

4. Ancillary Service Markets

4.1 Summary of Performance in 2005

Overall, average Ancillary Service (A/S) prices increased by 23 percent in 2005 compared to prevailing prices in 2004. This price increase resulted in an increase to the total cost of A/S procurement of 24 percent. The increase in the aggregate A/S price resulted primarily from price increases in both the Regulation Reserve and Spinning Reserve markets, despite a drop in average price in the Non-Spinning Reserve market.

Two changes to the market structure that occurred in the latter half of 2004 that encouraged bidding from units committed under the Must-Offer Obligation (MOO) process and provided for zonal procurement of services, do not appear to have provided sustained benefits in terms of increased offers from units denied MOO waivers. While the CAISO does observe some bidding into the A/S markets by units in receipt of a MOO Waiver Denial, such volumes have not proved as large as initially anticipated.

Despite limited offers from MOO Waiver Denial units, the A/S markets experienced a significant decline in both the volume and hours of bid insufficiency in 2005 compared to 2004. The majority of the decline in bid insufficiency in 2005 can be attributed to the fact that there was no zonal procurement in 2005. The zonal procurement of A/S in 2004, which occurred in the August-December 2004 timeframe, resulted in increased bid insufficiency in SP15, especially in the Regulation markets.

4.2 Ancillary Service Markets 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 Rational Buyer algorithm facilitates this procurement approach. The definitions for the actively procured A/S follow:

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 Changes in Ancillary Service Market Structures

The latter half of 2004 held two significant changes in A/S market structure that persisted through 2005. The first of these was a change in the eligibility rules for MOO units that had been denied a waiver and required to run. The second was a change to improve A/S procurement by procuring A/S by zone (as opposed to system-wide) during hours where transmission capacity on certain internal interfaces was projected to be insufficient, during contingencies, to deliver energy from A/S procured in the north to load in the south.

4.3.1 *Ancillary Services from Units Constrained-On via the Must-Offer Obligation*

Generating units that were constrained-on by the MOO waiver denial process (Constrained-On units), prior to Amendment 60, rendered themselves ineligible for Minimum Load Cost Compensation (MLCC) if they sold A/S to the CAISO. The CAISO sought to increase offers from these units by allowing them to keep the MLCC payment even if they sold A/S. Improvements to the transmission system in 2005 ultimately led to a significant decrease in volumes of Constrained-On capacity and a corresponding decrease in the capacity offered into the A/S markets from these units. Specifically, the market rule change allowing Constrained-On units to not forfeit their MLCC payments if they were awarded ancillary services only increased the capacity bid to Day Ahead and Hour Ahead Spinning and Non-Spinning Reserve markets by about 2 percent in 2005, compared to 12 percent in 2004. Figure 4.1 displays the average gross capacity bids from these resources for 2005.

Figure 4.1 Hourly Average Gross Capacity Bid into Day Ahead and Hour Ahead Markets by Constrained-On Units

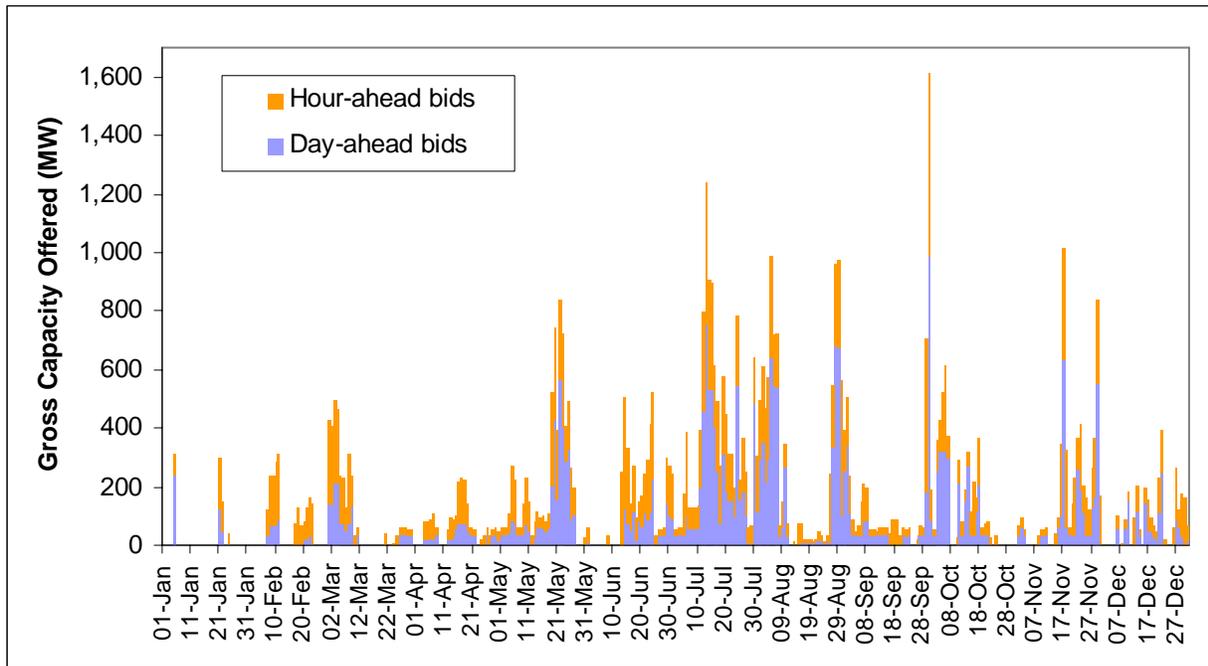
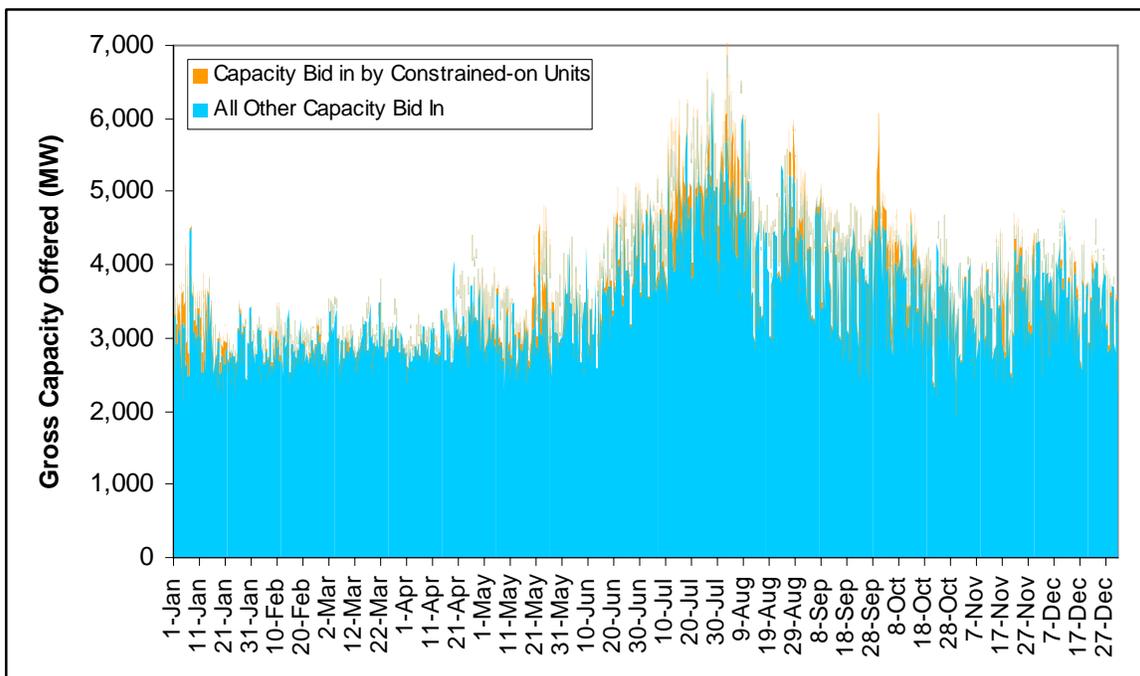


Figure 4.2 depicts the gross capacity bid from Constrained-On resources in relation to the remainder of the gross capacity bid into the day-ahead markets for 2005.

