New York ISO

LBMP:
Three Components Summary

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LBMP In-Depth Course

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Rensselaer, NY

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Session Objectives

- Upon completion of this module, trainees will be able to:
  - Explain how the marginal costs of Energy, Loss and Congestion are calculated in an unconstrained/constrained system using a two-bus model
  - Describe the role of shift factors in determining LBMP in an unconstrained system using a three-bus model
  - Determine how LBMP is established through co-optimization of Energy, Operating Reserves, and Regulation Service using a two-bus model
  - State how gen parameters (Ramp UP/DOWN rate) are factored into determining LBMP

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Outline

- Example 1: Unconstrained system
  - No losses and no congestion
- Example 2: Unconstrained system
  - With losses and no congestion
- Example 3: Constrained system
  - No losses and with congestion
- Examples 4 & 5: 3-bus model, Unconstrained system
  - No losses and no congestion
- Example 6: Co-optimization of Energy and Ancillary Services
  - No losses and no congestion
- Example 7: Understanding Ramp UP/DOWN rate; Unconstrained system
  - No losses and no congestion

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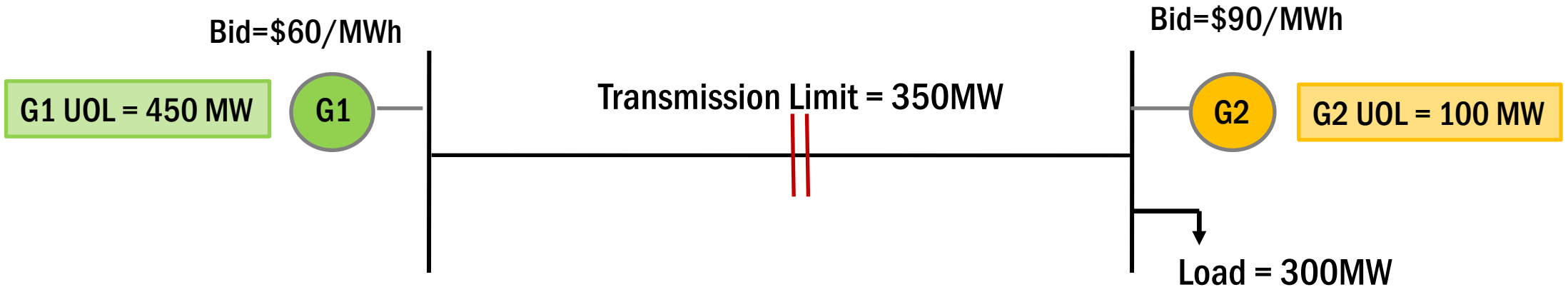
Example 1: Unconstrained System (No Loss & No Congestion)



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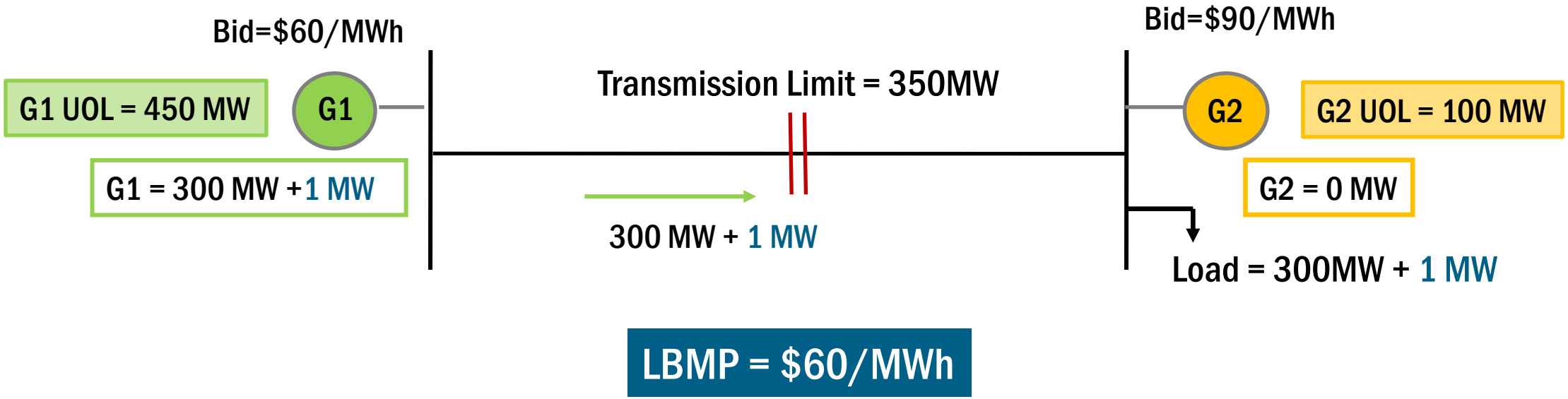

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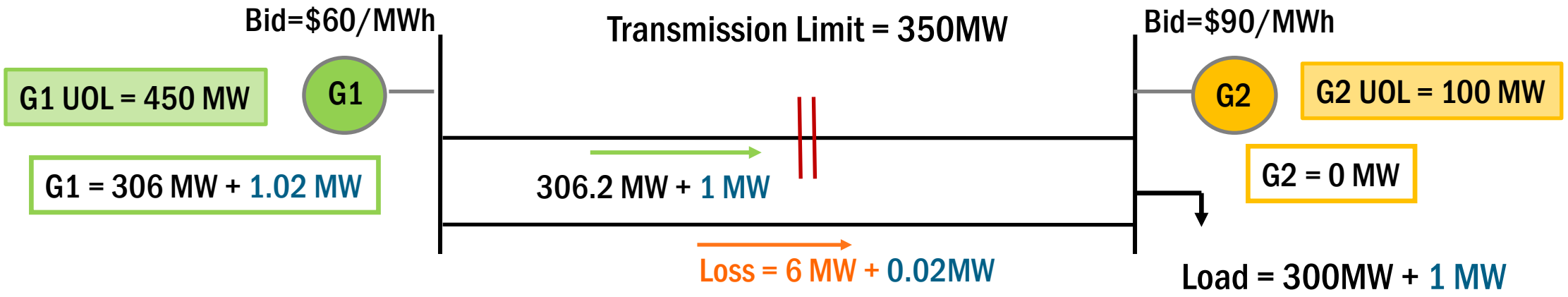
Example 2: Unconstrained System (With Loss & No Congestion)



