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Independent System Operator

Improve Duct-Firing Modeling – Update

John Meyer

SENIOR MARKET SOLUTIONS ARCHITECT

Vijay Kaki

ENERGY MARKET DESIGN SPECIALIST

Installed Capacity Working Group / Market Issues Working Group

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Agenda

- Background
- Problem Statement
- Proposed Approach
- Impacts of the Proposed Approach
- Prototype & Testing Update
- Next Steps

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Previous Presentations

Date	Working Group	Discussion Points and Links to Materials
08-24-2022	ICAPWG/MIWG	Improve Duct-Firing Modeling Update https://www.nyiso.com/documents/20142/32941988/DBimprove_MIWG_08242022_final.pdf/862020d9-faa1-ab30-9f02-e9aa8604d43f
04-05-2022	ICAPWG/MIWG	Improve Duct-Firing Modeling – Update https://www.nyiso.com/documents/20142/29688278/DBimprove_MIWG_040522_final.pdf/fe5ca5ce-d999-7609-a671-6311d06c573a
02-08-2022	ICAPWG/MIWG	Improve Duct-Firing Modeling – Kick-off https://www.nyiso.com/documents/20142/28305948/DBimprove_MIWG_020822_r2.pdf/cd34412c-cce6-5f84-230e-511b0f00e4cc

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Background

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Project Background

- The Improve Duct-Firing Modeling Project seeks to enhance the Operating Reserves product to better accommodate combined-cycle gas turbine generators (“CCGTs”) equipped with duct-firing.
- We are targeting a 2022 Market Design Concept Proposed (MDCP).

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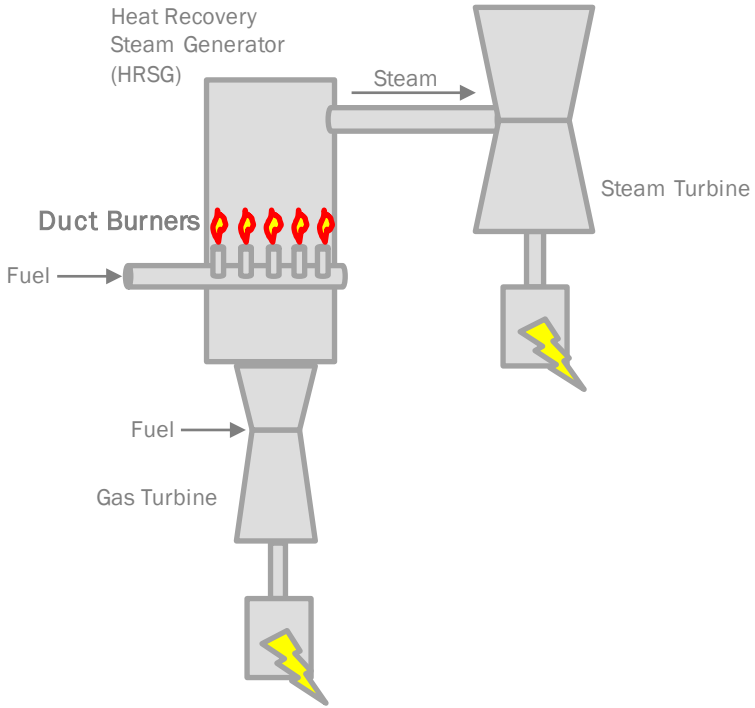
What is Duct-Firing?

- **In some combined-cycle power stations, the Heat Recovery Steam Generators (HRSGs) are equipped with duct burners, which add additional heat to the steam cycle by burning fuel directly in the exhaust duct.**
  - The additional heat from the duct burners increases steam flow to the steam turbine, and results in power increase from the steam turbine only.
  - Typically, the operation of duct burners is limited to the last 1-10% of combined cycle output and requires the gas turbine to be near (or at) maximum output prior to use.
  - There are exceptions to this typical operation in NYISO's fleet, mostly in plants designed for cogeneration.



