DRAFT - Comments Welcomed!

August 2, 1999

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Long-Term Transmission Rights for Transmission Expansions

The provision of long-term transmission rights for investors in transmission expansions was discussed at the TIRT meeting on July 14. The current proposal provides these rights in the form of Expansion TCCs. ISO staff recognized that there were problems with the proposal, and expressed an interest in developing alternatives for further analysis. Everyone agreed this was not a "Day 1" issue, but must be solved before new transmission investments can be undertaken. The following briefly summarizes the current proposal, discusses some problems identified with it, and proposes a specific alternative in which long-term transmission rights would be allocated as a series of TCC options. The appendix provides an example illustrating one of the problems discussed in the body.

Summary of Current Proposal

Expansion TCCs are intended to reflect the increase in transmission capacity along a single path due to a single transmission expansion. They would be allocated only after the expansion enters service, for a 20-year period. Expansion TCCs would generally go from a single point of injection (POI) to a single point of withdrawal (POW); investors request the POI and POW, but would have limited choices. The quantity of Expansion TCCs would be determined by the last Centralized TCC auction[1] prior to the in-service date. The proposed method is:

1. Determine the initial transmission capacity from the requested POI to the requested POW prior to the expansion. This is done by modeling all of the TCCs awarded at the last auction as fixed quantities of injections and withdrawals. OPF checks to make sure the transmission line to be expanded was filled in the last auction (i.e. the constraint between the requested POI and POW was binding). If not, additional flows are added as fixed injections and withdrawals to fill the line to capacity.

2. Add the transmission expansion to the OPF model of the transmission system.

3. Determine the additional transmission capacity from the requested POI to the requested POW due to the expansion. OPF accomplishes this step by adding a zero-cost generator at the POI and a bid curve for load at the POW; load is added (served by the zero-cost generator) until a transmission constraint is reached. The additional load that

[1] Separate quantities would be allocated for summer and winter capability periods. The last TCC auction for a summer capability period would be used to determine the quantities for the summer periods; the last TCC auction for a winter period would be used to determine the quantities for the winter periods.

could be served is a measure of added transmission capacity and is awarded as Expansion TCCs.

Discussion of Problems

Art Desell brought up one problem with this approach in terms of the proposed "end-state" auction. The end-state auction would sell TCCs for both shorter-term and longer-term periods at the same time. For example, bidders could request 1-year TCCs for $1000 per TCC, or 2-year TCCs for $2000, or 5-year TCCs for $3000. Separate power flows would be used to model each period (e.g. each year), yielding market-clearing prices and TCCs in each period. OPF would select among the shorter-term and longer-term bids to maximize total auction revenues.

The problem Art raised is that the award of Expansion TCCs would depend on which power flow (e.g. year 1 or year 2 or year 5) was used as the basis of comparison. A given transmission expansion might yield 100 MW in the auction's year-1 power flow, but only 80 MW in the year-2 power flow, and 130 MW in the year-3 power flow. It was not clear which power flow should be used to determine the Expansion TCCs to be awarded.

Another problem identified by staff and others at the meeting was that Expansion TCCs, like all TCCs, are directional - the owner receives the (congestion component of) LBMP at the POW minus the (congestion component of) LBMP at the POI. When power flows reverse direction, the LBMP prices at the TCC's (fixed) POW will become greater than the LBMP prices at the TCC's (fixed) POI. The transmission line is valuable in either case, since it allows parties to transmit in either direction, effectively buying at the low-priced end and selling at the high-priced end. However, an Expansion TCC that provides revenues in one case will impose payments (negative revenues) in the opposite case. As a result, Expansion TCCs may be worth much less than the actual value of the transmission expansion. This could provide inadequate financial incentives to invest in the transmission expansion in the first place.

Still another concern, not raised at the meeting, is that the proposed method for determining additional transmission capacity may fail entirely: investors may end up gaining no Expansion TCCs at all, even though their investment clearly expanded a constrained line.

This problem could occur if the power flow from the previous auction (representing the winning bids) had transmission constraints not only on the line being expanded, but also on one or more additional lines.[2] Under the proposed procedure for determining Expansion TCCs, OPF would

[2]Such an outcome is plausible, since there are a number of different transmission constraints in New York, each of which may be binding (filled to capacity) some time during the year. Each of these constraints would lead to congestion charges some time during the year, so TCCs reflecting each of them would be valuable. Now the winning bids for TCCs should reflect the sum of congestion charges expected over the period covered by the auction, i.e. congestion resulting from a number of different binding transmission constraints. This implies that the auction power flow (the

add a generator at the POI and attempt to serve additional load at the POW. However, OPF would distribute the additional power flows across the transmission system according to shift factors. It is entirely possible that a fraction of the additional power would flow across one of the remaining transmission constraints, overloading it. OPF would not be able to dispatch around the other transmission constraints because the previous auction bids had been converted into fixed flows. As a result, no Expansion TCCs would be allocated at all.

