

5. Ancillary Service Markets

The CAISO procures regulation, spinning reserve, non-spinning reserve, and replacement reserves in the Day-Ahead market and Hour-Ahead market, such that the total procurement plus self-provision meets or exceeds the WECC Minimum Operating Reliability Criteria (MORC) and NERC Control Performance Standards (CPS2). Ancillary service is procured at the lowest overall cost while maintaining the competitiveness of the markets. The definitions for the four ancillary services are as follows:

- **Regulation:** Provided by generation that is running and synchronized with the ISO Controlled Grid, so that the operating level can be increased (incremented) or decreased (decremented) instantly through Automatic Generation Control (AGC) to allow continuous balance between resources and demand.
- **Spinning Reserves:** Provided by generation that is running (“spinning”) with additional capacity that is capable of ramping over a specified range within 10 minutes and running for at least two hours. Spinning reserve is needed to maintain system frequency stability during emergency operating conditions and unforeseen load swings.
- **Non-spinning Reserves:** Provided by generation that is available but not running, that is capable of being synchronized and ramping to a specified level within 10 minutes, and then capable of running for at least two hours. Non-spinning reserve can also be provided by curtailable demand that is telemetered and capable of receiving dispatch instruction and performing accordingly within 10 minutes. Non-spinning reserve is needed to maintain system frequency stability during emergency conditions.
- **Replacement Reserves:** Provided by generation that is capable of starting up if not already operating, synchronized with the ISO-controlled grid and ramping to a specified level within one hour, and running for at least two hours. Replacement reserve can also be provided by curtailable demand that is telemetered and capable of receiving dispatch instruction and performing accordingly within 60 minutes.

The ISO market participants, the Scheduling Coordinators (SCs), can self-provide any or all of these A/S, bid them into the ISO markets, or purchase them from the ISO. The ISO procures two other A/S, *voltage support* and *black start*, on a long-term basis primarily through the Reliability Must Run (RMR) contracts. In the rest of the section, we use the term “ancillary services” to only refer to the four reserves defined above.

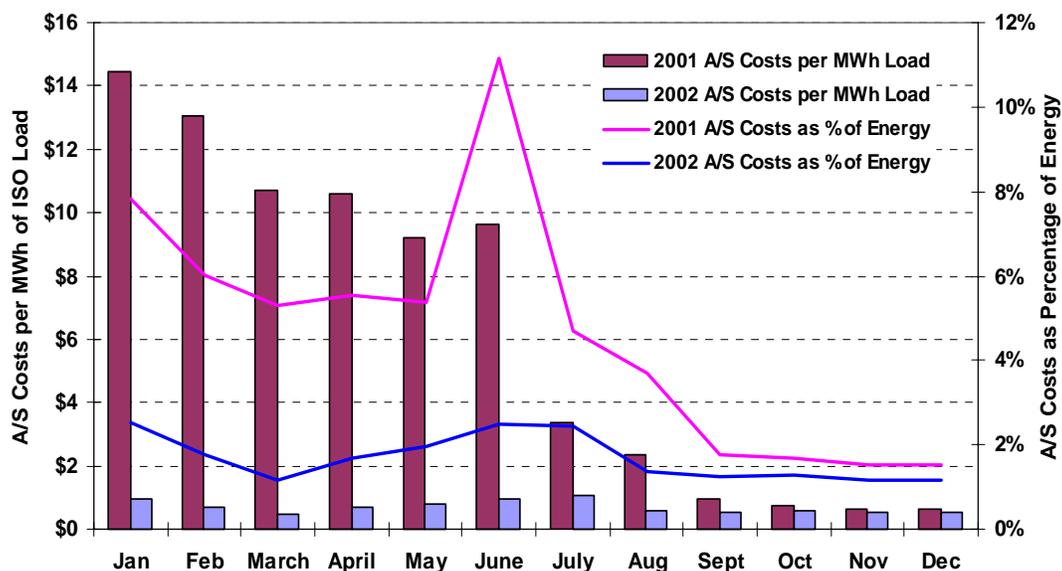
The SC’s simultaneously submit bids to supply any or all four ancillary services to the ISO by SCs, in conjunction with their preferred day-ahead and hour-ahead schedules. Submitted A/S bids must be associated with specific resources (system generating units, import interchange location, load, or curtailable export) and must contain a capacity component and an energy component. The ISO selects resources to provide A/S capacity based only on their capacity bid prices. Once the ISO selects units to provide A/S capacity, it uses their energy bid prices to dispatch units to provide real-time energy.

5.1.1 Summary of 2002 A/S Market Performance

The performance of the A/S markets improved dramatically in year 2002 compared to 2001. The A/S markets functioned in a highly efficient, competitive manner for the vast majority of hours during the year.

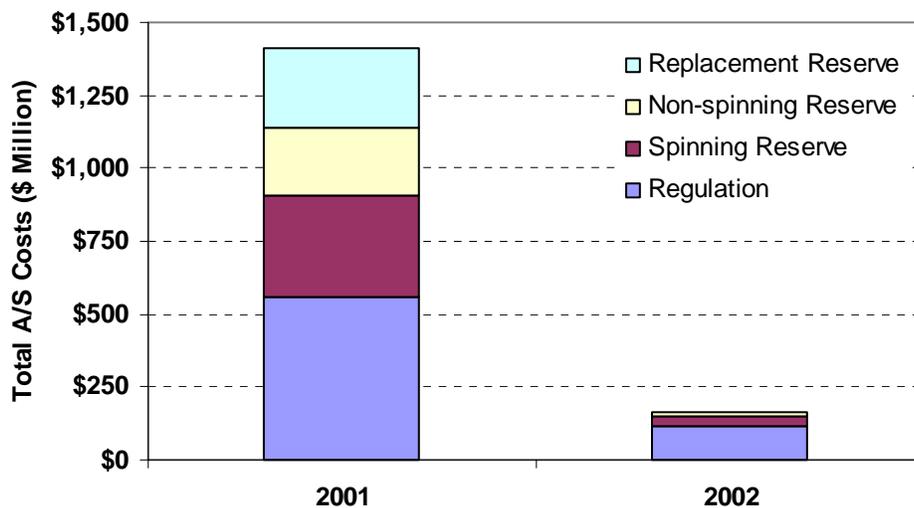
Figures 5.1 and 5.2 show overall A/S costs have dropped dramatically since September 2001. The cost of ancillary services in 2002 averaged about \$0.70 per MWh of total system load served compared to \$6.40 per MWh load in 2001. In 2002, ancillary services represented only 1.7 percent of total market energy costs, a drop of almost 70 percent from year 2001, when A/S costs averaged about 5.3 percent of total market energy costs.

