July and August for both 2006 and 2007. These results were also likely influenced by the day-ahead load forecast issues discussed in Section I of this report.

Although the costs are borne by load throughout ERCOT, the costs are caused in specific locations because these actions, with the exception of zonal RPRS, are taken to maintain local reliability. The rest of the analyses in this section evaluate in more detail where these costs were caused and how they have changed between 2004 and 2007. Figure 68 shows these payments by location.

Figure 68: Expenses for OOME, OOMC and RMR by Region
2004 – 2007
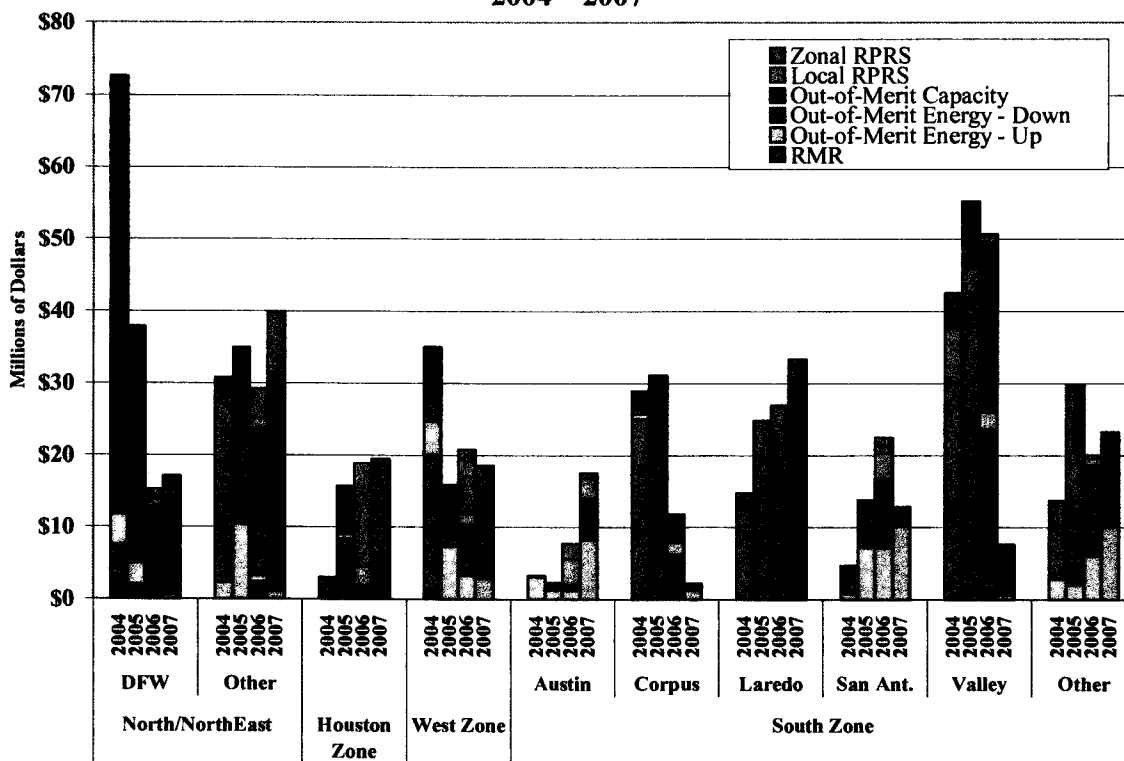
Uplift costs decreased dramatically from 2004 to 2007 in the Dallas/Ft. Worth ("DFW") area, in the West zone and in the South zone Corpus Christi and Valley area. In DFW, the reduction was due to less frequent OOMC commitments, whereas uplift was reduced in the West zone by the elimination of RMR status for units located in that area. Corpus Christi area uplift cost reduction was primarily caused by the decrease of RMR payments, from $23 million in 2005 to $0 in 2007. RMR costs in the Laredo area increased from 2004 to 2007 due to increased fuel costs, as the number of RMR units in that area remained constant during this time period. The Austin area

exhibited the highest increase of uplift costs, from $3 million in 2004 to $18 million in 2007. This increase is most likely associated with the increase in the frequency of North-to-South congestion in 2007 that was discussed previously in this section.

V.   ANALYSIS OF COMPETITIVE PERFORMANCE

In this section, we evaluate competition in the ERCOT market by analyzing the market structure and the conduct of the participants during 2007. We examine market structure using a pivotal supplier analysis, which indicates that suppliers were pivotal in the balancing energy market at a significantly smaller frequency in 2007 than in 2006. This analysis also shows that the frequency with which a supplier was pivotal increased with the level of demand. To evaluate participant conduct, we estimate measures of physical and economic withholding. We examine withholding patterns relative to the level of demand and the size of each supplier's portfolio. Based on theses analyses, we find that the overall competitive performance of the market continued its trend of improvement in 2007.

A.   Structural Market Power Indicators

We analyze market structure using the Residual Demand Index ("RDI"), a statistic that measures the percentage of load that could not be satisfied without the resources of the largest supplier. When the RDI is greater than zero, the largest supplier is pivotal (*i.e.*, its resources are needed to satisfy the market demand). When the RDI is less than zero, no single supplier's resources are required to serve the load as long as the resources of its competitors are available.

The RDI is a useful structural indicator of potential market power, although it is important to recognize its limitations. As a structural indicator, it does not illuminate actual supplier behavior to indicate whether a supplier may have exercised market power. The RDI also does not indicate whether it would be profitable for a pivotal supplier to exercise market power. However, it does identify conditions under which a supplier would have the *ability* to raise prices significantly by withholding resources.

