Memorandum

To: ISO Board of Governors

From: Eric Hildebrandt, Director, Market Monitoring

Date: April 24, 2017

Re: **Department of Market Monitoring update**

This memorandum does not require Board action.

EXECUTIVE SUMMARY

This memo summarizes key findings of the Department of Market Monitoring's forthcoming annual report on 2016 market performance. The memo also provides an update on key trends involving oversupply in the first quarter of 2017.

Market performance in 2016

In 2016, average electricity prices in the ISO markets remained highly stable and competitive. Average prices in the day-ahead and real-time markets are approximately equal to prices DMM estimates would result under highly competitive conditions in which supply is offered at or near marginal costs.

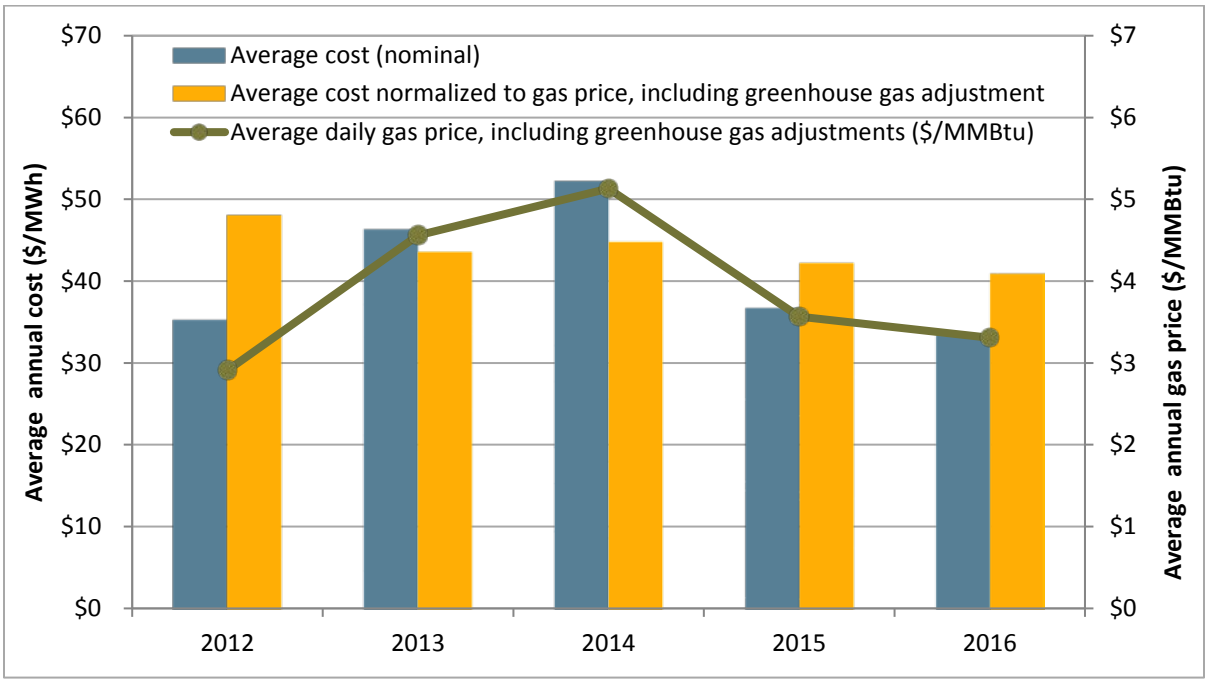
The total estimated wholesale cost of serving load in 2016 was about $7.4 billion or about $34/MWh. This represents a decrease of about 9 percent from about $37/MWh in 2015. The drop in electricity prices was driven mainly by a 9 percent decrease in natural gas prices. After normalizing for natural gas prices and greenhouse gas compliance costs, DMM estimates that total wholesale energy costs were about 4 percent lower.

In addition to lower gas costs, a variety of other factors contributed to decreased total wholesale costs:

- The continued growth of solar generation, which replaces more expensive generation during peak day-time hours;
- Increased hydro-electric generation after historic low output in 2015; and
- Continued low levels of congestion during most intervals.

Figure 1 shows total estimated wholesale costs per megawatt-hour of system load from 2012 to 2016. This represents a standard metric reported to FERC by all ISOs. Wholesale costs are provided in nominal terms (blue bar), and normalized for changes in natural gas prices and greenhouse gas compliance costs (gold bar). The green line represents the annual average daily natural gas price including greenhouse gas compliance.[1]

Figure 1. Total annual wholesale costs per MWh of load (2012-2016)



The drop in total wholesale cost in 2016 was primarily due to decreases in day-ahead energy costs, which fell by about $4/MWh or about 11 percent from 2015. The remaining components of the wholesale energy cost, which represent a relatively small portion of total cost, changed modestly from 2015.

