Virtual Bidding: Considerations Related to Potential Market Manipulation

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Abstract

Various ISOs, such as PJM and the New York ISO, have the ability to distinguish between bids associated with supply or demand that will physically deliver or consume power, and bids that will not deliver or consume actual power but instead are purely financial in nature. These purely financial bids are known generically as "Virtual Bids".

While much has been touted about the potential efficiency gains possible through "arbitrage" based on Virtual Bids, insufficient attention has been paid to their potential use as a means to manipulate electricity prices, manipulate congestion prices and physical transmission usage, manipulate the objective function used to determine prices, manipulate the physical dispatch of generation resources, or the use of such bids to create or enhance existing market power and to circumvent rules intend to mitigate market power. Moreover, because of their interaction with the determination of price and unit commitment, coupled with physical constraints that bind transmission operators, such bids cannot be viewed simply as an efficient mechanism for facilitating arbitrage.

Background of Virtual Bidding

Several existing ISOs, such as PJM and the NY ISO, run two markets for electricity, day-ahead and real-time. Transactions consummated in the day-ahead market represent a financially binding commitment to deliver a fixed amount of energy, in MWh, at a specific location and at a fixed price. Transactions consummated in real-time represent the price for energy instantaneously delivered and consumed in real-time. For a wide variety of reasons, the day-ahead and real-time prices for a corresponding location and delivery hour usually differ. It is important to note that because of the general lack of storage for electricity, both day-ahead and real-time purchases take delivery in real-time. That is, day-ahead purchases are not delivered day-ahead, stored, and then withdrawn from storage and used in real-time. Day-ahead contracts have varying degrees of obligation to deliver physical power in real-time.

In the context of such day-ahead/real-time electricity markets, Virtual Bids allow a participant to buy (or sell) electricity in the day-ahead market and to simultaneously assume an opposite obligation to sell (or buy) an identical amount of electricity in the real-time market. Also implicit with Virtual Bids is that power from such bids will not physically flow, the bids are for a purely financial contract. For example a Virtual 1 MWh generator would get paid a known day-ahead price for 1 MWh, but would have an obligation to pay an unknown real-time price for 1 MWh, the 1MWh is never actually produced. Virtual Bids also allow participants to schedule a flow on a transmission line in the day-ahead market and simultaneously assume an obligation to schedule a flow with the same magnitude, but opposite direction, over the same transmission line in the real-time market.

Virtual Bids are explicitly identified as "Virtual" and thus the ISO knows that any Virtual Bids selected in the day-ahead market will not result in the actual flow of power, but rather, will result only in a equal and opposite transaction in real-time time. With knowledge that such bids will not materialize, the ISO can take appropriate additional measures to ensure that sufficient physical resources, as opposed to Virtual Resources, are available to serve physical load in real-time.

It is important to note that although Virtual Bids are explicitly identified and that the ISO knows that no power will actually be delivered or consumed from Virtual resources, these bids *do* impact the physical operation of the grid. For example, Virtual flows on a transmission line consume real-transmission capacity in the day-ahead market and such transmission is no longer available for day-ahead schedules. This transmission capacity is then restored in the real-time market and is available only for real-time flows.

Arbitrage, Speculation, Market Power and Market Manipulation

In its strictest definition, arbitrage involves locking in a riskless profit by entering simultaneously into transactions in two or more markets.[1] Speculation, on the other hand, involves entering into risky transactions in the hope that the transactions will prove profitable. Obviously Virtual Bidding involves the assumption of significant risk as one trades the known day-ahead price for the unknown real-time price. Thus as a threshold matter for clarity, Virtual Bidding provides a mechanism for speculation, not a mechanism for arbitrage.

Because arbitrage provides riskless profits, such opportunities usually do not last long. Arbitrageurs, realizing the riskless opportunity, enter into the market to "buy low, and sell high", until all the bargains are snatched up and the arbitrage opportunity vanishes. In this case arbitrageurs have acted to move prices to equilibrium and to create an efficient market outcome. Relative to the initial conditions where some sellers were willing to sell below what some buyers were willing to pay, arbitrageurs increased the price paid to sellers and decreased the price paid to buyers. Bravo.

But now consider a different case where a speculator enters the market with the intention of cornering the market. Here, speculators are not "hoping" that they can buy low today and sell high tomorrow, rather, they are acting doggedly to increase the probability that prices will be high tomorrow. This is not an efficient outcome, but rather an attempt to manipulate markets to the detriment of the market at large and to primarily benefit only that "speculator".

