



*Working to Perfect the Flow of Energy*

PJM Manual 15:  
**Cost Development  
Guidelines**

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Prepared by

Cost Development Task Force

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## Section 8: Opportunity Cost Guidelines

Welcome to the *Opportunity Cost Guidelines* section of the PJM Manual for **Cost Development Guidelines**. In this section, you will find the following information:

- A description of the PJM Opportunity Cost Guidelines Policy and Definitions (see “Policy and Definitions”).

### Policy and Definitions

#### Cost Development Task Force Opportunity Cost Policy

- Opportunity Cost may be a component of cost under certain circumstances.
- Specific business rules for Opportunity Costs have been defined in the Operating Agreement of PJM Interconnection, L.L.C. for various products including energy and regulation.
- Requests for recovery of Opportunity Costs not defined in the Operating Agreement of PJM Interconnection, L.L.C. should be submitted to the PJM MMU for approval.

### Opportunity Cost Component for externally imposed run-hour restrictions

The following methodology is approved for computing opportunity costs associated with an externally imposed run-hour restriction on a generation unit. Examples would include a limit on emissions for the unit imposed by a regulatory agency or legislation, a direct run hour restriction in the operating permit, or a heat input limitation defined by a regulatory decision or operating permit. Generators may follow this methodology at their option or may develop and submit alternative methods specific to their units for approval. Requests for recovery of opportunity costs either using other methods or not defined in the Operating Agreement of PJM Interconnection, L.L.C. should be initially submitted to the PJM MMU for approval per Manual 15 Section 8.

Opportunity costs are a distinct component of the cost-based offer. As is the case with any computation of the cost-based offer in Manual M-15, market participants may elect to enter their cost-based offer at a value less than the computed cost-based offer. However, they may not exceed the computed value.

Opportunity costs calculated with this method will change frequently. Given that electricity and fuel futures can change daily, the opportunity costs computed can likewise change daily. Generation owners who include opportunity costs in their cost-based offers must recalculate their opportunity cost no less frequently than once per week.

### Definitions

- N=number of hours in the month (on-peak/off-peak)
- y=year
- m=month

- d=day of the month
- h=hour
- Peak=off-peak hours only or on-peak hours only
- FY=future year
- BUSLMP=LMP at the unit's bus
- PJMWesternHub=PJM Western Hub LMP
- Trading Day=In respect of a particular futures market a day on which that Market open for trading
- Dm=Delivery Month; Month the commodity contract is to deliver the commodity in the future.
- Base year= one of the three historical years used to create volatility in the fuel and power forecasts
- Peak=Peak hours are from 7:00 AM to 11:00 PM (the hour ending 0800 to the hour ending 2300) prevailing local time. Peak days are Mondays through Fridays, excluding North American Electric Reliability Council (NERC) holidays.
- Off-peak=Off-peak hours are from midnight to 7:00 AM (the hour ending 0100 to the hour ending 0700) and 11:00 PM to midnight (the hour ending 2400) Mondays through Fridays; also, all day Saturdays and Sundays (the hour ending 0100 to the hour ending 2400) and North American Electric Reliability Council holidays
- Frequently mitigated unit (FMU)= A unit that was offer-capped for more than a defined proportion of its real-time run hours in the most recent 12-month period. FMU thresholds are 60 percent, 70 percent and 80 percent of run hours. Such units are permitted a defined adder to their cost-based offers in place of the usual 10 percent adder.

### **STEP 1: Derive Historical Monthly LMP Basis Differential between the generation bus and western hub**

*Inputs required for STEP 1:*

*Platts-ICE Forward Curve for "PJM west" from the recent trading day,*

*Three years of historical hourly real-time LMPs at the generation bus, and*

*Three years of historical hourly real-time PJM Western Hub LMPs*

The mismatch between the location of the forward contract delivery point (Western Hub) and the relevant generator bus can be accounted for in the historic, monthly average basis differential for both peak and off-peak hours. This basis differential can be expressed as the average, over all peak or off-peak hours in a month, of the ratio of the hourly bus LMP to the hourly Western Hub LMP. If this ratio is greater than one, it means the bus LMP is greater than the Western Hub LMP on average. If this ratio is less than one, it means the bus LMP is less than the Western Hub LMP on average.