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Problem Statement

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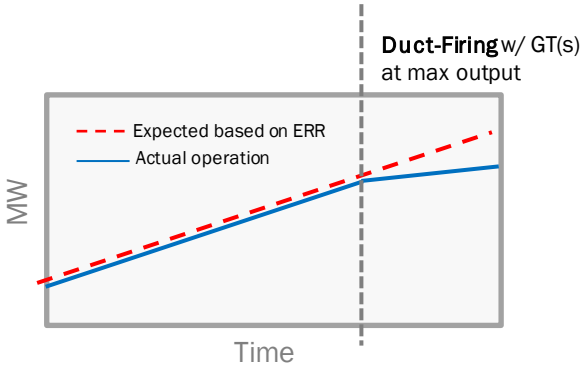
Problem Statement

- **For Energy market participation, up to three normal response rates (NRRs) may be used to characterize the MW/min ramp rate of a generator with respect to MW output.**
  - The NRR values and breakpoints can be tailored to best fit the specific generator's operating characteristics.
    - For example, reduced ramp rate capability in a certain range of operation (e.g., ramping on duct burners alone).
    - NRRs only apply to normal energy dispatch.
- **For Operating Reserves scheduling, the emergency response rate (ERR) is used.**
  - ERR is a single value required to be greater than or equal to all NRRs.
    - Thus, it does not appropriately capture the variable ramp rate over the complete operating range of some units.



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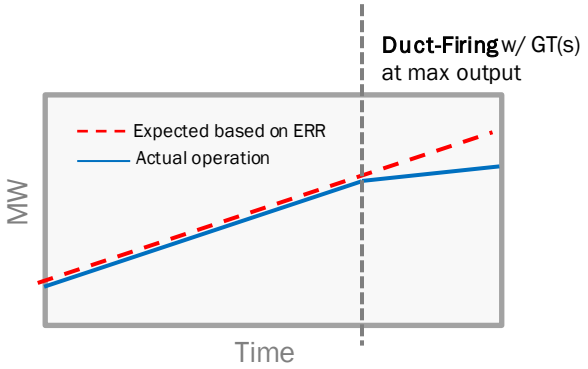
Problem Statement (cont'd)

- It has been observed that CCGTs equipped with duct-firing systems may not be able to physically achieve their registered ERR when ramping through the region where duct burners are used.
- This project will explore changes to accommodate the operating capability of CCGTs when they are in the duct-firing region and called upon to provide reserves.



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Proposed Approach

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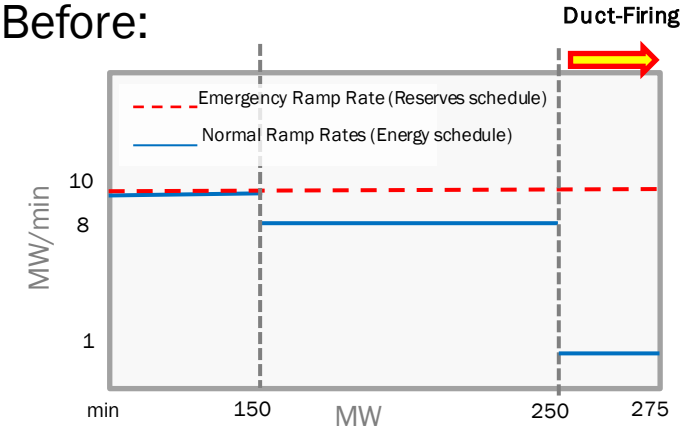
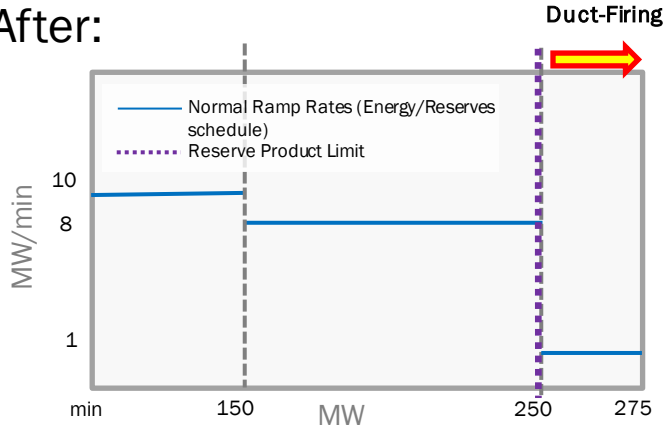
Proposed Approach