Figure 69 shows the RDI relative to load on an hourly basis in 2007. The data is divided into two groups: (i) hours during the summer months (from May to September) are shown using darker points, while (ii) hours during other months are shown using lighter points. The trend lines for each data series are also shown and indicate a strong positive relationship between load and the RDI. This analysis is done at the QSE level because the largest suppliers that determine the RDI values shown below own a large majority of the resources they are scheduling or

offering. It is possible that they also control the remaining capacity through bilateral arrangements, although we do not know whether this is the case. To the extent that the resources scheduled by the largest QSEs are not controlled or providing revenue to the QSE, the RDIs will tend to be slightly overstated.

Figure 69: Residual Demand Index 2007
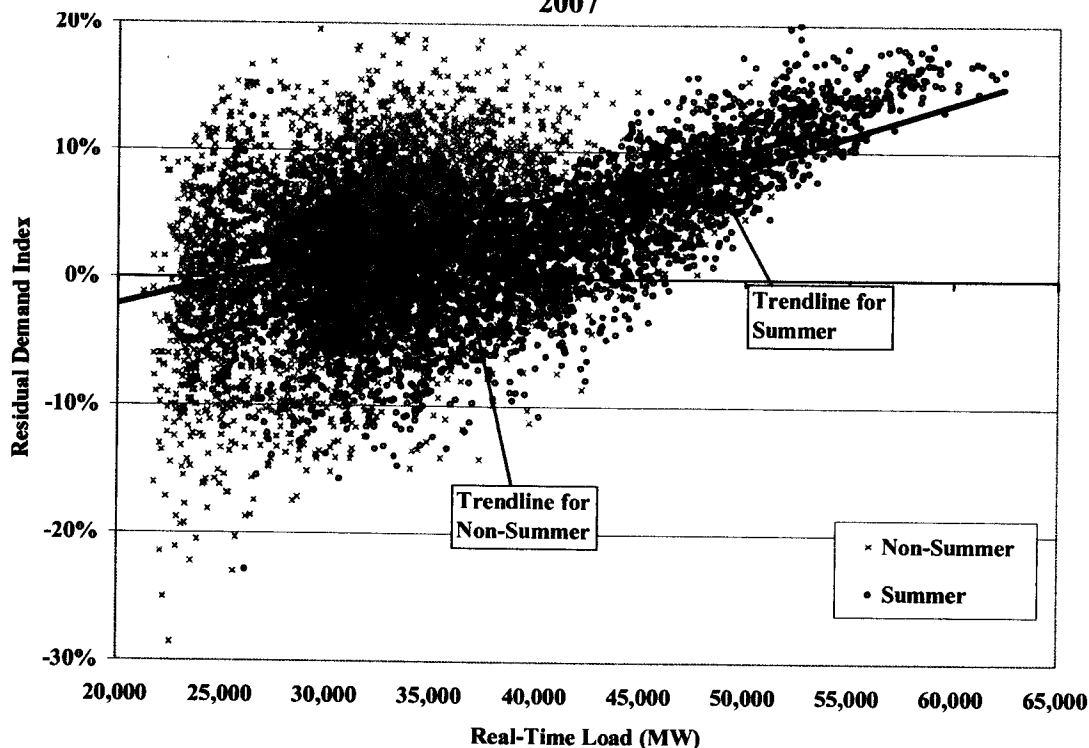
The figure shows that the RDI for the summer (i.e. May to September) was usually positive in hours when load exceeded 45,000 MW. During the summer, the RDI was greater than zero in approximately 70 percent of hours. The RDI was typically positive at lower load levels during the spring and fall due to the large number of generation planned outages and less commitment. Hence, although the load was lower outside the summer, our analysis shows that a QSE was pivotal in approximately 71 percent of hours during the non-summer period. It is important to recognize that inferences regarding market power cannot be made solely from this data. Retail load obligations can affect the extent of market power for large suppliers, since such obligations cause them to be much smaller net sellers into the wholesale market than the analysis above would indicate. Bilateral contract obligations can also affect a supplier's potential market power. For example, a smaller supplier selling energy in the balancing energy market and through short-

term bilateral contracts may have a much greater incentive to exercise market power than a larger supplier with substantial long-term sales contracts. The RDI measure shown in the previous figure does not consider the contractual position of the supplier, which can increase a supplier's incentive to exercise market power compared to the load-adjusted capacity assumption made in this analysis.

In addition, a supplier's ability to exercise market power in the current ERCOT balancing energy market may be higher than indicated by the standard RDI. Hence, a supplier may be pivotal in the balancing energy market when it would not have been pivotal according to the standard RDI shown above. To account for this, we developed RDI statistics for the balancing energy market. Figure 70 shows the RDI in the balancing energy market relative to the actual load level.

Ordinarily, the RDI is used to measure the percentage of load that cannot be served without the resources of the largest supplier, assuming that the market could call upon all committed and quick-start capacity[34] owned by other suppliers. Figure 70 limits the other supplier's capacity to the capacity offered in the balancing energy market. When the RDI is greater than zero, the largest supplier's balancing energy offers are necessary to prevent a shortage of offers in the balancing energy market. Figure 71 shows the same data as in Figure 70 except that the balancing energy offers are limited by portfolio ramp constraints in each interval.

