4 Ancillary Service Markets

4.1 Summary of Performance in 2006

Overall, average Ancillary Service (A/S) prices increased by 4 percent in 2006 compared to prevailing prices in 2005. The total procurement cost increased by 3 percent while the total procurement volumes of the four types of A/S products stayed almost at the same level as they were in 2005. The increase in the aggregate A/S price resulted primarily from price increases in Non-Spinning Reserve markets, despite a small drop in Regulation-Up Reserve. The average prices of Spinning Reserve and Regulation Down Reserve stayed flat compared with last year.

The A/S markets experienced a significant decline in hours of bid insufficiency in 2006 compared to 2005; however, bid insufficiency was highly concentrated in April and July of 2006 due to system conditions that resulted in relatively high frequency of price spikes during those months. The majority of hours with bid insufficiency in the Regulating Reserves market in 2006 occurred in April and can be attributed to the record high hydroelectric production during the spring months. The high frequency of bid insufficiency in the Operating Reserve markets in July can be attributed to tight supply conditions and high opportunity costs during periods of record-setting loads during the heat wave.

4.2 Ancillary Services Market Background

The CAISO procures Regulation Reserve, Spinning Reserve and Non-Spinning Reserve in the Day Ahead and Hour Ahead Markets such that the total procurement volumes plus self-provision volumes meet or exceed the Western Electricity Coordinating Council's (WECC) Minimum Operating Reliability Criteria (MORC) and North American Electricity Reliability Council (NERC) Control Performance Standards (CPS). The CAISO procures A/S at the lowest overall cost while maintaining the reliability of the system and the competitiveness of the markets. The combination of a single-price auction pricing mechanism across the control area and the Rational Buyer algorithm which allows for economic substitution of less expensive bids in place of more expensive bids across services facilitates a least-cost procurement approach to meeting reliability requirements.

The definitions for the actively procured Ancillary Services are:

1) Regulation Reserves: Reserved capacity provided by generating resources that are running and synchronized with the CAISO controlled grid, so that the operating levels can be increased (incremented) or decreased (decremented) instantly through Automatic Generation Control (AGC) to allow continuous balance between generating resources and demand. The CAISO operates two distinct capacity markets for this service, upward and downward Regulation Reserve.

2) Spinning Reserves: Reserved capacity provided by generating resources that are running (i.e., "spinning") with additional capacity that is capable of ramping over a specified range within 10 minutes and running for at least two hours.

The CAISO needs Spinning Reserve to maintain system frequency stability during emergency operating conditions and unanticipated variations in load.

3) Non-Spinning Reserves: Generally, reserved capacity provided by generating resources that are available but not running. These generating resources must be capable of being synchronized to the grid and ramping to a specified level within 10 minutes, and then be able to run for at least two hours. Curtailable demand can also supply Non-Spinning Reserve provided that it is telemetered and capable of receiving dispatch instructions and performing accordingly within 10 minutes. The CAISO needs Non-Spinning Reserve to maintain system frequency stability during emergency conditions.

CAISO market participants can self-provide any or all of these A/S products, bid them into the CAISO markets, or purchase them from the CAISO. The CAISO procures two other ancillary services on a long-term basis: voltage support and black start. Reliability Must Run (RMR) contracts serve as the primary procurement vehicle for these services. Through the remainder of this chapter, the term "ancillary services" (A/S) will be used only to refer to the three reserved-capacity products defined above.

Scheduling Coordinators (SCs) simultaneously submit bids to supply any or all three products to the CAISO 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 CAISO selects resources to provide A/S capacity based only on their capacity bid prices and deliverability. Thereafter, the CAISO uses the energy bid prices to dispatch units to provide real-time energy.

4.3 Increase in Ancillary Service Bid Cap

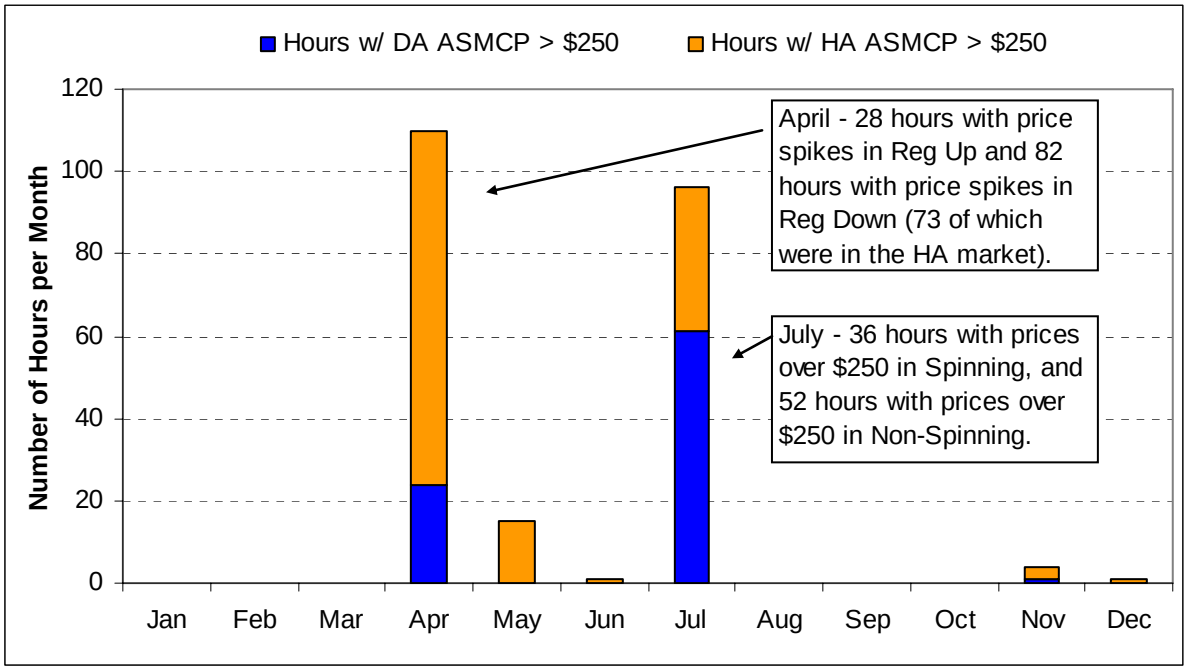
4.3.1 Background

As discussed in Chapter 1, on December 21, 2005, the CAISO submitted a filing to FERC to change the soft bid cap for Real Time Energy from $250/MWh to $400/MWh to alleviate concerns that increasing natural gas prices during the fourth quarter of 2005 may limit suppliers' willingness to bid into the CAISO Real Time Market. In its filing, the CAISO did not propose to increase the bid cap for ancillary services, which at the time was $250/MW. The proposal to raise the energy bid cap was overwhelmingly supported by industry participants, and was approved by FERC on January 13, 2006[1] (January 13 Order) to be effective the following day. The January 13 Order also instituted an investigation into the price cap in the WECC outside the CAISO and the ancillary service capacity bid cap in the CAISO Ancillary Services Market. After receiving comments, FERC issued an order on February 13, 2006 establishing a $400/MWh "soft" price cap in the WECC (outside the CAISO) and establishing a $400/MW "soft" bid cap for ancillary services bids in the CAISO market. The changes became effective upon issuance of the February 13 Order. Since this increase took effect, the Ancillary Service markets have experienced periods of prices in excess of $250/MW, primarily concentrated in the Regulation

[1] Federal Energy Regulatory Commission, "Order accepting and modifying tariff filing and instituting a section 206 Proceeding," issued January 13, 2006, 114 FERC ¶ 61,026.

markets in April due to high spring hydroelectric output and the Operating Reserve markets in July due to extreme peak load conditions.

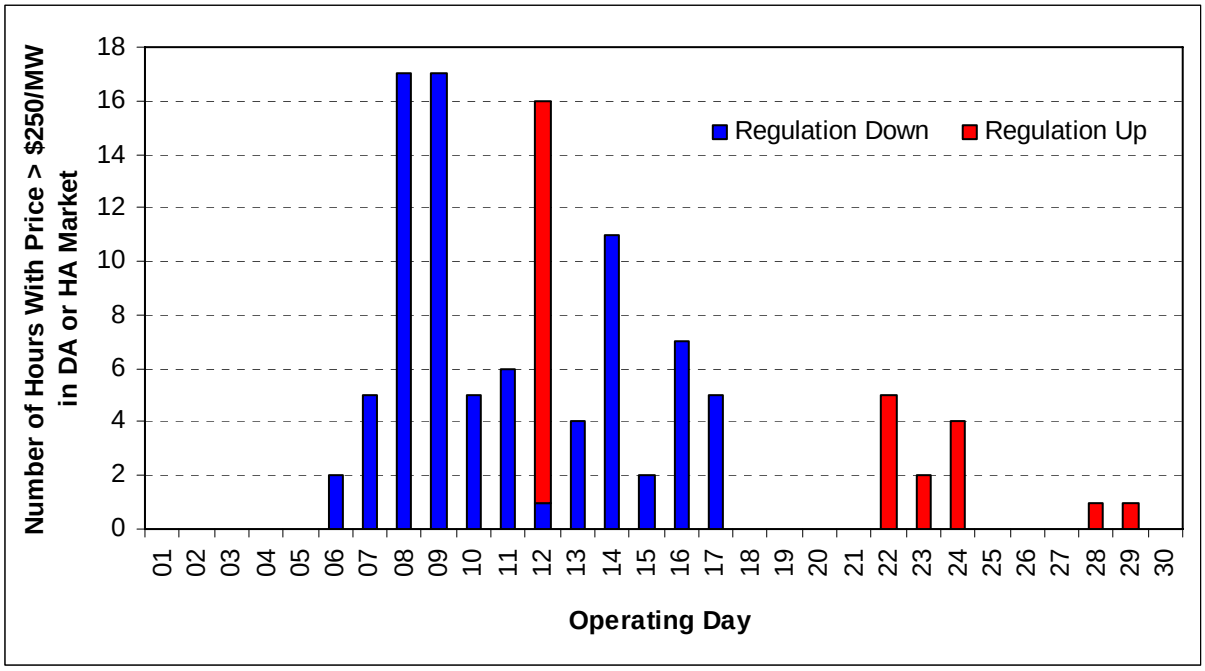
Figure 4.1 Frequency of Ancillary Service Prices Greater than $250/MW



4.3.2 Regulation Reserve Prices over $250/MW

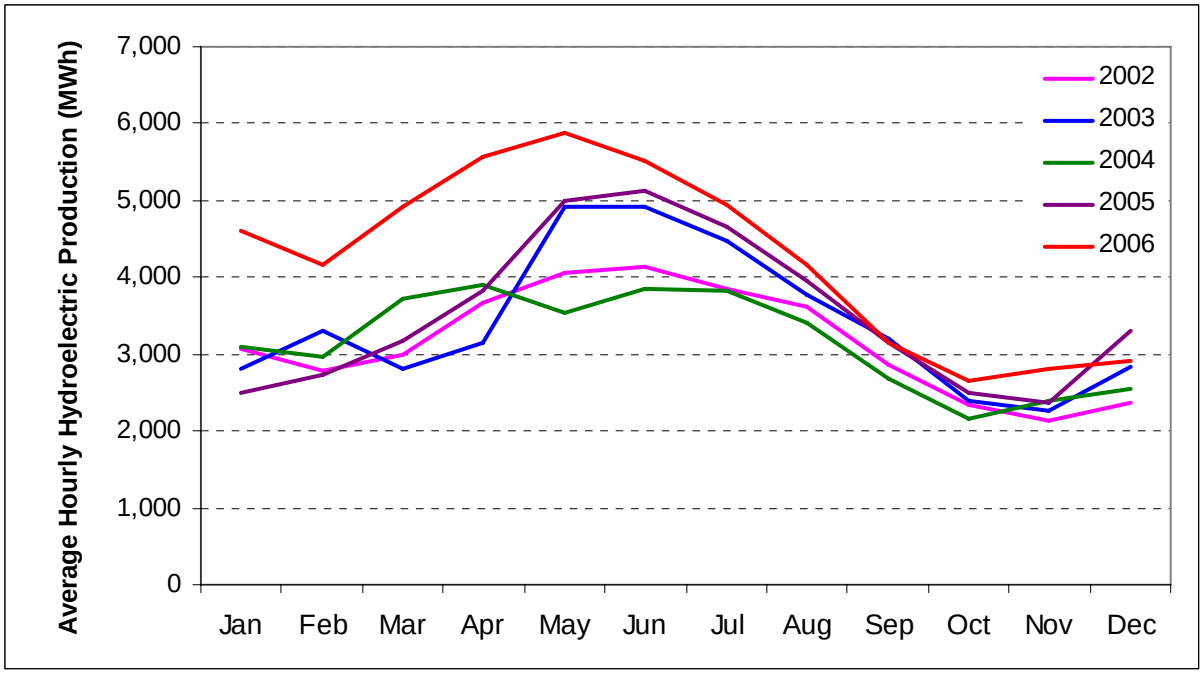
During the winter months of 2006, market clearing prices for ancillary services (A/S) exhibited a steady increase in each market, except for Non-Spinning Reserves. In late March and April, prices for regulating reserves increased significantly from prior price levels, moving into the price region between the prior bid cap of $250/MW and the current bid cap of $400/MW while prices in the Spinning Reserve markets remained well below the $100/MW mark and prices for Non-Spinning Reserve during this period remained below $30/MW.