- **Multiple ramp rates for reserves schedule**
  - Consistent with scheduling of energy today, leverage the normal ramp rate “segments” (instead of the single emergency rate) to schedule reserves.
  - The operating reserve ramp rates are expected to be consistent with the energy ramp rates which are registration parameters.
- **Threshold for limited participation in reserves**
  - If necessary due to limitations of the plant’s configuration, the MP may set a limit for allocation of operating capacity toward reserves.
  - The existing ramp rate breakpoint for duct-firing range will be used for setting the threshold limit when MP opts to limit participation in a specific reserve product.
  - Opting for a participation limit will be a registration parameter.
  - Regulation Capacity Scheduling is not affected by this limit.

Before:



After:



*example values

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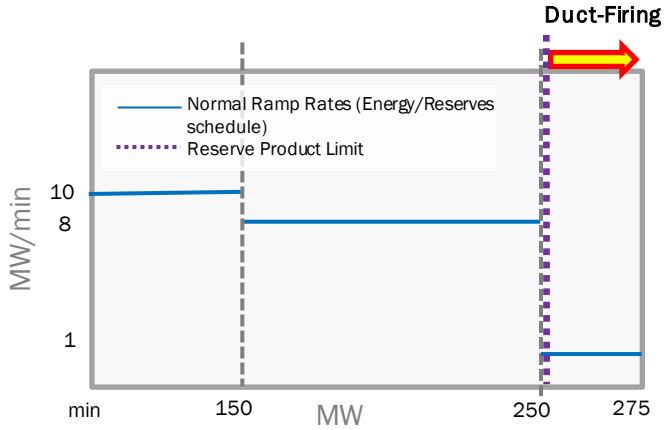
Examples

- **Example 1: Unit has multiple ramp rates as shown in the figure and has a transition time of 10 minutes to move from the second region (150-250 MW) to the duct-firing region (250-275 MW).**
  - Unit could opt for a participation limit in 10-min spinning reserve which would limit the unit's participation in 10-min reserves until 250 MW but provide full range of 275 MW in 30-min reserve.
- **Example 2: Unit has multiple ramp rates as shown in the figure, has no transition time but is unable to ramp up or down within the duct-firing region**
  - Unit could opt to limit participation in both 10-min and 30-min spinning reserve product which would limit the unit's participation in reserves until 250 MW.
- **The participation limit only applies to reserves and not to energy.**
  - The full range will continue to be used for energy when participation limit is employed for reserves.
- **Opting for a 30-min reserve participation limit would preclude the unit from providing reserves in the duct-firing region for both 10-min and 30-min reserve products.**



*example values

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Questions from last MIWG

- **Would the participation limit be applied for regulation as well?**
  - The participation limit would only be applied for reserves and not regulation. The participation limit is based on the ramp rate breakpoint which can be integrated well with the multiple ramp rates. Having a participation limit for regulation would require us to employ multiple ramp rates for regulation which can not be applied due to the complexities mentioned before.
- **Could the multiple ramp rates be biddable?**
  - Currently, the proposed approach has the operating reserve ramp rates to be consistent with energy ramp rates which are registration parameters. Having biddable ramp rates would not only impact reserve scheduling but also impact energy scheduling which would be outside the scope of this project since this project deals with enhancing the reserves. Exploring biddable ramp rates would add significant extra time and effort to this project and would require its own project prioritization if there is support among the stakeholders for this add-on.