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[34] For the purpose of this analysis, "quick-start" includes off-line simple cycle gas turbines that are flagged as on-line in the resource plan with a planned generation level of 0 MW that ERCOT has identified as capable of starting-up and reaching full output after receiving a deployment instruction from the balancing energy market.

**Figure 70: Balancing Energy Market RDI vs. Actual Load
2007**
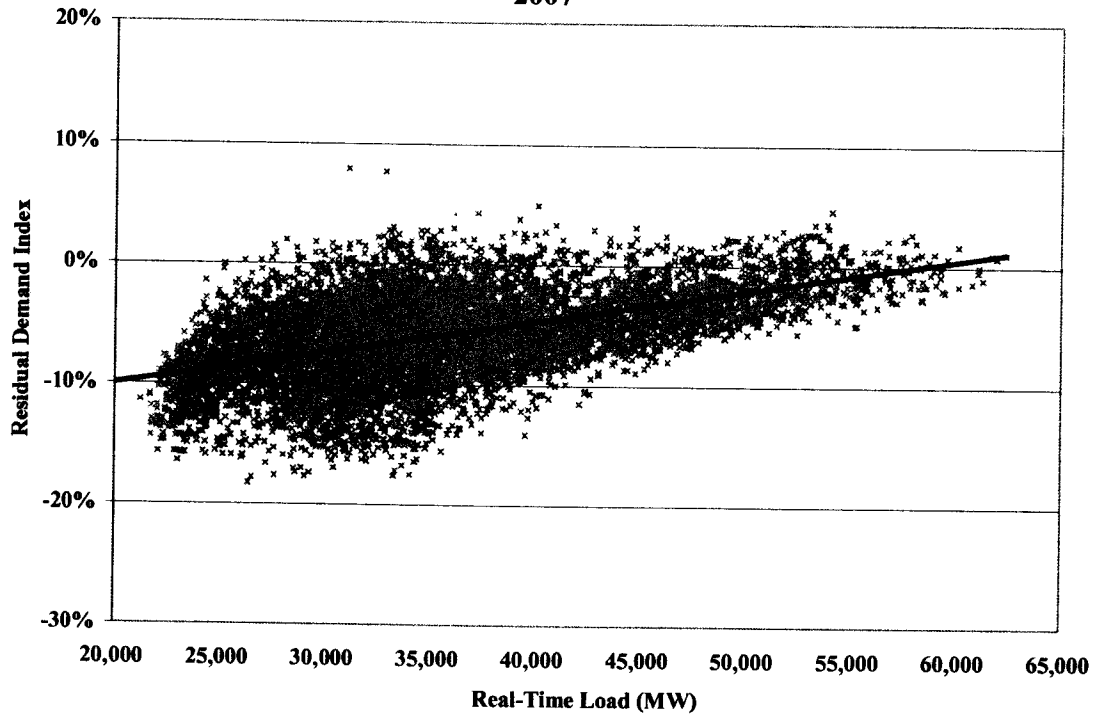
**Figure 71: Ramp-Constrained Balancing Energy Market RDI vs. Actual Load
2007**
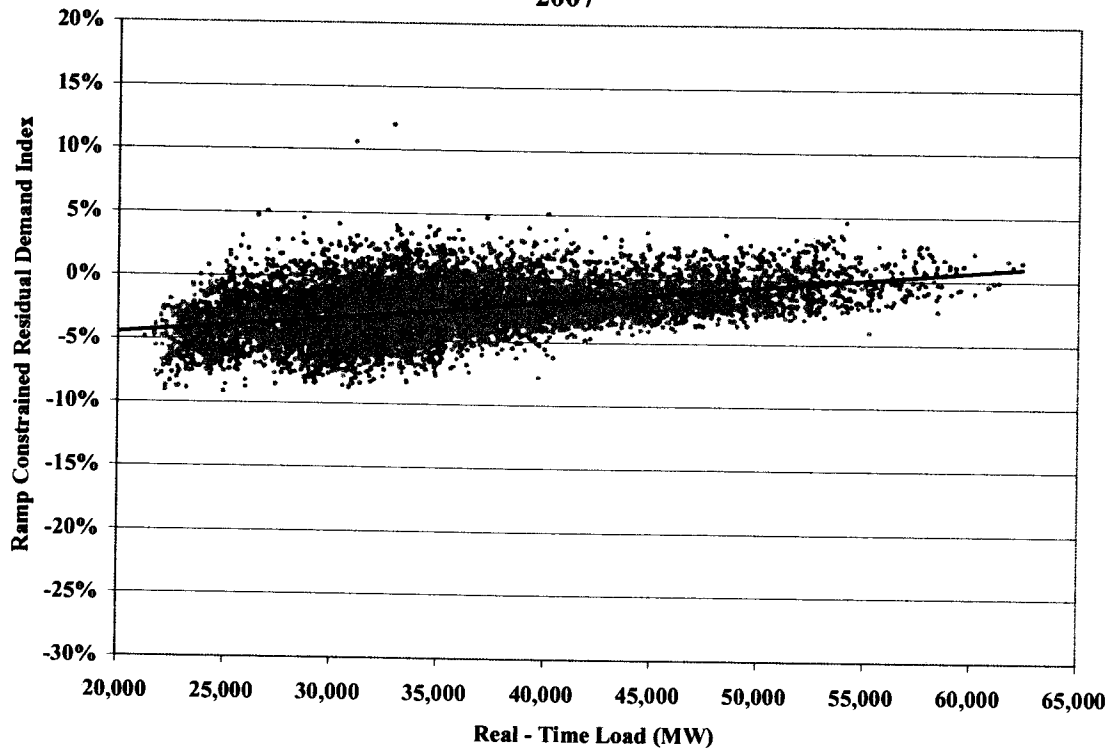
In 2007, the instances when the RDI was positive occurred over a wide range of load levels, from 26 GW to 63 GW. The RDI results for the balancing energy market shown in the preceding two figures help explain how transient price spikes can occur under mild demand while large amounts of capacity are available in ERCOT. The balancing energy market RDI data and trend line for 2007 are similar in shape to 2006, although the frequency of data points that are positive is significantly lower in 2007 than in 2005 and 2006. This difference is highlighted in Figure 72 which compares the balancing energy market RDI duration curves for 2005 -2007.