Platts-ICE Forward Curve for “PJM west” (PJM Western Hub) must be collected for this first step (<http://www.platts.com/>). These PJM Western Hub Forwards multiplied by a historical basis adjustment ratio for delivery to the generator’s bus creates monthly delivered bus prices. The three prior calendar year’s historical data is used to make this calculation. ~~For example, when computing opportunity costs in 2009, use historical LMP data from 2006, 2007 and 2008.~~ For example, when calculating opportunity costs for July 2, 2010 for a unit with a calendar year compliance period, use historical LMP data from July 2<sup>nd</sup> (2007,2008,2009) to December 31<sup>st</sup> (2007,2008,2009). The Opportunity Cost Calculator is also able to provide forecasts for a rolling compliance period (e.g. a rolling 12 months) rather than a calendar year period. For units with a 12 month rolling compliance period, use LMP data from the previous three years, beginning on the date calculated and ending two days previous. For example, when a unit is calculating opportunity cost for July 2<sup>nd</sup>, 2010 with a rolling 12 month compliance period, use historical LMP data from July 2<sup>nd</sup> (2007,2008,2009) to June 30<sup>th</sup> (2008, 2009, 2010). Begin by taking the hourly bus prices for the three prior calendar years at the generator’s bus, and for every hour, divide that hour’s price by the corresponding price at PJM Western Hub. The historic hourly basis differential in hour h, day d, month m, and year y is

$$\text{HourlyBasisDifferentialRatio}_{y,m,d,h} = \frac{\text{BUSLMP}_{y,m,d,h}}{\text{PJMWHLMP}_{y,m,d,h}}$$

NOTE: When PJMWHLMP is zero and the BUSLMP is zero, then the ratio value is one. If PJMWHLMP is zero and the BUSLMP is not zero then value is null and it is not included in the average.

**Example 1.1: Three hourly basis differential ratios values for the same hour in each of three historical years:**

$$\begin{aligned} \text{HourlyBasisDifferentialRatio}_{\text{June } 3,2006 \text{ H11}} &= \frac{\text{BUSLMP}_{\text{June } 3,2006 \text{ H11}}}{\text{PJMWHLMP}_{\text{June } 3,2006 \text{ H11}}} \\ \text{HourlyBasisDifferentialRatio}_{\text{June } 3,2007 \text{ H11}} &= \frac{\text{BUSLMP}_{\text{June } 3,2007 \text{ H11}}}{\text{PJMWHLMP}_{\text{June } 3,2007 \text{ H11}}} \\ \text{HourlyBasisDifferentialRatio}_{\text{June } 3,2008 \text{ H11}} &= \frac{\text{BUSLMP}_{\text{June } 3,2008 \text{ H11}}}{\text{PJMWHLMP}_{\text{June } 3,2008 \text{ H11}}} \end{aligned}$$

Once the hourly basis ratios are calculated for every hour during the three-year history, for each historic month take the sum of the on-peak hourly basis differentials in the month, and divide by the number of peak hours in the month (observations). Similarly, for every month, sum the off-peak hourly basis ratios, and then divide by the number of off-peak hours within that month. These monthly basis differentials adjust PJM Western Hub monthly peak and off-peak forward prices to expected peak and off-peak monthly forward prices delivered to the generator’s bus.

$$\text{MonthlyPeakBasisDifferentialRatio}_{y,m}^{\text{peak}} = \frac{\sum_{\text{peak hours}} (\text{HourlyBasisDifferentialRatio}_{y,m,d,h}^{\text{peak}})}{\text{Number of Peak Hours in month } m}$$

$$\text{MonthlyOffPeakBasisDifferentialRatio}_{y,m}^{\text{peak}} = \frac{\sum_{\text{off-peak hours}} (\text{HourlyBasisDifferentialRatio}_{y,m,d,h}^{\text{off-peak}})}{\text{Number of Off – Peak Hours in month } m}$$

