Dynamic Reserves Examples

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Overview

- This presentation follows up on the examples in the February white paper. The white can be found here: https://www.nyiso.com/documents/20142/26734185/RECA(Dynamic%20Reserves)%20Study%20Report.pdf/27990919-e81b-76a4-12e1-57b9458b553d.
- The design of these examples is to start by illustrating the operation of the current post contingency reserve design for an illustrative load pocket, then to one by one introduce the elements of the dynamic reserve design, illustrating how reserve schedules, prices, and total production costs change as each element of the new design is introduced.

Overview

- The transmission system will be secured for the worst transmission contingency such that:
  - Post transmission contingency flow ≤ Post contingency LTE limit
  - Sufficient 30 minute reserves to restore flows to the normal limit after single contingency

- The transmission system will be secured for the worst generation contingency such that:
  - Post generation contingency flow ≤ Post contingency LTE limit
  - Sufficient 30 minute reserves to restore flows to the normal limit after single contingency

Overview

Multiple Contingencies

- The transmission system will be secured for the worst combined transmission and generation contingency such that:
  - 30 Minute Reserves ≥ Largest Generation Contingency + restore flows to normal limit and restore 10 minute reserves following largest transmission contingency
- The transmission system will be secured for the 2 times the worst generation contingency.
  - 30 Minute Reserves ≥ 2 times largest generator contingency
- The transmission system will be secured for the two worst transmission contingencies.
  - 30 Minute Reserves ≥ restore flows to normal limit and restore 10 minute reserves following 2 largest transmission contingencies.

Which of these will be the binding requirement will vary depending on the transmission and generation configuration for a particular load pocket.

Overview

Dynamic Reserve Design Elements:

- Post generation contingency transmission system flows will be calculated based on the energy output of the resource with the largest output.
- Second contingency reserve requirements will be based on the sum of the output and ancillary service schedules of the resource with the largest total energy and ancillary service schedules.
- Unloaded transmission capacity = Normal Limit – Current flows will count toward 2nd contingency reserve requirements.

Overview

- Base Case (securing to the requirements on slides 3 and 4 with current reserve design)
- Dynamic Generation Outage Reserve Requirement
- Include Unloaded Transmission Capacity in Generation Outage Reserves- no change in unit commitment
- Include Unloaded Transmission Capacity in Generation Outage Reserves – with changes in unit commitment
- Include Unloaded Transmission Capacity in Generation Outage Reserves with redispatch

Assumptions

These assumptions are common to all of the examples

- No losses
- Real-time dispatch (no differences between bid and forecast load, no reserve offer prices)
- NYCA reserves prices = 0
- Six units inside load pocket
  - Three dispatchable units
  - Three off-line gas turbines – meet part of 30 minute reserve requirement
  - No intermittent resources within the load pocket

#1: Base Case - Current Design Static Requirements

Post Transmission Contingency Flows on Line A = 150MW = 150MW Post Transmission Contingency LTE Limit

Post Generation Contingency Flows on Lines A and B = 350 MW = 150MW + 200MW = 350 MW Post Generation Contingency LTE Limit

Transmission outage 30 minute reserves = Post Transmission Contingency Flows – Normal Limit = 150MW – 100MW = 50 MW

