New England’s Forward Capacity Market

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Scarcity Pricing in New England
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Operating Reserves Markets

• Locational Forward Reserves Market
  – Thirty Minute Operating Reserve
    • System Wide and Local
  – Ten Minute Non-Spinning Reserve

• Real-Time Reserves Markets
  – Co-Optimization of Energy and Reserves
    • Real Time Prices
      – Thirty Minute Operating Reserve (System-wide and Local)
      – Ten Minute Non Spinning Reserve
      – Spinning Reserve
Locational Forward Reserves Market

• Operating Reserves protect against unexpected generation or transmission outages.

• *Locational* Forward Reserve Market procures resources that can respond within 10 or 15 minutes to system-wide contingencies.
  – Resources procured seasonally through a sealed bid auction
  – Procures 30 minute resources required to protect import constrained areas

• Design includes performance penalties.
Real Time Reserves Pricing

• Joint optimization allows cost effectiveness to determine which resources should be dispatched for energy, and which should be designated for reserves in real-time.

• Real-Time pricing of operating reserves explicitly reflect energy opportunity costs or shortages as reserve prices.

• Send Correct Price Signals
  – Short term for real-time response
  – Long term for investment

• Real-Time pricing makes transparent the relative value of energy and reserves in real-time.
What Is Scarcity Pricing?

• An increase in the price of energy and operating reserves when the demand for energy and/or system operating reserves exceeds the available supply.
  – Reflects the value of operating reserves and the System Operator’s willingness to pay for operating reserves.
  – If available, system operator would dispatch energy up to the price cap to maintain sufficient operating reserves.
What Scarcity Pricing in New England Isn’t

• A Replacement for a capacity market
  – Even with scarcity pricing, the energy price cap is still in effect and limiting prices.

• Pricing based on the Value of Lost Load
  – Scarcity pricing prices more accurately prices operating reserves and energy based on the price cap, not the value of lost load.
How Is Scarcity Pricing Implemented?

- By pricing operating reserves in the real-time dispatch.
- A price for each reserve product is determined reflecting:
  - Opportunity Costs
  - Scarcity
How Were Scarcity Prices Determined?

- New England Offer Cap is $1,000/MWH
- The System Operator would be willing to pay up to $1,000 for energy to avoid a reserve shortage.
- Therefore, the maximum price for operating reserve would be $1,000.
# New England Scarcity Prices

<table>
<thead>
<tr>
<th>Product</th>
<th>Rest of Pool</th>
<th>Boston</th>
<th>Conn.</th>
<th>SW Conn</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMSR$_S$</td>
<td>$50</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
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<tr>
<td>TMNSR$_S$</td>
<td>$850</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
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<tr>
<td>TMOR$_S$</td>
<td>$100</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>TMOR$_L$</td>
<td>n/a</td>
<td>$50</td>
<td>$50</td>
<td>$50</td>
</tr>
</tbody>
</table>
Derivation of Scarcity Prices

• Consistent with operational requirements and practices

• Reflect the costs the ISO would be willing to incur to procure reserves given the $1000/MW Energy Cap.

• Reflect reserve shortages in stages for system and locational requirements.
Uses Of Scarcity Prices

– Allows the real time dispatch algorithm to achieve a feasible solution when a Reserve Constraint cannot be satisfied.

– Determines a real time Reserve Clearing Price (by product and location) when a Reserve Constraint cannot be satisfied.
Feasible Dispatch Solution

• Real time dispatch algorithm includes:
  – System TMSR Requirements
  – System TMNSR Requirements
  – System TMOR Requirements
  – Local reserve requirements for TMOR by Reserve Zone

• All real time reserve requirements calculated based on real time conditions.
Additional Dispatch Rules

• Unused MWs of higher quality reserves will be available to meet lower quality reserve requirements.
  – Lower quality Reserve Clearing Prices will cascade upward to higher quality Reserve Clearing Prices.

• Reserve capability of on-line Resources will be computed based on either 10*MRR or 30*MRR from DDP.

• Reserve capability of off-line Resources will be computed based on Offer data.
Dispatch Objective Function

- Minimize the cost of meeting all constraints from available Resources.

- Constraints include:
  - Nodal/system energy balance
  - Resource specific constraints (limits, MRR, etc.)
  - Transmission constraints (branch, interface, etc.)
  - System/local reserve requirements
Scarcity Pricing in Dispatch

• Value Of The Reserve Constraints Set To Scarcity Prices
• When a reserve constraint cannot be satisfied:
  – The constraint will bind
  – Reserve price will be set at appropriate scarcity price.
• This allows the dispatch algorithm to arrive at a feasible solution.
### Scarcity Pricing Example - Locational

**Initial conditions:**

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>EcoMin</th>
<th>EcoMax</th>
<th>Energy</th>
<th>MRR</th>
<th>Reserve</th>
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</thead>
<tbody>
<tr>
<td>GenA</td>
<td>25</td>
<td>25</td>
<td>100</td>
<td>$70</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>GenB</td>
<td>80</td>
<td>50</td>
<td>100</td>
<td>$50</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>GenC</td>
<td>0</td>
<td>5</td>
<td>25</td>
<td>$150</td>
<td>C10=25</td>
<td>25</td>
</tr>
<tr>
<td>GenD</td>
<td>0</td>
<td>5</td>
<td>25</td>
<td>$200</td>
<td>C30=25</td>
<td>25</td>
</tr>
</tbody>
</table>