Here Physical loss associated with transmission of 300 MW is 6MW

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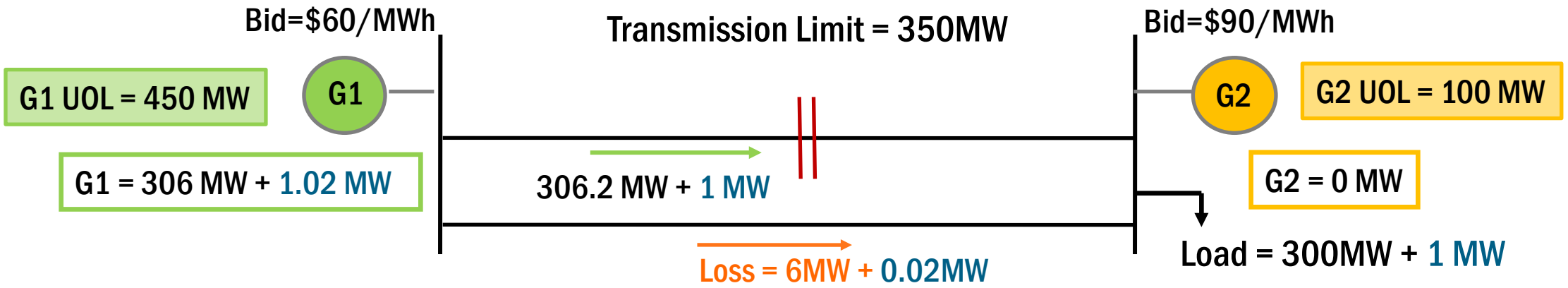

LBMP = $61.20/MWh

Energy=$60, Cong=$0, Loss=$1.20
LBMP=$61.20

Loss = .02 MW * 60 $/MW =$1.20

Here Physical loss associated with transmission of 300 MW is 6MW

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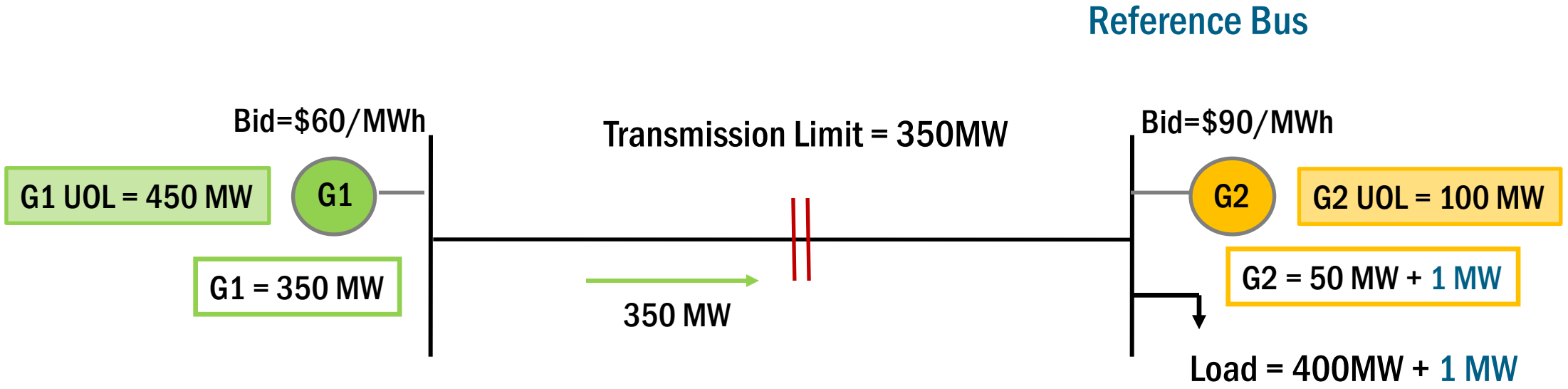
Example 3: Constrained System (No Loss & With Congestion)



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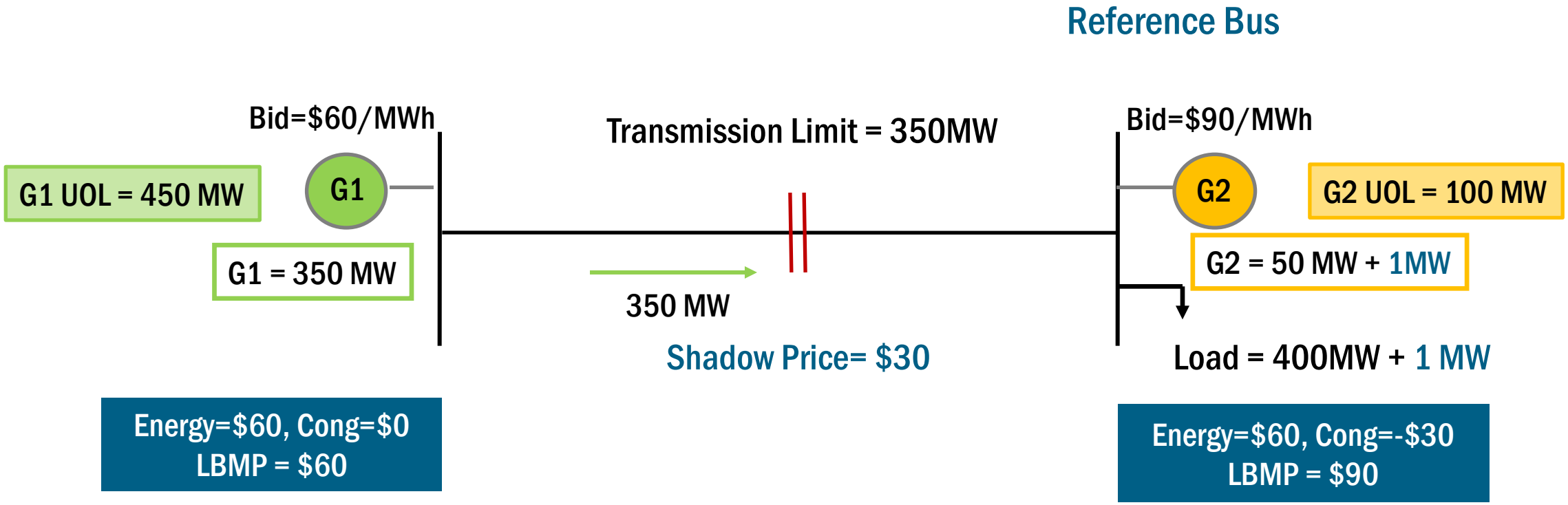