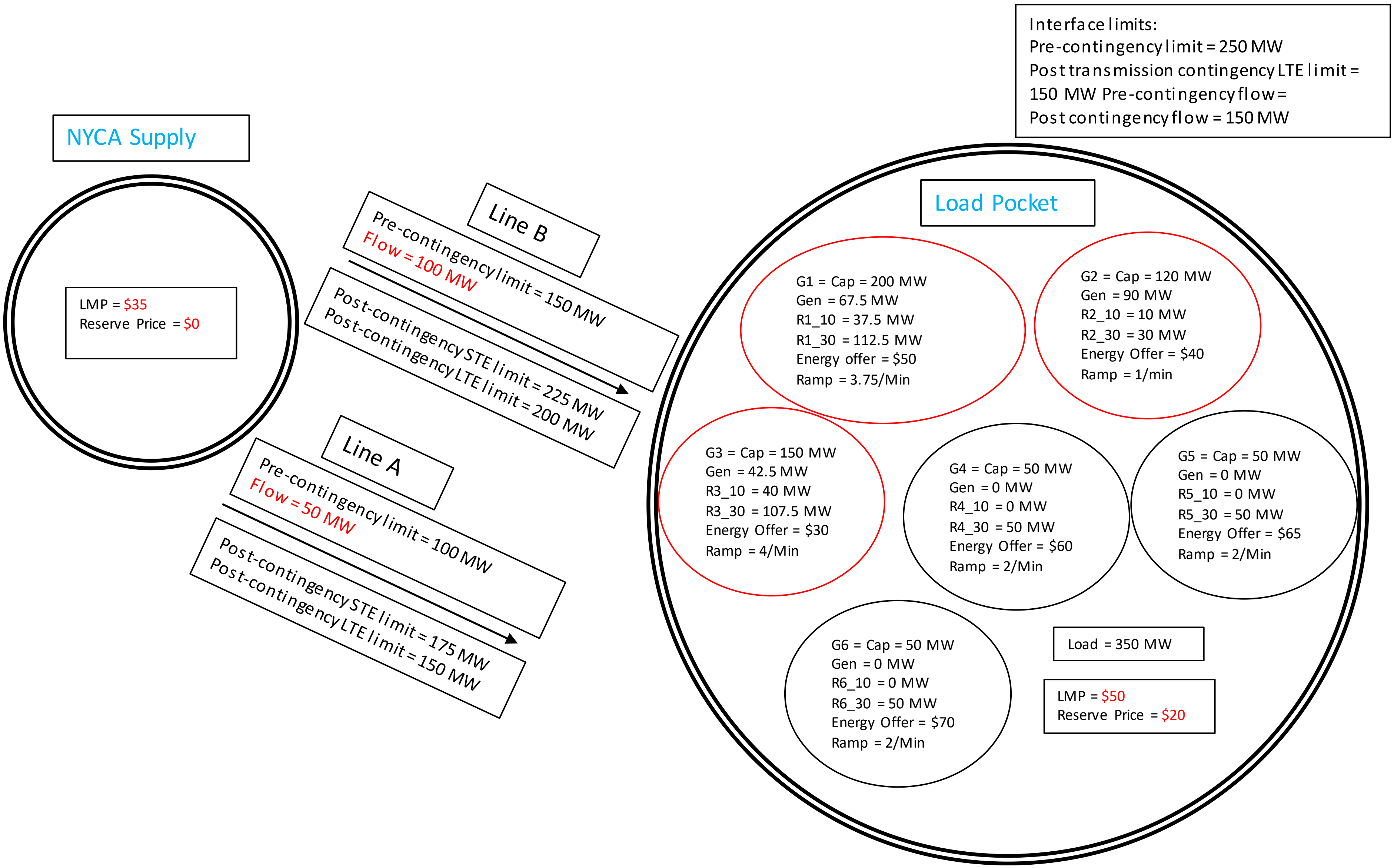
Generation outage 30 minute reserves = Post Generation Contingency Flows - Normal Limit = 350MW – 250MW = 100 MW

Worst double contingency is generation outages

30 minute reserves based on 2x capacity of largest on-line generator (G1) = 400 MW

- Reserves for loss of largest two transmission elements = 150MW
- Reserves for transmission and generation contingency = 350MW (150 + 200)

#1: Base Case Example



#1: Base Case - Current Design Static Requirements

Load Pocket Outcomes

- Energy Price $50/MWh [incremental load met by G1 at $50/MWh]
- Total 10 minute spin = 87.5 MW; requirement = 0 MW [shadow price =0]
- Total 30 Minute reserves = 400 MW; requirement = 400 MW
- 10 and 30 minute reserve price = $20/MWh
  - Cost of incremental 30 minute reserves = cost of dispatching G1 up ($50) and G3 down ($30) = $50 -$30 = $20/MWh
- Total generation = 200 MW
- Total production cost (including import supply) = $13,800
- Total Generator uplift = $0