**Example 1.2: Monthly Peak Basis Differentials for the three historical periods:**

$$\begin{aligned} & \text{MonthlyPeakBasisDifferentialRatio}_{\text{June } 2006}^{\text{peak}} \\ &= \frac{\sum_{\text{peak hours}} (\text{Hourly Basis Differential Ratios June 2006})}{\text{Number of peak hours in June 2006}} \end{aligned}$$

$$\begin{aligned} & \text{MonthlyPeakBasisDifferentialRatio}_{\text{June } 2007}^{\text{peak}} \\ &= \frac{\sum_{\text{peak hours}} (\text{Hourly Basis Differential Ratios June 2007})}{\text{Number of peak hours in June 2007}} \end{aligned}$$

$$\begin{aligned} & \text{MonthlyPeakDifferentialBasisRatio}_{\text{June } 2008}^{\text{peak}} \\ &= \frac{\sum_{\text{peak hours}} (\text{Hourly Basis Differential Ratios June 2008})}{\text{Number of peak hours in June 2008}} \end{aligned}$$

Multiply monthly peak and off-peak basis differential ratios by the respective monthly peak and off-peak PJM Western hub forwards to derive forecasted monthly peak and off-peak bus prices.

$$\text{Forecasted Monthly Bus Price}_{fy,m}^{\text{peak}} = \left[ (\text{PJMWestern Hub}_{fy,m}^{\text{peak}}) * (\text{MonthlyPeakBasisRatio}_{y,m}^{\text{peak}}) \right]$$

**Example 1.3: Forecasted monthly bus prices for three historical periods:**

$$\text{Forecasted Monthly Bus Price}_{\text{June 2010,base 2006}}^{\text{OFFpeak}} = \left[ (\text{PJMWH}_{\text{for delivery June 2010}}^{\text{OFFpeak}}) * (\text{MonthlyOffPeakBasisDifferentialRatio}_{\text{June 2006}}^{\text{OFFpeak}}) \right]$$

$$\text{Forecasted Monthly Bus Price}_{\text{June 2010,base 2007}}^{\text{OFFpeak}} = \left[ (\text{PJMWH}_{\text{for delivery June 2010}}^{\text{OFFpeak}}) * (\text{MonthlyOffPeakBasisRatio}_{\text{June 2007}}^{\text{OFFpeak}}) \right]$$

$$\text{Forecasted Monthly Bus Price}_{\text{June 2010,base 2008}}^{\text{OFFpeak}} = \left[ (\text{PJMWH}_{\text{for delivery June 2010}}^{\text{OFFpeak}}) * (\text{MonthlyPeakBasisRatio}_{\text{June 2008}}^{\text{OFFpeak}}) \right]$$

Outputs from STEP 1:

Three peak and off-peak monthly BUS LMP forecasts for each month remaining in the compliance

**STEP 2: Derive hourly volatility scalars to incorporate hourly volatility into the LMP forecast**

Inputs for STEP 2:

Three years historical hourly real-time LMP prices at the generation bus

The monthly futures prices quoted only consider the average peak and off-peak prices for the month and do not consider hourly LMP volatility. Step 2 derives will develop an hourly volatility scalar. This scalar will later be multiplied against the forecast in Step 1 to derive an hourly bus LMP forecast that incorporates historic hourly peak and off-peak LMP volatility as well as monthly peak and off-peak basis differentials with PJM Western Hub.