- Bid cost recovery payments dropped from $92 million in 2015 to $76 million in 2016 – or about 1 percent of total wholesale costs. Bid cost recovery payments have been generally declining since 2010.[2]

- Ancillary service costs increased to $119 million, nearly doubling from $62 million in 2015. This represents an increase from 0.7 percent of total wholesale energy costs

[1] The greenhouse gas compliance cost is added to natural gas prices beginning in 2013 to account for the estimated cost of compliance with California's greenhouse gas cap-and-trade program.

[2] More detailed information on trends in bid cost recovery payments in 2016 is provided in DMM's February 9, 2017 memo the Board. http://www.caiso.com/Documents/Department_MarketMonitoringUpdate-Feb2017.pdf

in 2015 to about 1.6 percent in 2016. This increase was primarily driven by higher regulation requirements to manage increased variability of renewable resources.

- Total energy from all exceptional dispatches totaled about 0.2 percent of total system energy in 2016 compared to 0.26 percent in 2015. The above-market costs resulting from these exceptional dispatches increased to $10.7 million from $10.3 million in 2015.

Expansion of the western energy imbalance market helped improve the overall performance of the real-time market. Real time prices in the ISO and different balancing areas in the energy imbalance market tracked closely as a result of additional transfer capability that became available with the integration of NV Energy in December 2015. Increased real-time transfers between balancing areas in the energy imbalance market helped increase the overall efficiency of generation dispatches throughout all balancing areas in the energy imbalance market.

Key market trends in 2017

Negative day-ahead prices

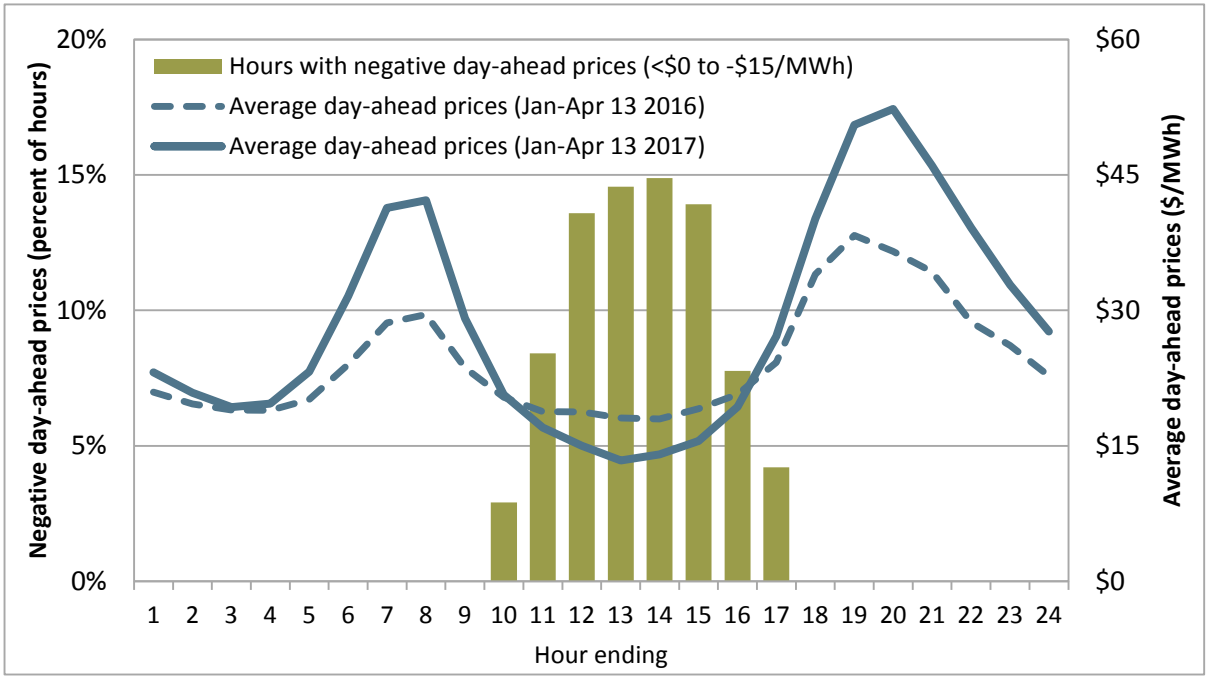
The first quarter of 2017 has been marked by low loads, and high hydro-electric and solar generation. The combination of these factors has led to low prices, including negative load area prices during many midday hours in the day-head market. Prior to this quarter, negative prices occurred in the day-ahead market during only a few hours since the day-ahead market was launched in 2009.

As shown in Figure 2, negative day-ahead prices for load areas as low as -$15/MWh have occurred in over 10 percent of all hours between hour ending 10 through 17 so far this year. These very low prices have driven average day-ahead prices during the peak solar hours well below prices during this same period last year, despite an increase of over 50 percent in the price of natural gas compared to last year.[3]

Meanwhile, as shown in Figure 2, day-ahead prices during the morning and evening ramping hours are up to $10/MWh higher than during this same period in 2016. This reflects significantly higher gas prices, as well as the increased upward ramp of net load for the ISO system during these hours of the day. For example, during the first quarter the average monthly maximum 3-hour ramp grew nearly 25 percent – from about 10,130 MW in 2016 to 12,500 MW in 2017.

