Energy Storage Resources (ESR) Cost Offer Development

Scott Benner
Senior Lead Engineer
Advanced Analytics
MIC February 6, 2019

Agenda

- Commitment
- Cost Development
- Opportunity Cost

Self-Scheduling and Commitment

- PJM does not plan to optimize an ESR's State of Charge
- In **Day-ahead Market (DAM)**, the market participant will:
  - Enter a profile of hourly-differentiated economic minimum and maximum limits for the market day
    - Each hour reflects the capability to produce or consume energy for the entire hour (in MW-h)
  - The unit will be considered "self-scheduled" / "running for company"; startup costs and no-load costs will be zero.

Day-Ahead Dispatchability

If there is a spread between min and max limits, then the unit will be economically dispatched on a participant-provided incremental offer curve

Operating Mode	Economic Min	Economic Max	If LMP < PRICE @ Min	If LMP > PRICE @ Max
Discharge (Injecting)	0 MW	Max MW > 0	No DA Commitment (0 MW)	Committed for Max MW
Continuous	Min MW < 0	Max MW > 0	Committed for Min MW	Committed for Max MW
Charge (Withdraw)	Min MW < 0	0 MW	Committed for Min MW	No DA Commitment (0 MW)

Why is this important?

- ESR are allowed to “self-schedule” to meet RPM must-offer req.
- Self-scheduled in DAM is considered “committed”
- Any unit can hourly-differentiate offers & limits in the DAM
- Only IDO-enabled units can update offers after Rebid up to 65 minutes before an interval, and are not committed for Day-ahead

- A unit that offered into DAM, with no committed MW (0 MW) should not be considered committed in RT so that it can update with IDO

Real-time Dispatchability

- DAM Commitment is not a RT “operating plan”
  - The participant is required to provide the DAM committed MW for the given hour, else they may be exposed to Deviation charges
  - The market participant is responsible for managing the real-time SOC to honor any DAM commitment

- The resource can modify the economic min and max limits to signal availability to charge/discharge in a given interval
  - If there is a spread between min/max, then the unit is potentially dispatchable, and eligible to set price with its energy offer

Why is this important?

- RTSCED solves a ramp-limited security-constrained economic dispatch for a *single interval* in “opportunistic” fashion
  - It does not optimize total energy (MWh) over future periods
  - The cheapest short run marginal cost unit will be dispatched first
  - At full injection, the battery may be depleted well before a peak

- Participants can modify economic max and min limits to represent their charge and discharge abilities in a given interval

Why is this important?

- PJM has a “fixed gen” flag where the resource self-schedules in real-time, injects whatever MW the unit wants, & is price-taker
  - Typically used for energy-only, intermittent, or renewables who don’t control output, but just want to be paid LMP for generation

- Otherwise, the unit is “economic”, and PJM follows the offer curve as bid-in. The participant determines the value of energy
- But what about *mitigation*?

Cost-based Offers

- There are situations where a participant may have *market power* when providing *reliability services*
  - Transmission Constraints, Reactive control, Black Start, etc.
  - During commitment, PJM executes the Three Pivotal Supplier (TPS) test to scan for market power in constraint relief

- The resource is switched to the cheapest of the available cost-based or price-based offers (cheapest schedule)
  - Cost-based schedule is typically short run marginal costs + adders

Types of Opportunity Costs

- Ancillary Service Opportunity Cost
  - A resource providing SR or REG “loses” the opportunity to provide its full range of energy *in the current interval*
  - This “product substitution” LOC is used in ancillary market pricing

- Operationally Limited Opportunity Cost
  - A unit has emission limitations that, if the unit runs *today*, it may not be available to run *later in the year* (e.g. at summer peak)
  - The Opportunity Cost Calculator (OPC) generates an cost-based adder that “optimizes” potential run hours; *evaluated daily*

Types of Opportunity Costs

- Limited Energy Opportunity Cost
  - A unit has charge limitations that, if the unit runs in *this interval*, it may not be available to run later in the *market day*

- Inter-temporal Opportunity Cost to Dispatch
  - Discharge now, then the marginal cost is the *inventory cost*
  - Discharge now, and have an opportunity to charge later, then the *replacement cost* is important for the future discharge interval
  - Without an operating plan, how does the ISO know when the unit would have wanted to run, and at what LMP?