In its August, 2002 report entitle "Initial Report On Company-Specific Separate Proceedings and Generic Reevaluations; Published Natural Gas Price Data; and Enron Trading Strategies Fact-Finding Investigation of Potential Manipulation of Electric and Natural Gas Prices", the FERC discusses a situation similar to cornering the market in which parties would purchase energy from the day-ahead market and sell it back to the ISO in real-time (Enron's "Ricochet" strategy). However, parties often did this during emergency periods, where the parties knew that the ISO would pay any price to avoid a blackout. The FERC concludes, "This behavior (raising prices at the last minute where buyers are unable or incapable of saying no) was not legitimate arbitrage, **but was an exercise of market power."** (bold added, page 94).

Thus during some instances, as in the arbitrage example mentioned earlier, behavior which moves market prices is legitimate and efficient. However, at other times behavior that moves prices is market manipulation and, according to FERC, an exercise of market power. Here lies the tension, and the reason for concern over Virtual Bidding.

[1] "Options, Futures, and Other Derivatives", page 12, John C. Hull

As will be demonstrated, Virtual Bidding can dramatically influence prices and dramatically impact physical power flows and the physical operation of the grid. Should such actions be view as useful speculation or as detrimental manipulation?

Impacts on Production

Even without Virtual Bids, electricity markets provide ample opportunities for participants to assume speculative financial positions. For example, forward contracts traded bilaterally often trade a year or more in advance of the actual delivery of power. Participants can enter into Contract For Differences (CFDs) on prices on an unlimited number of products. Speculation in these markets is generally positive to market efficiency as it adds price discovery and provides tools for buyers and sellers to manage risk. However CFD or forward financial contract participation is dramatically different than Virtual Bidding which, rather than happening well in advance of delivery and without impacting actual grid operations, takes place at time when actual delivery and consumption of power is imminent. Moreover Virtual bids, which can impact grid operations, are submitted at the same time that the ISO is attempting to manage physical limitations; physical limitations which if handled improperly can result in the damage to the electrical grid, and in some cases regional blackouts.

The day-ahead and real-time markets are not the same product and are not the same market. Not only is new information available between day-ahead and real-time, actual physical constraints on the transmission grid are potentially different. Further, there is the potential for much greater demand response in the day-ahead market than in real-time. In addition, because of issues such as long-startup times, and changes in the usage of resources outside of an ISO, possibly resulting from Virtual Congestion[2], the universe of suppliers is potentially very different between day-ahead and real-time markets. These features may be unique to electricity markets and must be considered before concluding that Virtual Bidding is desirable so that the day-ahead and real-time prices will equate.

Likewise, the analogy between traditional arbitrage and Virtual Bidding breaks down quickly. For example, Virtual Bidding is dissimilar from the arbitrage scheme of buying gold in London, transporting it to New York, and selling it in New York. Rather, because of the temporal nature of Virtual Bids, they are a speculative tool more closely comparable, but still different from buying and storing the commodity today and selling it tomorrow with the hope that tomorrow's price will prove profitable. Neither FERC's proposed Standard Market Design (SMD), nor any of the existing ISOs actually envisions any market of substance in which day-ahead energy is delivered and stored, then sold back in real-time. Rather, in these designs day-ahead market participants effectively sign a forward contract that goes to physical delivery the following day.

Arguably in these electricity markets, the correct "arbitrage" model for comparison is not "buy, transport, and sell", or even "buy, store and sell", but is that of trading a futures contract on the day before physical delivery. Virtual Bidding effectively

[2] Virtual Congestion occurs when Virtual Bids, in conjunction with physical bids, result in congestion on a transmission path, and when in the absence of these Virtual Bids the congestion would not exist. Note that when Virtual Congestion occurs, the line has the physical capability of moving additional power. Such Virtual Bids might prevent a unit outside of the ISO with a long startup time from self-committing day-ahead because Virtual Congestion made such sales unprofitable.

overlays a financial market on top of the physical market *which interacts with the physical market*, and in this financial market no contracts go to physical delivery. Thus Virtual Bids are most similar to a special case in which no future contracts are taken to physical delivery but rather function in a purely financial manner. Herein lies a fundamental difference between Virtual Bidding and speculation on futures contracts: In the futures market, although market transactions undoubtedly impact the contract price, transactions that do not go to physical delivery *do not* impact the actual production methods or costs of the underlying commodity, whereas Virtual Bids likely do impact both the actual production sources and the price for the underlying commodity. And with Virtual Bidding, these impacts can be significant!