#2: Dynamic Generator Reserve Requirement

Post Transmission Contingency Flows on Line A = 150 MW = 150 MW Post Transmission Contingency LTE Limit

Post Generation Contingency Flows Lines A and B = 292.5 MW =(150MW +142.5MW) < 350 MW Post Generation Contingency LTE Limit

Transmission outage 30 minute reserves = Post Transmission Contingency Flows – Normal Limit = 150MW – 100MW = 50MW

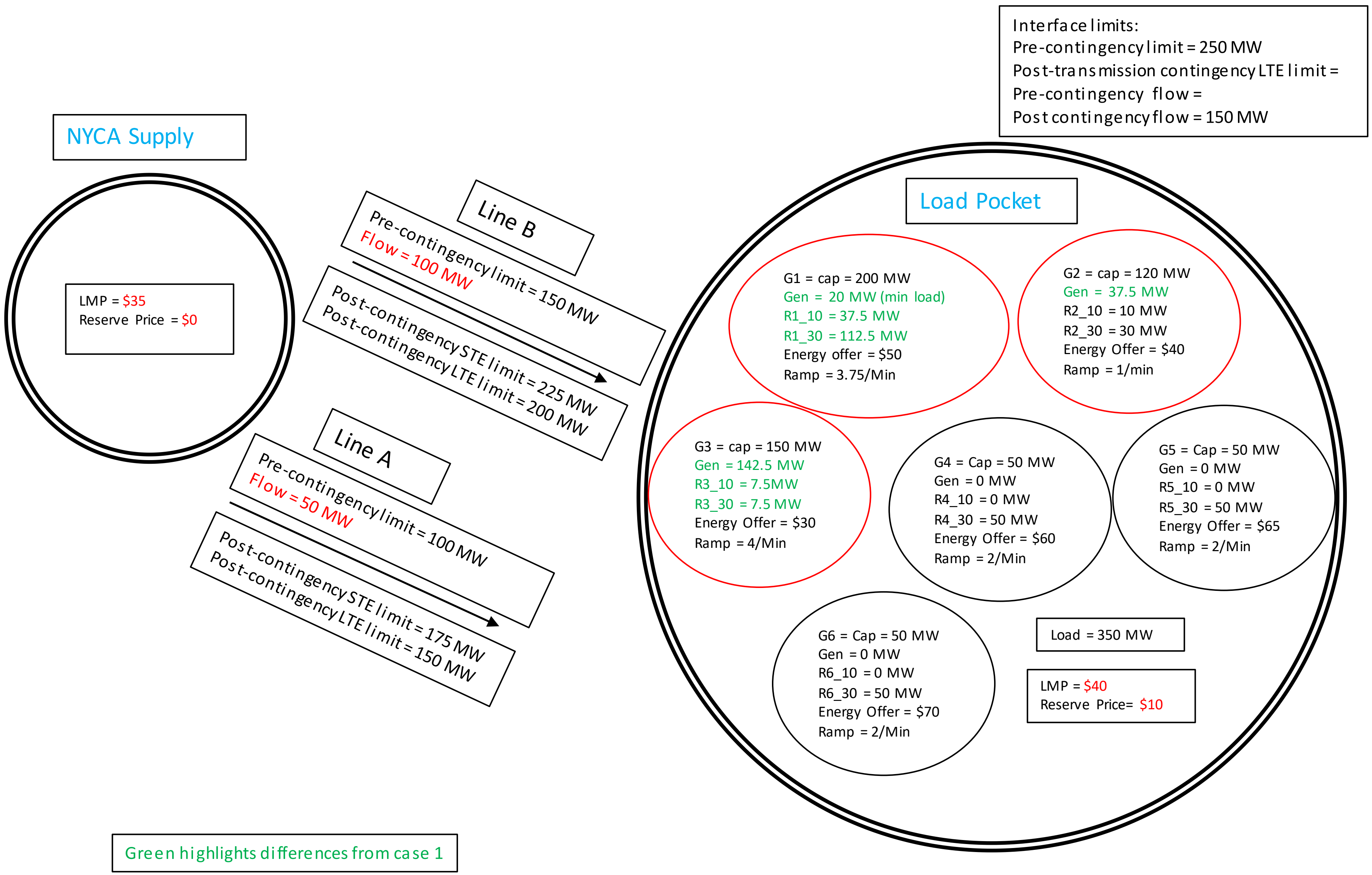
Generation outage 30 minute reserves = Post Generation Contingency Flows - Normal Limit = 292.5MW – 250MW = 42.5MW

