Day-Ahead Market Enhancements discussion

James Friedrich  
Market Design Policy Specialist

Market Surveillance Committee Meeting  
General Session  
March 13, 2020
Co-optimization of bid-in demand and system forecast will result in the efficient procurement of energy and capacity products.

**Forecast > Cleared Demand**
- **Upward Imbalance Reserve Requirement**
  - Imbalance Reserves Up, 15 minute product
  - Reliability Capacity Up, 60 minute product

**Forecast < Cleared Demand**
- **Upward Imbalance Reserve Requirement**
  - Imbalance Reserves Up, 15 minute product
- **System Operator Forecast**
- **Cleared Bid-In Demand**
  - Reliability Capacity Down, 60 minute product
  - Imbalance Reserves Down, 15 minute product
3-generator examples to help explain Locational Marginal Prices (LMPs)

<table>
<thead>
<tr>
<th>Generator 1 (G1)</th>
<th>Generator 2 (G2)</th>
<th>Generator 3 (G3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMIN: 0 MW</td>
<td>PMIN: 0 MW</td>
<td>PMIN: 0 MW</td>
</tr>
<tr>
<td>PMAX: 100 MW</td>
<td>PMAX: 100 MW</td>
<td>PMAX: 100 MW</td>
</tr>
<tr>
<td>Ramp Rate: 2 MW/min</td>
<td>Ramp Rate: 2 MW/min</td>
<td>Ramp Rate: 2 MW/min</td>
</tr>
<tr>
<td>Energy Bid: $20/MWh</td>
<td>Energy Bid: $25/MWh</td>
<td>Energy Bid: $30/MWh</td>
</tr>
<tr>
<td>RCU Bid: $5/MW</td>
<td>RCU Bid: $10/MW</td>
<td>RCU Bid: $2/MW</td>
</tr>
<tr>
<td>RCD Bid: $5/MW</td>
<td>RCD Bid: $10/MW</td>
<td>RCD Bid: $2/MW</td>
</tr>
</tbody>
</table>
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

LMP  | $24  | $2
---|-----|-----
| 100 MW | 100 MW | 100 MW | 100 MW
EN  | REN | EN  | REN
Energy Bid  | $20/MWh | Energy Bid  | $25/MWh
RCU Bid  | $5/MW | RCU Bid  | $10/MW
RCD Bid  | $5/MW | RCD Bid  | $10/MW

Objective cost = $-250
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

Load pays $23/MWh and allocated $2/MWh for energy schedule.
## Scenario 2: Load bids 125MW @ $21, Forecast = 155MW

<table>
<thead>
<tr>
<th>LMP</th>
<th>100 MW</th>
<th>100 MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN</td>
<td>$21</td>
<td>$2</td>
</tr>
<tr>
<td>REN</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Energy Bid
- EN: $20/MWh
- REN: $2/MWh

### RCU Bid
- EN: $5/MW
- REN: $5/MW

### RCD Bid
- EN: $5/MW
- REN: $5/MW

### EN Settlement
- $2,100

### REN Settlement
- $200

**EN LMP reflects marginal value of energy to load.**

**REN LMP reflects marginal cost of RCU.**

### Energy Bid
- EN: $25/MWh
- REN: $25/MWh

### RCU Bid
- EN: $10/MW
- REN: $10/MW

### RCD Bid
- EN: $10/MW
- REN: $10/MW

### EN Settlement
- $0

### REN Settlement
- $0

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

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

Load pays $30/MWh and allocated $-5/MWh for energy schedule
Scenario 4: Load bids 125MW @ $21, Forecast = 75MW

**LMP**

$21  |  $-1

**EN**  |  **REN**

| Energy Bid | $20/MWh | Energy Bid | $25/MWh |
| RCU Bid | $5/MW | RCU Bid | $10/MW |
| RCD Bid | $5/MW | RCD Bid | $10/MW |
| EN Settlement | $1,575 | EN Settlement | $0 |
| REN Settlement | $-75 | REN Settlement | $0 |

EN LMP reflects marginal value of energy to load.

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

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