However, in actual real-time operations, the transmission expansion would be valuable: During some hours its line might be the only binding constraint; and even if other lines were simultaneously constrained, the expansion would at least give the ISO more flexibility in dispatching around the constraints. So the investors would deserve some long-term transmission rights.

Note that the same problem would arise if the auction's power flow only constrained one of the lines. In that case, while expansion of that one line would earn Expansion TCCs, expansion of other lines (that actually would be constrained during some periods) might earn no Expansion TCCs. The reason is the same as before: OPF's attempt to inject power at the POI might lead to some flow over the constrained line, blocking that action. Here, the procedure failed to reflect the fact that, during some periods covered by the auction, different lines were constrained than the one in the auction's single power flow.

All of the above problems are part of a larger issue: the value of a transmission line (or expansion) depends critically on the power flows, which are not constant but always changing (due to changing patterns of loads and varying generator availability). Unfortunately, Expansion TCCs would be allocated based on a single power flow and are limited to a single direction. Thus they may not reasonably reflect the expected value of the physical transmission expansion over a 20-year period.

The following draft proposal for "TCC Options" is intended to provide long-term transmission rights in a manner that overcomes the problems discussed above. It accomplishes this by giving more flexibility to the long-term rights, while requiring owners to periodically convert their rights into short-term obligations through the semiannual (or shorter-period) TCC auctions. Recognizing that the exercise of TCC Options could lead to infeasible flows in the auctions, a method of rationing is proposed based on the method developed for rationing existing transmission capacity for native load (ETCNL).

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flow corresponding to the winning bids) should have several transmission constraints binding simultaneously. See Appendix for an illustrative example.

TCC Options

In the long term, the principal value of transmission lines is that they provide options: customers gain the choice of buying from local or distant generators, and generators gain the choice of selling to neighboring or distant customers. This suggests that long-term transmission rights be provided in the form of options, which would be exercised at the beginning of each TCC auction. The options could be exercised in either direction, more closely reflecting the physical attributes of transmission lines (which give parties the option of buying locally or from more distant sources). To ensure the revenue adequacy of the TCC auctions, these options would be subject to rationing in the event that their flows were not simultaneously feasible (i.e. if they "oversubscribed" the transmission system). This approach could also be extended to cover existing long-term transmission rights, since these could suffer similar problems.

1. Investors who fund a transmission expansion receive long-term rights in the form of a series of TCC options. The rights to be obtained from a given expansion would be determined in advance by the ISO.

2. Each TCC option provides the right to request TCCs covering the period of a particular TCC auction (for example the summer 2000 capability period, or July 2000 if auctions are held monthly). The series of options covers the duration of the transmission expansion, up to a maximum of Y years (e.g. 20 years).

3. Investors exercise an option by requesting up to X TCCs between points covered by the expansion, where X represents the increase in transmission capacity due to the expansion. The requested TCCs can be in either direction, and can be divided into segments along the path of the expansion. If the capacity expansion is greater in one direction than in the opposite direction, this will be reflected in differing values of X depending upon the direction requested.

4. For the period of a given TCC auction, it is possible that the total TCCs requested by long-term rights holders will not be simultaneously feasible, due to transmission outages or changes in TCC options exercised (e.g. various owners switching directions). This is comparable to the possibility that grandfathered and native load TCCs would not be simultaneously feasible (i.e. the transmission system may be "oversubscribed").

5. In the case of infeasibility, the requested TCCs would be rationed prior to the TCC auction. Holders would be free to negotiate among themselves to limit their requests to simultaneously feasible TCCs, to avoid rationing by the ISO.

6. One method for rationing requested TCCs would be to hold a special TCC auction in which only holders of long-term transmission rights could bid. This could be done as "Round 0" of the upcoming TCC auction. Holders of long-term rights could bid only up to their respective limits (Xs) of options they hold. In the absence of congestion (as

determined by the OPF simulation), the market clearing price of the TCCs will be 0, and all the TCCs requested will be awarded. In the presence of congestion, TCCs would be rationed by bid price. The objective function would be, as usual, to maximize the value of TCCs sold in this round. Payments under Round 0 of the Auction would be returned to all customers through offsets to their Transmission Service Charges (TSCs).

Appendix

Example of Failure to Allocate Expansion TCCs

Consider a 3-bus system connected (in a triangle) by 3 transmission lines of equal resistance and 100 MW capacity. Bus A has a 150 MW generator ("Cheap A") with a running cost of $20/MWh and another 150 MW generator ("Expensive A") with a running cost of $50/MWh. Bus B has a 150-MW generator ("Medium B") with a running cost of $30/MWh. Bus C has 180 MW of load. "Cheap A" is available for X% of the time; the others are always available. For simplicity, ignore line losses, generation reserve requirements, and contingencies.

