INITIAL REPORT ON PRICE DIFFERENTIALS

BETWEEN

BALANCE MARKET EVALUATION AND REAL-TIME

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May 23, 2000

Introduction

At NYISO, the implementation of the two-settlement process features a day-ahead settlement and a real-time settlement. Because there are many factors that change between the time the day-ahead settlement takes place and real-time, a Balancing Market Evaluation (BME) takes place each hour, starting at about 90 minutes ahead of the start of the hour. This process, while not resulting in a settlement, does produce advisory prices that reflect the effects of those changes. Prices and a full settlement are also produced in real time. The prices in real time are generated as a result of the periodic execution of a security-constrained dispatch program. The hour-ahead prices do not always track closely with the prices generated in real time. The purpose of this paper is to discuss some of the reasons for this apparent divergence of prices between the two processes.

This is Part I of a multi-part process to examine the relationship between prices produced in the NYISO two-settlement process. This paper will be followed closely by Part II, a statistical analysis of actual price differences over the period between January 1st, 2000 and early May. Subsequent parts will follow based upon response to the observations and recommendations in Parts I and II.

Executive Summary

Although there are major differences in the function and structure of the BME and SCD programs that contribute to the differences in their results, the primary source of the differing results are attributable to one of four major categories:

1) Changes in the amount and mix of generation available in real time versus that which was assumed during the execution of BME.
2) Changes in the amount of load that must be met in real time versus that assumed by BME
3) Differences in the security model used in the two programs which results in different sets of constraints being considered in the two environments
4) Changes in transmission topology that occur unexpectedly in real time

Various recommendations are put forth in an attempt to reduce these differences or their effect on the results. These are largely changes in procedures that allow BME to receive more accurate information in time to incorporate it into the BME solution. Some of the reasons for differences are within the ability of the ISO and the Market Participants to control. These can largely be remediated. Others are beyond the ISO's or the Market Participants' ability to anticipate or control. Thus, there will always be some differences.

The price differences between BME and SCD have market and reliability consequences. Therefore, the ISO will continue to pursue this multi-part process as follows:

- Continue the analysis of the scope and patterns of difference and the specific causes in order to better understand where changes or corrections are needed and where they will be most beneficial.
- Work with the governance committee structure and its working groups to establish specific actions and priorities with regard to this effort.

I. Contributing factors to price differences between BME and Real-Time Dispatch

In order to discuss the differences in structure and function of BME and SCD, it is first necessary to discuss the role each plays in the scheduling process.

Balancing Market Evaluation Program (BME) – BME is executed once an hour, starting about 90 minutes ahead of the hour in question. Its primary function is to adjust the day-ahead generation and transaction schedule for the upcoming hour to reflect changes that have occurred since the day-ahead schedule was established. These changes include:

- Load change – The day ahead hourly energy schedules are produced to serve only the day-ahead bid load. Load-Serving Entities can bid any portion of their forecast load into the day-ahead market. This load, while typically 95% to 98% of the total anticipated load, can sometimes be much lower. On May 8th, only 83% of the load was bid into the day-ahead market, for instance. BME, on the other hand, is designed to consider the entire forecasted peak load for the hour including any exports that have been bid into the real-time market.
- Generation change – BME will adjust day-ahead energy schedules to reflect new generation bid into the real-time market and reductions in price for day ahead energy as well as adjusting for the loss or reduction of planned day ahead generation when a generator is unable to meet its day-ahead obligation.
- Transaction changes –BME adjusts for cancellations and changes in value of the day-ahead transactions. It also integrates new transactions that were bid into only the real-time market. Import and export transactions appear to BME as generation and load and therefore have a significant effect on the final dispatch and the resulting prices. Wheel-through transactions can also affect prices through their effect on congestion.
- Transmission configuration changes – While the day-ahead schedules take into account scheduled transmission outages, forced outages or unexpected cancellation of scheduled outages can occur between the day-ahead solution and the execution of BME for the target hour. To the extent these outages affect congestion, BME will incorporate the revised transmission system configuration in the hourly solution.

