California Independent
System Operator Corporation

California ISO

Report on natural gas price volatility at western trading hubs

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Department of Market Monitoring

1 Introduction

Natural gas prices are a key input in the ISO markets as most prices are set by natural gas-fired resources. There are two ways in which the spot natural gas prices are directly used in the ISO markets.

- An index of various natural gas prices are used to calculate *default energy bids* (DEBs) used to mitigate energy bids when local market power mitigation screens are triggered. Default energy bids include a 10 percent adder that is applied to all fuel and variable cost components, including variable gas costs.

- Natural gas prices are also used to calculate start-up and minimum load commitment costs under the proxy cost option that applies to most gas-fired generating units.[1] Resources on the proxy cost option have the ability to bid in their start-up and minimum load costs up to 125 percent of their proxy costs.

Currently, the natural gas price index used by the ISO in the day-ahead market to calculate default energy bids and commitment costs for units under the proxy cost option is based on prices for the next day gas market at major gas trading hubs, which are usually lagged by one day. For instance, when the ISO's day-ahead market begins to be run at 10 a.m., default energy and commitment cost bids are based on an index of multiple gas prices that were published for next day gas trading that occurred on the prior day.

The ISO normally uses gas prices based on the previous day's trading since all but one of the sources of published gas prices for next day gas trading do not become available until after the time that the ISO's day-ahead market begins to run. The use of a gas index based on the average of multiple gas prices is designed to increase the accuracy of gas prices used and prevent potential manipulation. However, the timing that these multiple gas price publications become available requires a one day lag between the flow date of the next day gas prices used in this index and the flow date corresponding to the operating day for which the ISO's day-ahead market is being run.

The ISO recently modified market rules to address issues created when natural gas prices in next day trading, which occur on the day the day-ahead market runs, appear to have increased significantly above the gas prices that it would normally use for the day-ahead electricity market. Specifically, when the natural gas prices reflected in current trading in the InterContinental Exchange (ICE) market exceed the previous day's gas price index by 25 percent or more, the ISO now updates default energy and commitment cost bids used in the day-ahead market using these ICE prices.

In the real-time market, default energy bids automatically update each day to reflect the next day index price for the operational day, which traded on the previous day. However, commitment costs for units under the proxy cost option are currently based off of the natural gas price used in the day-ahead market.

[1] Resources that do not have a valid use-limitation are required to be on the proxy cost option, whereas use-limited resources have the option to be on either the proxy cost option or the registered cost option. The registered cost option uses monthly futures gas prices.

During the winter of 2013/2014, western natural gas markets experienced brief but extreme levels of volatility that have not occurred in years. In early February 2014, gas prices increased to levels and at rates that are more common in eastern natural gas markets, but are extremely rare in western markets. The quick rise in gas prices caused commitment challenges for the ISO as the market did not have a mechanism to adjust for large daily natural gas price changes at that time.[2]

To address this issue, the ISO asked for a temporary waiver and received FERC approval to update its natural gas price indices to account for price volatility by eliminating the one day lag in natural gas prices used in the day-ahead market.[3] Subsequently, the ISO held a stakeholder process in 2014 to review commitment cost enhancements, which resulted in updating the ISO tariff to codify the emergency procedures set in place earlier in the year with minor modifications. FERC approved this tariff change in late 2014.[4]

During the commitment cost stakeholder process in 2014, there was much discussion among stakeholders about natural gas price risk and volatility. The ISO requested information to help better understand this risk, but only received detailed information from one market participant. While the ISO had access to the ICE WebICE trading portal, which allowed the ISO to graphically view natural gas market prices and trades, the ISO did not have access to the raw ICE data to statistically analyze and assess natural gas market trends.

To help address this issue, DMM worked with the ISO to acquire more detailed ICE natural gas data that could be used to analyze the actual volatility of spot market natural gas prices.[5] While we recognize that bilateral trades can and do take place outside of the ICE platform, we believe that the ICE platform presents a strong representation of natural gas trading activity.

Analysis of the data in this report shows that the next day gas price used by the ISO is sufficient to cover almost 99 percent of the upward volatility of actual daily spot market gas prices relative to the gas prices used by the ISO to calculate default energy bids and commitment costs. As a result, DMM suggests that the ISO and stakeholders consider making only incremental modifications to its current natural gas price spike procedures and bidding rules.

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[2] As noted above, the ISO now has a mechanism to adjust for this lag.

[3] For more information see the following filings: http://www.caiso.com/Documents/Mar6_2014_TariffWaiver_GasPriceIndexRequirement-ExpeditedER14-1440-000.pdf and http://www.caiso.com/Documents/Mar6_2014_TariffWaiver_GasPriceIndexRequirement-Next-DayER14-1442-000.pdf, and FERC order: http://www.caiso.com/Documents/Mar14_2014_OrderGrantingWaiver-GasPricesER14-1442.pdf.

[4] More information on the stakeholder process and FERC approval can be found here: http://www.caiso.com/informed/Pages/StakeholderProcesses/CommitmentCostEnhancements.aspx.

[5] DMM recommended that the ISO enhance its subscription to include the raw trading information. The underlying data was obtained from ICE's end-of-day natural gas report, 'deals' tab.

2 Gas price risk

As part of this analysis, we evaluated three different sources of upward natural gas price risk.

- **The index price used in the day-ahead market is lagged.** As previously noted, the ISO reduced this risk as part of the emergency waiver and stakeholder process in 2014. The ISO modified the rules in this process so that when the natural gas price from the ICE market published just prior to the ISO's day-ahead market exceeds the previous day's price by 25 percent or more, the ISO updates the default energy and commitment cost bids used in the day-ahead market using these ICE prices. In this report, we review the effectiveness of this rule change using ICE data to assess the appropriateness of the 25 percent threshold used to trigger updates to the next day index price used in the day-ahead market.

- **The day-ahead index price is not reflective of intra-day or same day market prices.** While the bulk of natural gas trading occurs the morning before the flow date in advance of the ISO's day-ahead market, natural gas can trade at different points in time both the day before and during the operating day. For instance, participants may need to acquire some additional gas after the ISO day-ahead market schedules are published, as well as during the operating day.[6] The day-ahead natural gas price index, also known as the *next day index*, may not reflect the prices during these other periods.[7]

- **The index price does not reflect the range of trades.** Regardless of which spot market a participant is transacting in, the next day index price may differ substantially from the range of prices that trade. In other words, the maximum trade may be significantly different from the weighted average price of the trades used to calculate the index prices used in default energy bids and commitment costs.[8]

There is a fourth potential source of gas price risk for owners of gas-fired generation. If a market participant purchases gas at a high price with the expectation that they will burn the gas consistent with their ISO schedules and then for some unanticipated event the unit is decommitted, the participant faces the risk that they may not be able to sell the gas into the natural gas market without taking a loss. Participants may have the option of carrying the gas balance to another day, but may not be able to sell their power reflecting the higher gas price. This downward price risk is not included as part of this

[6] ICE calls these time periods strips, which are 'NxDay Intra' and 'Same Day,' respectively. The product we evaluated was what ICE calls 'NG Firm Phys, FP,' which stands for natural gas firm physical, fixed price product. In this report we will refer to next day as representing the trades that form the next day index, the next day intra-day will represent trades done the day before the operating day but after the next day index was formed, and the same day will represent trades done on the operating day for the operating day.