<u>Virtual Bids Increase the Size of the Real Time Market</u>

Industry observers generally agree, that because of the rigid physical constraints within the electric system, it is usually difficult to serve a significant portion of load in the real-time markets. It should be noted that Virtual Generation Bids can displace real generation, resulting in a post day-ahead capacity dispatch. This is a capacity dispatch only. The energy associated with this dispatch is not arranged until real-time. Moreover, Virtual Load has the ability to displace real load from the day-ahead market and move it into the real-time market.

Virtual Bids, of both generation and load, tend to increase the size of the real-time market. The negative reliability and market impacts resulting from increased real-time market activity must be considered in evaluating the total impact of Virtual Bids.

<u>Asymmetry Between Physical and Virtual Bids</u>

A fundamental asymmetry exists between Virtual and physical bids. That is, ultimately ISOs are responsible for operating physical systems, ensuring that physical constraints of the transmission grid are not violated, and ensuring that the "lights stay on" in all but the most extreme contingencies. They are not and should not be tasked with ensuring a speculator-friendly trading platform in which the ISO will bend over backwards to accommodate financial trades, regardless of consequence to price or to the physical utilization of grid resources. In the eastern ISOs with Virtual bidding, as well as SMD, reliability always trump financial fictions, and speculators know this.

To see this, it is important to understand that regardless of the amount of Virtual Generation bids, the ISO always dispatches enough physical generation to serve its forecasted load. If there is not enough physical generation bid or not enough physical load (real or Virtual) served in the day-ahead market, the ISO dispatches additional physical generation. So because of physical constraints and reliability requirements the deck is stacked. During its initial optimization the ISO "pretends" that Virtual Bids and physical bids are perfect substitutes, but after the initial optimization the ISO must take additional reliability steps because the two types of bids are not in fact substitutable. Virtual Generation bids are recognized by the ISO as incapable of providing the necessary physical capability to reliably operate the system, come real-time. Virtual Load bids, on the other hand, which may attract additional physical generation bids beyond that which would be necessary to meet the actual load bids, may not be viewed as requiring any ISO intervention. If such an asymmetry exists between the ISO's treatment of Virtual Generation with Virtual Load, the consequences of this asymmetry on efficiency must be considered. This asymmetry also demonstrates another fundamental difference between classic arbitrage and Virtual Bidding.

In addition to influencing price in the initial optimization, Virtual Bids can also impact the commitment of physical generation, as will be discussed in the example below.

The Multiple Impacts of Virtual Bidding – an Example

As discussed above, the eastern-ISOs include Virtual Bids when running their day-ahead energy markets, and in this initial optimization these Virtual Bids are treated just like physical bids. Virtual Bids are included with physical bids so that units are dispatched, subject to operating and transmission constraints, based on an objective function which minimizes *the total cost of energy and reserves.* After the day-ahead market is run, the ISO examines the results to determine if they have enough physical capacity committed to meet the forecasted load in the next day. If there is insufficient physical capacity committed, the ISO will then commit additional physical capacity based on an objective function that minimizes *unit commitment costs*, rather than energy costs.

Thus when the initial optimization produces insufficient physical capacity, the ISO *changes* its objective function and selects a different generation mix. This shift in objective function is important, because not only does Virtual Generation potentially displace physical generation in the day-ahead initial optimization, but Virtual Generation has the potential to change what units are actually committed and actually serve load.

Consider the following example. Generator A owns one 100MW steam unit with a long startup time. Generator B owns one 75MW steam unit with a long startup time and one 10MW peaking units with short startup time. Generator A has a startup and no-load cost of $12/h and a variable operating cost of $33/MWh. The startup and no-load costs for Generator B's 75MW plant is $11/h and it also has a variable operating cost of $33/MWh. The 10MW unit has a startup and no-load cost of $1/h and a variable operating cost of $40/MWh. Consider now a forecast load of 85MW, and this 85MW actually materializes in real-time, and a day-ahead bid load of 80MWs. These values are tabulated in Table 1.

