U.S. Energy Information Administration

Short-Term Energy Outlook
Energy Price Volatility and Forecast Uncertainty[1]

July 7, 2010 Release

Crude Oil Prices. WTI crude oil spot prices averaged $75.34 per barrel in June 2010 ($1.60 per barrel above the prior month's average), close to the $76 per barrel projected in the forecast in last month's Outlook. EIA projects WTI prices will average about $79 per barrel over the second half of this year and rise to $84 by the end of next year (West Texas Intermediate Crude Oil Price Chart).

Energy price forecasts are highly uncertain, as history has shown (Energy Price Volatility and Forecast Uncertainty). WTI futures for September 2010 delivery for the 5-day period ending July 1 averaged $77 per barrel, and implied volatility averaged 35 percent. This made the lower and upper limits of the 95-percent confidence interval $60 and $98 per barrel, respectively.
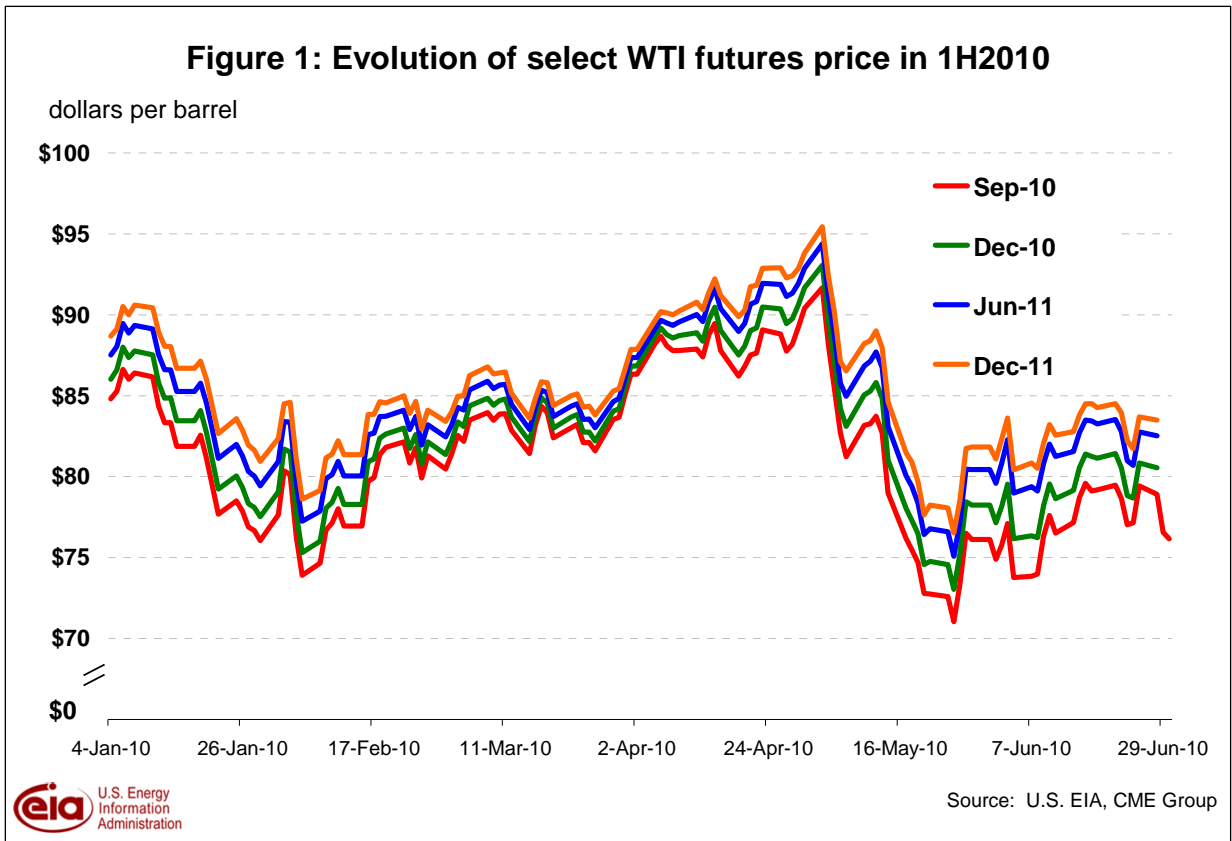
Last year at this time, WTI for September 2009 delivery averaged $70 per barrel, and implied volatility averaged 44 percent, rendering the limits of the 95-percent confidence interval $52 and $95 per barrel.

The occasional bouts of oil-price volatility and headline-grabbing news notwithstanding, the second quarter of 2010 ended not much different from the first. Futures prices for August 2010 to December 2011 were, on average, about a dollar higher by the end of the second quarter (Figure 1).

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[1] This is a regular monthly supplement to the EIA *Short-Term Energy Outlook*.
(http://www.eia.doe.gov/emeu/steo/pub/contents.html)
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Figure 1: Evolution of select WTI futures price in 1H2010

dollars per barrel

Source: U.S. EIA, CME Group

Most of the increase in the average futures prices during the second quarter was apparent in the deferred contracts, where press and analyst reports indicated market participants were pricing the impact of the 6-month deepwater drilling moratorium announced by Secretary Salazar on May 27 (Figure 2).