Figure 4.2 Incremental Ancillary Services Capacity Provided by Constrained-On Units in the Day Ahead Market



4.3.2 Assessment of Zonal Procurement

One major change in the ancillary services Markets in 2005 was the absence of any zonal procurement of A/S. During the period of August-December in 2004, the CAISO frequently procured A/S on a zonal basis and this practice resulted in a greater frequency of A/S bid insufficiency and higher prices in SP15. The absence of zonal procurement in 2005 resulted in much less bid insufficiency. This subsection briefly examines the effects of zonal procurement in 2004.

Traditionally, the CAISO procured A/S across the entire control area based on least cost. This approach was adequate when the availability of the services themselves was evenly distributed, and when there was sufficient reserve transfer capability between zones. In 2004, the CAISO began to notice that it procured most of its A/S from NP15 and less from SP15, the inverse of the load ratio between the two zones. There were a number of factors that contributed to this change:

- Increased energy imports from the southwest resulted in generators in SP15 staying off-line.
- In 2004, about 2,000 MW of additional RMR capacity was under Condition 2 of the contract, which limits participation in the A/S markets to only those hours that the unit is dispatched for RMR energy. This 2,000 MW of capacity represents about 300 MW of potential 10-minute reserve capacity that was often not bid into the A/S markets.
- More A/S capable units came online in NP15. This new A/S capability displaced the less efficient units in SP15, which had proportionally fewer A/S capable new units come online.
- Through the first half of 2004, market rules established that units Constrained-On under the Must-Offer Obligation were not able to bid into the A/S markets without jeopardizing their MLCC payments. This became a problem particularly in SP15. This was the zone with the most intra-zonal constraints (e.g., South-of-Lugo, Sylmar, SCIT). Generating units in the south were Constrained-On and prevented from bidding into the A/S markets, thereby thinning the A/S bid stack in that zone.

By the first quarter of 2004, the CAISO was procuring approximately 85 percent of A/S in NP15. The CAISO questioned the deliverability of these reserves and determined that such a least-cost procurement pattern was not giving enough emphasis to deliverability. Consequently, the CAISO embarked on a series of initiatives aimed at making the procured ancillary services inherently more deliverable by changing the procurement pattern, as well as trying to increase the volume of the bid stack, especially in the south. A more voluminous bid stack would, most likely, lower the overall cost of A/S, as well as ameliorate any market power concerns.

The CAISO had always retained the authority to split zones, but had ceased doing so in 2001. The CAISO began a dialogue with stakeholders in the spring of 2004 with the aim of explaining the issues to participants and seeking approval for its proposed zonal procurement solution. This solution allowed operators to forecast the flows on Path 26 to determine whether or not zonal procurement was necessary. The CAISO held stakeholder meetings, produced a white paper on zonal competitiveness, and solicited comments. The process resulted in a decision to go ahead with zonal procurement during times of insufficient transfer capability between Northern and Southern California and to dovetail the issue with the MLCC initiative mentioned

below. On August 3, 2004 the CAISO reactivated the practice of splitting the procurement of ancillary services when necessary and procured reserves on a zonal basis during the period August-December 2004. Specifically, zonal procurement occurred on 45 days and in 422 hours between August 03, 2004 and December 02, 2004. The CAISO has not procured reserves on a zonal basis since that time.

The operating decision for splitting the A/S markets lay solely with the operating shift manager. This option for operating the A/S markets has always existed and continues as a critical option today with respect to reliability.¹

Of the 45 days for which zonal procurement occurred, all but 7 days were weekdays and only 2 days were Sundays, i.e., entirely off-peak. On average, a split procurement day contained 9 split hours, which typically occurred between hours ending 11 and 20. Implementation of zonal procurement was split about evenly between the periods before and after Real-Time Market Application (RTMA) deployment. The pre-RTMA period had 24 A/S split days, while the post-RTMA period had 21.

A strong relationship exists between bid-insufficiency and zonal procurement of A/S. The number of shortage hours in a month corresponds well with the number of hours in a month having zonal procurement (Table 4.1).

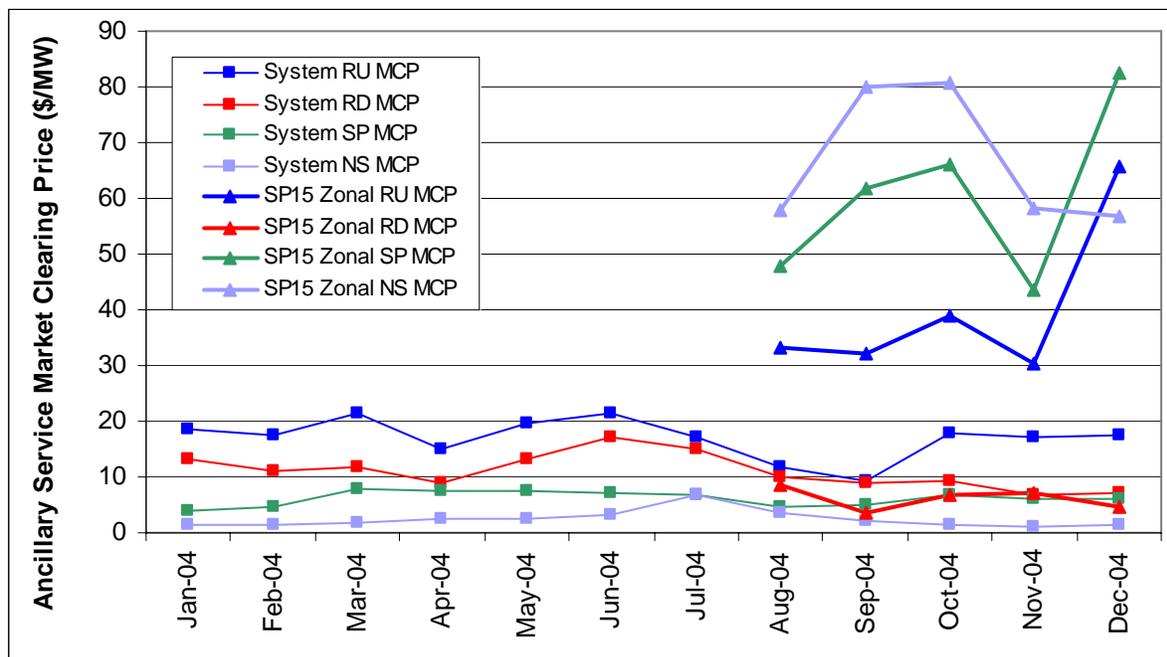
¹ The specific operating procedures used in determining the need for zonal A/S procurement are in Operating Procedure M-402, which can be found at <http://www.caiso.com/docs/1998/12/02/1998120218202714536.pdf>.

Table 4.1 Comparison of Split and Shortage Hours During the 2004 Zonal Procurement Period

Month	Number of Split Hours	Number of Hours Short
August	183	426
September	29	86
October	135	382
November	60	161
December	15	50