Figure 72: Ramp-Constrained Balancing Energy Market RDI Duration Curve 2005 - 2007
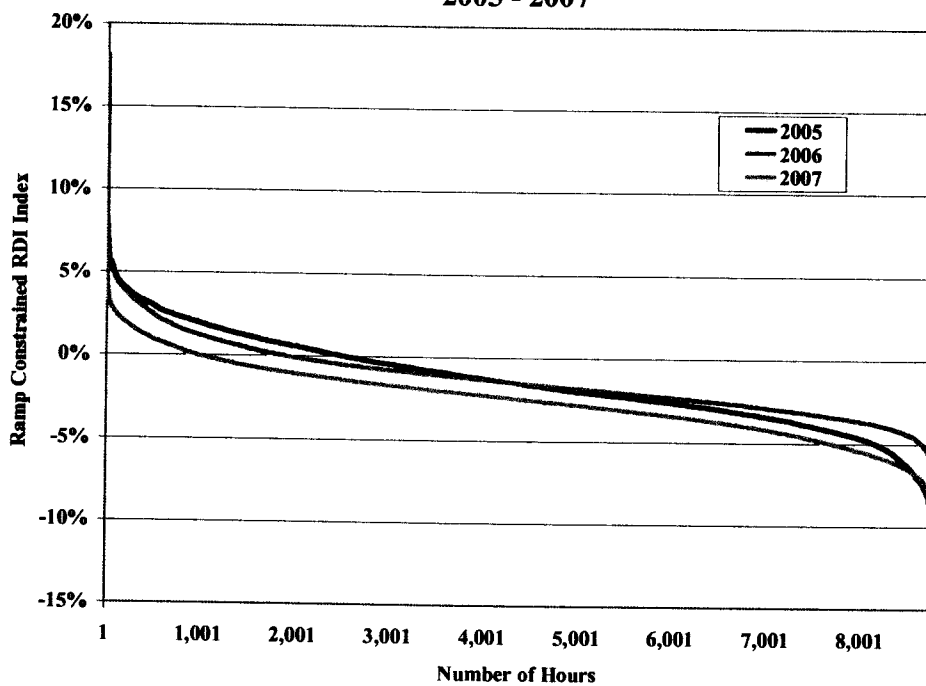
The frequency with which at least one supplier was pivotal in the balancing energy market *(i.e.,* an RDI greater than zero) has fallen consistently from 29 percent of the hours on 2005 to 21 percent of the hours in 2006 and less than 11 percent of the hours in 2007. These results indicate that the structural competitiveness of the balancing energy market continued to improve in 2007. Figure 73 examines how the balancing energy market RDIs are correlated with balancing energy market prices as adjusted for gas prices in 2007, and Figure 74 shows the same data for 2006.