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Example 4: Unconstrained System (No Loss & No Congestion), 3-bus system

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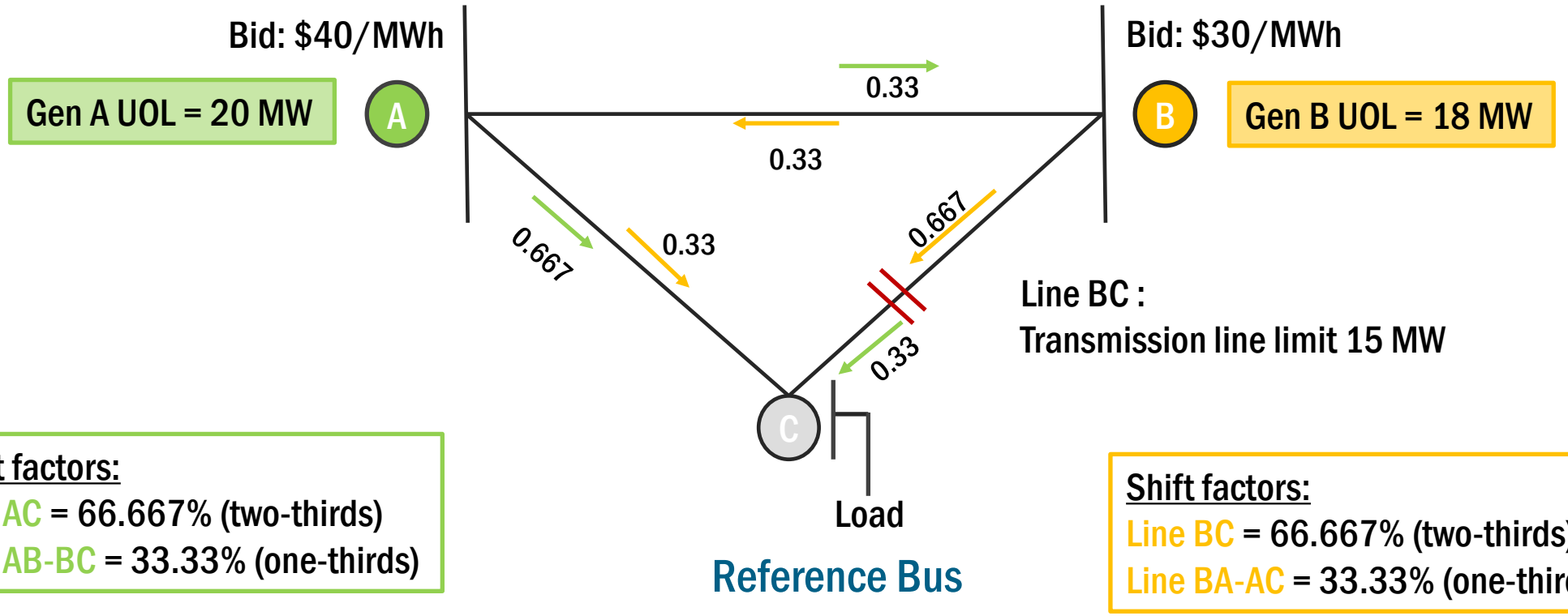
System



Shift factors:
Line AC = 66.667% (two-thirds)
Line AB-BC = 33.33% (one-thirds)

Shift factors:
Line BC = 66.667% (two-thirds)
Line BA-AC = 33.33% (one-thirds)

