Greater Than $1000/MWh Cost Offer Verification Proposal

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MIC Special Session Market Operations Price Transparency
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• FERC Order 831 “Offer Caps”:
  – Validation of cost of incremental energy offers that exceed $1,000/MWh before the unit is allowed to set LMP
  – Maximum incremental cost allowed to set LMP at $2,000/MWh

  “… ensure that a resource’s cost-based incremental energy offer reasonably reflects that resource’s actual or expected costs.”

• Ex ante Validation implementation November 1st, 2017 with IDO
All thermal units burn fuel for electricity, generally as:

- **Fuel Price**: $ / mmBTU
- **Heat Input**: MW/mmBTU
- **Operating Rate**: $/hour @ MW
- **Energy Offer**: No Load $, Incr. $/MWh

- Details are specified in the Operating Agreement Schedule 2
Data Collection

Provided by Market Seller

Unit Data
- Heat Input
  - Input/Output
  - Polynomial
- Performance Factor
- VOM
- Emissions
- Other Adders

Bid Data
- No Load ($/hr)
- Price/MW Pairs
- Emergency Max MW

Fuel Data
- Fuel Price ($/MMBtu)

3rd Party source referenced by PJM
• PJM will use a third party vendor for forward and intra-day (near real-time) commodity price data

• Each gas unit may specify up to four trading hubs
  – Trading hubs are documented in Fuel Cost Policy
  – Units behind a citygate or on a non-traded hub may specify nearest applicable proxy hub
  – PJM will use the highest price among assigned hubs, with a variance adder allowing for uncertainty
Examined historical natural gas, North NJ, Winter price ranges:

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</thead>
<tbody>
<tr>
<td>Mean + 1 σ</td>
<td>68%</td>
<td>11.6%</td>
<td>11.8%</td>
<td>5.2%</td>
<td>10.1%</td>
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<tr>
<td>Mean + 2 σ</td>
<td>95%</td>
<td>18.1%</td>
<td>17.2%</td>
<td>7.4%</td>
<td>15.2%</td>
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<tr>
<td>Mean + 3 σ</td>
<td>99%</td>
<td>24.5%</td>
<td>22.6%</td>
<td>9.5%</td>
<td>20.4%</td>
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\[
\text{PERCENT} = \frac{\text{HIGH TRADE} - \text{SETTLED PRICE}}{\text{SETTLED PRICE}}
\]
The **Heat Input Curve** describes the operational characteristics that convert fuel input to energy production:

- **1 mmBTU** = 1,000,000 BTUs = 10 therms = 1 dekatherm
- **1 MW** = 1,000 kW

The Heat Input can be represented as:

- Polynomial with MW ranges: \( \text{mmBTU} = a M W^2 + b M W + c \)
- Table of Input / Output pairs: mmBTU, MW

A Performance Factor (PF) scales heat up for actual/theoretical:
- Value of 1.0 is normal for recently performance-tested units
• Block-loaded machinery (CTs, Diesels) generally have 1 output point

• Fossil (Steam, Combined Cycle) operate on a non-linear curve
  – Operational data to find fuel / MWh pairs
  – Regression modelling to find coefficients

Heat Incremental = Addl. heat req. to increase output
Duct Burners = Supplementary burners that increase MW output w/ different operating characteristics, results in a second polynomial band
Maximum Allowable Operating Rate

For each energy offer segment (price, MW pair), \( i = 1 .. n \):

**Maximum Allowable Operating Rate** ($/hour @ MW) =

\[
\left\{ \left[ \text{Heat Input}_i @ \text{MW}_i \right] \times \left( \text{Performance Factor} \right) \times \left( \text{Fuel Cost} \right) \right\} + A \times (1 + B)
\]

Heat Input = Derived from coefficients or table
Performance Factor = 1.0 or greater
Fuel Cost = Estimated Fuel Cost plus Variance Adder
A = VOM, Emissions and Other Adders
B = Up to 10% Cost Adder
• Energy Offer data entered by Market Seller in Markets Gateway
  – Energy No Load Cost ($/hour)
  – Incremental Energy Offer segments (price $/MWh @ MW pairs)
• Operating Range (up to Emergency Maximum MW)
• Bid-Slope (yes/no) or block-loading
• If the last segment’s MW < Emergency Max, extra segment is added at \{ P_{\text{max}}, \text{Emergency Max} \}
For each energy offer segment (price, MW pair), \( i = 1 .. n \):

**Bid Production Cost** ($/hour @ MW) =

\[
(\text{Energy No Load}) + \\
\sum_{i=1}^{n} (MW_i - MW_{i-1}) x (P_i) - \frac{1}{2} x UBS x (MW_i - MW_{i-1}) x (P_i - P_{i-1})
\]

Energy No Load = Submitted Cost of Operation at 0 MW, in $/hour
MW = Segment MW, in MW
P = Segment Price, in $/MWh
UBS = Uses Bid-Slope = 0 for Block-loaded, 1 for Sloped
Segment “zero” = \( P_1 \) at 0 MW, always block-loaded
For each energy offer segment (price, MW pair), $i = 1 .. n$

**Maximum Allowable Incremental Cost ($/MWh @ MW)$ =**

\[
\left[ ( \text{Max. Allowable Oper. Rate}_i ) - ( \text{Bid Production Cost }_{i-1} ) \right] / (\text{MW}_i - \text{MW}_{i-1})
\]