Figure 73: 2007 Ramp-Constrained Balancing Energy Market RDI vs. Balancing Energy Price Adjusted for Fuel Price
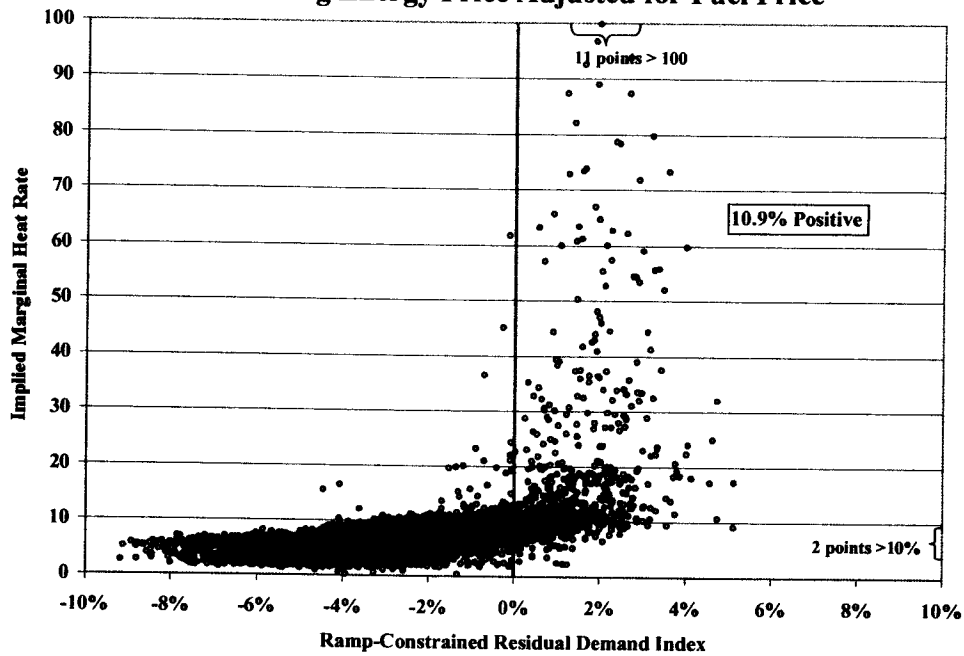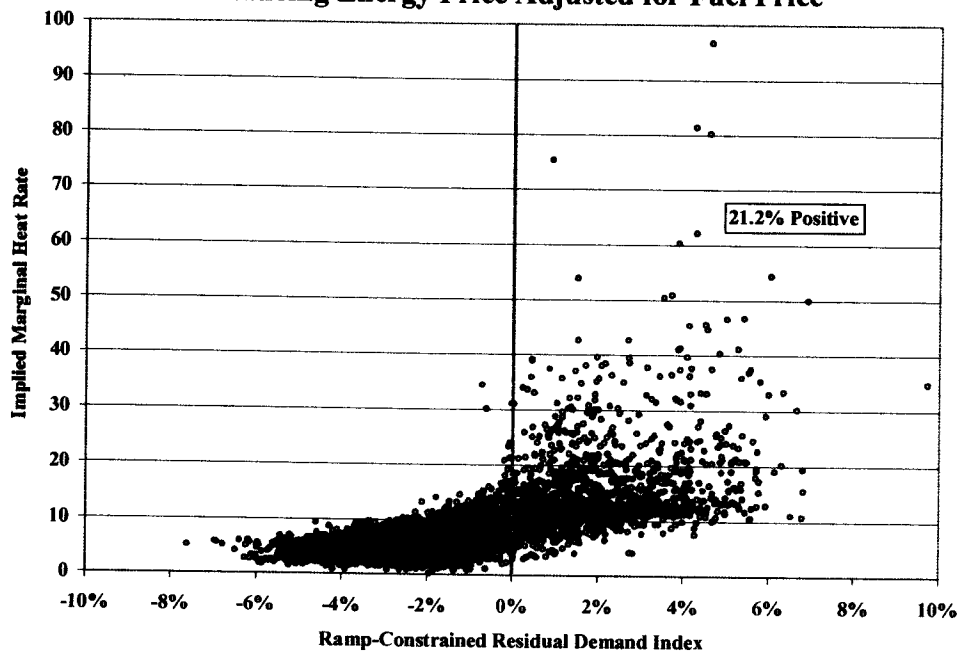

Figure 74: 2006 Ramp-Constrained Balancing Energy Market RDI vs. Balancing Energy Price Adjusted for Fuel Price


The figures above show a similar relationship between the ramp-constrained balancing energy market RDI and the gas price-adjusted balancing energy market price in 2006 and 2007, with the

rate of change becoming exponentially larger as the balancing energy market RDI enters the positive range. However, Figure 72 reveals that the number of data points with positive ramp-constrained balancing energy market RDIs is over 50 percent less in 2007 than in 2006.

A final structural measure used to evaluate the potential for economic withholding analyzes the number of balancing energy market price spikes compared to the available UBES remaining. If the market is operating competitively, price spikes should occur during shortage and near shortage conditions, and the number of price spikes should reduce significantly as the amount of available surplus energy increases.

Figure 75: Price Spikes vs. Available UBES Remaining
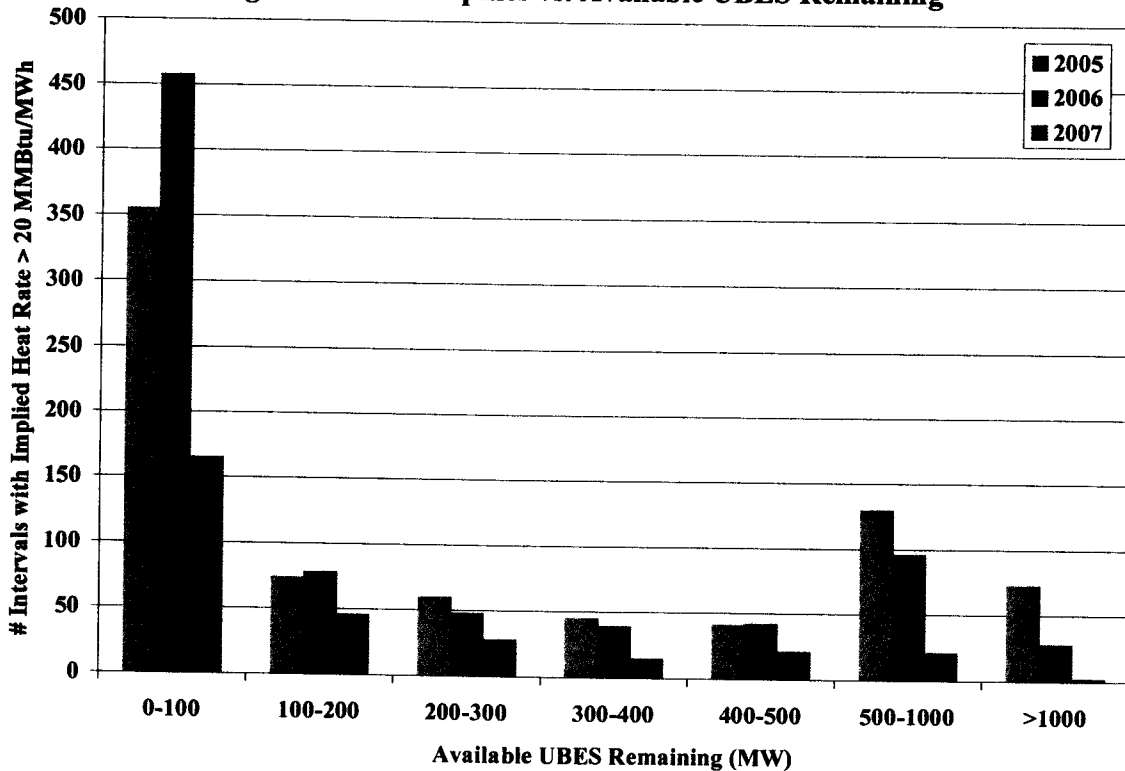
The results in Figure 75 indicate very competitive market outcomes in 2007, with over 92 percent of the price spikes occurring during intervals with less than 500 MW of available UBES remaining.[35] These results show significant improvement over 2005 and 2006 when only 74 and 84 percent, respectively, of the price spikes occurred during intervals with less than 500 MW of

