

Single Period Integer Relaxation Examples

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Dispatch Run

- Make no modifications to resource parameters
- Determine desired dispatch points
- Do not calculate prices

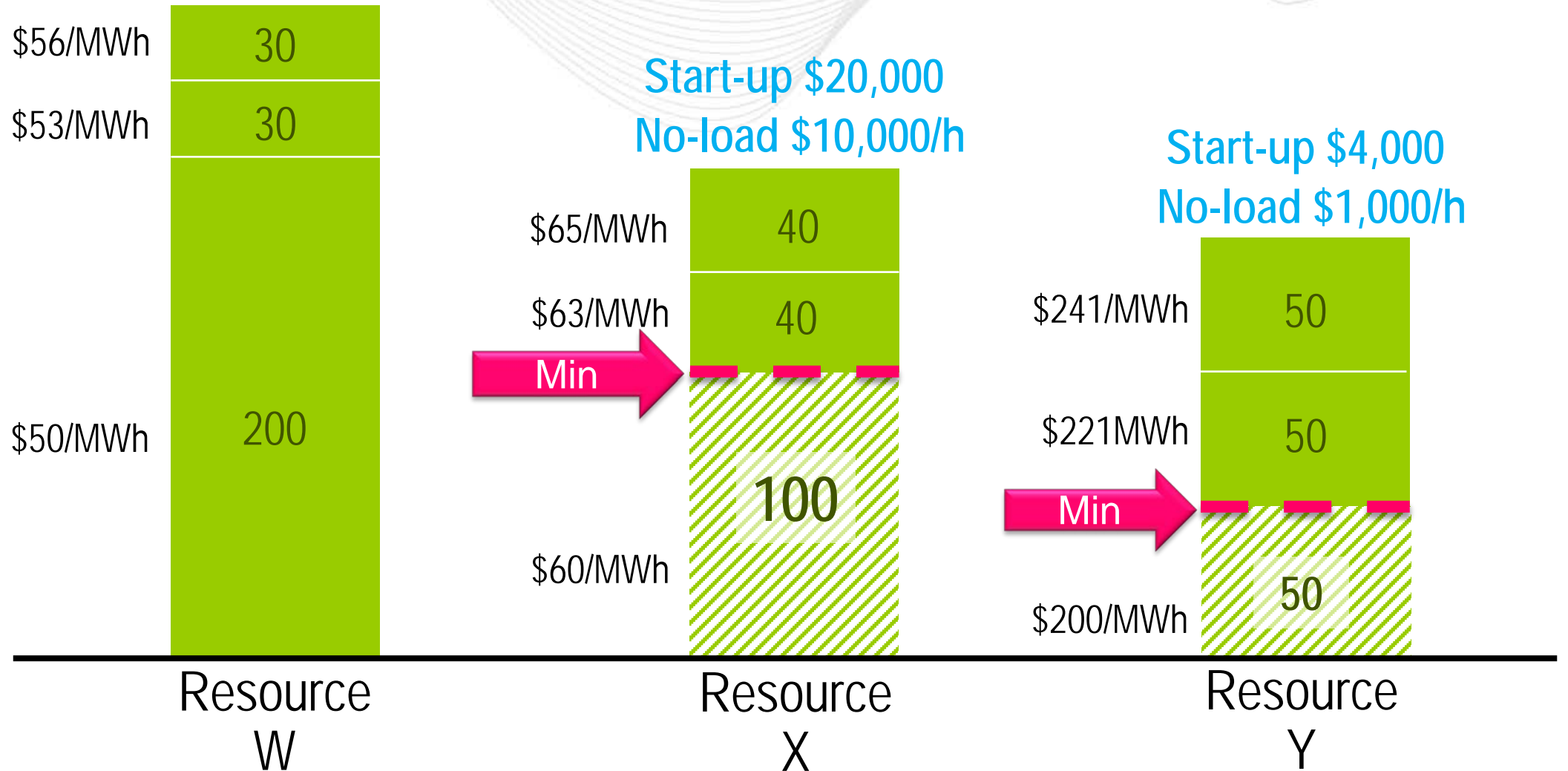
Pricing Run

- Modify resource parameters
- Calculate prices

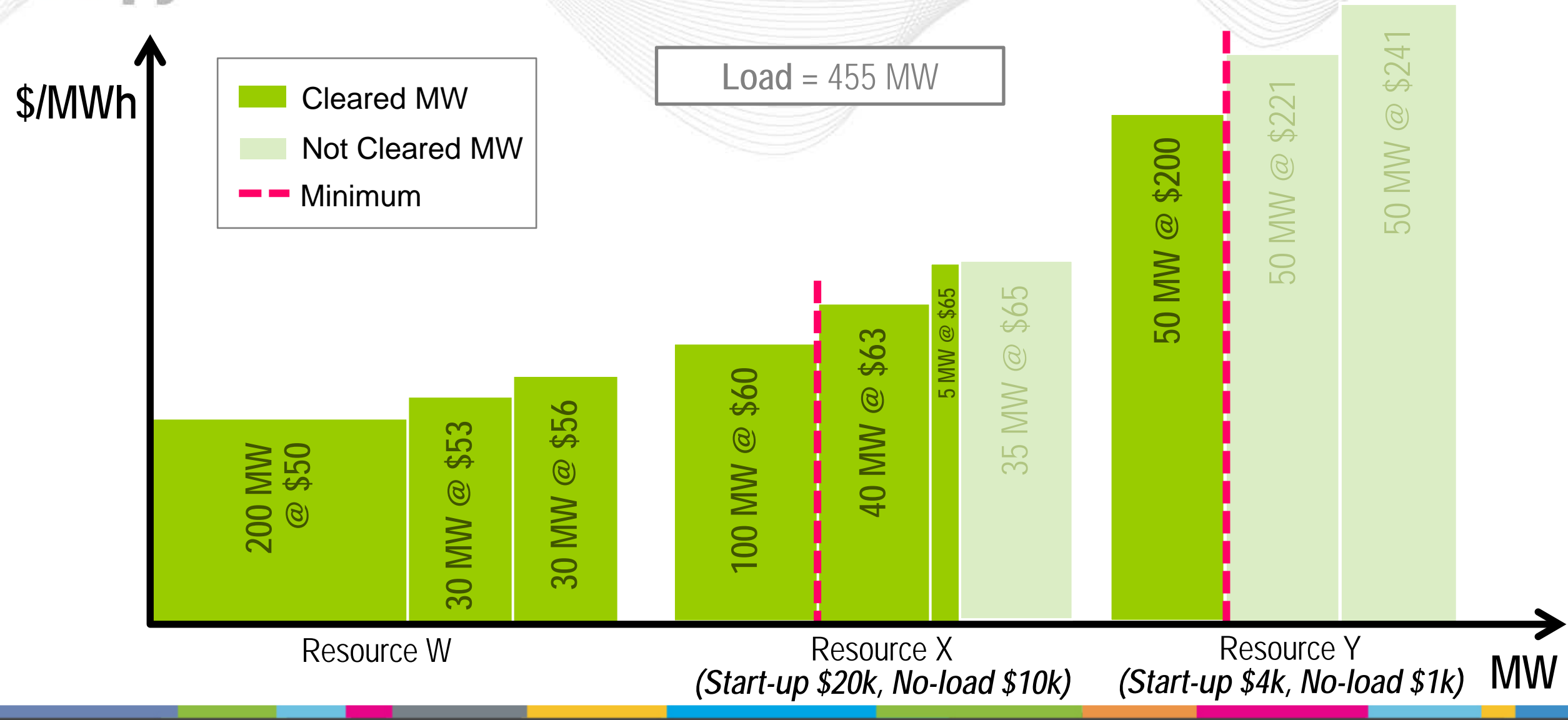
- Load equals 455 MW
- Fixed costs (start-up and no-load) are considered in setting the price.
- Assume all resources are eligible for integer relaxation treatment
- **Note:** Offline resources **do not** participate in pricing

Example #1: Offer Blocks (MW) & Fixed Costs

Any resource that is "committed" must run at least at its minimum



The Commitment and Dispatch Run: Example #1



- Allow resources to be partially committed for pricing calculations:
 - Equivalently, resources are allowed to be fully dispatchable between 0 and their economic maximums.
- Start-up and No-load costs of X and Y are considered in setting the price.
 - Equivalently, the bid blocks of Resources X and Y can be modified to incorporate the proportional start-up and no-load costs.

