Multi Interval Optimization Pricing

The price in the real time market is currently being calculated using a myopic algorithm. This algorithm calculates the price in each interval irrespective of the requirements of future intervals. Multi Interval Optimization (MIO) is a modification to the pricing algorithm that allows the algorithm to dispatch resources early to meet the demand in a future interval.

In June 2004 the dispatch algorithm was upgraded to utilize MIO in the constrained, or dispatch, sequence. This change was made to eliminate the manual interventions of the IESO control room operators and replace them with a systematic algorithm that provided optimized 'look ahead' results. The MIO algorithm calculates the set of resources that will satisfy the demand in the current interval and in a number of future intervals[1] at the lowest possible total cost. To do this MIO must predict, using past data and the current conditions, what the expected demand will be in future intervals so that the appropriate resources are positioned to meet that demand. Any unexpected changes to demand or a change to the available resources will eliminate the benefits of MIO as it has no way to prepare for these situations. In these unexpected situations the pricing and dispatch result will be the same as the 1X myopic solution.

In the MIO solution a generator who is not needed to meet the demand in the current interval yet is needed to meet demand in a future interval may be dispatched in the current interval so that it may reach the appropriate loading point to meet the demand in the future interval. MIO will only take this advance action when doing so would reduce the overall cost of dispatch over all of the intervals that MIO considers. Without MIO in the dispatch sequence when the future interval with higher demand is reached the original algorithm would have to move up the stack to dispatch more expensive generators to meet the expected demand.

The MIO dispatch algorithm works in two passes. Pass 1 performs an optimization across several critical intervals ignoring or simplifying constraints[2] to arrive at a near optimum solution. The result of this pass is Max and Min limits for resources which become constraints in the second Pass of the algorithm. Pass 2 performs a myopic optimization for each critical interval respecting the actual constraints that were relaxed in Pass 1.

If MIO is used to calculate prices in the unconstrained sequence, similar to the way dispatch is calculated in the constrained sequence, prices can be produced and retained from the Pass 1 (pass 1 pricing) or Pass 2 (pass 2 pricing) of the algorithm.

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[1] The future intervals that MIO uses to prepare resources are called 'critical intervals'. There are 5 critical intervals; the current interval and 4 future intervals.

[2] The constraints are simplified by linearizing, or ignoring the non-linear constraints (ramp limits, forbidden regions, steady operation).

An Example:

This example attempts to show the benefits of moving a generator early to meet expected future demand. There are 3 generators, each with offers as seen in the table below. Demand in interval 1 is 1200 MW and increases to 1300 MW in interval 2. In the MIO solution, Generator A has it's output reduced in the first interval (compared with the 1X Myopic schedule) so that Generator B can begin to ramp to meet the expected demand in interval 2. This eliminates the need for the high priced Generator C in interval 2.

Offers:

Generator	Offer Price ($)	Offer Quantity (MW)	Ramp Rate (MW/min)
A	30	1000	50
B	40	500	10
C	100	200	10

Market Schedule Results:

Interval	Demand	Generator	MIO Market Schedule (MW)	MIO MCP ($)	12X RR Market Schedule (MW)	12X RR MCP ($)
1	1200	A	950	30	1000	40
		B	250		200	
		C	0		0	
2	1300	A	1000	40	1000	40
		B	300		300	
		C	0		0	

More Information

For detailed examples using multiple pricing methodologies please see the document "Temporal Optimization (ramp rates) - Background Information on Price Calculation Methods" published for the January 20th meeting of the Market Pricing Working Group.
http://www.ieso.ca/imoweb/pubs/consult/mep/MP_WG-20060120-price-calculation-methods.pdf

For a review of the documents provided to the Market Pricing Working Group on temporal optimization and pricing methodologies please see "Temporal Optimization (ramp rates) - Summary of Previous Meetings" published for the January 20th meeting of the working group.
http://www.ieso.ca/imoweb/pubs/consult/mep/MP_WG-20060120-ramp-rates-summary.pdf