Figure 5.1. Comparison of Total Monthly Ancillary Costs for Year 2001 and 2002



Replacement Reserve accounted for less than 1 percent of total A/S costs in 2002, compared to 19 percent in 2001. Regulation accounted for 70 percent of total A/S costs in 2002, a significant increase from 2001, when Regulation accounted for about 40 percent of total A/S costs. Operating Reserve (Spinning and Non-Spinning) accounted for 30 percent of total A/S costs in 2002, while in 2001 Operating Reserve accounted for 41 percent of total A/S costs.

Figure 5.2. Comparison of Annual Ancillary Costs for Year 2001 and 2002



The DMA attributes the drop in A/S costs to a variety of factors, including fewer hours of extremely high peak loads and, more importantly, a variety of modifications in A/S requirement and procurement practices:

- Decrease in the quantity of A/S required and purchased. The largest single factor impacting the decrease in A/S costs was a significant decrease in the amount of A/S capacity required and purchased by the ISO, from 13 percent of total system load in 2001 to 10 percent in 2002.
- Decrease in the quantity of Regulation required and purchased since July 2, 2002 due to the adoption of the new Regulation Requirement Methodology. Prior to July 2, 2002, the ISO determined fixed amounts of regulation to purchase based on generation dispatcher recommendations. In practice, these amounts rarely changed from day to day. Although the determination was based in part on real-time operating knowledge, it had no direct relationship to actual or forecasted system conditions. Since July 2, 2002, the ISO has employed a new method that identifies actual regulation used over a historical period and uses it as the benchmark for procurements. The benchmark is then biased up or down due to CPS2 (Control Performance Standard) violations and to accommodate generation dispatcher and shift manager needs. Since July 2, the new methodology has resulted in reduced regulation procurement costs due to reduced volume. It has not appreciably affected the control performance standard directly related to regulation performance. As a result, total regulation cost in the second half of the year 2002 was \$48 million, compared to \$68 million in the first half of the year.
- Significant reductions in regulation cost were due to an increase in self-provision. Self-provision of regulation in 2002 increased 41 percent and 50 percent for upward and downward Regulation respectively from 2001 levels. Therefore, in 2002, the ISO purchased a smaller portion of regulation requirement in the A/S markets than in 2001.

- Continued decrease in the quantity of Replacement Reserve procurement due to the effect of FERC's June 2001 Must Offer Order. The Must Offer Order, to some extent, ensures that capacities not bid into the Day-Ahead Market and Hour-Ahead Market will be available in the real-time. This allows the ISO to reduce procurement of replacement reserve. In August 2002, the ISO removed Replacement Reserve Minimum Procurement Criteria.

The ISO implemented other A/S market improvements in 2002. Although we cannot measure the impact of these measures at this time, we expect them to help improve the future performance of the A/S markets, particularly under high load conditions.

- To ensure that ancillary services are not procured from resources that are out-of-service due to planned outage or forced outage, in January 2002, the ISO established a procedure to track resource outages and A/S availability. The ISO blocks resources that are out-of-service or limited on a planned outage or forced outage from providing ancillary services, dependent upon available capacity in the Day-Ahead Market and/or Hour-Ahead Market until the Scheduling Coordinator/Participating Generator declares the resource available. Along with the planned and forced outages from the Day-Ahead market, the ISO also blocks resources with real time forced outages from providing ancillary services in the Hour-Ahead market until such time that the resource is declared available. Resources awarded Ancillary Services in the Day-Ahead Market and then forced out in real time are subject to buy back in the Hour-Ahead Market. After a resource is declared available, its bids are considered in the next Hour-Ahead Market.

5.2 Demand for Ancillary Services

As the institution responsible for the reliable operation of California's bulk-power grid, the ISO must determine and procure the quantities of A/S it needs to fulfill this responsibility. The ISO calculates the A/S requirements and procures the required quantities in the Day-Ahead (DA) and Hour-Ahead (HA) markets.

5.2.1 Overall Demand for Ancillary Services

The ISO uses different procedures to calculate its requirements for the four ancillary services. Fundamentally, the demand for A/S is primarily a function of total system load. Figure 5.3 shows the monthly total A/S MW requirement as percentage of system load. In Year 2001, total A/S requirement averaged 12.9 percent of system load. In Year 2002, the ISO was able to reduce its A/S requirements and purchases as the market stabilized. As a result, the total A/S requirement averaged only 9.3 percent of system load in 2002.

The ISO continued to defer part of the A/S purchases from the Day-Ahead to the Hour-Ahead Market. However, compared to year 2001, the share of A/S that the ISO was required to purchase in Hour-Ahead was smaller in 2002 as the system stabilized. In 2001, about 8.8 percent of total A/S was required to be purchased in HA. This

share was reduced to 6.3 percent in 2002. Figure 5.4 shows the share of A/S required in DA and HA as percentage of actual load.