Figure 4.2 Majority of Regulating Reserve Price Spikes in April



The winter and early spring periods in 2006 were extremely wet and warm, causing swelling river and reservoir levels. This weather pattern and the resulting increased river flows resulted in increased generation from hydroelectric resources throughout the West. Under these conditions, hydro resources experience a "spill" state such that, if they did not generate, they would be forced to spill water without generating electricity, which is viewed as wasted water. Consequently, these resources often generate at full capacity, as the energy markets provide the final opportunity to capture value for the water behind the dam.

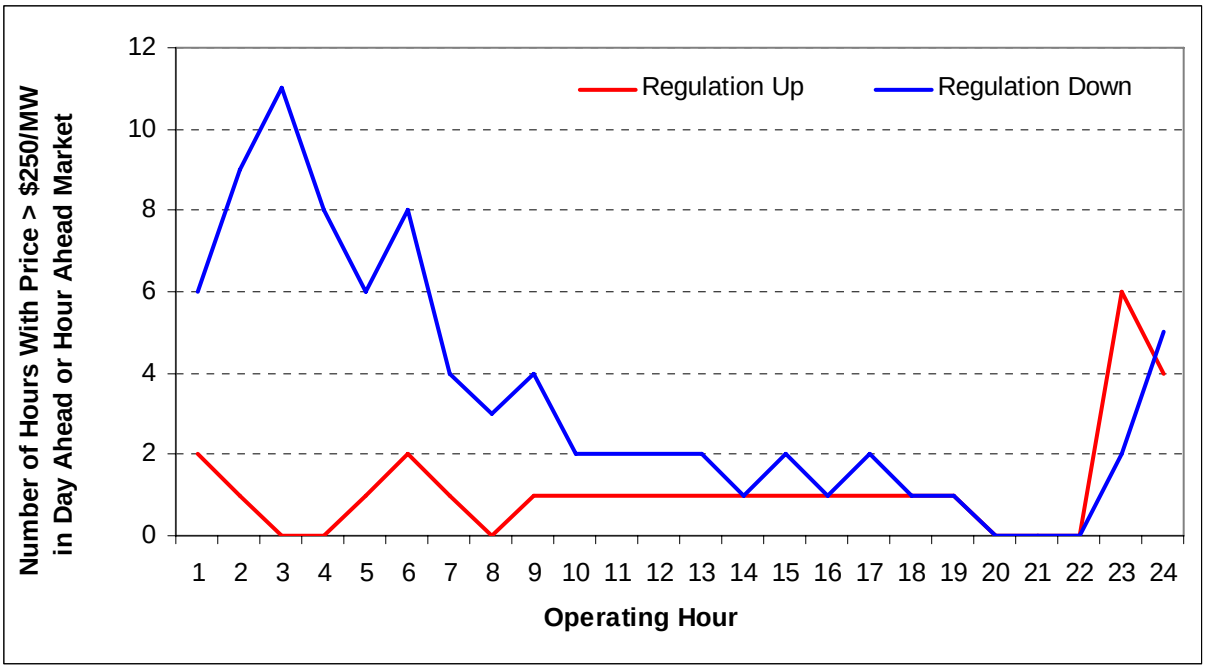
Figure 4.3 Hydroelectric Output for 2002 - 2006



Such strong hydro-electric conditions stress A/S markets, particularly those that require on-line resources. This is because hydro-electric resources can be producing near their limit, reducing the availability of Regulation Up Reserve capacity available. Also, they are reluctant to reduce output due to the spill conditions that accompany high rain and runoff periods, thus reducing the availability of Regulation Down Reserve capacity. Figure 4.3 above shows the high hydro output experienced in the months of January through June compared to prior years.

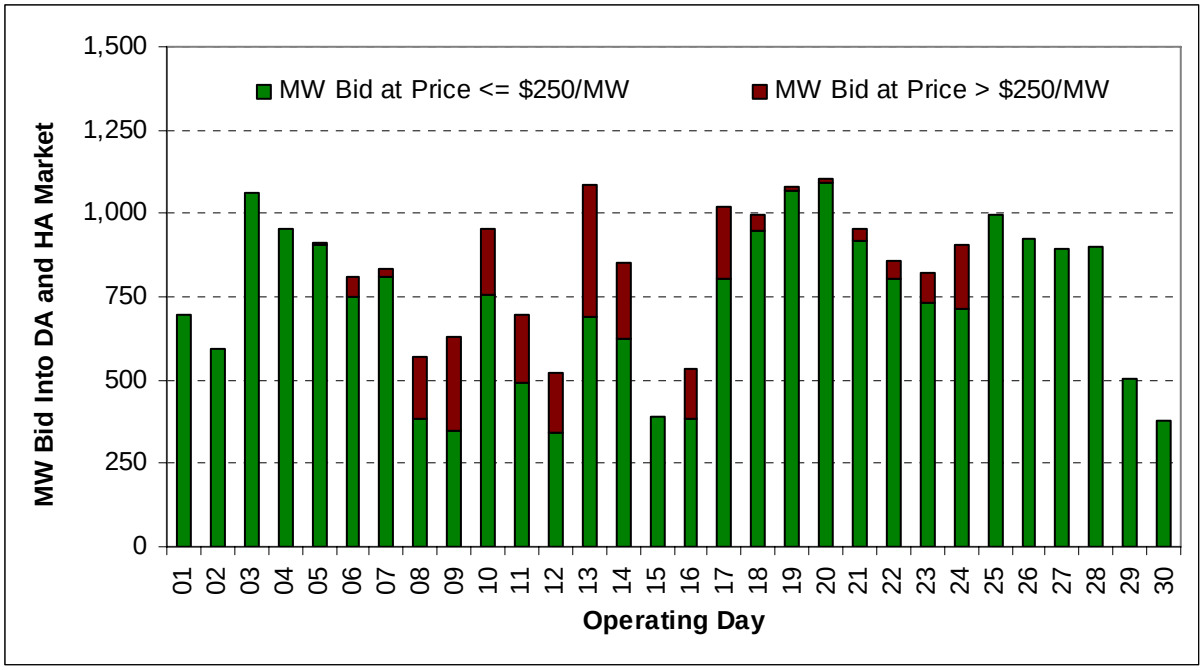
Daily load patterns also affect prices in these markets, as fewer resources are online and operating at a level at which they can provide regulating reserves during off-peak hours. Consequently, price spikes are more prevalent during the off-peak hours of the day. Figure 4.4 displays the price-spike profiles for each of the regulation markets in the month of April. Late evening and early morning hours compound the seasonal factors and results in a higher frequency of price spikes, as generation that had been on-line to meet the daily peak ramps down or shuts off.

Figure 4.4 Hourly Frequency of Regulating Reserve Prices Over $250/MW in April



As profit margins in Ancillary Service markets increase with price increases we expect to see some market response in terms of additional bids in the higher-priced services. The price spikes in the Regulation Reserve markets were fairly concentrated in the first half of April and, as seen in Figure 4.5 below, there was some measurable supply response to these spikes as suppliers bid in more capacity priced below $250/MW. Once additional, lower-priced supply bids began entering the market, the incidence of price spikes diminished and prices in the Regulating Reserve markets declined.

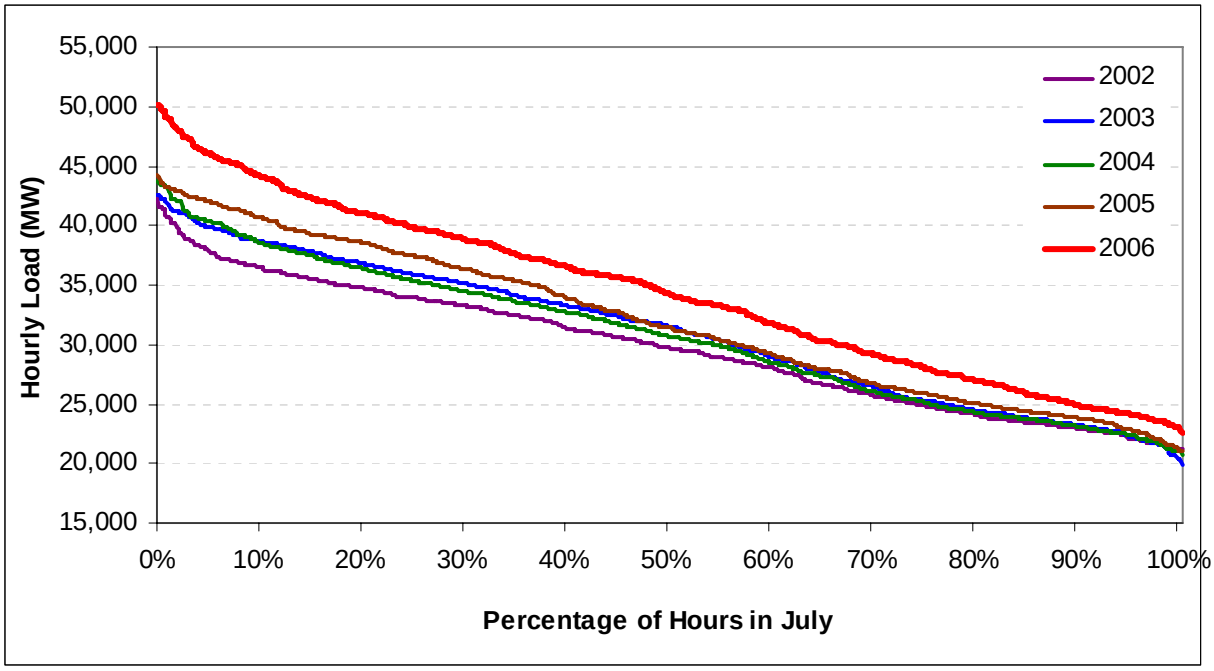
Figure 4.5 Supply Response to April Regulating Reserve Price Signals



4.3.3 Operating Reserve Prices over $250/MW

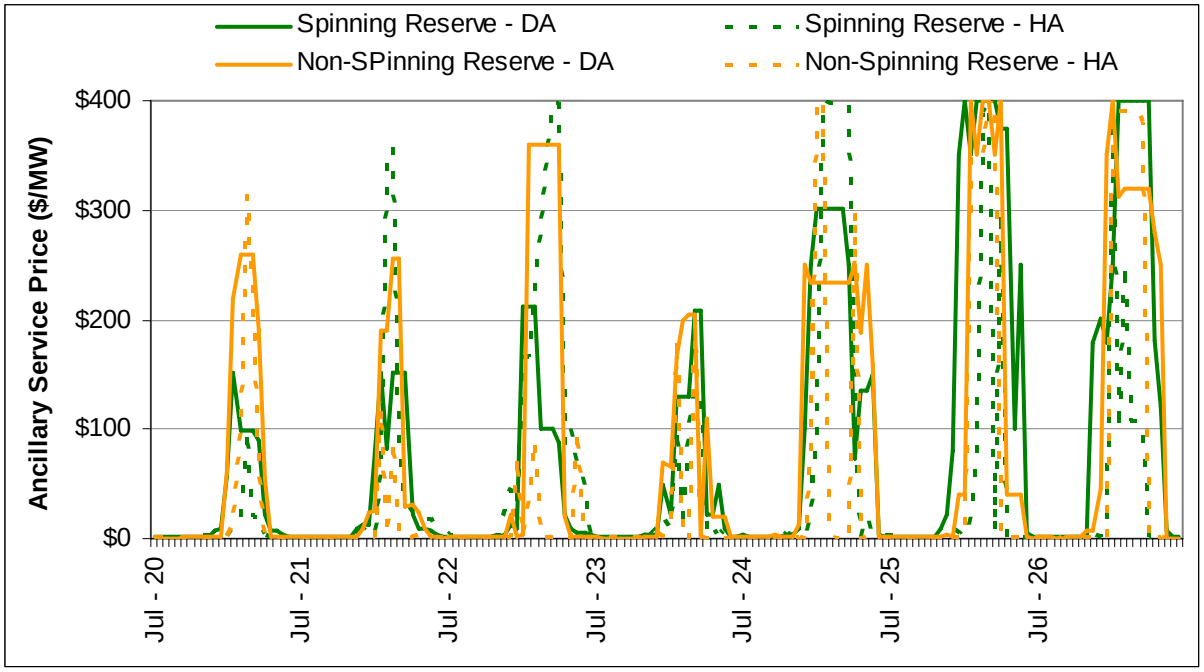
In July the west coast experienced a heat wave that resulted in peak load records being set on consecutive days. As seen in the load duration curves shown in Figure 4.6 below, loads in July of 2006, particularly peak loads, were considerably higher than in prior years.