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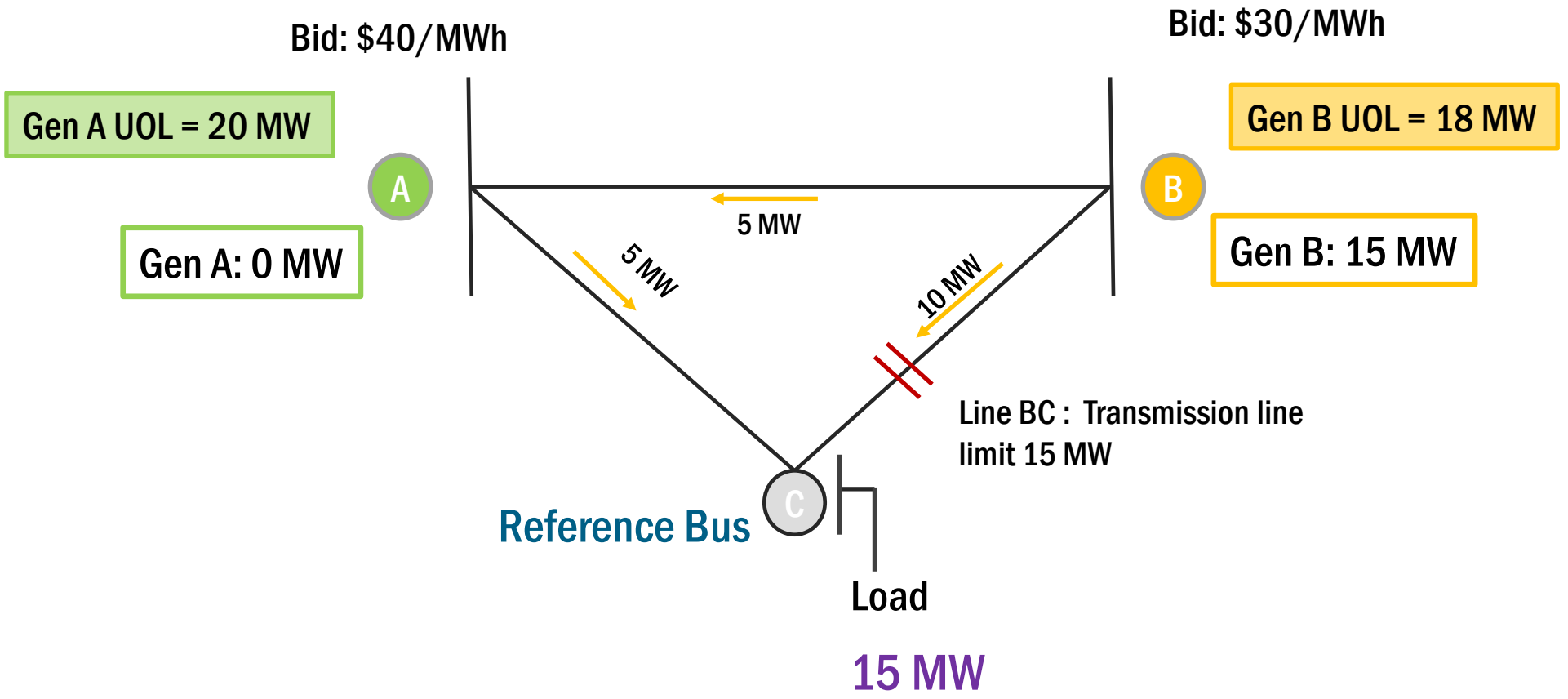
Example 4: Unconstrained System (No Loss & No Congestion), 3-bus system



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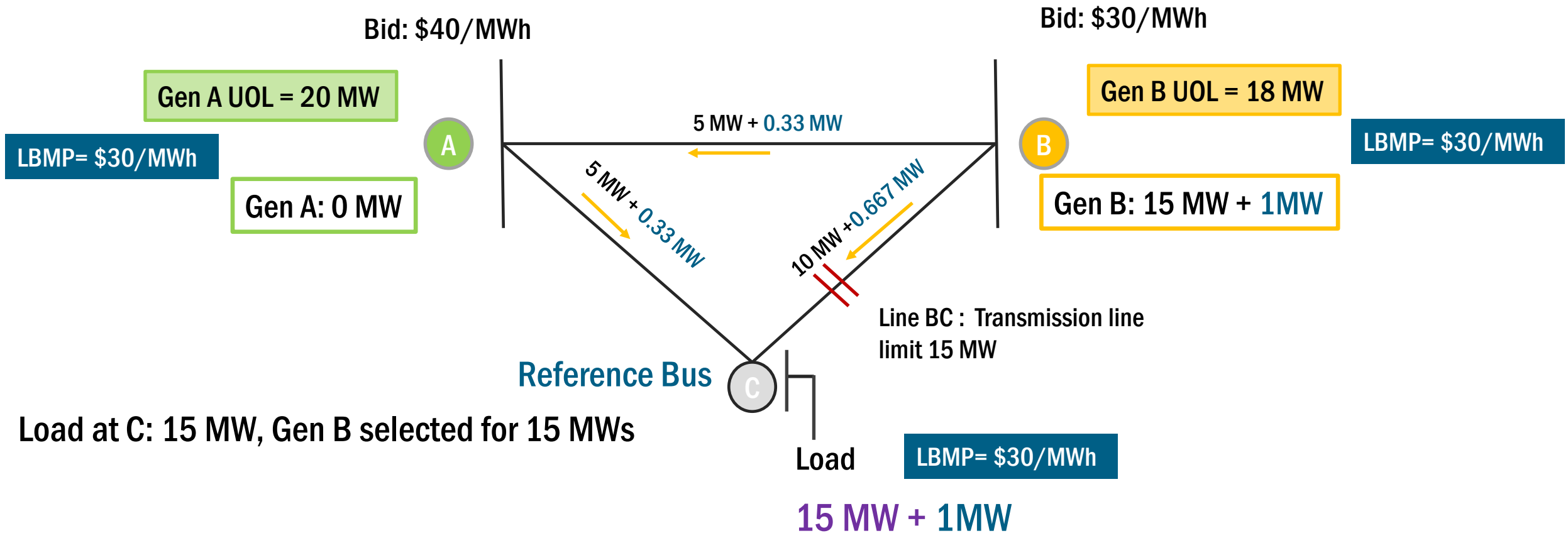
Example 4: Unconstrained System (No Loss & No Congestion), 3-bus system



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Example 5: Unconstrained System (No Loss & No Congestion)