In this example, 2/3 of generation at bus A will flow on the direct line from A to C, while 1/3 will flow via bus B. On the other hand, 2/3 of generation at bus B will flow on the direct line from B to C, while 1/3 will flow via bus A. As a result, the total flow on the line from A to C is (2/3)GenA + (1/3)GenB, where GenA = generation at A and GenB = generation at B; and the total flow on the line from B to C is (1/3)GenA + (2/3)GenB.

When "Cheap A" is available, in the absence of transmission constraints the least-cost dispatch would be 150 MW from "Cheap A" and 30 MW from "Medium B" to load at C. The price at all buses would be the running cost of Medium B, i.e. $30/MWh.

However, this would overload line A-C: (2/3)150 MW + (1/3)30 MW = 110 MW. The ISO can overcome this by redispatching, substituting 30 MW of Medium B for 30 MW of Cheap A: (2/3)120 MW + (1/3)60 MW = 100 MW, which is the limit for the transmission line. The cost of this redispatch would be 30x($30-$20) = $600/hr.

To calculate the price at C, we note that an additional MW of load at C would require further redispatch, reducing Cheap A by 1 MW while increasing Medium B by 2 MW: (2/3)119 MW + (1/3)62 MW = 100 MW. This would save $20 from Cheap A but cost $60 (2x$30) from Medium B. Thus the price at C is $40/MWh ($60-$20). The price at A is $20 (additional load at A can be served entirely by Cheap A without increasing flows on line A-C). The price at B is $30 (additional load at B must be entirely served by Medium B).

Based on these prices, valid when Cheap A is available, congestion from A to B costs $10; from B to C costs $10; and from A to C costs $20.

When Cheap A is not available, in the absence of transmission constraints the least-cost dispatch would be 150 MW from Medium B and 30 MW from Expensive A. The price at all buses would be $50/MWh. However, this would overload line B-C: (1/3)30 MW + (2/3)150 MW = 110 MW. As before, the ISO can redispatch to eliminate the overload, reducing medium B by 30 MW and increasing Expensive A by 30 MW: (1/3)60 MW + (2/3)120 MW = 100 MW. In this case, an additional MW of load at C would require reducing Medium B by 1 MW and increasing Expensive A by 2 MW, leading to a cost of $70/MWh (2x$50 - $30). Thus the price at C would be $70/MWh, while the price at A would be $50 (served by Expensive A) and the price at B would be $30 (served by Medium B).

Based on these prices, valid when Cheap A is unavailable, congestion from A to B costs -$20/MWh; from B to C costs $40; and from A to C costs $20.

Given that Cheap A will be available X% of the time, the average cost of congestion from A to C will be X%($20) + (100-X%)($20) = $20. The average cost of congestion from B to C will be X%($10) + (100-X)%($40) = $40 - X%($30). And the average cost of congestion from A to B will be X%($10) + (100-X)%(-$20) = -$20 + X%($30).

In the TCC auction, the winning bids should reflect the average costs of congestion. Thus a TCC from A to C should sell for $20; a TCC from B to C should sell for $40 - X%($30); and a TCC from A to B should sell for -$20 + X%($30). Under the rules of the TCC auction, these prices must reflect a single power flow. In general (unless X = 0% or 100%), this single power flow must constrain both the A-C line and the B-C line.

For example, if X = 2/3, then TCCs from A to C and from B to C should both sell for $20/MWh, while a TCC from A to B should sell for $0/MWh. The only power flow consistent with this outcome is for 100 MW to flow from A to C and for 100 MW to flow from B to C. Thus, assuming rational bidding, the auction would in this case allocate 100 TCCs from A to C for $20/MWh, and 100 TCCs from B to C for $20/MWh. For other values of X, the auction would still allocate 100 TCCs from A to C at a price of $20/MWh, but the 100 TCCs from B to C would range from $10/MWh to $40/MWh.

Now consider a 10-MW expansion of one line, e.g. A-C. Clearly this will benefit the system, since whenever Cheap A is available, the transmission constraint from A-C will be relieved, and the least-cost dispatch of 150 MW from Cheap A and 30 MW from Medium B will be feasible. This will save the redispatch cost of $600/hr and reduce prices at C from $40/MWh to $30/MWh, whenever Cheap A is available.

Unfortunately, in the TCC auction the expansion of A-C will not permit any additional flows from A to C or from B to C. The reason is that line B-C will be fully loaded by the 100 MW of TCCs from B to C. Any additional injection at A or B would add to the flow on line B-C, overloading it. Thus no Expansion TCCs could be allocated, even though the expansion had been clearly valuable.

In the absence of Expansion TCCs, the investors might still benefit from lower prices at C, but only so long as line A-C remains uncongested. If Cheap A were to expand, or load were to grow, line A-C could again become congested and the price at C would again rise to $40 (when Cheap A is available), while the price at A would again fall to $20. The investors would be left with no financial benefits, either from congestion rents or better energy prices.