Review of the Reserves and OpCap Markets:
New England’s Experience in the First Four Months

Peter Cramton
Professor of Economics, University of Maryland
President, Market Design Inc.
cramton@umd.edu www.cramton.umd.edu
www.market-design.com
November 17, 1999

Outline

• Scope and purpose of review
• Definitions and design objective
• Conclusions
• Recommendations
• How the markets work
• Market design flaws
• Details of recommendations
Scope of review

- Examine reserves and operable capability markets
  - TMSR: ten-minute spinning reserve
  - TMNSR: ten-minute non-spinning reserve
  - TMOR: thirty-minute operating reserve
  - OpCap: operable capability
- Data analysis covers May 1 to August 31, 1999
- All seven NEPOOL markets examined, since interrelated
- All bid, pricing, and settlement data examined
- Only an initial “first-order” analysis conducted due to time constraints
- Recommendations are preliminary and underdeveloped

Purpose of review

Independent review of markets (views are my own)

- Identify potential market flaws
- Look at performance of markets to see if potential problems materialized
- Evaluate ISO’s short-term remedies for market flaws
- Propose alternative medium-term solutions to identified problems
Definitions

• Short term
  – Can be (or is) done now

• Medium term
  – Can be done in a few months

• Long term
  – Can be done as part of the CMS/MSS redesign of markets (probably not until 2001)

Medium-term recommendations are severely limited by requirement that they can be implemented in a few months

Objective used in evaluating markets

Efficiency

• Do the rules send the right price signals?
• Do the rules minimize opportunities for gaming?
• Do the rules encourage system reliability?
Conclusions

• Energy market is working reasonably well
• Reserves and OpCap markets are seriously flawed
  – Losing bidders face the same obligations as winning bidders
  – In times of scarcity, prices are arbitrarily high
• Markets are working surprisingly well in light of flaws
  – Design flaws have not proved fatal
  – Bidders have not fully exploited gaming opportunities
• ISO’s short-term remedies are essential response to design flaws
  – Market-based caps on prices
    • reserve markets capped by energy price
    • OpCap market capped in OP 4 by 5 times average of three-highest non-OP 4 prices in prior 30 days
• Medium-term remedies can improve markets further

Medium-term recommendations

• Eliminate OpCap market
• Adopt smart buyer model for the reserve markets
• Restructure the reserve markets
• Develop long-term solution for reserve markets
# Salient Features of the NEPOOL Markets

<table>
<thead>
<tr>
<th>Market</th>
<th>Product</th>
<th>Residual or full requirements</th>
<th>Bid Submission</th>
<th>Settlement (all markets are settled after the fact)</th>
<th>Cost Burden</th>
<th>Losers provide the service?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>Electrical energy in MWh</td>
<td>Residual</td>
<td>Hourly bids submitted day-ahead</td>
<td>Single hourly clearing price</td>
<td>Load</td>
<td>No</td>
</tr>
<tr>
<td>Automatic generation control (AGC)</td>
<td>Automated load following in mWh</td>
<td>Full requirements</td>
<td>Hourly bids submitted day-ahead</td>
<td>Single hourly clearing price plus payment for AGC actually provided</td>
<td>Shared proportionally by load</td>
<td>Yes</td>
</tr>
<tr>
<td>Ten-minute spinning reserve (TMSR)</td>
<td>Reserves that are synchronized to the system and capable of responding within ten minutes in MW</td>
<td>Full requirements</td>
<td>Hourly bids submitted day-ahead</td>
<td>Single hourly clearing price plus payment for AGC actually provided</td>
<td>Shared proportionally by load</td>
<td>Yes</td>
</tr>
<tr>
<td>Thirty-minute operating reserve (TMOR)</td>
<td>Reserves that are capable of responding within thirty minutes in MW</td>
<td>Full requirements</td>
<td>Hourly bids submitted day-ahead</td>
<td>Single hourly clearing price</td>
<td>Shared proportionally by load</td>
<td>Yes</td>
</tr>
<tr>
<td>Operable capability (OpCap)</td>
<td>Operable capacity of each participant in MW</td>
<td>Residual</td>
<td>Hourly bids submitted day-ahead</td>
<td>Single hourly clearing price based on bids of participants with excess operable capacity</td>
<td>Participants who are deficient pay those with excess</td>
<td>Yes</td>
</tr>
<tr>
<td>Installed capability</td>
<td>Installed capacity of each participant in MW</td>
<td>Residual</td>
<td>Monthly bids submitted day before month starts</td>
<td>Single monthly clearing price based on bids of participants with excess installed capacity</td>
<td>Participants who are deficient pay those with excess</td>
<td>Yes</td>
</tr>
</tbody>
</table>

## Purpose of OpCap and reserves

Provide dispatch flexibility so that ISO can balance uncertain supply and demand in real time.
Basic design of New England market

- On day ahead, the ISO receives bids for energy, reserves, and OpCap markets
- ISO performs unit commitment to match supply and demand subject to the constraint that there is sufficient dispatch flexibility
- Committed units and offline units are obligated to respond to dispatch instructions unless declared inoperable
- At any instant, the amount of
  - TMSR is unloaded capacity of online units that can ramp in 10 minutes
  - TMSR + TMNSR is unloaded capacity of online and offline units that can ramp in 10 minutes
  - TMSR + TMNSR + TMOR is unload capacity of online and offline units that can ramp in 30 minutes