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Impacts of the Proposed Approach

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Impacts of the Proposed Approach

- Currently, the normal reserve audit process requires a generator to provide available reserves in 10/30 minutes starting from current basepoint and moving at emergency response rate (ERR).
- There would be updates to the reserve audit process since multiple ramp rates will now be used instead of the single emergency response rate.
- For units opting for the participation limit, the participation limit will be used as a limit beyond which the unit will not be tested for the specific reserve product that the limit is applied to.

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NYCA CCGT with Duct-Firing Fleet Information and Potential Impacts

- 29 Combined Cycle facilities which comprises 45 combined cycle units equipped with duct burners.
- Around 840 MWs in the Duct Burner region
- Additional MWs outside the Duct-Firing region could get qualified for reserves by employing the proposed approach.
- There would be a reduction in the amount of MWs available due to using a lower ramp rate as opposed to the higher emergency response rate. This would be a more accurate reflection of resource capabilities.
- In the next couple of slides, portion of Duct Burner capacity used for a 10-min reserve product and 30-min reserve product is depicted visually for the entire fleet in NY excluding 5 units that have opted out of providing reserves.
    - For example, a unit having a duct burner capacity of 20 MW, DB startup time of 5 minutes, and DB ramp rate of 2 MW/min would be able to provide 10 MW (50% of its DB capacity) for 10-min reserves and the full capacity for 30-min reserves.

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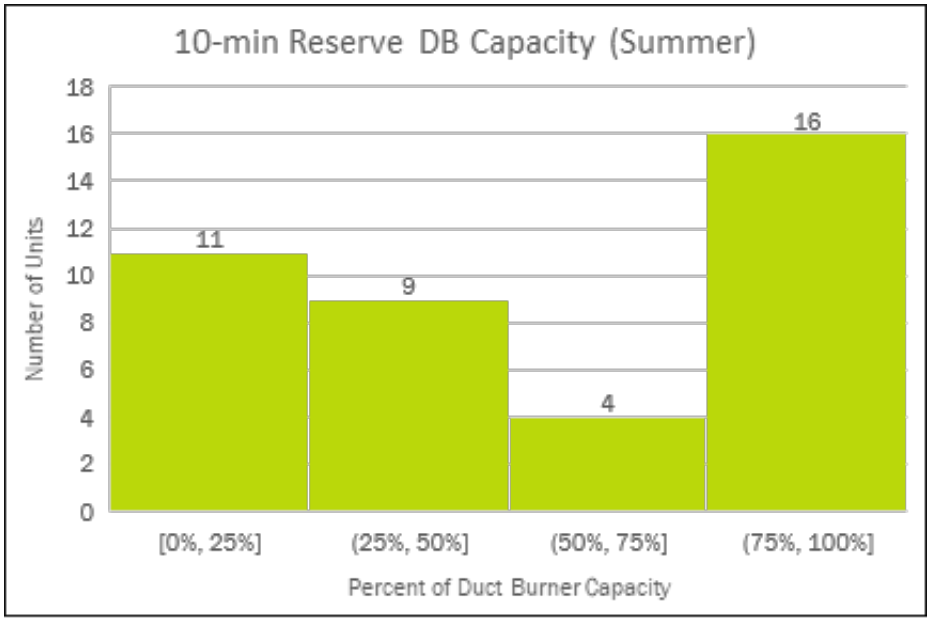
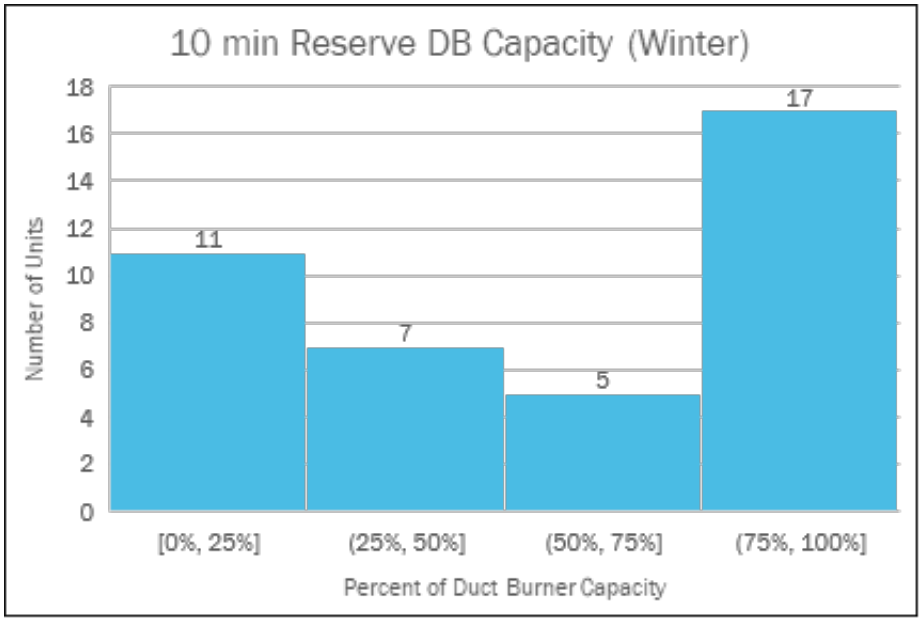
10 Minute Reserve Capacity of CCGT with Duct-Firing Fleet





