BEFORE THE
PUBLIC UTILITIES COMMISSION OF OHIO

In the Matter of the Application of Ohio Edison Company, The Cleveland Electric Illuminating Company and The Toledo Edison Company for Authority to Provide for a Standard Service Offer Pursuant to R.C. 4928.143 in the Form of an Electric Security Plan	)))))))	Case No. 14-1297-EL-SSO

REBUTTAL TESTIMONY OF

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ON BEHALF OF

OHIO EDISON COMPANY
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY
THE TOLEDO EDISON COMPANY

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PUBLIC VERSION

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I. INTRODUCTION

Q. HAVE YOU TESTIFIED PREVIOUSLY IN THIS MATTER?

A. Yes, I filed direct testimony in this matter on August 4, 2014.

Q. WHAT DID YOUR PRIOR TESTIMONY ADDRESS?

A. My prior testimony provided my long-term (2015 to 2034) forecast of wholesale electricity prices (electrical energy and capacity prices). I also provided forecasts of prices for inputs into the production of electricity, e.g., coal, natural gas, CO_2 emission allowances, and costs of new power plants. I made these projections using detailed computer modeling of the relevant power markets (i.e., ATSI Zone and AEP Dayton, and selected nodal markets for electrical energy and the PJM RTO capacity price), and associated fuel industries. I employed highly sophisticated computer models to develop my forecasts including such widely recognized and used computer models as ICF's IPM, General Electric's GE-MAPS and ICF's Gas Market Model (GMM). My direct testimony also describes the very high and in some cases extreme volatility of wholesale electric power and natural gas prices.

Q. WHAT IS THE PURPOSE OF YOUR REBUTTAL TESTIMONY?

A. The purpose of my rebuttal testimony is to respond to the direct and supplemental testimonies of two witnesses: James Wilson on behalf of the Office of the Ohio Consumers' Counsel and Northeast Ohio Public Energy Council,[1] and Tyler Comings on behalf of the Sierra Club.[2]

Q. WHAT SPECIFICALLY ARE YOU REBUTTING REGARDING THEIR TESTIMONY?

A. I am principally rebutting five of their assertions:

[1] Wilson Direct Filed December 22, 2014, and Supplemental filed May 11, 2015.
[2] Comings Direct Filed December 22, 2014 and Supplemental filed May 11, 2015.

- **Methodology** - Both witnesses criticize my forecasting methodology and accuracy. For example, Mr. Wilson claims that the forecasts presented in my testimony are unreliable and speculative in part because of improper treatment of the "missing money" not provided by energy prices.[3] Mr. Comings claims that energy and natural gas price uncertainty has not been addressed in my analysis, and that alternative scenarios should have been analyzed.[4] However, both witnesses fail to use any recognized model to formulate their projections, and their criticisms of my testimony are invalid.
- **Electrical Energy Prices** - Both witnesses assert that my forecasts of wholesale electrical energy prices are too high, and that their alternative projections of lower prices should be used.
- **PJM RTO Capacity Prices** - Both witnesses disagree with my PJM Reliability Pricing Model ("RPM") RTO capacity price forecasts. Mr. Comings argues that his alternative, lower capacity price case should be used. Mr. Wilson asserts that my forecast of prices is unreliable but does not offer an alternative. [5]
- **Natural Gas Prices** - Both witnesses assert that my forecasts of natural gas prices are too high and that their cases of lower natural gas prices should be used to project wholesale electricity prices.[6]
- **CO_2 Emission Allowance Prices** - Mr. Comings asserts that my CO_2 allowance price forecast is too low and that his higher price case should be used.

[3] Wilson Direct Filed December 22, 2014, page 10, line 17.
[4] Comings Direct Filed December 22, 2014, page 26, line 1.
[5] Wilson Direct Filed December 22, 2014, page 11, lines 3-4.
[6] Comings Supplemental Testimony, May 11, 2015 pages 5 line 3 to page 9, line 7. *See also* Comings Direct Testimony, page 49, line 9. On capacity prices, *see* Comings Supplemental, page 17, lines 1-21.

II. APPROPRIATE METHODOLOGY FOR FORECASTING ELECTRIC POWER PRICES

A. I Am The Only Witness Who Uses Any Appropriate Forecasting Methodology.

Q. WHAT IS THE APPROPRIATE APPROACH TO FORECASTING WHOLESALE POWER PRICES

A. The appropriate long-term forecasting of wholesale electric power prices involves computer modeling with the following features:

- **Widely Recognized and Used Forecasting Models** – Forecasting should employ widely used and recognized forecasting models in order to ensure that the model is meeting professional standards. Furthermore, the repeated use of the same model helps ensure that the results are not ad hoc and not easily tailored to a specific price objective. The model's long-term use also indicates that it has been found useful and acceptable in the past – e.g., in regulatory settings.
- **Reflect Economic Principles of Supply and Demand** – The models should incorporate the appropriate economic considerations relevant for price forecasting. This ensures that there is an appropriate basis for the forecasts. For example, the models should have explicit treatment of both key supply and demand parameters.
- **Conforms to Other Generally Accepted Price Forecasting Principles** – The methodology should also conform to other generally accepted principles. For example, the forecasting of long-term natural gas prices (i.e., for periods greater than five years) should rely on modeling of supply and demand in the industry. Long-term natural gas price forecasting should not rely on current spot prices or futures. This is because the spot and futures prices are very volatile, and the long-term futures prices primarily reflect bids, not transactions.

- **Use the Proper Level of Detail -** The models should have the proper level of detail in order to determine the drivers of the results. For example, there should be a detailed characterization of the key components of the industry to ensure comprehensive treatment of the drivers of pricing. These include industry production, consumption and transportation. Further, key drivers of these sub-sectors should be characterized. These include environmental regulations affecting production of power, the operational limitations of power plants, transmission lines, and the location and level of demand.
- **Treat Properly the Relationships among the Key Variables** - The change of inputs or conditions should result in changes in other variables, and thus, there should be a reasonable characterization of the relationships among the key variables – e.g., proper characterization of feedback loops. For example, if supply decreases, prices should increase, and the increase in prices should in turn increase supply. This feedback mechanism serves to moderate the increase in prices, and drive a market toward long-term equilibrium.
- **Properly Address Related Fuel Industries** – In the case of power, fuel sectors are important and need to be properly addressed. One important industry is the natural gas industry, which is the principal fuel for new thermal powerplants and many existing plants. Shale gas well production has declined dramatically, and a model must capture this critical dynamic. Experts must be very familiar with this issue in order to opine on market conditions. Similarly, coal is an important industry in the power space as nearly all coal is used in powerplants, and a very large share of power

in Ohio is derived from coal combustion. Ideally, the same principles used in forecasting electric power should be applied to the key relevant fuel industries.

- **Access to Information** – Experts familiar with modeling should be available for questions and be able to provide sufficient information.

Q. DO YOU USE AN APPROPRIATE APPROACH TO FORECASTING WHOLESALE POWER PRICES?

A. Yes. I used three widely used and recognized computer models: (1) ICF's IPM, (2) GE's MAPS model, and (3) ICF's GMM. These models are extensively used both in the public and private sectors. The use of ICF's IPM model is heavily documented within the U.S. Environmental Protection Agency ("EPA"). GE MAPS is also widely accepted and provides extremely detailed treatment of electricity transmission and production, and hence, has detailed price projections. These models and inputs have been described previously in this case. The models have extensive treatments of supply and demand and capture the level of detail required, including production, transportation and consumption. The relationships among the key variables are modeled – e.g., there is an integrated treatment of pricing, quantities, etc. I also have detailed treatments of the key fuel industries including natural gas via GMM and coal via IPM. I also do not violate key principles related to long-term energy price forecasting in the power and gas sectors such as inappropriate reliance on current conditions in highly volatile industries such as natural gas. Accordingly, my wholesale power price forecasts have an appropriate foundation.

Q. DOES MR. WILSON OR MR. COMINGS USE AN APPROPRIATE APPROACH TO FORECASTING WHOLESALE POWER PRICES?

A. No. Neither witness has performed a forecast of wholesale power prices. Regarding long-term forecasting of electrical energy prices, which account for the large majority of

powerplant revenues,[7] I disagree with their approach as well as their assumptions and scenarios. This is, in part, because neither Mr. Wilson nor Mr. Comings use an accepted computer model to forecast electrical energy prices. In fact, neither uses any model at all. Indeed, they did not perform energy market modeling at all. As such, they are relying on projections that lack a sound foundation. They do not explicitly address supply and demand, lack detailed treatment of industry segments, and do not model the proper relationships among key variables. Importantly, their inappropriate treatment extends to the key fuel industries like natural gas. They also violate a key long-term forecasting principle, which is not to rely on futures prices in the long-term. Furthermore, because they do not perform a forecasting exercise, they cannot provide the critical information needed about their projections.

Indeed, many of the mistakes that Mr. Wilson and Mr. Comings make directly result from not using an accepted methodology – e.g., failing to account for the impact of higher CO_2 price forecasts on gas and electrical energy prices. Their fundamental methodological errors extend to the projecting of capacity prices. For example, in the long run, if the witnesses are lowering natural gas and electrical energy prices, they should be raising long-term capacity prices, but they have no model, and hence, make no adjustment.