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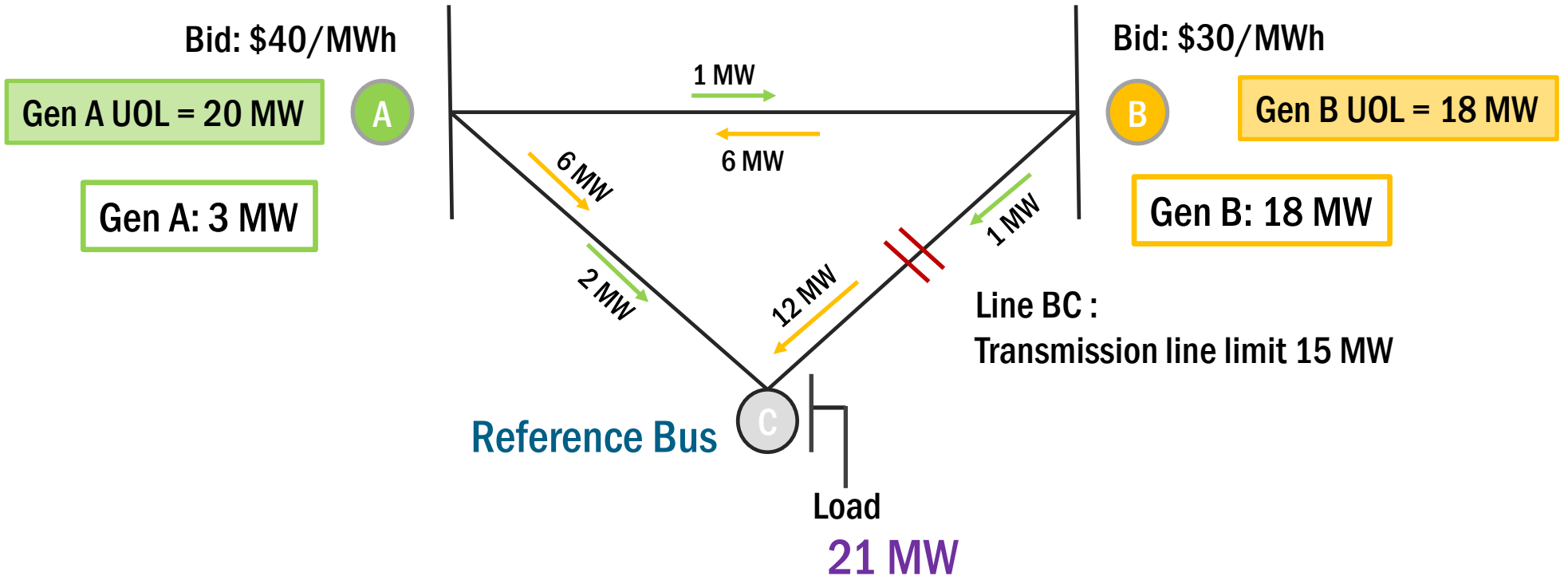
LOAD INCREASES TO 21 MW



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Example 5: Unconstrained System (No Loss & No Congestion)

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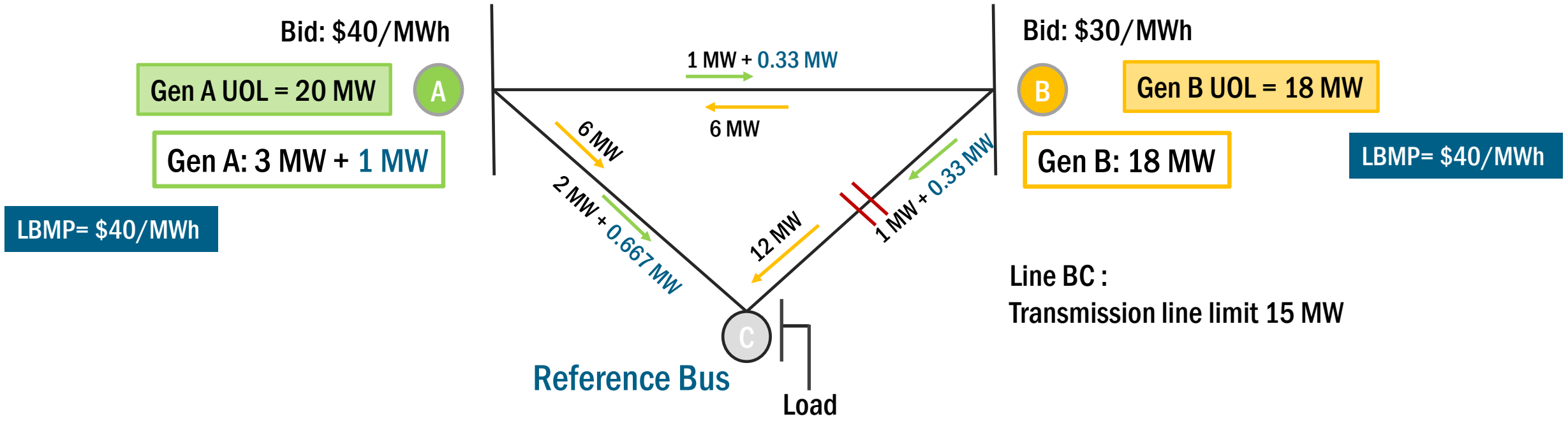
LOAD INCREASES TO 21 MW



Load at C: 21 MW, Gen B selected for 18 MWs, Gen A selected for 3 MWs

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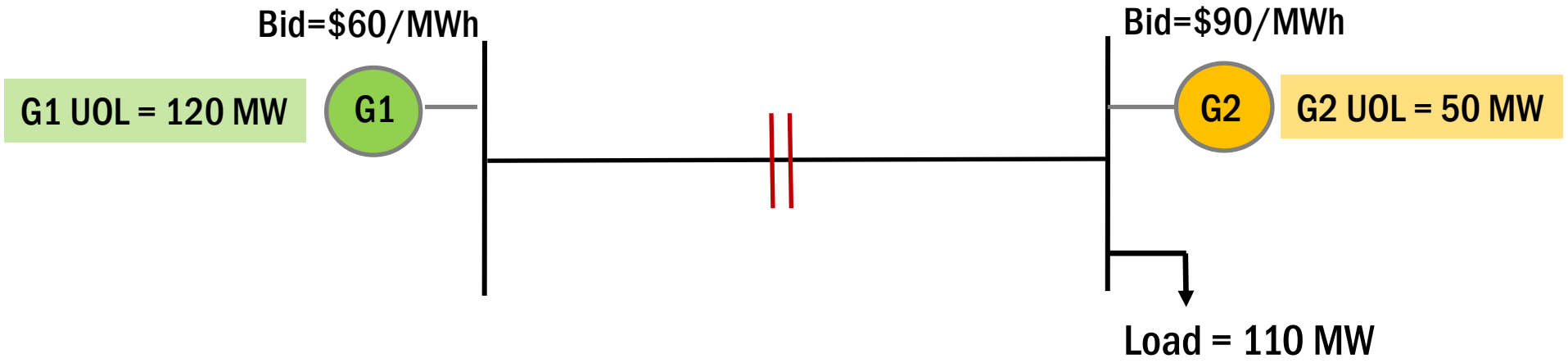
Example 6: Co-optimization Energy & Spinning Reserve (No Loss & No Congestion)



