Update on Constraint Violation Prices in the Pricing Algorithms

Introduction

This issue of Quick Takes provides an overview of constraint violation pricing in the pricing algorithms. The use of these prices allows calculation engines to violate required system and resource constraints in order to find a solution.

Constraint Violations in the Pricing Algorithms

The renewed market will use calculation engines to determine day-ahead, pre-dispatch, and real-time schedules and prices. Situations can occur when a calculation engine is unable to determine a schedule that meets demand while respecting all required system and resource constraints. For example, there may be insufficient transmission capacity to meet projected demand, or there might not be enough operating reserve offered to meet all reserve requirements. When this happens, a calculation engine can be allowed to violate constraints in order to find a solution. Prices must reflect the engine's actions so correct signals are sent to the market. The calculation engines achieve these goals by applying constraint violation (i.e., penalty) prices in their calculations when making scheduling and pricing decisions. The ordering of penalty prices from lower to higher signals the sequence in which the IESO will violate system constraints if no market outcome can otherwise be found. As such, penalty prices set a clear priority of constraint violations where those with less impact on reliability are priced at a relatively lower level so they are violated before those with more impact.

Calculation engines run two algorithms: The scheduling algorithm and the pricing algorithm. The intent of constraint violation prices in the pricing algorithm is to signal the market's maximum willingness to pay for resolving the constraint violation. The penalty prices to be used in the renewed market are derived using historical offer prices and are representative of true market-based outcomes. The methodology for determining constraint violation pricing was discussed in "Stakeholder Engagement Pre-Reading: Constraint Violation Pricing" issued on November 25, 2019. Constraint violation penalty curves including penalty prices for scheduling and pricing purposes will be included in Appendix C of Market Manual 4.2: Operation of the Day-Ahead Market and Appendix A of Market Manual 4.3: Operation of the Real-time Market.

The following sections provide a description of the IESO's proposed constraint violation prices in the pricing algorithm for the following types of constraints:

- Transmission Line Limits,

- Operating Reserve Requirements, and the
- Net Intertie Scheduling Limit

Transmission Line Limits

Transmission limits are operating security limits and thermal ratings used by the calculation engines to schedule resources within the capability of the IESO-controlled grid to accommodate the resulting energy flows. The transmission violation penalty price curve is divided into two segments. The break point between the two segments is a megawatt (MW) quantity equal to 2% of the given transmission limit. The first step signifies a minor transmission violation, which is priced accordingly with a lower value. The second curve segment covers all transmission violations that exceed 2%. This segment is priced to reflect all actions the IESO is required to take to alleviate a transmission constraint violation, including the possibility of shedding load.

The price for the first step of the curve was determined through analysis of historical occurrences of binding and violated transmission constraints from the current real time market (from Apr 12th, 2023, to Nov 12th, 2024). Based on historic analysis, the minor transmission constraint violation price was determined to be $2,300.

The second step of the curve is intended to reflect a violation with a significant impact on the reliability of the grid. Based on historic analysis, the major transmission constraint violation price was determined to be $8,000.

Operating Reserve Requirements

Operating reserve demand curves (ORDCs) are used in the process for determining settlement prices for the three classes of operating reserve: 10-minute synchronized (10S), 10-minute non-synchronized (10N), and 30-minute (30R). The total requirement for 10-minute reserve (i.e., both 10S and 10N) is referred to as 10T. The total operating reserve requirement (i.e., all 10S, 10N and 30R reserve combined) is referred to as 30T.

An ORDC allows settlement prices to be set based on offered energy and OR costs without charging excessively high prices for minor violations. When the MW quantity of offers is sufficient to meet the OR requirement at a price which is less than that specified by the ORDC, the OR price will be set by the marginal offer and not the ORDC. When the MW quantity of offers priced less than ORDC is insufficient, the OR price will be set by the ORDC. Any MWs scheduled to meet the operating reserve requirement which were offered at a price above the ORDC will receive make-whole payments.

ORDC penalty prices need to be high enough to allow offered costs to set market prices 99% of the time so the need for make-whole payments is largely avoided. The 99th percentile of reserve prices was established using a historical analysis over one year of actual real-time constrained results (from Oct 15th, 2023, to Oct 15th, 2024) where CAOR[1] offers were removed. Table 1-1 provides a summary of the different ORDC laminations.

[1] Control Action Operating Reserve (CAOR) was implemented in the current market to address counter-intuitive market pricing that can occur when the IESO uses emergency control actions to maintain grid reliability. These emergency control actions include voltage

Table Error! No text of specified style in document.**-1 Summary of ORDC Laminations in Pricing Algorithm**

OR Class	Requirement (MW)	Individual OR Class Prices ($/MW)	Cumulative Price ($/MW)
10S	0 – 118	$600	$1,900
	119 – 237	$400	$1,300
10T (10S + 10N)	0 – 473	$550	$900
	474 – 709	$450	$800
	710 – 945	$350	$700
30T (10S + 10N +30R)	0 – 1,102	$350	$350
	1,103 – 1,260	$300	$300
	1,261 – 1,418	$250	$250

Area Operating Reserve

The IESO uses operating reserve areas to specify limits for portions of the grid so either a minimum amount of 10-minute operating reserve must be scheduled there or in order to set a maximum MW amount of operating reserve of all kinds (i.e., 30T) that can be scheduled in an area. Using these area limits ensures operating reserve is distributed appropriately and can be activated when called upon without violating transmission limits.

Constraints for area operating reserve are tightly related to those for transmission line limits. Given this relationship, the maximum MW amount penalty price is set at $8,000 (see the Transmission Line Limits section above). The minimum area reserve requirement penalty price is set at $350, which is equal to the lowest pricing step for the system-wide 10T operating reserve requirement.

Net Intertie Scheduling Limit

The net intertie schedule is the sum of all changes in imports (positive) and exports (negative) from the previous hour's schedule. Responding to large changes in the net intertie schedule can have an adverse impact on the reliability of the IESO-controlled grid. Internal generation may not be able to ramp up or down fast enough to satisfy a large net change in intertie flows. To prevent these problems, the IESO uses the Net Intertie Scheduling Limit (NISL) to restrict the net hourly intertie schedule change from hour-to-hour to a set amount, usually 700 MW.

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reductions, emergency energy purchases, and non-dispatchable load cuts. Counter-intuitive pricing can occur when the emergency control action affects demand resulting in pricing outcomes and signals that do not reflect actual market conditions. CAOR was implemented in the current market as standing operating reserve offers from two fictional resources in the real-time constrained solution. CAOR will be removed in the renewed market as it will no longer be required with the implementation of ORDCs.

As part of MRP the detailed design process, the NISL constraint penalty price was calculated in 2019 based on the 99th percentile of historic NISL shadow prices in the constrained pre-dispatch sequence (where intertie schedules are set). This was determined to be approximately $500. Recent recalculation of the 99th percentile of NISL shadow prices over the last 5 years (from Oct 20th, 2019, to Oct 20th, 2024) shows it at approximately $100. Setting the NISL penalty price at this level would place it in the constraint violation price hierarchy below actions with less impact such as violating the 30T constraint. Because this would be counter to the purpose of the pricing hierarchy, the intention is to leave the $500 value in place.