B. I Appropriately Addressed Uncertainty.

Q. MR. COMINGS CLAIMS THAT YOU DID NOT PROPERLY ADDRESS THE UNCERTAINTY INHERENT IN YOUR FORECAST. DO YOU AGREE WITH HIS CRITICISM?

[7] Electric energy revenues account for 70 to 75% of total revenues paid to generators since 2010. PJM, "State of the Market Report …", vintages 2010 to 2014. http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2014.shtml

A. No. His claims that I did not address uncertainty and that more scenarios are required are wrong. Further, my treatment is the same as the treatment in ICF's Regulatory Impact Analysis ("RIA") of the Clean Power Plan conducted for the U.S. EPA using its assumptions. I provided a probability-weighted projection also referred to as an "Expected Value" forecast, which is the key basis for decision making. Probability-weighting incorporates uncertainty and the relative likelihood of a range of outcomes.

Q. WHAT IS THE APPROPRIATE TREATMENT OF FORECASTING UNCERTAINTY?

A. The Base Case projection should reflect the probability weighted (also referred to in mathematical parlance as the expected outcome) forecast of wholesale power prices. This allows decision makers to minimize expected costs using a risk-adjusted discount rate to discount the expected case - e.g., to calculate the discounted present value of expected future long-term prices with and without hedges. This is the proper approach to decision making for entities seeking to minimize expected cost. Thus, the most important wholesale price projection is the probability weighted case (i.e., the expected case).

Q. HOW IS SUCH A CASE CALCULATED?

A. There are two approaches that theoretically can be used. First, one can assign probabilities to multiple cases to calculate an expected value. In practice, however, this approach is not generally undertaken in long-term forecasting. This is because the main technique for assigning probabilities and making the calculations, referred to as a Monte Carlo simulation, is not feasible. Using this technique, each computer run is assigned a probability that is the inverse of the number of runs (so if there are 100 runs, each run has a probability of 1/100 or 1%). Each scenario is analyzed using two models, MAPS and IPM. The total run time of each model on a high performing computer is four to six

hours. Monte Carlo involves repeated running of the model to obtain a probability distribution. This can require 5,000 runs or more for simple models to create a probability distribution. 5,000 runs for two models, with a four to six hour timeframe per run is equal to 4.6 to 6.8 years. Even if multiple computers could be used, there is also the risk of error which would increase run time; every error detected could double the run time. Clearly, this is infeasible. Second, and standard in regulatory proceedings, is to develop a case using inputs that reflect expected values. This is usually referred to as the Base Case or Reference Case.

Q. WHAT DID YOU DO?

A. I provided a Base Case projection that reflects the probability weighted forecast of wholesale power prices. Specifically, I used expected values for inputs to calculate the expected value of prices.

Q. DOES MR. WILSON PROVIDE AN EXPECTED VALUE FORECAST?

A. No. In fact, he specifically chooses gas price projections that are not the reference case, or a case that is not even derived from a modeling effort. In addition, his calculations are in error.

Q. WHAT DO YOU MEAN THAT MR. WILSON'S CALCULATIONS ARE IN ERROR?

A. Mr. Wilson states that his energy price projections were developed as the product of multiplying one of his natural gas price projections by the implied heat rates.[8] Implied heat rates are the ratio of electrical energy prices in the marketplace to natural gas prices. As an illustrative example, an implied heat rate of 10,000 Btu/KWh x $5/MMBtu equals (with conversion of the units as explained below) $50/MWh. He further states that the

[8] Wilson hearing testimony, Hearing Transcript Volume XXII, Tr. p. 4545, starting on lines 17. *See also* Wilson Direct, page 44, lines 4-9. There he states he also uses ICF basis differences to adjust his gas price.

implied heat rates were developed by Mr. Lisowski's electrical energy prices and Mr. Rose's natural gas prices in each year.[9] But Mr. Wilson erroneously holds each year's implied heat rates constant even as he changes the natural gas prices. In power modeling, it is standard practice to regard implied heat rates and electrical energy prices as being market modeling outcomes (i.e., the dependent variables) with natural gas prices as an input or independent variable that impacts both the implied heat rate and the cost of gas generation. He violates this basic concept and practice by treating implied heat rates as a constant unaffected by large price changes to the underlying natural gas price stream. This will create significant understatements in his calculated electrical energy prices in markets with non-natural gas fired power plants setting marginal prices or when costs other than gas help set the price – e.g., environmental allowances, non-fuel variable O&M. This is a fatal flaw to his overall methodology especially in Ohio with massive coal generation and given the newly finalized Clean Power Plan ("CPP") CO_2 regulations which cause a portion of the electrical energy price to reflect CO_2 allowance prices, not gas prices.

For example, and only to illustrate the significant potential for understating electrical energy prices, if the electrical energy price is set 50% of the time by coal generation which costs $50/MWh, and set 50% of the time set by gas generation at $50/MWh, with gas prices at $5/MMBtu delivered (and therefore gas plants have a heat rate of 10,000 Btu/kWh or $50MWh/$5/MMBtu), the electrical energy price is ($50/MWh+$50/MWh)/2 = $50/MWh. The implied system heat rate in this case is (50$/MWh) / $5/MMBtu = 10,000 Btu/KWh.[10] If the gas price falls in half, and nothing

[9] Wilson hearing testimony, Hearing Transcript Volume XXII, Tr. p. 4545, Line 25.
[10] $50/MWh / $5/MMBtu = $50/MWh x MMBtu/$5 x 1000KWh/MWh x 1,000,000 Btu/MM = 10,000 Btu/Kwh.

else changes, Mr. Wilson would calculate electrical energy prices as $2.5/MMBtu times 10,000 Btu/Kwh = $25/MWh. In fact, in this simplified example, the electrical energy price would be much higher. This is because the correct calculation is 0.5 times $50/MWh (the cost of coal generation) + 0.5 times 10,000 Btu/KWh times $2.5/MMBtu = $37.5/MWh. His error would be $25/MWh - $37.5/MWh or -$12.5/MWh. Thus, he would underestimate prices and revenues by a full one-third ($25/MWh/$37.5/MWh). Put another way, it is well known that the implied heat rate rises when gas prices are lowered and Mr. Wilson does not adjust his implied heat rate for that well-known relationship.

Q. DOES MR. COMINGS PROVIDE AN EXPECTED VALUE FORECAST?

A. No. He provides a few scenarios, some of which are inconsistent with his contention that there will be higher CO_2 prices. Thus, he compounds the lack of explicit forecasting with the use of inappropriate and inconsistent cases.

Q. WHAT IS THE ROLE OF SENSITIVITY CASES?

A. Sensitivities can be used for two main purposes. First, as noted, one can assign probabilities to the sensitivity cases to calculate an expected value. This is very uncommon, especially in regulatory proceedings. Second, for risk-averse customers, sensitivities can examine the range of outcomes. This can become a basis for taking actions to hedge against unlikely outcomes and volatility.

Q. IS IT STANDARD OR TYPICAL FOR SENSITIVITY ANALYSES TO BE USED?

A. In complex analyses in the regulatory context, sensitivity cases are not often used. For example, ICF's RIA of the CPP conducted for EPA does not use sensitivity cases.[11] In

[11] EPA, Clean Power Plan for existing power plants, August 3, 2015 http://www2.epa.gov/cleanpowerplan/clean-power-plan-existing-power-plants

addition, RIA's issued for major EPA regulations referred to as Mercury and Air Toxics or the Cross State Air Pollution Rule also do not have economic sensitivities.

C. My Forecasts Are As Accurate As Forecasts Can Be.

Q. HAS EITHER MR. WILSON OR MR. COMINGS ADDRESSED ANY ALLEGED INACCURACY IN YOUR ENERGY PRICE FORECASTS THROUGH THEIR OWN ENERGY PRICE PROJECTIONS?

A. No. Neither witness directly addresses my forecast of electrical energy prices, which is the overwhelming source of power plant revenues in the wholesale industry (81%- 86%). Their calculations of electrical energy prices contain fundamental errors. Furthermore, when they focus their attention on current spot markets, they make two errors. First, current spot prices are not good indicators of average prices over the next 15 plus years. Second, they focus on gas and ignore electrical energy prices and the fact that in most hours electrical energy prices in Ohio are set by coal generation not gas generation. As a result, recently lower than expected gas prices have therefore not led to equally lower electrical energy prices; the effects are much more muted.

Q. DO EITHER MR. WILSON OR MR. COMINGS APPROPRIATELY ADDRESS THE RECENT DEVELOPMENTS IN THE PJM CAPACITY MARKET?

A. No. Neither witness even mentions key developments related to capacity prices even though these developments pre-date their filing of testimony. I forecasted that the PJM capacity market would undergo major reforms that would increase prices over the next few years. The FERC Capacity Performance Order of June 9, 2015 does just that.

