Opportunity Cost Methodology Comparison

PJM Markets and Reliability Committee Meeting February 24, 2010

This document provides a comparison of the Opportunity Cost Methodology approved by PJM Stakeholders in July 2009 and a proposed methodology developed by the PJM Independent Market Monitor ("IMM") during the fall of 2009. This comparison document was developed by the Cost Development Task Force ("CDTF") as directed by the Markets and Reliability Committee ("MRC") at their meeting on January 20, 2010.

Background

Opportunity costs are designed to provide a market signal when a generator has restricted run hours due to an externally imposed environmental or run time limit. A typical example would be a restriction on emissions in a given calendar year. If a unit is frequently run cost-capped, it may exceed the limit and be forced to shut down prior to peak load periods when most needed for reliability. This could have reliability impacts on the system, and limits the ability of the owner to manage their unit within externally imposed limitations.

In order to provide an appropriate price and reliability signal, the opportunity cost calculator determines future hours when a unit might be economical to operate over the course of the compliance period (currently the calendar year). This is accomplished by acquiring future fuel prices and future electricity prices to determine the hours of greatest margin (LMP above cost). The simulation projects the hours when need on the system would be greatest for a generator. This simulation uses three years of historical data to add volatility to the futures data. The results of the three yearly simulations are averaged together to determine opportunity cost for a generator.

Opportunity cost is the difference between the generator's cost and the lowest future hourly LMP the unit could run while not violating imposed restrictions. This allows the market to make the best use of the scarce resource, and the generator is compensated when needed to run for reliability at PJM's direction. These opportunity costs only apply to the cost based offer when the unit is needed to run for reliability and the owner fails the three-pivotal supplier test.

The Federal Energy Regulatory Commission ("FERC") issued an Order to PJM on February 19, 2009 directing PJM to submit a compliance filing by no later than July 31, 2009, proposing Tariff and Operating Agreement revisions that allow for opportunity costs to be included in default bids (also known as mitigated offers). In order to meet the tight timeline specified by the FERC, the CDTF agreed to focus on "generating units that are bound by externally defined run limits e.g. environmental/emissions, water temperature, etc". On May 28, 2009, the FERC found that it was reasonable for PJM to focus on opportunity costs related to energy and environmental limitations in the July 31, 2009 compliance filing and to include in that filing a plan for developing additional market rules for other types of opportunity costs.

The methodology described in this document as the "PJM Stakeholder Approved Methodology" represents the methodology developed by the CDTF and recommended to the PJM MRC in June 2009. The PJM MRC unanimously endorsed by acclamation this methodology for implementation on July 30, 2009. The PJM Members Committee ("MC") unanimously endorsed by acclamation and the PJM Independent Board of Managers approved this methodology in August 2009. Approval from FERC was requested no later than September 29, 2009 (60 days) from the date of the compliance filing to allow generators with externally defined run time limits to begin submitting opportunity costs on October 1, 2009. To date, the requested approval from FERC to allow generators to be able to include opportunity costs for units with externally defined run time limits has not been received.

The PJM IMM expressed several concerns with the methodology developed by the CDTF to the PJM MRC on July 30, 2009. During the discussions prior to taking the vote, the PJM MRC asked the PJM IMM to work with the CDTF to develop improvements deemed necessary for the accurate calculation of opportunity costs for units with externally defined run time limits. The PJM IMM developed a proposal, referred to as the "PJM IMM Proposed Methodology", with the CTDF to improve the opportunity cost calculation methodology.

The PJM IMM proposed additional changes for improvements to the CDTF for approval at the December 14, 2009 meeting. The CDTF voted down the adoption of the IMM Calculator at that meeting with 16 votes being cast for approval, 54 votes against approval, and 6 abstentions. The primary reason cited by CDTF participants for voting down the PJM IMM proposal was the need to gain experience with the approved version prior to implementing additional changes. The decision reached by the CDTF on this issue was presented to the PJM MRC at their January 20, 2010 meeting.

The PJM IMM presented proposed changes for improvements to the PJM MRC at their January 20, 2010 meeting. At this meeting the PJM MRC directed the Chair of the CDTF to put together a list of Pros and Cons for each key component proposed by the PJM IMM with all views being captured for presentation at the February 24, 2010 PJM MRC meeting. The result of this effort is as follows:

CDTF Overall Findings

Several Stakeholders expressed concern with changing the approved methodology at this time without operational experience with the approved methodology. Other Stakeholders felt that since this effort is still under development, and we still have not received approval from FERC to allow generators to include these opportunity costs, it is an opportune time to make changes to improve the method.