Figure 4.6 Hourly Load Duration Curves for the Month of July (2002 – 2006)



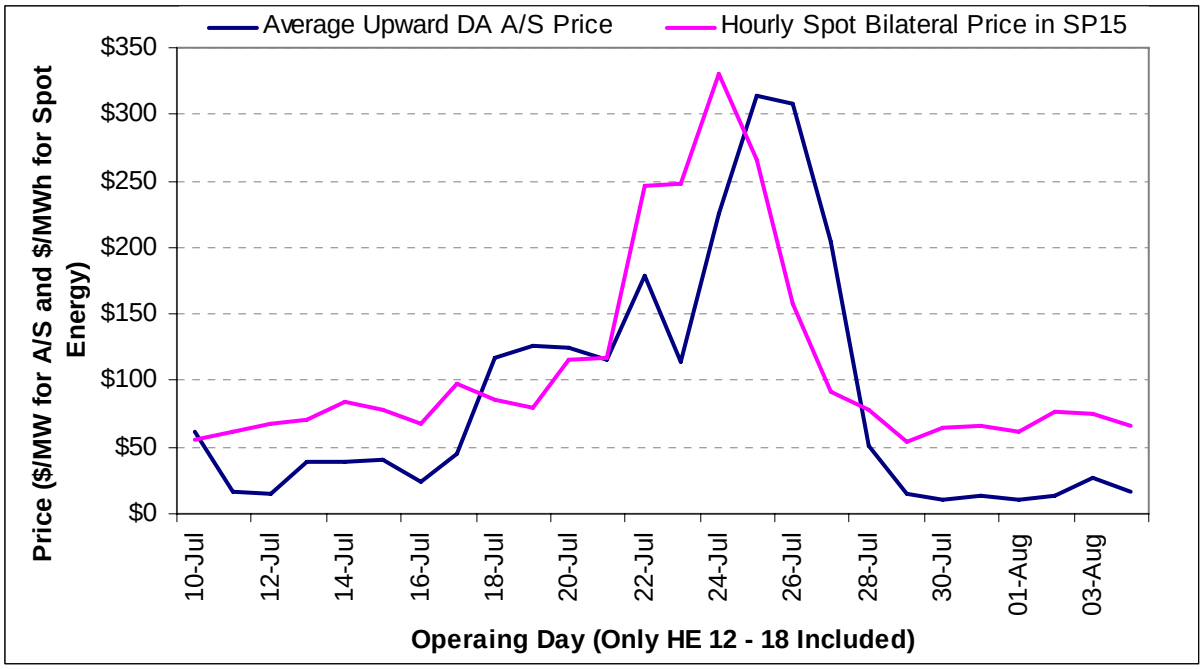
During the crest of the July heat wave (roughly from July 21 – 26) Grid Operators were faced with increasing frequency of bid insufficiency in the Operating Reserves (Spinning Reserve and Non-Spinning Reserve) and market prices for those services were significantly higher during the heat wave as seen in Figure 4.7 below. Unlike the price spikes in the Regulation markets that were seen primarily during the off-peak hours, prices in the Operating Reserve markets (both Day Ahead and Hour Ahead) were higher primarily when online capacity was most scarce, during hours ending 12 through 18.

Figure 4.7 Operating Reserve Prices During the July Heat Wave



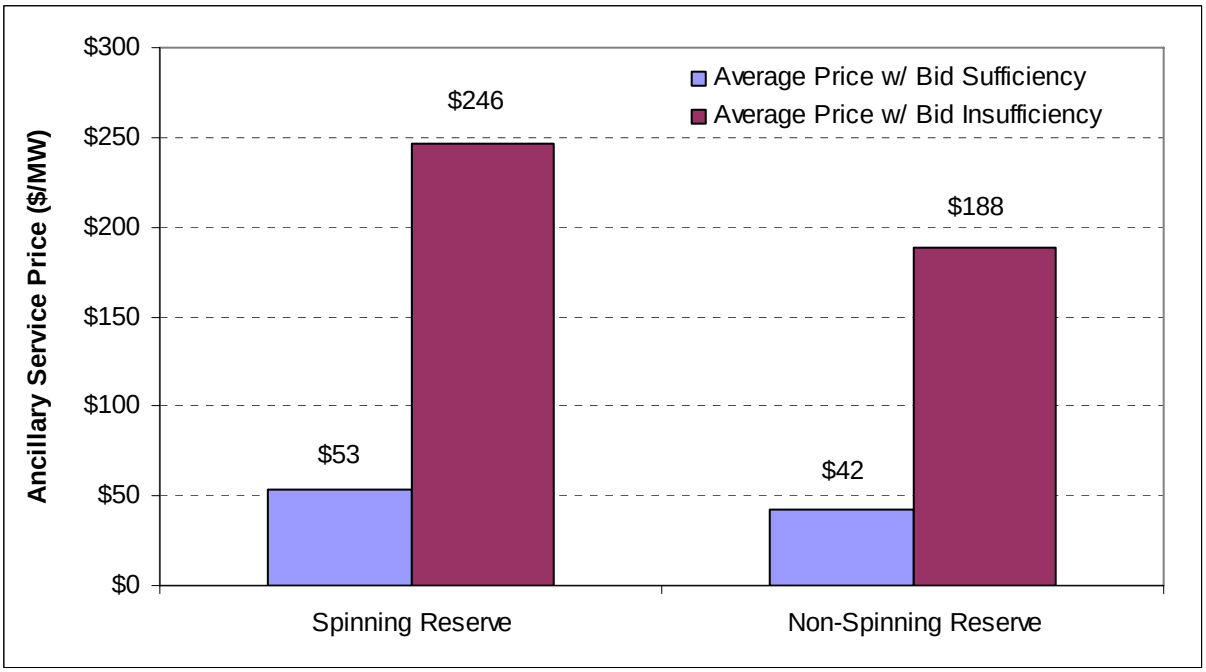
Though the CAISO Real Time Market prices were not well correlated with spot bilateral prices during extreme peak periods, Day Ahead Ancillary Service Market prices were. Thus the Day Ahead A/S prices reflected the opportunity cost of holding capacity in reserve as opposed to selling energy in the spot market, or the expectation of being held in reserve (not selling energy) when real-time prices are expected to be high. Figure 4.8 shows the correlation between upward Ancillary Service prices and day-ahead spot bilateral energy prices during the July heat wave.

Figure 4.8 Day Ahead Upward Ancillary Service Average Price and Hourly Spot Bilateral Price for July 20 - 26, 2006



Despite the higher prices for upward Ancillary Services, the CAISO did experience significant procurement shortages across the peak load days from July 21 – 26. (More detail on bid insufficiency is included later in this chapter beginning on Page 4.24.) During this time, both Spinning Reserve and Non-spinning Reserve experienced high levels of procurement shortages across the super-peak hours of HE 12 - 18. During periods of bid insufficiency, average prices for Operating Reserves were considerably higher, as seen in Figure 4.9.

Figure 4.9 Average Price of Operating Reserves with and without Bid Sufficiency (July 16 – 31 2006, Hours Ending 12 – 18)



4.4 Prices and Volumes of Ancillary Services

Overall, A/S prices increased 4 percent from a weighted average price of $10.72/MW in 2005 to $11.12/MW in 2006. The overall price increase tracked increases of roughly 50 percent for Non-Spinning Reserve, however, the level of average prices remained below $6/MW. Upward Regulation prices dropped 10 percent, while Spinning Reserve prices and Downward Regulation prices remained almost the same as last year.

Procurement volumes, in total, were essentially unchanged from 2005. The average volumes of all four types of procurements remained at the same level as last year. Table 4.1 compares prices and volumes from previous operating years.

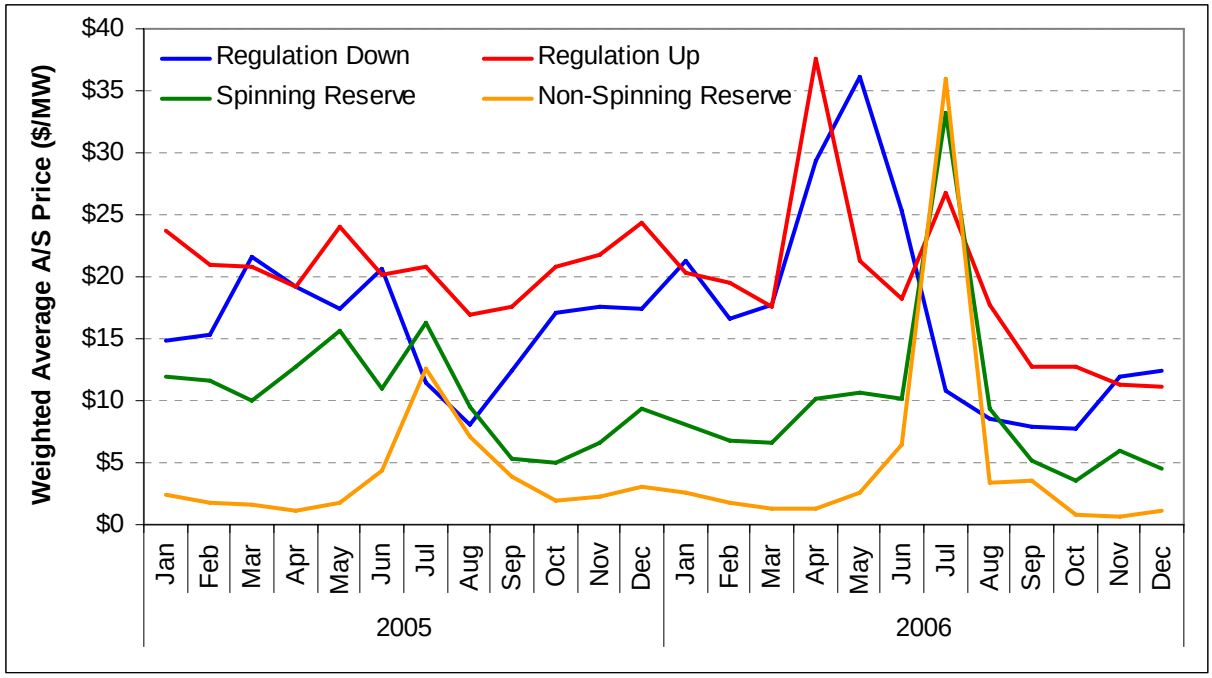
Table 4.1 Annual Hourly Average A/S Prices and Volumes