Figure 5.3. Total A/S MW Requirement as Percentage of ISO Load

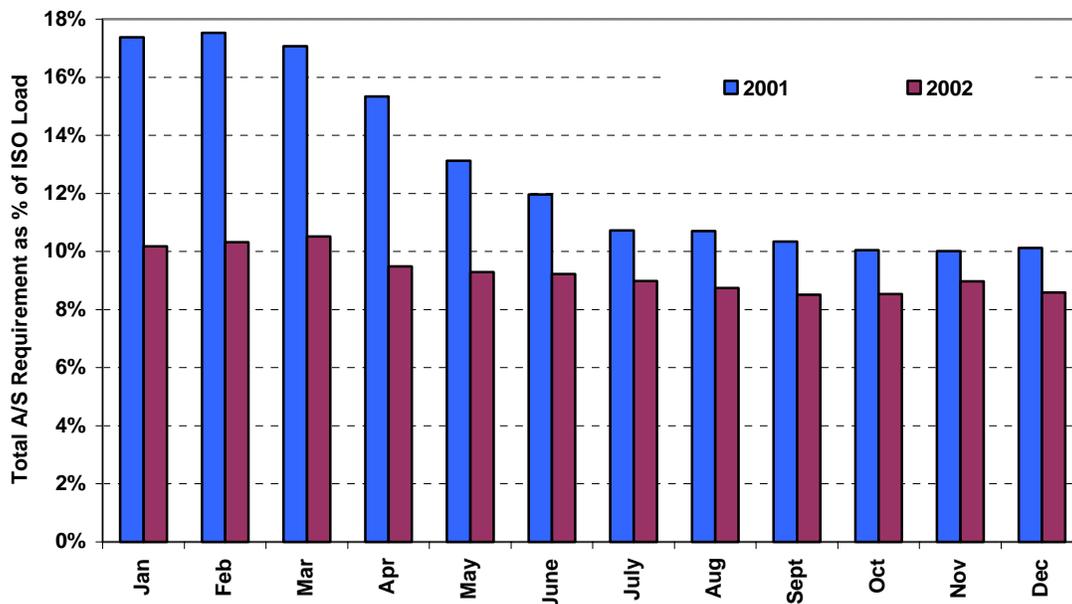
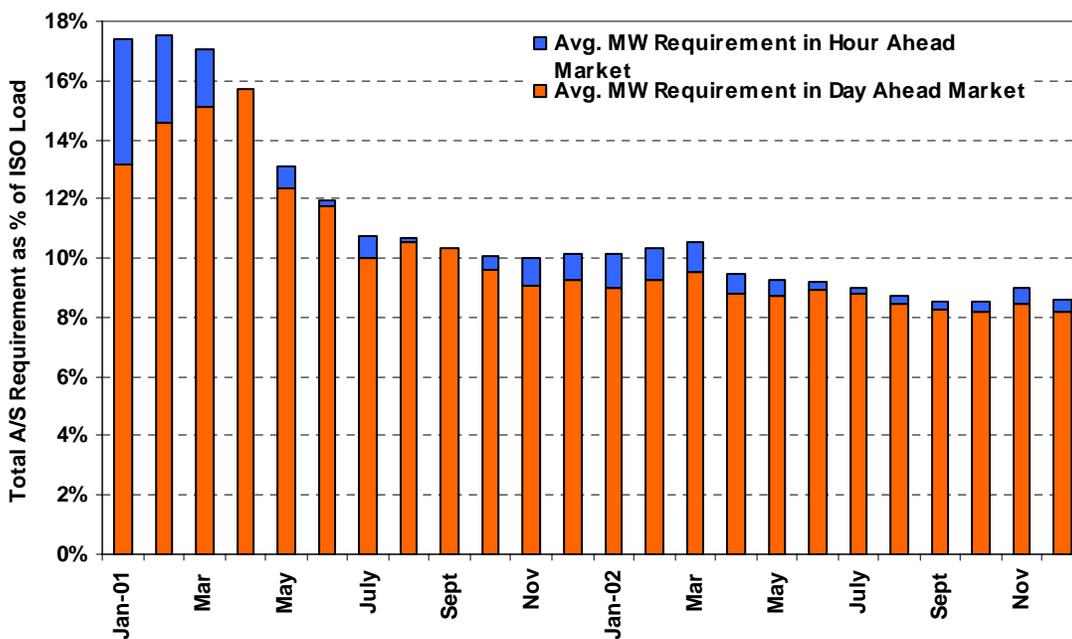


Figure 5.4. Total A/S MW Requirement per MW of ISO Load (Day-Ahead and Hour-Ahead Markets)



5.2.2 Demand for Regulation Reserves

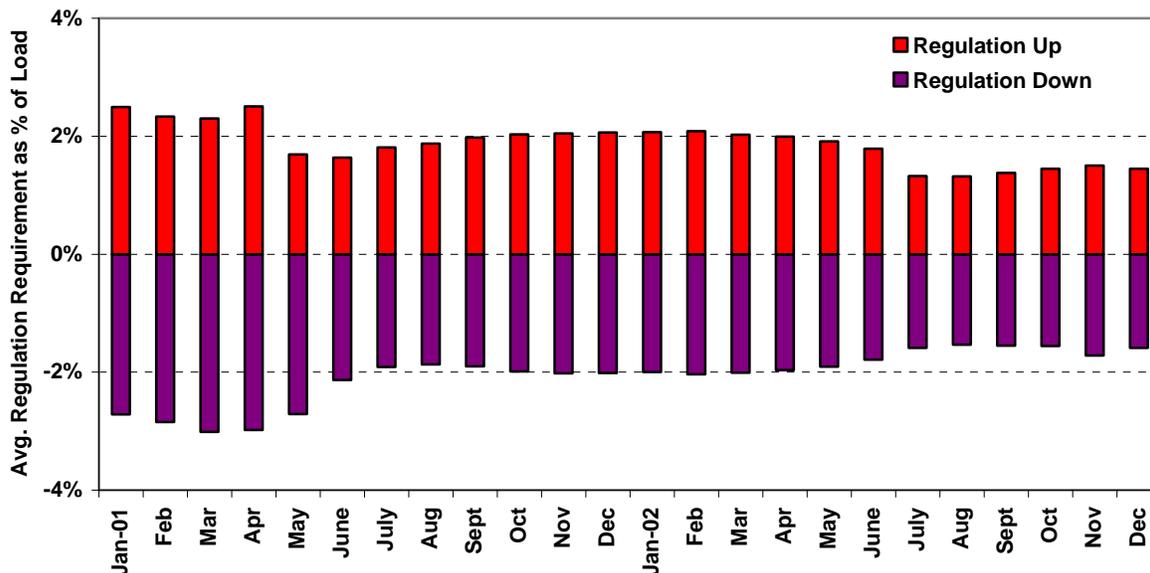
To meet the WECC Minimum Operating Reliability Criteria (MORC) and NERC Control Performance Standards (CPS2), the ISO requires sufficient generation units that respond immediately to Automatic Generation Control (AGC) of the ISO control area to allow continuous balance between resources and demand.

In DA and HA, Grid Resource Coordinators (GRC) usually determine the required regulation amounts based on a methodology that takes into consideration factors such as actual regulation used, CPS2 violation, and min/max procurement. Regulation requirements may be adjusted during the operating day to support any modifications to the ISO load forecast and forecast deviations, previous day's system loads, RMR dispatch instructions, previous day, week or month performance or real-time system conditions, interchange and generation schedule change magnitude. More specifically, the ISO Grid Operators determine the amount of Regulation to be procured as the sum of:

- (1) 25 percent more than actual average amount of Regulation used in each of the 24 hours of the previous 7 days;
- (2) an additional 2 percent for each CPS2 violation;
- (3) an additional amount for predetermined non-responsive units;
- (4) a procurement range for Regulation Up and Regulation Down of 350 – 600 MW each. All SCs with metered load within the ISO Control Area incur a pro-rata regulation obligation, unless offset by self-provision. Upward and downward regulation requirements are procured separately.