7 units have no 10-min capability due to DB startup time ≥ 10 mins.
11 units in summer and 12 units in winter have 100% 10-min capability

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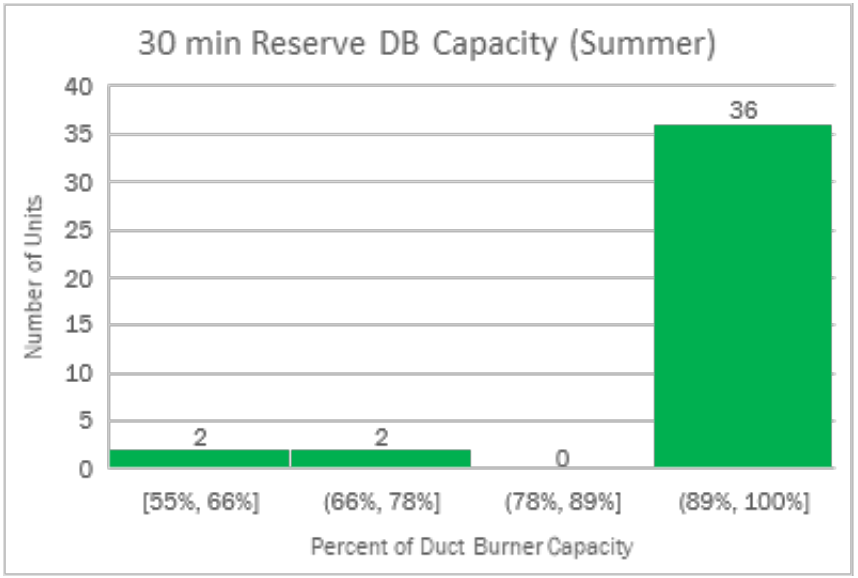
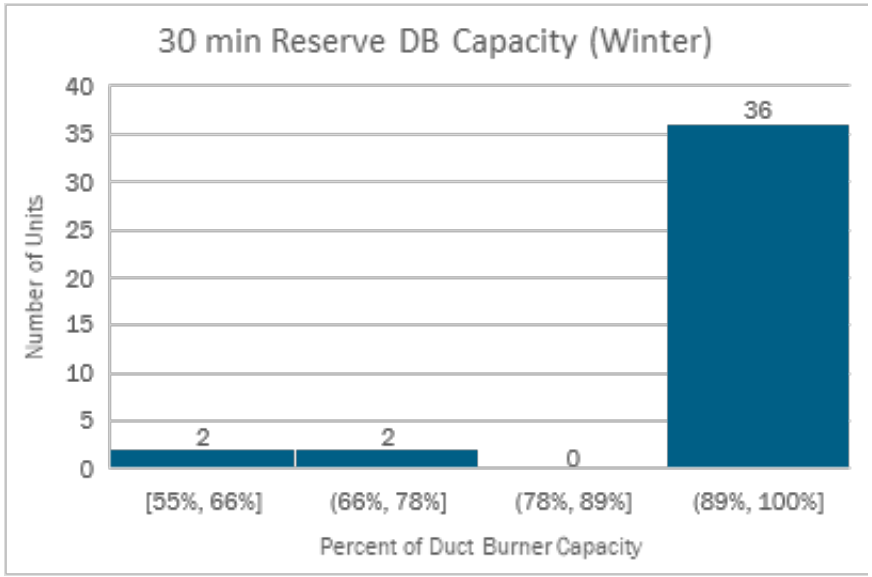
30 Minute Reserve Capacity of CCGT with Duct-Firing Fleet