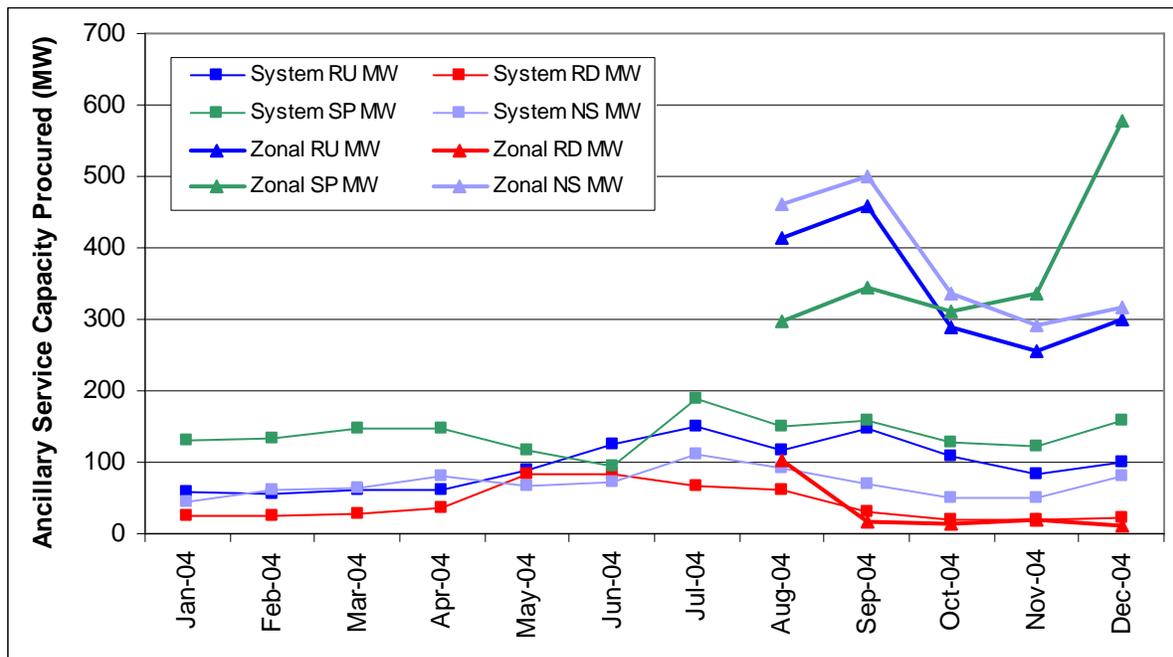
Figure 4.3 focuses on the price response to the zonal procurement practice. Comparing monthly average prices in SP15 across zonal and system procured hours during the August-December 2004 time frame shows that prices in SP15 for all the upward capacity products (Regulation-Up, Spinning and Non-Spinning Reserve) increased dramatically during hours where the markets were split. Regulation-Up increased about two-fold, while Spinning and Non-Spinning Reserves jumped up by factors of about 10 and 33, respectively. Interestingly, the average price of Regulation-Down moved slightly lower in hours of zonal procurement.

Figure 4.3 Comparison of 2004 DA A/S MCPs Under System and Zonal Procurement



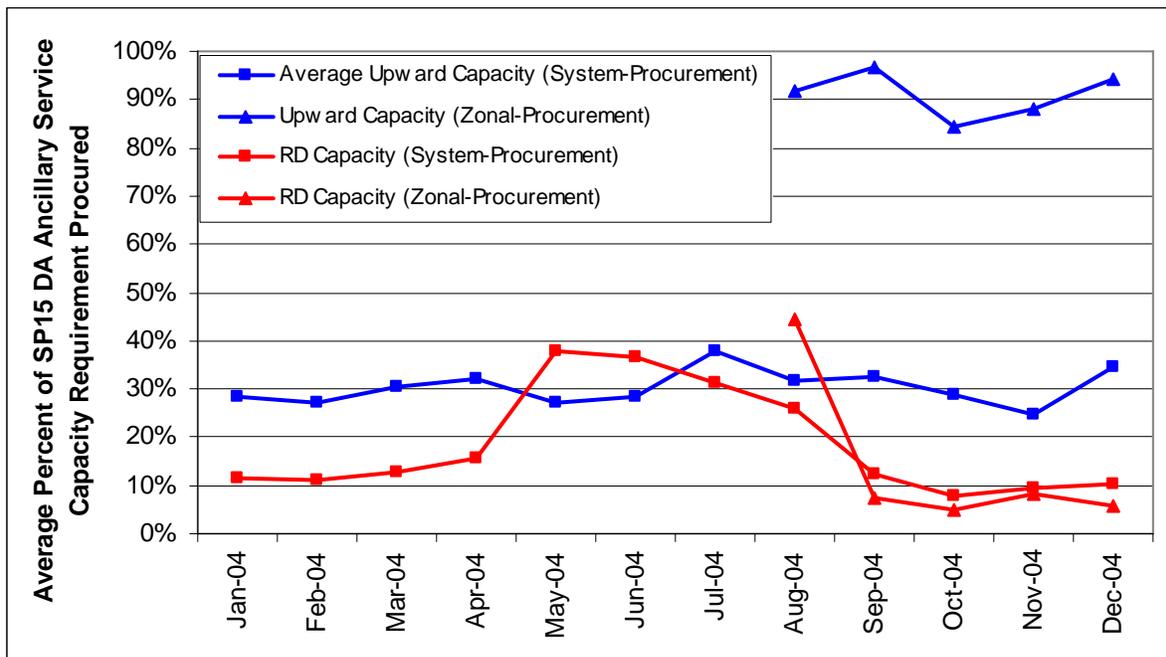
While these price increases under zonal procurement invoked some concern, procurement increases in SP15 accompanied the change. Regulation-Up procurement increased about two-fold, while Spinning and Non-Spinning Reserve procurement in SP15 increased by factors of about 1.5 and 4.5 respectively, as shown in Figure 4.4.

Figure 4.4 Comparison of 2004 Day-Ahead A/S Volumes in SP15 Under System and Zonal Procurement



Finally, an analysis of the Day Ahead Markets indicates that inter-temporal procurement patterns persist under zonal procurement. That is, operators require roughly the same levels of capacity in the Day Ahead Markets for both zonal and system procurement schemes. In fact, Regulation Reserve requirements remain virtually the same, while Operating Reserve requirements increase by less than 10 percent. Further, there was no shifting from day-ahead to hour-ahead procurement under zonal procurement. Figure 4.5 displays the ratios of procurement volumes to requirements for upward and downward capacity in SP15 on a system versus zonal basis. Here, the sum of Regulation-Up, Spinning and Non-Spinning Reserves comprise the measure of upward capacity procurement volumes and requirements. It is important to note that the comparison of system and zonal procurement shown in Figure 4.5 are not based on the same hours. Specifically, the average percent of requirement shown for the “system” procurement are for those hours that the CAISO was procuring A/S on a “system” basis. Similarly, the average percent of requirement shown for the “zonal” procurement are for those hours that the CAISO was procuring A/S on a “zonal” basis. During the August-December 2004 period, Figure 4.5 demonstrates that in hours of system A/S procurement the CAISO was only meeting, on average, 30 percent of its upward A/S requirements in SP15. In contrast, in hours when zonal procurement occurred, the CAISO was meeting approximately 90 percent of its upward A/S requirements in SP15. However, as seen in Figure 4.4 and Figure 4.5, while zonal procurement significantly increased the upward ancillary service procured in SP15 (i.e., Regulation-Up, Spinning and Non-Spinning Reserves) it did not increase Regulation-Down procurement, which had lowest percent of requirement value during the September through December period (Figure 4.5).

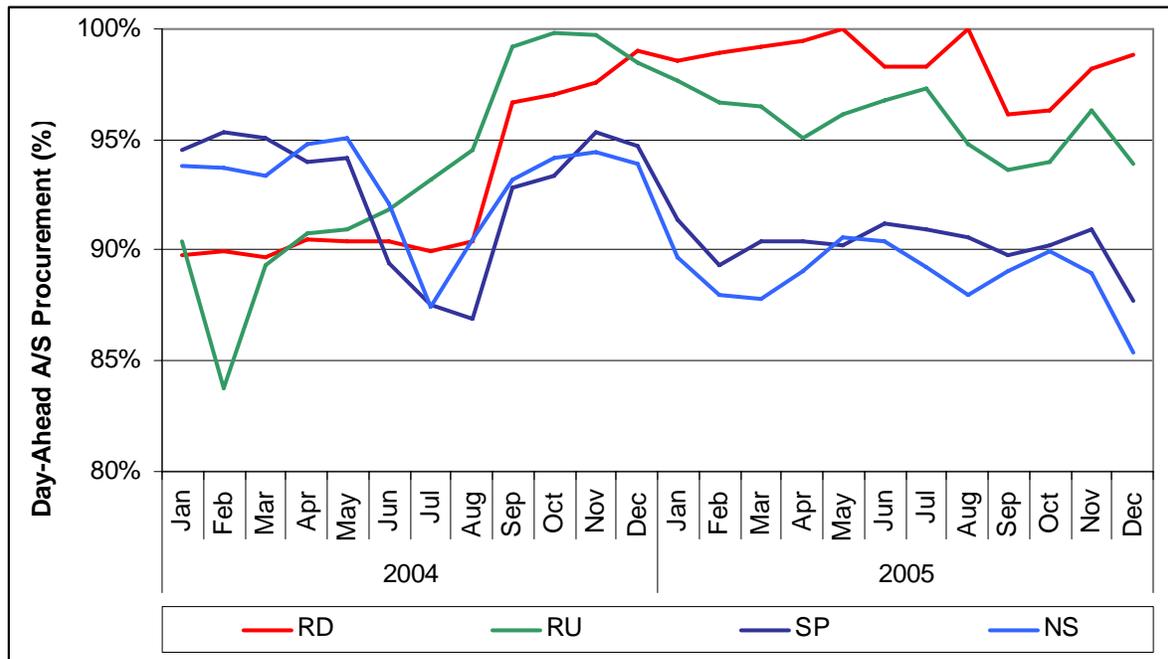
Figure 4.5 Comparison of 2004 DA Ancillary Service Capacity Volumes as Percent of Requirement for SP15: System versus Zonal Procurement