On April 7, 2015, more than a month before either witness filed supplemental testimony on May 11, 2015, PJM requested for the first time ever a delay in the PJM capacity auction. To give a sense of how important this reform was, in making this extraordinary request, PJM stated that its proposed capacity market reforms were critical

enough to justify the auction delay, and indeed that if capacity market reforms were to take more time,[12] it would be better to risk not having enough time to add new powerplants than to continue with the then-current flawed design that threatened reliability, and hence, public safety. Further, PJM specifically requested that FERC not take the extraordinary step of delaying the PJM capacity auction unless it agreed that it would approve something similar to the proposed reforms. On April 24, 2015, more than two weeks before Mr. Comings and Mr. Wilson filed testimony, FERC agreed with PJM to delay the auction.[13]

Thus, there was ample notice available to both Mr. Comings and Mr. Wilson of the impending FERC June 9, 2015 decision. Incredibly, Mr. Comings and Mr. Wilson are not only silent on this extraordinary development — a development consistent with my original testimony that reforms were coming — Mr. Wilson even asserted that everything is working just fine vis-à-vis capacity markets and grid reliability.[14] Their position was clearly belied by PJM's extraordinary actions and urgency about improving reliability.

Q. ARE THE CRITICISMS OF YOUR NATURAL GAS PROJECTION RELEVANT TO THE ACCURACY OF YOUR ELECTRICAL ENERGY PRICE PROJECTIONS OVER THE LONG-TERM?

A. No. Both witnesses devote much attention to recent spot and short run natural gas market conditions, wherein prices are currently below my 2015 forecasts. Natural gas prices are an important factor in power prices, but are not yet highly determinative in the Ohio area. Lower than expected short-term gas prices have therefore not led to equally lower

[12] The auction is for three year forward delivery. PJM did not delay the delivery date but delayed the auction, thereby decreasing the amount of time available to permit, contract, design, construct and test new capacity.
[13] PJM Interconnection, L.L.C., 151 FERC ¶ 61,067 (Docket No. ER15-1470-000), April 24, 2015, Page 1. http://www.pjm.com/~/media/documents/ferc/2015-orders/20140424-er15-1470-000_order.ashx
[14] Wilson Supplemental, page 9 lines 4 to 15, page 11 lines 7 to 11 and page 11 lines 17- 18.

electrical energy prices; the effects are much more muted. Furthermore, for the reasons discussed above, I do not believe that current prices indicate that my long-term gas and/or power forecast is wrong and no major change is warranted.

III. FORECASTING ELECTRICAL ENERGY PRICES

Q. WHAT ARE THE MOST IMPORTANT FORECASTS YOU MADE IN YOUR AUGUST 4, 2014 TESTIMONY IN THIS CASE RELATED TO FUTURE POWERPLANT REVENUES?

A. My forecasts of electrical energy prices are the most important forecasts I made in my August 4, 2014 testimony because electrical energy sales account for the large majority of total powerplant revenues. Electrical energy forecasts were made on an hourly basis and measured as the $/MWh price in that hour at that location. In 2014, electrical energy revenues accounted for 80.9% to 86% of total powerplant revenues.[15]

Q. WHAT DID MR. COMINGS AND MR. WILSON SAY ABOUT YOUR FORECASTS FOR 2015 OF ELECTRICAL ENERGY PRICES COMPARED TO ACTUAL YEAR TO DATE PRICES?

A. Nothing. Even though they filed supplemental testimony in May 11, 2015, they did not directly address electrical energy forecasts. Instead, they devoted most of their discussion to natural gas, even though electrical energy is more important.

Q. IS YOUR GAS FORECAST AS CLOSE TO CURRENT ACTUAL SPOT PRICES AS THE ELECTRICAL ENERGY FORECAST IS?

A. No. However, I believe that my long-term gas price forecast is accurate and reasonable. I discuss this issue later in this testimony.

Q. HOW CAN YOUR FORECAST OF SPOT YEAR-TO-DATE ELECTRICAL ENERGY PRICES BE SO CLOSE WHEN NATURAL GAS PRICES ARE NOT AS CLOSE?

[15]PJM, "2014 State of the Market Report", page 14-16, Volume 1, March 12, 2015 http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2014.shtml. The other non-transmission wholesale revenue sources were capacity at 13.7%, and ancillary services at 5.3%. Ancillary services are often correlated with energy prices, and hence, I also use an 81 to 86% estimate.

A. Natural gas prices become an increasingly important input to electricity prices in the long run, but are less important in the near term. Marginal sources of generation in this area setting the electrical energy prices in most hours are coal fired.

Q. WHAT DO MR COMINGS AND MR WILSON SAY ABOUT YOUR WHOLESALE ELECTRICAL ENERGY PRICES?

A. Both witnesses assert that my forecasts of electrical energy prices are too high, and that their alternative cases with lower prices should be used.

Q. WHAT DO THEY RECOMMEND AS THE ALTERNATIVE?

A. They each present alternative lower calculations.

Q. DO THEY USE ACCEPTABLE METHODOLOGIES TO DERIVE FUTURE PRICES?

A. No. Neither Mr. Wilson nor Mr. Comings uses an accepted computer model to forecast electrical energy prices. This contributes to a series of calculation errors.

Q. WAS MR. WILSON MORE SPECIFIC IN HIS CRITICISMS ABOUT YOUR FORECASTS OF FUTURE WHOLESALE PRICES?

A. Yes. Mr. Wilson states that ICF forecasts of long-term wholesale power prices are unreliable and speculative. He cites four reasons for this conclusion: 1) ICF forecasts are too high compared to forward market prices for natural gas and power; 2) they are different from other peer forecasts; 3) they ignore the "missing money"[16] problem which causes increases in electrical energy prices to be offset by decreases in capacity prices and vice versa; and 4) ICF's 2020 price forecast, which has a significant increase, assumes either irrational or surprised behavior.[17] [18] [19]

Q. IS MR. WILSON CORRECT?

[16] Wilson Direct, page 10, line 17
[17] Wilson Direct, page 10, line 12.
[18] Wilson Direct, page 18, line 14.
[19] Wilson Direct, page 11, line 1.

A. No. All four of his criticisms are incorrect. Regarding his first two, ICF forecasts being too high compared to forward prices for power or peer forecasts, Mr. Wilson presents no forecasts or forwards of electrical energy prices for AEP Dayton or ATSI or for any nodal location. He is also silent about my forecast of year-to-date electrical energy prices for 2015 or the proper degree of correlation between natural gas prices and electrical energy prices in the near term. He devotes his attention instead exclusively to natural gas prices, a matter I return to later. I disagree with him on natural gas prices, and on his approach to projecting electrical energy prices. Regarding the third, the missing money problem and the fourth, the claim that I have irrational price forecasts in 2020, I return to those later in the capacity price and natural gas price sections of this testimony, respectively.

Q. PLEASE SUMMARIZE YOUR RESPONSE TO MR. COMINGS AND MR. WILSON ON ELECTRICAL ENERGY PRICE FORECASTS.

A. In conclusion, I reject the alternative long-term projections of Mr. Comings and Mr. Wilson, and continue to recommend the use of my long-term electrical energy forecasts.

IV. FORECASTING CAPACITY PRICES

Q. DID WITNESS COMINGS PERFORM A CAPACITY PRICE FORECAST?

A. No. Mr. Comings presented a PJM RPM capacity price projection, but it is not based on any model. He simply takes the most recent RTO price, increases it to approximately half of the PJM RTO net CONE (the net Cost of New Entry), and escalates it at the rate of inflation per year. This is not an adequate basis for a projection and it suffers from the same methodological failure as his energy projection-not using the standard practice of modeling the market. These errors show the failure of Mr. Comings to recognize the relationship between long run electrical energy prices and capacity prices. He changes

long-term electrical energy prices without changing his calculation of capacity prices. In addition, his capacity projection is inconsistent with the June 9, 2015 FERC Order restructuring the PJM capacity market which I will refer to as the FERC Capacity Performance Order ("CP Order").[20] As a result of the CP Order, PJM capacity prices have already increased significantly even though the CP Order has only been partially implemented. I will explain the numerous flaws in Mr. Comings' testimony later.

Q. DID WITNESS WILSON PERFORM A CAPACITY PRICE FORECAST?

A. No. Mr. Wilson does not present an alternative capacity price forecast to mine, but states that my forecast is unreliable in part because the capacity price incorrectly treats what he describes as the "missing money" problem.[21] In the case of Mr. Wilson, the "missing money" problem refers to additional long-term money required by new power plants to supplement their earnings from sales of electric energy.[22] If the missing money is not provided, new entrants will fail to earn the required rate of return on capital investment and will not enter the market. The missing money is provided by the capacity market.[23] In equilibrium, where the need for capacity is balanced by the amount of capacity, greater earnings in the energy markets result in lower capacity market earnings, all else equal, and vice versa. Thus, Mr. Wilson claims that the increase in energy revenues resulting from higher electrical energy prices in my forecast should result in decreases in capacity prices, not increases.