**Figure 2: Average WTI futures prices in 1Q vs 2Q2010**
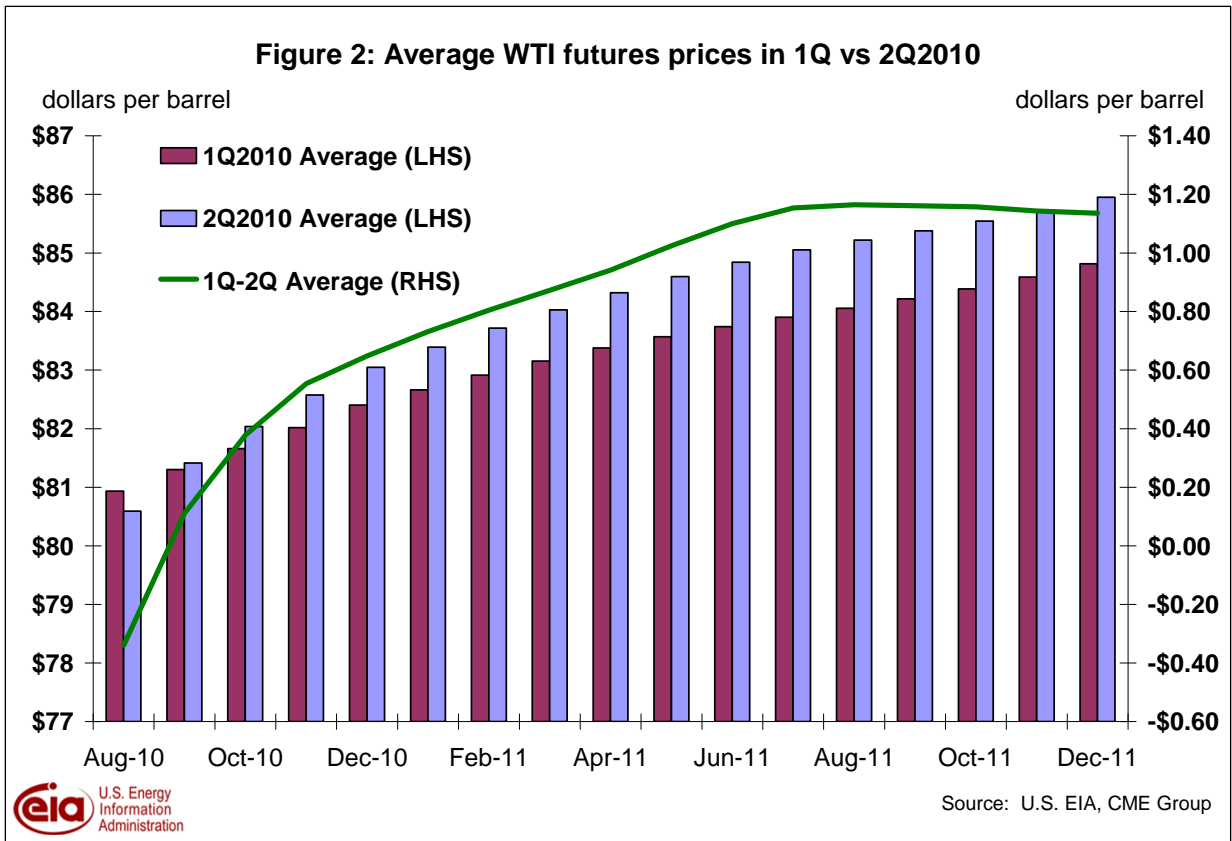
Implied volatility also ended the second quarter not much changed from first-quarter levels, albeit with occasional spikes during the April-June 2010 period (Figure 3).