- For example, under integer relaxation with a single offer block, in the pricing run the total offer cost of dispatching a resource is:

$$\begin{aligned} \textit{Total Offer Cost} = & \textit{Incremental Energy Cost} \times \textit{Dispatch} + \\ & \textit{Startup Cost} \times \textit{Commitment Status} + \\ & \textit{Noload Cost} \times \textit{Commitment Status} \end{aligned}$$

Where:

$$\textit{Commitment Status} = \frac{\textit{Dispatch}}{\textit{Economic Maximum}}$$

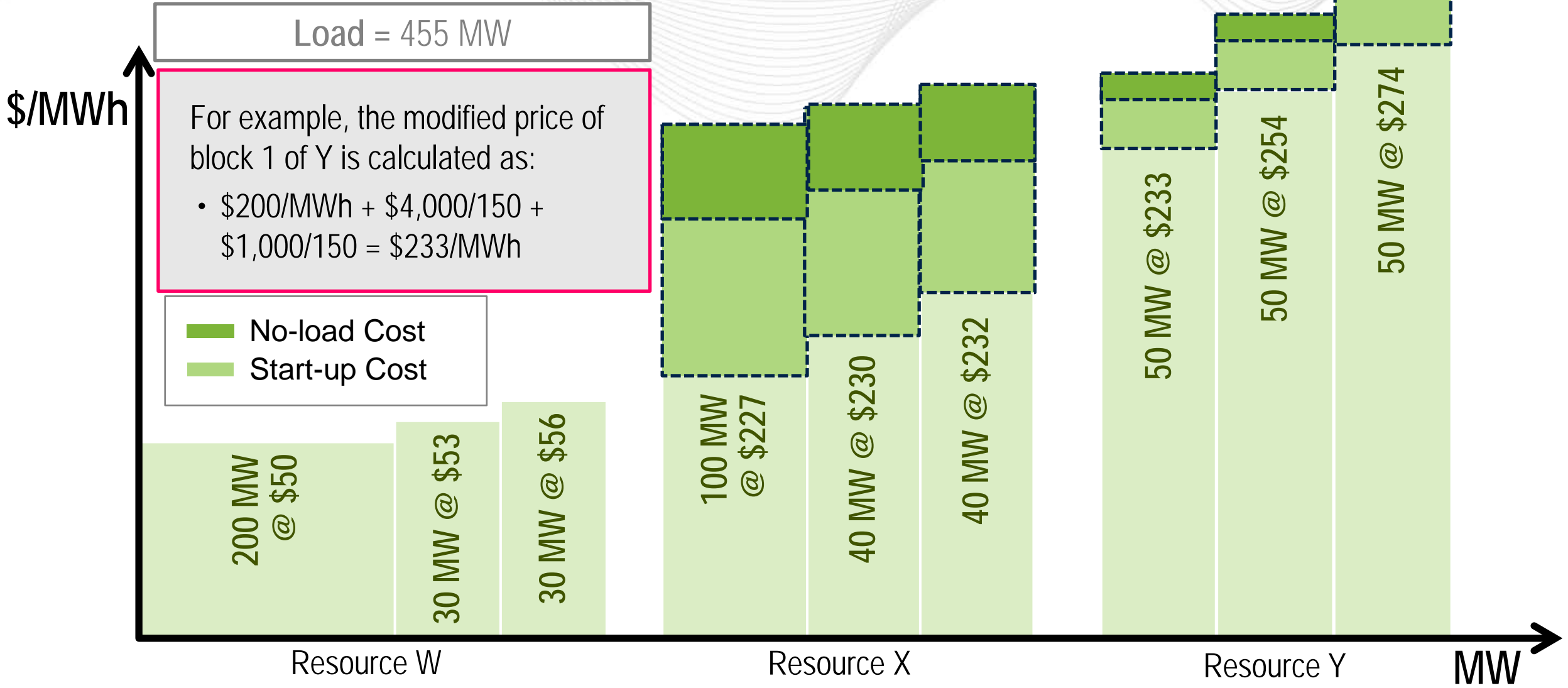
Pricing Run Offer Modifications for Example #1

- As a result, the total offer cost of dispatching a resource in the pricing run can be rewritten as:

