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PJM Manual 15:

Cost Development Guidelines

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Prepared by
Cost Development Subcommittee

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Section 12: Energy Market Opportunity Cost and Non-Regulatory Opportunity Cost Guidelines

12.1 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 for various products including energy and regulation.
- Requests for recovery of Opportunity Costs not defined in the Operating Agreement should be submitted to PJM and the MMU pursuant to the Cost Methodology and Approval Process.

The PJM Opportunity Cost Calculator described in Section 12.3 through 12.6 of this manual is retiredsuspended as of June 1, 2020. Market Sellers that wish to include an Opportunity Cost in a unit's cost based offers should use the IMM Opportunity Cost Calculator described in Section 12.7 of this manual. For details on how to obtain an opportunity cost adder from the IMM Opportunity Cost Calculator, contact the IMM at MMU_Energy_Offers_Review@monitoringanalytics.com . For any other questions related to Opportunity Cost adders please contact PJM at FuelCostPolicyAnalysis@pjm.com .

12.7 IMM Opportunity Cost Calculator

The IMM Opportunity Cost Calculator is a constrained optimization software application independently developed and owned by Monitoring Analytics, LLC. Any changes to the IMM Calculator must be approved by Monitoring Analytics, LLC. The IMM will notify PJM of any significant changes to the IMM Opportunity Cost Calculator and any such changes will be reflected in updates to Manual 15 Section 12.7. PJM will review any such changes to verify that the IMM Opportunity Cost Calculator continues to meet the requirements of Schedule 2 of the Operating Agreement.

On an annual basis, PJM will review the inputs and results of the IMM Opportunity Cost Calculator in consultation with the IMM to verify that the IMM Opportunity Cost Calculator continues to meet the documented requirements .

12.7.1 Calculation Method

The Opportunity Cost Calculator selects the hours of operation that will maximize the generator's energy market revenue net of the generator's short run marginal cost of producing energy, subject to the unit specific environmental or operational limits. The duration and structure (i.e. rolling compliance periods or a single compliance period) of the optimization period will be as specified in an environmental permit for environmental limitations, or as specified by the original equipment manufacturer or insurance carrier for physical equipment limitations. In the case of a fuel supply limitation, the duration of the optimization period must be approved by PJM and the MMU.

Inputs into the Opportunity Cost Calculator will include unit specific forward LMPs based on futures prices, unit specific forward fuel prices based on futures or contract prices, and unit specific operating parameters.

The opportunity cost is the shadow price corresponding to the binding environmental or operational limit. The shadow price is defined as the marginal decrease in the net revenue due to a one hour equivalent decrease in the binding environmental or operational limit. Opportunity cost therefore is the marginal value of the foregone opportunity to earn higher profits for an environmentally or operationally constrained unit.[1]

Energy Market Opportunity Costs and Non-Regulatory 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 15, Market Sellers 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.

12.7.2 Forward LMP

Unit specific hourly forward LMPs are based on off peak and on peak future contracts for PJM Western Hub or any neighboring frequently traded PJM hub with expiration dates during the optimization period. The futures contract price will be multiplied by a basis differential and an hourly volatility scalar. The basis differential accounts for the price difference between the location of the forward contract delivery point (PJM Western Hub) and the relevant generator bus. The hourly volatility scalar incorporates hourly volatility into the forward LMP.

Three different historical time periods will be identified and mapped on an hourly basis to the optimization period. Historical on peak hours will be mapped to on peak hours in the optimization period, and historical off peak hours will be mapped to off peak hours in the optimization with adjustments made to ensure historical holiday and weekend days are mapped to holiday and weekend days during the optimization period. For example, if the calculation date is January 25, 2019 and the optimization period is one year into the future, then three different historical time periods, each consisting of 8,760 hours from the three year period preceding January 25, 2019, will be identified. Each of the three historical time periods will be mapped to the 8,760 hours in the optimization period such that on peak hours are mapped to on peak hours, off peak hours are mapped to off peak hours, holidays are mapped to holidays, and weekend days are mapped to weekend days.

Three on peak and three off peak basis differentials will be computed for each futures contract used in the calculation of the forward LMPs using the three historical time period mappings. The on peak basis differential will be calculated as the average of the ratio of the hourly bus LMP to the hourly Western Hub LMP, with the average being taken over all on peak hours during the identified historical time period where the month corresponds to the futures contract month of expiry. The off peak basis differential will be calculated as the average of the ratio of the hourly bus LMP to the hourly Western Hub LMP, with the average being taken over all off peak hours during the identified historical time period where the month corresponds to the futures contract month of expiry.

Three hourly volatility scalars will be computed for each hour during the optimization period based on the three different historical time period mappings. For an on peak hour in the optimization period, the hourly volatility scalar will be calculated as the ratio of the historical bus LMP to the average historical bus LMP, with the average being taken over all on peak hours during the identified historical time period where the month corresponds to the month of the on peak hour in the optimization period. For an off peak hour in the optimization period, the hourly volatility scalar will be calculated as the ratio of the historical bus LMP to the average historical

[1] A separate opportunity cost adder, applicable to a specific portion of the generator's offer curve, may be appropriate for an environmental or operational limitation that applies to the duct fire capability of the generator (e.g. duct fire hours limit). If it is determined that a duct fire limit is binding, the corresponding opportunity cost is the shadow price corresponding to the duct fire limit.

bus LMP, with the average being taken over all off peak hours during the identified historical time period where the month corresponds to the month of the off peak hour in the optimization period.