The ISO adopted a new methodology for regulation requirements in 2002. As a result, monthly total upward regulation requirements declined from an average of 387,656 MW in 2001 to 324,790 MW in 2002. Monthly total downward regulation requirements declined from 439,092 MW in 2001 to 340,797 MW in 2002. Figure 5.5 shows the monthly total regulation requirements as percentage of system load. The figure shows a downward trend in the requirements for both upward and downward regulation. Upward regulation as percent of system load averaged 1.7 percent in 2002, a decrease from 2.1 percent in 2001. Downward regulation as percent of system load averaged 1.8 percent in 2002, less than the 2.3 percent in 2001.

Figure 5.5. Average Regulation Service Requirements



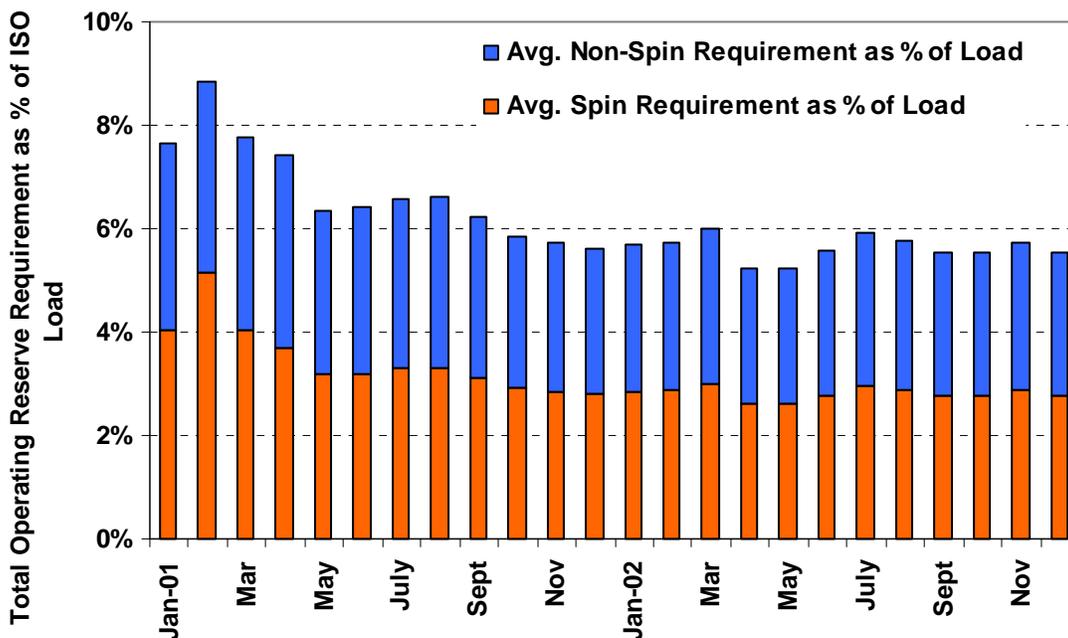
5.2.3 Demand for Operating Reserve

The ISO procures operating reserves, including regulating reserves, necessary to meet ISO requirements not met by self-provided reserves. ISO operating reserve standards for spinning and non-spinning reserves are set to meet the WECC MORC and NERC Control Performance Standards. More specially, the ISO procures the greater of the most severe single contingency or the sum of 5 percent of the load responsibility served by generation from hydroelectric resources and 7 percent of the load responsibility served by generation from other resources plus the non-self provided amounts to cover interruptible imports and on-demand obligations minus the non-firm exports on a MW to MW basis. To meet WECC MORC standards, a minimum of 50 percent of the operating reserves procured to meet the above requirements must be spinning reserve. Operating reserve from external resource is limited to 50 percent of the total requirement.

The operating reserve requirement is computed for each SC in each Reserve Region. The ISO takes into account individual import and export energy schedules and their firmness. For instance, there is no spinning reserve requirement for demand met by firm purchases from outside the ISO Control Area. For SC-to-SC trades, the SC that is responsible for serving the load is responsible for providing the A/S Requirement.

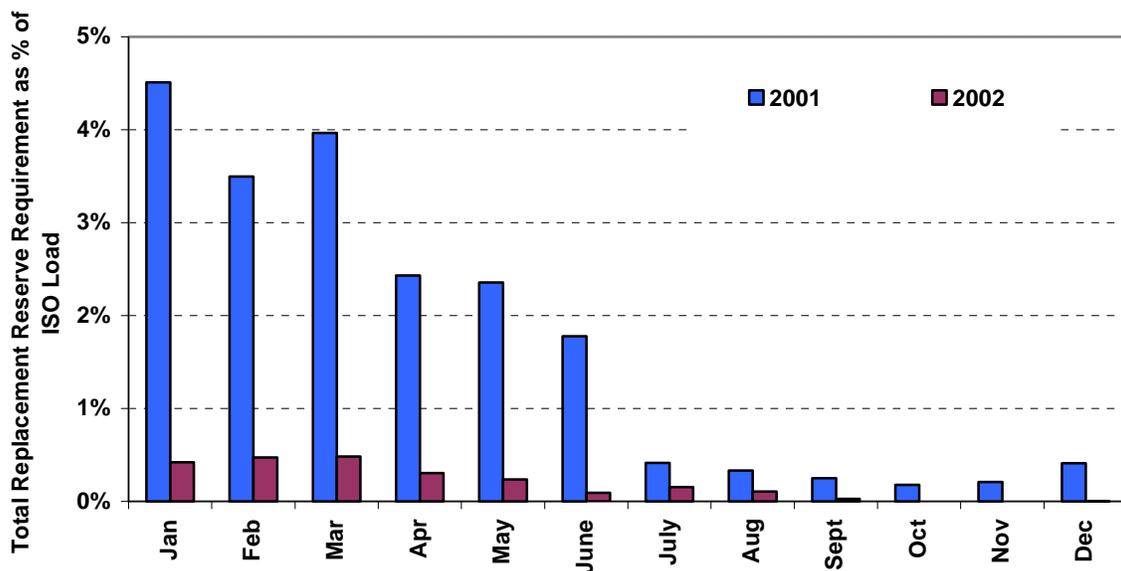
Figure 5.6 shows the monthly operating reserve requirements as a percent of system load. The requirements for spin and non-spin have been very stable since August 2001. Total requirements for operating reserve averaged 5.6 percent of ISO load in 2002, a decrease from 6.8 percent in 2001.