Worst double contingencies are double generation outages and transmission and generation outage

30 minute reserves based on 2x generation output and reserves of on-line generator with largest schedules (G3) = 300 MW

- Reserves for loss of largest two transmission elements = 150MW
- Reserves for transmission and generation outage = 300MW = 150MW + 150MW

#2: Dynamic Generation Outage Reserves



#2: Dynamic Generator Reserve Requirement

Load Pocket Outcomes

- Energy Price $40 –[Incremental load met by G2 at $40/MWh]
- Total 10 minute spin = 55 MW; requirement = 0 MW [shadow price =0]
- Total 30 minute reserves = 300MW; requirement = 300 MW
- 10 and 30 minute reserve price = $10
- Cost of incremental reserves = cost of dispatching G2 up ($40) and G3 down ($30) = $40 - $30 = $10
- Total generation = 200 MW
- Total production cost (including import supply) = $12,325 (compared to $13,800 base case)
- Total Generator Uplift = $0

#3: Dynamic Generator Outage Reserves with Reserves Provided by Unloaded Transmission – Fixed Commitment

Post Transmission Contingency Flows on Line A = 150MW = 150MW Post Transmission Contingency LTE Limit

Post Generation Contingency Flows Lines A and B = 300 MW = 150MW+150MW < 350 MW Post Generation Contingency LTE Limit

Transmission outage 30 minute reserves = Post Transmission Contingency Flows – Normal Limit = 150MW – 100MW = 50MW

Generation outage 30 minute reserves = Post Generation Contingency Flows - Normal Limit = 300MW – 250MW = 50MW

