

GridView Market Simulation

# Day-Ahead Market Challenges

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*Jin Zhu*  
(919) 807-8246  
[jinxiang.zhu@us.abb.com](mailto:jinxiang.zhu@us.abb.com)

# Day-Ahead Market

- **Day-Ahead Market (DAM) vs Real-time Market (RTM)**
  - DAM determines unit commitment and CRR value
  - RTM read commitment codes from DAM
  - RTM could adjust commitment and CRR payment due to Virtual Bids
  - Virtual bids in DAM but not in RTM
- **Uncertainties**
  - Load forecast v.s. actual load
  - Wind forecast v.s. actual wind generation
  - Generation and transmission outages
  - Transmission interface limits
  - PAR settings
  - External transactions and loop flows

# NYISO Day-Ahead Market

- **Day-Ahead Market (DAM) Inputs**
  - current generating unit operating status
  - constraints on the minimum up and down time of the generators
  - generation and start up bid prices
  - plant-related startup and shutdown constraints
  - minimum and maximum generation constraints
  - generation and reserve requirements
  - transmission facility maintenance schedules
  - transmission constraints
  - phase angle regulator settings
  - transaction bids

# Day-Ahead Market Modeling Challenges

- **Virtual Bids**
- **Dynamic Limits of Transmission Constraints**
- **Compressed Air Energy Storage (CAES)**
- **Concentrated Solar Power with Storage (CPS)**
- **Plug-in Hybrid Electric Vehicle (PHEV)**
- **Pumped Storage Operation**

# Virtual Bids

- **Virtual Generators**
  - Up to 10 Blocks with monotonic increasing cost bids
- **Virtual Demands**
  - Up to 10 Blocks with monotonic decreasing cost bids
- **Virtual Bids**
  - Can be distributed to multiple buses or multiple areas
  - Treated as real generator/Demand in DAM
  - Not active in RTM
  - Need DAM and RTM settlement to access the benefits of Virtual Bids
  - RTM simulation will start with DAM unit commitment

# Virtual Bid Implementation

- **Load Models in DAM and RTM**
  - RTM inherit load forecast from DAM
  - RTM could adjust load by temporal data for area loads
- **Generator's Start-Up Time**
  - Time required to commit a cold-start unit on-line, in Hours
  - RTM commits additional generator whose start-up time less than 5 hours, if capacity shortage
- **Virtual Bid Impacts**
  - DAM LMP, how about RTM LMP?
  - CRR payment
  - DAM settlement and RTM settlement