	Year	Regulation Down	Regulation Up	Spinning Reserve	Non-Spinning Reserve	Average A/S Price
Price ($/MW)	1999	$20.84	$20.22	$7.07	$4.35	$11.97
	2000	$50.15	$77.28	$44.07	$32.46	$41.03
	2001	$42.33	$66.72	$34.69	$30.03	$36.42
	2002	$13.76	$13.41	$4.66	$2.15	$7.08
	2003	$18.43	$18.08	$6.62	$4.20	$9.81
	2004	$10.95	$17.95	$7.25	$4.43	$8.63
	2005	$16.05	$20.94	$10.45	$3.98	$10.72
	2006	$17.01	$18.94	$10.11	$5.96	$11.12

	Year	Regulation Down	Regulation Up	Spinning Reserve	Non-Spinning Reserve	Total Volume
Volume (MW)	1999	769	903	942	735	3,349
	2000	594	633	818	861	2,907
	2001	614	492	1,148	862	3,117
	2002	469	460	775	763	2,466
	2003	416	381	767	722	2,286
	2004	408	395	817	782	2,403
	2005	363	386	841	839	2,428
	2006	354	389	831	831	2,405

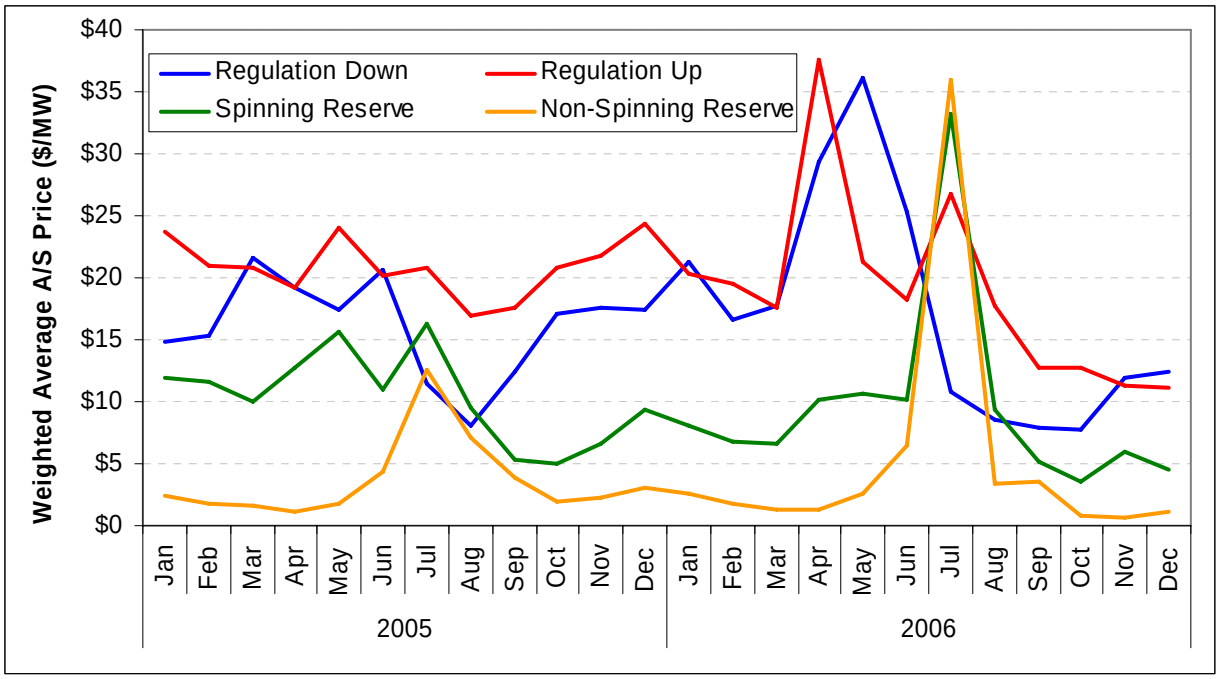
Figure 4.10 depicts the historical pattern of prices and volumes since 1999 and indicates that A/S prices and volumes have been relatively stable over the past five years (2002-2006) as compared to the period from 1999 to 2001.

Figure 4.10 Annual Hourly Average A/S Prices and Volumes



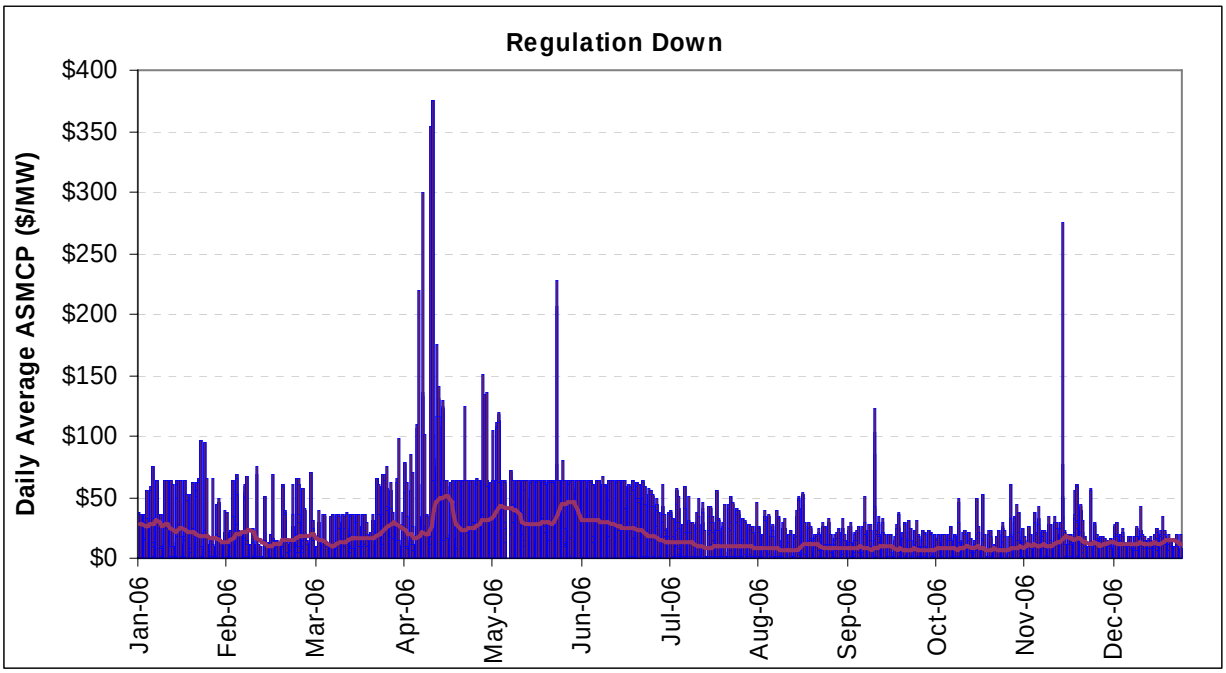
Hourly day-ahead reserve prices do tend to vary with system load levels and seasonal effects on generation as seen in Figure 4.11. As discussed in the previous section, high prices for Regulation Reserves occurred, though largely confined to the spring months. High price levels for Non-Spinning Reserves and Spinning Reserves rose dramatically and occurred primarily during the unprecedented loads seen during the July heat wave.

Figure 4.11 Monthly Weighted Average A/S Prices



Hourly day-ahead prices are shown in Figure 4.12 and Figure 4.13 along with seven-day moving averages showing the trend of prices, by service, across the year. The impact of spring hydro-electric runoff and summer peak load conditions can easily be seen in the pricing trends for Regulating and Operating Reserves in these figures.

Figure 4.12 Day Ahead Regulation Reserve Market Clearing Prices (A/S MCPs) with Seven Day Moving Averages



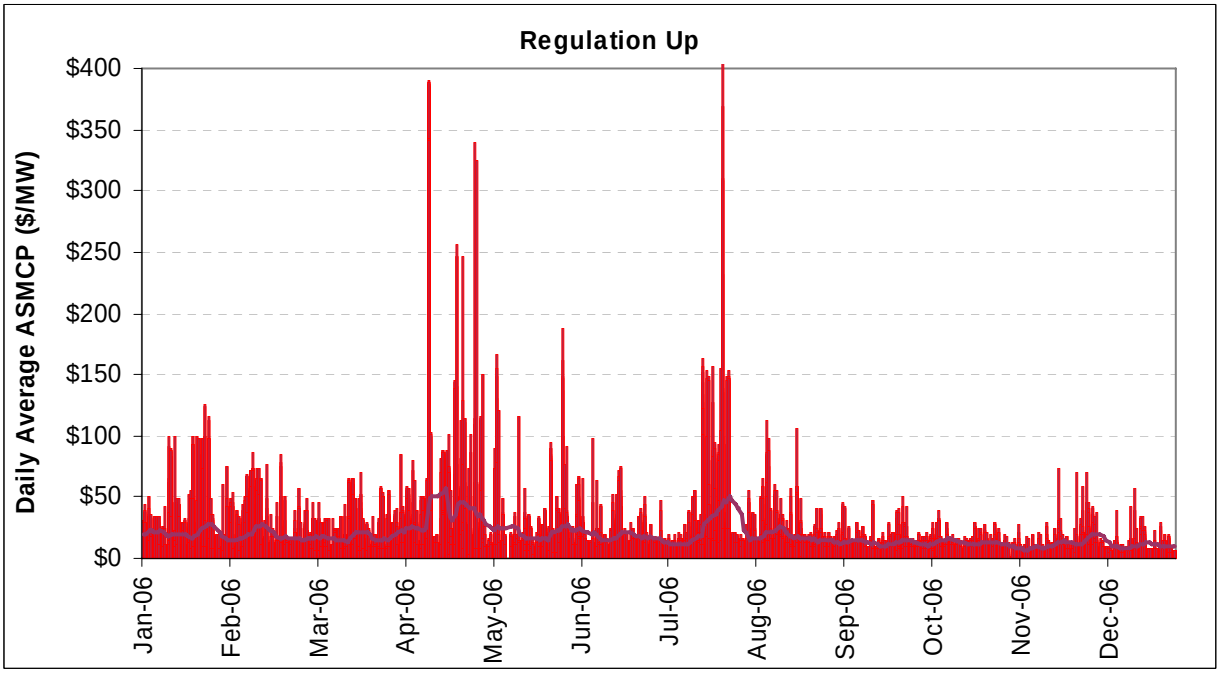
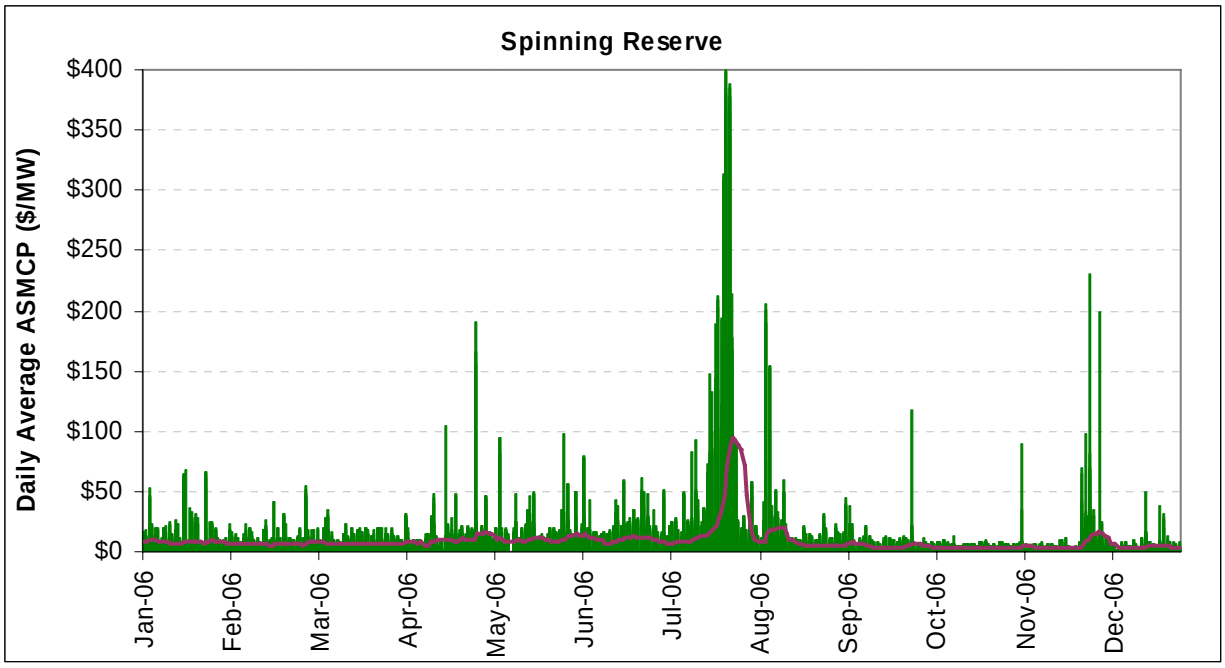
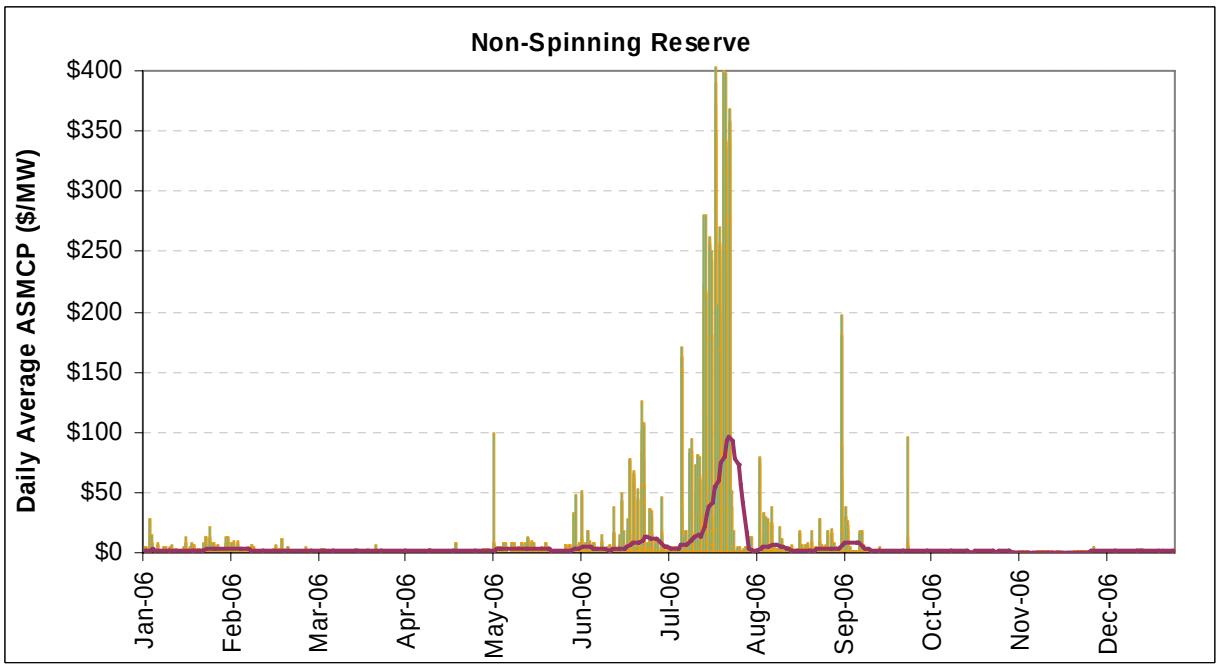