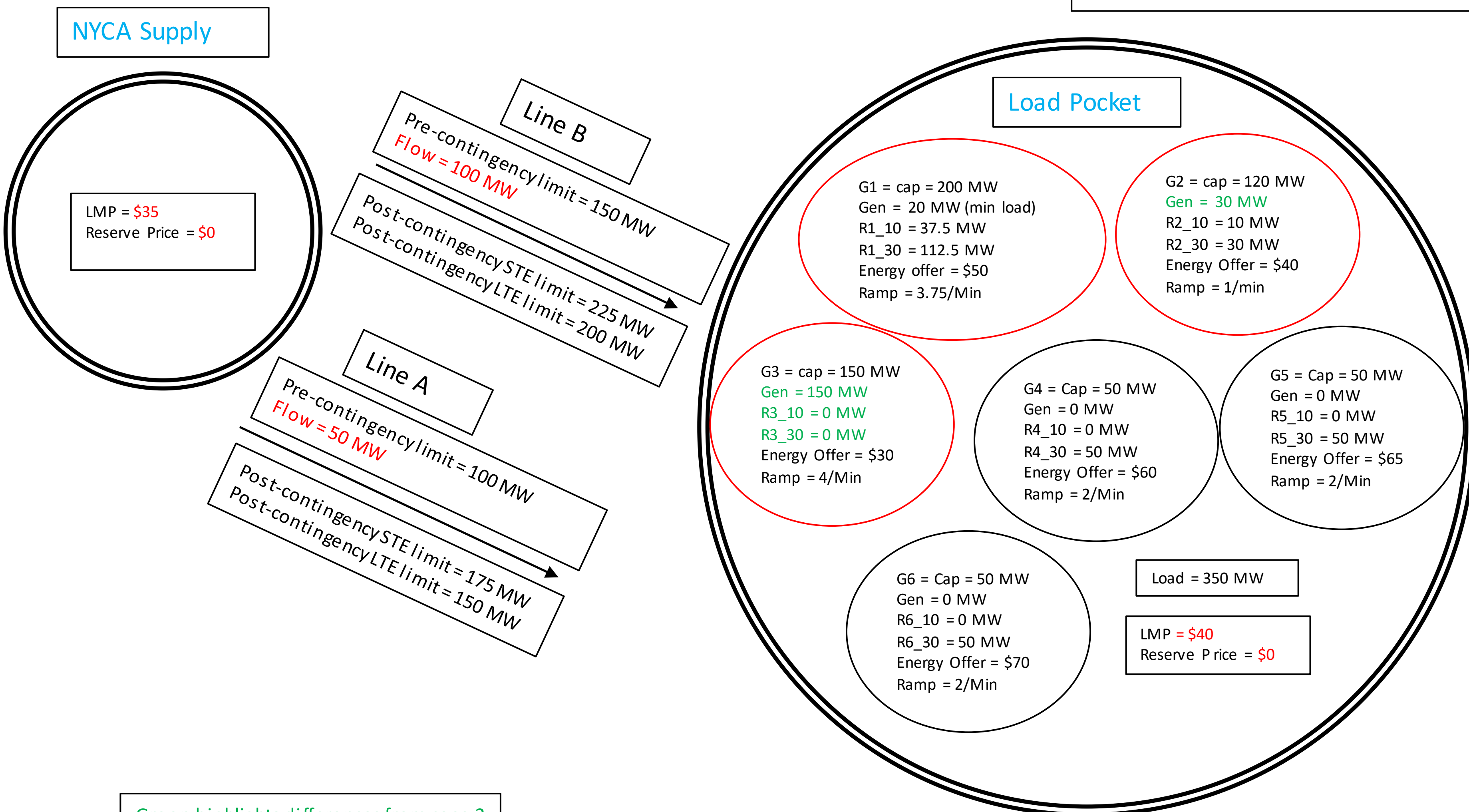
Worst double contingencies are double generation outages and transmission and generation outages

30 minute reserves based on 2x generation output and reserves of on-line generator with largest schedules (G3) less unloaded transmission = 300 MW-100MW = 200 MW

- Reserves for loss of largest two transmission elements = 150MW
- Reserves for transmission and generation outages = 200MW = 150MW + 150MW - 100 unloaded transmission

#3: Dynamic Generation Outage Reserves Including Unloaded Transmission – Fixed Commitment

Interface limits:
Pre-contingency limit = 250 MW
Post Transmission contingency LTE limit = Pre-contingency flow = Post contingency flow = 150 MW



Green highlights differences from case 2

#3: Dynamic Generation Outage Reserves with reserves provided by Unloaded Transmission - Fixed Commitment

Load Pocket

- Energy Price $40/MWh (incremental load met by G2 at $40/MWh)
- Total 10 minute spin = 47.5 MW; requirement = 0MW [shadow price = 0]
- Total 30 minute Reserves = 292.5 MW; requirement = 200 [shadow price = 0]
- 10 and 30 minute reserve price = $0 (more than required reserves available at 0 cost)
- Total Generation = 200 MW
- Total production cost (including import supply) = $12,250 (compared to $12,325 in case 2)
- Total Generator Uplift = $400 (compared to 0 in case 2)

#4: Dynamic Generator Outage Reserves with Reserves Provided by Unloaded Transmission - Optimal Commitment

Post Transmission Contingency Flows on Line A = 150MW = 150MW Post Transmission Contingency LTE Limit

Post Generation Contingency Flows Lines A and B = 280MW = 150MW+130MW < 300 MW Post Generation Contingency LTE Limit