Figure 5.6. Average Operating Reserve Requirements



5.2.4 Demand for Replacement Reserves

Through mid-2001, the ISO determined the requirements for replacement reserves based on analyses of patterns regarding unplanned generating unit outages, unexpected transmission outages, seasonal variations, and other factors that influence the ISO controlled grid’s ability to meet applicable reliability criteria. However, in June 2001, FERC implemented a must offer requirement for PGA generators within the ISO control area that significantly affected the ISO’s requirements for replacement reserve. Since then, the ISO has gradually reduced requirement for replacement reserve to less than 1 percent of system load. Figure 5.7 shows the monthly average requirements for replacement reserves.

Figure 5.7. Average Replacement Reserve Requirements

5.3 Supply of Ancillary Service

5.3.1 Overall Supply of Ancillary Services

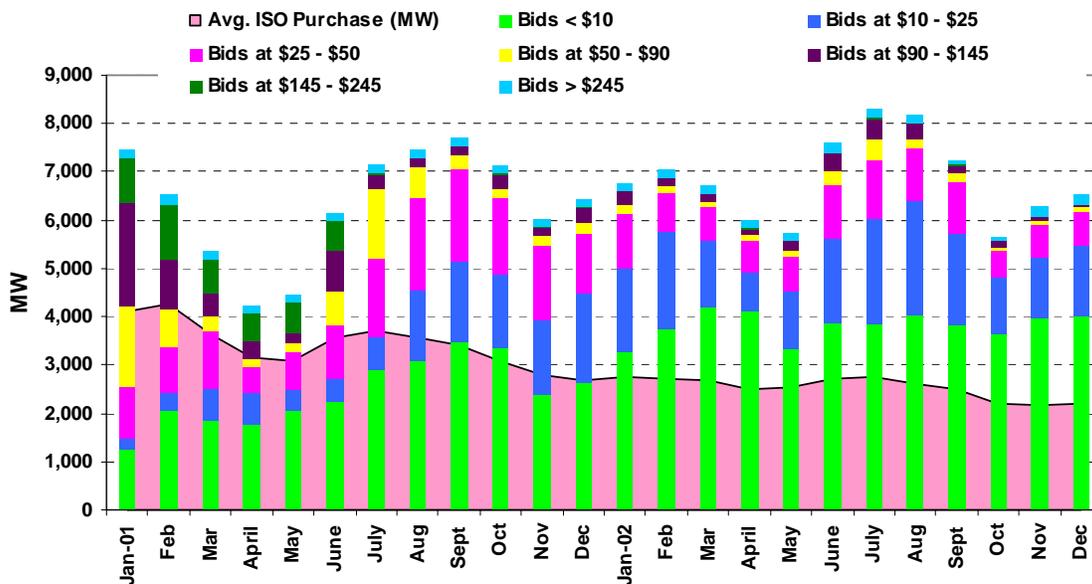
5.3.1.1 Bid Sufficiency and Bid Prices

Overall bid sufficiency has been improved dramatically since July 2001. The monthly average bid quantity of A/S was 6,838 MW/hour in 2002 compared to 6,343 MW/hour in 2001. More importantly, more low priced ancillary service bids were offered to the markets in 2002 than in 2001. Ancillary service bids below \$10/MW accounted for 56.5 percent of total ancillary service bids on average in 2002 compared to only 38.5 percent in 2001. Bids priced between \$10/MW to \$25/MW accounted for 23.1 percent of total bids in 2002 compared to only 15.0 percent in 2001. More ancillary services were bid into higher price ranges in 2001 compared to 2002. Bids between \$25 and \$50/MW accounted for 20 percent of total bids in 2001 compared to only 12.7 percent in 2002. Bids priced between \$50 and \$245/MW accounted for 23.74 percent of total bids in 2001 compared to only 5.3 percent in 2002. The shares of bids priced above \$245/MW were similar in 2001 and 2002, 2.8 and 2.4 percent of total bids respectively.

Figure 5.8 shows the monthly average total quantities bid and purchased per hour in the five ancillary services markets¹ in Years 2001 and 2002.

¹ The five ancillary services include regulation up, regulation down, spinning reserve, non-spinning reserve, and replacement reserve.

Figure 5.8. Average Bid Quantities and Purchases per Hour in the A/S Markets (Day-Ahead Market Plus Hour-Ahead Market)



5.3.1.2 Ancillary Services Prices and Costs

As the result of improved bid sufficiency and bid prices in ancillary service markets, market clearing prices and costs of ancillary services fell dramatically in 2002 from 2001 levels. Table 5.1 lists quantity-weighted average prices for each ancillary service (including both Day-Ahead and Hour-Ahead markets). The overall ancillary service prices averaged \$7.1/MW in 2002, considerably less than the \$45.5/MW averaged in 2001.

Table 5.1. Summary of Quantity-Weighted Average Prices (\$/MW) for Ancillary Services

	Regulation Up	Regulation Down	Spinning Reserve	Non-Spinning Reserve	Replacement Reserve	Overall
2001	\$66.72	\$42.33	\$34.69	\$30.03	\$102.38	\$45.51
2002	\$13.41	\$13.76	\$4.66	\$2.15	\$1.48	\$7.11

