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MEMORANDUM

From: Mark Bolinger and Ryan Wiser, Berkeley Lab (LBNL)
Subject: Comparison of AEO 2005 Natural Gas Price Forecast to NYMEX Futures Prices
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On December 9, the reference case projections from *Annual Energy Outlook 2005* (AEO 2005) were posted on the Energy Information Administration's (EIA) web site. As some of you may be aware, we at LBNL have in the past compared the EIA's reference case long-term natural gas price forecasts from the AEO series to contemporaneous natural gas prices that can be locked in through the forward market, with the goal of better understanding fuel price risk and the role that renewables play in mitigating such risk (see, for example, <http://eetd.lbl.gov/ea/EMS/reports/53587.pdf> or <http://eetd.lbl.gov/ea/ems/reports/54751.pdf>). As such, we were curious to see how the latest AEO gas price forecast compares to the NYMEX natural gas futures strip. This brief memo presents our findings.

As a refresher, our past work in this area has found that over the past four years, forward natural gas contracts (e.g., gas futures, swaps, and physical supply) have traded at a premium relative to contemporaneous long-term reference case gas price forecasts from the EIA. As such, we have concluded that, over the past four years at least, levelized cost comparisons of fixed-price renewable generation with variable price gas-fired generation that have been based on AEO natural gas price forecasts (rather than forward prices) have yielded results that are "biased" in favor of gas-fired generation (presuming that long-term price stability is valued). In this memo we simply update our past analysis to include the latest long-term gas price forecast from the EIA, as contained in AEO 2005. For the sake of brevity, we do not rehash information (on methodology, potential explanations for the premiums, etc.) contained in our earlier reports on this topic; readers interested in such information are encouraged to download that work from <http://eetd.lbl.gov/ea/EMS/reports/53587.pdf> or, more recently (and briefly), <http://eetd.lbl.gov/ea/ems/reports/54751.pdf>.

As was the case in the past four AEO releases (AEO 2001-AEO 2004), we once again find that the AEO 2005 reference case gas price forecast falls well below where NYMEX natural gas futures contracts were trading at the time the EIA finalized its gas price forecast. In fact, the NYMEX-AEO 2005 reference case comparison yields by far the largest premium – \$1.11/MMBtu levelized over six years – that we have seen over the last five years. In other words, on average, one would have to pay \$1.11/MMBtu *more* than the AEO 2005 reference case natural gas price forecast in order to lock in natural gas prices over the coming six years and thereby replicate the price stability provided intrinsically by fixed-price renewable generation. Fixed-price

renewables obviously need not bear this added cost, and moreover can provide price stability for terms well in excess of six years.

Update on Natural Gas Prices

As context for our analysis, we provide this brief update on natural gas prices. Figure 1 shows the daily price history of “first-nearby” (i.e., closest to expiration, and therefore a proxy for spot prices) NYMEX natural gas futures contracts back to 1990, along with the current (from 12/09/04) 72-month NYMEX futures “strip” tacked on to the end. The strip shows that one can currently lock in Henry Hub prices of between \$5.0/MMBtu and \$7.0/MMBtu over the next 6 years, with the entire 72-month strip averaging around \$6.0/MMBtu. These prices are well above the range of \$1-3/MMBtu that persisted throughout the 1990s.

Figure 1: NYMEX Natural Gas Futures Prices

Figure 1 focuses on the history of “first-nearby” gas futures prices (a proxy for spot prices) and provides only a current snapshot of the 72-month futures strip (i.e., the prices that can currently be locked in for the next 72 months). Figure 2, in contrast, shows the daily history of the *average* (and *levelized*) 72-month natural gas futures strip going back to December 2001, when the NYMEX first extended futures trading from 36 to 72 months. While “first nearby” prices (from Figure 1) are not currently at historic highs (though, as shown in Figure 1, they are higher than they were last fall), the average of the 72-month price strip is currently just below its recent historic high of just over \$6.5/MMBtu. Moreover, the average of the 72-month strip is currently about \$1.25/MMBtu higher than it was last year at this time. While first-nearby (spot) prices jump around quite a bit, the average price of natural gas that can be locked in over the subsequent 72 months has risen fairly steadily in the past three years.

Figure 2: Average and Levelized 72-Month NYMEX Natural Gas Futures Strip

The AEO 2005 Natural Gas Price Forecast

With natural gas prices significantly higher this fall than last (as seen in Figure 1 for current prices and Figure 2 for 6-year price projections), expectations have generally been that the EIA would, in *AEO 2005*, revise its reference case gas price forecast significantly upwards. As shown in Figures 3 and 4, this appears to have happened in the first few years of the forecast, but not necessarily over the longer term.

Figure 3 compares the *AEO 2005* projection of nominal natural gas prices delivered to electricity generators to the same price projection from *AEO 2004* and *AEO 2003*. While *AEO 2004*'s forecast represented a substantial increase over *AEO 2003*'s all along the curve, *AEO 2005*'s reference case forecast of nominal gas prices delivered to generators starts out much higher than in *AEO 2004*, but then *falls below* the *AEO 2004* forecast from 2011-2025.

Figure 3: Natural Gas Prices Delivered to Electricity Generators, Nominal \$/MMBtu

Reduced inflation expectations are partially responsible for the pattern depicted in Figure 3, which expresses prices in nominal dollars. Figure 4 shows the same price series in real (2003 \$) dollars. With the notable exception of the period from 2011-2018, the *AEO 2005* forecast is generally above the *AEO 2004* price forecast in real dollars.