Figure 4.13 Day Ahead Operating Reserve Market Clearing Prices (A/S MCPs) with Seven Day Moving Averages





The A/S price duration curves for the Day Ahead Markets, Figure 4.14 and Figure 4.15, reflect generally expected price behavior with the most valuable products exhibiting the highest sustained prices. Overall, Operating Reserve prices were at price levels above $25 in fewer than 5 percent of the operating hours. At the same time Regulation Reserve prices over $25 were exhibited in fewer than 20 percent of operating hours.

Figure 4.14 Price Duration Curves for 2006 Regulation Reserve Markets

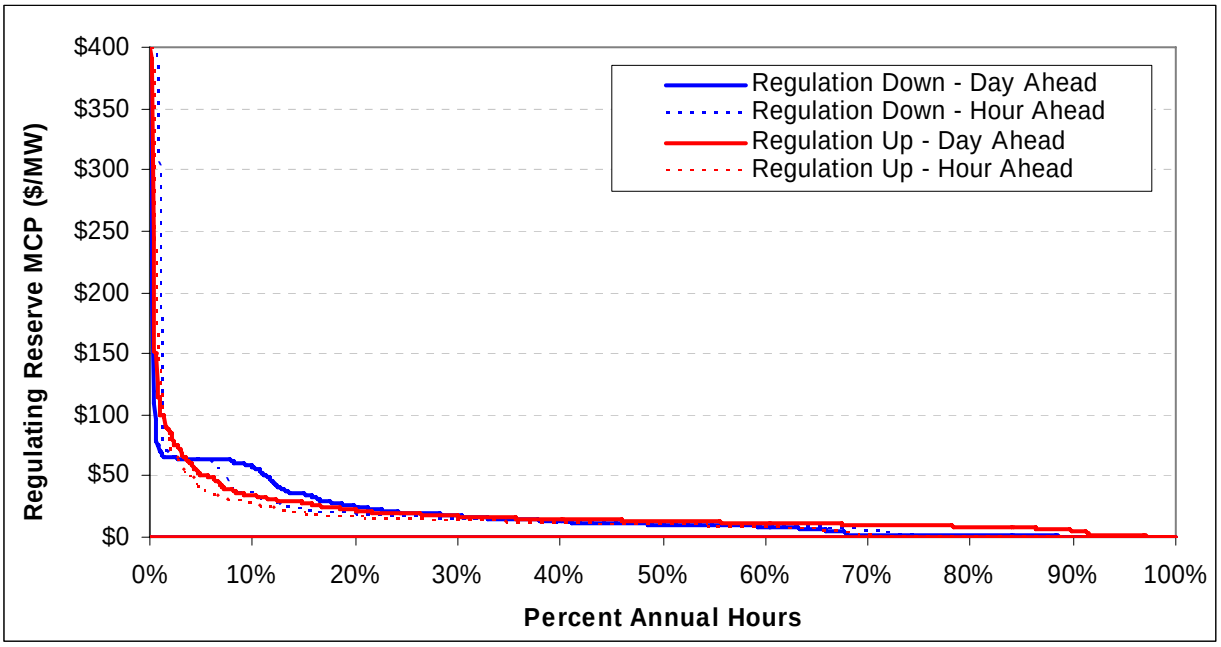
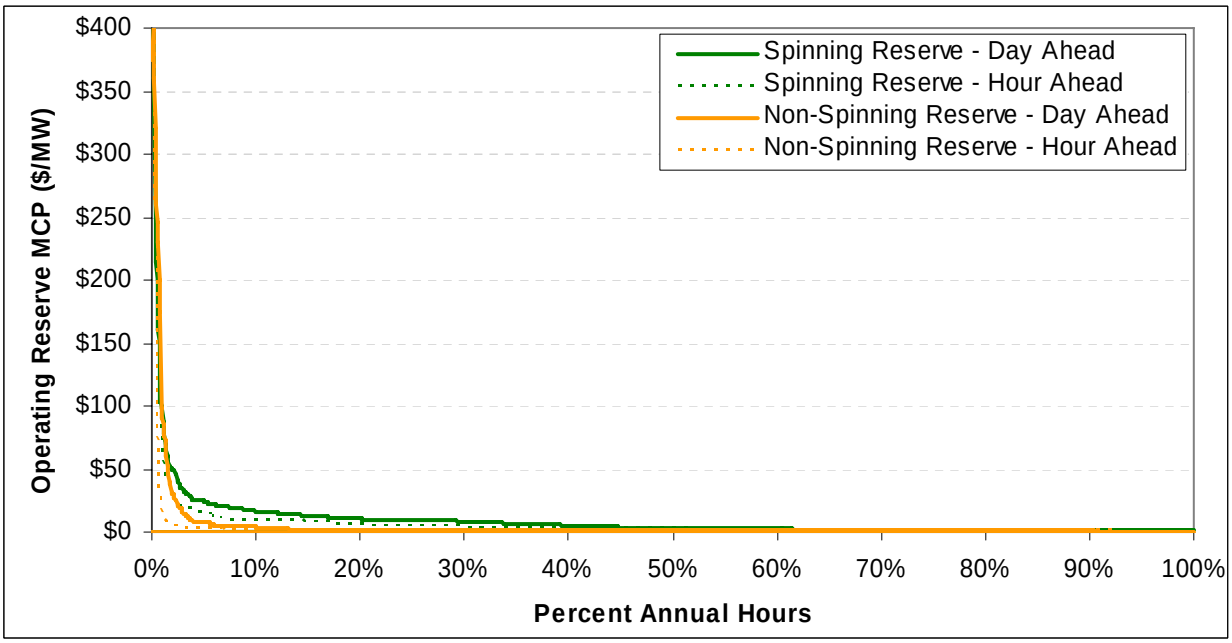


