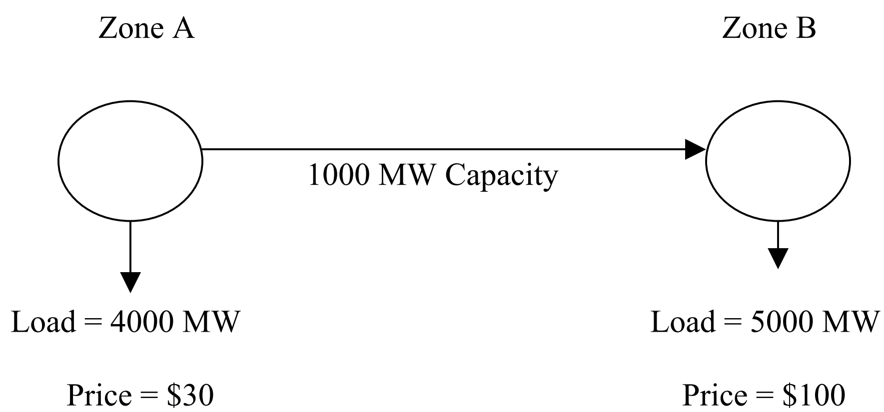
# Calculating the Cost of Congestion

**Example:** 2 zones, connected via transmission with transfer capacity of 1000 MW




Since prices are unequal, the flow across the line is at its capacity, 1000 MW, and therefore the generation (ignoring losses) is:

Zone A - 5000 MW
Zone B - 4000 MW

The monetary flows are:

Load in A pays 4000 x $30 = $120,000
Load in B pays 5000 x $100 = $500,000

Generators in A receive 5000 x $30 = $150,000
Generators in B receive 4000 x $100 = $400,000

The TCC holder(s) between A and B get the difference, which is the flow times the price differential, or 1000 x ($100-$30) = $70,000

The dollars balance, i.e.,
Payments ($120,000 + $500,000) = Receipts ($150,000 + $400,000 + $70,000)

**Question**: What are the congestion costs? This term is not defined in the NYISO tariff, although the terms "Congestion", Congestion component", and "Congestion rent" are. There are several alternatives:

1. Some people may wish to define congestion costs as the higher costs incurred by load in the congested zone as compared to the lower priced zone. This is the load in Zone B (5000 MW) times the price differential ($70), or $350,000.

2. An alternative would be the payments to the TCC holders, which is the flow times the price differential, or $70,000.

Note that both of these definitions are somewhat (but not entirely) consistent with the term, "Congestion Rent" defined as, "The opportunity costs of transmission constraints on the New York State transmission system. Congestion rents are collected by the ISO from loads through its facilitation of LBMP market transactions and the collection of TUCs from bilateral transactions".

3. A third possibility for the definition of congestion is, "Costs paid by load that would not be paid if the transmission system was congestion-free". In the above example, this would be the $620,000 (total payments from load), minus 9000 MW times the new price that would be in effect if there were sufficient transfer capacity between the 2 zones to levelize the prices. If this new price was also $30, then congestion would be $620,000 - (9000 x $30) = $350,000 (or the same as in alternative 1).

The price in zone B in absence of congestion will only be $30, however, if there exists substantial additional generation in zone A that will also bid in a $30 price. This is unlikely. Generally, if the system were made congestion-free through additional transmission capacity, the ISO will choose generators in zone A with prices higher up the bid stack. The system price will levelize somewhere between $30 and $100. Since this price is unknown, if we define "congestion costs" in such a manner, such costs cannot be directly calculated without using historical bid prices and re-running the SCUC software without the transmission constraints. But since prices have historically been bid in with the generator's full knowledge and expectation of constraints, such a calculation will, at best, be only an approximation.

There is an interesting idiosyncrasy possible here also. Let's say in the absence of congestion the new system-wide price in the above example rises to $70, because that is the marginal cost of the last generator in Zone A that now runs, displacing $100 generation in Zone B. Total costs paid by load are then 9000 MW x $70 = $630,000. This is greater than the amount the load paid with congestion, leading to the counter-intuitive, but correct, conclusion that a *congested* system provided a lower total cost to consumers. While this example may be a bit dramatic, this phenomenon is mathematically possible. It all depends on the marginal costs and bids of generators.

So, which is it?

It depends on what you want.

If you want "congestion costs" to be defined as what is paid to TCC holders, then #2 does the job.

If you want to use the value of "congestion costs" to justify infrastructure investment, clearly Alternative 1 overstates the cost of congestion, because it assumes all the load can receive the same low "unconstrained" price. Similarly, alternative 2 is not correct either, because its value depends on the capacity of the current system to support transfers. For example, if the transfer limit in the above example were 1 MW instead of 1000, the congestion costs calculated in such a manner would only be $70. That isn't enough to justify much of anything.

Clearly, to justify infrastructure investment, you must use #3. And such a calculation, even when computing past congestion, will require assumptions.

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