Transmission outage 30 minute reserves = Post Transmission Contingency Flows – Normal Limit = 150MW – 100MW = 50MW

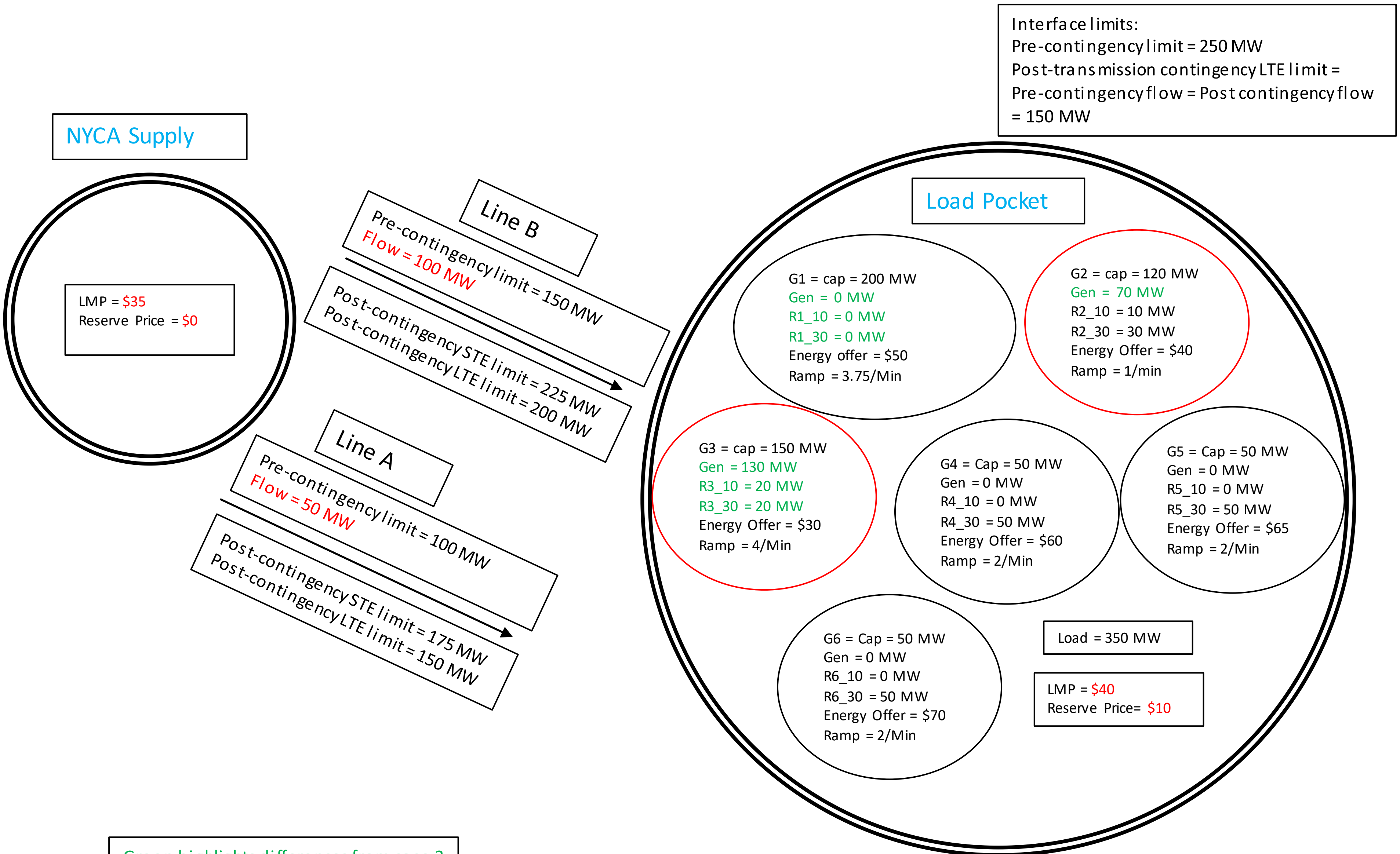
Generation outage 30 minute reserves = Post Generation Contingency Flows - Post Generation Contingency LTE Limit = 280 MW – 250MW = 30MW