First, for each historic month compute the average peak and off-peak price at the unit's bus for each remaining month in the compliance period.

$$\text{MonthlyAverageBusLMP}_{y,m}^{\text{peak}} = \frac{\sum_{\text{peak hours}} (\text{HourlyBusLMP}_{y,m,d,h}^{\text{peak}})}{\text{Number of Peak Hours in month m}}$$

$$\text{MonthlyAverageBusLMP}_{y,m}^{\text{off-peak}} = \frac{\sum_{\text{off-peak hours}} (\text{HourlyBusLMP}_{y,m,d,h}^{\text{off-peak}})}{\text{Number of Off - Peak Hours in month m}}$$

Next, for every hour, take the hourly bus LMP divided by the relevant monthly average peak or off-peak bus LMP computed above. If the hour is an on-peak hour, divide by the average peak LMP price for the month.

$$\text{HourlyVolatilityScalar}_{y,m,d,h}^{\text{peak}} = \frac{\text{BUSLMP}_{y,m,d,h}^{\text{peak}}}{\text{MonthlyAverageBusLMP}_{y,m}^{\text{peak}}}$$

If the hour is off-peak, divide that hour by the monthly off-peak average price for the corresponding month.

$$\text{HourlyVolatilityScalar}_{y,m,d,h}^{\text{off-peak}} = \frac{\text{BUSLMP}_{y,m,d,h}^{\text{off-peak}}}{\text{MonthlyAverageBusLMP}_{y,m}^{\text{off-peak}}}$$

### Example 2.1: Volatility scalar for the each of the three historical years:

$$\text{HourlyVolatilityScalar}_{\text{June } 3,2006 \text{ H24}} = \frac{\text{BUSLMP}_{\text{June } 3,2006 \text{ H24}}}{\text{Average Offpeak June 2006 BUSLMP}}$$

$$\text{HourlyVolatilityScalar}_{\text{June } 3,2007 \text{ H24}} = \frac{\text{BUSLMP}_{\text{June } 3,2007 \text{ H24}}}{\text{Average Offpeak June 2007 BUSLMP}}$$

$$\text{HourlyVolatilityScalar}_{\text{June } 3,2008 \text{ H24}} = \frac{\text{BUSLMP}_{\text{June } 3,2008 \text{ H24}}}{\text{Average Offpeak June 2008 BUSLMP}}$$

Output from STEP 2:

Three ratio values per hour for each of the historical years used for volatility

### STEP 3: Create three sets of hourly forecasted bus values

Inputs to STEP 3:

Output from STEP 1: On-peak/off-peak monthly bus LMP Forecast

Output from STEP 2: Hourly volatility scalars

Step 3 creates three hourly forecasts from the volatility scalars developed in step 2 and the monthly bus LMP forecast prices developed in Step 1. Multiply the hourly volatility scalars developed in step 2 by the corresponding forecasted monthly bus price calculated in step 1.

The expected or forecasted LMP for hour h, day d, month m, based on year y that is a peak hour is

$$\text{ForecastedBUSLMP}_{y,m,d,h}^{\text{peak}} = \text{HourlyVolatilityScalar}_{y,m,d,h}^{\text{peak}} * \text{ForecastedMonthlyBusPrice}_{fy,m}^{\text{peak}}$$

The expected or forecasted LMP for hour h, day d, month m, based on year y that is an off-peak hour is

$$\text{ForecastedBUSLMP}_{y,m,d,h}^{\text{off-peak}} = \text{HourlyVolatilityScalar}_{y,m,d,h}^{\text{off-peak}} * \text{ForecastedMonthlyBusPrice}_{fy,m}^{\text{off-peak}}$$

### Example 3.1: Forecasted bus LMPs for one hour for each of the three historical base years:

Assume that it is April 5, 2009. To create the set of three forecasted prices for each hour of June 3, 2009:

$$\begin{aligned} & \text{ForecastedBUSLMP}_{\text{June } 3, 2009 \text{ H00, base } 2006} \\ &= \text{HourlyVolatilityScalar}_{\text{June } 3, 2006 \text{ H00}} * \text{ForecastedMonthlyBusPrice}_{\text{June } 2009}^{\text{offpeak}} \end{aligned}$$

$$\begin{aligned} & \text{ForecastedBUSLMP}_{\text{June } 3, 2009 \text{ H00, base } 2007} \\ &= \text{HourlyVolatilityScalar}_{\text{June } 3, 2007 \text{ H00}} * \text{ForecastedMonthlyBusPrice}_{\text{June } 2009}^{\text{offpeak}} \end{aligned}$$

$$\begin{aligned} & \text{ForecastedBUSLMP}_{\text{June } 3, 2009 \text{ H00, base } 2008} \\ &= \text{HourlyVolatilityScalar}_{\text{June } 3, 2008 \text{ H00}} * \text{ForecastedMonthlyBusPrice}_{\text{June } 2009}^{\text{offpeak}} \end{aligned}$$