Solution with only Energy, no Spinning Reserves

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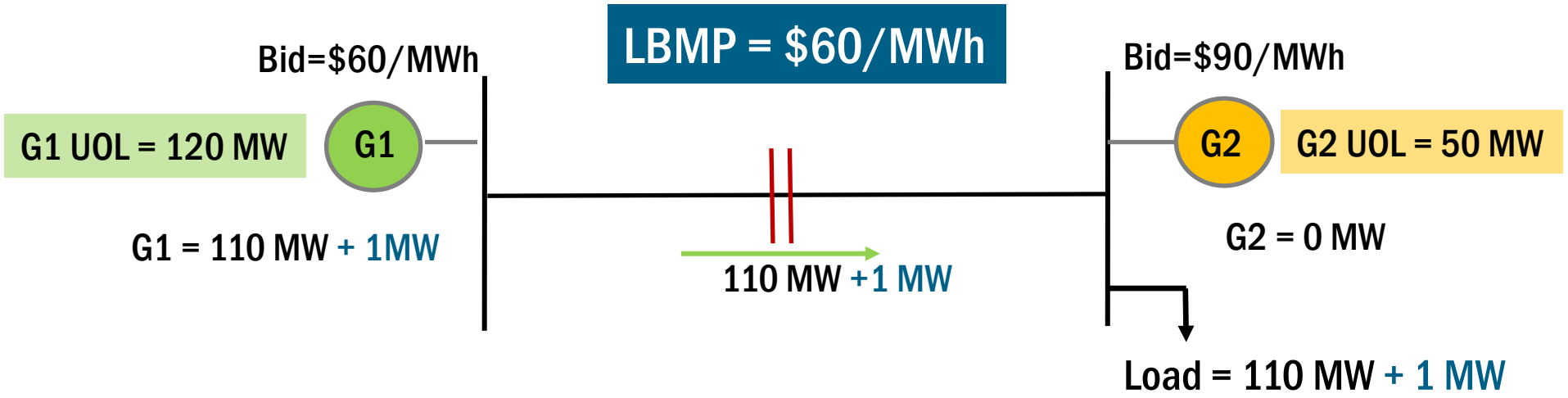

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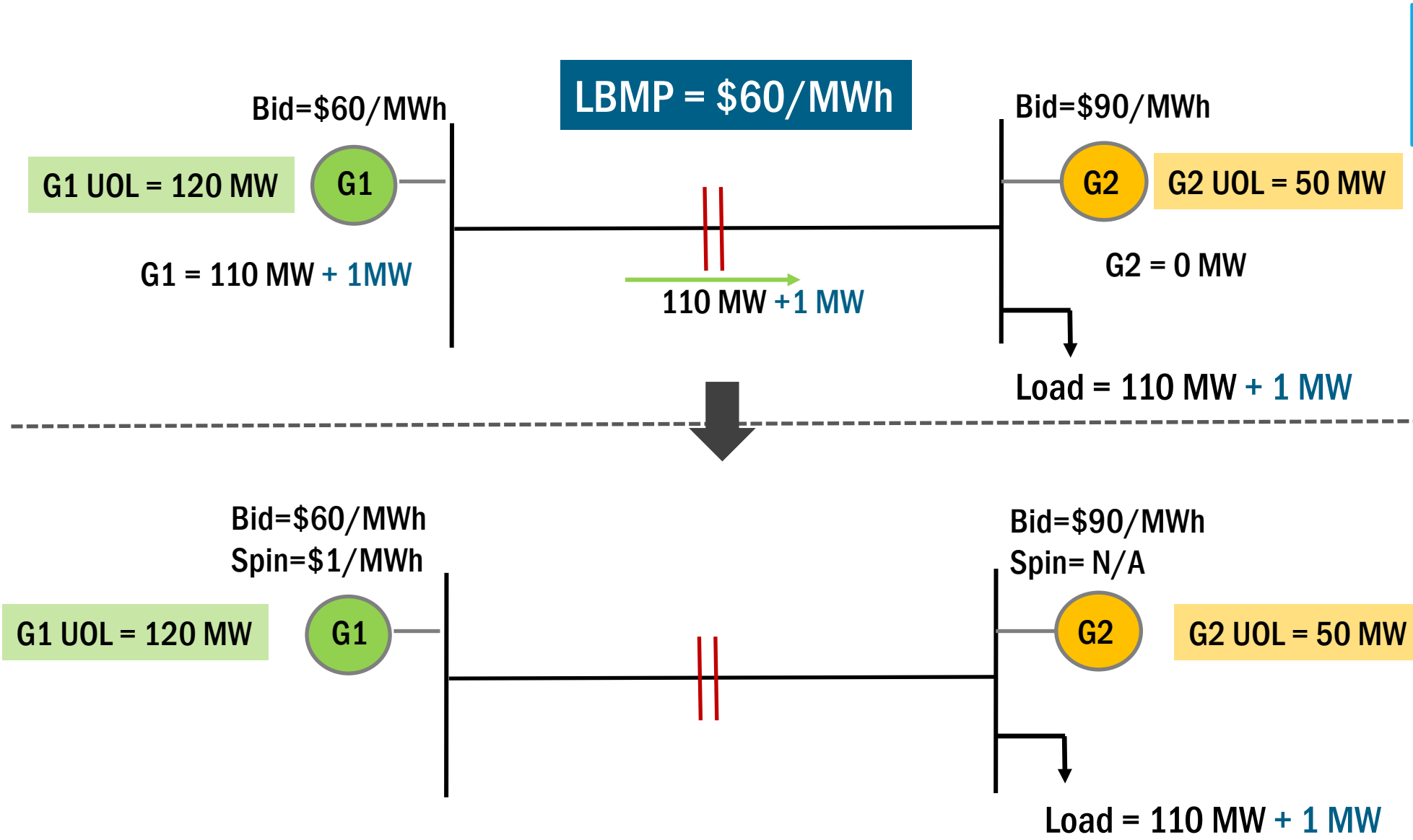