Another stakeholder expressed concern about prudency. The PJM IMM Proposed Methodology is more conservative and has more flexibility due to the greater number of parameters, which can be modified to gradually calibrate the model's performance as experience is gained with the implementation of this opportunity cost methodology.

The following pages present each key component of the IMM's proposal and provide a brief description of the each component, the methodology differences, pros and cons for each component, and additional actions and comments from the CDTF.

Rolling Time Period Restrictions

Adds the ability for the Opportunity Cost Calculator to provide forecasts for any compliance period a generator owner may be subject to. Some generators are limited by a rolling compliance period (e.g. a rolling 12 months) rather than a calendar year period.

PJM Stakeholder Approved Methodology	PJM IMM Proposed Methodology
Assumes a calendar year compliance period only. This is typical for most units currently under energy and environmental restrictions. Rolling compliance periods were not addressed due to implementation timing constraints which led the CDTF to focus on the most likely scenario. The current calculation can be expanded to include rolling time periods.	Accounts for restrictions based on calendar year or rolling 12 months, depending on actual environmental limits.

PJM Stakeholder Approved Methodology		PJM IMM Proposed Methodology	
PROS	**CONS**	**PROS**	**CONS**
Simpler and encapsulates the majority of restrictions.	Does not change the basic calculation method. Does not cover all externally mandated environmental restrictions (i.e. mercury emission restrictions)	Provides increased flexibility and does not change the basic calculation method	More complicated for users to replicate internally.

Additional Actions/Comments

The CDTF elected to vote on adopting this component of the IMM Proposed Methodology without specifying a date certain for implementation at their January 25, 2010 meeting. The IMM Proposed Methodology to allow for a Rolling Time Period restriction was approved unanimously by acclamation vote on January 25, 2010.

Minimum Run Time

The calculation for opportunity cost is essentially a simplified dispatch simulation based on future fuel and electricity prices. The simulation must determine, based on cost versus LMP comparison, when a generator would run. Generators cannot start and stop instantaneously. They have a minimum run time that determines the smallest block of hours the unit can run for safe and efficient operation.

PJM Stakeholder Approved Methodology		PJM IMM Proposed Methodology	
The simulation ignores the minimum run time. It assumes that a generator will run in any hour where the LMP is above the unit cost without constraining the unit to run several hours in a row. (Assumes a one-hour minimum run time.)		Accounts for minimum run time parameter limit for each unit. Minimum run time has an impact on calculated opportunity costs. For minimum run time, the adder is the average hourly adder for a block of hours, rather than the minimum hourly adder for the remaining run hours	
PROS	**CONS**	**PROS**	**CONS**
A straightforward and simple method, which allows easier calculation for generation owners and provides greater transparency and understanding for all market participants. Method represents a balanced forecast among the many uncertainties in the inputs.	Lacks many complexities that might add to more accuracy such as: minimum runtime, minimum downtime, maximum daily starts, maximum weekly starts, and turn down ratio. May not be accurate enough to be used for possible future non-environmental opportunity cost applications.	The inclusion of minimum run time parameter improves accuracy of calculation based on actual unit operating parameters. May be accurate enough to be used for possible future non-environmental opportunity cost applications.	Adds complexity to the calculation process and decreases transparency. Adds minimum run time without adding other parameters like minimum downtime, maximum daily starts, maximum weekly starts and turndown ratio. The accuracy this may add may be within the margin of error that is within future fuel and electricity prices. Level of accuracy not proven. Concern that there are no results with current methodology.

Additional Actions/Comments

None

Start Up Costs

The dispatch simulation determines what hours the generator would run based on the comparison of the projected price of energy versus the projected costs of operating the generator and determines the margin (LMP - cost of operation). Start up costs are spread over the hours of continuous operation of the unit and added to the cost to run the unit,

PJM Stakeholder Approved Methodology		PJM IMM Proposed Methodology	
The calculation does not include start costs in the margin calculation, only the marginal operating costs.		Accounts for startup costs. Start costs are a cost of operation and can have an impact on calculated opportunity costs.	
PROS	**CONS**	**PROS**	**CONS**
Results in a much simpler calculation to implement, understand and evaluate. It also eliminates the complexity of estimating how to average start costs over run hours.	This method ignores one of the components of dispatch cost.	The inclusion of start costs improves the accuracy by including actual unit costs.	Uses cold start costs only that may decrease opportunity cost and add a downward bias to calculation if a warm or hot start is appropriate. Adds complexity to the calculation. The accuracy improvements may be negated by other variables in the calculation, such as the accuracy of future fuel and electricity prices. Level of accuracy not proven.