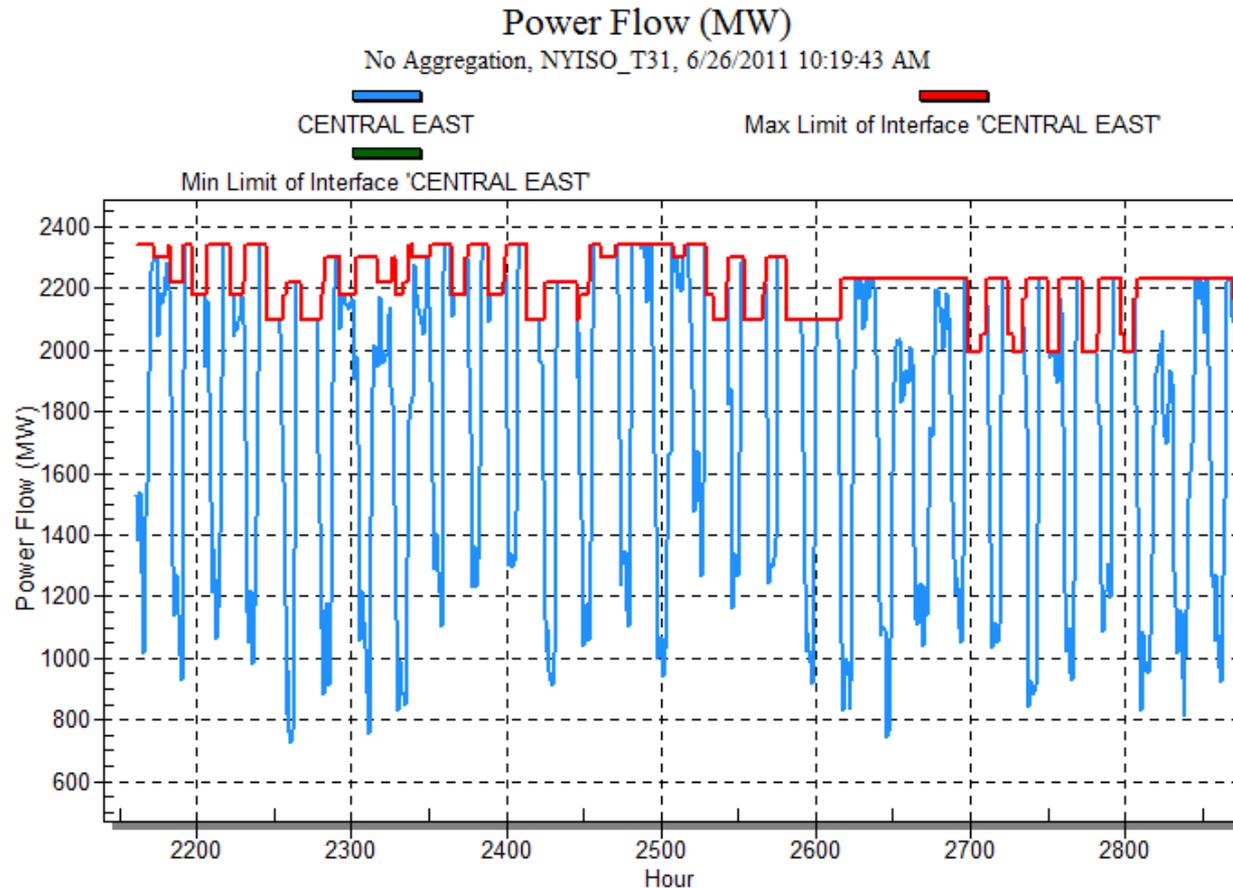
$$Credit = VirtualGen^{DA} * LMP^{DA} + (-VirtualGen^{DA} * LMP^{RT})$$

$$Credit = -VirtualLoad^{DA} * LMP^{DA} + (VirtualLoad^{DA} * LMP^{RT})$$

# Day-Ahead Market Modeling Challenges

- **Dynamic Limits of Transmission Constraints**
  - Dynamic line ratings – A Smart Grid Technology
    - Temperature, wind speed/direction, radiation
    - Increase asset utilization, especially good to wind power delivery
  - Voltage and Stability Limits of Interface
    - Unit Commitment
    - Transmission outages

