

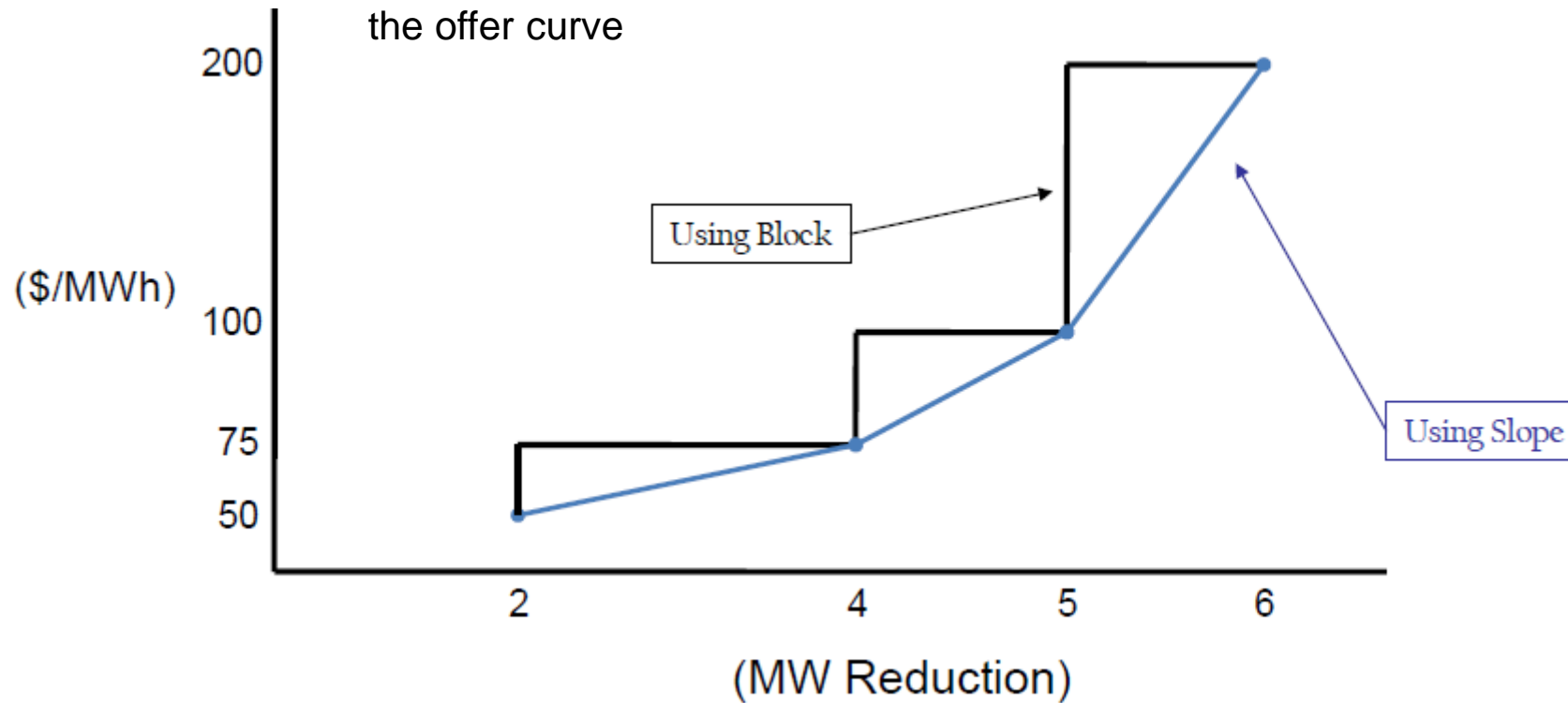
# Fixed / Price Sensitive Demand Bids, Load Response, Virtual Bidding & Pump Storage Optimizer in the Day Ahead Market

Keyur Patel - Sr. Lead Engineer, Day-Ahead Market Operations  
Stefan Starkov - Engineer, Day Ahead Market Operations  
Special MIC: Electric Storage Resource Participation Model  
June 14, 2018

Consumer's ability to reduce electricity consumption at their location when wholesale prices are high or the reliability of the grid is threatened.