4.3.3 Day-Ahead versus Hour-Ahead Procurement

Historically, the CAISO has procured approximately 90 percent of capacity requirements in the Day Ahead Market. This practice allows operators to take advantage of better load forecasting as real-time approached and lower overall costs. Improvements to the transmission system between Northern and Southern California alleviated many of the reliability concerns that led to the practice of 100 percent day-ahead procurement in the 2004 operating year. While Regulation Reserve procurement patterns remain in the 95 to 100 percent range, Figure 4.6 depicts the general return to more traditional levels of day-ahead procurement.

Figure 4.6 Hourly Average Day-Ahead Procurement, 2004 - 2005



4.4 Prices and Volumes of Ancillary Services

4.4.1 Weighted Average Price Increase

Overall, A/S prices increased 23 percent from a weighted average price of \$8.63 in 2004 to \$10.72 in 2005. The overall price increase tracked increases of roughly 45 percent for both the Spinning Reserve and Downward Regulation components. Upward Regulation prices rose 17 percent, while Non-Spinning Reserve prices fell 10 percent.

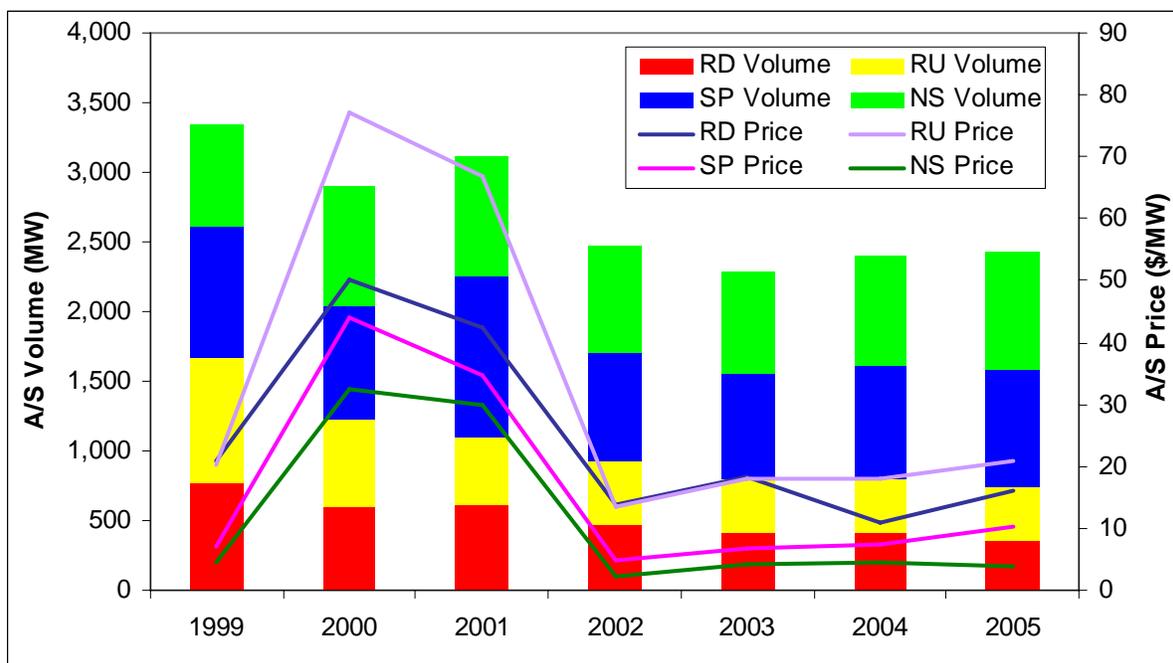
Procurement volumes, in total, were essentially unchanged from 2004. Changes to the mix of procured reserves were comprised of decreases to Regulation Reserve procurement and slight increases to Operating Reserve procurement. In particular, Upward and Downward Regulation procurement decreased by 2 and 11 percent, respectively, while Spinning Reserve and Non-Spinning Reserve rose 3 and 10 percent, respectively. Table 4.2 compares prices and volumes from past operating years.

Table 4.2 Annual A/S Prices and Volumes, 1999 – 2005

	Year	RD	RU	SP	NS	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
	Year	RD	RU	SP	NS	Total Volume
Volume (MW)	1999	769	903	942	735	3,687
	2000	594	633	818	861	3,479
	2001	614	492	1,148	862	3,420
	2002	469	460	775	763	2,524
	2003	416	381	767	722	2,309
	2004	408	395	817	782	2,427
	2005	363	386	841	839	2,428

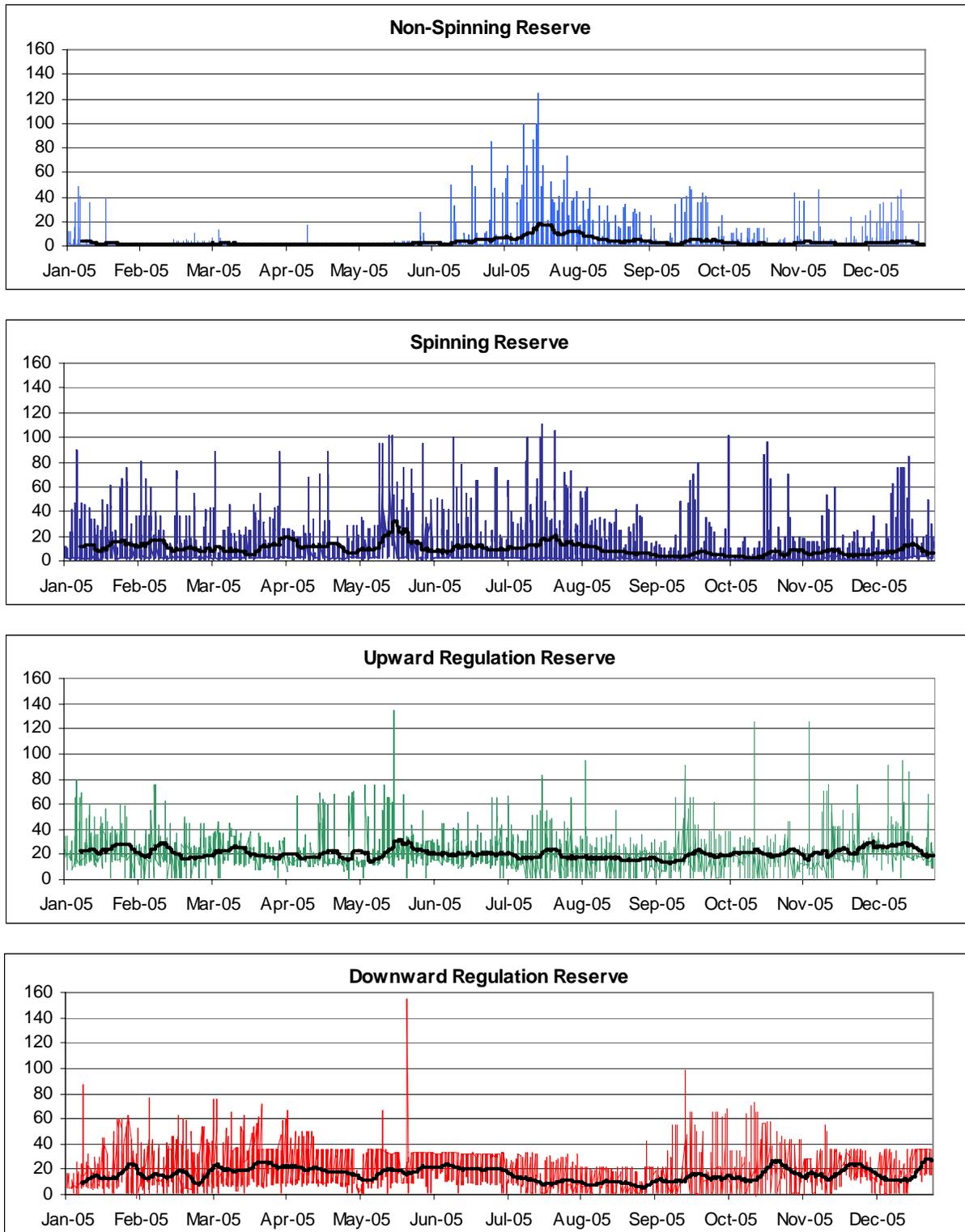
Figure 4.7 depicts the historic pattern of prices and volumes since 1999 and indicates that A/S prices and volumes have been relatively stable over the past four years (2002-2005) compared to the 1999-2001 period.

