NYISO
Day-Ahead Market Overview

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NYISO Markets
A showcase in advanced market design

- Full two-settlement LBMP market for Energy and Reserves
  - Forward and Real-Time Markets
  - Co-optimization of Energy, Operating Reserves and Regulation
    - Bid-Based Security Constrained Economic Dispatch (SCED) and Security Constrained Unit Commitment (SCUC)
  - Scarcity pricing for operating reserves
  - Virtual Bidding
  - Demand Side Participation
- Transmission Congestion Contracts (TCC)
- Installed Capacity Markets (ICAP)
State of the Markets

“The NYISO markets are at the forefront of market design and have been a model for market development in other areas.”

Dr. David Patton
Potomac Economics
Independent Market Advisor
2009 State of the Market Report for the NYISO
State of the Markets (cont.)

The NYISO was the first to:

- Jointly optimize the economic selection of energy and operating reserves
- Utilize locational requirements in operating reserve and capacity markets
- Introduce a demand curve to more effectively value incremental capacity and stabilize capacity prices
- Institute operating reserve demand curves that more efficiently determine price during shortage conditions

The NYISO is the only market to:

- Implement an optimized system to economically dispatch gas turbines and schedule external transactions
- Institute a mechanism for gas turbines to set energy prices when economic
- Develop a real-time dispatch system that optimizes over several time periods
Unit Commitment is at the heart of our Market Systems

Input
- Bids/Offer
- Forecasts

Bids & Offers
- GEN Supply
- LSE
- Virtual
- Regulation
- Reserve
- Bi-laterals
- Import/Exports
- Demand Response

SCUC

Output
- Least Cost Solution
- Meet reliability needs

Post Results
- Clearing Prices
  - LBMP (GEN & Zonal)
  - Reserve
  - Regulation
- GEN Schedule
- Transmission Schedule
- Bilateral Transactions
- Reserve Commitment
- Regulation Commitment

Security Constrained Economic Commitment and Dispatch
Generator Bidding Flexibility

- Fully featured market bidding capabilities
- Hourly bidding flexibility:
  - **Startup Cost**
  - **Minimum generation bid and MW**
  - **Incremental energy in 11 bid/MW pairs**
  - **Normal and emergency operating limits**
  - **Operating reserve bids**
  - **Regulation reserve bids and availability**
- Self-scheduling and economic scheduling options
- Response rates for normal, emergency and regulation operation
- Minimum run time, minimum down time, maximum starts per day
Load Bidding Flexibility

- Fully featured market bidding capabilities
- Hourly bidding flexibility
- Fixed load requirements
- Bilateral load
- Price capped load in 3 bid/MW pairs
- Demand Response with all generator bid characteristics
Four Pass Methodology

- Bid load pass
  - Including Local Reliability Requirements (LRR) evaluation
  - Including Automatic Mitigation Process (AMP)
- Bulk Power System (BPS) Forecast pass
- Forecast Re-dispatch pass
- Bid Re-dispatch pass
Bid Load Pass

- Evaluates generation bids to solve to the bid load and insure network security
  - *Initial Unit Commitment (IUC)*
  - *Network Data Preparation*
  - *Network Security Analysis* – evaluates impact of contingencies on the IUC or NCUC
  - *Network Constrained Unit Commitment (NCUC)* – determines schedules that satisfy both commitment constraints and network security constraints

- Optimization to minimize total production cost
- Includes In-City mitigation evaluation
- Load is a combination of fixed and zonal price-cap load/virtual load
- Solves for bulk power system (BPS) facilities and contingencies
Automatic Mitigation Procedures (AMP)

- Integrated into the Day-Ahead and Real-Time market solutions for generators located In-City
  - **Conduct** – evaluate generator bids (submitted hourly) for conduct based on specified thresholds and reference bids
  - **Impact** – if conditions exist that enable the exercise of market power (for example transmission constraints) then generators that have conduct will be evaluated for impact
  - **Mitigation** – if a generator is found to have impact, its bids will be substituted with reference bids
Bid Load Pass – LRR Evaluation

- As of February 2009, the Local Reliability Rules (LRR) are incorporated with the Bid Load Pass.
- Solves for additional capacity constraints for New York City network security
- LRR capacity constraints are developed and evaluated using the NYISO forecast load
- A Day-Ahead Reliability Unit (DARU) may be designated by a TO or the NYISO for commitment for reliability reasons in advance of the DAM
- Advantages of including LRR within the Bid pass: Allows economic de-commitment of units that are not required after securing local reliability rules and reduces the potential for SREs
- Optimization to minimize total production cost given reliability requirements
Bulk Power System (BPS) Forecast Load Pass

- Determines the additional generators required to meet the NYISO forecast load
- Price sensitive and virtual resources are not included in this evaluation
- Capacity evaluation – modifies generator cost curves to consider start up and minimum generation costs only
- Optimization for least additional uplift
- Solves for bulk power system (BPS) facilities and contingencies
- Wind forecast incorporated
Forecast Re-Dispatch Pass

- Economical re-dispatch of commitments determined from previous passes using original cost curves (or mitigated curves where applicable)
- Dispatches to NYISO forecast load
- Price sensitive and virtual resources are not included in this evaluation
- Produces hourly load flows for review by TOs regarding local reliability
- Interface flows used in Available Transfer Capability (ATC) calculation
Bid Re-Dispatch Pass

