Real-Time Price Formation

Technical Session #6

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ISO New England
Session Objectives

- Review pricing concepts from previous sessions
- Discuss real-time pricing with fast start (FS) generators
- Use a simple example to show how ISO New England currently prices electricity when FS generators are needed
Format of these Sessions

• This is NOT a Markets Committee meeting and will not follow normal MC rules (posting, interactive Webex, etc.).

• Sessions are meant to help the ISO frame the problem set and the potential solution set. ALL input is welcome and essential.

• We may use flip charts, white boards, or similar tools to help facilitate the discussion.

• We will end the session summarizing the action items (additional examples/issues) for the ISO and Participants before the next session.

• We will try to summarize at the beginning of each session where the previous session left off and what the goals for the current session are.
Purpose of this Session Series

1) TODAY –
   • Fast Start Generators
   • ISO New England pricing with FS generators

2) Next Two Sessions –
   • Examine alternatives used by different ISOs to address FS generator pricing
   • Present alternative pricing methods currently being evaluated by ISO New England
Basic Layout of the Sessions

• Session #6 – September 22, 2014 – Today
  – Fast Start Generator pricing considerations
  – ISO New England pricing method with Fast Start Generators

• Session #7 – November 14, 2014
  – Begin discussion on other ISO pricing methods with Fast Start Generators

• Session #8 – December 15, 2014
  – Finish other ISO pricing methods with Fast Start Generators
  – Present alternative pricing methods currently being evaluated by ISO New England
Review Idea #1: Pricing Principles

Three key pricing principles:

1) Efficiency
2) Transparency
3) Simplicity
Review Idea #1: Pricing Principles

1) **Efficiency.** *In the context of the RT energy market, this means two things:*

   a) Real-Time (RT) dispatch on **offers** will minimize **actual** production cost

   b) Assets want to produce to the cleared (dispatched) MW amount, not something else
      
      • More precisely, each asset is no worse off than its next best amount alternative (“NWOTNBA”)
Review Idea #1: Pricing Principles

2) Price Transparency

a) Defined as when "much is known by many“ about transaction price(s)

b) In this context, it is everyone knowing the price(s) others receive
Review Idea #1: Pricing Principles

3) Simplicity

a) As few prices as possible (for each location and time)
   • Example: Pay-as-bid systems can have many different prices for the same location and time (to different sellers); uniform pricing has one price

b) Price formation process should have a simple logic that buyers/sellers understand (ideally)
   • No difficulties answering questions like: “How do we interpret the price?”
Review Idea #2: A Root Cause of Pricing Concerns

• “Lumpiness” – Many generating units have
  – Minimum production constraints: Ecomin values, minimum run times, minimum down times
  – Commitment-related costs: start-up costs

• Unfortunately, there is NO “perfect” pricing approach that satisfies all three principles when “lumpy” units are needed.

• As a consequence, there are NO “perfect” LMPs. All pricing methods make compromises to achieve their goal.
  – Recall the three pricing methods discussed in the Spring seminar series: two-tier pricing, convex hull pricing, approximate ELMP
Layout of Today’s Presentation

Section 1

• Fast Start Generators

Section 2

• ISO New England pricing with Fast Start Generators
Layout of Today’s Presentation

Section 1

• Fast Start Generators

Section 2

• ISO New England pricing with Fast Start Generators
Fast Start Generators: Definition*

• A generation resource that the ISO may dispatch within the hour through electronic dispatch and that meets the following criteria:
  – Minimum run time does not exceed one hour
  – Minimum down time does not exceed one hour
  – Time to start does not exceed 30 minutes
  – Available for dispatch and manned or has automatic remote dispatch capability
  – Capable of receiving and acknowledging a start-up or shut-down dispatch instruction electronically
  – Has satisfied its minimum down time

* ISO New England Inc. Transmission, Markets and Services Tariff, Section I.2.2
Fast Start Generators: General Treatment

• Three costs are submitted to the ISO
  – Incremental energy offer ($/MWh)
  – Start-up cost ($/start)
  – No-load cost ($/hour)
Fast Start Generators: Contributions to the System

• Allow for rapid response to changing system conditions

• Help satisfy peak load

• Can provide reserves (i.e., TMNSR, TMOR) when offline
Relevant FS Questions for ISO New England

Addressed in this presentation

1. **When do** FS units set LMPs?
2. **Why aren’t** fast start units’ costs “fully reflected in real-time prices”?

Broader questions to keep in mind

1. **When should** FS units set LMPs?
2. **How could** FS unit costs be “fully reflected in real-time prices”?
   - How could FS start-up costs be reflected in the LMPs?
   - How could FS no-load costs be reflected in the LMPs?
3. Other issues?