# A Voltage Stability Constraint

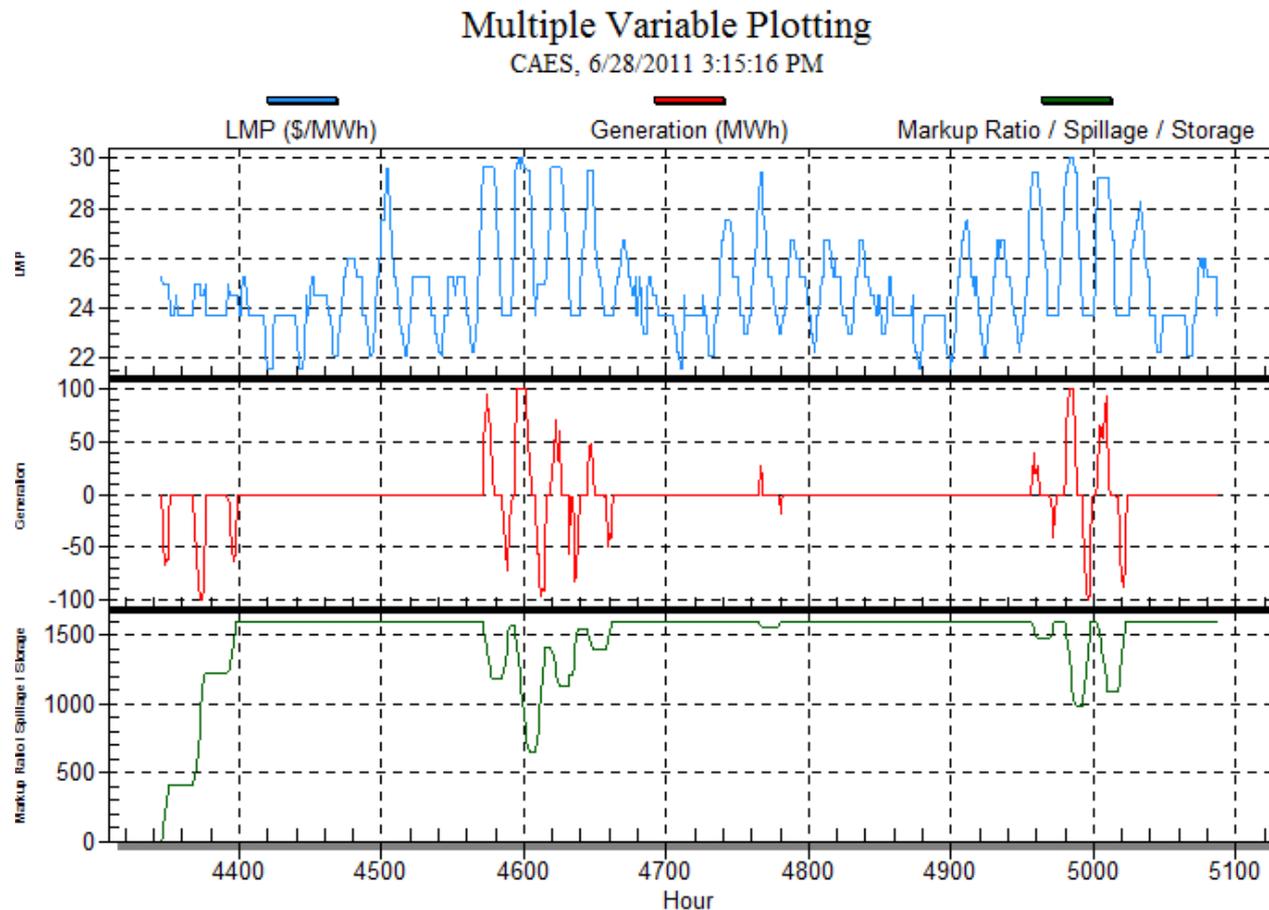


- Limit is dependent on unit commitment and transmission outages.
- Modeled as conditional constraints.

