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How Regulators Should Use Natural Gas Price Forecasts

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Abstract

Natural gas prices are critical to a range of regulatory decisions covering both electric and gas utilities. Natural gas prices are often a crucial variable in electric generation capacity planning and in the benefit-cost relationship for energy-efficiency programs. High natural gas prices, for example, can make coal generation the most economical new source, while low prices can make natural gas generation the most economical.

Gas price forecasters face multiple uncertainties, including (1) the time frame of the current economic recovery and long-term economic growth, (2) the effects of recent shale gas discoveries, (3) liquefied natural gas (LNG) market developments, (4) carbon dioxide regulation, (5) demand for new electric generation, and (6) the effectiveness of energy-efficiency initiatives. The totality of these uncertainties speaks to the unreliability of any natural gas price forecast, especially for longer-term periods (e.g., beyond five years).

This presentation makes two recommendations. First, regulators should require utilities and other parties to submit a range of forecasts rather than a single "best guess" forecast. Basing a large investment decision solely on a single-point, "best guess" forecast adds risk unnecessarily. Doing so is a valid decision only when (1) the regulator places a high degree of confidence in single-point forecasts, and (2) the consequences of an incorrect price forecast are small. Second, regulators should require utilities to forecast the risks associated with the price forecasts. A range of forecasts or scenarios can help utilities and regulators quantify and then evaluate the risks associated with individual decisions related to electric generation planning, energy efficiency, or other matters. The regulator can then judge whether these risks are large enough to disqualify a decision from further consideration.

How Regulators Should Use Natural Gas Price Forecasts

Forecasting is like driving a car blindfolded while following directions given by someone who is looking out of the back window.

Anonymous

I. Introduction

A. When making important decisions, state public utility commissions ("PUCs" or "regulators") frequently must choose among competing natural gas price forecasts submitted by parties.

1. Forecasts vary in quality and credibility.

2. With potentially hundreds of millions of dollars at stake, regulators need to know the difference.

3. Just as important, regulators also need to know the reasonable range of forecasts and the risks associated with individual decisions.

The risks of actions involving large sums of dollars can affect the optimal utility and regulatory decision.

B. Gas price forecasters face multiple uncertainties, including:

1. The time frame of the current economic recovery and long-term economic growth,

2. The emerging but still unknown future supply of shale gas,

3. Liquefied natural gas (LNG) market developments,

4. Carbon dioxide regulation,

5. Demand for new electric generation, and

6. The effectiveness of energy-efficiency initiatives

The totality of these uncertainties speaks to the high unreliability of any natural gas price forecast.

C. This presentation recommends that regulators require utilities and other parties to submit a reasonable range of forecasts to justify their positions.

1. Basing a large investment decision solely on the "best guess" forecast, or the future deemed most likely to occur, can result in substantially higher costs relative to the best action determined *ex post facto* with actual prices.

2. In other words, a risky decision can result from an action based only on the information provided by a "best guess" price forecast that does not consider other possible futures and their implications for the preferred decision.

3. A range of forecasts or scenarios can help utilities and regulators quantify and then evaluate the risks associated with individual decisions related to electric generation planning, energy efficiency, or other matters, then judge whether these risks are intolerable.

4. Uncertainty requires regulators and utilities to ask: Are the possible losses from a particular decision large enough to disqualify that decision from further consideration?

5. I will later illustrate with a numerical example the risks or losses associated with choosing one forecast when the future turns out differently.

II. Regulators Rely on Natural Gas Price Forecasts to Make Major Decisions

A. The relative economics of renewable energy, nuclear power, and coal-fired generation: The economics of new gas-fired generation and economic dispatch, relative to alternative resources, depend on future natural gas prices. The uncertainty of forecasts also affects the benefits placed on fuel and technology diversity. A primary rationale for diversity is that the benefits of having a more diversified portfolio (which could include both self-generation and power purchases) hedge against price, fuel supply, electric reliability, and government risks.