The BME software function is implemented using the same Unit Commitment and Security Analysis software that is used in the day-ahead Security Constrained Unit Commitment (SCUC). BME solves for the expected load distribution in each hour of the approaching three hour period, the first hour of which is the target hour. The fact that it solves for two additional hours is irrelevant to this discussion and we will focus on the

target hour solution only. BME provides a commitment and dispatches that commitment to meet the target load assuming a one-hour ramp period is available from the previous hour's solution. The solution represents a single instant in time that is the expected highest load for that hour. BME will set the hour's schedules for off-dispatch units and the import and export transactions with neighboring control areas consistent with security requirements and including any needed adjustments in ancillary service schedules. The commitment and associated single instance dispatch will be optimized to minimize production cost. This is a characteristic of both BME and SCUC worth noting for its potential impact on price differentials. These are both optimizing functions and as such will search for the least cost solution. This means that they will not supply any more capacity than is called for by the reserve requirements because it will increase costs with no benefit. It is often true that only a moderate change in circumstances can result in a substantial price change. This is due to the shape of certain units' bid curves. The upper portions of the curves are bid at a series of higher priced blocks. Commitment software does not look beyond the level on energy it needs to solve its problem and will frequently dispatch a unit right up to the threshold of the next higher priced block of energy in order to take full advantage of the lower priced portion of the bid. Any subsequent increase in requirements causes a dispatch into the higher priced block. This is not a failure of the functions or the process but the result of the design objectives of the market.

Security-Constrained Dispatch - The primary function of SCD is to dispatch the set of units presented to it to meet load. It normally executes every 5 minutes and therefore dispatches to meet the load as expected 5 minutes into the future. It can also be executed on demand by the dispatcher. Included in the load computation is the Desired Net Interchange (DNI) with neighboring control areas that has been scheduled. SCD seeks the most economic solution to this requirement that also satisfies a set of security-related flow limits that address various likely contingencies. SCD therefore can create twelve or more unique solutions to the real-time conditions for each hour, each of which is likely to be different from the last.

While it is true that the actual dispatch logic of BME and SCD is the same, none of the hour's SCD solutions may represent exactly the same set of conditions predicted by the solution created by BME. The result is that SCD prices will not coincide with the BME estimate. The degree of difference between the conditions expected by the BME estimate and the actual conditions encountered by SCD will determine the consistency (or lack thereof) between the estimate produced by BME and the real time prices produced by SCD. This is particularly true under rapidly changing load conditions such as the morning load pickup.

Discussion of Price Differences – There are several areas that can be readily identified as a source of changes between the BME and SCD environments that cause differences in prices. Those areas that do change are:

- Available Generation
- Load
- Constraint Modeling

- Transmission System configuration

The following paragraphs discuss some of the causes of identified differences in each of the four areas. While the body of this section discusses these changes individually it should be remembered that these things happen in combination to create differences between the BME and actual real-time conditions. Some act to increase prices some to decrease prices some to create congestion where none existed and others to reduce congestion where it existed in the BME solution. From our examination of the logs and data covering the period from January through early May it is apparent that most hours are affected by one or more of these changes.

1. **Changes in generation**

The generation available to SCD can differ significantly from that assumed by BME. This occurs for one of at least four reasons:

- Off dispatch units not following the hourly scheduled base-points. Data gathered in March for the January February period showed frequent daily differences between the base-points assumed by BME and sent out during the hour by SCD and the actual operating points of certain generators. Differences were observed totaling from 300 to 1200 Mw per hour for PURPA units alone. Gas Turbines (GTs) are not always able to meet the output levels implied by their registered upper operating limit. Since this limit represents their actual normal operating point, BME and SCD assume that this will be the actual output of the unit when it is running. Climatic conditions often reduce the actual achievable output of these units and unless the upper operating limit has been adjusted prior to the hour, the BME solution will be in error. During the hot weather of May 8th and 9th, this error was consistently between 200Mw and 300 Mw in hours when substantial numbers of GTs were in use. As a consequence of off-basepoint operation by these units, SCD must dispatch higher cost energy to make up for the deficiency.
- Transactions cut during the checkout process and in-hour for security reasons is a second consistent and substantial contributor to the generation differences between the BME and SCD solutions. The BME processor is the mechanism by which transactions are scheduled in NY for the coming hour. Following completion of the BME execution, the NYISO dispatchers know which transactions are eligible to be scheduled in the coming hour. The dispatchers then engage in a "checkout" process with each of their neighboring control areas in which they agree on the transaction set that will actually set the interchange between their respective control areas. As part of this process any transactions that are problematic for either control area are cut as are any transactions that have been scheduled in one control area but not the other. When import transactions are cut, the effect is the same as if an internal NY generator scheduled to supply energy trips off-line just prior to the hour. These cuts are a frequent (near constant) hourly occurrence and examination of data from April and early May show them ranging from a few Mws to 500Mw or more. Also,

whenever an in-hour cut to an import transaction is required for security reasons, it has the same effect as the loss or reduction of internal generation.