GenA and GenB committed, Local Reserve Req’t = 100 MW
Interface Limit = 200 MW, Interface Flow = 150 MW
Local Load = 255
System LMP = $50, Reserve Prices = $0
Conditions at t=0
Local Load = 255

Reserve Zone

GenA 25  R=30
GenB 80  R=20
GenC 0   R=25
GenD 0   R=25
Load 255
L Res = 150
Local LMP $50
L RCP = $0

System
Limit = 200
Actual = 150
System LMP = $50
System RCPs = $0

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Conditions at t=1

Local Load = 300

Energy Balance is satisfied
Local Reserve Req’t is satisfied
Conditions at t=2

Local Load = 310

GenA  30  R=30
GenB  100  R=0
GenC  0  R=25
GenD  0  R=25
Load = 310
L Res = 100
Local LMP = $70
L RCP = $15

System

System LMP = $55
System RCPs = $0

Limit = 200
Actual = 180

Energy Balance is satisfied
Local Reserve Req’t is satisfied
Re-dispatch of Interface - similar to Gen opportunity cost

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Conditions at $t=3$

Local Load = 351

- GenA 70 R=30
- GenB 100 R=0
- GenC 0 R=25
- GenD 0 R=25
- Load = 351
- L Res = 99

Local LMP = $105$
L RCP = $50$

Energy Balance is satisfied
Local Reserve Req’t is violated

System LMP = $55$
System RCPs = $0$

Limit = 200
Actual = 181
Conditions at $t=4$

Local Load = 371

Reserve Zone

- GenA  71  R=29
- GenB  100 R=0
- GenC  0   R=25
- GenD  0   R=25

Load = 371
L Res = 79
Local LMP = $120
L RCP = $50

System

- System LMP = $55
- System RCPs = $0

Energy Balance is satisfied
Local Reserve Req’t is violated
Reserve Shortages

- Previous example shows local reserve shortage and use of local RCPF.
- Similar concept employed for system reserve shortages.
- Typical condition would begin with a shortage of TMOR followed by shortage of TMNSR, and in extreme cases, a shortage of TMSR.
- Under this scenario, system TMOR constraint would bind first followed by system TMNSR constraint and finally system TMSR constraint.
Reserve Shortages

• Frequency of System Reserve Shortages
  – Historical analysis indicates that the Control Area has experienced a deficiency in Operating Reserves (TMOR) in real time approximately 0.26% of time.

  – Of the total Number of deficient conditions (24), five resulted in a deficiency of TMNSR, and of the five, three may have resulted in a deficiency of TMSR.
Scarcity Pricing and the Forward Capacity Market

• Wholesale Markets Objective:
  – Provide proper price signals to obtain the energy and ancillary services needed to reliably operate.

• Consistent with Scarcity Pricing Capacity Market Design has to be:
  – Maintain the incentives to perform in shortages
  – Assure that prices are correct
Forward Capacity Market: Performance Incentives

• Capacity Payments Reduced For Resources Unavailable In Reserve Shortages, AND

• Energy Option During Hours Of Scarcity Pricing.
  – System-wide Shortages only
    • Capacity Resources Must Provide Energy Or Operating Reserve When Prices Exceed The Cost Of A Peaking Unit With A 22,000 Heat Rate
  – Capacity Payment To All Resources Is Reduced By This Amount.
FCM Performance Incentive – Energy Option

• Capacity Market provides Energy Price Hedge.
  – Load exposure to energy price capped at strike price
  – High scarcity prices for those selling capacity

• A supplier that wins 10% of ICR in auction has sold call options to cover 10% of load in hours of system-wide scarcity pricing.
  – Load = energy + required reserves
  – It must hedge 10% of load during all hours of scarcity pricing
FCM Performance Incentive – Energy Option

• The hedge is priced properly
  – Based on Suppliers’ Bid in competitive auction

• Capacity Market Design hedges weather risk:
  – Most scarcity conditions are driven by extreme weather.
  – In an energy only market, the weather uncertainty would drive up energy prices.
  – The Capacity Market hedges this weather risk. If there are three years with no high prices, resources receive full capacity payment, reducing risk and lowering capacity costs.
FCM Performance Incentive – Energy Option

- Reduces Incentives to Exercise Market Power in energy market.
  - If a supplier withholds from the market, its capacity payment is reduced and it doesn’t earn the energy market revenues.
- Rewards those who perform when needed.
- Over time, should reduce need for capacity.
FCM Performance Incentive – Shortage Hours

- In Addition to Energy Option
- Resources unavailable in shortage events get reduced capacity payments.
  - Penalty = 5% of annual FCA Payment per event
  - Capped at 10% per day
  - Monthly penalty cannot exceed 2.5 times FCA Payment in that month
  - Annual penalties cannot exceed total FCA Payment less PER adjustments
  - FCA Payment = FCA cleared MW x Clearing Price
Questions and Discussion