**Figure 3: Evolution of select WTI implied volatilities in 1H2010**
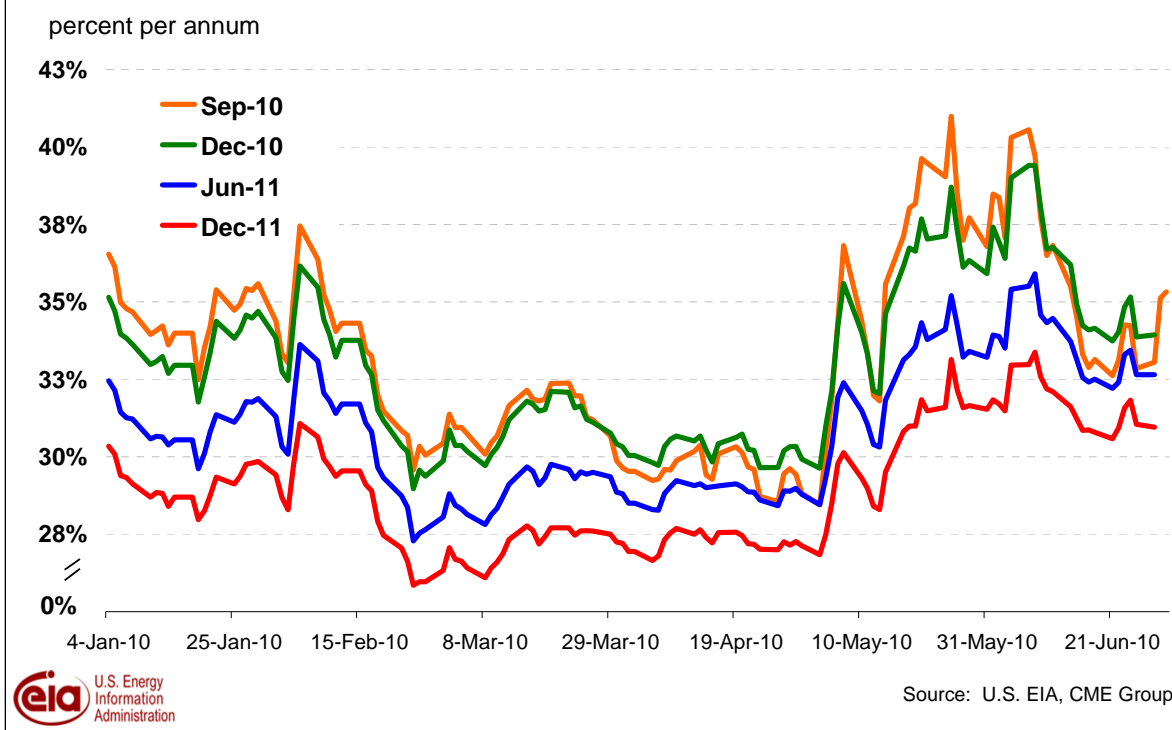
An overall firming of the market was apparent in the behavior of WTI timespreads (i.e., the difference between a prompt-delivered WTI futures and a deferred contract), which are sensitive to storage conditions at Cushing, Oklahoma, the location of WTI futures physical deliveries (Figure 4). As storage levels are drawn lower, the timespreads narrow as storage holders sell from inventory. The opposite happens when demand for prompt-delivered crude is less than the supply of prompt-delivered crude. In such a market, a refiner without an immediate need for crude oil must account for storage costs, which will be incurred until the crude is needed, so he will bid less for the prompt barrel relative to the deferred barrel. This results in a "contango," in which prompt prices are less than deferred prices. The price difference allows the refiner to buy the prompt barrel and sell a futures or forward contract for deferred delivery at a cost that covers his all-in carrying cost.