Outputs from STEP 3:

Three hourly bus LMP forecasts per hour remaining in the compliance year

### STEP 4: Create a daily fuel volatility scalar

Inputs to STEP 4:

Three years historical delivered daily fuel prices at the generator bus (\$/mmBtu)

Fuel Weights if dual fuel

Step 4 creates a daily fuel volatility scalar using historic daily delivered fuel prices (as used to develop a unit's TFRC) from the previous three calendar years. Take each daily bus-delivered fuel price and divide it by the monthly average bus delivered fuel price to create a ratio for every day in the three-year history. For units that have dual fuels; the daily delivered fuel prices need to be multiplied by their respective weights and then added together.  $N_m$  is the number of days in month m.

Units with Single Fuel Type:

$$\text{DailyFuelVolatilityScalar}_{y,m,d} = \frac{\text{DeliveredFuelPrice}_{y,m,d}}{\left( \frac{\sum_{n=1}^{N_m} (\text{DeliveredFuelPrice}_{y,m})}{N_m} \right)}$$

**Units with Dual Fuel:**

$$\text{DailyFuelVolatilityScalar}_{y,m,d} = \frac{(\text{DeliveredFuelPriceFuelTypeA}_{y,m,d} * \text{WeightFuelTypeA}) + (\text{DeliveredFuelPriceFuelTypeB}_{y,m,d} * \text{WeightFuelTypeB})}{\left( \frac{\sum_{n=1}^{N_m} ((\text{DeliveredFuelPriceFuelTypeA}_{y,m} * \text{WeightFuelTypeA}) + (\text{DeliveredFuelPriceFuelTypeB}_{y,m} * \text{WeightFuelTypeB}))}{N_m} \right)}$$

**Example 4.1: Three daily fuel volatility scalars values developed for June 3 in each of three historic years for a unit with a single fuel:**

$$\text{DailyFuelVolatilityScalar}_{\text{June } ,3,2006} = \frac{\text{DeliveredFuelPrice}_{\text{June } 3,2006}}{\text{Average June 2006 DeliveredFuelPrice}}$$

$$\text{DailyFuelVolatilityScalar}_{\text{June } ,3,2007} = \frac{\text{DeliveredFuelPrice}_{\text{June } 3,2007}}{\text{Average June 2007 DeliveredFuelPrice}}$$

$$\text{DailyFuelVolatilityScalar}_{\text{June } ,3,2008} = \frac{\text{DeliveredFuelPrice}_{\text{June } 3,2008}}{\text{Average June 2008 DeliveredFuelPrice}}$$

If there is no fuel cost record for a given date, use the previous available value.

*Output from STEP 4: Three years of historic daily scalars for fuel volatility*

**STEP 5: Create three daily delivered fuel forecast**

*Inputs for STEP 5:*

*Platts Forward curve for Fuels from the most recent trading day, for delivery in the compliance period (\$/mmBtu)*

*Fuel Weights if dual fuel*

*Fuel contract monthly prices if applicable*

*Output from STEP 4: Three years historic daily scalars for fuel volatility*

Step 5 takes fuel futures and/or contract prices and the daily delivered fuel scalars from step 4 and multiplies them together to create a fuel forecast that corresponds on an average monthly basis to the fuel futures, yet maintains historical volatility. For units that have dual fuels: the fuel forwards for the two fuels will be multiplied by their respective weights (derived from expected use of each fuel), added together, and then multiplied by the daily fuel

volatility scalar. For units with some or all of their fuel procured by contract, the contract and fuel forwards are multiplied by their respective weights (derived from expected use of each fuel) and added together and then multiplied by the daily fuel volatility scalar.