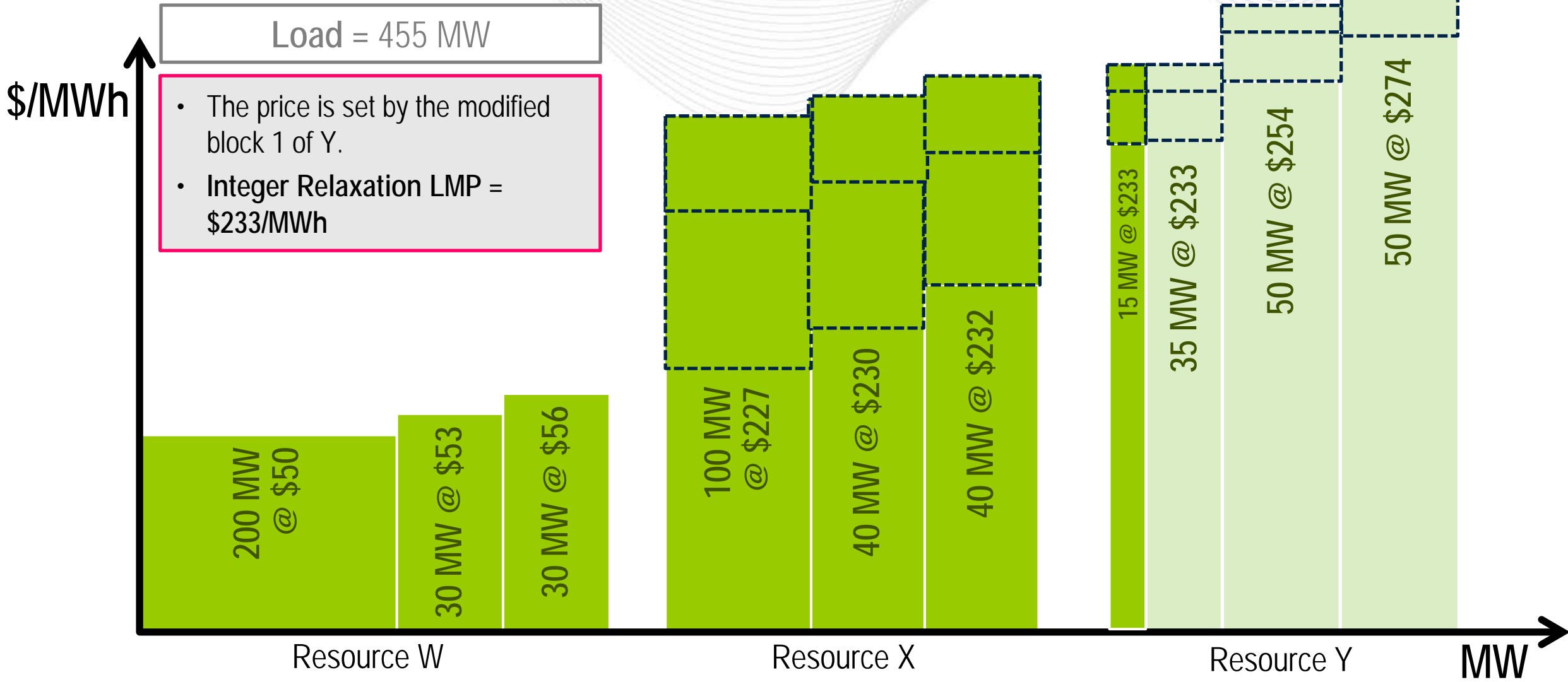
$$\begin{aligned}
 \text{Total Offer Costs} = & \boxed{\text{Incremental Energy Cost}} \times \text{Dispatch} + \\
 & \boxed{\frac{\text{Startup Cost}}{\text{Economic Maximum}}} \times \text{Dispatch} + \\
 & \boxed{\frac{\text{Noload Cost}}{\text{Economic Maximum}}} \times \text{Dispatch}
 \end{aligned}$$

- A resource's equivalent offer is equal to the sum of all three components in the boxes above.

Pricing Run Equivalent Offers for Example #1



Pricing Run Integer Relaxation LMP: Example #1



- The integer relaxation LMP is set by the first block of Resource Y, which includes its start-up and no-load costs in the price
- The dispatch MWs for all resources come from the dispatch run where Resource X and Y incur their full start-up and no-load costs
- Resource Y **will** need a make-whole payments since it is only recovering part of its start-up and no-load costs through the price since it is not being dispatched at its economic maximum

The **Integer Relaxation LMP** is calculated at **\$233/MWh**.