B. Price forecasts in organized wholesale electric markets: In some organized markets, such as the New England Power Pool (NEPOOL) and the Electric Reliability Council of Texas (ERCOT), gas-fired plants in most periods set the market price. By affecting wholesale electricity prices, natural gas prices play an important role in the economics of mergers and buyouts that involve electric generating units.

C. **Cost-benefit of energy-efficiency measures:** The gross benefits of gas utility energy-efficiency initiatives are proportional to natural gas prices, which represent avoided costs to the utility. Marginal energy-efficiency initiatives that avoid high natural gas prices are no longer cost-beneficial at lower prices. The recent development of gas shale and its likely downward effect on future natural gas prices might make some energy-efficiency actions less tenable (e.g., those energy-efficiency initiatives with a benefit-cost ratio of 1.1 at a natural gas price of $7 would have a ratio of less than one when gas prices fall below $6).

D. **Energy burden on low-income households:** Higher prices mean less affordability of natural gas, which in turn translates into a greater need for energy assistance to low-income households. If the expectation is that natural gas prices will increase dramatically over the next few years, regulators and utilities might consider action today to assist low-income households in the future.

E. **The economics of gas-fired generation:** Prices affect operating costs, which are a major part of the total costs for gas-fired plants. Both regulated and unregulated electric generators might consider natural gas as a possible fuel source for new generating capacity. The difficulties in forecasting natural gas prices, in addition to their inherent price volatility, make gas-fired facilities less economically attractive. Natural gas prices can also affect the cost of controlling carbon dioxide in a regulated environment. This cost, in turn, is an important determinant of the relative economic attractiveness of different generation technologies.

F. **The need for new gas-utility investments:** Storage facilities become more valuable as price volatility and future prices increase, and the need for new distribution pipes depends on future peak demands, which in turn depend upon future gas prices. Gas utilities use storage to buy gas during periods of low prices so that they can avoid buying gas during the winter months when prices can rise dramatically.

G. **Hedging activities:** The level of future price volatility affects the benefits of hedging for a utility and its customers. The magnitude of price volatility also affects how a utility carries out hedging.

H. **Natural gas demand forecasts:** Future test-year sales, often an issue in rate cases, hinge on natural gas prices; longer-term demand forecasts also depend on natural gas prices. Some gas consumers, especially industrial firms, have the ability to shift away from higher-priced fuels when price expectations suggest that such switching can provide large long-term savings.

I. **Electricity demand forecasts:** Electricity and gas are substitutes for various end uses. The relative prices of natural gas and electricity are major drivers of changes in energy choices over time, and among and between regions in the U.S.

III. Regulators Have Different Options

A. The meaning of "forecast":

1. I use the term "forecast" to encompass both:
    a. The future outcome that is most likely to occur (i.e., the "best guess" or single-point forecast) and
    b. A future outcome that is less likely to happen, which is based on an alternative set of assumptions on predictors of price such as economic conditions, the demand for natural gas and electricity, and the growth of renewable energy.
2. Some analysts refer to "best guess" forecasts as "reference forecasts" when they reflect the future with the highest probability of occurrence.
3. They might alternatively define the outcomes in 1.b above as "projections," or outcomes conditioned on assumptions or "what if" scenarios.
4. The "best guess" forecast is based on a set of events that the forecaster expects will occur, or *considers more likely to occur than other events*.
    a. If you had to choose a single forecast with a bet of $100 on the line, what would it be?
    b. It would presumably be the "best guess" forecast, since it is assumed that the payoff would go to the person whose forecast lies closest to the actual outcome.

B. Rely only on the "best guess" forecast

1. The regulator could approve the utility action based on the single-point price forecast—for example, the "best guess" price of natural gas is $7, so the decision is contingent only on this price. This is a valid decision, however, only when:
    a. The regulator places a high degree of confidence in single-point forecasts, and
    b. The consequences of incorrectly forecasting price within a large range are minimal (e.g., the preferred decision does not depend upon whether natural gas prices are $4 or $9).
2. This situation is analogous to a person choosing a financial asset with the

highest expected return—say, stock in a high-tech company—without considering its risk relative to other assets. Most people would decide not to allocate all of their investments to this high-return, high-risk asset.

