Day-Ahead Market Enhancements discussion

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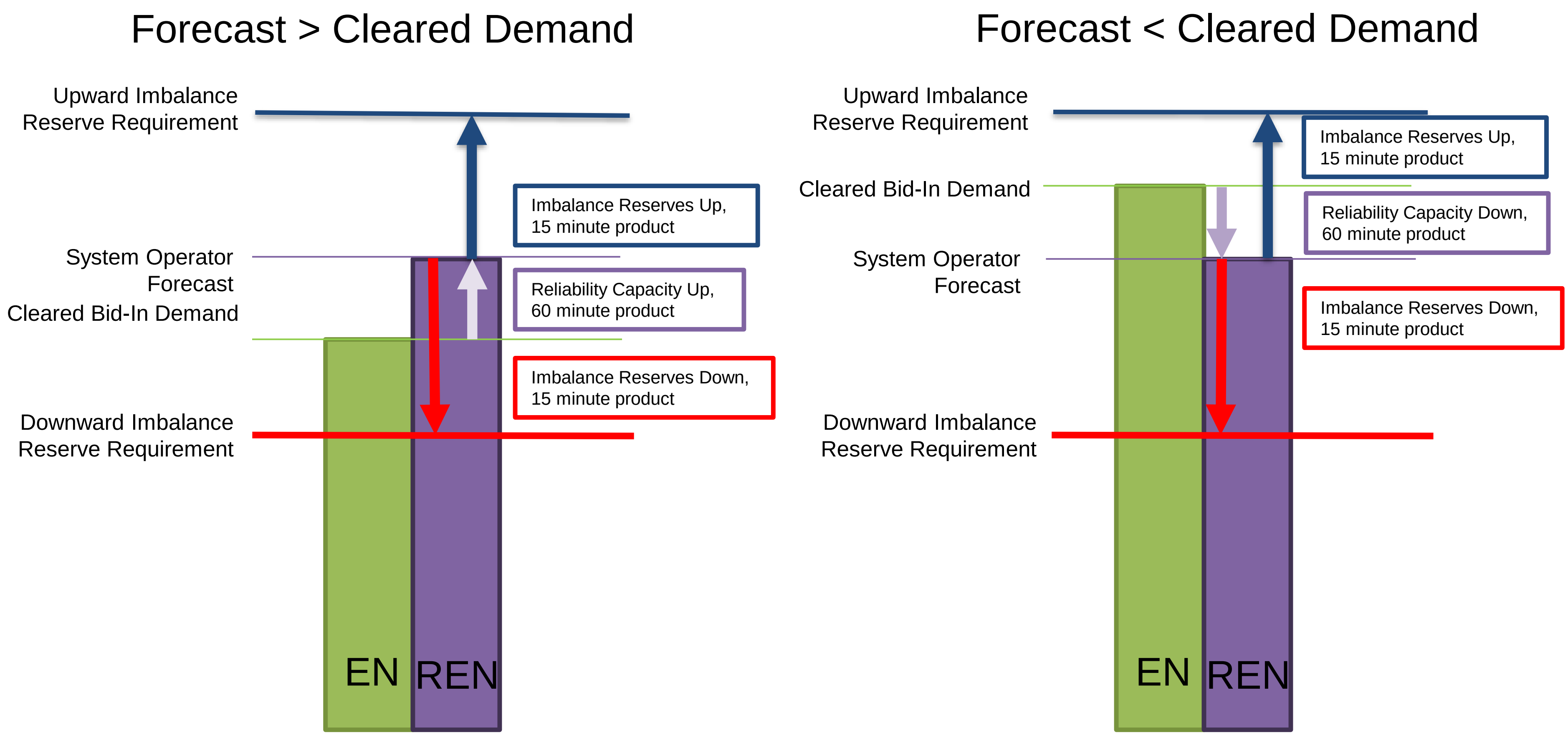
Co-optimization of bid-in demand and system forecast will result in the efficient procurement of energy and capacity products