Figure 4.15 Price Duration Curves for 2006 Operating Reserve Markets

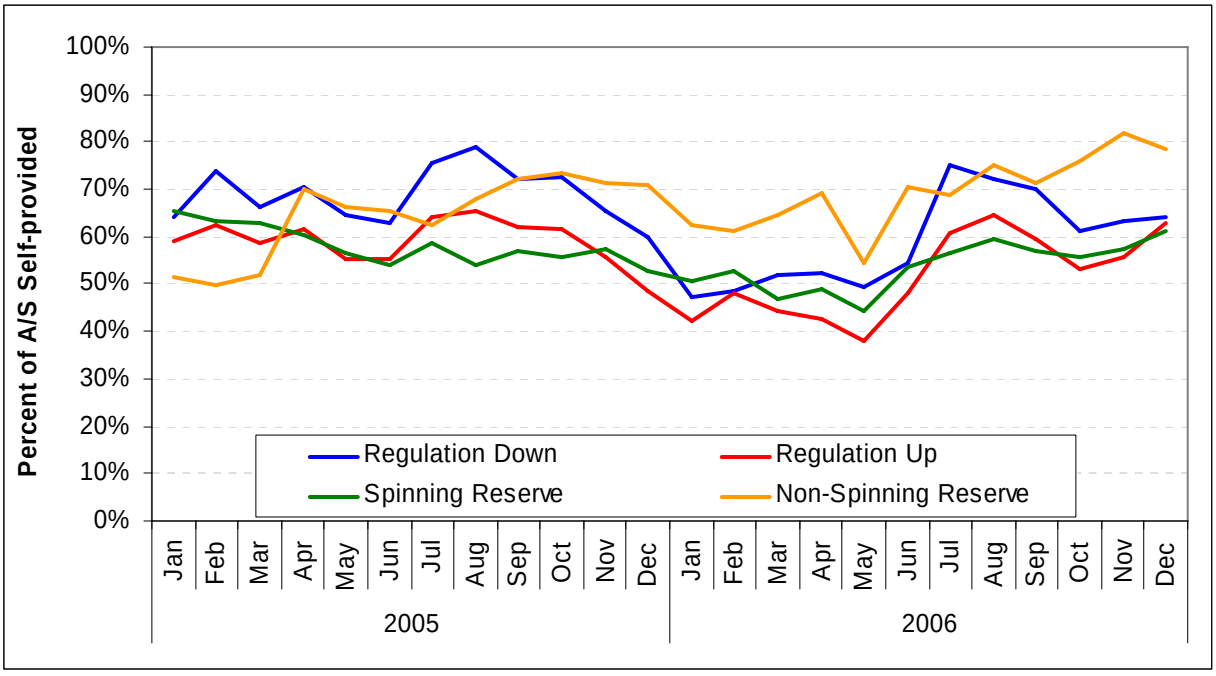


4.5 Ancillary Services Supply

4.5.1 Self-Provision of Ancillary Services

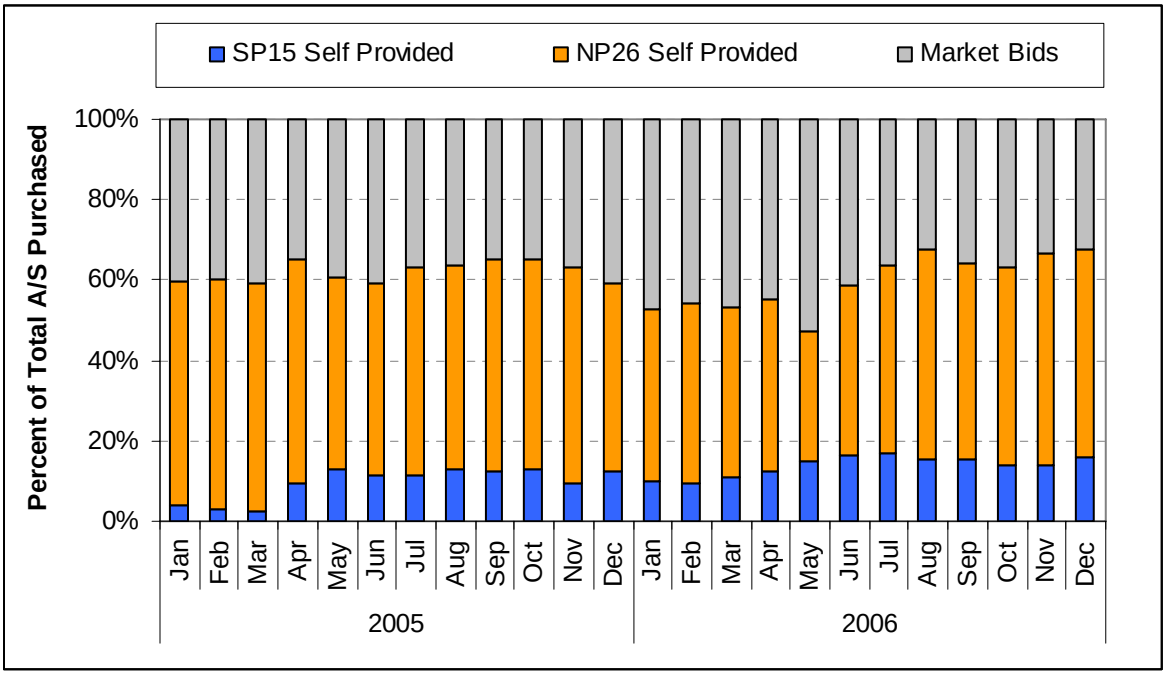
Self-provided ancillary services remained a significant share of the total supply in 2006, ranging between 40 and 70 percent for most services in most months. With the exception of Non-Spinning Reserve, however, self-provision on all other services was down in the first half of 2006 compared to 2005, particularly for upward regulation (Figure 4.16). This decline is likely attributable to the abundance of hydro-electric generation which, as discussed in previous sections, reduced the available capacity for ancillary services. A high level of generation maintenance outages that occurred in the spring of 2006 may have also contributed to this trend. Hourly average self-provided Regulation Reserves, as a percent of purchases, increased during the summer months after the price spikes during the spring months.

Figure 4.16 Hourly Average Self-Provision of A/S



It is also interesting to view self provision by zone; accordingly, Figure 4.17 shows the breakout of total A/S procured by source (market bid, self-provided in NP26, and self-provided in SP15). During 2005 and 2006, the CAISO purchased A/S on a system-wide basis and did not practice zonal procurement during this period. Consistent with this practice, the percentages shown in this figure are with respect to total system-wide A/S procurement. Note that hourly average self-provision by resources (generation units or imports) in NP26 ranged from 32 percent to 53 percent during 2006 while the corresponding figure in SP15 was much lower, between 10 percent and 20 percent throughout 2006. Typically, due to relative loads in the north and south, the calculated A/S requirement in SP15 is higher that than of NP26. Although not shown in this chapter, on average, roughly 70 percent of A/S is procured in NP26 with the remainder in SP15. Combined procurement from resources in SP15 (procurement from market bids and self-provided A/S) is significantly lower than the calculated zonal A/S requirement. This disparity between north and south is facilitated by transmission capability on Path 15 and Path 26, along which energy from A/S can be transferred from north to south to provide reliability support in the event of a contingency.

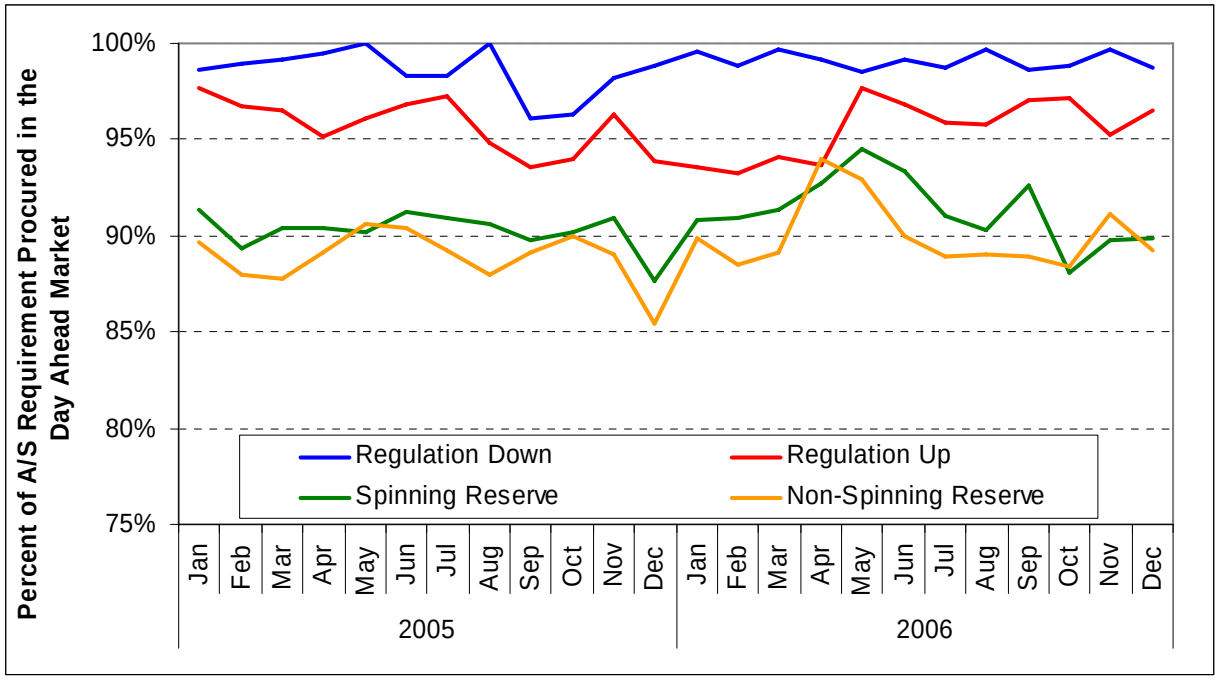
Figure 4.17 Hourly Average Self-Provision of A/S as a Percent of Total Procurement, by Zone for All Services Combined



4.5.2 Day-ahead vs. Hour-ahead Procurement

With the exception of Non-Spinning Reserve, the percent of A/S requirement procured in the Day Ahead Market remained relatively stable around or above 90 percent. The proportion of Non-Spinning Reserve procured in the Day Ahead was between 85 percent and 90 percent for most of the year (Figure 4.18).

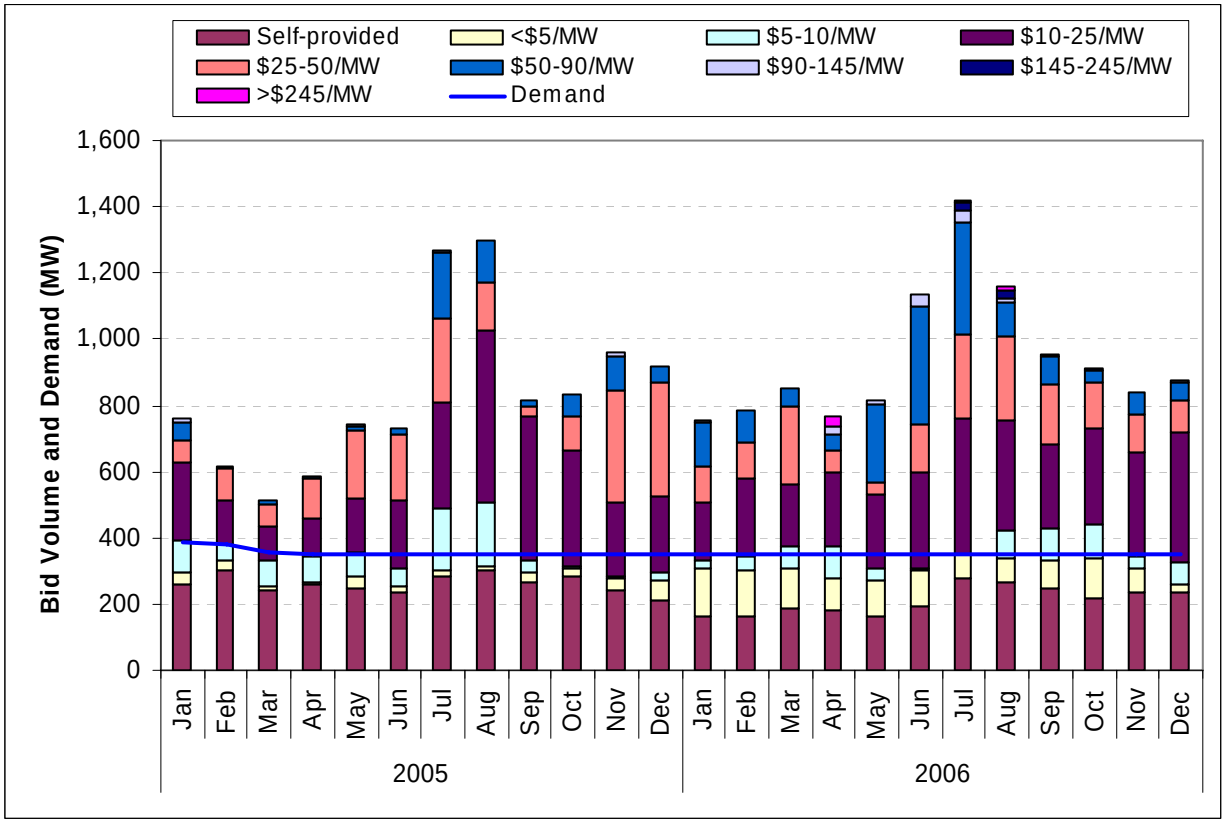
Figure 4.18 Hourly Average Day-Ahead Procurement, 2005 - 2006



4.5.3 Downward Regulation Reserve

Figure 4.19 displays the Downward Regulation bid composition by month for the past two years. The total hourly average supply of Downward Regulation bids was higher for most months in 2006 relative to 2005. There was also a higher share of bid volumes for Downward Regulation at the lowest price range of "less than $5/MW" throughout most of the year compared to 2005. Figure 4.19 also shows a significant increase in the quantity of bids at $50/MW or greater during the May to August timeframe in 2006.