- Out of Merit (OOM) generation adjustments in all cases represent a change between the BME-assumed generation profile and that which actually occurs in real-time. These actions are designed to address specific reliability concerns either for the bulk power system at the direction of the ISO or for local reliability concerns at the request of a Transmission Owner's control center. Most often, these moves are to raise generation on a particular unit, thus causing a corresponding reduction in output from dispatchable units and a corresponding reduction in prices. OOM changes in generation are a daily occurrence and an examination of logs indicates that they are in effect for substantial numbers of hours per day . At present, OOM changes are not scheduled for particular time periods and cannot be considered by BME. They therefore represent a non-trivial contribution to BME vs. SCD price differences.
- Unit De-rates that are not scheduled more than ninety minutes ahead of time also have the effect of reducing the available energy assumed by BME. Unscheduled de-rates, usually due to an operating problem at the plant, are a regular occurrence. Unit deratings can be accounted for after the first hour since the modified limits are made known to BME. However, there will be up to 90 minutes in which the mismatch will occur.

2. **Changes in load**

Another frequent but generally less severe cause of price differences is a different hourly load than was assumed by BME. The primary reason:

- Transactions cut during the checkout process and in-hour for security reasons is a consistent and substantial contributor to the load differences between the BME and SCD solutions. When an export transaction is cut, it has the same effect on prices as a corresponding difference between the expected load in NY and what actually occurs. Changes to export transactions are frequent and result from the hourly "checkout " process and in-hour security cuts described above.

3. **Differences in constraints**

Consistent with reliability rules of the ISO there are portions of the transmission network in New York City that are secured by the day-ahead and hour-ahead scheduling software but that are not secured by SCD. This can cause price differentials in a situation where there are binding constraints (shifts in generation required to avoid limit violations due to normal or contingency conditions) in the BME solution on the portions of the network not secured in real-time. The operating rules for the Transmission Owner for these portions of the network require them to operate to more restrictive limits than those used by the scheduling software but do

not require them to take specific action if the violation is of a contingency condition that could be cleared by operator action within 10 minutes of the occurrence of the contingency. BME will assure that the capacity exists to relieve the condition. However, depending upon operating conditions, the capacity provided by BME may not be utilized in real-time. Therefore in these circumstances BME will shift generation to relieve a contingency that is not treated in real-time by SCD, resulting in a corresponding difference between BME and real-time prices.

4. **Changes in transmission configuration**

An occasional cause of price differences is an unscheduled change in transmission network conditions that occurs between the time BME executes for a given hour and the end of that hour of real-time operation. These can occur for two reasons:

- A forced outage or the unscheduled termination of an outage of a transmission line or transformer bank. Such conditions, while occasional, are not infrequent and can have a significant effect on price differences through creation or relief of congestion. The recent unscheduled trip of the 345 kV Gilboa Leeds #3 transmission line (5/3/00 @ 20:05) immediately caused the Central-East interface limit to be reduced, causing immediate congestion. SCD quickly shifted generation to relieve the overload, driving prices in the west way down and prices in the east and south way up. These significant price excursions were obviously not anticipated in BME. It should be noted that restoration of facilities ahead of their scheduled return time also represents an unexpected change in conditions that can be reflected in real-time price changes.
- When certain outages are scheduled that have a significant effect on interface flow limits, ISO dispatchers will begin reducing the limits on the affected interface up to two hours in advance. This is done to prevent the disruption that can result from a sudden loss of substantial transfer capacity that such an outage could otherwise cause. While the SCUC and BME processes consider scheduled outages, if they are not aware of the early transfer capacity reductions the schedules for these pre-outage hours will not be consistent with the real-time conditions created by the dispatcher's preventive action. If the stepped reduction of the affected interface is coordinated between SCUC, BME, and real time, the resulting excursions in prices (and the differences between the three solution environments) can be minimized.

II. Recommendations for reducing the impact of contributing factors

Having identified several sources of change that affect prices in real-time versus those computed in the BME environment, there are certain actions that can be identified that would help to reduce the differences in prices that have been observed. This section discusses those recommended actions.

1. **The functional and structural difference between BME and SCD**

There are fundamental differences in the functional and structural makeup of the two programs. However, no short-term changes are recommended. Possible long term actions, while not currently planned, include:

a. Examine the potential means and benefit of substantial redesign of BME, SCD or both in order to yield greater consistency of prices between the two functions.
b. As has been suggested by several market participants, examine the possibility of creating an hourly forward market with its own complete hour-ahead settlement. While this would not directly reduce the differences between the two, it would further insulate the market from these differences by further reducing the amount of energy settled at the real-time price.