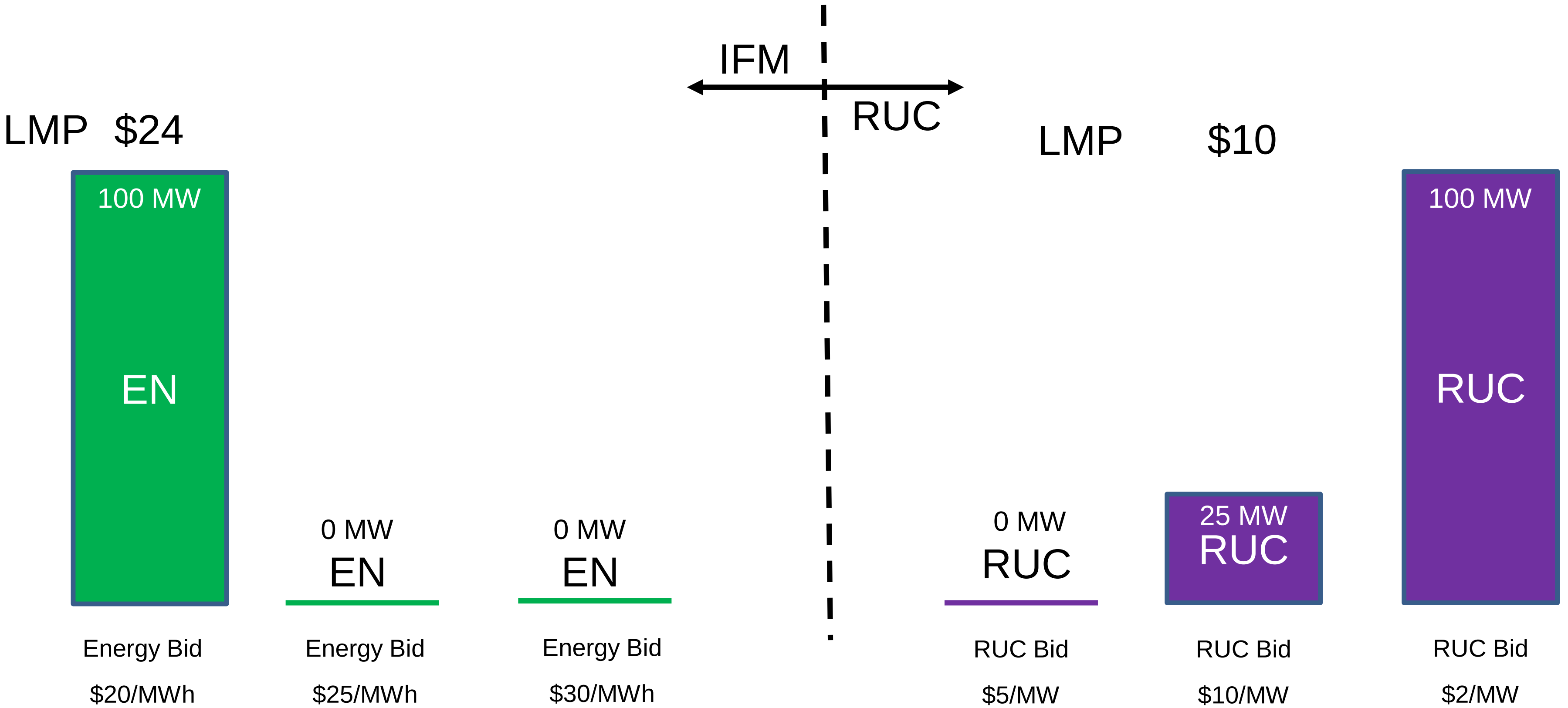


3-generator examples to help explain Locational Marginal Prices (LMPs)