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[35]   The data in Figure 75 exclude intervals where there was zonal congestion or when non-spinning reserves were deployed.

available UBES remaining. The significant number of price spikes in 2005 and 2006 in intervals with significant available surplus energy (*i.e.*, available UBES remaining greater than 500 MW) give rise to competitive concerns, although the performance improved in 2006 relative to 2005.

B.   Evaluation of Supplier Conduct

The previous sub-section presented a structural analysis that supports inferences about potential market power. In this section we evaluate actual participant conduct to assess whether market participants have attempted to exercise market power through physical and economic withholding. In particular, we examined unit deratings and forced outages to detect physical withholding and we evaluate the "output gap" to detect economic withholding.

In a single-price auction like the balancing energy market auction, suppliers may attempt to exercise market power by withholding resources. The purpose of withholding is to cause more expensive resources to set higher market clearing prices, allowing the supplier to profit on its other sales in the balancing energy market. Because forward prices will generally be highly correlated with spot prices, price increases in the balancing energy market can also increase a supplier's profits in the bilateral energy market. The strategy is profitable when the withholding firm's incremental profit is greater than the lost profit from the foregone sales of its withheld capacity.

1.   Evaluation of Potential Physical Withholding

Physical withholding occurs when a participant makes resources unavailable for dispatch that are otherwise physically capable of providing energy and that are economic at prevailing market prices. This can be done by derating a unit or designating it as a forced outage. In any electricity market, deratings and forced outages are unavoidable. The goal of the analysis in this section is to differentiate justifiable deratings and outages from physical withholding. We test for physical withholding by examining deratings and forced outage data to ascertain whether the data is correlated with conditions under which physical withholding would likely be most profitable.

The RDI results shown in Figure 69 through Figure 74 indicate that the potential for market power abuses rises as load rises and RDI values become more positive. Hence, if physical withholding is a problem in ERCOT, we would expect to see increased deratings and forced

outages at the highest load levels. Conversely, because competitive prices increase as load increases, deratings and forced outages in a market performing competitively will tend to decrease as load approaches peak levels. Suppliers that lack market power will take actions to maximize the availability of their resources since their output is generally most profitable in these peak periods.

Figure 76 shows the average relationship of short-term deratings and forced outages as a percentage of total installed capacity to real-time load level during the summer months for large and small suppliers. Portfolio size is important in determining whether individual suppliers have incentives to withhold available resources. Hence, the patterns of outages and deratings of large suppliers can be usefully evaluated by comparing them to the small suppliers' patterns.

We focus on the summer months to eliminate the effects of planned outages and other discretionary deratings that occur in off-peak periods. Long-term deratings are not included in this analysis because they are unlikely to constitute physical withholding given the cost of such withholding. Renewable and cogeneration resources are also excluded from this analysis given the high variation in the availability of these classes of resources. The large supplier category includes the four largest suppliers in ERCOT, whereas the small supplier category includes the remaining suppliers (as long as the supplier controls at least 300 MW of capacity).