*The fast-start pricing issues presented here are not unique to ISO New England.*
Layout of Today’s Presentation

Section 1
• Fast Start Generators

Section 2
• ISO New England pricing with Fast Start Generators
Current Goal

• Present how FS unit costs are treated by the ISO New England pricing method
Steps in Real-Time Market

1) Commitment process
   – When to commit (start-up) and decommit (shut-down) FS units

2) Dispatch process
   – Determine energy dispatch for each asset (DDPs)

3) Pricing process (closely related to Dispatch process)
   – Calculate market prices
Steps in Real-Time Market

• Each ISO considers FS start-up and no-load costs in its commitment process for fast-start units

• However, treatment of FS start-up and no-load costs varies among ISOs in the dispatch and pricing processes
Fast Start Generators: Pricing Issues*

• From 2013 External Market Monitor’s report:

“Fast-start generators are routinely deployed economically, but the resulting costs are often not fully reflected in real-time prices...

-> We recommend that the ISO evaluate potential changes in the pricing methodology that would allow the deployment costs of fast-start generators to be more fully reflected in the real-time market prices.”

* Potomac Economics, 2013 Assessment of the ISO New England Electricity Markets (page 22)
FS Unit Pricing Status Timeline

Legend
- Hypothetical generator output

(Unit Status: Pricing)
FS Offer Treatment depends on its Pricing Status

<table>
<thead>
<tr>
<th>Unit pricing status</th>
<th>FS offer elements in pricing determination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offline</td>
<td>-</td>
</tr>
<tr>
<td>Start-up</td>
<td>Start-up, no-load, and incremental</td>
</tr>
<tr>
<td>Online</td>
<td>Incremental</td>
</tr>
<tr>
<td>Shut-down</td>
<td>-</td>
</tr>
</tbody>
</table>
Pricing with FS units

- **FS unit pricing status**: **Start-up**
  
  **A. Costs** – All 3 costs are considered in the price calculation
  
  a. Incremental energy offer
  
  b. Start-up cost “amortized” over 1 hour and Ecomax
  c. No-load cost amortized over Ecomax

  Marginal cost = Incremental energy offer + \( \frac{\text{Start-up cost}}{\text{Ecomax} \times 1 \text{ hour}} \) + \( \frac{\text{No-load cost}}{\text{Ecomax}} \)

  \[
  \left( \frac{\$/\text{MWh}}{\$/\text{MWh}} \right) + \left( \frac{\$/\text{MW} \times \text{h}}{\$/\text{MW}} \right)
  \]

  **B. Dispatch range** – **Assumed** to be dispatchable between 0 and Ecomax, even if Ecomin > 0

  - This approach can be called “Ecomin relaxation” (*We will see it again...*)

- **FS fixed costs** (start-up, no-load) can be reflected in LMPs
Key Observations, Start up

A. Fixed costs. The [amortized] start-up and no-load costs are included in the FS unit’s “marginal” cost.
   - These fixed costs will be reflected in the LMP if the FS unit is marginal

B. Ecomin Relaxation. The pricing problem relaxes the FS unit’s Ecomin to 0
   - FS unit is “not lumpy” when the LMP is calculated, thereby allowing the FS unit to be marginal

Note: Ecomin relaxation can create other problems (more about this later...)
Pricing with FS units

- FS unit pricing status: **Online**
  
  **A. Costs** – Only the incremental energy offer is considered in the price calculation

  Marginal cost = Incremental energy offer

  **B. Dispatch range** – Dispatchable between Ecomin and Ecomax
  - “Block loaded” if Ecomin = Ecomax

- FS fixed costs (start-up, no-load) cannot be reflected in LMPs
Key Observations, Online

A. Fixed costs. Start-up and no-load costs are not included in the FS unit’s “marginal” cost.
   - These fixed costs cannot be reflected in the LMP

B. Dispatchable range. The pricing problem treats the FS unit as dispatchable between Ecomin and Ecomax
   - FS unit can be marginal
Pricing with FS units

- FS unit pricing status: **Shut-down** 🔴 or **Offline** ⬜
  
  A. **Costs** – Irrelevant for price calculation
  
  B. **Dispatch range** – 0 MW

- FS units cannot set LMPs
Issues with Ecomin relaxation

• Can lead to a mismatch between dispatch and pricing energy production levels
  – Do the prices really reflect the cost of satisfying the next MW of demand in this case?