Figure 4: WTI prompt time-spreads
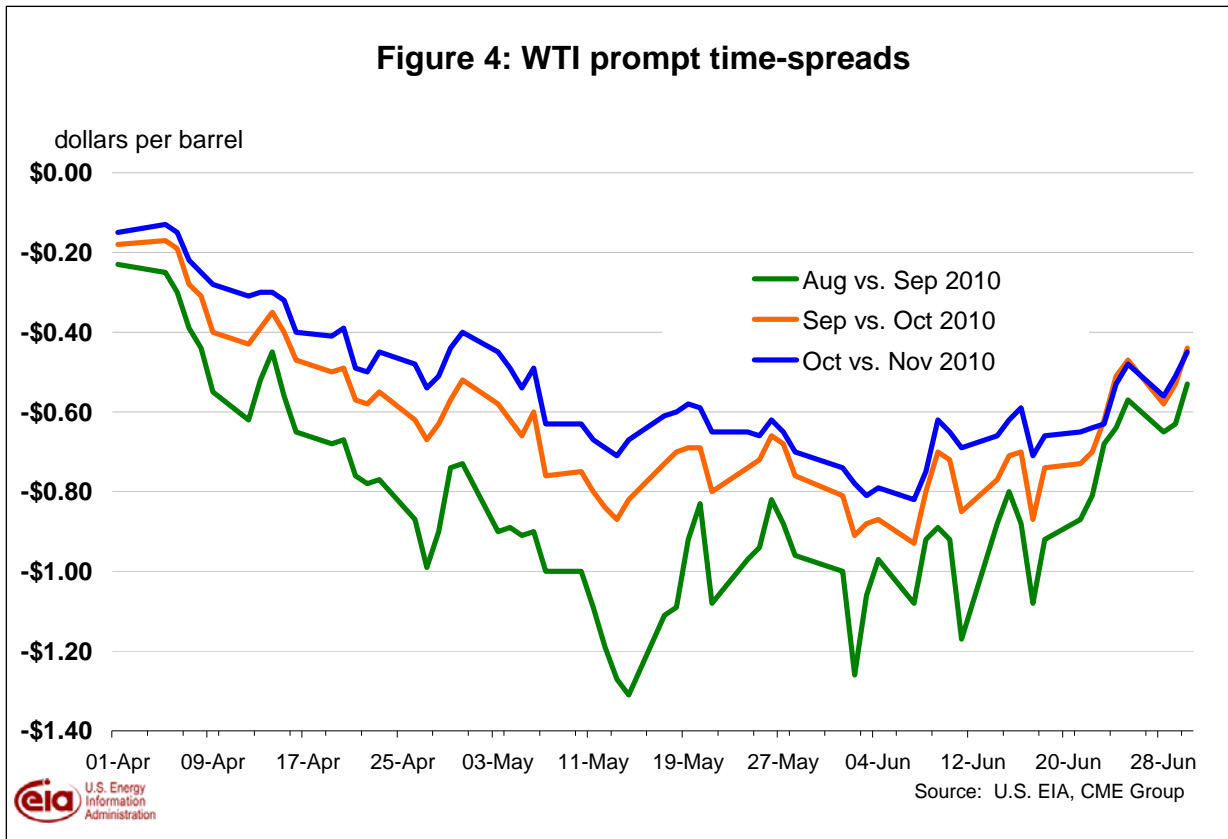
In addition, WTI-Brent spreads, which are closely tracked by market participants to gauge whether transporting North Sea Brent and other grades of crude oil to the United States for refining is economical, firmed toward the end of the second quarter (Figure 5). This indicates market participants may be anticipating the need for additional imports – e.g., if a trader sources barrels offshore (e.g., in the North Sea), he will need to sell a futures or forward contract for deferred delivery to cover the transit of the crude. To avoid the risk of loss the trader will, in this example, price the prompt physical barrels in the North Sea at a discount to the barrels sold forward so that the costs of the vessel transporting the oil (including insurance, inspection, etc.) are covered. The market signals its need for imported barrels by bidding the price of domestic crude over the cost of comparable crudes that can be imported.
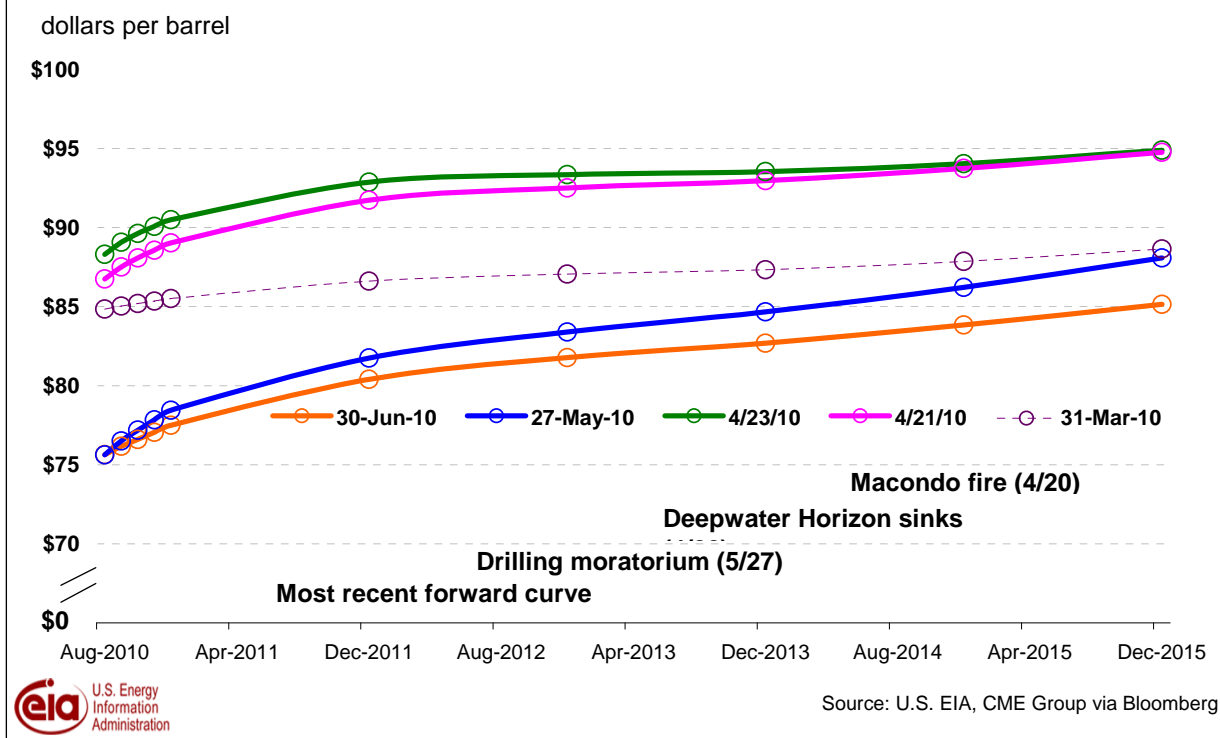
Figure 5: WTI - Brent spreads