3. Modern portfolio theory takes into account the risk inherent in various types of financial and physical assets and develops methods for combining investments to optimize the tradeoff between risk and return.

C. Apply a range of forecasts and conduct sensitivity analysis

1. Regulators could approve the utility action based on a range of price forecasts.

2. They could, for example, review several forecasts from credible sources to select high, medium, and low price forecasts that represent reasonable pricing possibilities. The evidence might show, for example, that price forecasts within the range of $6 to $9 result in the same preferred decision (e.g., spend $50 million on energy efficiency).

3. This sensitivity analysis makes the decisionmaker more confident that the action taken will carry little risk, unless it assigns a non-trivial probability to prices beyond the selected range. (The risk would be the opportunity cost of making a particular decision when another decision would have produced a better outcome after the fact.)

4. Analysts consider such actions to be robust or preferred under a wide range of conditions. Robustness means that regulators could demand less precision from a “best guess” forecast.

D. Use only the statistically expected forecast

1. The regulator could approve the utility action based only on the statistically expected price forecast.

2. Such a forecast is equivalent to the probability-weighted sum of possible prices.

3. In the statistical sense, it differs from the “best guess” or most probable value.

    a. It reflects an average price calculated over different possible future states. The probability of natural gas prices being $6, $7, and $8, for example, is 0.3, 0.5 and 0.2, respectively; thus, the expected price is $6.90.

   - b. Unlike the “best guess” price, the expected price as calculated here takes into account the possibility that price can take on different values.
   - c. It also assigns greater importance to those forecasts with the highest probabilities of occurrence.

4. The problem with these forecasts lies with trying to estimate the probabilities of specific outcomes.

   - a. The probability of the natural gas price being $8 depends upon several factors, such as natural gas demand and supply, governmental policies, and economic growth.
   - b. These conditions, in addition, must be consistent with each other—for example, a high-natural-gas-demand future would likely infer a high degree of economic growth or legislation favoring the use of natural gas, or both.
   - c. This correlation between the different factors complicates any reasonably accurate calculation of a probability for a particular price future.

E. Measure the losses from wrong forecasts

1. Finally, the regulator could approve the utility action after considering the cost of making the wrong decision based on erroneous price forecasts (i.e., the loss function).

2. The building of a gas-fired plant based on a gas price of $6, for example, could cost the utility an additional $50 million a year compared with building a coal plant when the actual price of gas turns out to be $9.

3. The regulator might want the utility to “hedge” its plan to moderate the cost (i.e., loss) from mis-forecasting price and other variables instrumental to an action.

   - a. The regulator, for example, might want the utility to take a wait-and-see posture as it accumulates more information to improve its forecasting accuracy before spending substantial sums on a particular action.
   - b. To the extent that waiting reduces price uncertainty, the utility may reap an “option value” from an investment delay stemming from this uncertainty. By waiting two years to make a major decision that depends on future natural gas prices, for example, the utility could know more about the status of shale gas and carbon dioxide

regulations.

IV. The Rationales for a Reasonable Range of Forecasts and Possible Losses from Individual Decisions

A. Future natural gas prices have high uncertainty

B. Three dimensions to price uncertainty and utility decisionmaking

1. Not knowing the future price:
    a. Almost without exception, analysts cannot even assign an accurate probability to different price futures.
    b. They might be able to say that one price future or a range of price futures is more likely than others, but trying to quantify the probabilities with tolerable accuracy is beyond the realm of possibility.
2. Not knowing all the factors that affect prices and to what degree they affect price:
    a. How much do physical demand and supply conditions affect price, for example, relative to financial speculation?
    b. If long-term economic growth is 3 percent per annum instead of 4 percent, how would that affect natural gas prices?
    c. How would slower growth in electricity consumption affect the demand for gas-fired generation and, therefore, the price of natural gas?
3. Not knowing the consequences of an action when the natural gas price can take on a range of values:
    a. If, for example, a gas utility decides to spend $50 million on energy efficiency based on a future price of $7, what would be the opportunity cost if the actual price is $6?
    b. "Opportunity cost" here refers to the greater benefits that would result from spending the $50 million or a portion of it on something else.