[7] In particular, the ICE index is published too early to include trades that may happen after their index publishes at 10 a.m. Pacific time. However, other index publishers that are used in the ISO's gas price index calculation, such as Platts, don't publish their indices until later in the day and may incorporate information about trading that is available after ICE publishes.

[8] The minimum trade may also be substantially different as well. However, the ISO market allows for participants to bid their commitment and energy costs below the default level. This analysis seeks to understand the limitations on upward bidding only.

analysis.[9] We recognize that this problem is not unique to California and has also been an issue experienced in eastern ISO and RTO markets.

[9] Under these circumstances, allowing participants to increase their bids in the ISO markets to reflect the higher natural gas costs may cause the resource to not run. For instance, if natural gas prices fell on the subsequent day, then participants bidding their resource commensurate with their high natural gas prices would likely price themselves out of the market as other gas-fired resources would be referenced to a lower gas price. In this case, pricing the gas would make their bids uncompetitive and make it less likely they would generate. Selling the gas in the gas market may also result in a loss if the gas market prices drop.

3 Analysis and results

In this analysis, we evaluated ICE data from January 2010 through March 2015.[10] The products reviewed include the Next Day Gas, NxDay Intra, and Same Day gas products for the PG&E and SoCal Citygate hubs for fixed price firm natural gas. For each of the three sources of upward gas price risk described in Section 2 of this paper, we performed the following calculations:

- **The index price used in the day-ahead market is lagged.** To evaluate this risk, we compared the next day index price to the next day index price for the prior flow day. We specifically identify the frequency that the next day index price rose more than the 10 percent adder incorporated in default energy bids or the 25 percent level used in the ISO's current approach for triggering its special price spike procedures.

- **The day-ahead index price is not reflective of intra-day or same day market prices.** To evaluate this second source of risk, we first created a weighted average price for the next day gas, next day intra-day, and same day products. We then compared the weighted average of the next day intra-day price and the same day price to the next day gas price. In this analysis, we use the next day index for the operational flow date rather than the lagged next day gas price used in the ISO's day-ahead market to isolate this specific risk.

- **The index price does not reflect the range of trades.** To evaluate this third source of risk, we evaluated the maximum of the weighted average price in the next day gas market and the next day intra-day market to the maximum trades in the next day gas and next day intra-day markets.[11] For the same day market, we evaluated the maximum weighted average price in the next day gas market and the same day market to the maximum trades in the next day gas and same day markets. We use the next day index for the operational flow date rather than the lagged next day gas price used in the ISO's day-ahead market to isolate this specific risk.

By analyzing the data in this fashion, we believe we can better evaluate each source of risk independently, without overlapping the impacts of the different sources of risk.

We specifically identify the frequency that the next day index price increased more than the 10 percent adder incorporated in default energy bids or the 25 percent level used in the ISO's current approach for triggering its special price spike procedures and the cap for proxy commitment costs. Results of this analysis indicate that the 10 percent adder currently used in default energy bids appeared to be a natural breaking point.[12]

[10] We recognize that the ISO's analysis in its commitment cost enhancement stakeholder process went back to the beginning of MRTU in April 2009. The dataset available for analysis began at the beginning of 2010.

[11] We took the maximum of both markets because there are times when the next day market had the largest range of prices even though the next day intra-day or same day markets may have had a higher average but lower maximum price.

[12] For instance, at a 10 percent cutoff, the next day price lag included 15 days, whereas it included 26 days at a 7.5 percent cutoff and 59 days at a 5 percent cutoff.

Results

Of the 1,916 days in this sample, the three different gas price volatilities noted above were below 10 percent during 1,885 days. This represents 98.4 percent of the sample.

To illustrate this, Figure 1 and Figure 2 compare the highest trade in either the next day or same day markets to the next day index price. The figures show the range of trades in a scatterplot of prices for the PG&E Citygate (Figure 1) and the SoCal Citygate (Figure 2).[13]

The X-axis represents the next day index price. The Y-axis represents the maximum trade in either the same day market or the next day market. The yellow dots represent each individual day.

The black line represents the point at which the gas values on the X-axis and Y-axis are the same.[14] The large dashed lines represent what the price would be at 110 percent of the next day average, consistent with the level of the default energy bid. The small dashed lines represent what the price would be at 125 percent of the next day average, consistent with the cap on proxy commitment costs.

Figures 1 and 2 both show the following:

- The maximum trade in either the next day or same day markets is covered by the 10 percent threshold in the vast majority of days in our sample of over 5 years.
- Only a handful of observations were more than 25 percent above the next day index.[15]

The remainder of this analysis focuses on the remaining 31 days in the 63 month period (1.6 percent) that are above the 10 percent threshold.

Table 1 provides a detailed summary of gas prices on these 31 days relative to the next day index price.[16] Of these 31 days, 24 days were during the winter 2013/2014, which was mostly affected by supply and demand conditions outside of California influencing natural gas prices in California.[17]

[13] The appendix to this report shows all the various combinations of risk for both the PG&E Citygate and SoCal Citygate prices.

[14] Because we are comparing the maximum trade to the average, no dots will ever fall below this line.

[15] In order to scale both figures to make the results viewable, we excluded one observation in each chart. In both cases, this observation represented trading for the flow date February 6, 2014.

[16] We do not report specific natural gas prices or trading values as part of our results because we do not want to present any proprietary ICE information. Thus, our analysis focuses only on the relationship between different prices.

[17] There are four weekend packages in this 31 day period, December 7 through 9, 2013, February 8 through 10, 2014, February 22 through 24, 2014, and March 1 through 3, 2014. Only the first day of the weekend package includes the lagged next day gas price risk because the ISO software will update the next index for the final two days of the package, eliminating the lag. Thus, February 23 and 24, 2014, and March 2 and 3, 2014, are not included as the ISO's natural gas index would have been updated for the next day gas price index lag on these dates.