- End-use customers participate in DSR via Curtailment Service Providers (CSP)
- Meter data required to establish Baseline (CBL)
- Offer curves are required for Energy Market participation (offers submitted via Markets Gateway)
- Only one offer curve can be made available on a daily basis
  - Market Type participation can be Day Ahead, Balancing or Both and is associated with a schedule that can be changed daily by the CSP
  - *DA Market* – If hour clears in DA market then DR should respond with associated MWs. PJM will not dispatch in RT for hours that clear in DA market.
  - *Balancing Market* – DR should follow RT dispatch signal
  - *Both* – If hour does not clear then hour is eligible to be dispatched in RT

- Markets Gateway allows for the selection of either Slope or Block
- Offer curves consist of MW-Price pair segments. Up to ten (10) segments can be defined for each offer curve
- Resource will be cleared / dispatched economically in accordance with the offer curve



Hourly demand quantities for which a participant commits to purchase energy at Day-Ahead prices for consumption in the next Operating Day. Bid must specify MW quantity and location (aggregate or bus)

- Fixed Demand → Location, MW                      Price-Sensitive Demand → Location, MW & Price
- Price-Sensitive Demand bids are accepted in single bid-blocks only (up to 9 segments may be submitted per market participant at a specific location)
- If a Market Buyer submits no Day Ahead bid information, then a 0 MW quantity is assumed
- The total MW quantity of Fixed and Price-Sensitive demand bids submitted by an LSE for a given Operating Day must not exceed the LSE's Daily Demand Bid Limit

- Increment (Inc) offer
  - Looks like a spot market sale or dispatchable resource
  - “virtual generator” (injects MW)
  - If LMP goes above offer price, Inc will be cleared
- Decrement (Dec) bid
  - Looks like a spot market purchase or price-sensitive demand
  - “virtual load” (withdraws MW)
  - If LMP goes below bid price, Dec will be cleared



WT-11



- INCs & DEC's are part of the Day-Ahead Supply curve
- Inc offers/Dec bids can be placed at any eligible trading point where either generation, load, or interchange transactions are settled, or at trading hubs where forward positions can be taken
- Treated just like generation to clear the market
- Can displace more expensive generators and set clearing price in the Day-Ahead Market

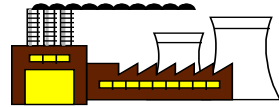
## INC Offer

- Sells MW into Day Ahead Market at High Price
- Buys replacement MW from Real-Time Market at Lower Price
- Profits when Day-Ahead Prices are Higher than Real-Time Prices

## DEC Bid

- Buys MW from Day Ahead Market at Low Price
- Sells those MW in Real-Time Market at Higher Price
- Profits when Day-Ahead Prices are Lower than Real-Time Prices

## Day-Ahead



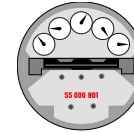
Participant offers 100 MW at \$30

 Assume Day-Ahead LMP= \$35

Day-Ahead Settlement = 100 MW \*  
\$35 = \$3,500 credit

**Day-Ahead Position = \$3,500**

## Real-Time



 Assume Real-Time LMP = \$20

Deviation from DA  
schedule = -100 MW

Balancing Settlement = -100 MW \*  
\$20 = \$2,000 charge

**Balancing Position = -\$2,000**

Net position = \$3,500 - \$2,000  
= \$1,500 credit



## Day-Ahead



Participant bids 100 MW at \$20

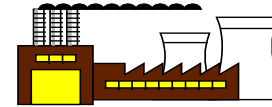
 Assume Day-Ahead LMP= \$15

Day-Ahead Settlement = 100 MW \*  
\$15 = \$1,500 charge

**Day-Ahead Position = -\$1,500**



## Real-Time



 Assume Real-Time LMP = \$25

Deviation from DA  
schedule = 100 MW

Balancing Settlement = 100 MW \*  
\$25 = \$2,500 credit

**Balancing Position = \$2,500**

Net position = -\$1,500 + \$2,500  
= \$1,000 credit

# Pump Storage Optimizer Input Parameters

- Initial Storage
  - Final Storage
  - Maximum Storage
  - Minimum Storage
  - Pump Efficiency
  - Economic Minimum (Gen)
  - Economic Maximum (Gen)
  - Economic Minimum (Pump)
  - Economic Maximum (Pump)
  - Minimum Run Time
  - Maximum Run Time
  - Minimum Down Time
- } Gen

- No offers are modeled in objective function for optimized pump storage hydro units
- Optimized Pump Storage hydro units can't set price
- Typically follow Day-Ahead Schedule in Real-Time
- Charged deviation if deviate from Day Ahead schedule