All of these uncertainties are quantifiable at varying levels of accuracy. They are all estimates, however, that hinge on assumptions and statistical methods subject to inevitable error.

C. Specific information that utilities should submit to regulators

1. Price scenarios

   a. Utilities should present their regulators with a range of plausible prices.

      (1) As an example, they can point out that "it is highly likely with a 5 percent level of statistical error that actual gas prices will be in the range of $6 and $8 over the period 2020–2025."

      (2) The first observation is that the actual price will likely lie within the specified range. The regulator or utility can with a high degree of confidence conclude that prices will fall between $6 and $8.

      (3) The narrower is the range of high probability, the more precise the forecast and the more useful the information.

      (4) If instead the price range is wide, say between $4 and $9, the regulator or utility becomes less certain of what it should do. A price of $4 might mean that energy efficiency is uneconomical, but if the actual price is $9 or even $7, the utility could justify spending $50 million on energy efficiency.

      (5) In this example, the utility has three choices: (1) spend nothing on energy efficiency today, (2) spend $50 million today, or (3) spend a portion of the $50 million today.

   b. Rational risk-averse decisionmakers, implicitly if not explicitly, apply what is called a "loss function."

      (1) This function calculates the cost of a decision conditioned on a single forecast or range of forecasts that turn out to be wrong.

      (2) Assume that the decision to build a new gas-fired generating plant is contingent on natural gas prices being in the range of $6 to $8. If actual prices were $9, the utility's revenue requirements would be $300 million lower if it chose to build a coal plant instead. The $300 million

represents a loss from relying on the wrong forecasts, which is inevitable when dealing with something as dynamic and unpredictable as natural gas prices.

c. The above example has a parallel in the current global warming debate.

2. Numerical example of decision options for energy efficiency

   a. Assume that a utility is contemplating an energy-efficiency initiative in which it wants to know what strategy to pursue.

   b. The utility is looking at three alternative actions—“low,” “moderate,” and “aggressive”—that represent increasing levels of spending on energy efficiency.

   c. The utility has also forecasted three future prices for natural gas: $5, $7, and $9. (These prices represent average prices over the next several years corresponding to the lives of the energy-efficiency initiatives.)

   d. It assumes different future gas supply and demand conditions in addition to assuming different values for other price predictors (e.g., economic growth, greenhouse gas legislation).

   e. The forecasted prices, when multiplied by the estimated net savings, measure the gross benefits from the energy-efficiency initiatives.

   f. Assume that the utility considers the middle price, $7, more likely to occur than the other two prices. It has not explicitly estimated the probability of occurrence for each price.

   g. *Table 1* shows the net benefits from energy efficiency for the three price forecasts:

      (1) These benefits derive from a cost-effectiveness test that measures the benefits and costs of the energy-efficiency initiatives.

      (2) Under the Total Resource Cost (TRC) test, the utility compares the cost savings from producing, transporting, and distributing less electricity or natural gas with both the utility and customer costs for energy efficiency. The difference constitutes net benefits.

(3) The reader should note a few things from *Table 1*:

  (a) At a price of $5, when the utility moderately or aggressively spends on energy efficiency, some individual initiatives have negative net benefits. In fact, at $5 the net benefits are greatest under a “low” strategy. When the utility spends more at this price, additional initiatives fail to pass the TRC test and thereby produce gross benefits lower than the incremental costs.

  (b) At a price of $7, the optimal strategy is the “moderate” action. At this price, for example, the utility is forgoing cost-beneficial initiatives by pursuing the “low” action. The “aggressive” action is also suboptimal because the utility is spending additional money on initiatives that do not pass the TRC test.