Table 1

Owner	Size (MW)	Variable Cost ($/MWh)	Startup/no-load ($)	Long Startup?
A	100	33	12	Yes
B	75	33	11	Yes
B	10	40	1	No

Forecast Load: 85MW
Actual Load: 85MW
Day-ahead Bid Load: 80MW

Scenario 1: Without Virtual Bidding

Assume that in the day-ahead market, units bid their actual operating cost. In the initial energy cost minimization the ISO will select and dispatch the 100MW unit and purchase 80MWs. The total cost will be 80MWh*$33/MWh + $12 = $2652. The ISO will compare its forecast, 85MW, to the amount actually purchased, 80MW, and determine that it needs 5MWs of capacity for real-time. Since Generator A has 100MW capacity but has only sold 80MWs, the ISO has 20MW of unloaded capacity available from this unit. As a result, the ISO does not need to commit any additional capacity. Assume now that the additional 5MWh of load will be served in real-time from Generator A at a total cost of 5MWh*$33/MWh = $165. The total cost to serve the load, including day-ahead, real-time and startup/no-load costs is $2562+$165 = **$2817**.

Scenario 2: With Virtual Bidding

Given the same set of units and the same bid load and forecast load, assume that Generator B submits a physical bid for its 75MW plant at $33/MWh, with a startup/no-load cost of $11, and a Virtual Generation bid of 5MW at a price of $33/MWh with startup and no-load costs equal to zero. In this case, the ISO will select the 75MW unit for a cost of 75MW*$33/MWh+11 = $2486 and the Virtual Bid of 5MW*$33 = $165 for a total day-ahead cost of $2651. However, the ISO then compares the amount of physical generation dispatched, 75MW, with their forecast of actual load, 85MWh, and determines it must dispatch an additional 10MW of capacity. It now changes its optimization objective function to minimize startup/no-load cost, rather than energy plus startup and no-load cost. It has a choice: it can dispatch one 100MW unit for a startup/no-load cost of $12 or it can dispatch the 10MW peaker for a startup/no-load cost of $1. Since the new objective function minimizes startup/no-load cost, and not the total costs of energy plus start up and no-load cost, the ISO will select the 10MW peaker. Total day-ahead cost is now $2651+$1= $2652.

The remaining load will now have financial exposure to 5MWh in the real-time market. Note that here the only unit running in real-time is the 10MW peaker. Because of Virtual Bidding, the 100MW unit with the long startup time was not committed in the day-ahead market and is therefore unavailable in real-time. The cost of the 10MW unit is $40/MWh, but since it is now the only unit physically available in real-time, let's assume that the unit uses its newly obtained market power, with some restraint, and sets the real-time price not at its variable operating cost of $40/MWh, but at a market power based $80/MWh. The total cost to serve the 85MWs of load is now $5MWh*$80/MWh+$2652 = **$3052.**

Note the cost to load without Virtual Bidding was only $2817, and thus this Virtual bidding strategy increased the cost to load by $235! Also note that this strategy was profitable to Generator B. Generator B receives payments totaling $3,452[3], and has costs inclusive of its Virtual Bid of only $3,287[4] for a net profit of **$165**. Results are summarized in Table 2.

[3] 75MW*$33+5MW*$33+10MW*$80+$11+$1 = $3,452. Note that in the Virtual Bidding case the day-ahead optimization selects only 75MW of physical generation. Since actual load is 85MW, the real-time market must physically serve 10MW. In the case without Virtual Bidding, the optimization select 80MW of physical generation and the real-time market serves only 5MW.

[4] 75MW*$33+10MW*$40+5MW*$80+$11+$1 = $3,287.

Table 2

	Without Virtual Bids	With Virtual Bids
Generator A Output	85MW	0MW
Generator B Output	0MW	85MW
Generator A profits	$0	$0
Generator B profits	$0	$165
Cost to Load	$2817	$3052

Observations

This example illustrates four important results associated from Virtual Bidding. First, the most efficient economic outcome, the dispatch of Generator A's 100MW unit, was not achieved. Rather, Generator A was not dispatched at all and instead Generator B, who would not run at all in an efficient outcome, was the only entity dispatched. Virtual Bidding turned the efficient outcome on its head. Second, because Generator A was not dispatched in the day-ahead market and has a long startup time, Generator B obtained market power through its own Virtual Bidding. Generator B accomplished this by using a Virtual Bid to change the ISO objective function to ensure that Generator A would not be selected. Third, because of Virtual Bidding, the total cost to serve load increased from $2817 to $3052. Virtual Bidding increased costs. And fourth, this strategy was profitable to Generator B. Assuming the restriction that in the day-ahead market physical bids were based on cost, without Virtual Bids Generator B would not have had market power, would not have produced a single MW and would not have made a single dollar of profit. But with Virtual Bids, Generator B produced 85MW and made a $165 profit.