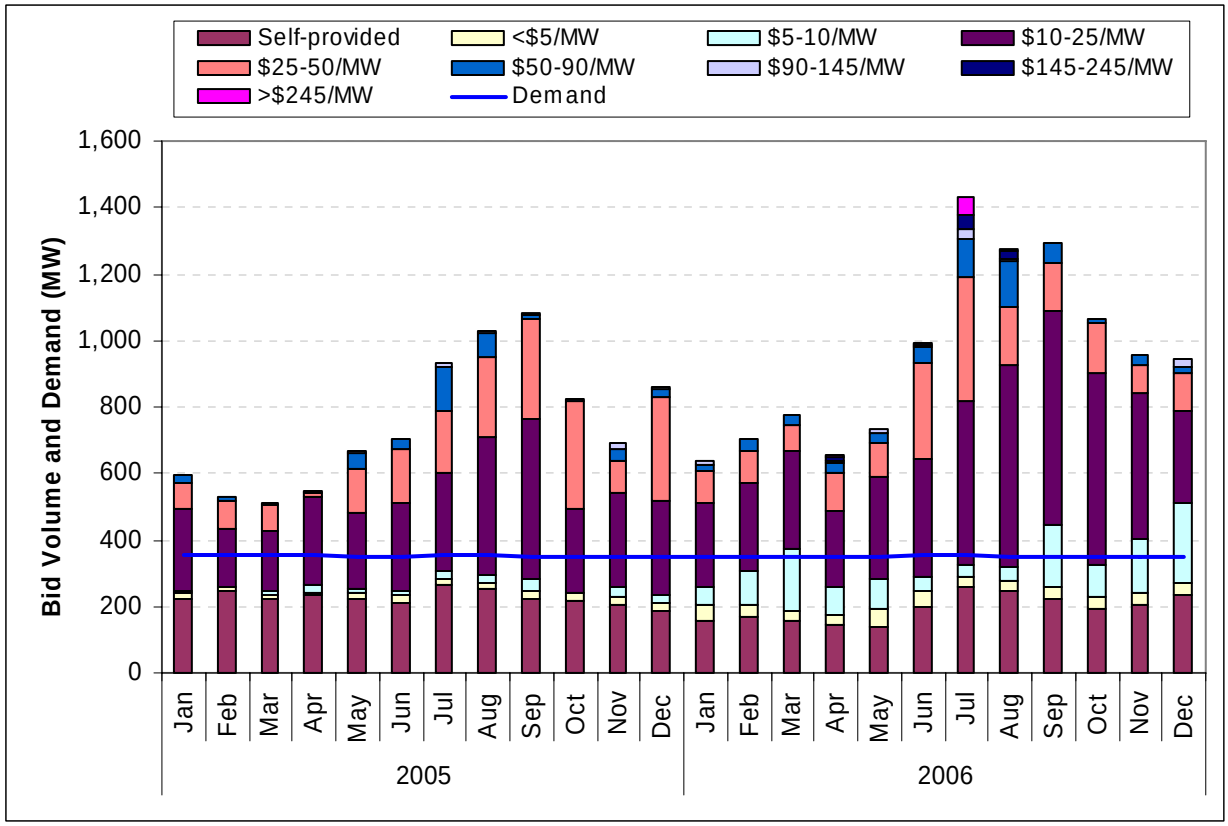
Figure 4.19 Day-Ahead Downward Regulation Reserve Bid Composition: 2005 – 2006 (Hourly Averages)



4.5.4 Upward Regulation Reserve

The Upward Regulation bid composition by month for the past two years appears in Figure 4.20. Similar to Regulation Down, the average hourly supply of Upward Regulation bids was higher in most months in 2006 relative to 2005, particularly during the summer months of July through August. Also evident in Figure 4.20 is an increase volume of bids in the "less than $5/MW" and "$5-$10/MW" bid categories, which helped to offset the decline in self-provision quantities and moderate Upward Regulation prices in most months. On the other hand, a relatively small percent of self-procurement occurred during the April 2006 and this, along with the high hydroelectric conditions, contributed to increased price spikes in April. Additionally, high price bids reflecting scarce capacity and higher expected opportunity cost in July 2006 contributed to the spikes during that month.

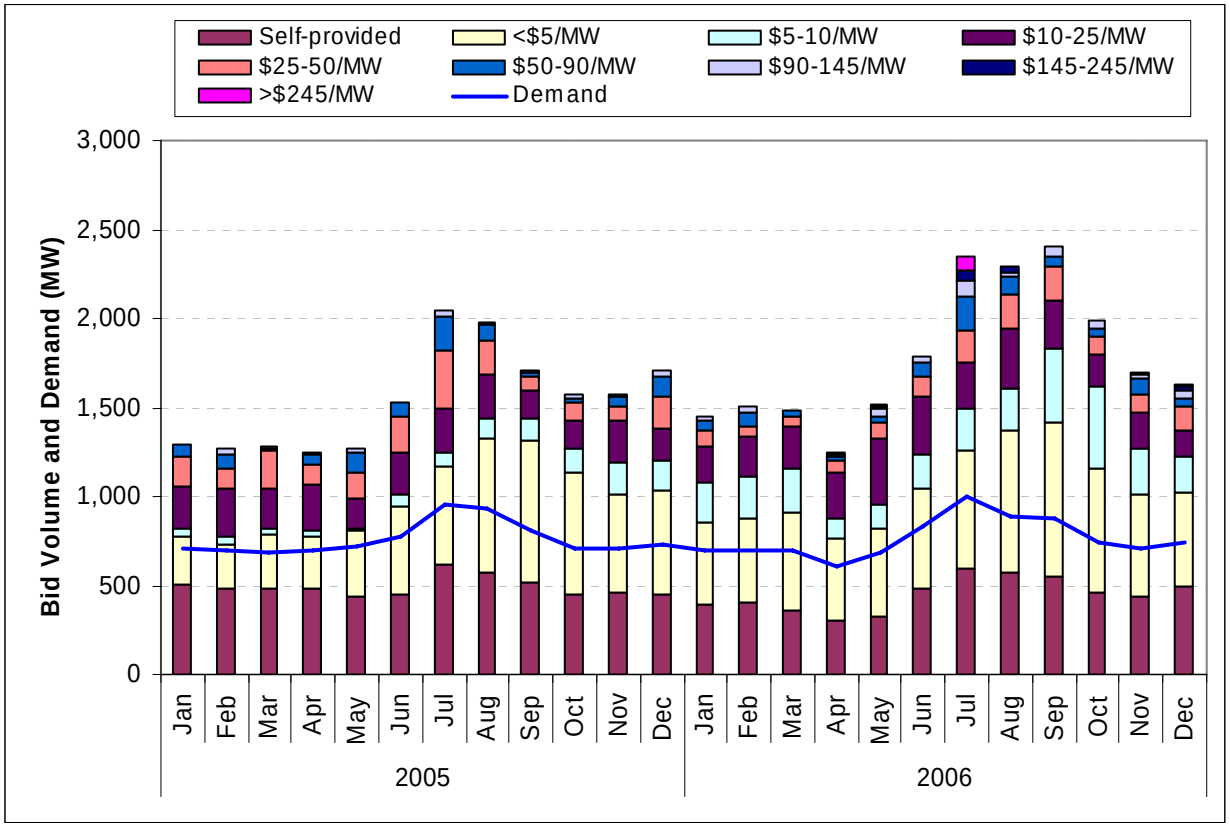
Figure 4.20 Day-Ahead Upward Regulation Reserve Bid Composition: 2005 – 2006 (Hourly Averages)



4.5.5 Spinning Reserve

As was the case for the Regulation Reserve Markets, average bid quantities for Spinning Reserve were also higher for most months in 2006 as compared to 2005 (Figure 4.21). A relatively large supply of Spinning Reserve bids priced below $5/MW kept the Spinning Reserve prices low during the off-peak season in 2006. Figure 4.21 also shows a significant quantity of Spinning Reserve bids greater than $245 in July 2006, which accounted for the price spikes observed in that market during the heat wave.

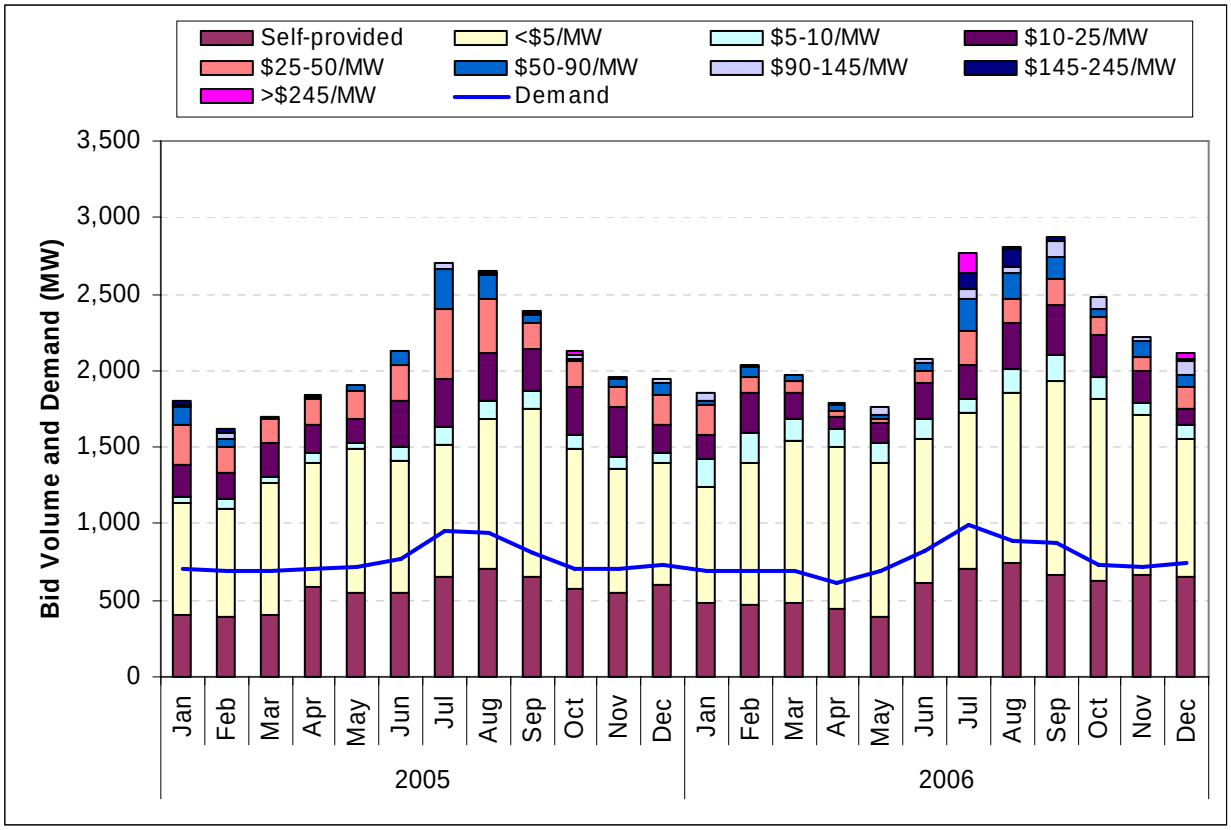
Figure 4.21 Day-Ahead Spinning Reserve Bid Composition: 2005 – 2006 (Hourly Averages)



4.5.6 Non-Spinning Reserve

Following the same trend as the other reserve markets, the hourly average supply of Non-Spinning Reserve bids was higher in most months of 2006 as compared to 2005. Substantial bid volumes at the sub-$5/MW level drove the overall decline in the average price for Non-Spinning Reserves. Extreme bid prices in the "greater than $245/MW" range in July 2006 accounted for the majority of the spikes that occurred during the heat wave. Figure 4.22 depicts the Non-Spinning Reserve bid composition by month for the past two years.

Figure 4.22 Day-Ahead Non-Spinning Reserve Bid Composition: 2005 – 2006 (Hourly Averages)



4.5.7 Bid Sufficiency

Bid insufficiency occurs when there is not enough available capacity bid into the markets to meet the procurement requirements. In addition to potentially creating reliability issues, bid insufficiency in the A/S markets can result in market power concerns as essentially any supplier to the A/S market in bid deficient hours is pivotal. Additionally, market power concerns can arise if bid sufficiency exists but only marginally so. In these cases, certain suppliers may also be pivotal in the sense that the A/S requirements could not be met absent their supply. The CAISO employs several measures of bid sufficiency. Volumes of capacity shortages convey information about the magnitude of the deficiency events and the count of operating hours where bid-in capacity falls short of requirements represent commonly used metrics that provide insight into

the frequency and severity of shortage events. Table 4.2 provides these two metrics for the past two operating years.

