# REM and Regulation: Separate Products or Practical Substitutes?

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# When are Products Separate?

- Two situation in which products are differentiated:
  1. *For reserves: when time scales of response are appreciably different*
     - Regulation ↔Spin ↔Replacement (↔ RA)
     - Cascading substitutability (higher quality for lower in co-optimization)
  2. *Qualitatively different services*
     - E.g., reactive power vs. black start vs. reserves
- Issue:
  - *REM and normal regulation both provide same service*
    - At least within 1.5 intervals, if REM starts at set-point
    - So neither Situation #1 or #2 apply
  - *But with different constraints*
    - REM generally faster ramp
    - REM requires RTD back to operating point after use, and has tighter energy limits
  - *With different constraints, there are other system impacts that may lead to operator preferring one or the other*
    - Given same bid per MW per hour, which preferred?
    - Ambiguous – can depend on system conditions

# Example of REM Impacts During Extended RegUp Dispatch: *Battery that can deliver/take 20 MW, store 5 MWh*

**Storage Set Point**

| Interval | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Time | :00 - :05 | :05 - :10 | :10 - :15 | :15 - :20 | :20 - :25 | :25 - :30 | :30 - :35 | :35 - :40 |
| Charge at Start, MWh | 2.5 | | | | | | | |
| RTD Schedule MW | 0 | 0 | | | | | | |
| + RegUp Gen MW | | | | | | | | |
| = Gen MW | | | | | | | | |

| RTD Scheduling Process MW | | | | | |
|---|---|---|---|---|---|
| (Reason) | | | | | |

# Example of REM Impacts During Extended RegUp Dispatch: *RegUp Generation Required*

**RegUp**

| Interval | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Time | :00 - :05 | :05 - :10 | :10 - :15 | :15 - :20 | :20 - :25 | :25 - :30 | :30 - :35 | :35 - :40 |
| Charge at Start, MWh | 2.5 | 0.83 | | | | | | |
| RTD Schedule MW | 0 | 0 | -20 | | | | | |
| + RegUp Gen MW | + 20 | | | | | | | |
| = Gen MW | = 20 | | | | | | | |

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| RTD Scheduling Process MW | Schedule -20 for Interval 3 |
|---|---|
| (Reason) | (Anticipate 0.83 MW charge at 3:10) |

# Example of REM Impacts During Extended RegUp Dispatch


| Interval | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Time | :00 - :05 | :05 - :10 | :10 - :15 | :15 - :20 | :20 - :25 | :25 - :30 | :30 - :35 | :35 - :40 |
| Charge at Start, MWh | 2.5 | 0.83 | 0 | | | | | |
| RTD Schedule MW | 0 | 0 | -20 | -10 | | | | |
| + RegUp Gen MW | + 20 | + 20 | | | | | | |
| = Gen MW | = 20 | = 10 | | | | | | |

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| RTD Scheduling Process MW | Schedule -20 for Interval 3 | Schedule -10 for Interval 4 |
|---|---|---|
| (Reason) | (Anticipate 0.83 MW charge at 3:10) | (Anticipate 1.67 MW charge at 3:15) |

# Example of REM Impacts During Extended RegUp Dispatch


| Interval | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Time | :00 - :05 | :05 - :10 | :10 - :15 | :15 - :20 | :20 - :25 | :25 - :30 | :30 - :35 | :35 - :40 |
| Charge at Start, MWh | 2.5 | 0.83 | 0 | 0 | | | | |
| RTD Schedule MW | 0 | 0 | -20 | -10 | -20 | | | |
| + RegUp Gen MW | + 20 | + 20 /0 = 10 mean | + 20 | | | | | |
| = Gen MW | = 20 | = 10 | =0 | | | | | |

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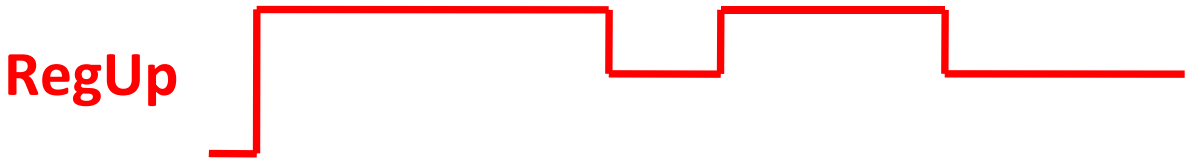
| RTD Scheduling Process MW | Schedule -20 for Interval 3 | Schedule -10 for Interval 4 | Schedule -20 for Interval 5 |
|---|---|---|---|
| (Reason) | (Anticipate 0.83 MW charge at 3:10) | (Anticipate 1.67 MW charge at 3:15) | (Anticipate 0.83 MW charge at 3:20) |

# Example of REM Impacts During Extended RegUp Dispatch




| Interval | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Time | :00 - :05 | :05 - :10 | :10 - :15 | :15 - :20 | :20 - :25 | :25 - :30 | :30 - :35 | :35 - :40 |
| Charge at Start, MWh | 2.5 | 0.83 | 0 | 0 | 0 | | | |
| RTD Schedule MW | 0 | 0 | -20 | -10 | -20 | -10 | | |
| + RegUp Gen MW | + 20 | + 20 /0 = 10 mean | + 20 | + 10 | | | | |
| = Gen MW | = 20 | = 10 | =0 | =0 | | | | |