Clearly, a Virtual Bidding paradigm that can result in the inefficient dispatch of units, that allows bidder to displace competitors and thereby gain market power, that increases costs to consumers, and is profitable to the bidder wishing to exploit these opportunities, cannot be viewed simply as market enhancing "arbitrage". Virtual Bidding provides a mechanism for market manipulation and this fact needs to be acknowledged by Virtual Bidding proponents and opponents alike.

Virtual Bidding and General Manipulation

Although the previous example illustrates the potential impact of Virtual Bidding, it is admittedly a rather complex construct. Nevertheless, the example meaningfully reflects potential real world situations. Complex cases are not necessary however to illustrate the potential manipulative tool Virtual Bidding provides. Several such cases will now be discussed.

Case 1: Increase the MCP Paid to a Portfolio via Virtual Load Bids

Assume that without any Virtual Bids, the day-ahead market clears at price Da. What will happen to the market price Da if a participant now submits a quantity of

Virtual Load bids of V? The result will depend on the shape of the supply curve that is needed to serve this additional amount of Virtual Load and the shape of the demand curve. Depending on market conditions, the slope of the supply curve to serve this additional load can be quite steep, and thus this additional Virtual Load could significantly increase the market clearing price above Da. Let's call the increase in price resulting from the Virtual Load bid Delta, and therefore the final day-ahead price in the case of a Virtual Load bid is Da+Delta.

Now if a participant submitted only this Virtual Load bid, it would likely prove to be a poor speculation strategy because this participant would purchase a quantity of energy V at a day-head price of Da+Delta, and would sell back V at the real-time price, that would likely be less than Da+Delta. Lets call this real-time price Rt.

But now consider the case in which the participant submitting the Virtual Load bid is a generator that is also **selling** 1,000MW in the day-ahead market. This generator will realize additional revenue of 1,000*Delta-V*(Da+Delta-Rt) as a result of the Virtual Load bid. This "portfolio" effect, leveraging an increase in market clearing price across the full 1000MW portfolio, provides an incentive for large sellers to submit Virtual Load bids in order to artificially inflate day-ahead prices.

One might argue that Virtual Bids are not needed to inflate the day-ahead price, this same generator can simply withhold an equal amount of generation V from the market. Although the impact on the day-ahead price would be the same, assuming the supply is withheld from both the day-ahead and real-time markets (a tactic that might be necessary to avoid raising suspicions) the two strategies in fact produce different results, and there are several possible reasons the Virtual Bidding strategy would be preferred. First, there may be rules that explicitly prohibit withholding. Second, withholding of generation may be easier to detect than the submission of Virtual Bids. Third, the payoff of the two strategies is different and the generator will likely find the Virtual Bidding strategy more profitable than simply withholding.

Case 2: Increase Congestion to Profit from Congestion Revenue Rights (CRRs)

Consider a case of a simplified transmission system which consists of a single transmission line, one 100 MW generator at one end of the line and a 75MW load at the other end of the line. Assume a transmission line capability of 80MW. With only physical bids, this line will never be congested. And thus CRRs on this line will be worthless.

Now consider a Virtual Load bid of 6MWs on the load side of the transmission line. In conjunction with 75MW of physical load there is now 81MW of load trying to access an 80MW transmission line. This will result in congestion and 1MW of either Virtual or physical load will not be served in the day-ahead market. Assume that the Virtual Load "wins" rights to the 6MW of power. This means congestion prices reached a sufficiently high level that 1MW of physical load abandoned the day-ahead market and instead moved to the risky real-time market. Depending on the risk aversion and expectations of that load, the day-ahead price may have risen substantially. Lets again call the increase in price resulting from the Virtual Load bid, which represents the cost of congestion to use the line, Delta.

Again in isolation this may prove to be a poor speculation strategy on behalf of the Virtual Load bidder because they will buy 6MW at the high price of Da+Delta, and sell at the potentially lower price Rt. But now consider the case where the Virtual Load bidder also owns 80MW of CRRs such that positive payments result when there is congestion between the generation and the load. Although a third party owning all the CRRs is a limiting example for illustration, it may not be that unrealistic. Recall that there was an 80MW line that only served 75MW of physical load. Without the games created by Virtual Bidding, there should be no congestion and the load should not need to purchase CRRs. Thus in the case of a naive load coupled with a nefarious Virtual Bidder intent on playing this congestion game (recall Enron's purchase of Path 26 FTRs), the full 80MW of CRRs might be acquired by a third party at almost no cost.