dollars per barrel

Source: U.S. EIA, CME Group
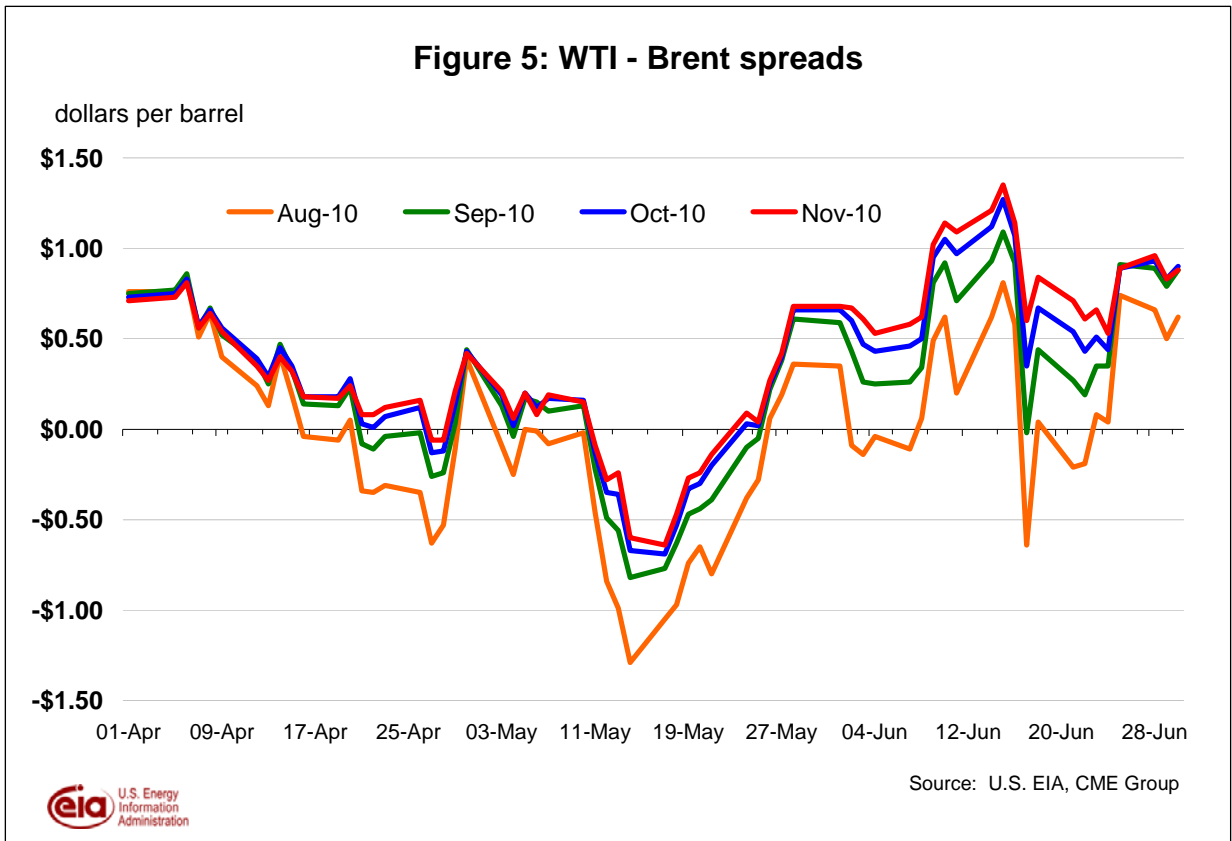
Market participants lowered the probability of WTI trading at a price higher than $100 per barrel at the end of this year by the end of the second quarter versus first-quarter assessments. However, by mid-2011 and December 2011 the market was pricing a roughly 1-in-4 chance of WTI trading at over $100 (Figure 6). Overall, the market's expected probabilities for next year ended the second quarter in line with where they ended the first quarter of the year.

Figure 6: Probabilities for higher near-term WTI prices
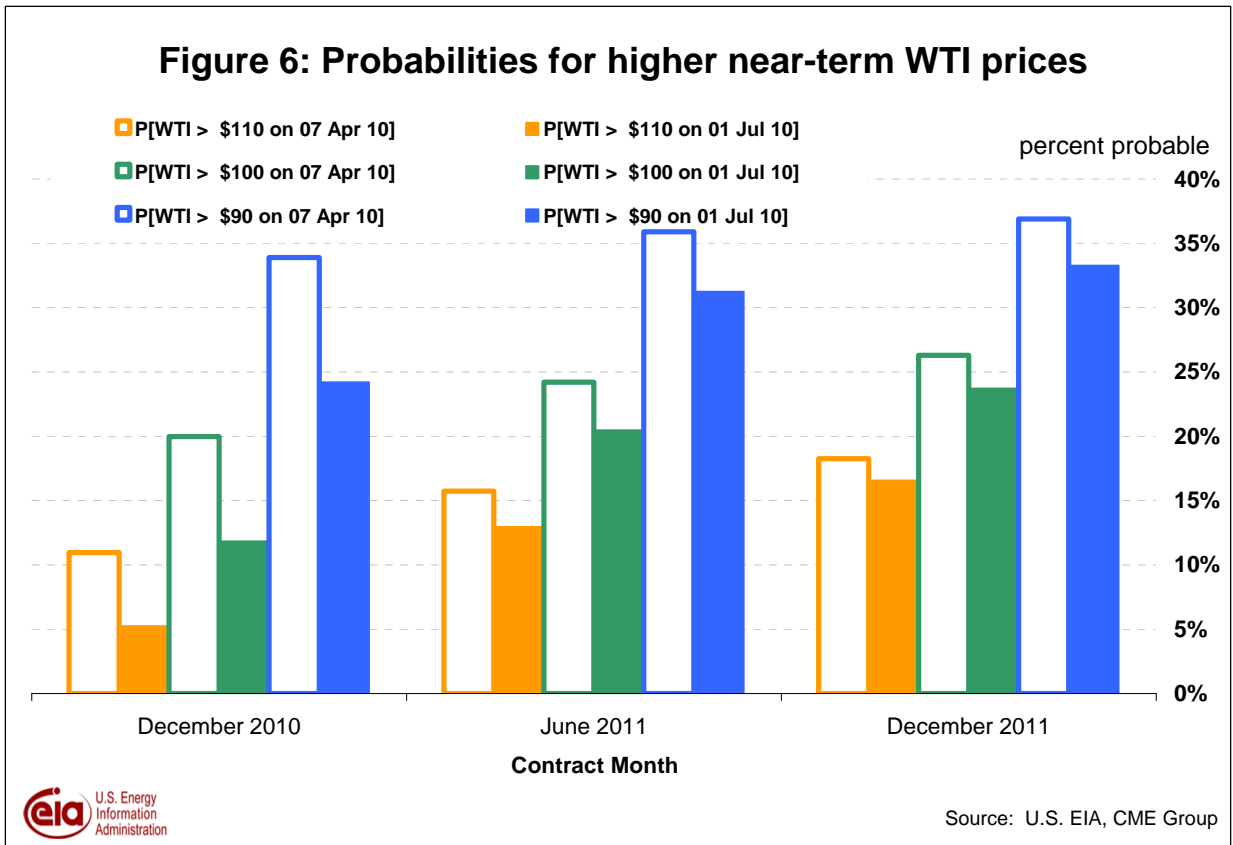
The forward curve to December 2015 also ended the second quarter close to its first-quarter level (Figure 7).