### Unit with a single fuel:

$$\begin{aligned} \text{Daily Delivered Fuel}_{fy,m,d} &= \\ \text{Daily Fuel Volatility Scalar}_{y,m,d} &* \\ & \left( \text{WeightSpot}_m * (\text{Fuel Forward}_{fy,m}) + \text{WeightContract}_m * (\text{Contract Price}_m) \right) \\ \text{Where } \text{WeightContract}_m + \text{WeightSpot}_m &= 1 \end{aligned}$$

### Unit with dual fuel:

(Permits the use of dual fuels for units that may burn multiple fuels or source fuels from different areas at different prices. For units with restrictions on consumption of specific fuels, this method allows accounting for both fuels in the same calculation.)

$$\begin{aligned} \text{Daily Delivered Fuel}_{fy,m,d} &= \\ \text{Daily Fuel Volatility Scalar}_{y,m,d} &* \\ & \left[ \text{WeightFuelTypeA}_m \right. \\ & * \left( \text{WeightContractFuelTypeA}_m * \text{Contract PriceFuelTypeA}_m \right. \\ & + \left. \text{WeightSpotFuelTypeA}_m * (\text{Fuel ForwardFuelTypeA}_{fy,m}) \right) \\ & + \text{WeightFuelTypeB}_m \\ & * \left( \text{WeightContractFuelTypeB}_m * \text{Contract PriceFuelTypeB}_m \right. \\ & + \left. \left. \text{WeightSpotFuelTypeB}_m * (\text{Fuel ForwardFuelTypeB}_{fy,m}) \right) \right] \end{aligned}$$

$$\text{Where } \text{WeightFuelTypeA}_m + \text{WeightFuelTypeB}_m = 1$$

$$\text{Where } \text{WeightContractFuelTypeA}_m + \text{WeightSpotFuelTypeA}_m = 1$$

$$\text{Where } \text{WeightContractFuelTypeB}_m + \text{WeightSpotFuelTypeB}_m = 1$$

**Example 5.1: Create three daily delivered fuel forecasts from the volatilities of three historic years:**

**Unit with a single fuel:**

$$\begin{aligned} & \text{DailyDeliveredFuelForecast}_{\text{June } 3, 2009, \text{base } 2006}^{\text{baseyear } 2006} \\ &= \text{DailyFuelVolatilityScalar}_{\text{June } 3, 2006} * \text{FuelForward}_{\text{June } 2009} \end{aligned}$$

$$\begin{aligned} & \text{DailyDeliveredFuelForecast}_{\text{June } 3, 2009, \text{base } 2007}^- \\ &= \text{DailyFuelVolatilityScalar}_{\text{June } 3, 2007} * \text{FuelForward}_{\text{June } 2009} \end{aligned}$$

$$\begin{aligned} & \text{DailyDeliveredFuelForecast}_{\text{June } 3, 2009, \text{base } 2008} \\ &= \text{DailyFuelVolatilityScalar}_{\text{June } 3, 2008} * \text{FuelForward}_{\text{June } 2009} \end{aligned}$$

Outputs from STEP 5:  
*Daily generator-bus delivered fuel forecast*

**Step 6: create generating units dispatch cost for each of the three forecasts**

*Inputs for STEP 6:*  
*Expected future full load seasonal (May-September/ October – April) heat rate for the compliance period*  
*Fuel Prices output from Step 5*  
*Unit SO<sub>2</sub>, CO<sub>2</sub>, and NO<sub>x</sub> Emission Rates (lbs/mmBtu)*  
*(Note that the CO<sub>2</sub> adder is in effect only for incurring carbon emission charges)Futures prices for SO<sub>2</sub>, CO<sub>2</sub> and NO<sub>x</sub> from Evolution Markets (\$/ton) modified to \$/lb*  
*Maintenance Adder, VOM and FMU as defined in M-15*