5.3.2 Supply of Regulation Service

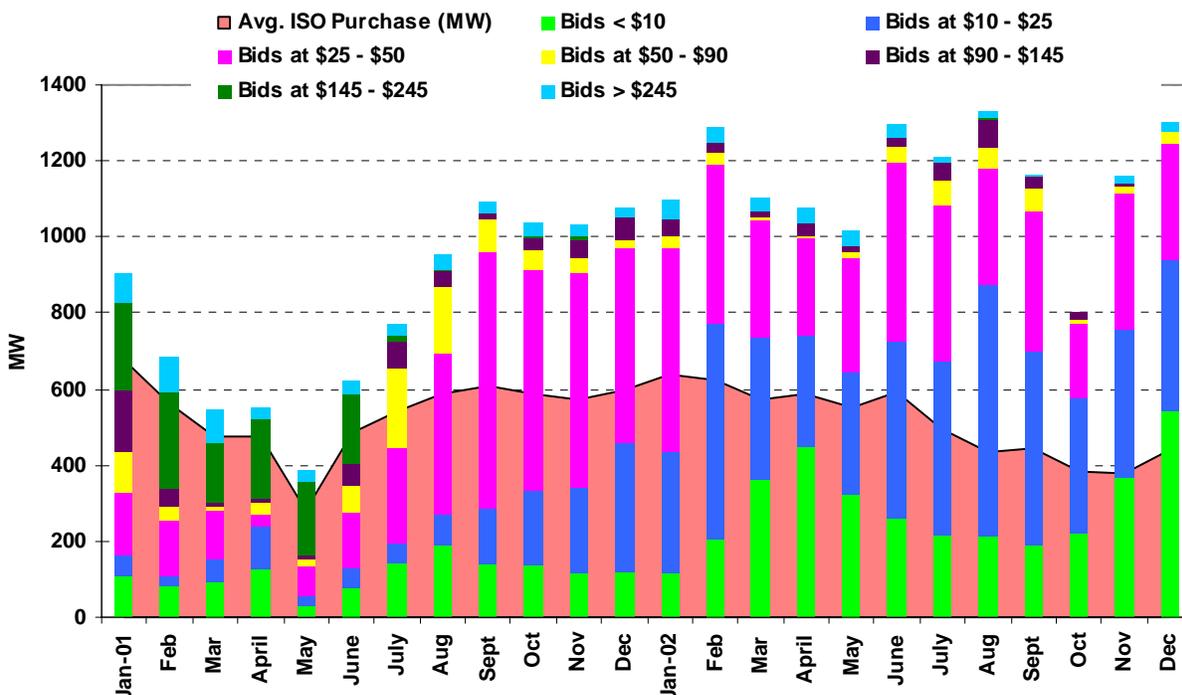
5.3.2.1 Upward Regulation Bid Sufficiency and Bid Prices

The level of supply of upward regulation bid into the market in 2002 significantly improved from 2001. In 2001, only 806 MW of upward regulation was bid into the market per hour on average compared to 1,155 MW in 2002. More importantly, bid prices in 2002 were much lower than in 2001. About 92.5 percent of upward

regulation bids during hours ending 18 to 23 were priced lower than \$50/MW in 2002 compared to only 66.6 percent in 2001.

Figure 5.9 shows the average quantities bid and purchased per hour in the upward regulation market for each month in 2001 and 2002 for hours ending 18 through 23, when the need for upward regulation is the greatest and the supply is tightest.

Figure 5.9. Upward Regulation – Average Bid Quantities and Purchases Operating Hours 18 – 23 (Day-Ahead Market plus Hour-Ahead Market)

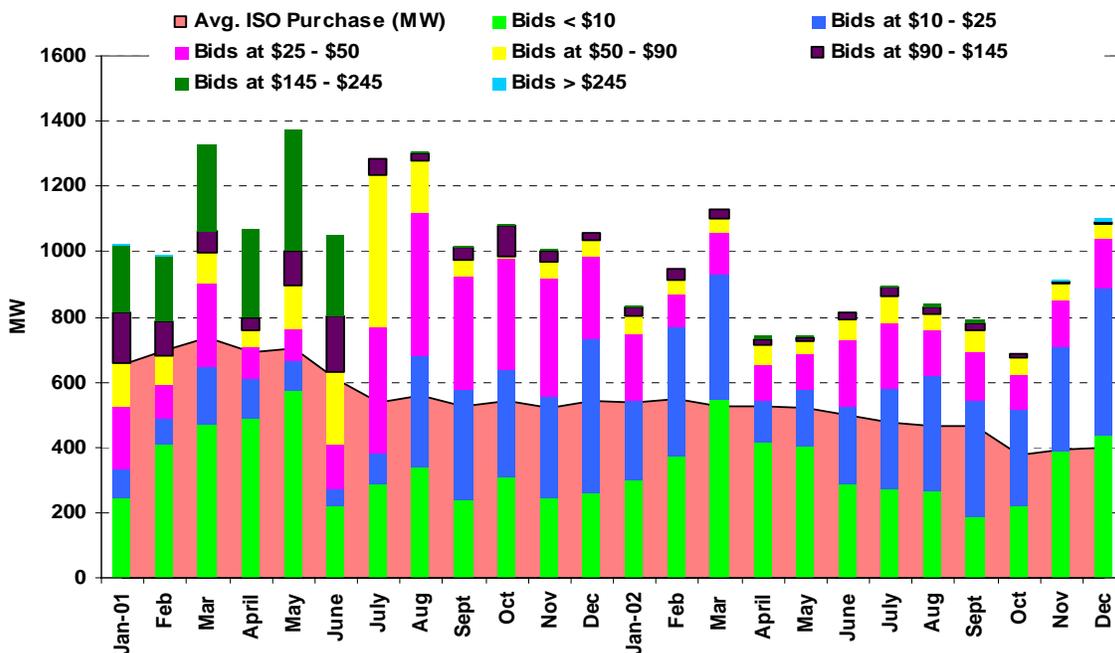


5.3.2.2 Downward Regulation Bid Sufficiency and Bid Prices

The supply of downward regulation actually declined in 2002 from 2001. In 2001, on average, 1,133 MW of downward regulation was bid into the market between hours ending 4 and 9 compared to only 870 MW in 2002. However, bids were at much lower prices in 2002 than in 2001. About 90.9 percent of all downward regulation bids were priced lower than \$50/MW in 2002, compared to only 70.6 percent in 2001.

Figure 5.10 shows average quantities bid and purchased per hour in the downward regulation market for each month during 2001 and 2002 for hours ending 4 through 9, when the demand for this service is greatest and the supply is tightest.