Figure 7: WTI futures term structure evolution

dollars per barrel

Legend: 30-Jun-10 | 27-May-10 | 4/23/10 | 4/21/10 | 31-Mar-10

Macondo fire (4/20)
Deepwater Horizon sinks
Drilling moratorium (5/27)
Most recent forward curve

Source: U.S. EIA, CME Group via Bloomberg

Last year at this time, WTI for September 2009 delivery averaged $67.54 per barrel, and implied volatility averaged 47.47 percent. The lower and upper limits of the 95-percent confidence interval were $49.26 and $92.60 per barrel, respectively.

U.S. Natural Gas Prices. The Henry Hub spot price averaged $4.80 per MMBtu in June, $0.66 per MMBtu higher than the average spot price in May (Henry Hub Natural Gas Price Chart). The forecast price for the second half of 2010 averages $4.68 per MM Btu, $0.32 per MMBtu higher than last month's Outlook. The risk of hurricane outages and the projected reduction in drilling activity combine to strengthen prices through the year. A small decline in U.S. production alongside increased consumption leads to higher prices in 2011; the projected Henry Hub spot price averages $5.17 per MMBtu.

Uncertainty over future natural gas prices is lower this year compared with last year at this time. Natural gas futures for September 2010 delivery for the 5-day period ending July 1 averaged $4.77 per MMBtu, and the average implied volatility over the same period was 53 percent. This produced lower and upper bounds for the 95-percent confidence interval of $3.16 and $7.18 per MMBtu, respectively. At this time last year the natural gas September 2009 futures contract averaged $4.00 per MMBtu

and implied volatility averaged almost 76 percent. This rendered the lower and upper limits of the 95-percent confidence interval at $2.25 and $7.14 per MMBtu.

Natural gas prices trended higher during the second quarter (Figure 8). April marks the beginning of the natural gas injection season, and during the April – October period market participants are weighing the likelihood gas storage injections will be interrupted by hurricanes or supply and demand shocks. On June 29, the U.S. National Hurricane Center issued a hurricane warning for the coast near the Texas-Mexico border around the mouth of the Rio Grande, where the first hurricane of the 2010 season (Alex) was due to make landfall.