34 units in summer and 36 units in winter have 100% 30-min capability

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Prototype & Testing Update

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Testing Objectives

- **Accurate to design intent**
  - Verify that 10- and 30-minute spinning reserves are accurately scheduled across multiple ramp rates for units subject to new code (i.e., all units having more than one normal response rate).

- **No harm to other functions**
  - Verify no impact to other units not subject to new code,
  - No impact to the existing scheduling of energy or regulation capacity for any unit, and
  - With exception of different outcomes due to Energy & Reserves/Regulation co-optimization.

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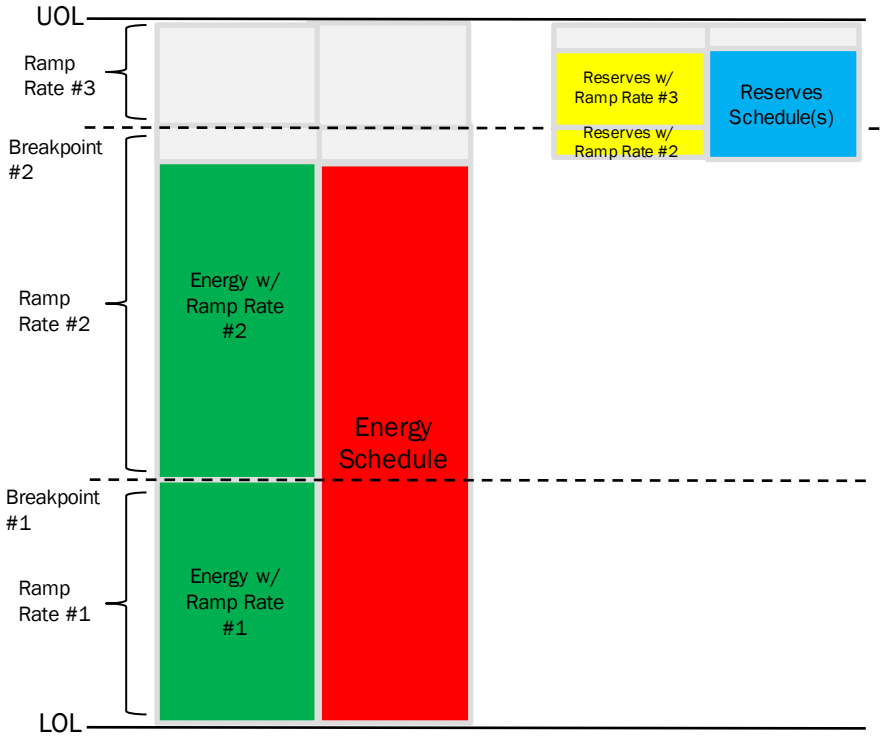
Illustration of multiple ramp rates