Figure 4.7 Annual A/S Prices and Volumes, 1999 - 2005



Hourly day-ahead reserve prices do tend to vary with system load levels and seasonal effects on generation. These prices appear in the composite charts, Figure 4.8. Excursions to high prices for Regulation Reserves occurred, though largely confined to the shoulder seasons of spring and fall. High price levels for Non-Spinning Reserves occurred through the peak months, while those for Spinning Reserves demonstrated a persistent tendency to reach high price levels throughout the year.

Figure 4.8 Day Ahead Ancillary Service Market Clearing Prices (A/S MCPs) with Weekly Moving Averages



The A/S price duration curves for the Day Ahead Markets, Figure 4.9 and Figure 4.10, 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 10 percent of the operating hours. At the same time Regulation Reserve prices logged fewer than 25 percent of operating hours at prices over \$25.

Figure 4.9 Price Duration: 2005 Operating Reserve Markets

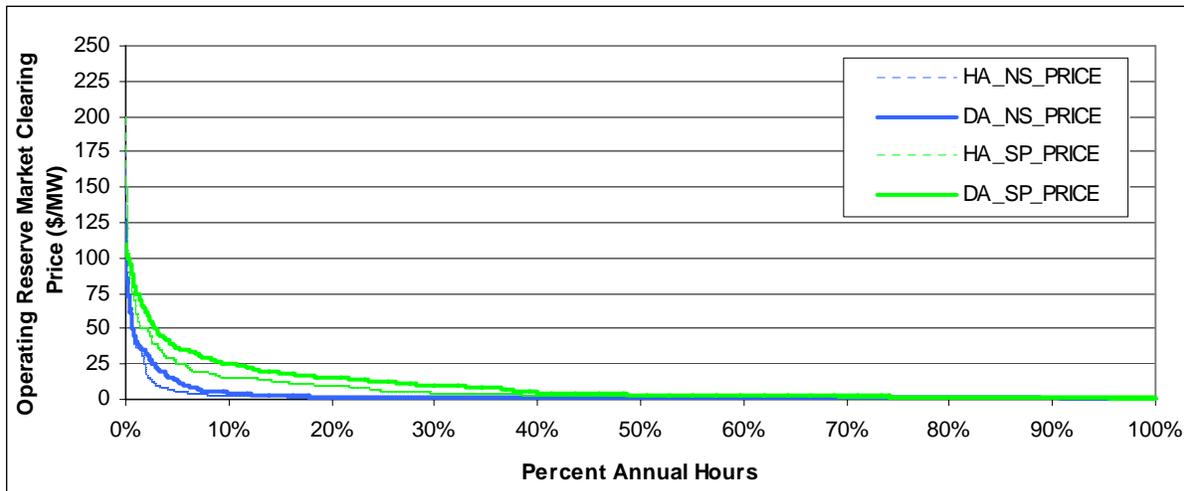
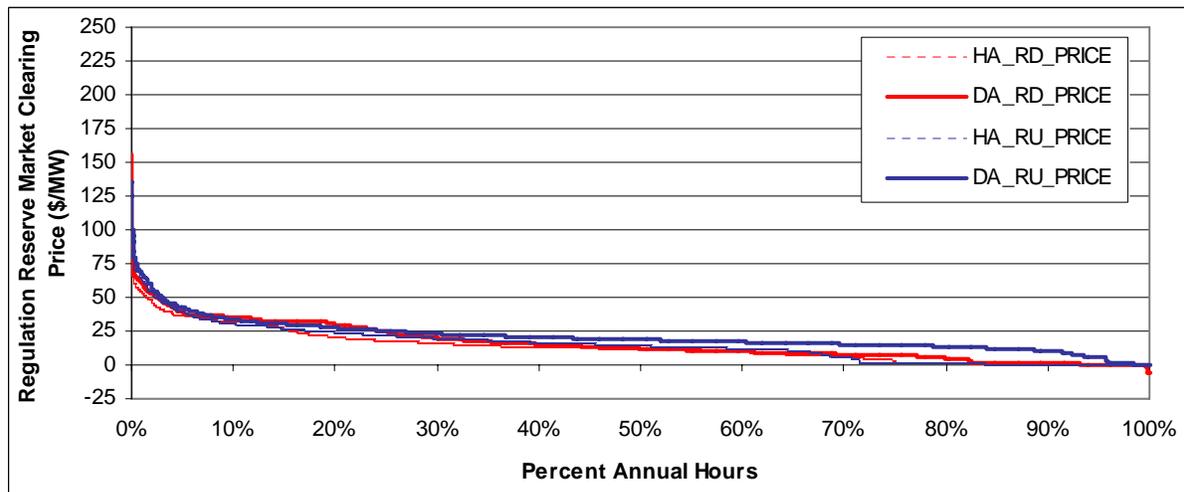


Figure 4.10 Price Duration: 2005 Regulation Reserve Markets

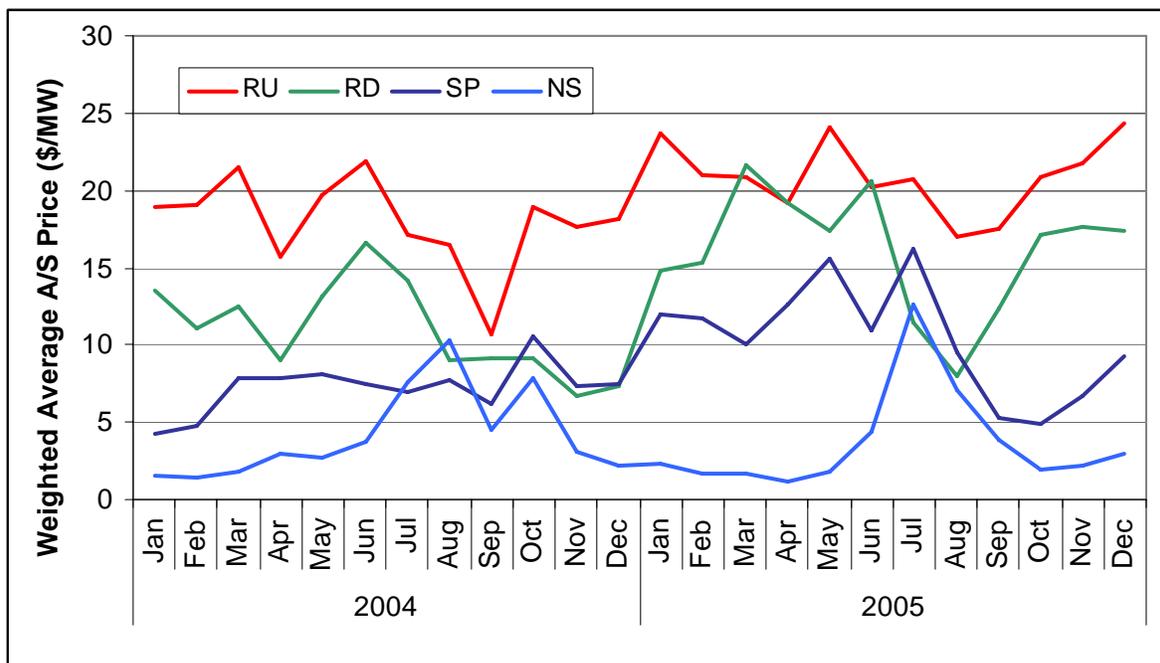


4.5 Monthly Prices of Ancillary Services

4.5.1 Price Patterns

Figure 4.11 charts the price pattern by month over the last two years. As expected, prices for Upward Regulation moved highest during seasons when loads were light and lowest during the peak load seasons as generating resources positioned themselves to be available to meet the energy needs of the system. Downward Regulation prices followed a similar trend, but deviated during times when heavy hydro flows accompanied light loads. The March 2005 and June 2005 price patterns characterize this effect. In contrast, high Operating Reserve prices generally accompany the heavy load periods, as higher energy demands reduced available capacity for reserves.