Figure 8: NG price evolution from start of 2010 injection season
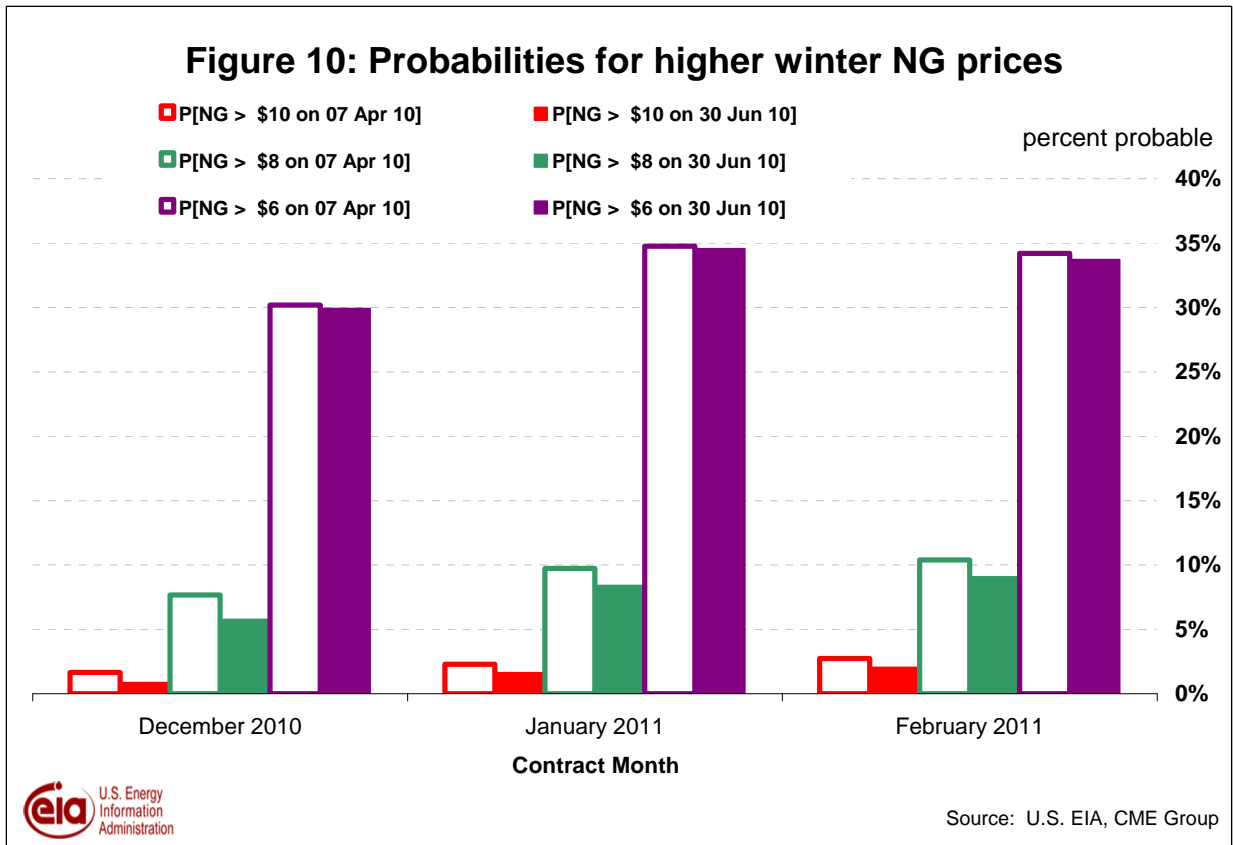
Source: U.S. EIA, CME Group
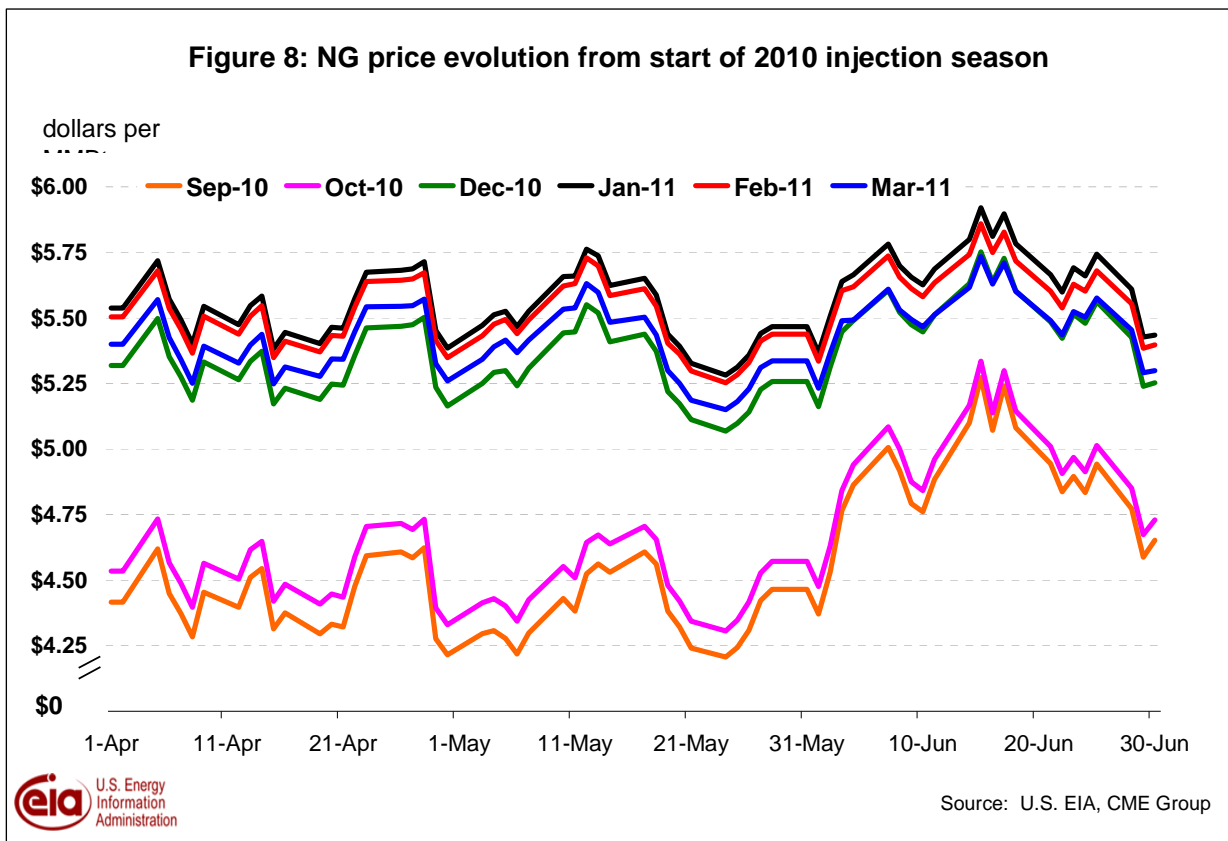
As was the case in May 2010, implied volatility for options on October natural gas futures, at 57 percent per annum, registered the highest level of the natural gas futures contracts traded on the New York Mercantile Exchange (NYMEX). The September 2010 contract was the next highest implied volatility, at 54 percent. During the 5-day period ended June 30, September futures averaged $4.86 per MMBtu, which made the lower and upper limits of the 95-percent confidence intervals $3.16 and $7.47 per

MMBtu, respectively. At this time last year, September natural gas futures averaged $3.77 per MMBtu and implied volatility averaged 76.6 percent. This rendered a lower and upper limit for the September 95-percent confidence interval of $2.14 and $6.65 per MMBtu, respectively.