In step 6, take the unit characteristics, future emission allowance prices, the three daily fuel forecasts and create a daily unit dispatch cost for the three forecasts using the appropriate heat rate for the forecast day. For each day in the three fuel forecasts, a unit dispatch cost is as follows:

$$\begin{aligned}
 \text{UnitDispatchCost}_{fy,m,d}^{\text{base year}} = & \\
 & \left\{ \left[ \text{UnitHeatRate}(\text{mmbtu}/\text{mwh}) * \text{DailyDeliveredFuelForecast}(\$/\text{mmbtu})_{fy,m,d}^{\text{base year}} \right] + \right. \\
 & \left[ \text{UnitHeatRate}(\text{mmbtu}/\text{mwh}) * \text{UnitNOxEmissionRate}(\text{lbs}/\text{mmbtu}) * \text{Cost of NOx} (\$/\text{lb}) \right] + \\
 & \left[ \text{UnitHeatRate}(\text{mmbtu}/\text{mwh}) * \text{UnitSO}_2\text{EmissionRate}(\text{lbs}/\text{mmbtu}) * \text{Cost of SO}_2 (\$/\text{lb}) \right] + \\
 & \left[ \text{UnitHeatRate}(\text{mmbtu}/\text{mwh}) * \text{UnitCO}_2\text{EmissionRate}(\text{lbs}/\text{mmbtu}) * \text{Cost of CO}_2 (\$/\text{lb}) \right] \\
 & \left. + \text{VOM} + \right\} + \text{either a 10\% margin or FMU adder}
 \end{aligned}$$

**Example 6.1: Daily dispatch cost:**

Unit heat rate=10.345 mmBtu/MWh  
 Unit NOx emission rate =0.328 lbs/mmBtu  
 Unit SO<sub>2</sub> emission rate=1.2 lbs/mmBtu  
 Unit CO<sub>2</sub> emission rate=117 lbs/mmBtu  
 DailyDeliveredFuelForecast=\$3.01/mmBtu  
 Combined NOx Allowance cost=\$1375/ton  
 SO<sub>2</sub> Allowance cost=\$200/ton  
 CO<sub>2</sub> emission cost = \$8/ton  
 VOM & Maintenance Adder=\$2.22/MWh  
 FMU= \$0.00/MWh

*UnitDispatchCost* =

$$\begin{aligned} & \left[ \left( \frac{10.35 \text{ mmbtu}}{\text{mwh}} \right) * \left( \frac{\$3.01}{\text{mmbtu}} \right) \right] + \\ & \left[ \left( \frac{10.35 \text{ mmbtu}}{\text{mwh}} \right) * \left( \frac{0.328 \text{ lbs}}{\text{mmbtu}} \right) * \left( \frac{\$1375.00}{\text{ton}} \right) * \left( \frac{\text{ton}}{2000 \text{ lbs}} \right) \right] + \\ & \left( \left[ \left( \frac{10.35 \text{ mmbtu}}{\text{mwh}} \right) * \left( \frac{1.2 \text{ lbs}}{\text{mmbtu}} \right) * \left( \frac{\$200}{\text{ton}} \right) * \left( \frac{\text{ton}}{2000 \text{ lbs}} \right) \right] \right) + \\ & \left[ \left( \frac{10.345 \text{ mmbtu}}{\text{mwh}} \right) * \left( \frac{117 \text{ lbs}}{\text{mmbtu}} \right) * \left( \frac{\$8}{\text{ton}} \right) * \left( \frac{\text{ton}}{2000 \text{ lbs}} \right) \right] \\ & + \left( \frac{\$2.22}{\text{MWh}} \right) \end{aligned}$$

$$\text{UnitDispatchCost}_{\text{fy,m,d}}^{\text{base year}} = \left( \frac{\$31.16}{\text{MWh}} \right) + \left( \frac{\$2.34}{\text{MWh}} \right) + \left( \frac{\$1.25}{\text{MWh}} \right) + \left( \frac{\$4.85}{\text{MWh}} \right) + \left( \frac{\$2.22}{\text{MWh}} \right) = \$41.82/\text{MWh}$$