**Figure 76: Short-Term Deratings by Load Level and Participant Size
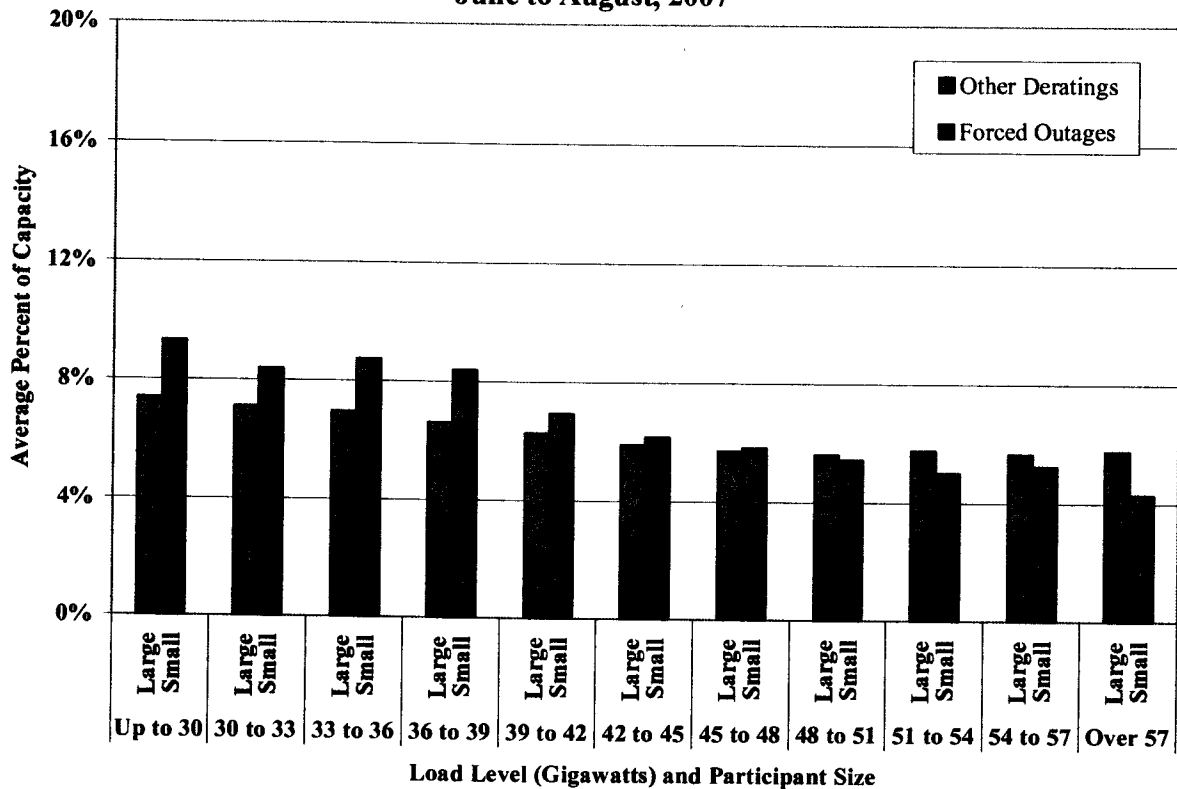June to August, 2007**

Load Level (Gigawatts) and Participant Size

Figure 76 suggests that as electricity demand increases, both large and small market participants tend to make more capacity available to the market. For both large and small suppliers, the short-term derating and forced outage rates decreased from approximately 7 and 9 percent respectively at low demand levels to about 6 and 4 percent respectively at load levels above 57 GW.

Large suppliers have derating and outage rates that are lower than those of small suppliers across the range of load levels up to 48 GW. Furthermore, large suppliers' deratings and outages generally decline as load levels increase. Given that the market is more vulnerable to market power at the highest load levels, these derating patterns do not provide evidence of physical withholding by the large suppliers. The average derating rates for large and small suppliers are approximately 2 and 3 percent lower, respectively, than in 2006 at load levels greater than 51 GW. Further, although the forced outage rate for large suppliers increases slightly at higher load levels, the highest forced outage rate for large suppliers is approximately 3 percent, which is within the range of expected outcomes.

2.   Evaluation of Potential Economic Withholding

To complement the prior analysis of physical withholding, this subsection evaluates potential economic withholding by calculating an "output gap". The output gap is defined as the quantity of energy that is not being produced by in-service capacity even though the in-service capacity is economic by a substantial margin given the balancing energy price. A participant can economically withhold resources, as measured by the output gap, by raising the balancing energy offers so as not to be dispatched (including both balancing up and balancing down offers) or by not offering unscheduled energy in the balancing energy market.

Resources can be included in the output gap when they are committed and producing at less than full output or when they are uncommitted and producing no energy. Unscheduled energy from committed resources is included in the output gap if the balancing energy price exceeds the marginal production cost of the energy by at least $50 per MWh. The output gap excludes capacity that is necessary for the QSE to fulfill its ancillary services obligations. Uncommitted capacity is considered to be in the output gap if the unit would have been profitable given published zonal day-ahead bilateral market prices.[36] The resource is counted in the output gap for commitment if its net revenue (market revenues less total cost, which includes startup and operating costs) exceeds the total cost of committing and operating the resource by a margin of at least 25 percent for the standard 16 hour delivery time associated with on-peak bilateral contracts.[37]

As was the case for outages and deratings, the output gap will frequently detect conduct that can be competitively justified. Hence, it is important to evaluate the correlation of the output gap patterns to those factors that increase the potential for market power, including load levels and portfolio size. Figure 77 shows the relationship between the output gap from committed resources and real-time load for all hours during 2007.

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[36]   Day-ahead bilateral prices are from Megawatt Daily.

[37]   The operating costs and startup costs used for this analysis are the generic costs for each resource category type as specified in the ERCOT Protocols.

