

# Combined Cycles and Specialized Boilers Heat Input Guidelines

CDS

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IMM



Monitoring Analytics

# Background

- **Combined cycles with 2x1 configuration or higher and steam turbines with multiple boilers can reflect their heat input curves in cost-based offers using multiple methods. The methods can be:**
  1. **One heat input curve of entire operating range, regardless of configuration.**
  2. **Multiple heat input curves, one per configuration.**
  3. **Pseudo heat input curve for combined cycles that choose to be modeled using the combined cycle pseudo model.**

# Problem/Opportunity Statement

- **The work is intended to include in Manual 15 the different methods available to combined cycles and specialized boilers to reflect their heat input.**
- **Activities:**
  1. **Review the current methods combined cycles and specialized boilers can use to reflect their heat input.**
  2. **Explore additional methods not currently used.**
  3. **Document methods in Manual 15.**



# Method 1: One Heat Input

- **Uses all the historical operating data (MW output, MMBtu input) to calculate a single heat input curve.**
- **The unit's cost-based offer is submitted using a single schedule regardless of configuration.**
- **Start heat input is based on starting the full configuration.**



## Method 2: Heat Input per Configuration

- **Uses all the historical operating data (MW output, MMBtu input) to calculate multiple heat input curves per configuration.**
- **The units can either:**
  - **Submit multiple cost-based offers, each one using the corresponding heat input curve and start heat input (preferred) or**
  - **Submit one cost-based offer but required to update the heat input curve and start heat input used when a certain configuration is being used.**
- **Start heat input is based on each configuration.**



## Method 3: Pseudo Model

- **Uses all the historical operating data (MW output, MMBtu input) to calculate multiple heat input curves per configuration.**
  - **The full configuration heat input is split among the pseudo units.**
  - **The X0 (no load heat) is divided by the number of pseudo units.**
  - **The X1 is kept the same.**
  - **The X2 is multiplied by the number of pseudo units.**



## Method 3: Pseudo Model

- **The unit's cost-based offer is submitted using a single schedule. The schedule must be based on the full configuration when all units are available.**
  - **It can also be based on the smaller number of configurations when entire unit is not fully available.**
- **Start heat input is equal to the full configuration divided by the number of pseudo units.**
  - **It can also be based on starting a smaller number of configurations when entire unit is not available.**



# Method 3 Example

| Heat Input Curve Coefficient  | Full Unit Heat Input Curve | Pseudo Unit Heat Input Curve |
|-------------------------------|----------------------------|------------------------------|
| X0                            | 800.00                     | 400.00                       |
| X1                            | 5.00                       | 5.00                         |
| X2                            | 0.0010                     | 0.0020                       |
| Eco Max (MW)                  | 500                        | 250                          |
| Eco Max Heat Input (MMBtu)    | 3,550                      | 1,775                        |
| Average Heat Rate (MMBtu/MWh) | 7.10                       | 7.10                         |

| Full Unit Inc. Heat Rates |                            | Pseudo Unit Inc. Heat Rates |                            |
|---------------------------|----------------------------|-----------------------------|----------------------------|
| MW                        | Inc. Heat Rate (MMBtu/MWh) | MW                          | Inc. Heat Rate (MMBtu/MWh) |
| 0                         | 5.00                       | 0                           | 5.00                       |
| 50                        | 5.10                       | 25                          | 5.10                       |
| 100                       | 5.20                       | 50                          | 5.20                       |
| 150                       | 5.30                       | 75                          | 5.30                       |
| 200                       | 5.40                       | 100                         | 5.40                       |
| 250                       | 5.50                       | 125                         | 5.50                       |
| 300                       | 5.60                       | 150                         | 5.60                       |
| 350                       | 5.70                       | 175                         | 5.70                       |
| 400                       | 5.80                       | 200                         | 5.80                       |
| 450                       | 5.90                       | 225                         | 5.90                       |
| 500                       | 6.00                       | 250                         | 6.00                       |





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