Figure 4.11 Monthly Weighted Average A/S Prices, 2004 - 2005

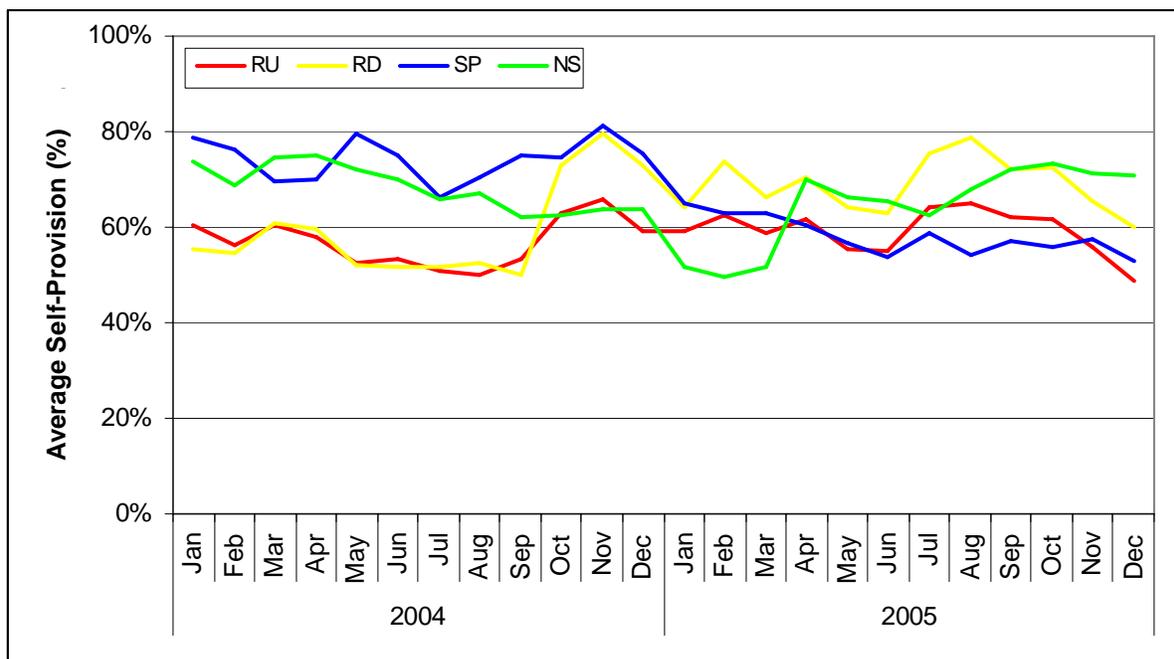


4.6 Ancillary Services Supply

4.6.1 Self Provision of Ancillary Services

Self-provided capacity reserves remain a core element of the A/S supply basis. Depending on the service and the season, self-provided capacity met from 50 to 80 percent of A/S requirements. Figure 4.12 captures this variation for the past two years.

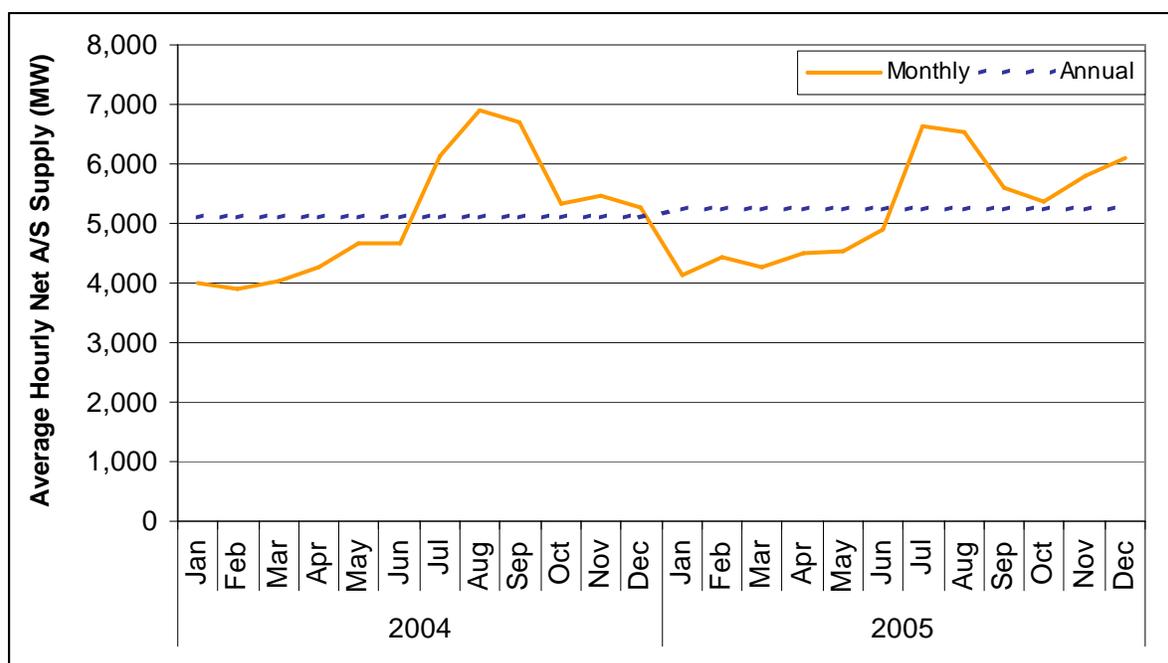
Figure 4.12 Hourly Average Self-Provision of A/S



4.6.2 Market Supply of Ancillary Services

Offers of physical capacity to the A/S markets went essentially unchanged from 2004 to 2005, increasing by just 2 percent. Net A/S supply measures the physical capacity offered to the market. Since physical capacity can be offered to several markets in the case of upward reserves, summing the capacity offers from a resource overstates the physical capacity offered to the markets. The net A/S supply accounts for market clearing mechanisms that only allocate distinct capacity portions to a single market. The monthly pattern in Figure 4.13 shows both the increase in supply as more units turn on in the summer and the sharp drop-off in supply from August to October, reflecting declining loads and the onset of the maintenance season.

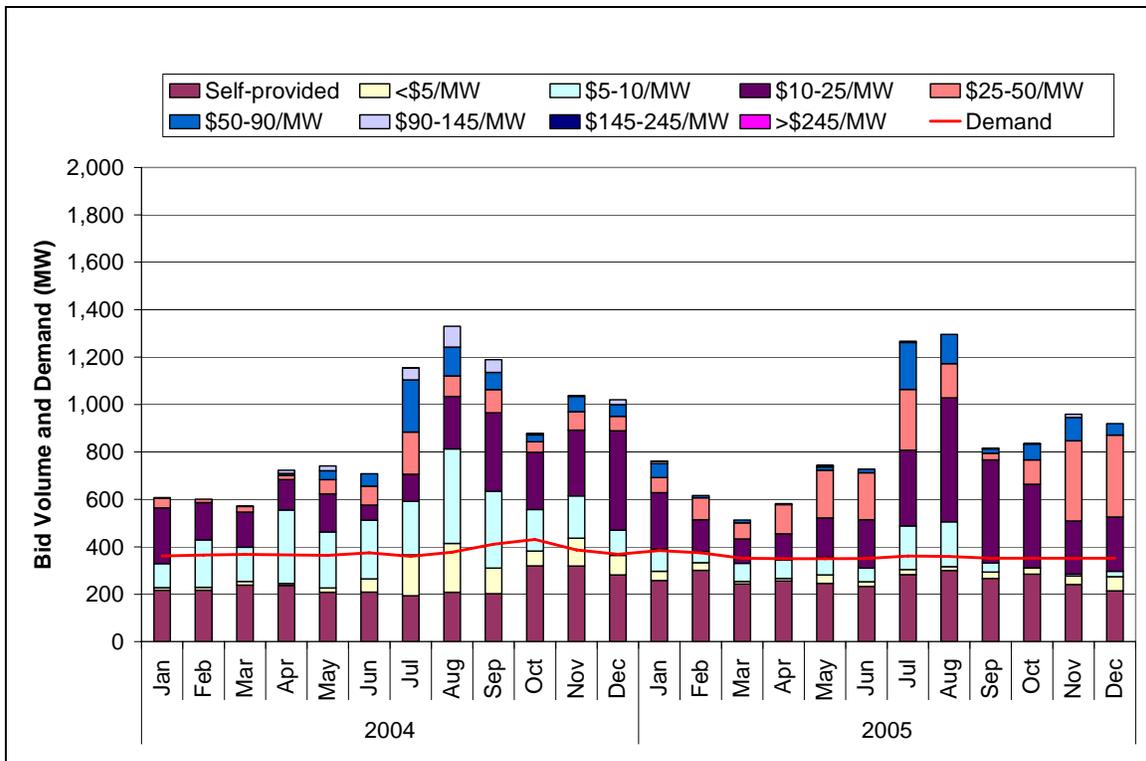
Figure 4.13 Average Hourly Net A/S Supply by Month, 2004 - 2005