Asset	Commit.	Dispatch (MW)	EcoMax (MW)	Total Offer Cost (\$)	Payment (\$)	MWP (\$)	LOC (\$)
W	On	260	260	13,270	60,580	0	0
X	On	145	180	38,845	33,785	5,060	820
Y	On	50	150	15,000	11,650	3,350	0

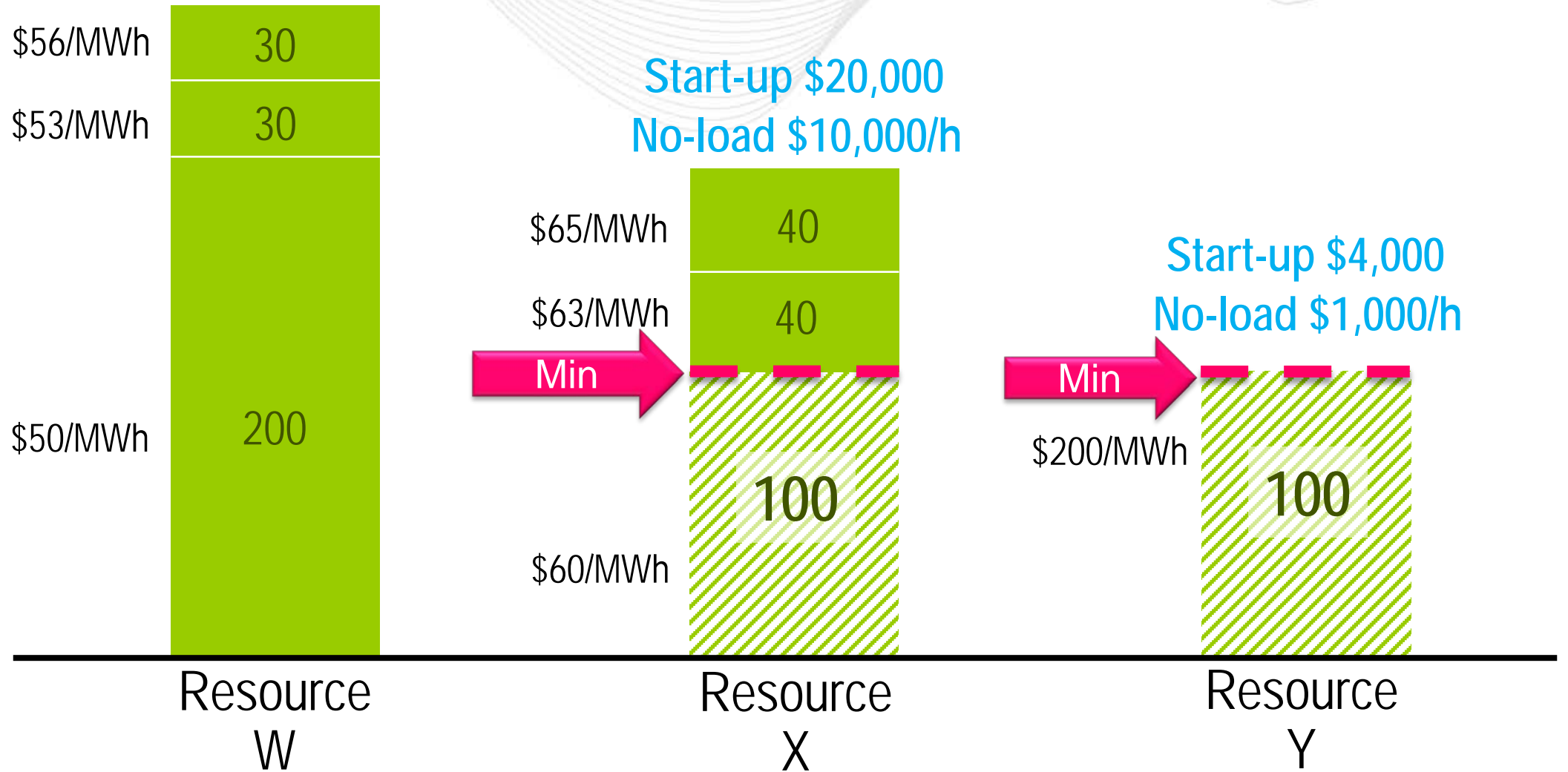
Both X and Y receive a make-whole payment to make them whole to their total offer cost.