But Mr. Wilson admits that capacity prices and electrical energy prices can increase together in circumstances where artificial incentives that have suppressed

[20] *PJM Interconnection, L.L.C.*, 151 FERC ¶ 61,208 (2015).
[21] Wilson Direct, page 10, lines 12-20, page 11, lines 1-6.
[22] In order to simplify the discussion, the supplemental income is often also needed by existing powerplants in order to prevent excessive retirements, and hence, loss of reliability.
[23] Though not mentioned by Mr. Wilson, it can also be provided by price spikes.

historical capacity prices are corrected and supply and demand for capacity come into balance via retirements and load growth.[24] This assumption is an important underlying theme in ICF's capacity price forecast. Indeed, my expectation of the end of the suppression of capacity prices by artificial incentives for inferior demand resource products and a failure to address reliability of capacity was well documented in my testimony.[25] Hence, by his own admission, Mr. Wilson believes that my forecast is not only possible but supported under such circumstances. Indeed, as noted, the CP Order strongly supports the likelihood of this occurring.[26]

Further, even though he incorrectly cites the simultaneous increase in electrical energy and capacity prices as the basis for rejecting ICF's near term forecasts, it is true that when markets are functioning efficiently, changes in long-term electrical energy prices should result in offsetting changes in long-term capacity prices. ICF factors this relationship into its long-term projections after the markets recover from the impacts of past artificial incentives. Ironically, Mr. Wilson creates a scenario using an unacceptable methodological approach and makes the same error he cites as a basis for rejecting ICF's forecasts – namely, he lowers long-term electrical energy prices without calculating offsetting long-term capacity price increases. It is unlikely this mistake could have occurred if he used professional standard modeling approaches. This is highly problematic because he lowers my long-term energy price, but he fails to raise his long-term capacity price projection. As energy earnings of new powerplants decrease due to lower energy prices, the costs of new powerplants that must be recovered via the capacity

[24] Hearing Transcript Volume XXII, pp. 4578-4579.
[25] Direct Testimony of Judah Rose, pp. 39-42.
[26] PJM Interconnection, L.L.C., 151 FERC ¶ 61,208 (2015), page 7. http://www.pjm.com/~/media/documents/ferc/2015-orders/20150609-er15-623-000-el15-29-000-and-er15-623-001.ashx

market increase in the long run. Thus, long-term capacity prices should increase, all else equal.

A. My Capacity Forecast

Q. WHAT WAS YOUR FORECAST FOR PJM RTO CAPACITY PRICES?

A. I forecast a very significant increase in PJM capacity prices. Capacity prices are expressed as $/kW-yr or $/MW-day. In my August 2014 testimony, I stated:

> Regarding capacity prices, the RTO capacity price for delivery years 2013 to 2017 averages $30/kW-yr in real 2013 dollars ($81/MW day). I anticipate that the RTO price will average [**BEGIN CONFIDENTIAL**] [redacted] [**END CONFIDENTIAL**] (emphasis and underlines added)

I forecast the increase in large part due to my expectation that FERC would approve major reforms in the PJM capacity market.

Q. IS THE CAPACITY FORECAST IMPORTANT?

Yes. After electrical energy revenues, capacity revenues are the second most important revenue source for power plants. Mr. Comings and Mr. Wilson ignored my August 2014 testimony regarding the forthcoming FERC reforms of PJM's capacity market including the CP Order, as well as the various statements regarding the CP Order that were available prior to the filing of their May 11, 2015 testimony. In fact, they assert that everything is business as usual vis-à-vis reliability.[27] They ignored the following changes:

[27] Comings Supplemental Testimony, May 11, 2015, page 29, lines 8-9; page 29, lines 12-23; page 31, lines 8-9; page 32, lines 25-26.

- FERC increased the capacity offer price cap by a factor of 3.5x. This new level is up to as much as 80%[28] above Mr. Comings projected capacity prices. Offers to provide capacity at this price are deemed competitive and not subject to additional review by the market monitor. This may result in a price regularly near this level over time if bids rise towards the caps.
- FERC increased the maximum penalty for outages or unavailability of capacity by a factor of 3.1 to 3.4 times his projected of capacity prices. This increased the expected costs of providing capacity, and also contributed to the recent price increase. Furthermore, this impact could have been anticipated.[29]

Q. HOW IS YOUR FORECAST FARING?

A. My forecast is faring very well. Since I filed my testimony, PJM capacity price increases have been significant:

- On August 10, 2015, the 2018/2019 PJM Base Residual Auction (BRA) CP capacity price increased from $120/MW-day to $165/MW-day (+38%); $165/MW-day was the second highest RTO capacity price;[30]
- The PJM incremental transition auction for 2016/2017 held on August 27, 2015, increased the RTO CP capacity price from $60/MW day to $134/MW day (+123%); this auction was the first auction ever held to resolve deficiencies in the

[28] Mr. Comings uses the formula of one half of 2017/2018 net CONE of approximately $350/MW day. *See* Comings Direct Filed December 22, 2014, page 47, footnote 47. If one uses the offer cap long-term estimate of 0.9 x net CONE and divides it by his projection of one half net CONE, the result is 0.9/0.5 or 1.8. The net CONE for the next BRA 2018/2019 auction has been lowered. Alternatively, if one uses the RTO offer cap from the 2018/2019 BRA of $239/MW-day, the cap is 37% above his projection – i.e., 239/175.

[29] The new higher penalty is 1.5 times CONE. The previous penalty cap was 0.5 x net CONE. 1.5 x CONE divided by 0.5 net CONE is approximately (400 x 1.5)/175 or 3.43. For 2018/2018 PJM RTO CONE is $381.56, and UCAP Net CONE is $300.57.

[30] The previous BRA price of $120/MW day was for delivery in 2017/2018 for a product that is not the same as either the CP or the base product, the two products in the 2018/2019 auction. For example, the summer only limited DR, 60 hours a summer product, was available in the 2017/2018 but not the 2018/2019 auction. The comparison is relevant because most capacity clears in the BRA for the product then available.

previous BRA for 2016/2017 delivery. PJM undertook this extraordinary step in light of the seriousness of past deficiencies in capacity procurement and pricing.

- The PJM also held a second incremental transition auction on September 3, 2015; this one was for 2017/2018 procurement. In this auction, the RTO CP capacity price increased from $120 to $152/MW day (+27%). This second extraordinary auction was also held to resolve deficiencies in the previous BRA for 2017/2018 delivery.
- The COMED (a PJM sub-zone to the west of the RTO zone) BRA 2018/2019 CP capacity price was $215/MW day (+79%); this was the first time the COMED price separated from the RTO price. This is the highest price ever recorded for this capacity zone. This is evidence of the potential for PJM capacity prices in western PJM to exceed $200/MW-day. Also, higher prices in other parts of PJM support higher prices in the RTO region, all else being equal, because RTO exports capacity to higher price regions.
- The East MAAC (a PJM sub-zone to the east of the RTO zone) BRA 2018/2019 CP capacity price increased to $225/MW day in the 2018/2019 BRA (+88%). This price was 99% of the bid cap, and hence, is evidence that PJM capacity prices can reach the offer price cap. Also, as noted, higher prices in other parts of PJM support higher prices in the RTO region, all else being equal, because RTO exports capacity to higher price regions.
- These increases were associated with partial implementation of the CP Order. The share of capacity purchased as CP product (as opposed to Base Capacity which is not subject to the new CP rules) was 60%, 70% and 80% in the three auctions

held in August through September). PJM is scheduled to purchase 100% CP capacity starting in the 2020/2021 delivery period. The first 100% CP BRA occurs in May 2017. At that time, demand will increase for CP product by 25% (100% divided by 80%), due to full implementation of the CP program. Thus, even greater price increases are expected.

- The "Base Capacity" product capacity prices were also high in the PJM BRA held on August 10, 2015; the average increase in Base prices in the RTO, COMED and EMAAC regions was by 56%. This is evidence that even a product which contributes less to reliability and which is being phased out by May 2017 is experiencing very large price increases.
- Nearly all approximately 11,000 MW of Demand Response (DR), which is mostly interruptible load) cleared as base capacity product. This demonstrates that most of the DR is incompatible with the CP product or can only participate at much higher prices. Because the base product is scheduled to disappear in the 2020/2021 auction, there could be even greater upward price pressure as this capacity resource (i.e., DR) is decreased.
- Further, DR faces potential legal problems associated with Supreme Court review of its legality in the current session of the Court. If the Supreme Court upholds lower court decisions, the DR resource could be further decreased also adding to upward capacity price pressure.
- On August 3, 2015, EPA announced final Clean Power Plan (CPP) regulations of CO_2 .[31] These could result in higher capacity prices.

[31] Clean Power Plan for Existing Power Plants. http://www2.epa.gov/cleanpowerplan/clean-power-plan-existing-power-plants

Furthermore, this set of increases reflects major structural changes in the PJM capacity market, and hence, is a long-term change not a short-term temporary phenomenon.

B. The PJM Capacity Performance Order

Q. WHY IS THE CP ORDER IMPORTANT?

A. The predicate to understanding why the CP Order is important is related to consumers having two categories of capacity related costs. The first is capacity price times the amount of capacity purchased. The second is the costs of reliability problems (e.g., the costs of blackouts). The reliability cost category is further divided into those reliability costs that occur when the capacity procurement system is working properly (grids are designed for some expected reliability problems not zero problems), and the added reliability problems caused by paying for capacity whose performance is exaggerated by procurement problems.