Now the payoff to the Virtual Load bidder/CRR holder is 6MW*(Rt-Da-Delta)+ 80MW*Delta. Even with a large gap between a high day-ahead and a low real-time price, this strategy will be profitable because of the Virtual Bidders large CRR holdings. As a point of emphasis, without Virtual Bids there would have been no congestion and the CRRs would have been worthless. But with Virtual Bids, Virtual Congestion resulted in a *real* transfer of wealth from physical load to the Virtual Bidder/CRR holder.

Case 3: Virtual Bids to Restrict Lower Cost Imports

Although the situation is improving, California remains dependent on imports. However, Virtual Bids can be used to prevent the physical flow of power into California. It is interesting to note that on May 24, 1999 Enron attempted to schedule 2800MW on a 15MW path knowing that all but 15MW would be cut during the congestion process. Here, as a result of Enron's own ad hoc "Virtual" bid strategy, some 2800MW of physical power was displaced from the liquid day-ahead market and buyers were forced into the relatively illiquid congestion and real-time markets. The California Power Exchange eventually ruled that this behavior violated their Tariff and explicitly prohibited such behavior. Without admitting guilt, Enron agreed not to engage in "substantially the same conduct" and paid the California Power Exchange $25,000 to help defray the costs of the investigation.

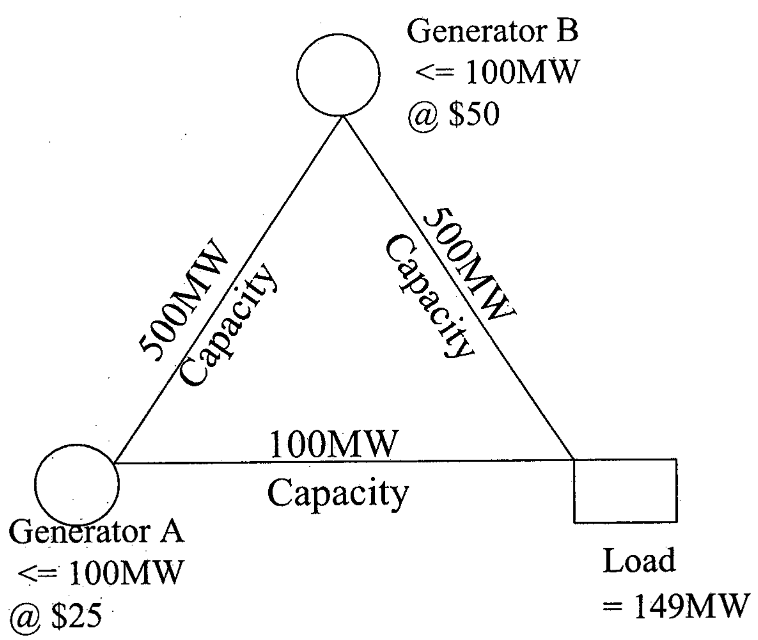
In the limiting case, Virtual Bids can prevent any imported power from being scheduled into California in the day-ahead market. In this case, even a subsequent residual unit commitment which commits all available California resources will not produce sufficient capacity to serve the load forecast on a high load day. What happens next? Even if the ISO is confident that the congestion is only Virtual, can the ISO handle the vast amount of power that would now be served in the real-time market, some from the capacity that was dispatched day-ahead and some from imports that it hopes will materialize? What impact would such a strategy have on the commitment decisions made outside of the ISO? Could such a strategy result in a feedback situation where Virtual Import Bidding resulted in both high day-ahead prices , and because of insufficient internal resources within California, panic buying by the ISO and even higher real-time prices? The same dynamic as that created by "Ricochet" can be created with Virtual Bidding, with the same disastrous results.

Case 4: Virtual Bidding and LMP Specific Manipulation

Although both the generic examples of using a Virtual Load bid to increase market prices paid to a portfolio, as well as the use of Virtual Load Bids to create artificial congestion have been discussed, it is worth considering an example where a single Virtual Bid exploits both effects simultaneously. Because of congestion, it is possible to obtain a LMP greater than the highest bid of any utilized generator. For example, although PJM has a $1000/MWh bid cap, prices at specific nodes have exceeded $5000/MWh. (For example, Monocacy on July 29, 2002.)