Outputs for step 6:

*Three forecasts based on historic year factors for daily generator dispatch cost*

### Step 7: Calculate the margin for every hour in the three hourly forecasts

Inputs for Step 7:

*Daily Generator Dispatch Cost from Step 6*

*Hourly Generator bus LMP forecast from Step 3*

Step 7 calculates the hourly margin the generator would receive by comparing the cost offer developed in step 6 against the hourly forecasted bus LMPs developed in step 3. This methodology assumes no minimum run time, no ramping time restrictions and no startup cost. Calculate the hourly margin for every hour in the three forecasts:

$$\text{HourlyUnitMargin}_{\text{y,m,d,h}}^{\text{base year}} = \max[0, (\text{ForecastedBUSLMP}_{\text{y,m,d,h}}^{\text{base year}} - \text{UnitDispatchCost}_{\text{y,m,d}}^{\text{base year}})]$$

If the HourlyUnitMargin < 0, then the HourlyUnitMargin is normalized to zero because the unit would not wish to run in any hour in which its dispatch cost exceeds LMP.

### Example 7.1: Computing hourly margins

$$\text{HourlyUnitMargin}_{\text{June } 3,2009}^{\text{base } 2006} H07 = \text{ForecastedBUSLMP}_{\text{June } 3,2009}^{\text{base } 2006} H07 - \text{UnitDispatchCost}_{\text{June } 3,2009}^{\text{base } 2006}$$

$$\text{HourlyUnitMargin}_{\text{June } 3,2009}^{\text{base } 2007} H07 = \text{ForecastedBUSLMP}_{\text{June } 3,2009}^{\text{base } 2007} H07 - \text{UnitDispatchCost}_{\text{June } 3,2009}^{\text{base } 2007}$$

$$\text{HourlyUnitMargin}_{\text{June } 3,2009}^{\text{base } 2008} H07 = \text{ForecastedBUSLMP}_{\text{June } 3,2009}^{\text{base } 2008} H07 - \text{UnitDispatchCost}_{\text{June } 3,2009}^{\text{base } 2008}$$

$$\text{HourlyUnitMargin}_{\text{June } 3,2009}^{\text{base } 2006} H07 = \max[0, (\$53.23 - \$41.66)] = \$11.57$$

$$\text{HourlyUnitMargin}_{\text{June } 3,2009}^{\text{base } 2007} H07 = \max[0, (\$55.44 - \$57.88)] = \$0.00$$

$$\text{HourlyUnitMargin}_{\text{June } 3,2009}^{\text{base } 2008} H07 = \max[0, (\$49.78 - \$49.72)] = \$0.06$$

*Output from step 7: Three hourly margin forecasts for each hour in the compliance period.*

### Step 8: Outages and dates passed

*Input to Step 8: All future maintenance outage information*

For any future date that the unit will be offline, or for any date that has passed, set the margin equal to zero. Therefore, for each of the three forecasts, set all dates that the unit will be unavailable to have zero margins.

*Output from step 8:  
Three hourly margin forecasts for each hour in the compliance period with all future outages and previous days having margins equal to zero.*

### Step 9: Rank the hourly margin forecasts for each of the three years from largest to smallest value

*Input for Step 9: Three hourly margin forecasts from step 8 adjusted for outages and days passed*

For each of the three years, rank the hourly margin forecasts from largest to smallest value. Number each by their rank order. The three numbers that correspond to the minimum run hour are averaged together to get the maximum opportunity cost available to the generator.



**Example 9.1: A unit with 700 run hours:**

700th Margin<sub>base 2006</sub> = \$2.10/MWh

700th Margin<sub>base 2007</sub> = \$0.00/MWh

700th Margin<sub>base 2008</sub> = \$0.06/MWh

700<sup>th</sup> hour maximum opportunity cost component =  $\frac{\$2.10 + \$0.00 + \$0.06}{3} = \$0.72/\text{MWh}$