Q. WHAT DO YOU MEAN EXAGGERATED BY PROCUREMENT PROBLEMS?

A. Before the June 9, 2015 CP Order, the performance of capacity was exaggerated by PJM procurement problems. This exaggeration was the result of procurement terms and conditions that lacked the necessary penalties for poor performance or lacked proper performance requirements. Plants without firm fuel supply were excused if there was no fuel; DR was excused from performing in non-summer months and for more than 60 hours a year (maximum of 10 requests for interruption during the summer of a maximum of 6 hours each; in contrast competing powerplants were subject to operation all year and up to full availability); delayed new powerplants were effectively excused from being on line, and penalties for mechanical powerplant outages during periods with acute grid reliability problems were insufficient to justify the maintenance to prevent the outages.

The situation was like a contract for provision of goods and services without reasonable terms and conditions for performance requirements or penalties for non-performance.

Q. WHAT WERE THE CONSEQUENCES OF THESE PROCUREMENT DEFICIENCIES?

A. The consequences were suppressed capacity prices and less reliability and higher reliability costs than demanded by consumers and society. On August 20, 2014, PJM announced its analysis indicated that in the event of a repeat of the Polar Vortex, it would shed load – i.e., there would be blackouts. Also, in the past, generators could collect revenues from the capacity market with little concern about providing the capacity because the penalties were low, and hence, without incurring the costs to maintain capacity – e.g., conducting maintenance, making investments in generating equipment fully, and obtaining firm fuel supply. Low costs meant low prices.

Q. UNDER THE CP ORDER, WILL BOTH PERFORMANCE PENALTIES AND DEFAULT OFFER CAPS INCREASE?

A. Yes. FERC's approval of PJM's Capacity Performance proposal is grounded in its finding that PJM's former penalty mechanism was insufficient to ensure performance.[32] Furthermore, the increase in penalties under PJM's Capacity Performance proposal is the basis for raising the PJM default offer cap to Net CONE times the Balancing Ratio,[33] because "an appropriate competitive offer for a Capacity Performance Resource should

[32] *PJM Interconnection, L.L.C.*, 151 FERC ¶ 61,208 (2015)at P 5 ("PJM states . . . that its construct has failed to keep pace with the level of resource commitments required, has applied inadequate charges for sub-par performance, and otherwise has not adequately ensured actual performance. PJM adds, and we agree, that a resource adequacy construct that fails to provide adequate incentives for resource performance can threaten the reliable operation of PJM's system and force consumers to pay for capacity without receiving commensurate reliability benefits.").

[33] Net CONE is the Cost of New Entrants less energy earnings. Balancing ratio is the ratio of total load and reserve requirement to total committed UCAP during the performance assessment hour. "Response of PJM Interconnection, L.L.C. to Commission's March 31, 2015 Information Request Docket No. ER15-623-000", April 10, 2015. http://www.pjm.com/~/media/documents/ferc/2015-filings/20150410-er15-623-001.ashx

include all of the marginal costs faced by that resource"[34] and increasing penalties increase the marginal costs associated with accepting a capacity obligation.[35]

Q. WHAT WILL BE THE LIKELY LONG TERM EFFECT OF THESE CHANGES?

A. Higher penalties effectively increase the costs of providing capacity because generators must recover the costs of expected penalties. Higher costs for providing capacity raise capacity prices. In addition, raising the cap on offers facilitates higher offers and higher prices by decreasing the scrutiny of offers and the potential for disputes.

Q. WHAT IS A DEFAULT OFFER CAP?

A. As noted, a key feature of PJM's Capacity Performance Proposal was the establishment of a much higher default offer cap — sometimes referred to as a "safe harbor" colloquially in FERC pleadings. FERC held "the Capacity Performance Resource offer cap set at Net CONE times the Balancing Ratio, as well as a standard of review of unit-specific offer caps based on the competitive offer equation presented by PJM, to be just and reasonable."[36] As long as the offer is below the cap, no scrutiny by the PJM Independent Market Monitor will occur. As FERC explained:

> We therefore agree with PJM that it is reasonable to set a default Capacity Performance Resource offer cap equal to the competitive offer estimate for a Low ACR Resource, i.e., Net CONE times the Balancing Ratio, because that estimate will always be lower than the competitive offer estimate for a High ACR Resource. Any Capacity Performance offer below the default offer cap can properly be deemed competitive (underline added), and any offer above that level will be scrutinized by the Market Monitor and PJM to ensure that it is based on legitimate costs and reasonable estimates of unit-specific performance and system parameters.[37]

[34] *Id.* at p. 315.
[35] *See id.* at pp. 334-41.
[36] Capacity Performance Order, 151 FERC ¶ 61,208 at p. 336; *accord id.* at p. 341.
[37] *Id.* at p. 340.

All else equal, this reinforces and is consistent with the likelihood of higher long-term capacity prices. In addition, FERC explained that offers above PJM's BRA default offer cap were allowable, and hence possible. These offers are not subject to the default offer cap but are mitigated through *ex ante* unit-specific review by the PJM Independent Market Monitor and PJM.

Q. HOW MUCH HIGHER WILL THE DEFAULT OFFER CAP INCREASE ABOVE THE CURRENT DEFAULT OFFER CAP, RECENT CAPACITY PRICES, AND MR. COMINGS' CAPACITY PRICES?

A. As noted, FERC set the default offer cap equal to Net CONE times the Balancing Ratio, which is approximately $239/MW day in the RTO zone. The PJM default offer cap is above the most recent PJM RTO BRA price of $165/MW-day by 1.45 times. The PJM default offer cap is also well above (approximately 3.5 times higher) PJM's Avoided Cost Recovery ("ACR") reference offer caps previously in place, which were roughly $70/MW-day for a coal plant.[38] Lastly, the new PJM default offer cap is approximately 1.4 to 1.6 times above Mr. Comings' projection.[39] Thus, even greater increases in capacity prices are facilitated and made likely by the higher bid cap.

C. Mr. Comings Capacity Prices Are Flawed.

Q. PLEASE SUMMARIZE MR. COMINGS' CAPACITY PRICES.

A. In his direct, and again in his supplemental testimony, Mr. Comings presents his view of capacity prices starting from the $120/MW-day result in the 2017/2018 BRA auction, increasing to $175/MW-day in the next year.[40] This projection reflects no modeling or even an acknowledgement of the importance of recent structural changes in the capacity

[38] Net of energy gross margins.
[39] Compared to Comings' 2018/2019 capacity price ($176/MW-day in nominal dollars), the Capacity Performance Market Seller Offer Caps for 2018/2019 Delivery Year is $239/MW-day for RTO or 1.36 times. If one uses one-half net CONE as revised as the Comings' price, this increase to 1.59 times.
[40] Again the range is due to the discrepancy between his projection and the calculated basis for his projection.

market that make reliance on historical data inappropriate. There is also no modeled relationship between long-term energy and capacity prices. He assumes that capacity prices will be approximately one-half of net PJM RTO CONE held flat for all years in real terms based on historical averages in spite of the changes in market regulations and structure.[41] Mr. Comings projects that the PJM capacity prices stay at this level in real dollars to the 2030/2031 planning year – i.e., to the end of his projection horizon. As noted, PJM lowered the net PJM RTO CONE ICAP to $300/MW-day and one half this level is $150/MW day not $175/MW-day.

Q. IS MR. COMINGS' PROJECTION OUT-OF-STEP WITH ACTUAL REGULATION?

A. Yes. Mr. Comings' capacity prices are similar to recent 2015 auction results, but these prices only reflect partial -- i.e., 60%, 70% and 80% -- implementation of the CP order; full 100% procurement of the CP product is scheduled for the 2020/2021 BRA to be held May 2017. Full implementation increases demand for the CP product by 25% (100%/80%). Thus, prices above the ones used by Mr. Comings are likely to be too low. The extent of this gap between the long-term average price and Mr. Comings' prices is highlighted by the extent to which his capacity prices are likely to be too low. Forecasting Natural Gas Prices

Q. ARE NATURAL GAS PRICE FORECASTS IMPORTANT?

A. Natural gas prices are an important factor in setting power prices, especially electrical energy prices in Ohio, with the importance less in the near term but growing over time because coal generation currently sets the price in most hours. Over time, natural gas

[41] He states on page 45 of his testimony: The net CONE estimate changes each year. I assumed the latest PJM 2017/2018 net CONE of approximately $350/MW-day escalating at 2.5% inflation each year. The average price relative to net CONE was calculated as the capacity-weighted average over the past eight auctions.

prices will eventually become the most important determinant of electrical energy prices because all new thermal power plants are expected to be natural gas fired power plants. However, they are not yet the leading determinant.

Q. WHAT ARE YOUR NATURAL GAS FORECASTS?

A. [**BEGIN CONFIDENTIAL**] [redacted] [**END CONFIDENTIAL**] for delivery to ATSI. This is [**BEGIN CONFIDENTIAL**] [redacted] [**END CONFIDENTIAL**] than actual prices for delivery in 2014 [**BEGIN CONFIDENTIAL**] [redacted] [**END CONFIDENTIAL**] versus $5.26/MMBtu). My forecast for the Henry Hub average 2015 to 2034 gas price in my forecast is [**BEGIN CONFIDENTIAL**] [redacted] [**BEGIN CONFIDENTIAL**] versus $4.32/MMBtu) in 2013 real dollars. 2014 is the last year for which full data is available; 2015 year to date prices are lower.