Consider the energy and reserves schedule of a generator unit in one interval…

- Both energy (in production today) and reserves are scheduled considering the registered normal ramp rates (configurable up to 3 rates and 2 breakpoints).
- Allocations of 10- and/or 30-minute spinning reserves are sequenced after the energy schedule in this context of ramp rates.
- Where a unit is scheduled for both 10- and 30-minute spinning reserves, 10-minute spinning reserves are sequenced first after energy schedule, followed by incremental MWs for 30-minute spinning reserves.



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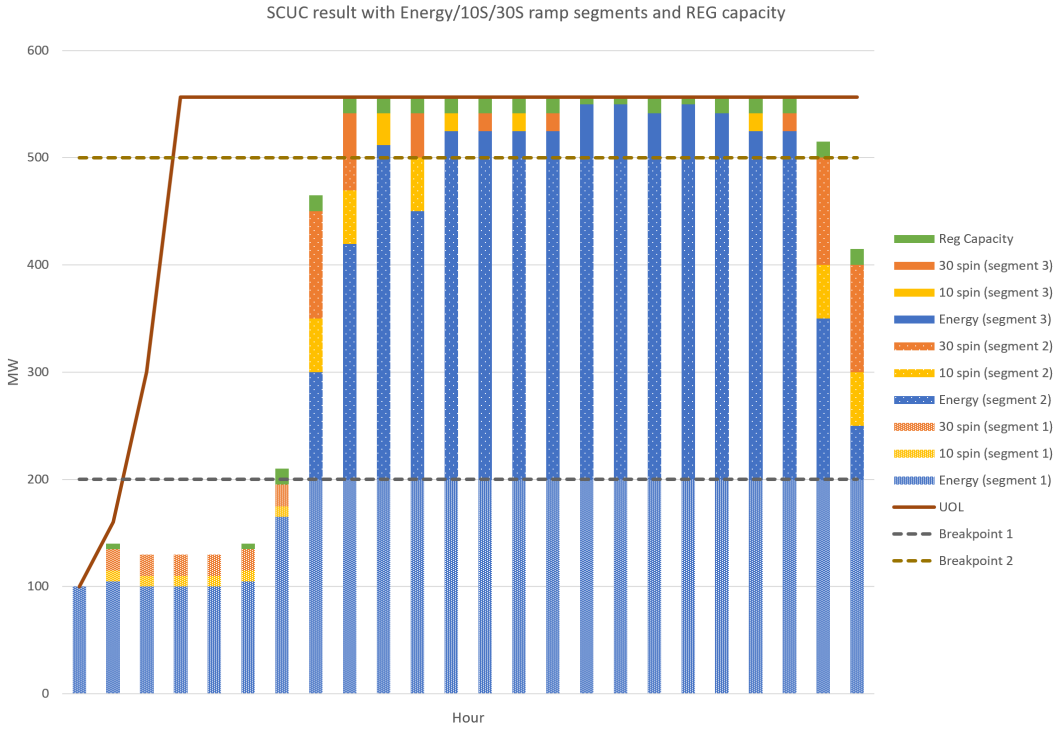
Confirming design intent and No Harm

Many scenarios were run to demonstrate the correctness of the optimization changes.

- This is one such result that illustrates proper allocation and sequence of 10- and 30-minute spin in the context of 3 ramp rate 'segments'.
- 'No harm' to the function of energy and regulation capacity scheduling was also verified. (this functionality was not touched)



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Next Steps

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Next Steps

- **Targeted for the End of October:**
  - Market Design Concept Proposed (ICAPWG/MIWG)
  - Commence prototyping of Limiting Participation

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Our Mission & Vision

Mission

Ensure power system reliability and competitive markets for New York in a clean energy future

Vision

Working together with stakeholders to build the cleanest, most reliable electric system in the nation

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