Figure 5.10. Downward Regulation – Average Bid Quantities and Purchases Operating Hours 4 – 9 (Day-Ahead Market Plus Hour-Ahead Market)

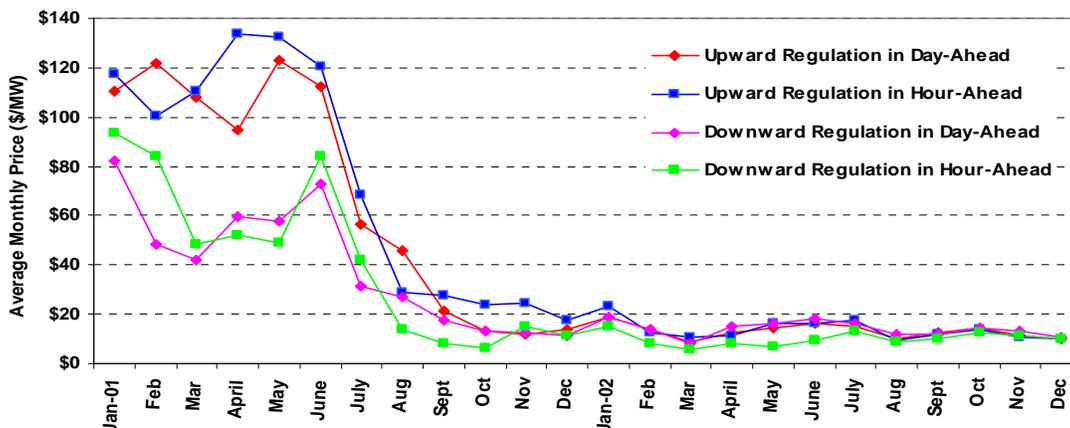


5.3.2.3 Market Clearing Prices for Upward and Downward Regulation

Both upward and downward regulation prices dropped significantly from 2001 levels. Unlike the situation in 2001, no prolonged price spikes were experienced in the regulation market in 2002.

Figure 5.11 shows the quantity-weighted average prices for upward and downward regulation service in Day-Ahead and Hour-Ahead markets.

Figure 5.11. Average Monthly Prices in Day-Ahead and Hour-Ahead Markets



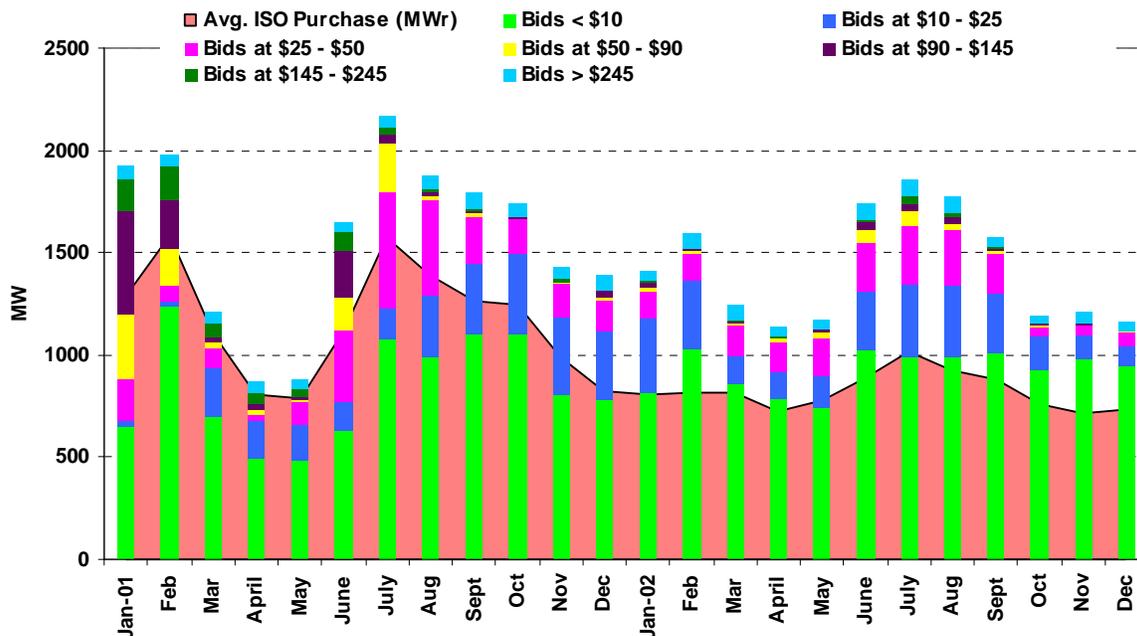
5.3.3 Supply of Operating Reserve and Replacement Reserve

5.3.3.1 Spinning Reserve Bid Sufficiency and Bid Prices

Although the average quantities bid into the spin markets were more stable in 2002 than in 2001, there were less bids on average. In 2001, on average 1,576 MW of spinning reserve per peak hour was bid into the markets compared to 1,420 MW in 2002. However, 2002 bids were much lower than bids in 2001 due to more competitive market conditions. In 2002, on average, about 65.1 percent of all spinning bids during peak hours were below \$10/MW compared to only 53.2 percent in 2001.

Figure 5.12 shows the average monthly quantities of spinning reserve bids into the Day-Ahead and Hour-Ahead Markets during peak hours for each month in 2001 and 2002.

Figure 5.12. Spinning Reserves - Average Bid Quantities (MW) and Prices During Peak Hours (Day-Ahead plus Hour-Ahead Markets)

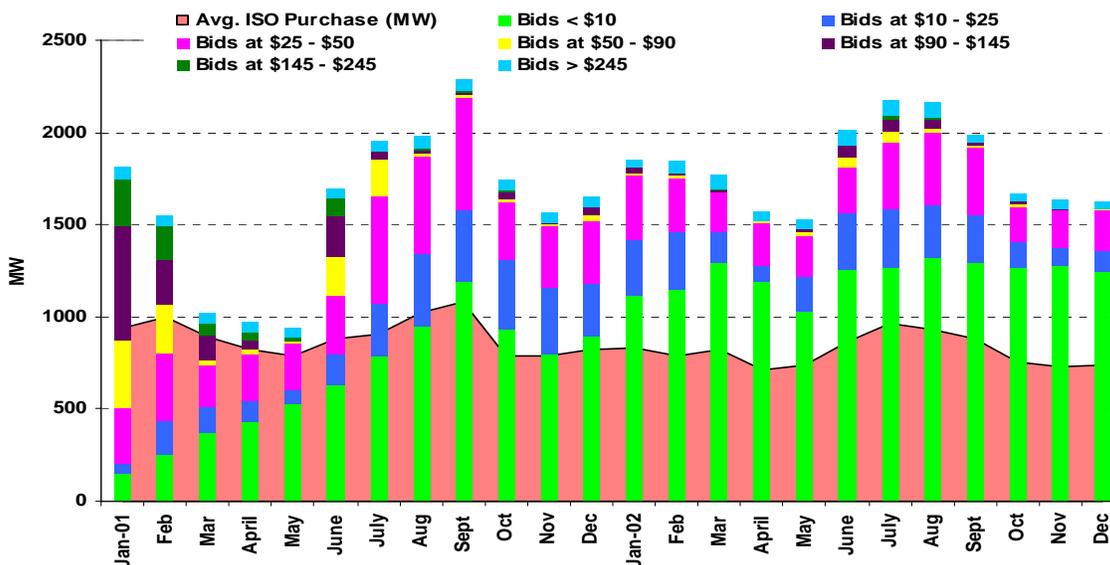


5.3.3.2 Non-Spinning Reserve Bid Sufficiency and Bid Prices

The average quantities bid into the non-spin markets were significantly higher in 2002 than in 2001. In 2002, on average, 1,820 MW non-spinning reserve per peak hour was bid into the markets compared to 1,601 MW in 2001. 2002 bid prices were much lower than bids in 2001 because of the more competitive market conditions. In 2002, 67.3 percent of all non-spinning bids during peak hours were below \$10/MW compared to only 41.2 percent in 2001.