Q. WHY IS YOUR FORECAST HIGHER THAN RECENT PRICES?

A. My forecast is higher than 2014 levels because of massive increases in demand for natural gas. In addition, my forecast reflects the impact of the CPP regulations which were finalized August 3, 2015 and which start January 1, 2022. Were it not for these unprecedented increases in demand and regulatory changes, my forecast prices would be much lower.

Q. WHAT DO MR. WILSON AND MR. COMINGS STATE ABOUT YOUR FORECASTS OF GAS PRICES?

A. They both believe my natural gas price forecasts are too high, yet neither use an accepted computer model of the natural gas industry for forecasting. Both witnesses devote much attention to recent spot and short run natural gas market conditions. For example, 2015 year to date price are lower than 2014 prices by approximately one-third. Mr. Wilson

proposes two alternative lower natural gas price cases, and also specifically criticizes my 2020 gas price forecast. Mr. Comings relies on the U.S. Energy Information Administration's ("EIA") Annual Energy Outlook ("AEO") 2014 "Reference Case" projection, but also the NYMEX futures in some unspecified manner. Mr. Comings also criticizes my change in natural gas price forecasts over time.

Q. DO RECENT GAS PRICES INDICATE THAT YOUR LONG-TERM FORECASTS ARE WRONG?

A. No. I do not believe recent gas prices indicate that my long-term forecast is wrong.

Q. IS IT SURPRISING THAT RECENT GAS PRICES CAN BE LOWER THAN YOUR FORECASTS?

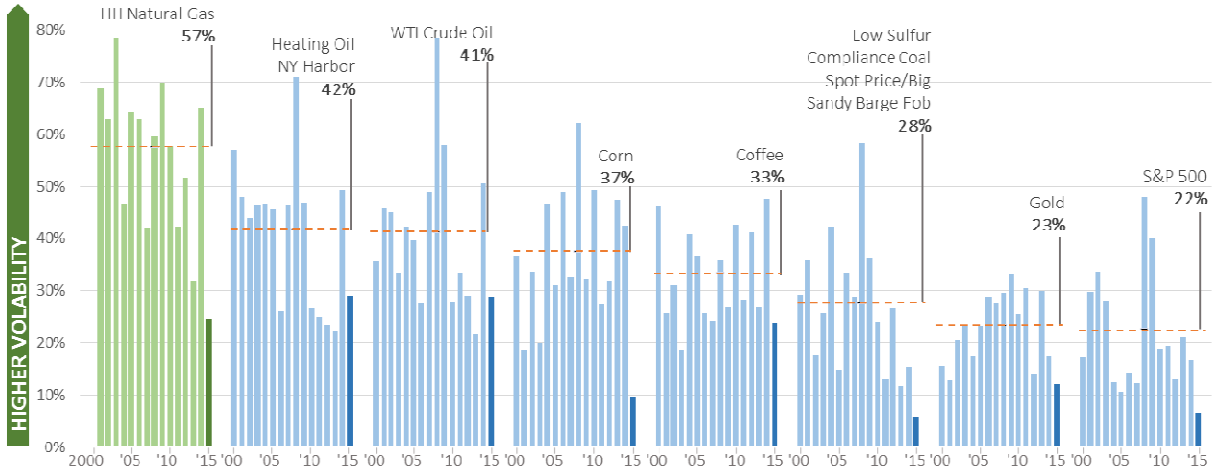
A. No. Natural gas prices are especially volatile, and hence, neither periods with prices below the trend or above the trend are surprising. Indeed, of the most highly traded commodities on the NYMEX, including both energy and non-energy (including S&P 500, corn, coffee and gold), natural gas prices had the highest volatility on average from 2000 to 2015. The average natural gas price volatility was 57%, and the average of the eight other most highly traded commodities was 28.5%. The volatility of gas over the last ten years is 2.6 times the volatility of even the very volatile S&P 500 stock market index. Hence, deviations from average expected conditions are not uncommon. This high price volatility is shown in Figure 1.[42] Sometimes gas prices are down (e.g., 2015) and sometimes they are up (e.g.,2013 and 2014). In addition, gas prices on the commodity level (i.e., Henry Hub) can be up some, but delivered prices can be up even more. For example, delivered gas prices in parts of the northeastern U.S. during the 2014 Polar

[42] Price range method was used to calculate the volatility. Annual Volatility = (Annual Max Price – Annual Min Price) / Annual Max Price.

vortex reached the highest levels ever recorded in the U.S. of $120/MMBtu. Thus, extrapolating a partial year's data to a 15 or 20 year projection is highly inappropriate.

Figure 1

Volatility of the Most Traded Commodities on the NYMEX



Source: S&P 500 prices were obtained from Google Finance. Other prices were obtained from Bloomberg. 2015 reflects the trades as of 5/22/2015.

A. Recent Supply Developments

Q. IS THERE SUPPLY EVIDENCE THAT NATURAL GAS PRICES WILL INCREASE?

A. Yes. Producers are responding to lower natural gas/oil/Natural Gas Liquids (NGLs which include propane) prices by reducing exploration and production activity, which will in turn reduce production growth. Between June 2014 and July 2015:

- Gas (Henry Hub spot) prices have decreased by 40% [43]
- Oil (WTI, Brent) prices have decreased by 50%[44]
- Propane (Mt Belvieu TX propane spot) have decreased by 61% [45]

[43] Henry Hub spot prices were obtained from SNL and reflect July 13, 2015
[44] WTI Oil prices were obtained from Bloomberg and reflect July 13, 2015.
[45] Propane (Mt Belvieu TX propane spot) prices were obtained from EIA and reflect July 13, 2015, http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EER_EPLLPA_PF4_Y44MB_DPG&f=D

In response to recent hydrocarbon price declines, the U.S. rig count dropped by 55% from June 2014 to July 2015.[46] This supports the view that supply will not continue to support these low prices.

Q. PLEASE ELABORATE ON THE DRILLING SITUATION AND ITS IMPLICATIONS FOR GAS PRICES.

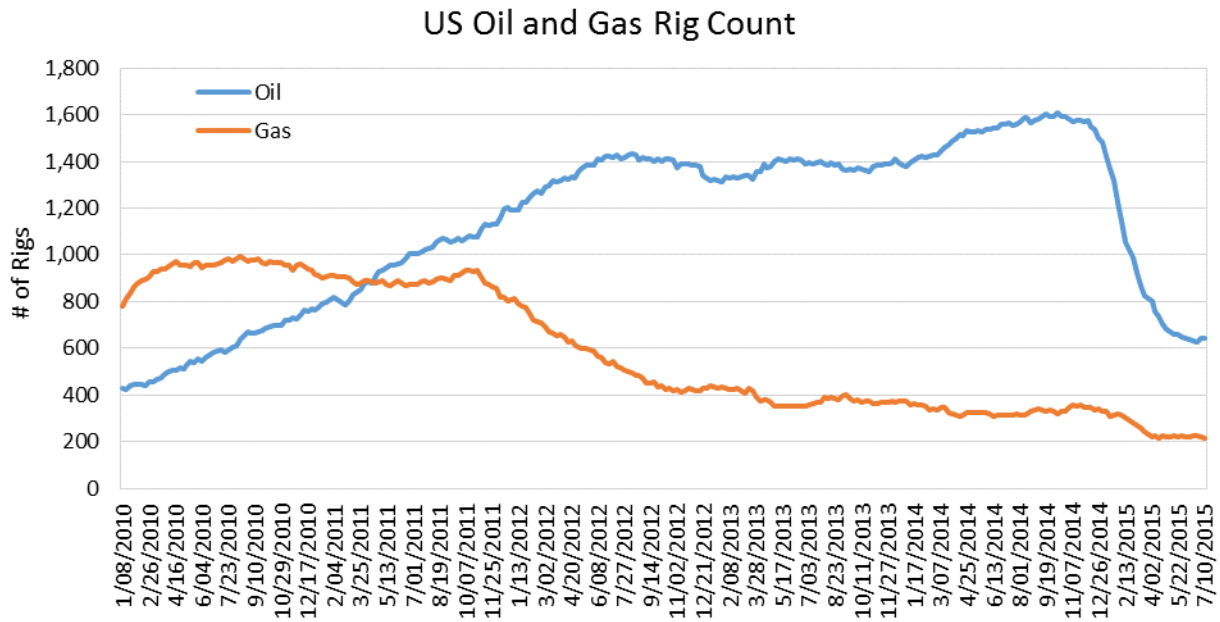
A. Total well drilling is divided into gas directed and oil directed. U.S. natural gas directed drilling is at its lowest level since 1985. The decrease in gas-directed well drilling has been 75% to 80% since 2011, and the decrease has recently accelerated with well drilling approaching 200 wells versus 800 to 1000 wells in the 2010 to 2011 period. This is consistent with natural gas prices being too low to meet future gas demand. A shale well is not like a typical factory with a relatively fixed maximum annual output level. Within 5 years, a shale gas well's maximum output decreases 60% to 70%. Thus, in order to maintain a constant level of production, drilling must stay high enough to offset the large declines in production rates of existing wells. To illustrate, by 2020, in the absence of any drilling, ICF estimates that the U.S. would lose approximately two-thirds of its gas or shale gas output. Thus, current low prices cannot be sustained even if gas demand does not grow, because current low drilling levels mean that production will decline and exert upward pressure on prices.