In addition, X receives a LOC payment since at X's offer prices of \$60–\$65/MWh, it would want to produce at its economic maximum at a \$233/MWh clearing pricing since it would make a profit of \$820.

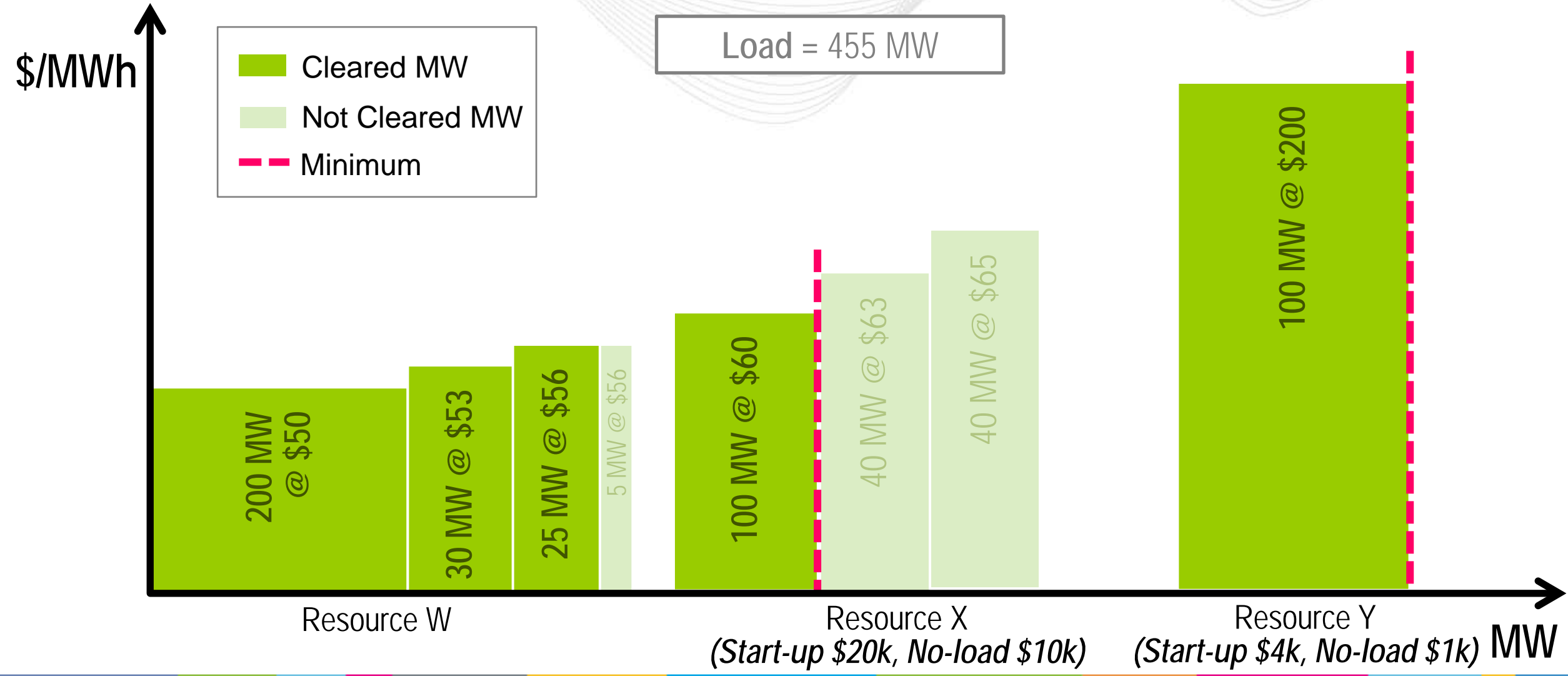
- Load equals 455 MW
- Fixed costs (start-up and no-load) are considered in setting the price.
- Assume all resources are eligible for integer relaxation treatment
- **Note:** Offline resources **do not** participate in pricing