Downward Regulation Reserve

A systemic decline in bid volumes at the \$5-\$10/MW level led to higher prices for Downward Regulation on average for the year. Figure 4.14 displays the Downward Regulation bid composition by month for the past two years.

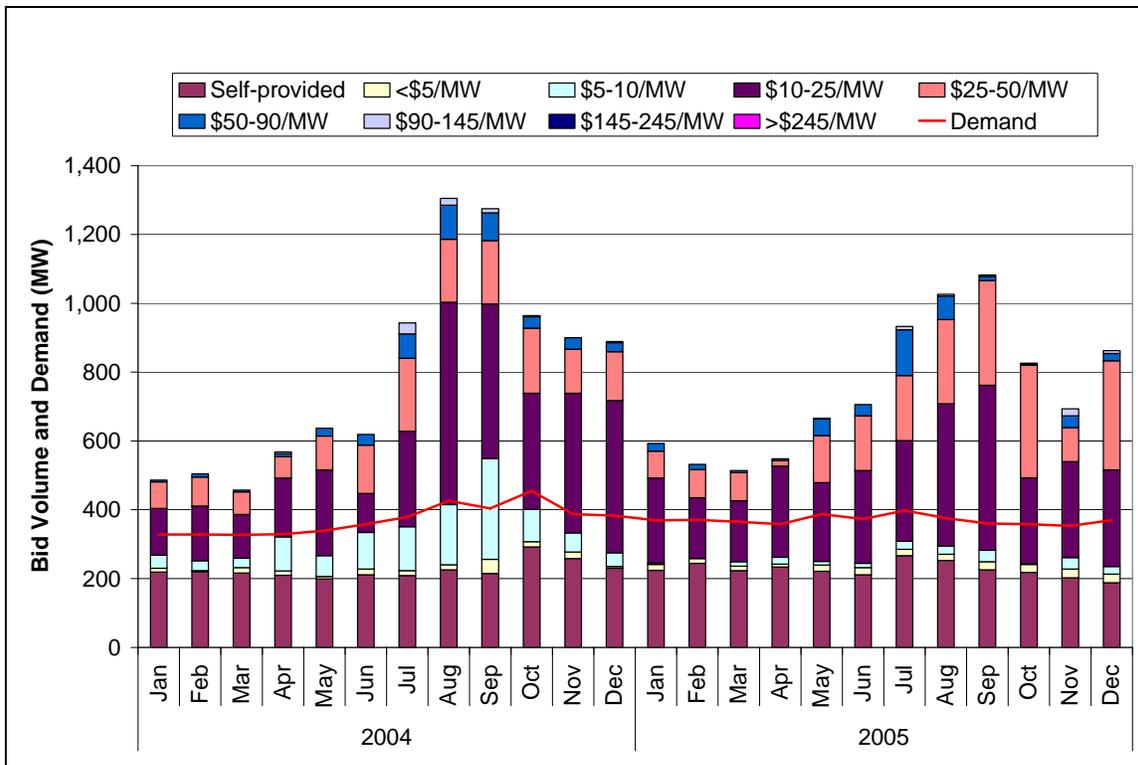
Figure 4.14 Day-Ahead Downward Regulation Reserve Bid Composition, 2004 – 2005 (Hourly Averages)



Upward Regulation Reserve

The same decline in bid volumes at the \$5-\$10/MW level led to higher prices for Upward Regulation on average for the year. The Upward Regulation bid composition by month for the past two years appears in Figure 4.15.

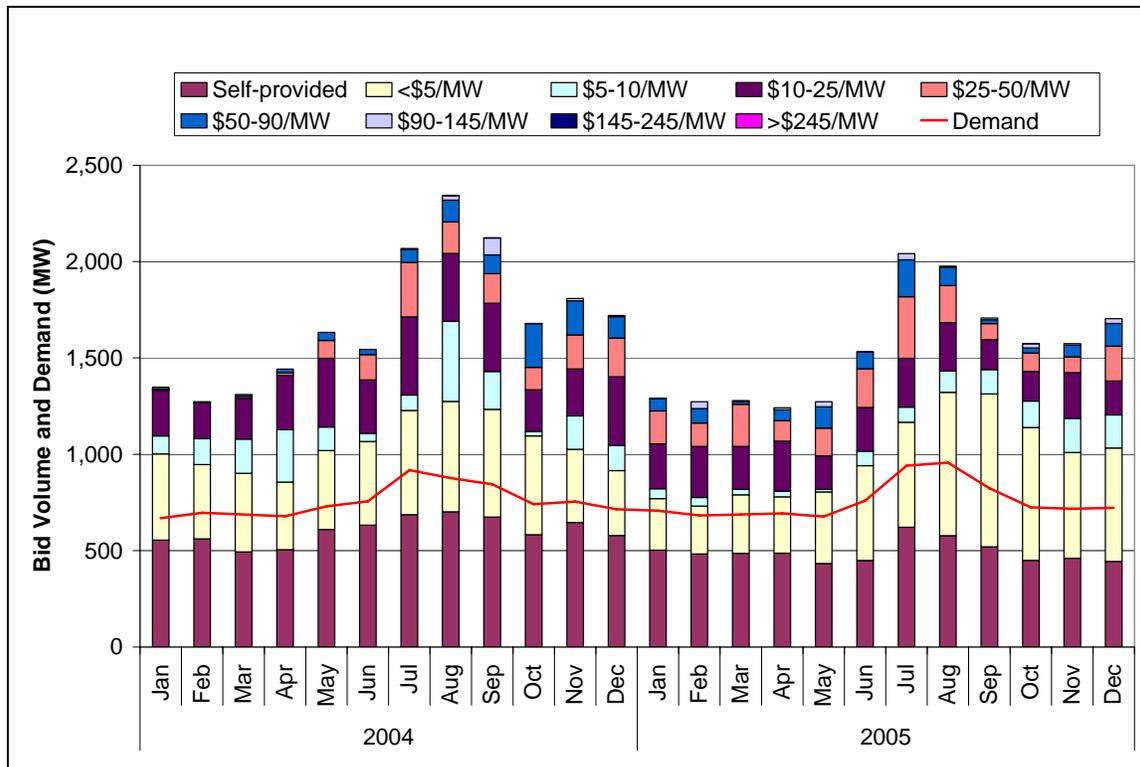
Figure 4.15 Day-Ahead Upward Regulation Reserve Bid Composition, 2004 – 2005 (Hourly Averages)



Spinning Reserve

Despite a significant supply of Spinning Reserve bids priced below \$5/MW, thinner bid stacks at and above the \$5-\$10/MW level and lower self-provision volumes combined to push Spinning Reserve prices higher, on average, for 2005. Bid composition details for Spinning Reserves comprise Figure 4.16.