Figure 4: Natural Gas Prices Delivered to Electricity Generators, 2003 \$/Mcf

As shown in Figures 3 and 4, the much-anticipated increase in *AEO 2005* natural gas price projections appears to have materialized primarily over the near term (i.e., through 2007), while the longer-term price projection remains largely unchanged from that contained in *AEO 2004*.

Natural Gas Futures Prices Still Trading at a Premium to AEO Price Forecasts

Despite the sharp upward revision to the EIA's near-term (i.e., 2005-2007) gas price forecast in *AEO 2005*, the first six years of that forecast are still not on par with where natural gas futures contracts have been trading.¹ Figure 5 compares the basis-adjusted *AEO 2005* reference case projection of gas prices delivered to electricity generators (which resulted from an October 20, 2004 modeling run) to the NYMEX natural gas futures strip (with monthly prices averaged each year) from October 19, 2004. While the spread between the two data series varies somewhat from year to year, on a 6-year levelized basis the premium equals \$1.11/MMBtu.²

¹ This is also the case with respect to the *AEO 2005* reference case oil price forecast and NYMEX oil futures contracts. In fact, the EIA acknowledges that back in October, basis-adjusted NYMEX crude oil futures contracts for 2010 were trading for about \$6/barrel more than the reference case oil price forecast for that year. In response to this disparity, the EIA ran an "October oil futures case" where oil prices are based on the NYMEX strip. Somewhat surprisingly, despite higher oil prices, natural gas prices projected in the "October oil futures case" are *slightly below* those projected in the reference case.

² To shift from the price of gas delivered to electricity generators to Henry Hub prices, we subtract \$0.38/MMBtu from delivered prices (see <http://eetd.lbl.gov/ea/EMS/reports/53587.pdf> for explanation, rationale, and confidence intervals). Alternatively, the EIA has, in <http://www.eia.doe.gov/oiaf/analysispaper/henryhub/index.html>, proposed two basis adjustments to shift from wellhead to Henry Hub prices. The first, increasing wellhead prices by 10.8%, yields a 6-year levelized premium of \$1.00/MMBtu. The second, adding \$0.316/Mcf to wellhead prices, results in a 6-year levelized premium of \$1.19/MMBtu. While no basis adjustment is perfect, given the three different methods presented, a premium (in Henry Hub terms) in the range of \$1.00-\$1.19/MMBtu seems reasonable.

Figure 5: Comparison of NYMEX Futures Strip to AEO 2005 Gas Price Projection

Picking the Correct Date of Comparison

As mentioned above, the *AEO 2005* reference case natural gas price projection resulted from a NEMS run completed on October 20, 2004. For the comparison made above in Figure 5, we therefore chose to sample the NYMEX strip from October 19, 2004 in order to reflect the latest market information available to the EIA at the time the gas price projections were being finalized. In order to ensure that October 19, 2004 is in fact representative of where gas futures had been trading around the time the EIA was finalizing its *AEO 2005* forecast, we examined the average 6-year NYMEX strip from the beginning of September 2004 through the December 9 release date. The results, which are shown in Figure 6, suggest that October 19 was a fairly representative choice over this period. Furthermore, had we picked any other day on which to conduct this comparison, we still would have found a premium in excess of *AEO 2005*'s 2005-2010 forecast average of \$4.92/MMBtu. For example, at the lowest point on the NYMEX curve – September 2, 2004 – the average 72-month NYMEX strip is still \$0.59/MMBtu higher than the average 2005-2010 *AEO 2005* price forecast.

Figure 6: Average 72-Month NYMEX Strip vs. Average AEO 2005 Forecast (2005-2010)

Increasing our Sample Size

The release of *AEO 2005* allows us to add another data point to our small (but growing) sample of comparisons between contemporaneous forward prices and *AEO* gas price forecasts. As shown in Figure 7, the premiums observed with respect to the *AEO 2005* forecast are noticeably larger than what we have observed in previous years relative to *AEO 2001*, *2002*, *2003*, and *2004*. Even so, given the relatively tight range of previously documented premiums, the average premium over the past 5 years (and across contract maturities) remains roughly \$0.8/MMBtu, or 0.5¢/kWh assuming a heat rate of 7,000 Btu/kWh.

Figure 7: Levelized Premiums (Forwards – Forecasts)

Cause of Premium Remains Elusive

As explained in our past reports on this topic (see <http://eetd.lbl.gov/ea/EMS/reports/53587.pdf> or <http://eetd.lbl.gov/ea/ems/reports/54751.pdf>), the cause of these observed empirical premiums remains uncertain. One potential explanation is that the premiums represent the cost of locking in prices over time – a cost that owners or purchasers of renewable generation need not bear in order to achieve price stability. An alternative explanation is that the *AEO* gas price forecasts have simply been biased downwards relative to market expectations over the past six years, thereby creating the appearance of a premium. Even with the addition of this *AEO 2005* data point, our sample size remains prohibitively small for drawing any type of definitive conclusion on this matter. We nevertheless find it interesting that the empirical premium between forward prices and the EIA’s reference case price forecast is still present, despite rather sharp upward revisions to the EIA’s natural gas price forecasts in *AEO 2004* and *AEO 2005* (at least in the early years). As has been the case over the past four years (*AEO 2001-AEO 2004*), levelized cost comparisons of fixed-price renewable generation with variable price gas-fired generation that are based solely on the *AEO 2005* natural gas price forecasts will likely once again yield results that are “biased” in favor of gas-fired generation (presuming that long-term price stability is valued).