Figure 5.13 shows the average monthly quantities of non-spinning reserve bid into the Day-Ahead and Hour-Ahead Markets during peak hours for each month in 2001 and 2002.

Figure 5.13. Non-Spinning Reserves - Average Bid Quantities (MW) and Prices During Peak Hours (Day-Ahead plus Hour-Ahead Markets)

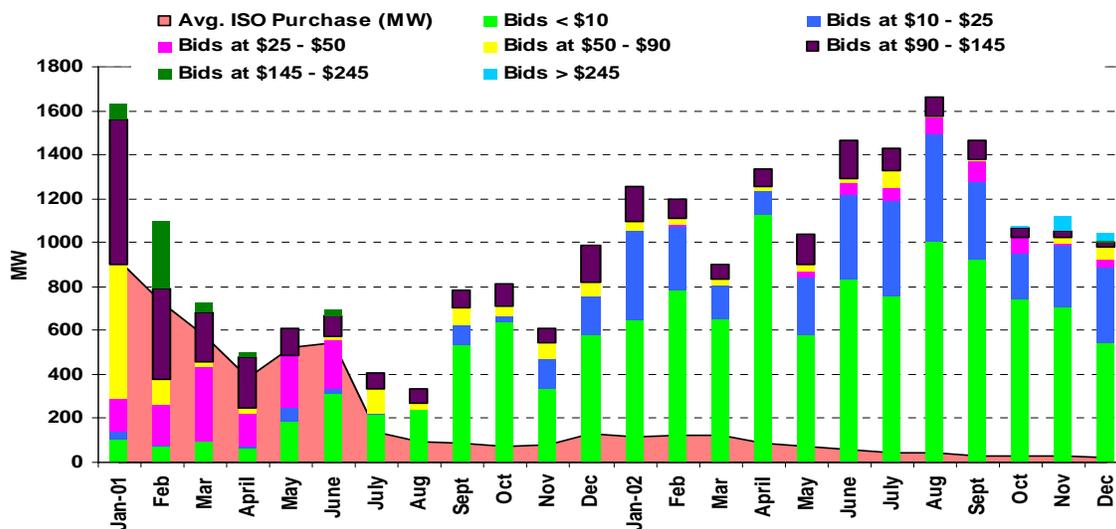


5.3.3.3 Replacement Reserve Bid Sufficiency and Bid Prices

Bid sufficiency improved dramatically for replacement reserve in 2002 compared to 2001. However, due to the effect of FERC’s June 2001 “Must Offer Order”, the ISO’s purchase of replacement reserve was lowered dramatically due to the rational expectation that units without Must Offer Waiver would be available at real-time.

Figure 5.14 shows average bid quantities and prices for replacement reserves during peak hours.

Figure 5.14. Replacement Reserves - Average Bid Quantities (MW) and Prices During Peak Hours (Day-Ahead plus Hour-Ahead Markets)

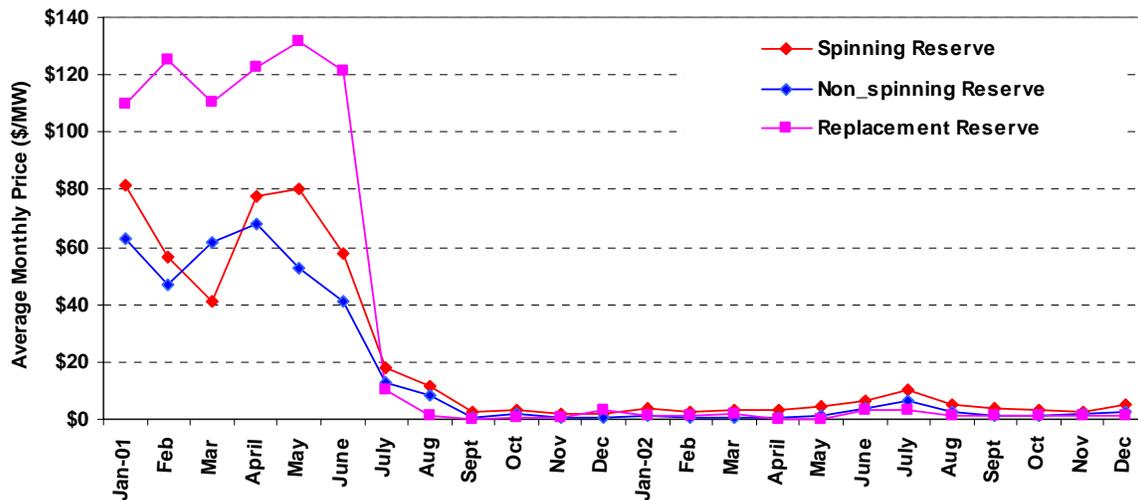


5.3.3.4 Market Clearing Prices for Operating Reserve and Replacement Reserve

Both spinning and non-spinning prices dropped dramatically since September 2001. In fact, the spinning reserve price averaged only \$4.7/MW in 2002, a significant reduction from 2001's \$34.7/MW level. The non-spinning reserve price averaged \$2.2/MW in 2002, also down dramatically from 2001's \$30.0/MW level. Replacement reserve price averaged \$1.5/MW in 2002, extremely low compared to \$102.4/MW in 2001.

Figure 5.15 shows quantity-weighted average day-ahead and hour-ahead prices for operating reserve and replacement reserve during peak hours in each month of 2001 and 2002.

Figure 5.15. Monthly Average Prices for Operating Reserve During Peak Hours



5.4 Conclusion

Dramatically improved supply and demand conditions in the ancillary services markets in 2002 resulted in more competitive and stabilized A/S markets and significant A/S cost reduction. A/S markets are essential to reliable operation of the ISO system. The ISO will continue to make necessary A/S market changes to ensure a reliable electricity grid system and efficient wholesale market with minimum cost.