Additional Actions/Comments

None

<table>
<tr><th colspan="4">Adjustment for Negative Margins</th></tr>
<tr><td colspan="4">The calculation uses historical data to add volatility to the futures pricing for the simulation so prices are not constant for a month but rather reflect more typical hourly and daily fluctuations. The calculation determines the opportunity cost adder three times, using one of the past three years of historical data for each value. The three results are averaged together to determine the final adder.</td></tr>
<tr><th colspan="2">PJM Stakeholder Approved Methodology</th><th colspan="2">PJM IMM Proposed Methodology</th></tr>
<tr><td colspan="2">If any of the three adders are calculated to be a negative number (meaning the limit was not binding that year as the unit would not have been "in the money" for some of the hours), the adder is set to zero and the zero is included to determine the final adder. This reflects current treatment of units by not forcing them to run at a negative margin.</td><td colspan="2">Calculated negative margins are included in the average as-is. Negative margins reflect actual simulation results from prior years.</td></tr>
<tr><th>PROS</th><th>CONS</th><th>PROS</th><th>CONS</th></tr>
<tr><td>Units do not see "negative margins" at the dispatch of PJM. At a minimum, they are paid uplift and made whole to their offer. The approved method is consistent with current PJM dispatch logic.</td><td>Reduces volatility of historical averages.</td><td>More accurately accounts for yearly volatility and reflects actual values of hours in prior years. Consistent usage of data regardless of outcome. The occurrence of negative values is infrequent and unlikely to affect the outcome.</td><td>This usage of a negative margin is counter-intuitive to how units are called to run and are compensated. PJM units will never have a negative margin from a settlement perspective.</td></tr>
<tr><th colspan="4">Additional Actions/Comments</th></tr>
<tr><td colspan="4">None</td></tr>
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<tr><th colspan="4">Dual Fuel Inputs</th></tr>
<tr><td colspan="4">The calculation must use future fuel prices to do a dispatch simulation. The fuel prices are used to estimate the future cost of operation of the unit.</td></tr>
<tr><th colspan="2">PJM Stakeholder Approved Methodology</th><th colspan="2">PJM IMM Proposed Methodology</th></tr>
<tr><td colspan="2">Only one fuel per generator can be selected. The calculation does not address dual-fuel generators. A generator can use only one fuel price (both the type of fuel and delivery point) in the calculation.</td><td colspan="2">Permits 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.</td></tr>
<tr><th>PROS</th><th>CONS</th><th>PROS</th><th>CONS</th></tr>
<tr><td>Simpler calculation as only a few units require this capability</td><td>Does not address units with dual fuel capability.</td><td>Permits dual fuel units to have more accurately forecasted dispatch costs.</td><td>None.</td></tr>
<tr><th colspan="4">Additional Actions/Comments</th></tr>
<tr><td colspan="4">The CDTF elected to vote on adopting this component of the IMM Proposed Methodology without specifying a date certain for implementation at their January 25, 2010 meeting. The IMM Proposed Methodology to allow for Dual Fuel Inputs was approved unanimously by acclamation vote on January 25, 2010.</td></tr>
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Spot or Contract Monthly Fuel Flexibility

The calculation must use future fuel prices to do a dispatch simulation. The fuel prices are used to estimate the future cost of operation of the unit. Some generators use spot prices in determining their cost offers while others have longer term contracts for fuel and use contract prices in determining their cost offers (according to their fuel policy.)

PJM Stakeholder Approved Methodology		PJM IMM Proposed Methodology	
The approved calculation uses only forward price projections for fuel. Contract prices are not used.		Allows the use of contract fuel prices instead of, or in conjunction with, forward prices. Allows members to identify when a contract will end and permits the use of spot prices or new contract prices if a contract ends in the middle of a compliance period.	
PROS	**CONS**	**PROS**	**CONS**
A simpler calculation, and provides consistency across all units	Less accurate for generators using contract fuel prices.	More accurate for generators with contract fuel prices.	More complex inputs for users.

Additional Actions/Comments

The CDTF elected to vote on adopting this component of the IMM Proposed Methodology without specifying a date certain for implementation at their January 25, 2010 meeting. The IMM Proposed Methodology to allow the use of contract fuel prices instead of, or in conjunction with, forward prices was approved unanimously by acclamation vote on January 25, 2010.