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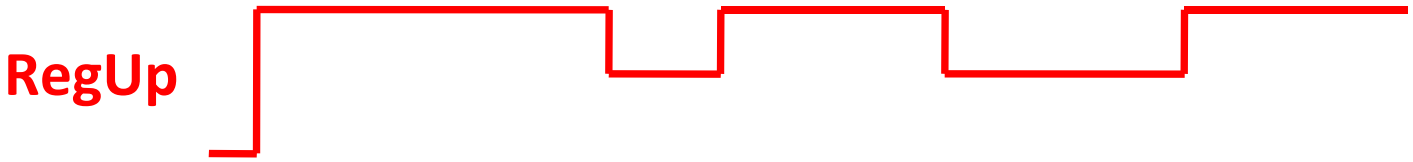
| RTD Scheduling Process MW | Schedule -20 for Interval 3 | Schedule -10 for Interval 4 | Schedule -20 for Interval 5 | Schedule -10 for Interval 6 |
|---|---|---|---|---|
| (Reason) | (Anticipate 0.83 MW charge at 3:10) | (Anticipate 1.67 MW charge at 3:15) | (Anticipate 0.83 MW charge at 3:20) | (Anticipate 0.83 MW charge at 3:25) |

# Example of REM Impacts During Extended RegUp Dispatch




| Interval | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Time | :00 - :05 | :05 - :10 | :10 - :15 | :15 - :20 | :20 - :25 | :25 - :30 | :30 - :35 | :35 - :40 |
| Charge at Start, MWh | 2.5 | 0.83 | 0 | 0 | 0 | 0 | | |
| RTD Schedule MW | 0 | 0 | -20 | -10 | -20 | -10 | -20 | |
| + RegUp Gen MW | + 20 | + 20 /0 = 10 mean | + 20 | + 10 | + 20 | | | |
| = Gen MW | = 20 | = 10 | =0 | =0 | =0 | | | |

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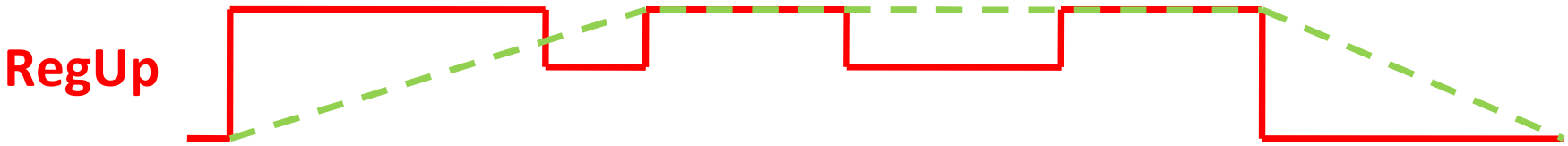
| RTD Scheduling Process MW | Schedule -20 for Interval 3 | Schedule -10 for Interval 4 | Schedule -20 for Interval 5 | Schedule -10 for Interval 6 | Schedule -20 for Interval 7 |
|---|---|---|---|---|---|
| (Reason) | (Anticipate 0.83 MW charge at 3:10) | (Anticipate 1.67 MW charge at 3:15) | (Anticipate 0.83 MW charge at 3:20) | (Anticipate 0.83 MW charge at 3:25) | (Anticipate 0.83 MW charge at 3:25) |

# Example of REM Impacts:
# *Return to Set Point*


| Interval | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Time | :00 - :05 | :05 - :10 | :10 - :15 | :15 - :20 | :20 - :25 | :25 - :30 | :30 - :35 | :35 - :40 |
| Charge at Start, MWh | 2.5 | 0.83 | 0 | 0 | 0 | 0 | 0.83 | 2.5 |
| RTD Schedule MW | 0 | 0 | -20 | -10 | -20 | -10 | -20 | |
| + RegUp Gen MW | + 20 | + 20 /0 = 10 mean | + 20 | + 10 | + 20 | + 0 | + 0 | |
| = Gen MW | = 20 | = 10 | =0 | =0 | =0 | = -10 | =-20 | |

# Characteristics of Rem RegUp Profile during Sustained RegUp Period




- Rapid ramp-up (good)
  - Cf. thermal resource
- Inability to sustain 20 MW (not good)
- Real-Time recharge load during period of RegUp generation (not good)
- *Is this a different product? More or less desirable than normal regulation? Depends on:*
  - *Frequency of extended RegUp, RegDown*
  - *Value of fast ramp*

# Questions to Consider

- *How often do such extended periods occur?*
  - E.g., X% of days experience one or more RegUp generation periods where RegUp energy is >80% of RegUp capacity
  - Y% of days will result in REM hitting either storage constraint (full/empty)
  - Possibly rarely; need to confirm
- *What is value of REM ramp capability?*
- *What is experience elsewhere?*
- *Can we wait and see?*
  - Monitor: If operational problems experienced, limit REM as fraction of RegUp, RegDown, and/or spin
  - If binding, yields separate (lower) price for REM
    - Not a separate product, but the same product subject to a constraint and priced differently
    - Analogous to energy delivered to different places, or CAISO vs imported reserves