Worst double contingencies are double generation outages and transmission and generation outages

30 minute reserves based on 2x generation output and reserves of on-line generator with largest schedules (G3) less unloaded transmission = 300MW -100MW = 200 MW

- Reserves for loss of largest two transmission elements = 150MW
- Reserves for generation and transmission outage = 200MW =150MW +150MW – 100MW unloaded transmission

#4: Dynamic Generation Reserves including Unloaded Transmission – Optimal Commitment



Green highlights differences from case 3

#4: Dynamic Generation Outage Reserves- Including Unloaded Transmission - Optimal Commitment

Load Pocket

- Energy Price $40/MWh (incremental cost of meeting load with G2 at $40/MWh)
- 10 Minute spin = 30 MW; requirement = 0 MW [shadow price = 0]
- 30 minute reserves = 200 MW; requirement = 200 MW
- 10 and 30 minute reserve price = $10
  - Cost of incremental reserves = cost of dispatching G2 up ($40) and G3 down ($30) = $40 -$30 = $10
- Generation = 200 MW
- Total production cost (including import supply) = $12,150 (compared to $12,250 case 3)
- Total Generator Uplift = $0 (compared to $400 case 3)

#5: Dynamic Generator Outage Reserves Reserve Requirement- with Optimal Redispatch

Post Transmission Contingency Flows on Line A = 130MW < 150MW Post Transmission Contingency LTE Limit

Post Generation Contingency Flows Lines A and B = 280 MW = 130MW + 150MW < 300MW Post Generator Contingency LTE Limit

Transmission outage 30 minute reserves = Post Transmission Contingency Flows – Post Transmission Contingency LTE Limit = 130MW – 100MW = 30MW

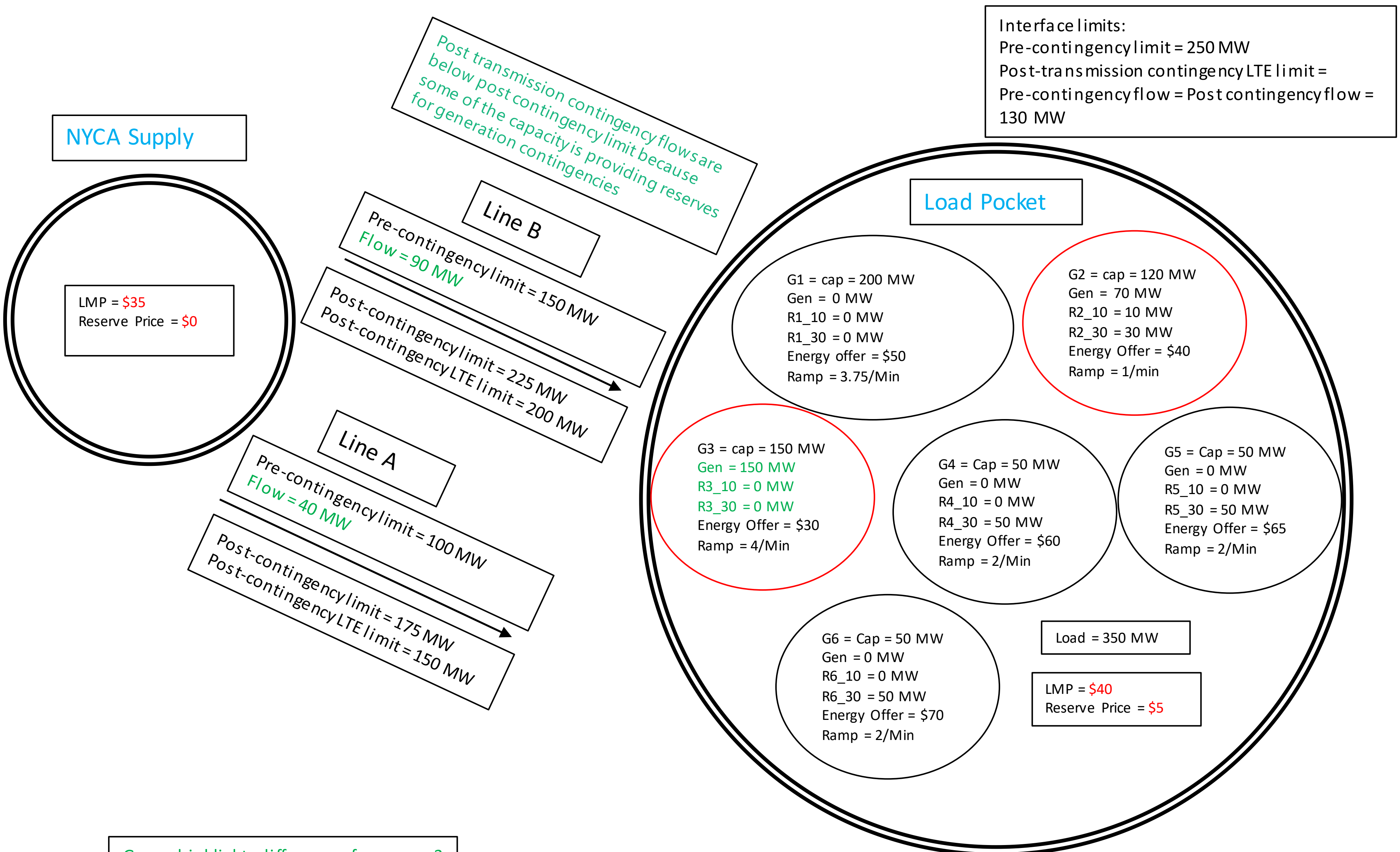
Generation outage 30 minute reserves = Post Generation Contingency Flows - Post Generation Contingency LTE Limit = 280MW – 250MW = 30MW