- Economical re-dispatch excluding GTs added during either forecast pass (Note: GTs are re-evaluated for commitment in Real-Time)
- Dispatches to bid load
- Load is a combination of fixed and zonal price-cap load/virtual load
- Results in settlement prices and schedules
Co-optimizing for Operating Reserve

- Market based service to ensure backup generation is available in the event of a system contingency
- This service is provided by:
  - Generators
  - Demand Side Resources
- Establish market based prices for each service and location based upon the results of the competitive auction
- Demand procures service from Day-Ahead Market
- Suppliers compete in Day-Ahead and Real-Time Market
  - Forward contracts issued from Day-Ahead Market
Co-optimizing for Regulation Reserve

- Market based service for regulation and frequency response to provide for the continuous balancing of resources with demand
- This service is provided by:
  - Generators
  - Flywheels and Batteries (LESRs)
  - Demand Side Resources
- Establish market based prices for the service based upon the results of the competitive auction
- Demand procures service from Day-Ahead Market
- Suppliers compete in Day-Ahead and Real-Time Market
  - Forward contracts issued from Day-Ahead Market
Day-Ahead to Real-Time Transition

Bids by 5 a.m. Day before

Day-Ahead Market (SCUC)

Forward Contracts

Bids by 75 min before hour

Hour-Ahead Process (RTC)

Hourly Schedules

Supplemental Resource Evaluation

Actual Conditions

Real-Time Market (RTD)

5-minute Schedules

Gen

SCUC = Security Constrained Unit Commitment
RTC = Real Time Commitment
RTD = Real Time Dispatch

Forward Contracts

Day-Ahead Market (SCUC)

Hour-Ahead Process (RTC)

Supplemental Resource Evaluation

Real-Time Market (RTD)

5-minute Schedules
Energy Market Timeline

**Who**

**Market Participants**

- Load Forecast, Load Energy Bids, Generator Offers for Energy, Reserve and Regulation and DADR bids submitted for the day-ahead market

**NYISO**

- Posting of day-ahead schedules and LBMPs

**Market Participants**

- Real-time bid submission deadline

**NYISO**

- Dispatch signals and calculation of RT LBMPs

**What**

**Day Ahead**

- 5 A.M.

- 11 A.M.

**SCUC**

**Real Time**

- 75 Min. prior to Op. Hr.

**RTC & RTD**

**Operating Hour**
Future Considerations

❖ Market Functionality
  ▪ *Expanded opportunities for virtual trading participation in the Day-Ahead Market*
  ▪ *Enhanced Interregional Transaction Coordination with neighboring systems (PJM and ISO-NE) under development.*
  ▪ *Integration of demand response into the real-time energy market*
  ▪ *Aggregations of demand response providers in the energy and ancillary service markets*
  ▪ *Smart Grid and PHEV potential applications*

❖ Software Algorithms
  ▪ *Evaluating the capabilities and performance of MIPs solution engine*
Future Considerations

- Achieving necessary execution times may become more difficult with increasingly complex market functionality and volume of participants
- Identifying the best way to address in-hour variability in an hourly Day-Ahead Market solution
- Capturing increased levels of intermittent generation uncertainty in the most efficient and reliable manner
NYISO uses ABB’s Ranger Platform for its Security Constrained Unit Commitment (SCUC) Function

NYISO SCUC implementation uses the Lagrangian Relaxation methodology for Its Optimization Engine.
Update on MIP
MIP Study

- Previous performance testing reached infeasible solutions at 4x current virtual bid volume
- Technical achievements allowed us to overcome this constraint
- Able to test MIP and LR up to 20x current virtual bid volumes
- As indicated on the next slide, MIP and LR have comparable run times and results.
MIP Feasibility July 2010

LR vs. MIP UC Performance

UC Run Times

Bid Volumes

LR Avg. MIP Avg.
Current Configuration

Current Itanium Configuration

Ranger

- Bids → UC Input → LR → ED
- UC Output
- AMPL Input x.tab → AMPL MIP → AMPL Output x.tab
- Model Files
  - Control Files
  - (x.mod, x.run, x.opt)
Proof of Concept Configuration

Current Itanium Configuration

Ranger

Bids → UC Input → LR → ED

UC Output

AMPL Input x.tab → AMPL MIP → AMPL Output x.tab

Model Files
Control Files
(x.mod, x.run, x.opt)

Power7/AIX Configuration
MIP Feasibility Update 2011

❖ Background
  ▪ Alternative Hardware being investigated
  ▪ Testing performed on Power 780 and 740
  ▪ Required implementation of AIX (OS) and MIP

❖ Benefits
  ▪ Preliminary test performed using 3 test cases
    • Showed promising results from up to 260 - 280% improvement on MIP calculation
    • This would put performance within acceptable run times
MIP & LR Next Steps

- NYISO will continue to validate the feasibility of MIP’s use in the DA process, focusing on 1) optimal commitment solutions and 2) production cost savings.
  - *NYISO is evaluating several proposals from our vendor, ABB, which promise to significantly improve run times for MIP implementations.*
- NYISO will look to implement the MIP solution in the near future.
The New York Independent System Operator (NYISO) is a not-for-profit corporation responsible for operating the state’s bulk electricity grid, administering New York’s competitive wholesale electricity markets, conducting comprehensive long-term planning for the state’s electric power system, and advancing the technological infrastructure of the electric system serving the Empire State.

www.nyiso.com