Figure 1. Next day index price versus maximum trade price (PG&E Citygate)

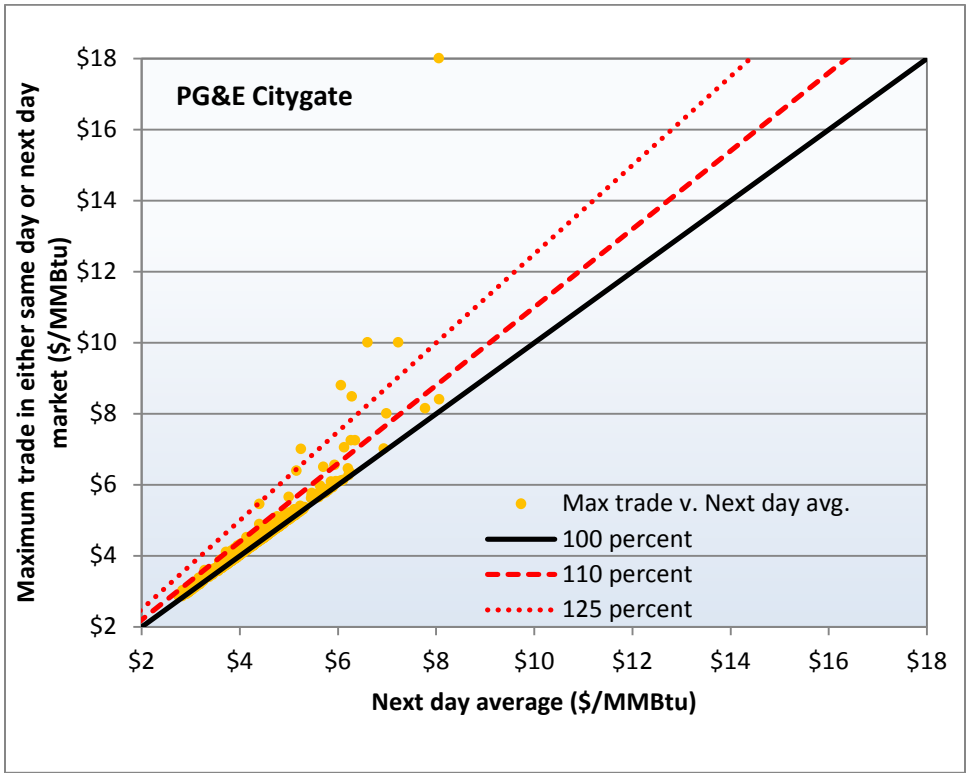


Figure 2. Next day index price versus maximum trade price (SoCal Citygate)

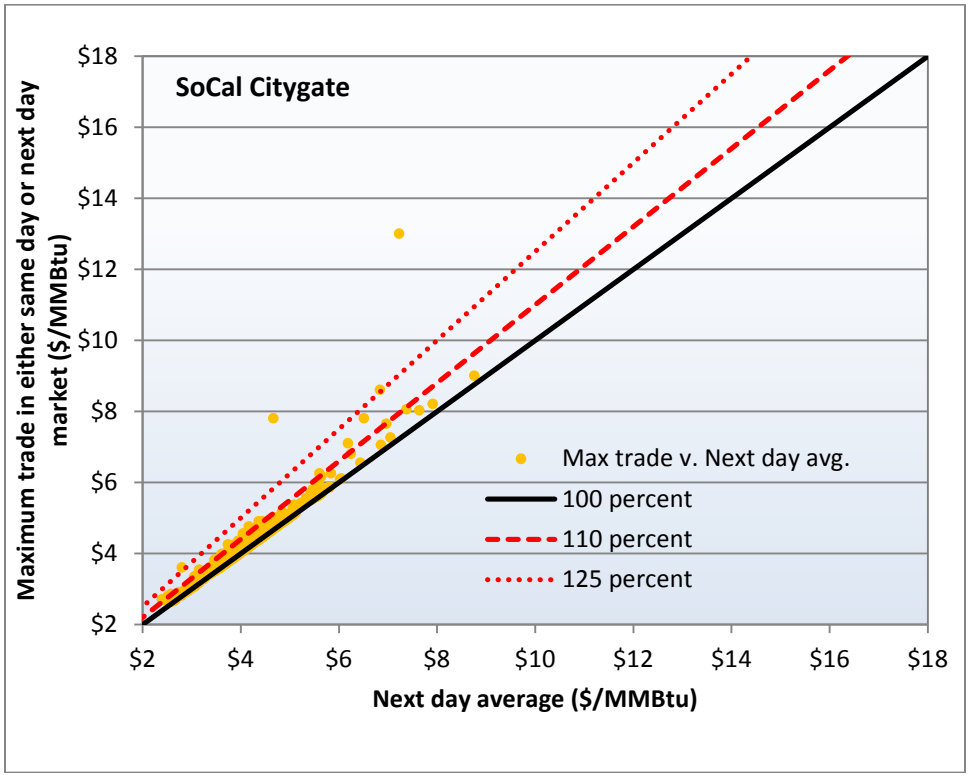


Table 1 shows for each trade date and flow date the three categories of risk associated with the PG&E and SoCal Citygate hubs.[18] The first set of data, showing the risk of the one day index lag, is comparable to the analysis that the ISO has already performed as part of the commitment cost enhancements process, but with a threshold of 10 percent. On trade date February 5, 2014, for flow date February 6, 2014, the table shows a 170 percent increase in price from flow date February 5 to flow date February 6 for the PG&E Citygate. In these columns, any lag equal to or greater than 25 percent would be covered under the new manual gas price update, which addresses five days during this period. This is consistent with the findings that the ISO identified in its analysis.[19]

The second section of Table 1, labeled "Next Day Intra-Day," shows a comparison of the next day gas index price for the flow date to the next day intra-day gas price for that flow date. This section identified instances where the average next day index differed from the average of the next day intra-day trades as well as when the maximum trade in the two markets exceeded 10 percent. As noted above, we did not account for the lagged gas price in this part of the calculation because we wanted to keep the analysis separate from the risk identified in the previous columns. For the December 7 flow date, the average next day intra-day price was 5 percent higher than the average next day index price at the PG&E Citygate hub. The maximum trade was 9 percent higher than the next day intra-day average price. Thus, the highest trade was 14 percent higher than the next day index price.

The third section of Table 1, labeled "Same Day," is similar to the second section, but instead of comparing the next day intra-day trades, it compares the next day gas index price for the flow date to the same day gas price for that flow date. Specifically, this section identified instances where the average next day index differed from the average of the same day trades as well as when the maximum trade in the two markets exceeded 10 percent. For the December 7 flow date, the average same day price was 21 percent higher than the average next day index price at the PG&E Citygate hub. The maximum trade was 2 percent higher than the same day average price. Thus, the highest trade was 23 percent higher than the next day index.