# Day-Ahead Market Modeling Challenges

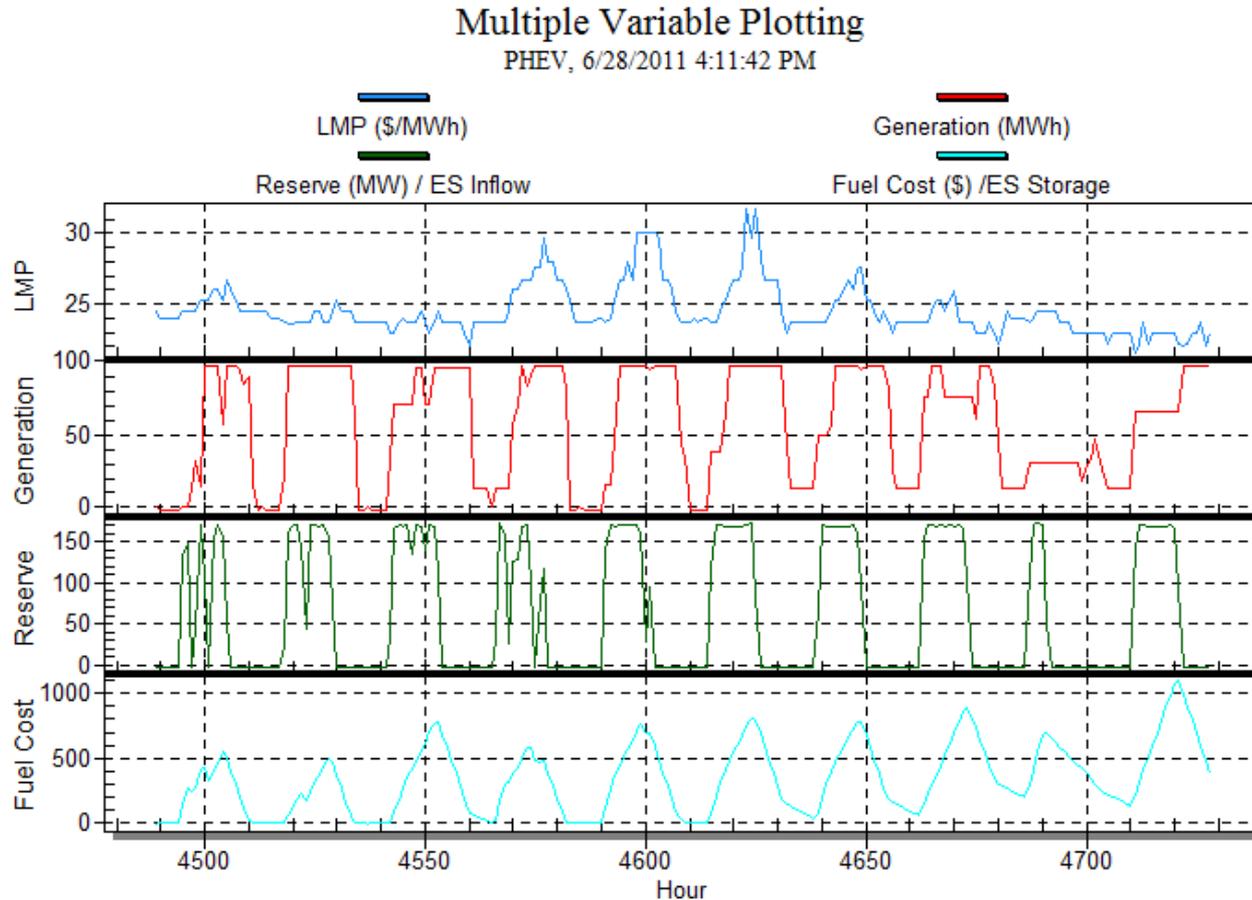
- **Concentrated Solar Power with Storage**
  - Tank Loss, Pump Loss, Startup Loss, Efficiency
  - Re-dispatch price
  - Limited storage capacity
- **Compressed Air Energy Storage (CAES)**
  - Generating with high efficient GT with compressed air
  - If compressed air storage is empty, GT cannot run
  - Maximum pumping price
  - Limited storage capacity

# Compressed Air Energy Storage



- Pumping air as price low, → Rolling average price for compressed air
- Generating cost is calculated based compressed air cost plus fuel cost
- Provides spinning reserve