Generator 1 (G1)		Generator 2 (G2)		Generator 3 (G3)	
PMIN	0 MW	PMIN	0 MW	PMIN	0 MW
PMAX	100 MW	PMAX	100 MW	PMAX	100 MW
Ramp Rate	2 MW/min	Ramp Rate	2 MW/min	Ramp Rate	2 MW/min
Energy Bid	$20/MWh	Energy Bid	$25/MWh	Energy Bid	$30/MWh
RCU Bid	$5/MW	RCU Bid	$10/MW	RCU Bid	$2/MW
RCD Bid	$5/MW	RCD Bid	$10/MW	RCD Bid	$2/MW

Scenario A: Sequential process leads to less efficient scheduling with non-zero bids

Load bids 225MW @ $24, Forecast = 225MW



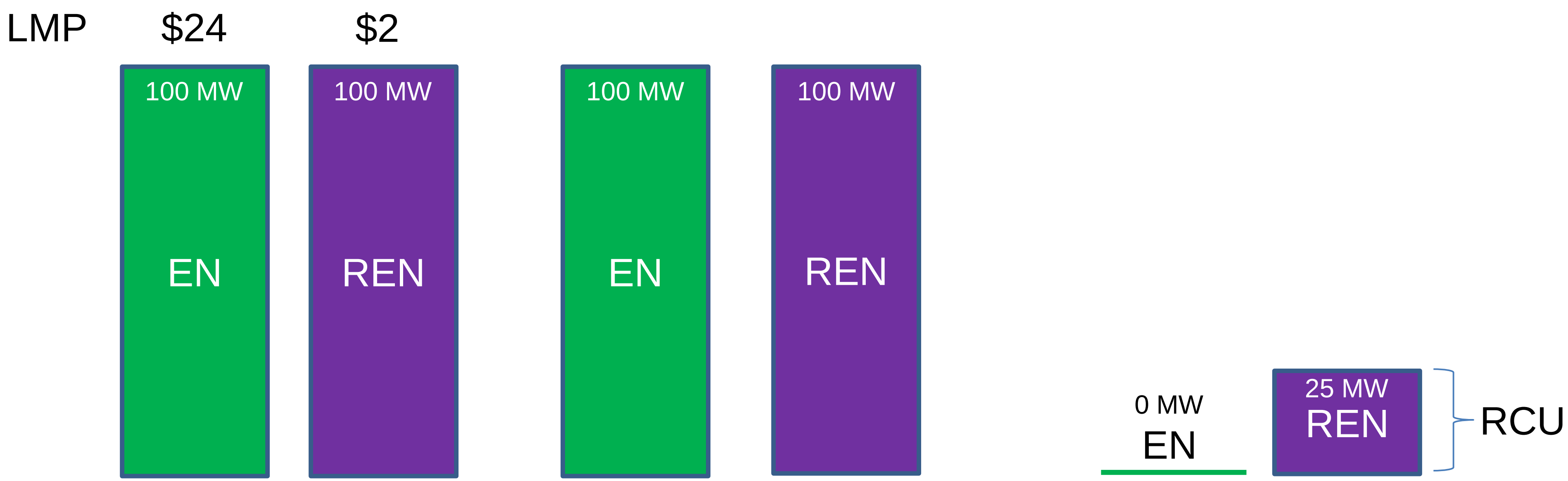
Objective cost = $-400

Combined objective cost = $50

Objective cost = $450

Scenario B: Co-optimization of reliability capacity leads to more efficient scheduling with non-zero bids

Load bids 225MW @ $24, Forecast = 225MW



Energy Bid	$20/MWh	Energy Bid	$25/MWh	Energy Bid	$30/MWh
RCU Bid	$5/MW	RCU Bid	$10/MW	RCU Bid	$2/MW
RCD Bid	$5/MW	RCD Bid	$10/MW	RCD Bid	$2/MW

Objective cost = $-250

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Co-optimization of EN and REN result in efficient pricing and scheduling of reliability capacity

- Co-optimization of EN and REN considers the avoided RCU (or RCD) cost when scheduling physical supply, which can lead to more efficient unit commitment than a sequential process

- Under this design, the entire REN schedule needs to be settled for physical resources to be paid consistent with their bids

REN co-optimization results in different scheduling and pricing implications depending on whether supply or load sets the market price

- Scenarios 1 and 3 illustrate price and scheduling impacts when supply sets the price

- Scenarios 2 and 4 illustrate price and scheduling impacts when load sets the price

Scenario 1: Load bids 125MW @ $50, Forecast = 155MW

LMP $23 $2

100 MW EN | 100 MW REN

EN LMP reflects tradeoff between energy and RCU.