• Can create incentive issues for non-FS units
  – E.g., non-FS units may be dispatched down even though prices are high

• Can result in system over-generation
  – Dispatch does not maximize efficiency
ISO New England: Example

• Assume demand is 105 MW

• Consider one online non-FS unit and one FS unit

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit A (Non-FS)</th>
<th>Unit B (FS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecomin (MW)</td>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>Ecomax (MW)</td>
<td>100</td>
<td>15</td>
</tr>
<tr>
<td>Incremental energy offer ($/MWh)</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>Start-up cost ($/start)</td>
<td>5000*</td>
<td>750</td>
</tr>
<tr>
<td>No-load cost ($/hour)</td>
<td>500*</td>
<td>150</td>
</tr>
</tbody>
</table>

* These values are not used in Real-Time commitment, dispatch, or pricing
Units' Offers

(Unit A) (Non-FS unit)

$30/\text{MWh}

(Unit B) (FS unit)

$100/\text{MWh}

Ecomin
Commitment Solution

Online

Unit A

50

$30/MWh

Ecomin

Unit B

5

10

$100/MWh

Online

(Non-FS unit)

(FS unit)
Dispatch Solution, Start-up

• FS unit Ecomin is relaxed to 0
• The minimum cost solution is 100 MW from Unit A and 5 MW from Unit B
• Because Unit B cannot be sent a DDP lower than its Ecomin, it is sent a DDP of 10 MW

110 MW generation for 105 MW demand → 5 MW over-generation!
Dispatch Solution, Online

- FS unit Ecomin is respected
- The minimum cost solution is 95 MW from Unit A and 10 MW from Unit B

105 MW generation for 105 MW demand
→ System is balanced
Example: Pricing Calculation

• For **Start-up**
  – the FS unit “marginal” cost in the pricing problem is
    \[
    \text{Marginal cost} = \text{Incremental} + \text{Start-up} + \text{No-load}
    \]
    \[
    = $100/\text{MWh} + \frac{$750}{15\text{MWh}} + \frac{$150/\text{h}}{15\text{MW}} = $160/\text{MWh}.
    \]
  – for pricing purposes, the FS unit can be “dispatched” between 0 and 15 (Ecomax)

• For **Online**
  – the FS unit “marginal” cost is its incremental energy offer, $100/\text{MWh}
  – for pricing purposes, the FS unit can be “dispatched” between 10 (Ecomin) and 15 (Ecomax)
Pricing: Inputs, Start-up

Unit A

Unit B

- FS marginal price = $160/MWh (includes start-up and no-load)
- FS dispatchable between 0-15 MW (Ecomin relaxed)

100 MW@$30/MWh

15 MW @ $160/MWh
“real-time LMPs usually reflect the full cost of deploying the fast-start resource, partly because UDS considers the no-load offer and the start-up offer of the generator.”*

The FS unit sets the LMP at its “marginal” cost, including amortized start-up and no-load costs.

* Potomac Economics, 2013 Assessment of the ISO New England Electricity Markets (page 89)
Pricing: Input, Online

- **Unit A**
  - 100 MW@$30/MWh

- **Unit B**
  - 15 MW@$100/MWh

- FS marginal price = $100/MWh (incremental only)
- FS dispatchable between 10-15 MW (Ecomin respected)
“real-time LMPs usually do not reflect the full cost of deploying the fast-start resource, even if the generator is still economic to be online.”*

* Potomac Economics, 2013 Assessment of the ISO New England Electricity Markets (page 89)
ISO NE FS Pricing: Evaluation, Start-up

- **Efficiency:** Dispatch instructions result in system overproduction

- **Transparency:** No side-payments are needed given the $160/MWh LMP

- **Simplicity:** Relatively simple (as FS pricing methods go), LMP is still the “cost” of meeting the next increment of demand
ISO NE FS Pricing: Evaluation, Online

- **Efficiency:** The correct amount of generation is dispatched

- **Transparency:** FS unit needs a make-whole payment given the $30/MWh LMP

- **Simplicity:** Relatively simple (as FS pricing methods go), LMP is still the “cost” of meeting the next increment of demand
ISO New England Fast-Start Pricing: Summary

• **FS fixed costs**
  – Incorporates FS no-load and start-up costs when Start-up
  – Does not incorporate FS no-load and start-up costs when Online

• **Lumpiness treatment in pricing**
  – Relax EcoMin to 0, amortize FS start-up and no-load costs when Start-up
  – Respect offered EcoMin value when Online

• **Side-payments and transparency**
  – Relatively easy to understand and implement
  – FS units may still require make-whole payments to recover bid-in cost
RECAP – WHAT HAVE WE LEARNED?

• Fast-start units have “lumpy” characteristics that cause difficulty with pricing
  – When should FS units be able to set LMPs?
  – How should FS fixed costs be included in LMPs?

• ISO New England practice
  – No-load and start-up costs incorporated into marginal FS production cost via Ecomin relaxation when Start-up 🟢
  – No-load and start-up costs not incorporated into marginal FS production cost (Ecomin respected) when Online 🔴
Next Steps

- Present and discuss FS pricing practices of other ISOs/RTOs
- Contrast with ISO New England pricing method