[3] Spot market prices of natural gas at the SoCal Citygate hub averaged about $3.15/MMBtu in 2017 (January through April 13), compared to an average cost of $2.07/MMBtu during the same period last year.

Figure 2. Day-head market prices (January – April)



Even with these low day-ahead market prices, real-time market prices continue to be lower than average day-ahead prices during most hours. Low real-time prices are driven in large part by increased supplies of renewable generation and other sources of supply in real time. In some cases, negatively priced bids to decrement renewable energy sources are dispatched in the real-time market due to oversupply.

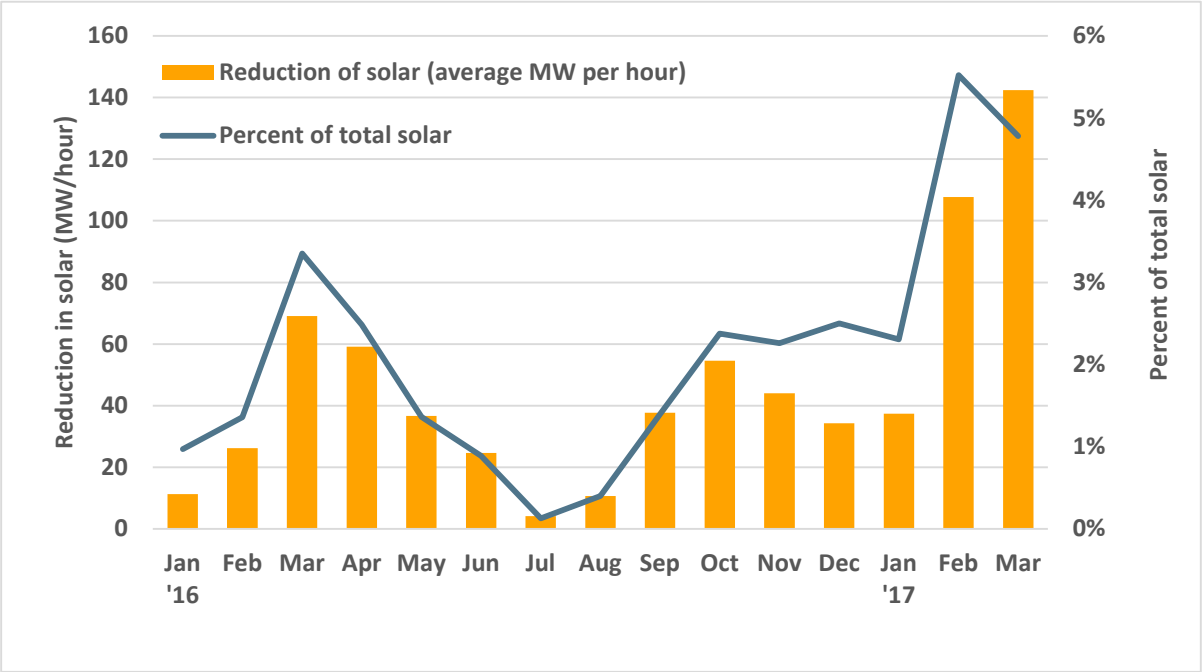
Low or negative prices in the day-ahead market can provide an incentive to reduce self-scheduling of non-renewable resources in the day-ahead market. This can reduce the need to decrement renewable energy resources in the real-time market. DMM's review of interties provides some indication that net imports have declined in the day-ahead market in response to the very low and negative prices that have begun to occur in the day-ahead market during some midday hours.

Solar reductions due to oversupply

Despite a 32 percent growth in solar generation during 2016, the amount of solar energy that was dispatched down due to oversupply and congestion in the real-time market increased to only 1.6 percent of solar forecasts compared to 1.2 percent in 2015. In 2016, the need to decrease renewable generation was moderated by the expansion of the energy imbalance market.

The amount of renewable energy that has been dispatched down in the real-time market has increased significantly in the first quarter of 2017. As shown in Figure 2, the amount of solar energy dispatched down grew from an average of about 36 MW per hour in the first quarter of 2016 to about 95 MW per hour in 2017.

Figure 3. Reductions in real-time solar schedules



In Q1 of this year, about 4.3 percent of solar output scheduled in real-time was dispatched down, compared to about 2 percent in Q1 2016. Wind schedules tend to be reduced much less than solar. In Q1 of this year, about 11 MW per hour of wind generation was reduced, representing about 1 percent of total potential wind output.

Almost all reductions in solar and wind generation in the ISO balancing area in 2016 resulted from economic downward dispatch instructions from negative economic bids, rather than curtailment of self-schedules. Most curtailment of self-schedules in real-time continue to appear to be due to localized transmission constraints rather than oversupply at a system-wide level. This indicates that despite the increased need to decrement solar generation due to oversupply, the current -$150/MW bid floor is sufficiently low to allow oversupply to be resolved through market bids rather than curtailment of self-scheduled resources.