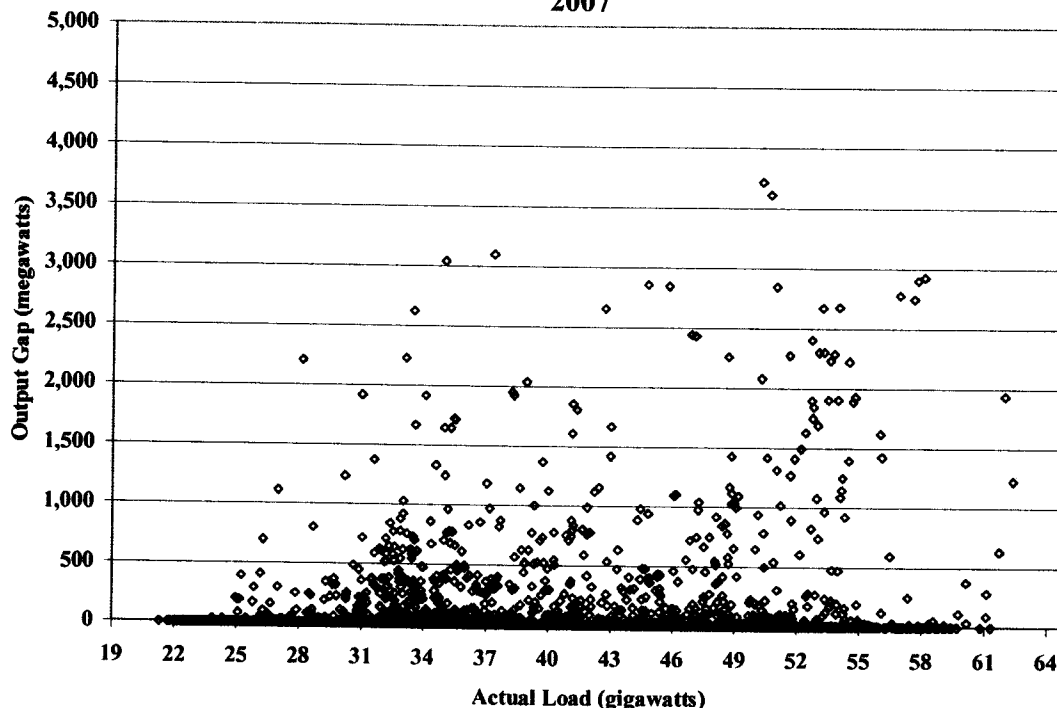**Figure 77: Output Gap from Committed Resources vs. Actual Load 2007**

Figure 77 shows that the output gap from committed resources ranged from zero in most hours to a maximum of around 3,700 MW during 2007. As more clearly shown in Figure 78, the average output gap from committed resources rises slightly with real-time demand. This is not surprising given that clearing prices tend to be higher at higher load levels. Many of the high output gap values occurred during transitory price spikes under a wide range of demand levels that make most of the unscheduled energy appear economic. The transitory nature of most of these instances would make a large share of the identified output unavailable due to the resources' ramp limitations. Ramp limitations prevent resources from responding instantaneously to an unpredicted price spike. The next analysis further examines the output gap results by size of supplier and load level.

Figure 78 compares real-time load to the average output gap as a percentage of total installed capacity by participant size. The large supplier category includes the four largest suppliers in ERCOT, whereas the small supplier category includes the remaining suppliers that each controls more than 300 MW of capacity. The output gap is separated into (a) quantities associated with

uncommitted resources and (b) quantities associated with incremental output ranges of committed resources.

Figure 78: Output Gap by Load Level and Participant Size 2007
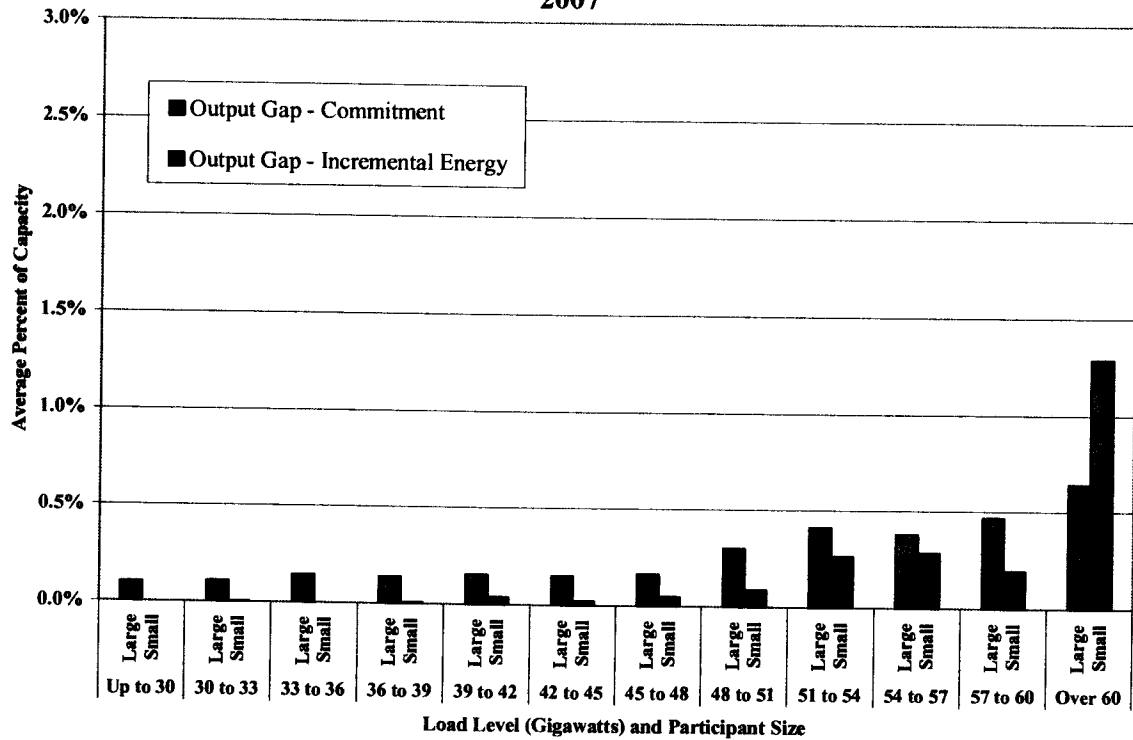

Figure 78 shows that the output gap quantities for incremental energy of large and small suppliers were comparable across all load levels. Overall, the output gap measures in 2007 were comparable with the levels in 2006, with both years showing improvement over 2005.

Overall, based upon the analyses in this section, we find that the ERCOT wholesale market performed competitively in 2007.