REN LMP reflects marginal cost of RCU.

Sum of EN and REN LMPs makes marginal energy supplier whole to their energy bid.

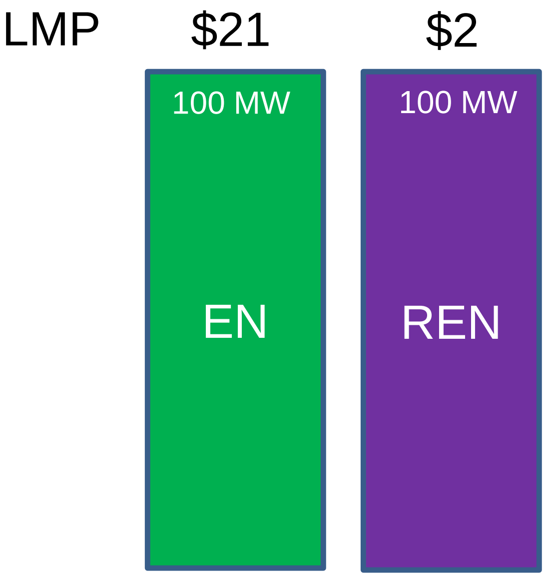
25 MW EN | 25 MW REN

0 MW EN | 30 MW REN — RCU

Energy Bid	$20/MWh	Energy Bid	$25/MWh	Energy Bid	$30/MWh
RCU Bid	$5/MW	RCU Bid	$10/MW	RCU Bid	$2/MW
RCD Bid	$5/MW	RCD Bid	$10/MW	RCD Bid	$2/MW
EN Settlement	$2,300	EN Settlement	$575	EN Settlement	$0
REN Settlement	$200	REN Settlement	$50	REN Settlement	$60

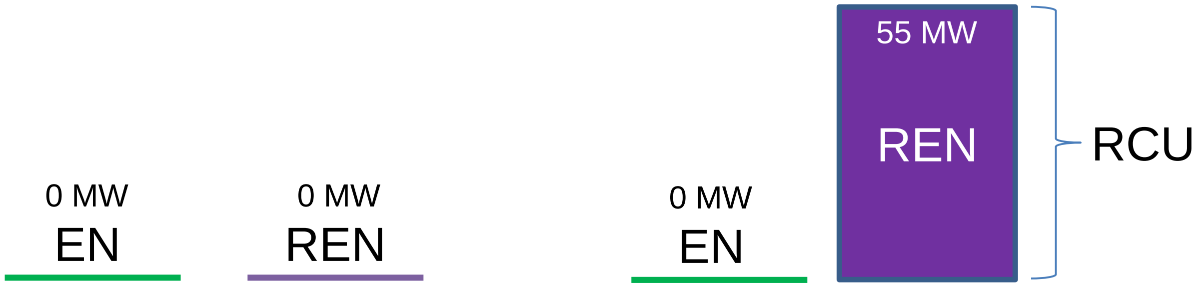
Load pays $23/MWh and allocated $2/MWh for energy schedule

Scenario 2: Load bids 125MW @ $21, Forecast = 155MW



EN LMP reflects marginal value of energy to load.

REN LMP reflects marginal cost of RCU.