Statistically, hurricane activity peaks in September, when the NYMEX October futures contract is pricing for delivery into Henry Hub, Louisiana. October also marks the end of the natural gas injection season. This tends to give the October contract the highest expected and realized volatility of the injection season (Figure 9).

Figure 9: Natural gas implied volatility during 2010 injection season
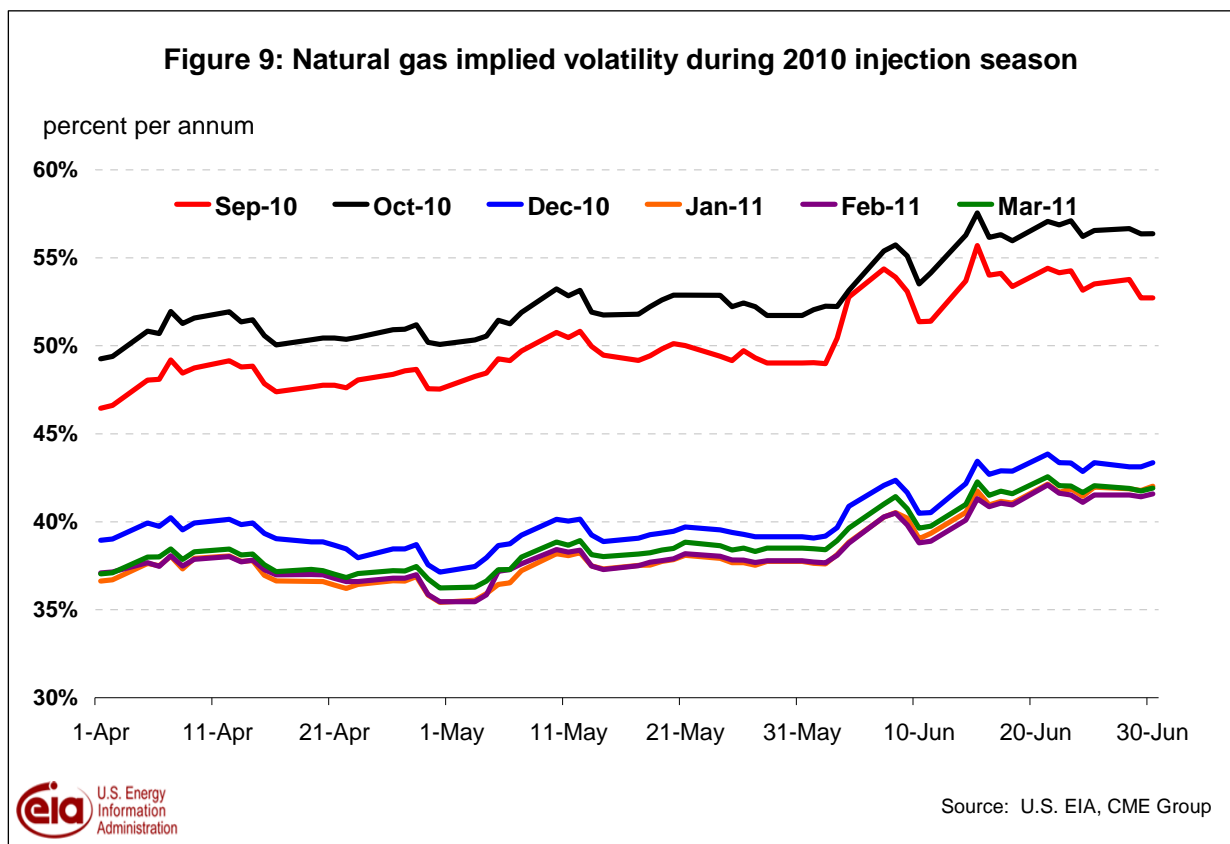
For the upcoming winter season, market participants assigned approximately a one-in-three chance to natural gas futures trading at a price over $6 per MMBtu in the December 2010 – February 2011 period as the second quarter drew to a close (Figure 10). The likelihood of natural gas trading over $8 per MMBtu is less than 10 percent, based on market expectations.

Figure 10: Probabilities for higher winter NG prices

Legend:
- P[NG > $10 on 07 Apr 10]
- P[NG > $10 on 30 Jun 10]
- P[NG > $8 on 07 Apr 10]
- P[NG > $8 on 30 Jun 10]
- P[NG > $6 on 07 Apr 10]
- P[NG > $6 on 30 Jun 10]

percent probable

Contract Month: December 2010, January 2011, February 2011

Source: U.S. EIA, CME Group

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The probabilities in Figures 6 and 10 are cumulative normal densities (see Appendix II of Energy Price Volatility and Forecast Uncertainty), showing the market's assessment for various price outcomes in 2010 and 2011. EIA uses market-based parameters derived from futures and options prices to calculate these densities (see April STEO Supplement, Probabilities of Possible Future Prices).