12.7.3 Forward Delivered Fuel Price

Unit specific daily forward delivered fuel prices are based on traded forward fuel prices from a published source or prior contractually agreed prices. A fuel delivery charge is added to the monthly forward fuel prices to obtain delivered fuel prices, and the delivered fuel prices are multiplied by daily volatility scalars to obtain a daily forward delivered fuel price for the generator. For generators procuring fuel at a contractual rate, a volatility scalar is not applied and a constant contracted price is used. Three volatility scalars are computed for each day in the optimization period based on the three different historical time period mappings. The daily volatility scalar is computed as the ratio of the historical daily delivered fuel price to the average monthly historical delivered fuel price.

12.7.4 Operating Cost

The hourly operating cost ($ per MWh) is the short run marginal cost of generating energy. Inputs into the calculation of the hourly operating cost consist of the forward delivered fuel price, the generator's heat rate data, emission rate data, and VOM cost available in the Member Information Reporting Application (MIRA), and emission futures prices. The calculation of hourly operating cost is consistent with the calculation of cost based offers specified in PJM Manual 15.

The hourly operating cost or operating parameters may be adjusted in cases where the unit's historical offer behavior deviates from the short run marginal cost or the commitment and dispatch of the generator has historically differed from expected economic outcomes due to actions taken by the Transmission Provider or other factors outside the control of the Market Participant. The application, and the magnitude and direction, of any adjustment is dependent upon an expectation that the offer behavior or conditions that cause the noneconomic commitment and dispatch of the unit will persist into the optimization period and that the unit will be subject to mitigation.

12.7.5 Emissions and Operating History

Up to date emissions totals, hours of operations, or number of starts are critical inputs into the Opportunity Cost Calculator. Market Participants are required to provide these values on a routine basis and as requested by the MMU. If Market Participants fail to provide emissions data at the required temporal granularity, actual generation history and the generator's emissions rates and heat rate will be used to calculate daily emissions. Opportunity cost adders will not be calculated for generators that do not have up to date emissions totals, hours of operations, or number of starts, and Market Participants will not be allowed to include an opportunity cost adder in the generator's cost based offer.

12.7.6 Opportunity Cost Adder

For each of the three sets of forward LMPs and forward delivered fuel prices, the Opportunity Cost Calculator selects the hours of operation that maximize the generator's energy market revenue net of the generator's short run marginal cost of producing energy, subject to the unit specific environmental or operational limits. The duration and structure (i.e. rolling compliance periods or a single compliance period) of the optimization period will be as specified in an environmental permit for environmental limitations, as specified by the original equipment manufacturer or insurance carrier for physical equipment limitations, or as agreed upon by the Market Participant, PJM and the MMU in cases of fuel supply limitations.[2]

For resources with a single compliance period (e.g. calendar year), the opportunity cost is the shadow price corresponding to the binding environmental or operational limit. For resources with rolling compliance periods, the opportunity cost is the shadow price corresponding to the earliest binding environmental or operational limit. The shadow price is defined as the marginal decrease in the net revenue due to a one hour equivalent decrease in the binding environmental or operation limit.

The opportunity cost adder is calculated as the average of the three opportunity cost values corresponding to the three sets of forward LMPs and forward delivered fuel prices.

12.7.7 Market Participant Requirements

Market Participants must make available to the MMU the following information:

- Permits describing environmental limitations imposed on the generator;
- OEM documentation or insurance carrier documentation for physical equipment limitations;
- Operating parameters necessary for the calculation (Economic Minimum, Economic Maximum, heat rate curve, minimum downtime, maximum weekly starts, maximum daily starts, emission rates, start-up emission rates, fuel consumption rates during start-up);
- Fuel price information;
- Emission levels for the previous 12 month period in the case of environmental limitations;
- Hours of operation and number of starts for generators subject to operational limitations.

Information that is currently included in the Cost Offer Assumptions (COA) or the Fuel Policy as part of the Member Information Reporting Application (MIRA) does not need to be resubmitted.

12.7.8 Dual Fuel Opportunity Cost Adder

Dual fuel generators with an environmental or operational limitation that applies regardless of the fuel type may use the dual fuel opportunity cost adder in the cost schedule associated with the secondary fuel. The dual fuel opportunity cost adder is determined under the assumption that the generator operated for the minimum run time on the first day of the optimization period using the secondary fuel. For the remaining days in the optimization period, the generator is dispatched according to a daily determination of the cheaper fuel based on forward prices modified by the historical daily volatility. The opportunity cost adder applicable to the cost schedule associated with the primary fuel is determined according to Sections 12.7.1-12.7.7.

[2] The required opportunity cost is a solution of a constrained optimization problem and the IMM Opportunity Cost Calculator uses an integer programming solver that finds the maximum energy market revenue net of the generator's short run marginal cost of producing energy while simultaneously satisfying all generator parameter limits (e.g. minimum run time, economic minimum economic maximum) and environmental or operational limits.