As part of the current bidding rules stakeholder initiative, the ISO is proposing to update proxy commitment costs used for the real-time market for those resources that did not receive a day-ahead or residual unit commitment award. This would allow market participants to rebid these costs in the real-time market to reflect the updated natural gas index price to relieve the lag effects for these resources. This analysis supports that change as it will add additional bidding flexibility in real time to cover natural gas price volatility. For instance, 15 of the 22 days represented in the table with high real-time natural gas price volatility had combined volatility in both average and maximum trades below 25 percent.[20] If the ISO left the rules as is, the combined volatility on December 7, 2013, and February 22, 2014, would have exceeded 25 percent.[21] The seven remaining days include flow days for February 4 through February 10, 2014.

[18] The term flow date is similar to real time in the ISO markets.

[19] The ISO results may differ as the ISO used the gas price index in its calculations, not the ICE price. For more information on their analysis, see: http://www.caiso.com/Documents/Nov25_2014_DeficiencyResponse_CommitmentCosts_ER15-15.pdf.

[20] For example, flow date December 6, 2013, had a combined risk of 12 percent at the SoCal Citygate.

[21] For example, February 22 volatility would have been 18 percent for the lagged gas price plus 14 percent compared to the maximum of the next day intra-day market and the next day market for a total difference of 32 percent.

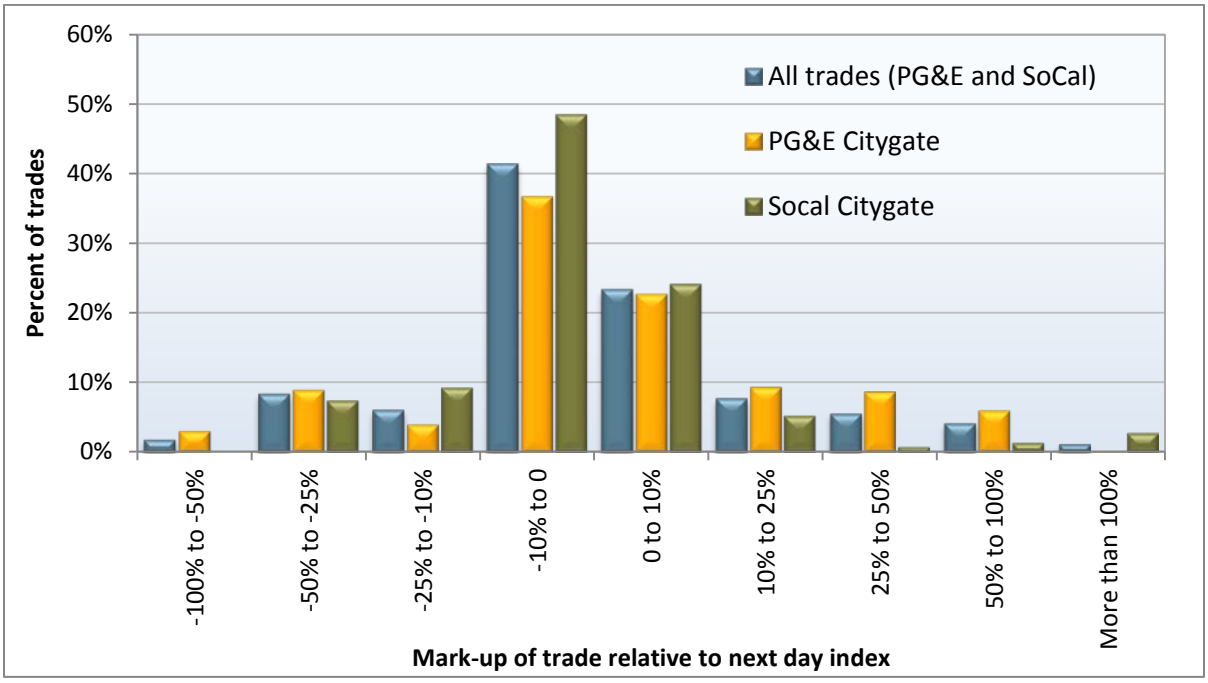
Table 1 Days with high natural gas price volatility (January 2010 through March 2015)

Trade Date	Flow Date	Next day index lag		Next Day Intra-Day				Same Day			
				PG&E-Citygate		Socal-Citygate		PG&E-Citygate		Socal-Citygate	
		PG&E-Citygate	Socal-Citygate	Average higher than next day index	Maximum trade above average	Average higher than next day index	Maximum trade above average	Average higher than next day index	Maximum trade above average	Average higher than next day index	Maximum trade above average
4/5/2010	4/6/2010		10%								
11/8/2010	11/9/2010									10%	
5/31/2011	6/1/2011		10%								
11/28/2011	11/29/2011		12%								
1/2/2013	1/3/2013		12%								
12/5/2013	12/6/2013									8%	4%
12/6/2013	12/7/2013	17%		5%	9%			21%	2%		
12/6/2013	12/8/2013			5%	9%			21%	2%		
12/6/2013	12/9/2013			5%	9%			21%	2%		
12/9/2013	12/10/2013	22%	64%						16%		
1/28/2014	1/29/2014							7%	6%		
2/3/2014	2/4/2014	20%	17%					30%	3%	14%	1%
2/4/2014	2/5/2014	28%	19%					75%	28%		
2/5/2014	2/6/2014	170%	62%		61%		151%		61%	40%	139%
2/6/2014	2/7/2014			32%	5%	90%	9%	16%	19%		80%
2/7/2014	2/8/2014			48%	3%						
2/7/2014	2/9/2014			48%	3%						
2/7/2014	2/10/2014			48%	3%						
2/10/2014	2/11/2014	18%	21%								
2/11/2014	2/12/2014								15%		
2/20/2014	2/21/2014							10%	3%		
2/21/2014	2/22/2014	18%			14%						
2/21/2014	2/23/2014				14%						
2/21/2014	2/24/2014				14%						
2/24/2014	2/25/2014								14%		
2/25/2014	2/26/2014					11%					
2/27/2014	2/28/2014							7%	6%	10%	1%
2/28/2014	3/1/2014		22%								
3/3/2014	3/4/2014	33%	28%								
11/10/2014	11/11/2014		12%								
12/29/2014	12/30/2014		29%								

Because the price volatility for flow days February 4 through 10, 2014, was above the levels covered under the ISO's current processes, we focused on these days in further detail.