# Concentrated Solar Power with Storage

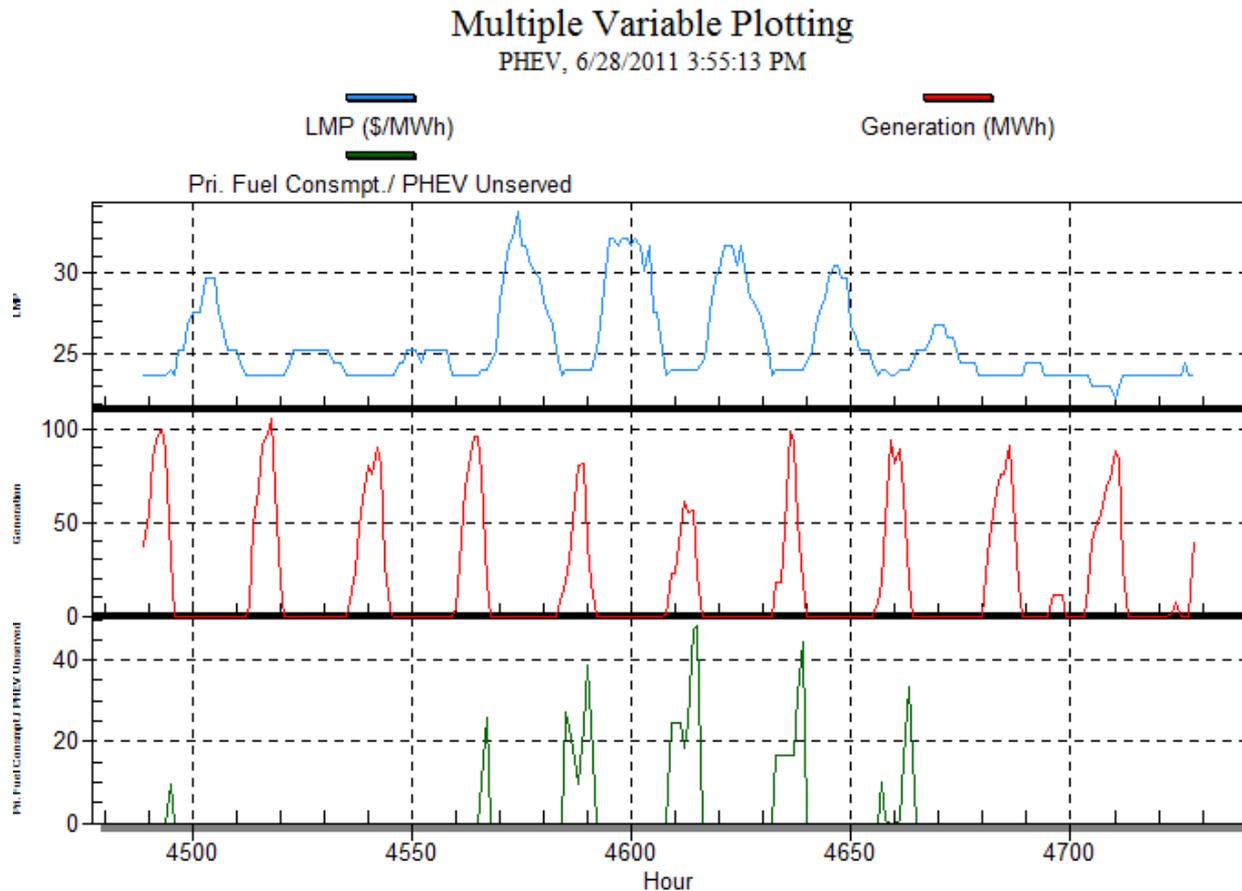


- Thermal storage can regulate the electric generation
- Provide spinning reserve
- Reduce volatility for market operation
- Stay on-line overnight if the storage available to save startup cost

# Day-Ahead Market Modeling Challenges

- **Plug-in Hybrid Electric Vehicle (PHEV)**
  - Dispatchable demand
  - Start and End Charging hours overnight
  - Maximum charging price
  - Daily Energy requirement

# Plug-in Hybrid Electric Vehicle



- PHEV can be unserved if the price is above its maximum charging price.
- Provides spinning reserve as charging.

# Day-Ahead Market Modeling Challenges

- **Pumped Storage Operation**
  - Price-driven decision making
  - Local congestion could affect profitability
  - Storage limits
  - Fixed block pumping