Consider Figure 1, a simple three-line "triangle" transmission system with Generator A at one point of the triangle, Generator B at a second point, and load at the third. Assume that the impedances of all three lines are equal, with the line loading capacities between Generator A and B equal to 500MW, the capacity between Generator B and the load equal to 500MW, and a smaller line connecting Generator A to the load with only 100MW capacity. Assume that Generator A has a capacity of up to 100MW and is bidding $25/MWh, and that Generator B has a capacity of up to 100MW and is bidding $50/MWh. Assume initially that load is 149MW.

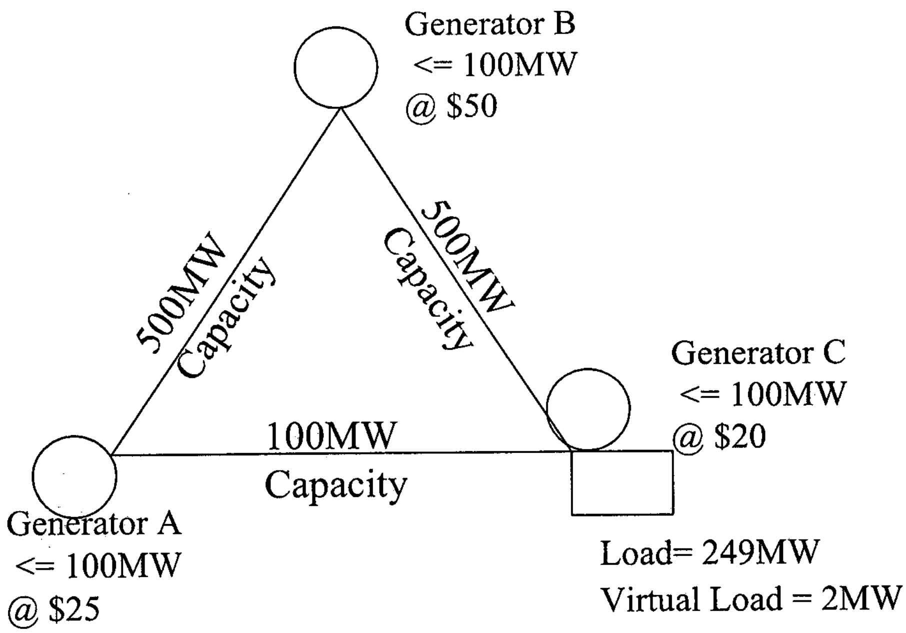
Figure 1



In this system, Generator A will be loaded to 100MW and Generator B will be loaded to 49MW. The LMP at the load location will be $50/MWH. Now there is no congestion on this simple system until load reaches 150MW. At this time the 100MW line connecting Generator A to the load is fully loaded. Because of congestion, to serve an additional MW of load, Generator B must be INCed by 2MW and A must be DECed by 1MW. Thus, once there is congestion, the LMP at the load location will jump from $50/MWh to 2*$50-$25 = $75/MWh.

Now let's consider two modifications to this example as shown in Figure 2. First, increase load by 100MW, and second add a new Generator C with 100MW capacity at the same node as the load. Assume that Generator C bids $20/MWh and is operating at maximum capacity. Now Generator C will be supplying 100MW, Generator A will also be supplying 100MW and Generator B will be providing 49MW. As long as the there is no congestion, the LMP at the load node will be equal to the cost of Generator B, $50/MWh. But now if load at the node exceeds 250MW, congestion will come into play and the LMP will once again jump from $50 to $75/MWh.

Figure 2



Here Virtual Bidding can be used to create Virtual Congestion and increase the LMP for both the load, and for Generator C. Assume that load is physically 249MWs. If Generator C simply submits a Virtual Bid of 2MWs the price will jump from $50 to $75/MW. The incremental payoff to Generator C is now 100MW($75-$50)-2MW($75-Rt). By submitting a strategic Virtual Load Bid, Generator C reaps a windfall profit on its 100MWs of physical generation and only faces a small risk of low real-time prices on the 2MW Virtual Load Bid.