Table 4.2 Bid Insufficiency (2005 – 2006)

	Number of Hours With Shortage				
	Regulation Up	Regulation Down	Spinning Reserve	Non-Spinning Reserve	All Services
2005	163	135	279	107	684
2006	159	110	145	113	527
Percent Δ	-2%	-19%	-48%	6%	-23%

	Average Percent of Requirement Short				
	Regulation Up	Regulation Down	Spinning Reserve	Non-Spinning Reserve	All Services
2005	9%	14%	5%	6%	7%
2006	21%	16%	8%	15%	13%

A/S markets experienced a significant decline in hours of bid insufficiency in 2006 compared to 2005, with the exception in the Non-Spinning Reserve market for which the number of hours experiencing bid insufficiency increased by 6 percent. Nonetheless, the average percent of requirement shortage during bid deficiency hours actually increased significantly in 2006 for all four types of reserves. Figure 4.23 through Figure 4.26 show the frequency of hourly bid deficiencies and the average amount of deficiency (expressed as a percentage of the total requirement) by month and by service, for the past two years. The majority of the bid insufficiency of Regulation Reserves occurred during the spring months of 2006. During these periods of heavy hydro flows, hydroelectric generation tended to displace higher cost non-hydroelectric resources (e.g., thermal resources) resulting in less non-hydroelectric resources being on-line and available to offer regulation services. This factor coupled with the fact that many hydro resources choose not to provide regulation services due to water management constraints and other operational considerations, resulted in greater hours of bid insufficiency for Regulation Reserves. Most Spinning and Non-Spinning bid insufficiencies occurred during the peak summer months when demand for energy and reserves was at record levels. Mild fall and winter conditions contributed to the overall drop of the total insufficient hours.

Figure 4.23 Frequency of Bid Insufficiency in the Hour Ahead Market and Average Capacity Short – Regulation Down

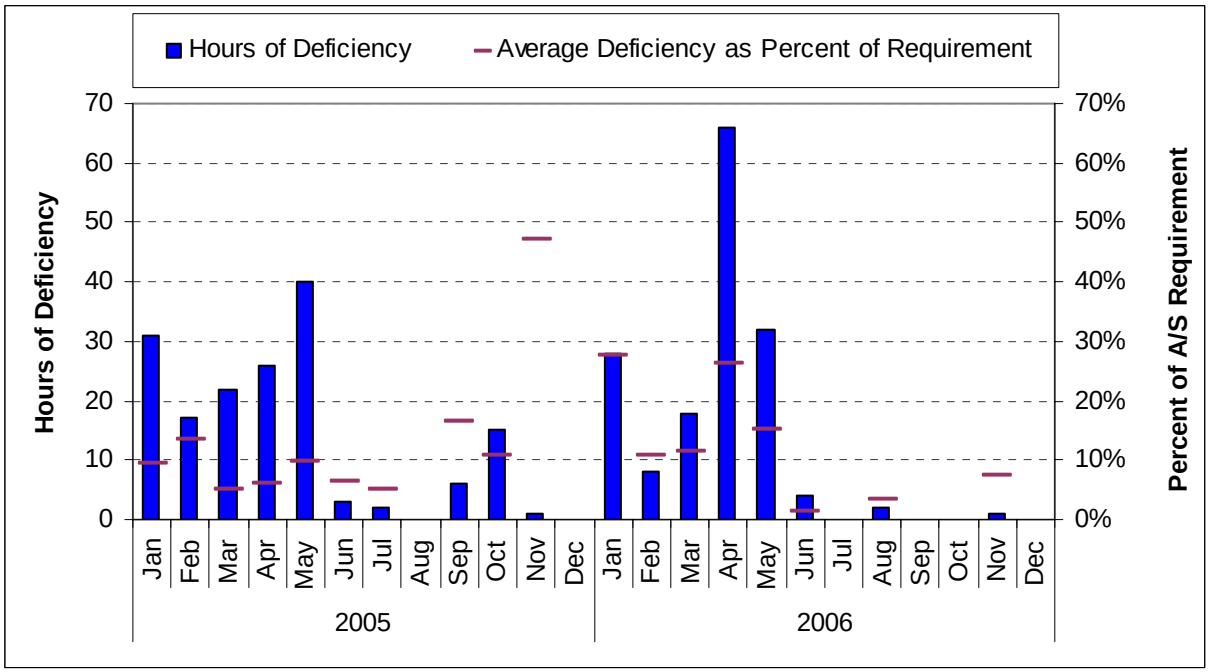


Figure 4.24 Frequency of Bid Insufficiency in the Hour Ahead Market and Average Capacity Short – Regulation Up

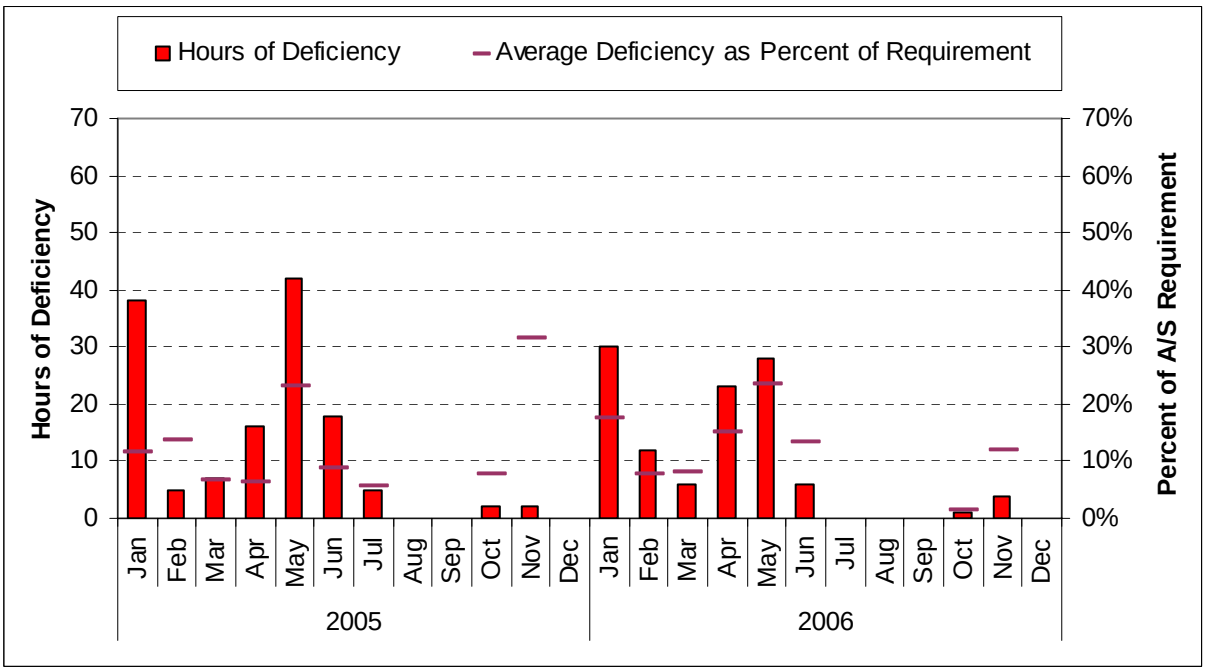


Figure 4.25 Frequency of Bid Insufficiency in the Hour Ahead Market and Average Capacity Short – Spinning Reserve

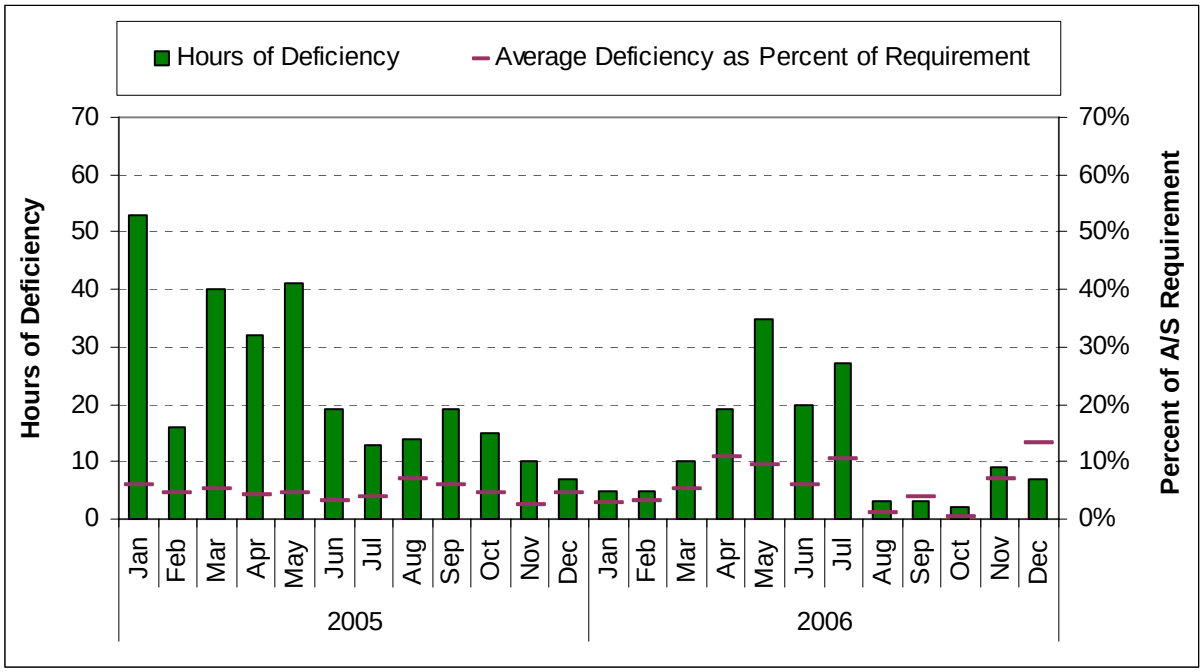
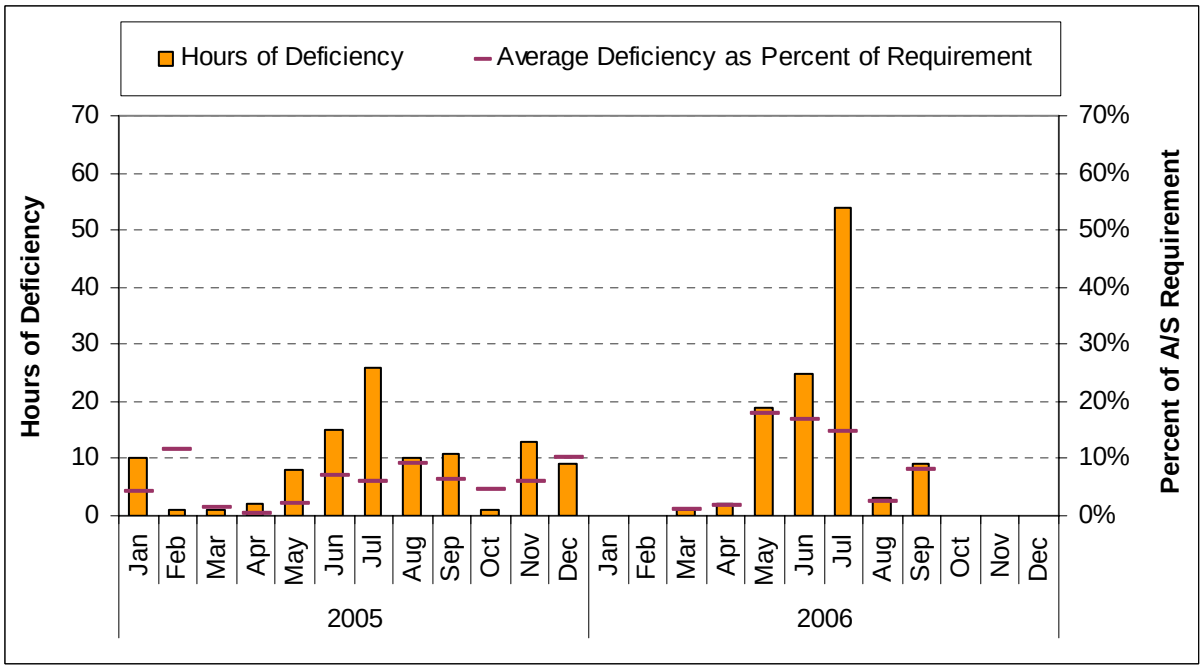


Figure 4.26 Frequency of Bid Insufficiency in the Hour Ahead Market and Average Capacity Short – Non-Spinning Reserve



4.6 Costs

The total cost of A/S capacity per unit of MWh load remained nearly unchanged from 2005, despite the price spikes seen above $250/MW seen in April and July. The average cost to load in 2006 averaged $0.95/MWh compared to a $0.96/MWh average the year prior. Figure 4.27 provides the monthly details on these costs.

Figure 4.27 Monthly Cost of A/S per MWh of Load