Specifically, we compared the next day index price with every trade at the PG&E Citygate and SoCal Citygate hubs on these days, and calculated the mark-up of each trade to the next day index price. For example, if the index price was $11/MMBtu and a specific trade was $13.50/MMBtu, this resulted in a 23 percent markup. Figure 3 shows this calculation for all trades in the next day, next day intra-day and same day markets. We included the next day market in this calculation because there were several days where the volatility in the next day market exceeded 25 percent and in some cases had the highest priced trade for that flow day.

Figure 3. Frequency of price mark-up relative to next day index (Flow dates February 4 - February 10, 2014)



Our analysis found that given all the trades reported on ICE, about 90 percent of all trades were less than 25 percent higher than the next day average price with most trades between positive and negative 10 percent. Just under 95 percent were below a 50 percent markup, and about 99 percent were below a 100 percent markup. This represented about 9 percent, 4 percent, and 1 percent of the total traded volumes during this period, respectively. Of the instances with a mark-up above 50 percent, 64 percent of the instances were same day trades, 33 percent were next day trades and the rest were next day intra-day trades. Breaking this analysis down further by trading hub resulted in overall similar results.

4 Conclusions and recommendations

Our analysis finds that 99 percent of the upward daily natural gas price risk is covered within the current bidding rules in place within the ISO markets. Our analysis further shows that in the 1 percent of days with high gas price volatility in early February 2014, 90 percent of the trades were below 125 percent of the next day average price, the current cap on proxy costs. Thus, we see that the ISO's current rules cover a large amount of the historical upward natural gas risk. This reinforces the fact that the next day gas price – when combined with the upward headroom currently provided for start-up, minimum load and default energy bids – is a very good proxy for spot natural gas prices.

The ISO has already worked to reduce some of this upward price risk by removing the next day price lag through its manual update procedure when next day gas prices increase by 25 percent from the previous day. Most of the remaining days not covered under the current provisions are concentrated in early February 2014.

Thus, DMM finds that only incremental changes to the ISO's current bidding rules are warranted. Specifically, DMM provides the following recommendations:

- DMM supports the ISO's proposal to allow resources not committed in the day-ahead market to rebid in their proxy costs with updated natural gas prices in the real-time market. This will help reduce the risk associated with using lagged natural gas indices in the real-time market.
- DMM suggests that the ISO consider dropping the threshold for when the ISO invokes the update to its special price spike procedures. The current threshold is set at a 25 percent change in next day index prices from the previous index price. For instance, dropping the threshold that triggers the manual update process from 25 percent to 15 percent would have included an additional 5 days in our sample period, representing 16 percent of the days with high gas price volatility in our sample.
- DMM supports further consideration and discussion of the ISO's general concept to allow for cost recovery for resources that don't cover their fuel costs due to gas price volatility. However, DMM believes this approach would need to be limited by strict and clear conditions that are spelled out in detail as part of this stakeholder initiative, rather than at a later point as part of the implementation process. Design details should include specific reporting and documentation requirements required from generators, and data verification and calculational rules that would be employed by the ISO. In addition, the ISO would also need to commit to ensuring that the necessary resources and processes were in place to implement this change. DMM notes that this may require additional expertise in gas procurement and auditing that do not currently exist within the ISO. Thus, we recommend that the ISO carefully flesh out this option as early as possible to ensure clarity and completeness.

Appendix A

The following charts highlight graphically the three forms of upward price risk at both the PG&E and SoCal Citygate hubs. The figures show the range of trades in a scatterplot of prices.

The X-axis represents the next day index price. The Y-axis represents either the average or maximum in the next day, next day intra-day, or same day markets. The yellow dots represent each individual day.

The black line represents the point at which the gas values on the X-axis and Y-axis are the same.[22] The large dashed lines represent what the price would be at 110 percent of the next day average, consistent with the level of the default energy bid. The small dashed lines represent what the price would be at 125 percent of the next day average, consistent with the cap on proxy commitment costs.[23]

The figures show that most records are below 110 percent of the index price and that very few records exceed 125 percent of the index price.

[22] Values below this line indicate the records are smaller than the next day index.

[23] In many of these figures, we have excluded the results for February 6, 2014, in order to allow the chart to be readable.

Figure A.1 Next day index price compared to previous next day index price (PG&E Citygate)

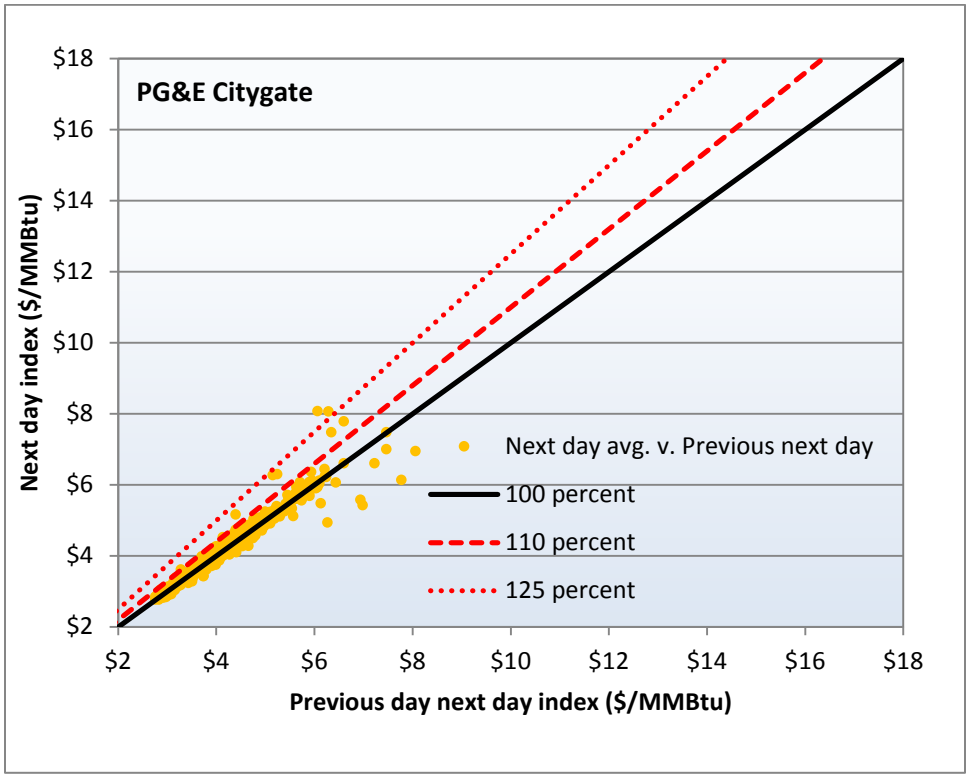


Figure A.2 Next day index price compared to previous next day index price (SoCal Citygate)