  (c) At $9, the “aggressive” action is optimal, as the utility would be forgoing cost-beneficial initiatives under the other two actions.

h. *Table 2* shows the losses from forecast error:

(1) These losses are the difference between the maximum net benefits under each price scenario and the net benefits obtained by selecting a particular action.

  (a) Under the $5 scenario, Table 1 shows that the preferred action is “low” because it has the highest net benefits.

  (b) The “3” and “5” in the $5 column in Table 2 represent the losses (i.e., forgone net benefits, sometimes called the “regret”) from pursuing the “moderate” and “aggressive” actions, respectively, when the price is $5.

  (c) The same process applies to calculating the losses for the other price scenarios. Under the $9 scenario, for example, losses occur for both the “low” and “moderate” actions. The utility forgoes $18 million of net benefits when it pursues the “low” action and the price turns out to be $9.

(2) The calculations in Table 2 show that the largest risk might lie with pursuing the “low” action. This strategy produces the largest sum of losses ($27 million).

(3) But in assessing the risk associated with each action, an analyst could assign probabilities to each of the price scenarios, if she can make reasonable estimates.

  (a) Assume that the probabilities for the three prices are 0.3, 0.4, and 0.3, respectively. These probabilities allow for the calculation of the expected losses for each action.

  (b) The expected losses for the “low,” “moderate,” and “aggressive” actions are: $9 million, $3 million, and $3.5 million. Expected losses are the lowest under the “moderate” strategy. It is also true that the expected net benefits are the highest under this same strategy. It is likewise true that the “moderate” action is preferred under the “best guess” forecast.

  (c) Overall, it appears that the utility should pursue the “moderate” action, given that it has both the lowest risk and the highest expected “payoff.” But the preferred “moderate” action is not robust in the sense that at $5 and $9 it represents the best choice: If we know today that the price will be $5, the “low” strategy is the preferred option; at $9, the preferred option is the “aggressive” strategy.

(4) Whether the utility would take the “moderate” route depends on its risk adversity and the regulatory policy on cost recovery:

  (a) The utility, for example, might fear that a pro-energy-efficiency commission might penalize it for not taking the most aggressive action if the actual price turns out to be $9 or above.

  (b) Another utility operating in a state whose commission is skeptical toward energy efficiency might want to pursue the “low” strategy even if, from a social perspective, it seems inferior to the other strategies.

D. The relevance of option value

1. A utility that has $50 million today to spend on a particular action, for example, may assign an "option value" to a wait-and-see posture as new developments unfold before deciding whether to spend the $50 million.

2. Option value also comes into play when deciding whether or not to sign a long-term gas contract:

    a. A buyer, for example, might hesitate to sign a multi-year contract at a price that could turn out to be much higher than the market or spot price.

    b. The buyer might choose not to commit now to a contract but, instead, buy short-term until it is more certain of the future market price.

3. The option value results from the ability to make a better decision when conditions vary from the expectations in earlier periods.

4. The option value increases with the degree of prevailing uncertainty and the length of the time horizon for new investments and other actions.

5. It relates to the opportunity for a utility to reduce the cost of over-commitment to an investment that turns out less well than expected.

6. If a utility is uncertain about future natural gas prices, it might hesitate to commit, for example, to investing large amounts of money in new storage capacity.

    a. It might instead want to wait for new information that could reduce the uncertainty of future prices.

    b. This decrease in the level of uncertainty would in turn reduce the utility's risk in spending money on new storage capacity.

Table 1. Net Benefits from Energy Efficiency for Three Gas Price Forecasts (in 10^6 Dollars)

Natural Gas Price Forecast

Energy-Efficiency Action	**$5**	**$7**	**$9**
Low cost/low effort	15	21	27
Moderate cost/moderate effort	12	30	38
High cost/aggressive effort	10	25	45

Table 2. Losses from Forecast Error (in 10^6 Dollars)

Natural Gas Price Forecast

Energy-Efficiency Action	**$5**	**$7**	**$9**
Low cost/low effort	0	9	18
Moderate cost/moderate effort	3	0	7
High cost/aggressive effort	5	5	0