

Fast Start Pricing

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Implement separate dispatch and pricing runs in day-ahead and real-time markets

Define fast-start resources as those with a total time to start and minimum run time of less than or equal to one hour

Amortize start-up and no-load in “effective” offer using integer relaxation

Validate composite offers greater than \$1000/MWh prior to setting price

Use lost opportunity cost (LOC) to provide incentive to follow dispatch

Address any issues regarding double payment stemming from implementation in day-ahead and real-time market

Fast Start Pricing allows quick start resources the ability to set price which improves performance incentives during tight system conditions through transparent price signals.

Separate dispatch and pricing runs will be executed in Day-ahead and Real-time Energy Markets



Dispatch Run

- Status Quo
- No modifications to resource parameters
- Determines desired dispatch points sent to resources



Pricing Run

- Modify resource parameters using integer relaxation
- Includes amortized startup and no-load costs in LMP formation for Eligible Fast-Start Resources
- Calculates the final LMPs and MCPs used for Settlement

- The pricing run is calculated via a subsequent optimization using same inputs as dispatch run optimization, but performs the following:
 - Uses integer relaxation to allow Eligible online Fast-Start Resources to be committed below Economic Minimum
 - Includes amortized startup and no-load costs in LMP formation for Eligible Fast-Start Resources, based on results of offer verification
- Constraints active in the dispatch run solution are included in pricing run solution:
 - Constraints may bind in dispatch run but may not bind in pricing run and vice versa
- Transient Shortage pricing is only triggered based upon the pricing run:
 - There are typically less reserves available in the pricing run than in the dispatch run, so false negative shortages (short in dispatch run but not in pricing run) are unlikely

- The “integer” in integer relaxation refers to the commitment status of a particular resource.
- In the dispatch run, the commitment variable is represented by a value of zero or one indicating whether the resource has been committed or not.
- In the pricing run, the commitment variable is allowed to fluctuate between zero and one rather than being forced to an integer state of one or the other.
- For example, if a 100 MW inflexible fast-start resource’s commitment variable is set to 0.5 in the pricing run, it indicates that 50 percent of the output of the unit was needed. If it was set to 0.75, 75 percent of the output of the unit was needed.

- Integer relaxation automatically incorporates commitment costs (start-up and no-load costs) into the clearing price calculation without the additional administration required by economic minimum relaxation.
- In the optimization model, the commitment variable is multiplied by the start-up and no-load cost parameters. Thus, increasing the commitment state of a resource causes the objective function to incur start-up and no-load costs automatically.
- Integer relaxation eliminates the need to modify multiple constraints in the optimization model as in economic minimum relaxation.

PJM defines fast-start resources as those with a total time to start and minimum run time of less than or equal to one hour.
All Economic Load Response are considered fast start capable resources.

Fast Start Capable

- Resources must first be deemed FS capable before being eligible to set price.
- Capability predefined bases on technology type
- Created request process for resource not deemed capable by default



Fast Start Eligible

- Must be capable and bid-in with:
 - Notification Time + Startup Time \leq 1 hour
 - Minimum Run Time \leq 1 hour
- Resources must be online and running for PJM

- Startup cost and No Load cost are amortized and included in LMP formation:
 - Startup cost is amortized across the resources Min Run Time
 - No Load cost is amortized for the duration the unit is online and running for PJM
- A unit can specify a Minimum Run Time less than one hour:
 - Day-Ahead amortizes Startup costs over the entire hour as that is the smallest duration of a commitment
 - Real-time amortizes Startup cost over its actual Minimum Run Time as that is the smallest duration of a commitment in RT:
 - Startup cost are amortized over first 5 minute interval if Minimum Run Time of the unit is 0
 - Startup cost are amortized over the whole 5 minute interval if Minimum Run Time of the unit falls between two target intervals. For example, if unit's Minimum Run Time is 27 minutes, then Start-up cost will be amortized over six 5 minute intervals

- Fast Start Capable resources Composite Energy Offer above \$1000/MWh are subject to Offer Verification
 - Generation Resources
 - Economic Load Response Resources
- Composite Energy Offer = incremental offer + amortized No Load cost + amortized Startup cost
 - Startup and No load cost are always considered for Offer Verification purposes under Fast Start Pricing

- **Composite Energy Offer** = incremental offer + (no load (\$) / EcoMax (MWh)) + (startup (\$) / (EcoMax (MWh)*min run time))
- The following logic will be applied for the Composite Energy Offer above \$1000/MWh and less than or equal to \$2000/MWh

Startup	No Load	Composite Offer	Adjustment (If needed)
Pass	Pass	INCR + ASU + ANL	None
Pass	Fail	INCR + ASU + adjustment	Take from No Load to get offer to \$1000/MWh, up to submitted No Load value
Fail	Pass	INCR + ANL + adjustment	Take from Startup to get offer to \$1000/MWh, up to amortized submitted Start Up value
Fail	Fail	INCR + adjustment	Take from No Load first, up to submitted No Load, then from Start Up, to get \$1000/MWh

INCR = Incremental Offer at Ecomax

ASU = Amortized Start Up Cost

ANL = Amortized No Load Cost

- Objective
 - Minimize incentive for a resource to deviate from dispatch instructions by chasing LMP
- Approach
 - Calculate a Dispatch Differential LOC (DD LOC) that is the difference between additional revenue above cost that a resource would have received if it operated at the Pricing Run MW and the actual revenue above cost the resource earned
- Dispatch Differential LOC is only calculated for the Real-time Market.

- Costs recovered via uplift in the Day-Ahead Market that are subsequently recovered in Real-time Market revenues are subtracted from Day-ahead uplift
- Implemented by calculating Operating Reserve Targets:
- Total Offer Cost includes Incremental Offer + Startup + No Load
- Total Revenue includes DA Credits + Balancing Credits + Ancillary Service Revenue + Real-time Make Whole Credits

- Multiple delays between initial FERC order and PJM filing acceptance.
 - Compliance obligation, order held in abeyance, settlement rules changes and offer verification impact
- Impact on pricing has been minimal potentially due to eligibility criteria.
 - PJM originally proposed to consider resources with a total time to start and minimum run time of less than or equal to **two** hours
 - FERC accepted Fast Start resources with a total time to start and minimum run time of less than or equal to **one** hour
- Learning curve with Dispatch run vs Pricing run
 - Impact on DA Case approval and Price Verification
 - Market participants

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