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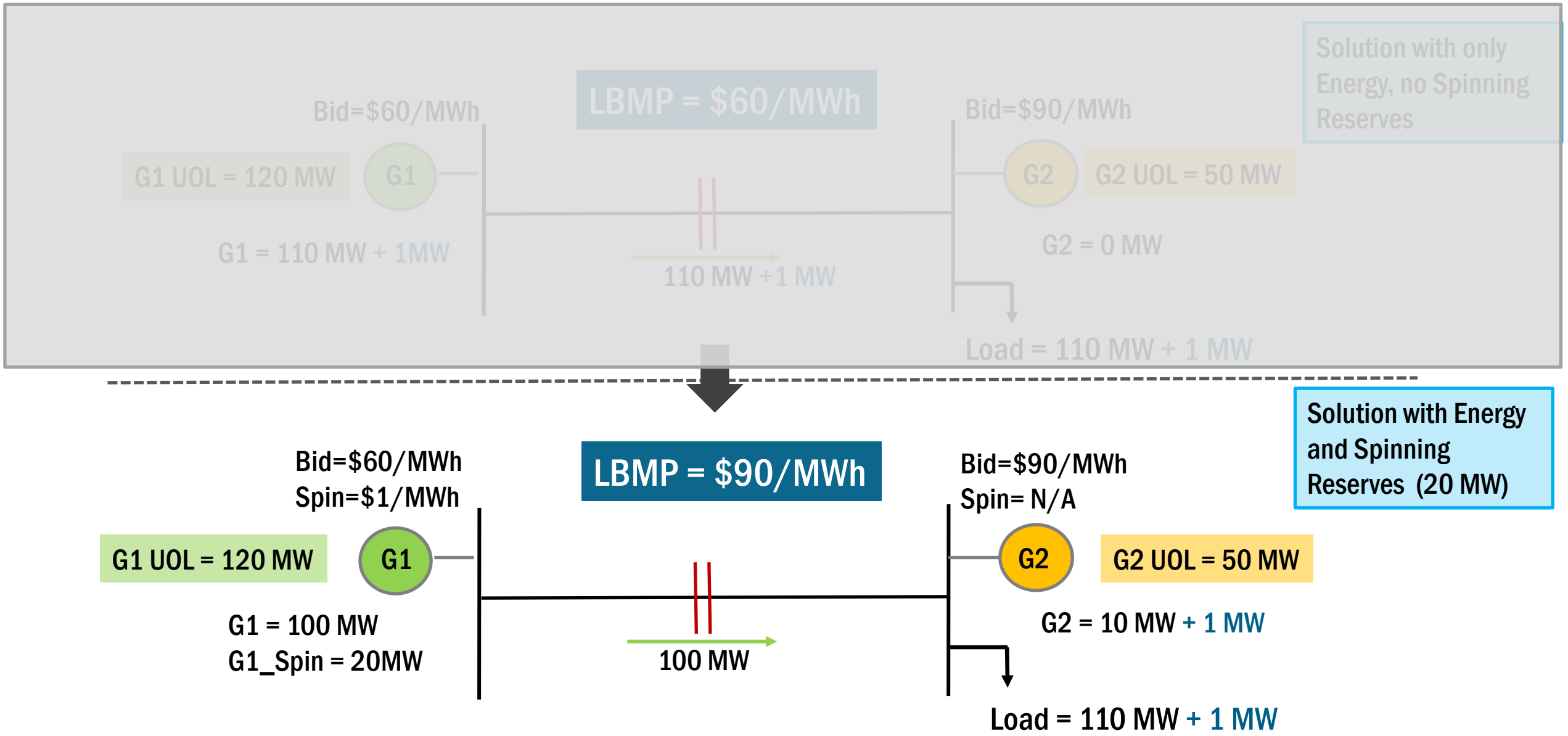

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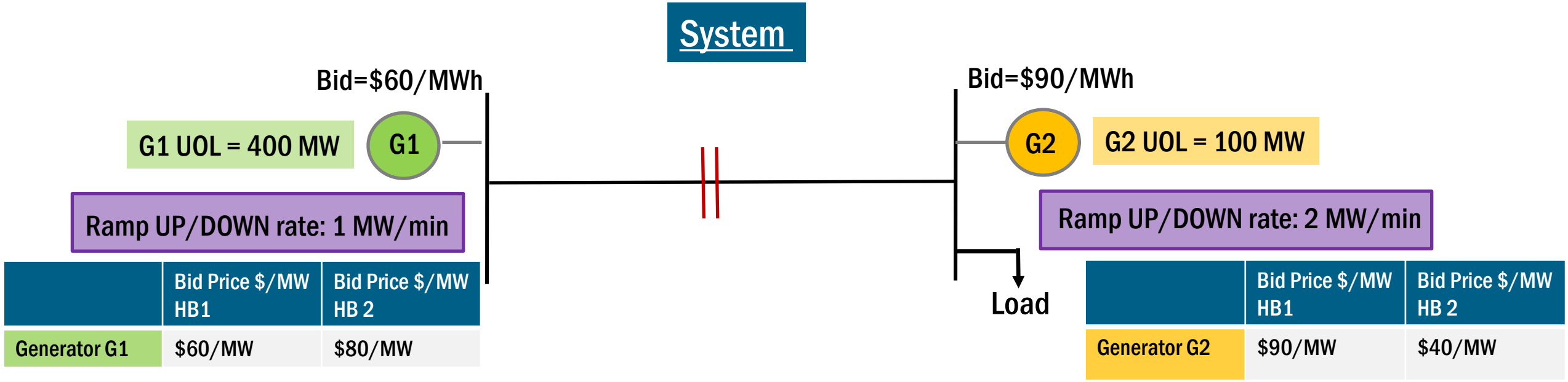
Example 7: Understanding Ramp UP/DOWN Rate; Unconstrained System (No Loss & No Congestion)