- At each offered MW (up to Emergency Max), calculate the estimated cost (incl. no load) to output at that level from the heat rate data
- The maximum incremental cost of each segment in the energy offer is set by the remaining difference from fuel costs

Segment “zero” bid production cost is the No Load Cost @ 0 MW
For each energy offer segment (price, MW pair), \( i = 1 \ldots n \):

**Maximum Allowable Incremental Cost ($/MWh @ MW) =**

@ MW\(_1\): \( \{ \text{MaxRate}(MW_1) - [\text{No-Load}] \} / MW_1 \)

@ MW\(_2\): \( \{ \text{MaxRate}(MW_2) - [\text{No-Load} + (MW_1 \times P_1)] \} / (MW_2 - MW_1) \)

@ MW\(_3\): \( \{ \text{MaxRate}(MW_3) - [\text{No-Load} + (MW_1 \times P_1) + (MW_2 - MW_1) \times P_1 + ((MW_2 - MW_1) \times (P_2 - P_1) \times S)] \} / (MW_3 - MW_2) \)

@ MW\(_n\): \( \{ \text{MaxRate}(MW_n) - [\text{Bid Production Cost}_{n-1}] \} / (MW_n - MW_{n-1}) \)

UBS = \( \frac{1}{2} \) or 1
Segment 1 = Price$_1$ @ MW$_1$

Heat Input @ MW$_1$

Max Allow Op Rate$_1$ @ MW$_1$

BPC$_0$ = Energy No Load

Price 1 verified if

\[
\leq \frac{(\text{MaxRate}_1 - \text{NoLoad})}{\text{MW}_1}
\]
**Segment 2** = \( \text{Price}_2 \) @ \( \text{MW}_2 \)

Heat Input @ \( \text{MW}_2 \)

Max Allow Op Rate @ \( \text{MW}_2 \)

\( \text{BPC}_1 = \text{Energy No Load} + (\text{Pr}_1 \times \text{MW}_1) \)

Price 2 verified if

\[
\leq \frac{\text{MaxRate}_2 - \text{BPC}_1}{\text{MW}_2 - \text{MW}_1}
\]
Segment 3 = Price$_3$ @ MW$_3$
Heat Input @ MW$_3$
Max Allow Op Rate$_3$ @ MW$_3$

BPC$_2$ = BPC$_1$
+ \( (Pr_2 \times (MW_2 - MW_1)) \)

Price 3 verified if
\[
\leq \left( \frac{\text{MaxRate}_3 - \text{BPC}_2}{MW_3 - MW_2} \right)
\]
Segment 4 = \( \text{Price}_4 @ \text{MW}_4 \)

Heat Input @ \( \text{MW}_4 \)

Max Allow Op Rate\(_4 @ \text{MW}_4\)

\[ \text{BPC}_3 = \text{BPC}_2 + (\text{Pr}_3 \times (\text{MW}_3 - \text{MW}_2)) \]

Price 4 verified if

\[ \leq (\text{MaxRate}_4 - \text{BPC}_3) / (\text{MW}_4 - \text{MW}_3) \]
• The **Bid Production Cost** should align with the **Maximum Allowable Operating Rate**, since the incremental offer \{ price, MW \} pairs are derived from the heat input curve
  – If any segment of the Incremental Cost ($/MWh) exceeds $1,000/MW, then the cost offer is subject to verification
  – Schedule is *verified* if all segments pass incremental cost test

• All units with an incremental of $1,000/MWh or greater are expected to provide documentation *ex post*, regardless of screening success
Verification Process

- PJM will not block any data entry in Markets Gateway
  - Data can be submitted up to 7 days in advance (status quo)
  - Verification will apply to a single market day, as fuel data exists
  - Once verified for a given market day, the offer will remain verified until the next cost update
- Offers that do not pass the automated Verification Process may use the Exception Process to request approval
  - Documentation of costs subject to manual review & verification
  - Cost Offer must conform to the approved Fuel Cost Policy
Ex Ante Verification

- **DA, 06:00-10:30**, verification of >$1,000/MWh cost schedules as new offer data is submitted into Markets Gateway
  - Schedules begin the day as unverified
  - Periodic update of commodity trading data from third party vendor
  - Member can retrieve verification status

- **RT, up to 65 mins before each hour**, verification of >$1,000/MWh cost schedules as new hourly offers are submitted
FERC Order 831 Summary

Available Schedule
- Committable on the schedule
- Dispatchable to any point on the submitted curve

Verified *ex ante*
- Eligible to set LMP up to $2,000/MWh
- Unit-specific make whole to costs above $2,000/MWh

Verified *ex post*
- Not eligible to set LMP
- Unit-specific after-the-fact make whole to verified costs
Cost Offer Verification Summary

• Screening Process = *ex ante* verification of >$1,000/MWh cost offer
  – Automated Verification w/ best available data
  – Manual Verification w/ Member Submitted evidence

• Exception Process = Exception to the Screening Limits

• Verified Costs = Eligible to set LMP above $1,000/MWh

• Unit-specific Make Whole > $2,000/MWh or to *ex post* verified offer

• Unverifiable *ex post* = potential penalty