Basic design of New England market

- For OpCap and reserve markets, ISO forms aggregate supply curve
- Demand curve is fixed reserve requirement
- After the fact, the ISO finds the clearing price at the intersection of supply and demand
- Bids at or below the clearing price are accepted
- These winning bids are designated for reserves, and the winning bidders are paid the clearing price for each MW of designation
Losing bidders face the same obligation as winning bidders

(a) Current Market Structure for Reserves

There is no difference in the costs or risks incurred by those participants who receive payment in the market and those who do not

Incentive for bids of 0 (better to be paid than not)

In times of scarcity, prices in these markets are arbitrarily high

- In Operating Procedure 4 conditions, there is a shortage of reserves (or OpCap)
- ISO must accept all bids, regardless of price
- Prices may be arbitrarily high with no basis in cost and no economic constraint on behavior
  Incentive for arbitrarily high bids
- “Ask and it shall be given” game
  - Each bidder names a price
  - All bidders are paid the highest bid
Two flaws lead to severe gaming in OpCap

Consider 1000 MW unit:

- Bid $0 on first 999 MWs, so get paid clearing price on entire capability (less 1 MW) during normal times
- Bid $999 on last 1 MW, so get at least $999 on entire capability in times of scarcity

**Best of both worlds:** get the clearing price on the largest possible quantity absent scarcity, and then in times of scarcity set an extremely high clearing price and receive it on the entire quantity!

Gaming in reserve markets also

- Only bid a single price in each market, not a schedule, so cannot do extreme gaming (except those with many units)
- Bid $0 if think that it is sufficiently unlikely that you will set the clearing price
- Bid a modest amount if you think that you have a reasonable chance of setting the clearing price, but you think that the clearing price will be low
- Bid $999 in times of scarcity
- If you have many units, you can bid all but the smallest at $0 and then bid $999 on the last unit (hence, get paid for as large a quantity as possible, and set a high price in times of scarcity)
Eliminate OpCap market

- Severe market flaws
  - Winning and losing bidders face same obligations
  - Arbitrarily high prices in times of scarcity
- Market serves no purpose
  - ISO needs dispatch flexibility; market does not provide dispatch flexibility
    - Can bid 1000 MW unit with a ramp rate of 1 MW/hr
    - Unit is worthless for dispatch flexibility yet it gets full 1000 MW credit as operable capability
  - reserve markets are better able to reward dispatch flexibility
  - With well-run energy and reserve markets, OpCap is totally redundant, even if redesigned to address market flaws
  - OpCap is an option with an unspecified strike price; such an option is worthless

Adopt smart buyer model for reserves

Under the smart buyer model, the ISO:
- Never pays for additional reserves more than the economic value of the additional reserves
- Reduces its demand for reserves as prices increase
- Shifts purchases toward higher quality reserves when they are priced less than lower quality reserves

*ISO currently does 3rd bullet by treating reserves as a cascade in both quantities and prices
1st and 2nd bullet come from demand curve for reserves*
Constructing the demand curve for reserves

• Setting a fixed reserve requirement results in a vertical demand curve for reserves (same quantity of reserves is required regardless of price)
• True demand curve for reserves comes from the marginal value that an additional MW of reserves brings to system
• Calculated from shadow price of additional MW of reserves, which is the change in probability of lost load times the value of lost load
• As reserves are added, each additional MW results in a smaller decrease in the probability of lost load
• Hence, true demand is downward sloping curve
• Must be careful in estimating POLL and VOLL

Constructing the demand curve for reserves

In medium term, one possible option is:
• Cap shadow price at energy price
  – Justified if energy demand is not vertical
  – Then can shift a MW of energy to reserves, and marginal value of energy is just the energy price
• Set a floor on the TMSR price equal to the largest lost opportunity cost among those providing spin
  – Guarantees that everyone providing spin is compensated at least their lost opportunity cost (and typically more)
• Otherwise, reserve price is shadow price of an additional MW of reserves, calculated from the reduction in the probability of lost load times the marginal value of lost load
Revise market structure for reserves

- No bids are submitted in reserve markets
- Recognition that supply curve for reserves is vertical under current NEPOOL rules
- Everyone that provides dispatch flexibility is paid clearing price
- Clearing price is determined from intersection of true demand curve and true supply curve
Reserve markets with plenty of supply

[Diagram showing supply and demand with price and quantity axes, labeled P_{\text{spin}} and Q_{\text{spin}} for initial conditions and P_{\text{spin}+10} and Q_{\text{spin}+10} for contingencies.]
Reserve markets with plenty of supply

Reserve markets with tight supply
Reserve markets with tight supply

Price

$P_{spin}$

$P_{10}$

$P_{30}$

Quantity

$Q_{spin}$

$Q_{spin+10}$

$Q_{spin+10+30}$

$S_{spin+10}$

$D_{spin+10}$

$D_{spin+10+30}$
Summary of medium-term recommendations

- Eliminate the OpCap market.
- Establish a downward sloping demand curve for reserves. The demand curve would be capped in real-time by the energy price or zero, whichever is larger.
- Pay the clearing price to all resources that provide the service.
- Establish the true real-time supply curve as simply the quantity of the resource made available in real time. The current service availability bidding would be eliminated.
- Establish back down bids in the TMSR market. Bids would be infrequent, perhaps monthly.
- Never set a price in the TMSR market less than the largest lost opportunity cost.
- Continue to cascade the quantities of the bids between operating reserve products. (Bid prices would not be cascaded because they would not exist.)
- Correct the classification of off-line units that provide a service that looks and acts like TMSR.