In addition, as shown in Figure 2 below, oil well drilling has similarly significantly declined, with the decline accelerating in recent months. Over the last nine months (from 10/10/2014 to 7/10/2015), oil drilling has decreased by nearly 60%. Drilling that is primarily oil based also produces significant amounts of natural gas, and

[46] Source: Baker Hughes rig counts, U.S. total count on 7/10/2015 vs 10/10/2014 http://phx.corporate-ir.net/phoenix.zhtml?c=79687&p=irol-reportsother. Baker Hughes is the most authoritative market compilation of well drilling in the United States.

is therefore also an important indicator of future gas production. Further, the natural gas produced from oil wells is usually low cost natural gas since the gas is often a co-product of producing oil. Hence, the decrease in oil drilling is removing a low cost natural gas supply resource.

Figure 2



Source: Baker Hughes, from January 8, 2010 to July 10, 2015.

Q. WHAT IS THE RELATIONSHIP BETWEEN GAS DRILLING AND GAS PRICES?

A. The decrease in drilling will result in decreased supply available to meet demand, because in the absence of new production, existing production levels fall. Lower supply will raise prices. As noted, in the absence of drilling, ICF estimates that gas production from all existing wells (every U.S. well drilled and completed through the end of 2014) will decline by about 66% through 2020. Hence, gas prices will increase.

Q. WHAT IS THE RELATIONSHIP BETWEEN FUTURE MARCELLUS PRODUCTION AND NATURAL GAS PRICES?

A. Marcellus is the largest gas producing area in the U.S., and even though ICF projects a doubling of Marcellus output by 2030, gas prices still increase. But in the Marcellus, like wells in other so called unconventional areas, exhibit higher depletion rates than so called conventional well. As shown in Figure 4, each colored section of the figure is the output of wells in their first year, and the narrowing over time for each colored section captures the decline of the well output. As Marcellus grows, the amount of drilling grows faster than if there were not this phenomenon of output decline. Thus, in the long run, even though Marcellus growth is projected to be large, 45% of the drilling is just to maintain output at 2014 levels. Figure 5 shows the relationship of the decline in production for wells drilled before 2015 with production of wells drilled after 2015.

Figure 3

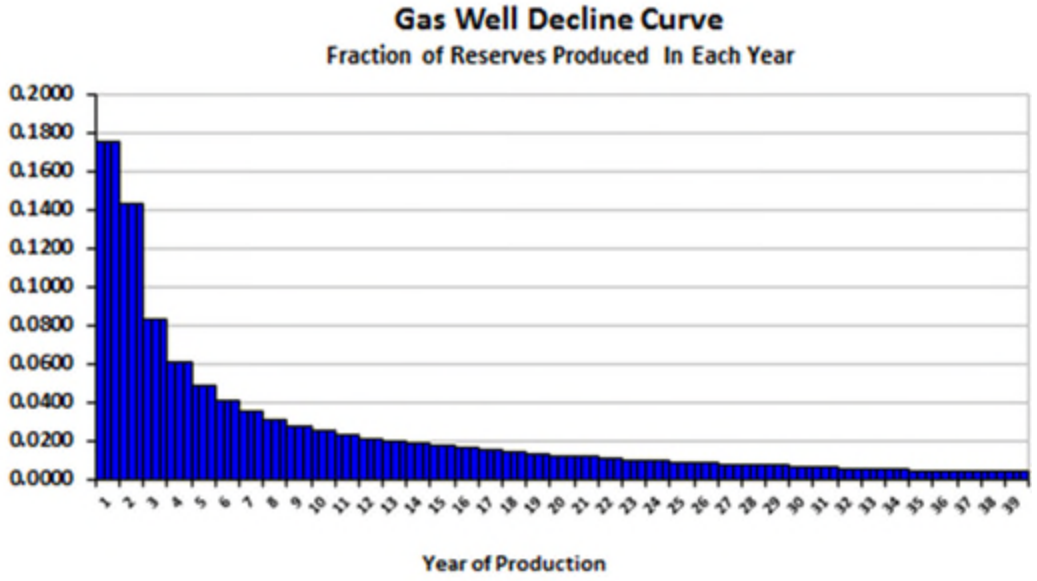
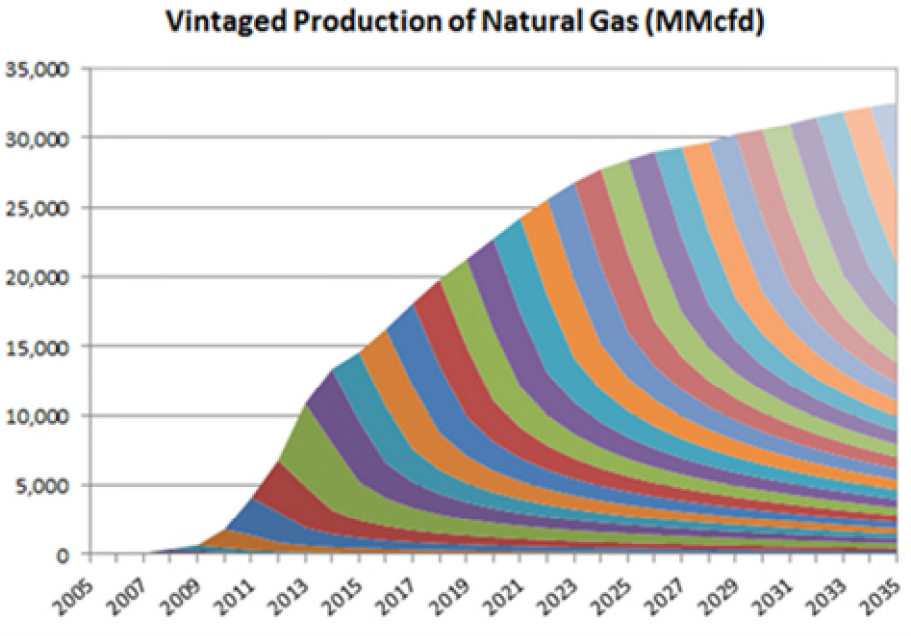
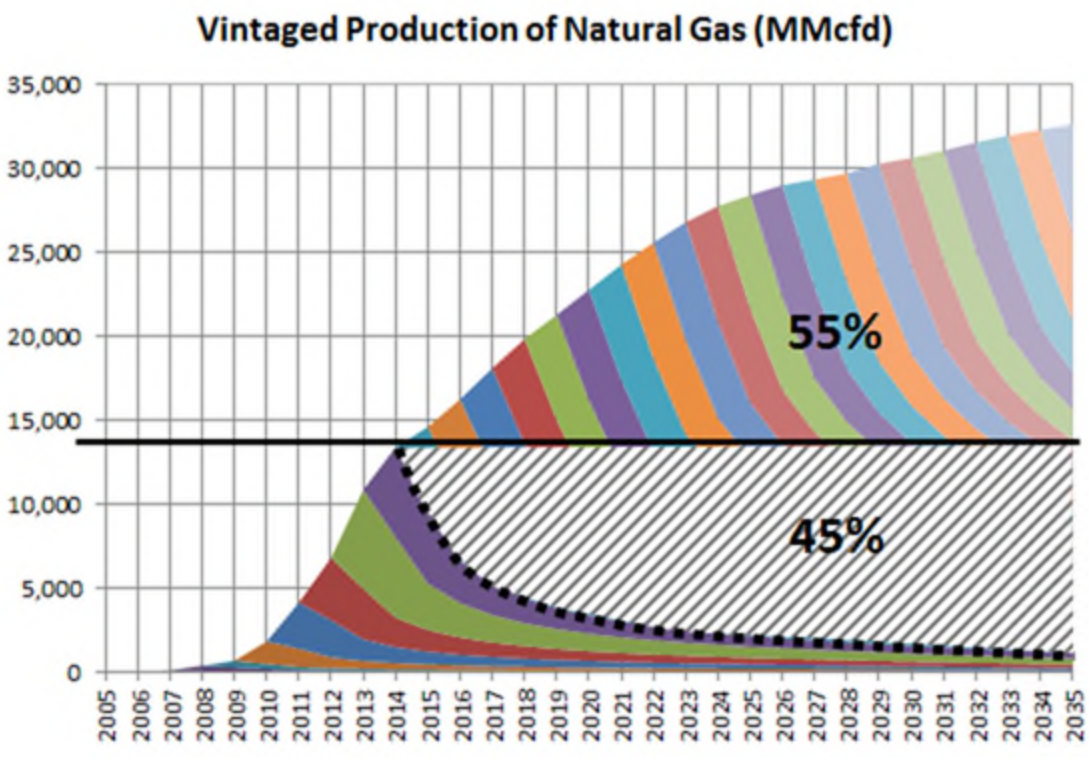


Figure 4



Source: ICF International

Figure 5



Source: ICF International

Q. IS THERE OTHER SUPPLY EVIDENCE SUPPORTING THE EXPECTATION OF HIGHER GAS PRICES?

A. In addition to lower drilling, there is a general decline in production-related spending. This is another sign that the level of prices is too low to support the level of current demand. Planned exploration and production capital expenditures for 2015 are down 30-40 percent versus the 2014 level.