Virtual Bidding Permits Circumvention of Existing Market Power Mitigation Rules

In the previous examples, one could argue that, to various degrees, the sellers already had market power and therefore Virtual Bidding is not the culprit, rather market power is the real culprit. In the very first "complex" example, it was assumed that in the day-ahead market sellers bid cost. Virtual Bids were used to change the commitment decisions of the ISO and to obtain real-time market power. This could have been accomplished, although not as profitably, by Generator B "dumping" power, that is selling below cost in the day-ahead market to displace Generator A in order to achieve real-time market power. In Case 1 of bidding Virtual Load to increase the MCP, we discussed the option of withholding generation, either physically or economically, to increase prices. Again, depending on assumed restrictions Virtual Bidding was potentially more profitable than withholding.

In Case 2 of the Virtual Bidder that is also CRR holder things are a bit trickier. Here the Virtual Bidder controlled neither generation nor load, and thus it is difficult to argue that aside from the Virtual Bids, market power already existed. In Case 3 in which Virtual Bids are used to restrict imports, one might be able to simply cut power schedule in the day-ahead market prior to real-time. Finally in the LMP-congestion leveraging example, one could argue that Generator C could have withheld power, physically or economically, to create congestion and benefit from an increased LMP. Although the math is not shown, depending on assumptions of Rt, Virtual Bidding might again prove more profitable than simple withholding.

However, the "brute force" exercise of market power may typically be detectible and in many cases mechanisms intended to mitigate such abuses are either proposed or implemented. Forced outages are subject to audit and reporting. Units with known locational market power have mitigation devises, such as RMR contracts, in place. Certain behaviors, such as hockey stick bidding, intended to result in either economic withholding or to set a high MCP, have been identified and prohibited. NY ISO has automated mitigation procedures (AMP) to mitigate excessively high bids. Rules are in place which prevent parties from routinely cutting firm schedules. Many markets outside of electricity have instituted rules against dumping.

Yet Virtual Bidding provides a mechanism to circumvent such rules. And in many cases can prove more profitable than even the brute force exercise of original market power. In some instances, such as the CRR example and the ability to manipulate commitment decisions, Virtual Bidding provides a mechanism to obtain market power when none originally existed. At an absolute minimum, advocates of Virtual Bidding must address restrictions on Virtual Bidding to ensure that existing and proposed market power mitigation rules cannot be circumvented via Virtual Bidding. For example, FERC's standard market design envisions PGA's that enumerate market power mitigation measures. Under such a model, PGA's must also include specific limitations on Virtual Bidding. Virtual Bidding behavior and incentives seem dangerously similar to the behavior and incentives that existed for marketers such as Enron during the California energy crisis of 2000-2001. Market designers once bitten should be twice shy.

One Good Game Deserves Another, Really?

The potential for manipulation through Virtual Bidding should now be obvious. However, one could argue that any impact of Virtual Bids can be "undone" by a second party simply submitting an equal and opposite Virtual Bid. If generation submits a Virtual Load bid in an effort to increase prices, load simply needs to submit a Virtual Generation bid to offset the impact. If that 80MW line in Case 2 has congestion serving 75MW of physical load because of a Virtual Load bid, well load can simply bid Virtual Generation at its location and relieve the Virtual Congestion. Is that really FERC's vision for America?

The question boils down to this: do we endeavor to facilitate a complex financial game of speculation in which parties try to second-guess what other parties are "Virtually" doing to then "Virtually" undo it, or do we desire to run a physical network and provide the essential physical commodity of electricity to public infrastructure, offices, manufactures, hospitals and households? For the sake of emphasis, the answer is of course the latter.

Conclusion

Virtual Bidding facilitates speculation, not arbitrage. Moreover, Virtual Bids can be used to profitably manipulate electricity market prices, congestion and the physical dispatch of resources. In many instances Virtual Bids enhance market power and increase the potential profits associated with its exercise. In some instances, market power can be created via Virtual Bids. Virtual Bids can be used to circumvent existing and proposed market power mitigation measures. This paper was not exhaustive; many additional manipulative schemes considered for presentation were not included. Because of the potential for manipulation, and because of documented proof of the actual use of related manipulation schemes, Virtual Bidding should not be implemented in the manner envisioned by SMD. In California, it is clearly inappropriate to even consider introducing a complex financial bidding scheme such as Virtual Bidding until the basic components of the market have been implemented and are fully functional. Even in a fully functional market, at a minimum, comprehensive rules must be in place to prevent the manipulative use of Virtual Bids before such bids should be allowed.