### “Standard” Market Design – by components

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| Real-time Energy Market:       | Security Constrained Economic Dispatch | Dispatch energy resources in merit order (least-cost) while accounting for the following reliability and operational constraints | Dispatch energy resources in merit order (least-cost) while accounting for the following reliability and operational constraints:  
  - Ensuring all transmission assets are operated within acceptable thermal rating and voltage limits;  
  - Recognizing generator operating constraints such as minimum generation levels, ramp rates, capacity limits, minimum run times, min = max (inflexible generation) etc.  
  - Supply and demand are balanced at all times to ensure frequency is maintained at 60 Hertz (cycles per second)  
  If the least-cost set of resources cannot be dispatched due to transmission constraints, then some lower cost resources causing violations of transmission limits must be dispatched down to ensure safe and reliable operation of the transmission system while other higher cost resources that relieve the transmission constraints are dispatched upward to ensure supply-demand balance.  
  If generating units are inflexible or have minimum run times, some units may be operating that are higher costs due to these limits, and as a consequence some lower cost units may not be dispatched or dispatched downward to maintain supply-demand balance. | This is the mechanism through which prices in the real-time energy market are consistent with reliability and operational needs in operations. |
|                               | Locational Marginal Pricing (LMP):  | Pricing of congestion in real time                                       | The marginal cost to deliver 1 MWh of electricity any location on the system. It is the system-wide marginal cost of energy (assuming no transmission constraints), plus the marginal cost of congestion which is the cost of re-dispatching resources to ensure transmission | The cost of an unconstrained transmission system is cost prohibitive.  
  LMP in combination with market power mitigation |

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1 While there is no real “Standard” market design, the attached are components that are found in many markets. The particulars of the design may be different; however, the underlying basics are usually similar.
limits are maintained, plus the marginal cost of line losses on the system.

to guard against market power downstream of congested transmission facilities, allows competition for new generation or transmission to be built based on price signals.
Helps better manage the system in real-time operation by ensuring prices are consistent with dispatch for reliability and operational needs.

| Financial transmission rights | Payments based on price differences between different points on the transmission network | FTRs entitle their holder to receive a payment based on the difference of prices at two different points on the transmission system. FTR capture the congestion rent and redistribute it to the holders of the relevant FTR. There are more complex FTR in some markets.

  In PJM, for example, holders of transmission service, primarily load, are allocated FTRs or their financial equivalent, as a means to hedge congestion costs for serving load from generation that is not at the same location.

  When there are LMP (or just price differences at the boundary, FTR are held to hedge this type of price variation.

  FTRs are only meant to hedge the cost of congestion and not price differences associated with marginal losses.

  FTRs are functionally equivalent to holding physical transmission rights as both are a hedge against congestion costs. |

| Capacity performance period | Periods in which performance of capacity resources is assessed | These are hours in which the system is either in emergency conditions or approaching emergency conditions. The idea is that capacity purchased by load on the system is designed to be available to avoid such conditions or be available and operating during such conditions to avoid an involuntary load shedding event.

Incentivizes resources to be available as system conditions approach emergency levels so as to avoid involuntary load shedding. Moreover, it capacity commitments being backed up by good maintenance practices and outage scheduling to avoid such conditions if at all possible.

It may also have the side benefit of reducing real-time price volatility during extreme circumstances in which the system enters emergency conditions. |

| Ancillary Services | AS Products | Spinning or synchronized reserves to cover the largest | As day-ahead –products. Committing reserves and regulation day-ahead provides optionality in operation to keep these

Needed for reliability in operations. See co-optimization below for optimal pricing and |
| Co-optimization of energy and ancillary services | Opt. of dispatch across energy ancillary service products | The prices and commitments (where applicable) of energy and reserves and regulation are determined simultaneously so that the costs of supplying all products in minimized, and that the prices of energy and reserves are such that no generation resource would wish to be supplying another product | This ensures that energy ancillary service prices are consistent with the needs of the system to produce energy hold reserves in reserve. If energy AS are not co-optimized, prices for reserves could result in resources wanting to be reserves instead of producing energy as needed by the system. |
| Operating Reserve Demand Curve | Pricing during contingencies | Places a price on allowing the system to go short on holding reserves which is a signal of system stress. This ensures that if the system turns reserves into energy, without replacing those reserves, the system incurs an additional cost and this cost is reflected in the price of energy and price of reserves. In theory, the shorter the system becomes on reserves, the higher the cost and the higher will be the energy price. | Sends a price signal to generation resources and demand response that the system is close to shedding firm load and encourages additional generation (if available) and demand response to come into the market to maintain reliable operations. It also provides an additional incentive for resources to be available in real-time during system emergencies, and reinforces the incentives for generation to be available during system emergency conditions. |
| Reliability Unit Commitment | SCUC closer to real time (usually after close of a DAM) | Unit Commitment for reliability purposes. | Allows operators to commit resources that may be needed to meet forecast physical demand and meet reliability objectives if they were not committed in the Day-ahead Energy Market. |
| Day-ahead Energy Market (DAM) Security Constrained Unit Commitment (SCUC) | Similar to SCED. The commitment and hourly block dispatch energy resources in merit order (least-cost) while accounting for the following reliability generator operational constraints: | Going to be more variability in RT operation with additional intermittent generation integrated into the system, and helps ensure sufficient resources |
- Ensuring all transmission assets are operated within acceptable thermal rating and voltage limits;
- Recognizing generator operating constraints such as start-up times and costs, minimum generation levels and minimum run level costs, ramp rates, capacity limits, minimum run times, min = max (inflexible generation) etc.
- Supply and demand are balanced at all times to ensure frequency is maintained at 60 Hertz (cycles per second)

If the least-cost set of resources cannot be dispatched due to transmission constraints, then some lower cost resources causing violations of transmission limits must be dispatched down to ensure safe and reliable operation of the transmission system while other higher cost resources that relieve the transmission constraints are dispatched upward to ensure supply-demand balance.

If generating units are inflexible or have minimum run times, some units may be operating that are higher costs due to these limits, and as a consequence some lower cost units may not be dispatched or dispatched downward to maintain supply-demand balance.

If generating units with large start-up and/or minimum run costs are large, but running costs are low, they may be committed as part of the least-cost solution and could require uplift payments to make them whole financially if their market revenues are less than their costs.

Available and prices tend to be more stable DA than in RT providing more revenue certainty to controllable resources need for reliability purposes.

This is the mechanism through which prices in the day-ahead commitment are consistent with reliability and operational needs going into real-time operations.

Reduces risk for resources being committed through the market regarding the ability to cover costs as opposed to self-commitment as costs will at least be covered even if committed units do not run in real-time.

In combination with the real-time market, if energy prices are lower in real-time than day-ahead, backing down from the financially binding day-ahead schedule reward flexible resources that can reduce. This is especially valuable with increasing amounts of intermittent resources on the system.