Worst double contingencies are double generation outages and transmission and generation outages

30 minute reserves based on 2x generation output and reserves of on-line generator with largest schedules (G3) – unloaded transmission = 300MW -120MW = 180 MW

- Reserves for loss of largest two transmission elements = 150MW
- Reserves for generation and transmission outage = 180MW =130MW +150MW – 100MW unloaded transmission

#5: Dynamic Generation Reserves Including Unloaded Transmission – with Optimal Redispatch



Green highlights differences from case 3

Dynamic Generation Outage Reserves- Including Unloaded Transmission- with Optimal Redispatch

Load Pocket

- Energy Price $40
- Total 10 minute spin = 10 MW; requirement = 0MW [shadow price = 0]
- Total 30 Minute reserves = 180 MW; requirement = 180 MW
- 10 and 30 minute reserve price = $5 (shadow price of reserves in load pocket)
  - Cost of incremental reserves = cost of dispatching G2 up (+$40/MW) and reducing imports (-$35/MW)
- Total Generation = 220 MW
- Total production cost (including import supply) = $12,050 (compared to $12,150 case 4)
- Total Generation Uplift = $0 (compared to $0 in case 4)

Summary

	Energy Price	10-Minute Reserve Price	30-Minute Reserve Price	Total Production Cost	Uplift
Base Case (Status quo)	$50	$20	$20	$13,800	$0
Dynamic Generator Requirement	$40	$10	$10	$12,325	$0
Unloaded Capacity Provides Reserves - Fixed Unit Commitment	$40	$0	$0	$12,250	$400
Unloaded Capacity Provides Reserves - Optimal Unit Commitment	$40	$10	$10	$12,150	$0
Unloaded Capacity Provides Reserves with Optimal Redispatch	$40	$5	$5	$12,050	$0

Next Steps

- Intermittent resources within the load pocket
- DAM model and TCC revenue adequacy case (bid load = load forecast, non-zero reserve offer prices)
- DAM model with bid load < load forecast, with simultaneous clearing of bid and forecast load
- Others???