	Bid Price $/MW HB1	Bid Price $/MW HB 2
Generator G1	$60/MW	$80/MW

	Bid Price $/MW HB1	Bid Price $/MW HB 2
Generator G2	$90/MW	$40/MW

Load:
t = 312 MW
t+15 = 354 MW

Dispatch solution for timesteps t and t+15:

Solution for timestep t uses the Bid prices from HB 1
Solution from timestep t+15 uses the Bid prices from HB 2

Initial Metering:
G1 = 300 MW
G2 = 0 MW

Initial metering is the MW level the generators are at time of software execution to determine the dispatch solution

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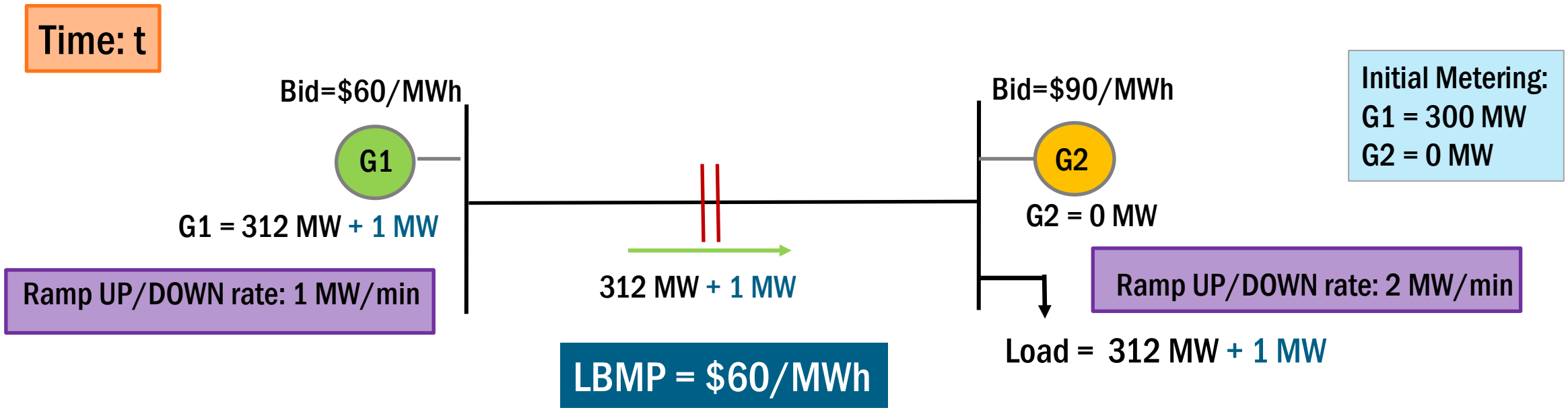
Example 7: Single-Period Dispatch (No Loss & No Congestion)



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Example 7: Single-Period Dispatch (No Loss & No Congestion)

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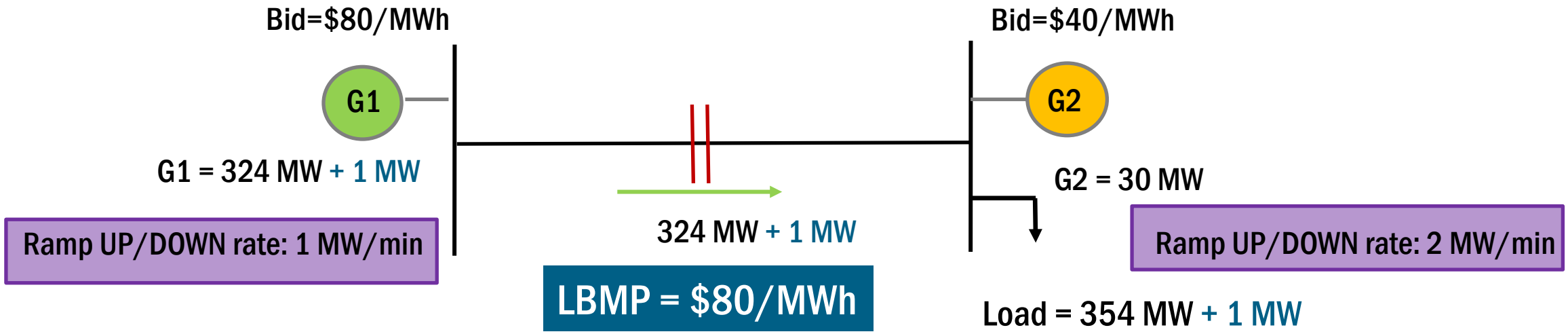
Initial Metering:
G1 = 312 MW
G2 = 0 MW

Time: t+15min



- For timestep t+15, G2 is the cheaper generator, and therefore chosen first
- G2 will be committed for 30 MW (2 MW/min x15 min), because Ramp UP/DOWN rate for G2 = 2 MW/min

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