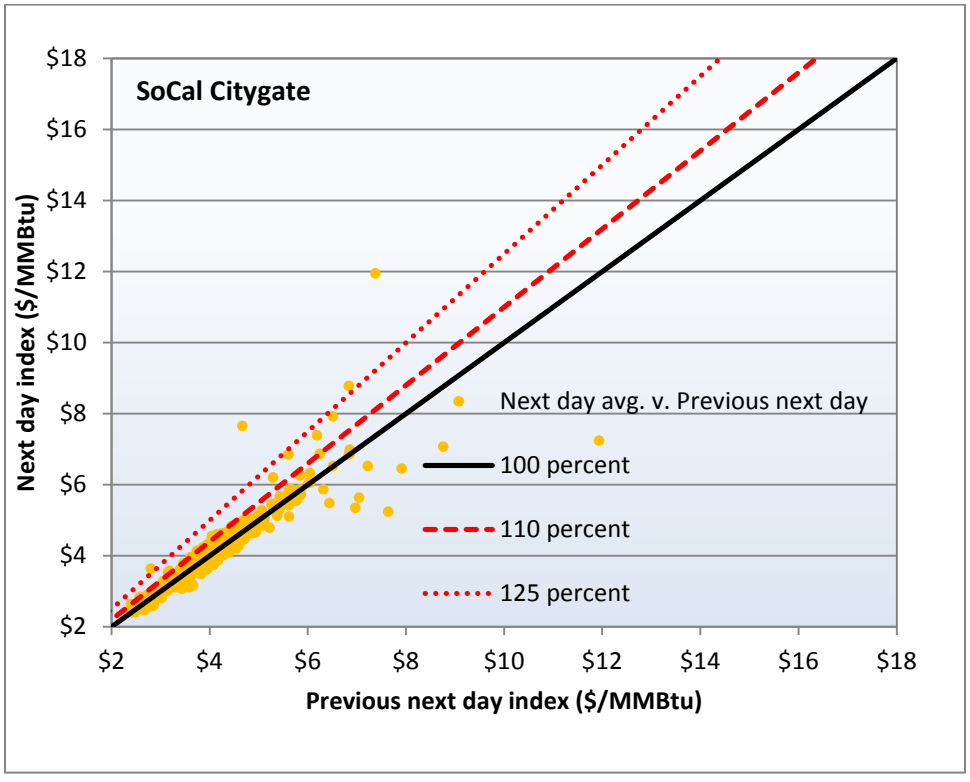


Figure A.3 Average next day intra-day price compared to next day index price (PG&E Citygate)

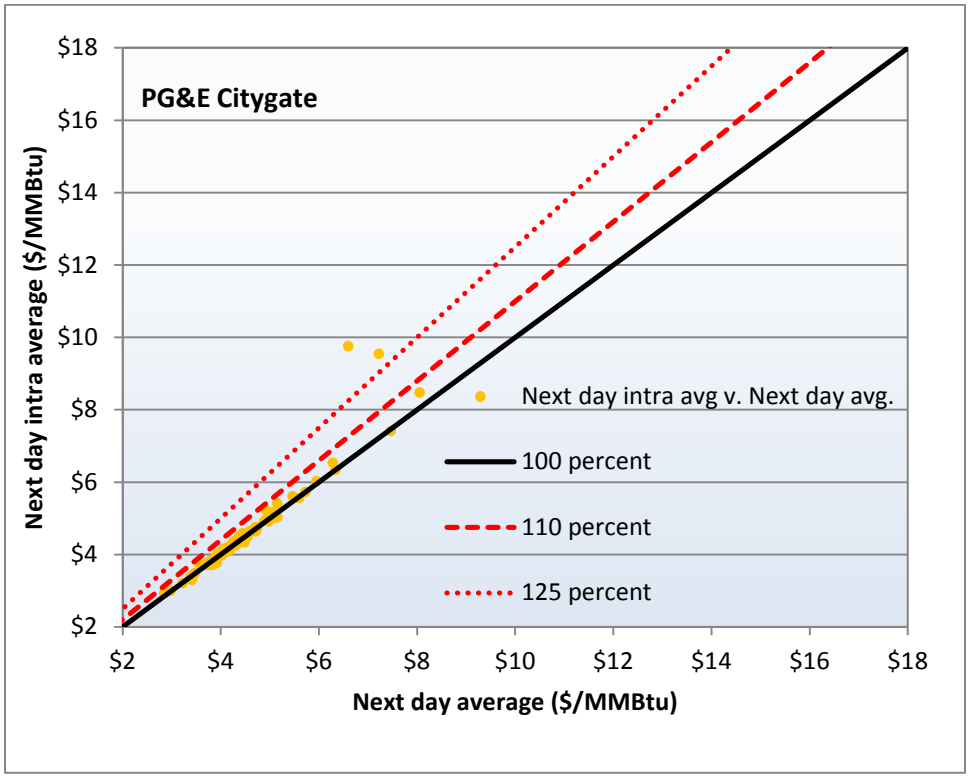


Figure A.4 Average next day intra-day price compared to next day index price (SoCal Citygate)