2. Changes in generation

a. Generators can make a substantial contribution to improving consistency in prices by keeping their Transmission Owner and the ISO informed as much in advance as possible of any expected or predictable deviations from their daily or hourly schedules. This includes de-rates of units that will be unable to achieve scheduled output or for GTs, adjusting their upper operating limits. Prompt and accurate de-rating will also minimize potential penalties to generators.
b. To further reduce the impact of units operating off of their base-points, the ISO and market participants should work through remaining issues and adopt the process arrived at in the PURPA discussions of adjusting the input data to BME for certain off-dispatch units to reflect their actual operating levels rather than their bid limits or day ahead schedules. These units include PURPA, intermittents, and possibly non-qualifying supplier types such as GTs and non-PURPA combined cycle units. Further work is required on issues such as applicability of penalties, qualifying unit types, balancing obligations and possibly others.
c. The ISO should examine with its counterparts in neighboring control areas the possibility of developing a pre-BME assessment of known next hour curtailments. In this way the number of transactions that BME considers will not include those known prior to the checkout period to be cut. As a result, the import energy component of the BME solution will be that much more accurate. It should be noted that this will be particularly helpful in high load (regional energy shortage) periods when energy import cuts are most prevalent.
d. Transmission Owners should undertake to limit the use of Out of Merit generation adjustments if alternative and less disruptive means are available to manage the problems. The ISO and Transmission Owner operations personnel should develop a protocol whereby Out of Merit orders that are likely to last more than an hour are identified, the duration estimated and factored into BME executions over the period.

3. Changes in load

a. The single recommendation pertaining to reducing load differences is contained in recommendation 2c for changes in generation. Minimization of check-out time transaction cuts that occur after execution of BME will also limit the change in external load served as export transaction accuracy is improved and the load component of the BME solution will be that much more accurate.
b. The ISO continues to evaluate the accuracy of its load forecasting tools and methods. The tools available to BME operators are part of that process and work on them will be continued with improvements made where possible.

4. Differences in modeling constraints

a. The operational issues that generate the differences in contingency management between the scheduling software of BME and of real-time operation are based upon reliability considerations and will require a lengthy process to evaluate for possible modification. There may be some opportunity for improvement here. These areas are currently part of discussions between the ISO and affected Transmission Owner Operations personnel. No substantive changes have yet been identified.
b. Recommendations to the ISO have been made by Navigant on an approach to limit some of the adverse impact of price differences caused when these constraints are binding during a BME execution and are likely to be absent in real-time. The remaining design work at the ISO to determine how to incorporate this recommendation and the review with Market Participants through the committee working groups will begin as soon as resources are available.

5. Changes in transmission configuration

The ISO has been working with Transmission Owners to minimize any scheduling errors resulting from communications errors associated with scheduled outages. Some improvement may be available in earlier notification to the ISO when outages are canceled. Early notification will, on occasion prevent substantial price dislocation and the ISO should pursue this with the Transmission Owners. In addition, the ISO has implemented procedures to ensure that BME properly accounts for the pre-outage step-down process.

III. Conclusions

Taken with a reasonable degree of understanding of the NY wholesale energy market, the discussion contained in sections I and II above leads to a number of conclusions that will be helpful in determining how to respond to the differences we find in the prices produced for the day-ahead market, the hour-ahead balancing market evaluation and the real-time market. While the economic theorists instruct us that the prices in these three processes should converge in a properly functioning market, we can see that the following is also the case.

1. The prices associated with the day-ahead, BME and real-time markets are going to differ for some fundamental structural reasons.
2. The BME and real-time market prices should bear a similarity but changes that occur between the estimate produced in BME and actual real time activity can and do cause distortion.
3. Some of these changes can be reduced or eliminated and plans can and should be taken to eliminate unnecessary price distortions.
4. There are some consequences to differences between BME and RT prices to market participants in the area of external transactions and off dispatch unit scheduling. Otherwise BME prices are largely advisory and do not present financial consequences to market participants.
5. We have taken actions such as bid production cost guarantees to external energy suppliers to mitigate some of these consequences. Others may exist and they should be identified and evaluated and appropriate measures taken when appropriate to properly address the consequences to market participants of price differences between BME and Real-time.