# PSP Simulation

## Detailed simulation model with transmission considerations

### GridView™ functionality

#### Scheduling modes

- Fixed schedule,
- Peak-shaving or
- Price-driven

#### Technology

- Fixed-block pumping or
- Variable-speed pumping

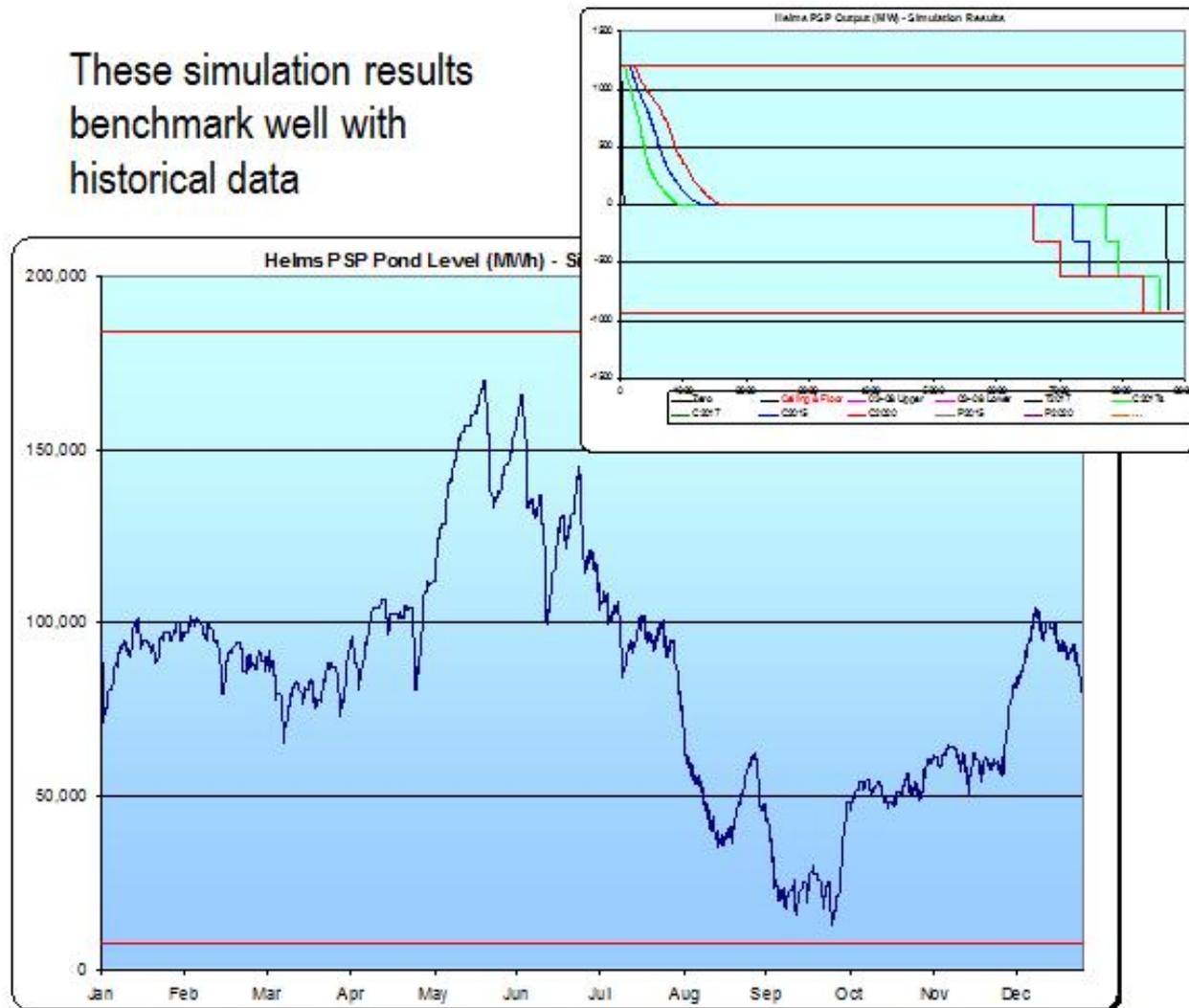
#### Transmission constraints

- Normal constraints
- Contingency constraints
- SPS in pumping mode

#### Control parameters

- Cycling efficiency
- Cost-benefit ratio
- Pond-level control

These simulation results benchmark well with historical data



# GridView Contact

**Jinxiang (Jin) Zhu**  
**Senior Principal Consultant, ABB Inc.**

**940 Main Campus Drive, Suite 300**  
**Raleigh, NC 27606**

**Email: [jinxiang.zhu@us.abb.com](mailto:jinxiang.zhu@us.abb.com)**  
**Phone: (919) 807-8246**  
**Fax: (919) 807-5060**

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