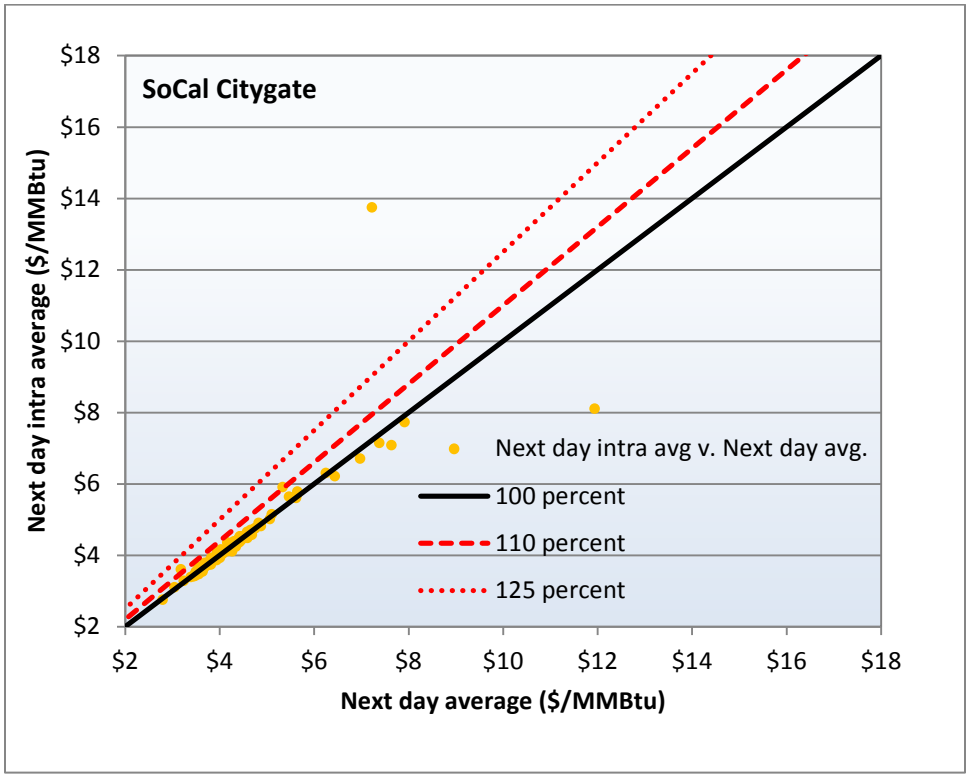


Figure A.5 Maximum of next day intra-day price and next day index price compared to next day index price (PG&E Citygate)

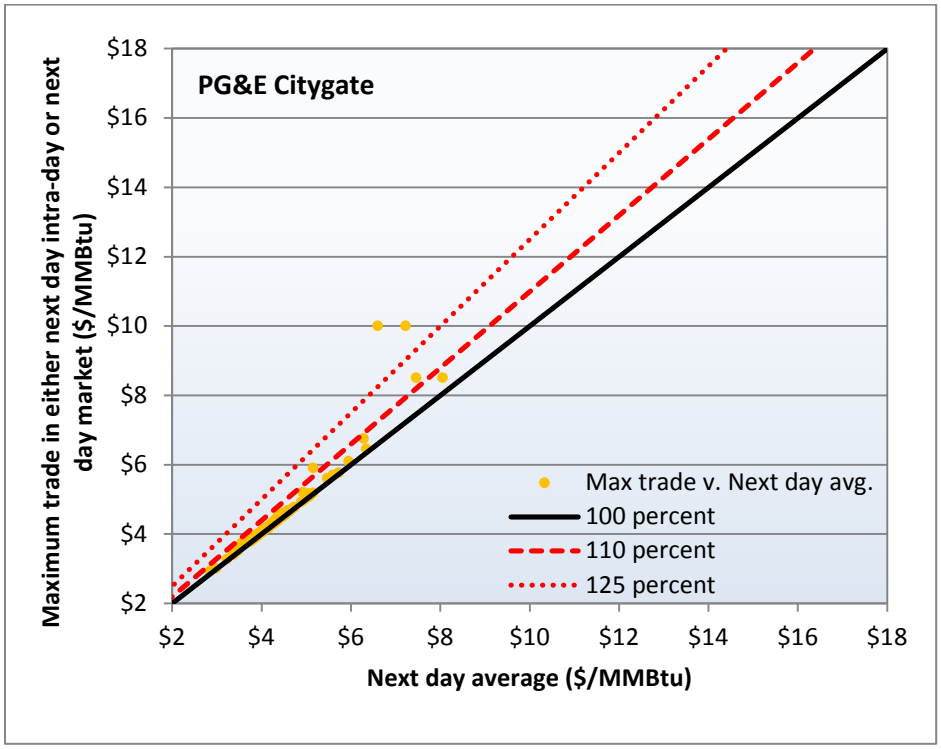


Figure A.6 Maximum of next day intra-day price and next day index price compared to next day index price (SoCal Citygate)

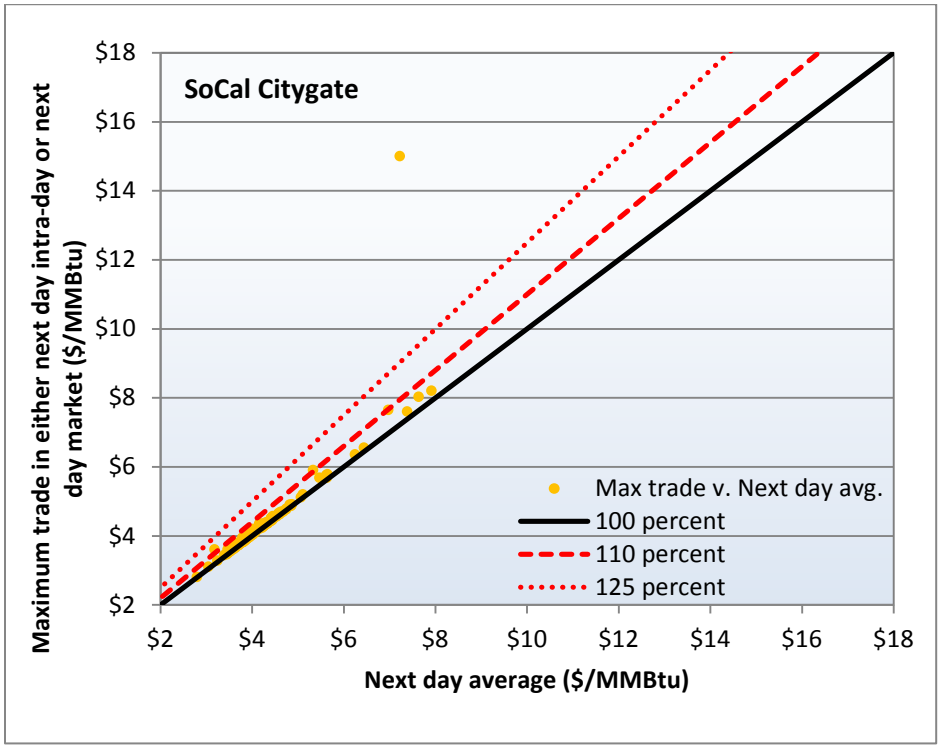


Figure A.7 Average same day price compared to next day index price (PG&E Citygate)

