Congestion Cost Metrics

One of the features of a Locational Marginal Price (LMP) based market is the ability to identify grid locations that are difficult to serve with economic generation due to transmission bottlenecks (constraints) and quantify the cost of this congestion. The NYISO calculates and publishes LMP's with three components:

Energy component – Marginal electricity cost without the adjusted cost of congestion and losses.

Congestion component – Cost of out-of merit generation dispatch relative to an assumed unconstrained reference point at Marcy substation.

Losses component – Cost for supplying the losses from the accessible marginal generators to the grid point in question.

The cost of congestion commonly reported is the simple sum of the day ahead market LMP congestion component times the amount of load being affected (positively or negatively) by congestion (later referred to as "congestion payments"). While this congestion cost is relatively simple to calculate, this value is generally felt to be an over-simplified and deceiving congestion impact metric because:

1. This calculation does not incorporate the effect of supply and demand response when congestion is removed.
2. The congestion cost is relative to an assumed uncongested reference point. If this reference point is moved, the congestion cost is shifted to the LMP energy component. The congestion versus energy cost calculation becomes arbitrary depending on the reference point chosen.

To better measure the true cost of transmission congestion, analysis tools and protocols were developed by the NYISO. The fundamental idea is to calculate what the day-ahead hourly clearing prices would be if there were **no** transmission constraints, using the same data and calculation approach as the NYISO Security Constrained Unit Commitment software (SCUC). The congestion cost then is the difference between the actual SCUC transmission constrained LMP's, loads, and bids, and the same calculation with all transmission constraints ignored. Annual cost is the sum of daily costs.

The reported numbers are the result of a simulation of the NYCA market using the hourly bids and network status actually used by NYISO to clear the day-ahead market. The simulation performs a security constrained unit commitment for the market "as it was", then removes all transmission constraints (other constraints such as desired net interchange (DNI), generator ramp rates and minimum run times are still enforced). Unit commitment and dispatch are then recalculated for this unconstrained scenario with no changes in bids from those actually submitted. The constrained and unconstrained results are compared to derive the cost of congestion. All calculations represent all market segments (e.g., fixed load, virtual load and generation, imports and exports), and actual hour-by-hour network status. The unconstrained scenario fixes the amount of virtual load and generation at their original MW levels.

The Congestion Metrics

To suit various needs for viewing the impact of congestion, four congestion metrics were developed. All metrics report the difference between a constrained and an unconstrained value.

1. Change in Production Cost – This is the primary congestion impact metric chosen for use by the NYISO Operating Committee. The calculation compares the total production cost, based on mitigated bids, with and without transmission constraints limiting the unit commitment and

dispatch. This measures the economic inefficiency introduced by the existence of transmission bottlenecks. In a sense, this is the *societal cost* of transmission congestion.

A positive number means that transmission congestion increased electricity production cost.

An advantage of this metric is that production cost will always decrease when constraints are removed. The direct objective of SCUC is to minimize bid production cost; LMP's are the result of the commitment and dispatch that result from achieving this objective under generating unit and transmission constrained conditions. Since SCUC does not directly attempt to minimize LMP's, relieving all or some of the constraints may or may not decrease the market based electricity cost to load. In LMP markets, the load in a location pays the marginal price of the supply at that location, not the bid price. The result of constraint relief in an LMP market depends on how much load is affected, where the load is, and the response of supply and demand as constraints are relieved.

2. Change in Congestion Payments – This calculation, the sum of the LMP congestion component times the load affected, ignores the energy cost change as constraints are removed. With no simulation truly required to arrive at this congestion impact metric (the congestion cost in an unconstrained market is 0), this is the *accounting cost* of congestion. Congestion payments can be hedged with transmission congestion contracts (TCC's) resulting in the unhedged congestion numbers reported. For this analysis, it was assumed that all TCC's are owned by load and are available for hedging congestion payments.

   A positive number means congestion increases load cost.

3. Change in Generation Payments –In addition to the LMP payments to generation (or other supply sources such as virtual generation, or imports), generators are also paid a Bid Production Cost Guarantee (BPCG) and for Ancillary Services (AS). BPCG compensates generators that are committed for reliability despite the fact their bids are greater than the LMP at the generator location. This can happen if ramp rates, minimum run times or other limits force unit operation, which minimizes overall production cost, even including BPCG payments.

   A positive number means generation payments went up due to congestion.

4. Change in Load Payments – This metric is the opposite side of the generation payments calculation. The calculation uses simulation to include the local energy cost response when transmission constraints are removed. Where the first congestion metric measures efficiency, this metric determines how much more New York load actually pays due to congestion and the market design; that is, the *bills impact*.

   The load payments congestion impact includes the effect of all market segments that can change when transmission constraints are relieved. These segments are:

   - LMP Components: While the LMP congestion component will be pushed to zero when no transmission constraints exist, the unbottled generation will sell more energy at a slightly higher price (in accordance with the bid curves), albeit at a lower bid than the units put on out-of-merit in the transmission limited case. This results in a likely increase in the LMP energy component as the LMP congestion component decreases. The LMP loss component will also change depending on the location and prices of the generation unbottled when constraints are relieved. Ancillary service costs (e.g., reserves) also affect LMP's, as generators trade-off between selling ancillary services or energy.
   - Load payments due to congestion are hedged with TCC's, leading to the reported unhedged load payment. In this analysis, it was assumed that all TCC's were credited to load. The TCC auction cost is ignored, as it is part of the Transmission Service Charge (TSC).

- TCC shortfall – In the event of a TCC shortfall (or surplus), the load pays for the imbalance. As transmission constraints are relieved or removed the imbalance changes. While the shortfall may be compensated for elsewhere in the TSC, from a congestion impact perspective this is considered a load cost. Although the NYISO OATT describes details of the allocation of shortfall by transmission owner, for this analysis shortfall is stated for the NYCA only.
- Schedule 1 imbalances – In accordance with the NYISO OATT, imbalances of energy and loss payments are a component of the OATT defined Schedule 1 payments. Relieving or eliminating transmission constraints affects these payments, and is thus considered a congestion impact in this analysis. Like shortfall, this analysis states the Schedule 1 effect for the NYCA only.

A positive number means congestion increases load payments.

Congestion by Constraints

The congestion payment metric is the only one available for allocating congestion impact to individual causative constraints. Congestion payments, either total or unhedged, is not a useful number in the absolute, but the relative payments are felt to be of value in identifying transmission constraint location and severity. Therefore, to prevent confusion and misinterpretation of absolute numbers, the unhedged congestion payments by constraint are only reported as the percentage of the total for the period reported.

As discussed above, the use of congestion payments does not consider the change in energy payments when the constraint is relieved (or in the case of the congestion metrics calculation, when all transmission constraints are relieved). Moreover, and very importantly, if a constraint is relieved, another existing or “just below the surface” constraint will almost certainly become constraining, limiting the congestion reducing benefit of the constraint relief.