Energy Bid	$20/MWh
RCU Bid	$5/MW
RCD Bid	$5/MW
EN Settlement	$2,100
REN Settlement	$200

Energy Bid	$25/MWh
RCU Bid	$10/MW
RCD Bid	$10/MW
EN Settlement	$0
REN Settlement	$0

Energy Bid	$30/MWh
RCU Bid	$2/MW
RCD Bid	$2/MW
EN Settlement	$0
REN Settlement	$110

Load pays $21/MWh and allocated $2/MWh for energy schedule

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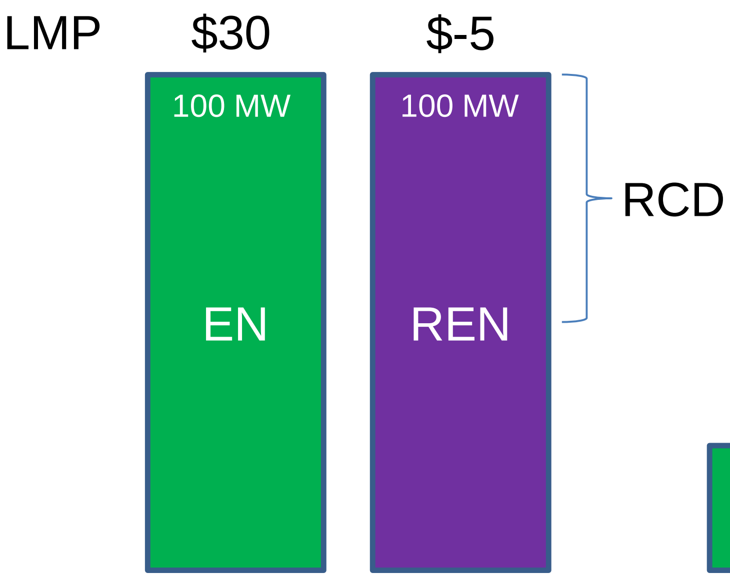
Scenario 3: Load bids 125MW @ $50, Forecast = 75MW



EN LMP reflects tradeoff between energy and RCD.

REN LMP reflects marginal price of RCD.

Sum of EN and REN LMPs makes marginal energy supplier whole to their energy bid.

Energy Bid	$20/MWh
RCU Bid	$5/MW
RCD Bid	$5/MW
EN Settlement	$3,000
REN Settlement	$-250

Energy Bid	$25/MWh
RCU Bid	$10/MW
RCD Bid	$10/MW
EN Settlement	$750
REN Settlement	$-125

Energy Bid	$30/MWh
RCU Bid	$2/MW
RCD Bid	$2/MW
EN Settlement	$0
REN Settlement	$0

Load pays $30/MWh and allocated $-5/MWh for energy schedule

Scenario 4: Load bids 125MW @ $21, Forecast = 75MW

LMP $21 $-1

EN LMP reflects marginal value of energy to load.

REN LMP reflects lost marginal value to load of REN power balance constraint.

75 MW EN	75 MW REN

Energy Bid	$20/MWh
RCU Bid	$5/MW
RCD Bid	$5/MW
EN Settlement	$1,575
REN Settlement	$-75

0 MW EN	0 MW REN

Energy Bid	$25/MWh
RCU Bid	$10/MW
RCD Bid	$10/MW
EN Settlement	$0
REN Settlement	$0

0 MW EN	0 MW REN

Energy Bid	$30/MWh
RCU Bid	$2/MW
RCD Bid	$2/MW
EN Settlement	$0
REN Settlement	$0

Load pays $21/MWh and allocated $-1/MWh for energy schedule

Do the REN co-optimization benefits outweigh the impacts that can occur when load sets the price?

- In comparison to a sequential approach, the co-optimization introduces scheduling and price efficiencies
- However, there are potential adverse impacts when load sets the price
  - In Scenario 2, load is exposed to a REN cost that they can't avoid
  - In Scenario 4, load is prevented from procuring its desired day-ahead energy position
  - In Scenario B, load is forced to procure more energy than its desired day-ahead energy position

Additional topic for consideration:

- Are there risks to having physical and virtual supply settled at different LMPs at the same node? Or is it appropriate to price them differently?
  - Cost allocation can be used to charge virtuals when they are “wrong”
  - When they are “right” they arguably have the same capacity value as physical supply or load