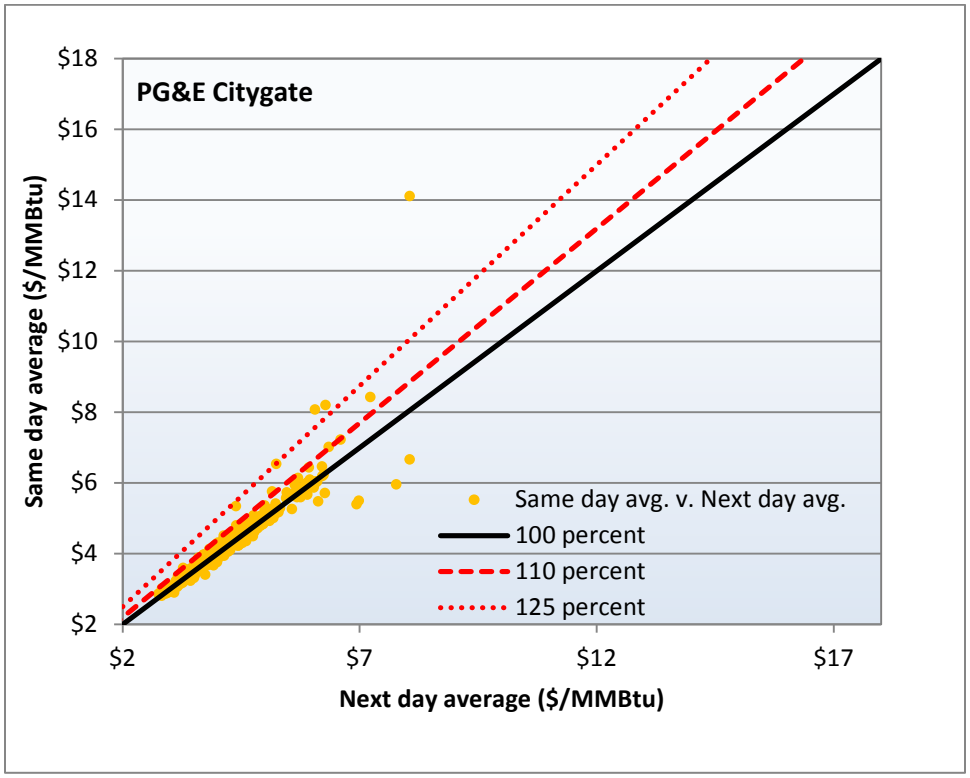


Figure A.8 Average same day price compared to next day index price (SoCal Citygate)

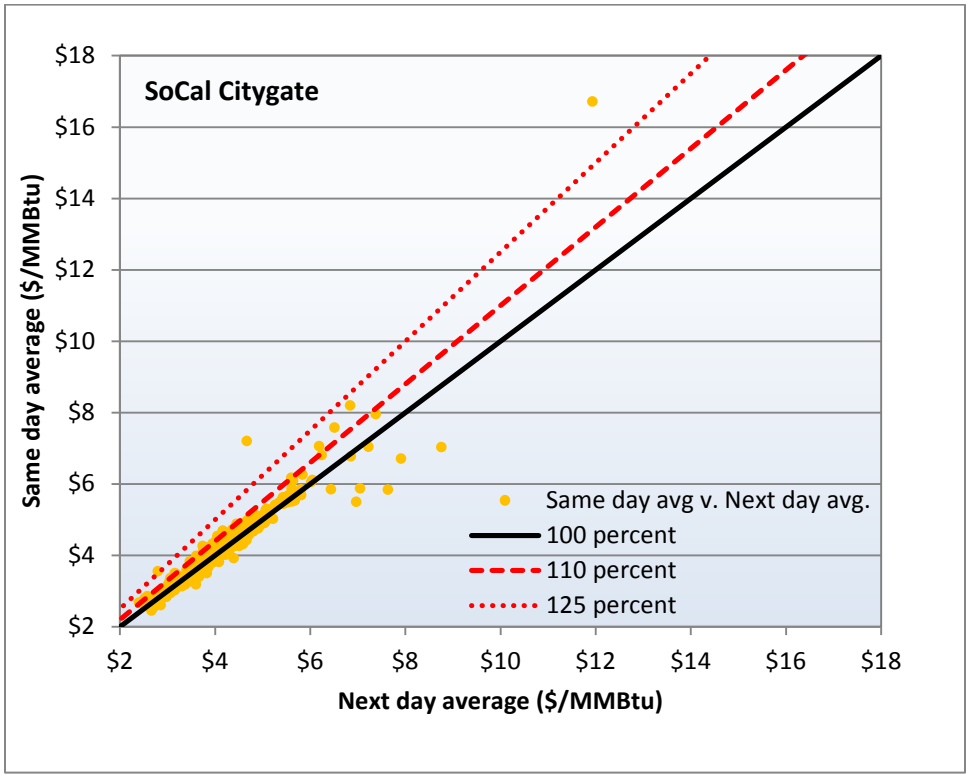


Figure A.9 Maximum of same day price and next day index price compared to next day index price (PG&E Citygate)

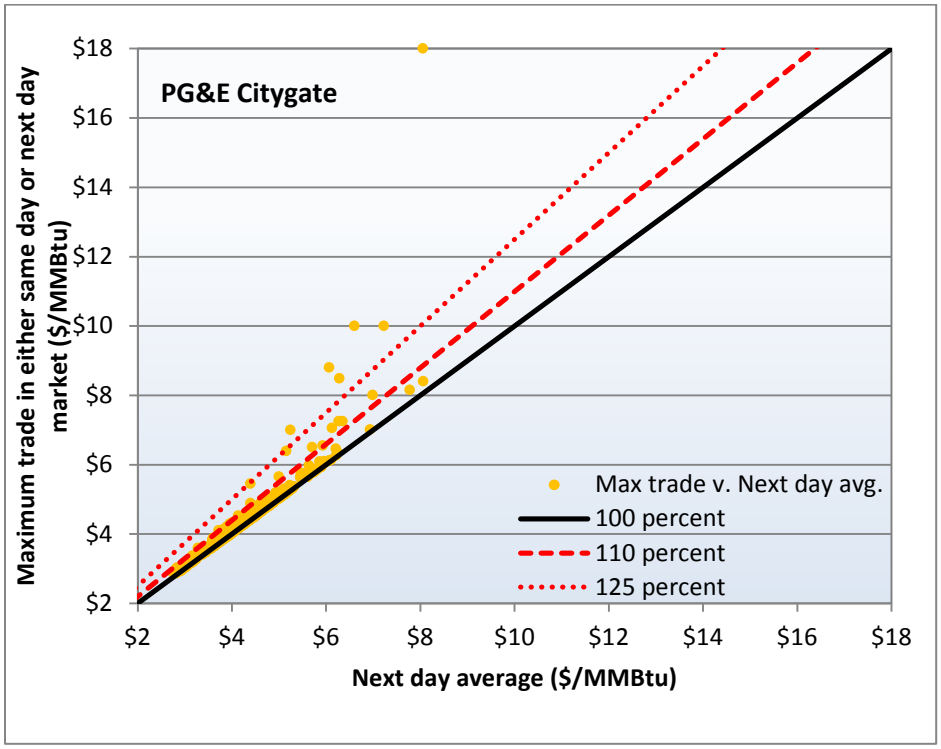


Figure A.10 Maximum of same day price and next day index price compared to next day index price (SoCal Citygate)