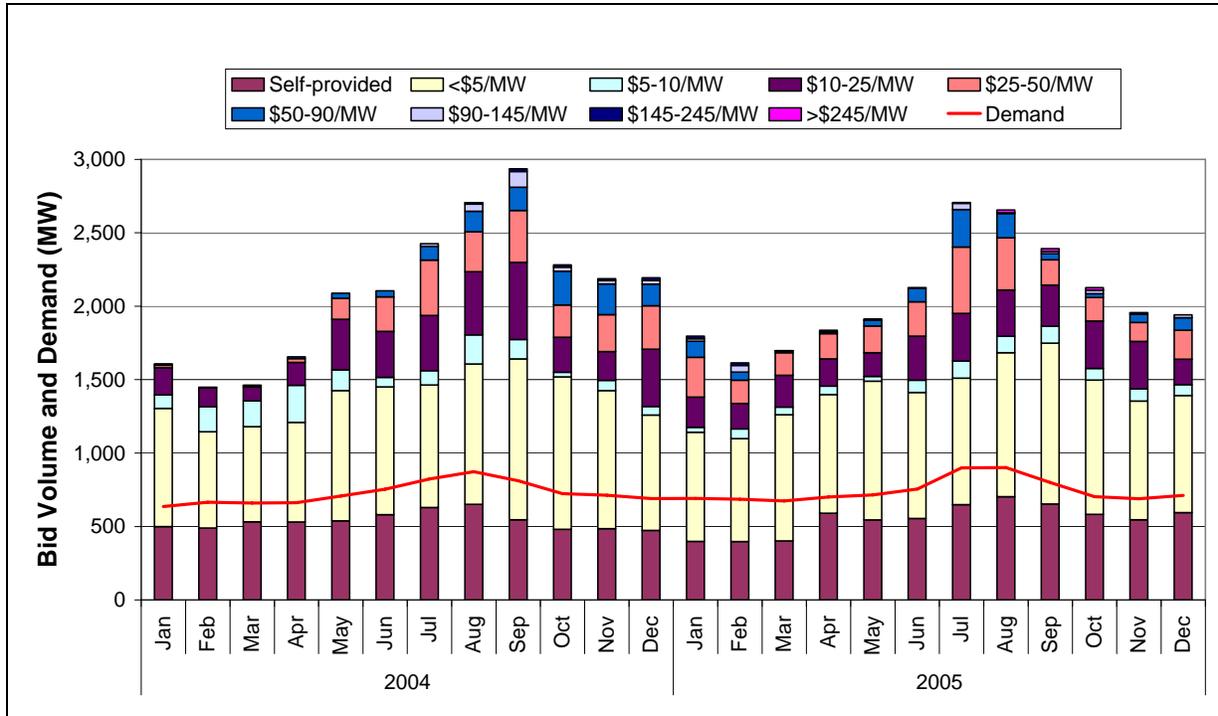
Figure 4.16 Day-Ahead Spinning Reserve Bid Composition, 2004 – 2005 (Hourly Averages)



Non-Spinning Reserve

Substantial bid volumes at the sub-\$5/MW level drove the overall decline in the average price for Non-Spinning Reserves. Figure 4.17 depicts the Non-Spinning Reserve bid composition by month for the past two years.

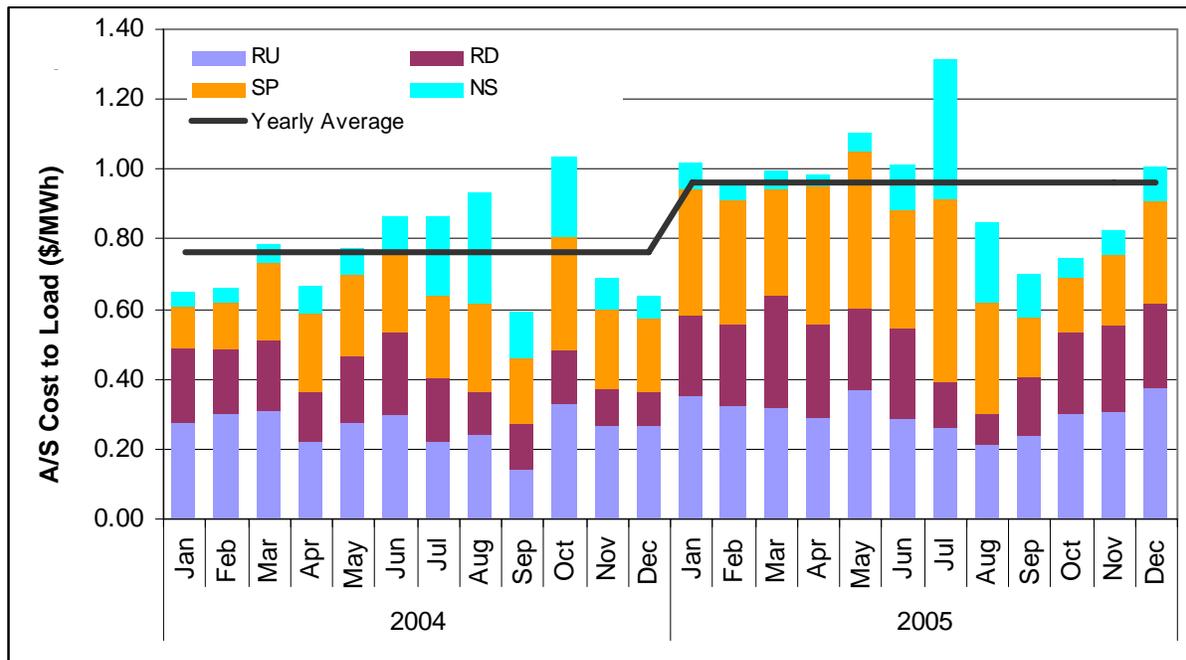
Figure 4.17 Day-Ahead Non-Spinning Reserve Bid Composition, 2004 – 2005 (Hourly Averages)



4.7 Cost to Load of Ancillary Services

The total cost of A/S capacity per unit of MWh load increased 26 percent from 2004 to 2005. The cost to load in 2005 averaged \$0.96/MWh compared to a \$0.76/MWh average the year prior. The 2005 operating year marks the fourth consecutive year resulting in an average cost to load under \$1 (see Table 2.5). Figure 4.18 provides the monthly detail on these costs.

Figure 4.18 Monthly Cost of A/S per MWh of Load



4.8 Ancillary Service 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 also 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 4.3 provides these two metrics for the past two operating years.

Table 4.3 Bid Insufficiency (2004 – 2005)

Total Capacity Short (MW)					
Year	RU	RD	SP	NS	Grand Total
2004	7,310	4,519	15,641	12,338	39,809
2005	2,607	2,550	6,681	4,417	16,255
Percent	-64%	-44%	-57%	-64%	-59%
Number of Hours Exhibiting a Shortage					
Year	RU	RD	SP	NS	Grand Total
2004	408	137	556	462	1,563
2005	135	163	279	107	684
Percent	-67%	19%	-50%	-77%	-56%

A/S markets experienced a significant decline in both volume and hours of bid insufficiency in 2005 compared to 2004, with a notable exception in the Downward Regulation market where the number of hours experiencing bid insufficiency increased by 19 percent. Figure 4.19 shows the average capacity shortfall per hour of bid insufficiency, by month and by service, for the past two years. The majority of the decline in bid insufficiency in 2005 can be explained by a comparison of the August-December timeframes across the two years. As previously discussed in Section 4.3.2, in August of 2004, the CAISO reinstated the practice of procuring A/S by zone and continued this practice into the first week of December 2004. During these months, the CAISO experienced levels of bid insufficiency that rose well above historical levels. Comparing these five months of 2004 to the same five months of 2005 shows that much of the decline in the annual bid insufficiency metrics can be attributed to discontinuation of the zonal procurement of A/S as the CAISO did not procure at the zonal level in 2005. While the total Downward Regulation capacity shortages decreased 44 percent, the number of shortage hours for Downward Regulation capacity increased by 26 on the year. Stronger hydrological conditions in the first half of 2005 drove the increase in bid insufficiency for Regulation-Down for this period, relative to the first half of 2004. During periods of heavy hydro flows, hydroelectric

generators tend to sell large volumes of energy cheaply, which essentially creates a disincentive for would-be non-hydroelectric suppliers of Downward Regulation to be online.

Figure 4.19 Bid Insufficiency by Capacity and Hour