Example #2: Offer Blocks (MW) & Fixed Costs

Any resource that is "committed" must run at least at its minimum

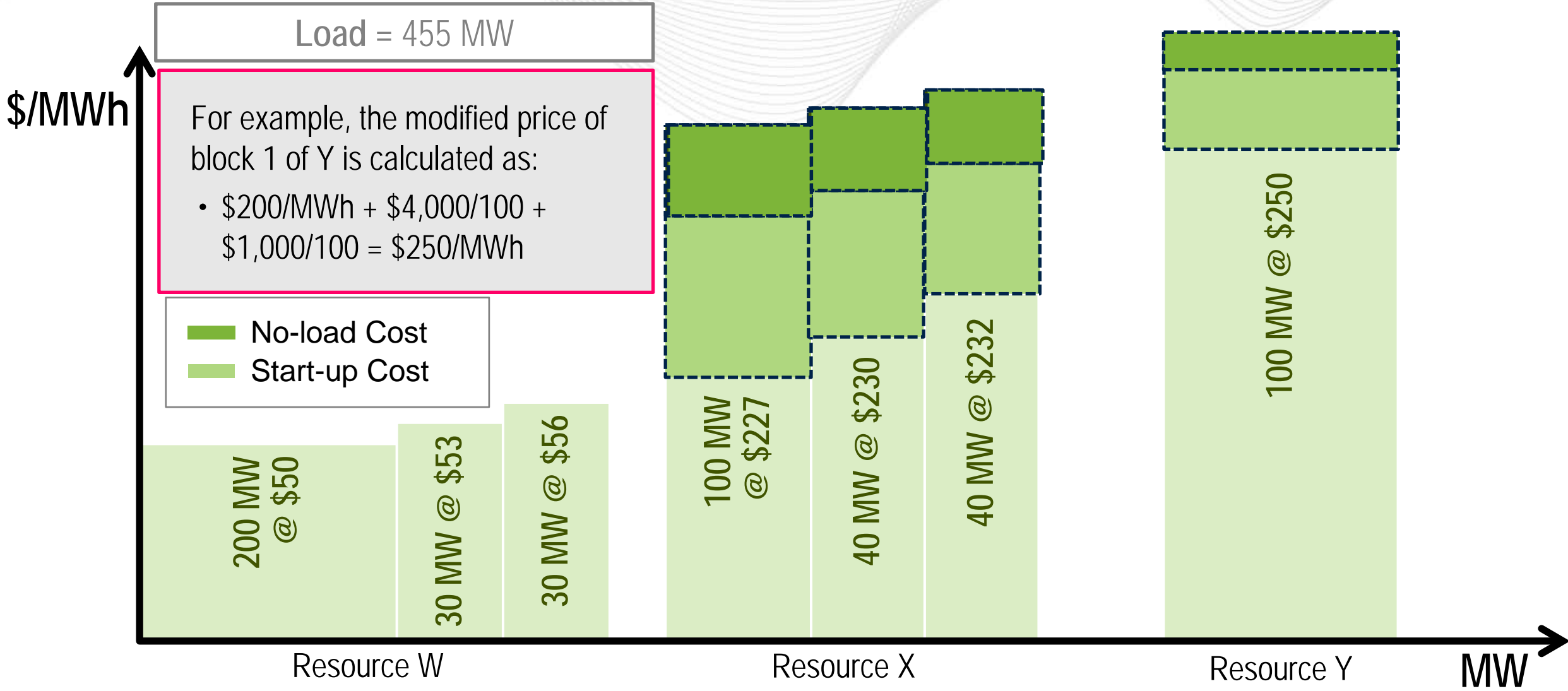


The Commitment and Dispatch Run: Example #2

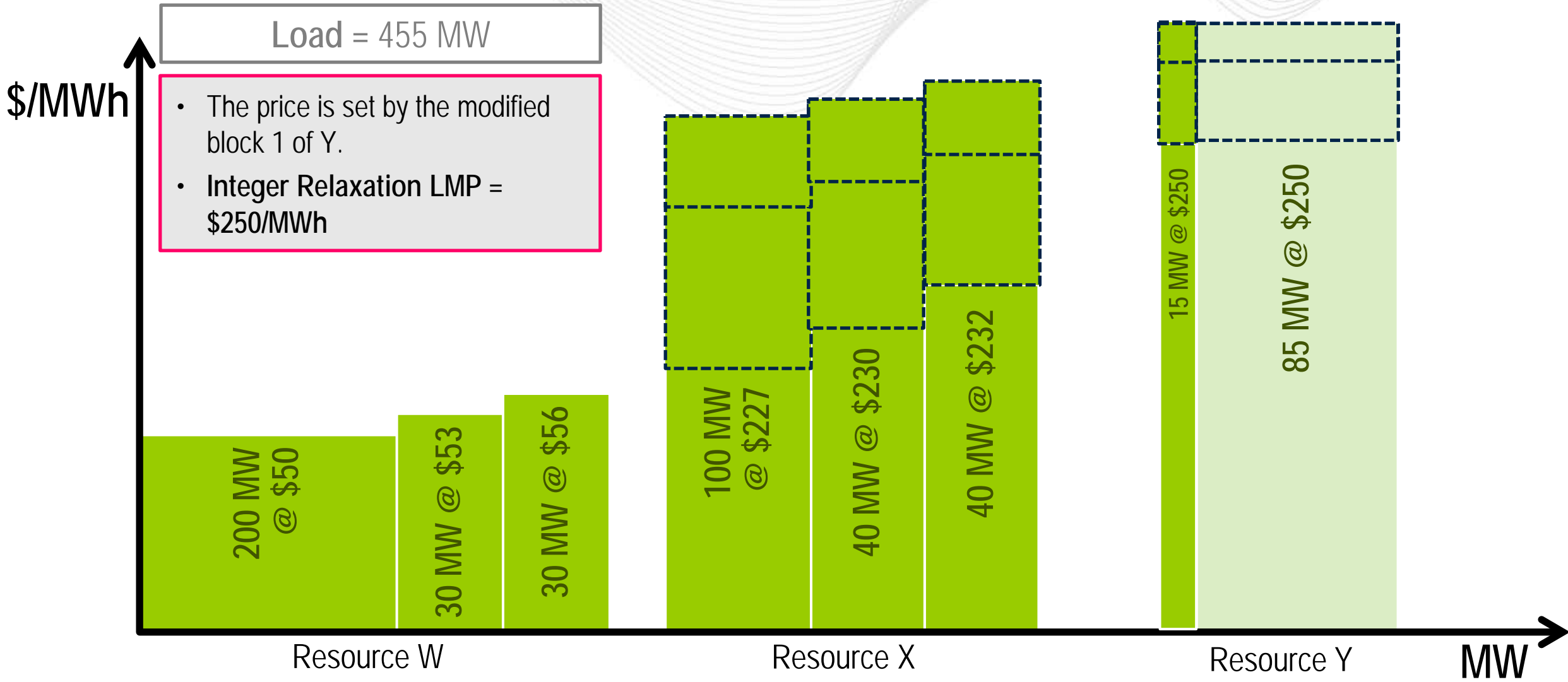


- Allow resources to be partially committed for pricing calculations:
 - Equivalently, resources are allowed to be fully dispatchable between 0 and their economic maximums.
- Start-up and No-load costs of X and Y are considered in setting the price.
 - Equivalently, the bid blocks of Resources X and Y can be modified to incorporate the proportional start-up and no-load costs.

Pricing Run Equivalent Offers for Example #2



Pricing Run Integer Relaxation LMP: Example #2



- The integer relaxation LMP is set by the first block of Resource Y, which includes its start-up and no-load costs in the price
- The dispatch MWs for all resources come from the dispatch run where Resource X and Y incur their full start-up and no-load costs
- Resource Y **will not** need a make-whole payment since it is being dispatched to its economic maximum in the dispatch run and is recovering its entire start-up and no-load costs through the price

The **Integer Relaxation LMP** is calculated at **\$250/MWh**.

Asset	Commit.	Dispatch (MW)	EcoMax (MW)	Total Offer Cost (\$)	Payment (\$)	MWP (\$)	LOC (\$)
W	On	255	260	12,990	63,750	0	970
X	On	100	180	36,000	25,000	11,000	3,880
Y	On	100	100	25,000	25,000	0	0

Resource X receives a make-whole payment to make it whole to its total offer cost.

In addition, Resource W and X receive a LOC payment since at Resource W's and X's offer prices of \$50-\$56/MWh and \$60-\$65/MWh, they would want to produce at their economic maximums at a \$250/MWh clearing pricing since they would make a profit of \$970 and \$3,880, respectively.