramped + 10-minute OR is limited to 5,000MW (5MW/min x 10 minutes) \* 100

c. Energy ramped + total OR is limited to 15,000MW (5MW/min x 30 minutes) \* 100

Some Feasible and Illustrative Schedules:

- E: 275, 10M: 0, 30M: 0
- E: 275, 10M: 50, 30M: 100
- E: 275, 10M: 0, 30M: 150
- E: 250, 10M: 50, 30M: 100
- E: 200, 10M: 50, 30M: 100
- E: 200, 10M: 25, 30M: 125

### 3. RTC: All three limits must be met for a feasible schedule

Energy ramped is limited to 25MW (5MW/min x 5 minutes)

b. Energy ramped + 10-minute OR is limited to 50MW (5MW/min x 10 minutes)

c. Energy ramped + total OR is limited to 150MW (5MW/min x 30 minutes)

Some Feasible and Illustrative Schedules:

- E: 200, 10M: 50, 30M: 100
- E: 200, 10M: 0, 30M: 150
- E: 200, 10M: 25, 30M: 125
- E: 225, 10M: 0, 30M: 125

- Leave modifications as they are; however leave this issue open, but on hold, with the intent to consider changing/removing the modifications once analysis of 3x impact is completed (i.e. changing/removing the modifications could be the next incremental change to RT pricing).
- Rationale:
  - The analysis conducted supporting the proposed change from 12x to 3x was conducted using the existing modifications.
  - Analysis of the impact of the change to 3x ramp rate multiplier is not yet complete and the IESO has committed to do analysis over the next year. It is prudent to not change any other aspect of RT pricing until that analysis is completed.