B. Recent Demand Developments

Q. DO TRENDS IN NATURAL GAS DEMAND ALSO SUPPORT THE VIEW THAT NATURAL GAS PRICES WILL INCREASE IN THE LONG-TERM?

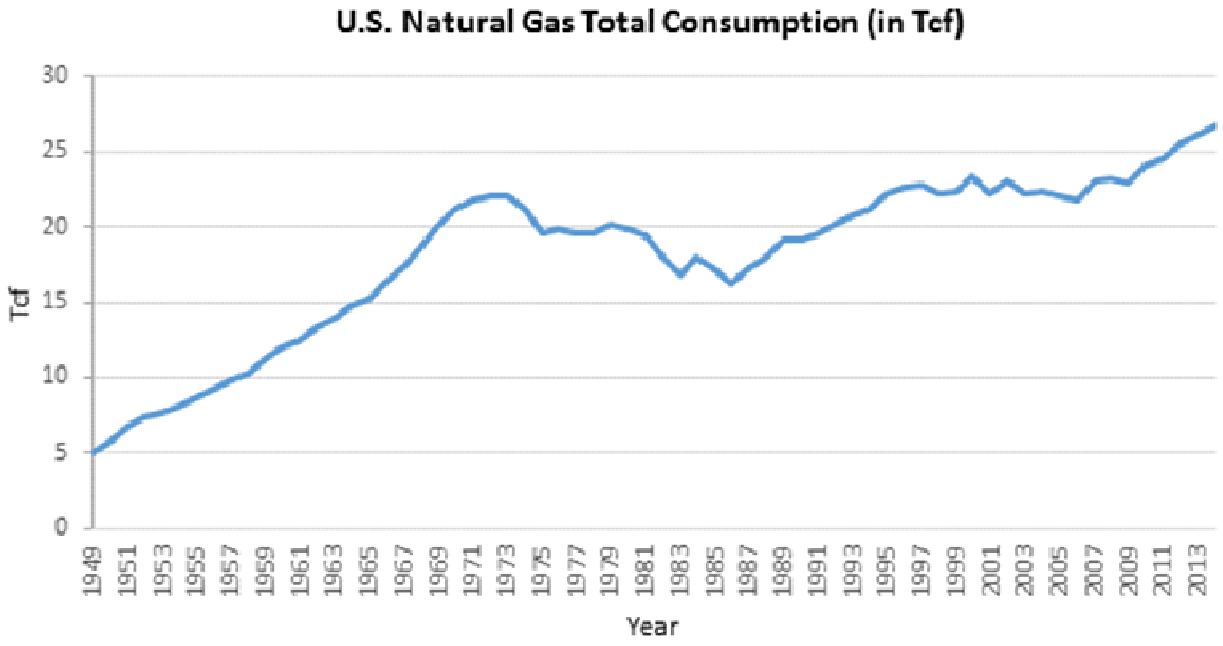
A. Yes.

Q, PLEASE SUMMARIZE NATURAL GAS DEMAND DEVELOPMENTS.

A. Gas demand is growing. Between 2008 and 2015, natural gas demand in the U.S. increased by approximately 15% in spite of the Great Recession.[47] Investments in export pipelines to Mexico, LNG export terminals, new petrochemical industry equipment, etc., are ongoing, and will increase U.S. gas consumption by one-third over the next ten years or approximately 9 TCF. This is as large as any ten year increase in gas demand in U.S. history.[48] The only comparable period, from the early 1960s to early 1970s, resulted in widespread US gas shortages and the passage of the Fuel Use Act which banned new baseload gas power plants. I do not expect a repeat of the shortages, or the associated legislation, because the absence of price controls will allow the prices to increase. However, the demand growth makes the current lull in drilling is even less sustainable, and hence, the current low gas prices are even less likely to be sustained than if the gas industry only needed to offset the massive declines in shale and conventional well output.

[47] EIA, U.S. Natural Gas Total Consumption, http://www.eia.gov/dnav/ng/hist/n9140us2a.htm
[48] *See* Figure 6.

Figure 6



Source: US EIA

Q. WHAT IS THE BASIS FOR YOUR FORECAST FOR INCREASING DEMAND FOR NATURAL GAS?

A. Some increases in demand for natural gas require large capital investments that involve several years of lead time. Nonetheless, evidence is accumulating for very large increases in demand over the next ten years including significant construction of new pipelines to Mexico, new gas powerplants, new LNG export facilities and new domestic industrial facilities.[49]

Figure 7
Summary of Demand Change Over the Next Decade (BCF/d)

Sector	Demand Increase
LNG Exports (including losses)	12
Mexican Exports	4
Power Generation	5
Industrial (Petrochemicals, Oil Sands, L&P)	3
Total Demand Growth	24

Source: ICF. Note, 24 BCF/D equals approximately 9 TCF per year.

[49] *See* Figure 7.

Further, consumers are responding to lower gas prices by increasing consumption:

- **Industrial Consumption** – Competitively-priced natural gas and ethane are enabling chemical companies to build new plants, expand, or improve their facilities in the United States and this increase will result in $138 billion in new capital investment.
- **Ammonia** - Six million metric tons per annum ("MTPA") of new capacity (+66%) will be added over the next 3 years. U.S. production was 9.5 million MTPA as of 2012, per the U.S. Geological Survey.[50]
- **Export Growth - U.S. Exports to Mexico** - Mexico's national energy ministry, SENER, projects that U.S. pipeline exports to Mexico will reach 3.8 billion cubic feet per day (Bcf/d) in 2018. This would be more than double U.S. pipeline exports to Mexico in 2013, which averaged 1.8 Bcf/d.[51]
- **U.S. LNG Exports** - As of May 2015, the U.S. DOE has approved 10 LNG export applications and has another 33 under review (this doesn't include multiple applications for some facilities).[52] Five of the ten approved facilities are under construction, with projected start dates ranging from fourth quarter 2015 to 2018.[53]
- **Power Generation Gas Consumption** - In EIA's AEO 2014 report, natural gas consumption for U.S. power generation follows an increasing trend. It is projected that consumption for the whole U.S. would increase from 72 Bcf/d in 2018 to 77

[50] http://minerals.usgs.gov/minerals/pubs/commodity/nitrogen/mcs-2013-nitro.pdf
[51] June 2015 U.S. gas exports to Mexico averaged over 3.0 BCFD. Source: http://www.eia.gov/todayinenergy/detail.cfm?id=16471
[52] http://energy.gov/sites/prod/files/2015/05/f22/Summary%20of%20LNG%20Export%20Applications.pdf
[53] https://www.stratfor.com/analysis/how-us-lng-production-will-ultimately-exploit-global-markets. http://www.ferc.gov/industries/gas/indus-act/lng/lng-approved.pdf

Bcf/d (+5 Bcf/d) in 2024, and consumption in the electric power sector will increase from 23 Bcf/d in 2018 to 26 Bcf/d (+3 Bcf/d) in 2024.[54]

Q. WHAT DOES YOUR REVIEW OF THE GAS INDUSTRY CONCLUDE?

A. I conclude that my long-term forecast is reasonable.

Q. ARE YOU THE ONLY FORECASTER TO COME TO A SIMILAR CONCLUSION REGARDING FUTURE NATURAL GAS PRICE INCREASES?

A. No. I am not the only forecaster to conclude that in spite of low current gas prices, long-term prices will rise. The EIA AEO 2015 average Henry Hub gas price forecast for 2015 to 2031 is lower than the EIA AEO 2014 forecast, a point Mr. Comings makes (as discussed later), but only by a very small 1.5% in their reference case. Thus, EIA long-term gas price reference cases are relatively stable and show large increases in prices from current levels. Furthermore, both EIA AEO reference cases (i.e., 2014 and 2015) are [**BEGIN CONFIDENTIAL**] [redacted] [**END CONFIDENTIAL**]. However, they are biased downward by not including any effects for proposed CO_2 emission regulations. If this were corrected, the impact would be to raise EIA gas price reference cases above mine.

C. Mr. Wilson's Scenarios And Criticisms Are Flawed.

Q. DOES MR. WILSON PREPARE ALTERNATIVE PRICE SCENARIOS?

A. Yes. Mr. Wilson initially proposes three different natural gas price cases. He then adopts the two lowest scenarios. In addition, Mr. Wilson's gas price approach is incorrect in all three cases, and the impact is especially erroneous in the two cases he relies upon. Mr. Wilson's three natural gas price scenarios are: (1) the AEO 2014 "Reference Case"

[54] EIA, AEO 2014 Report, http://www.eia.gov/forecasts/AEO/

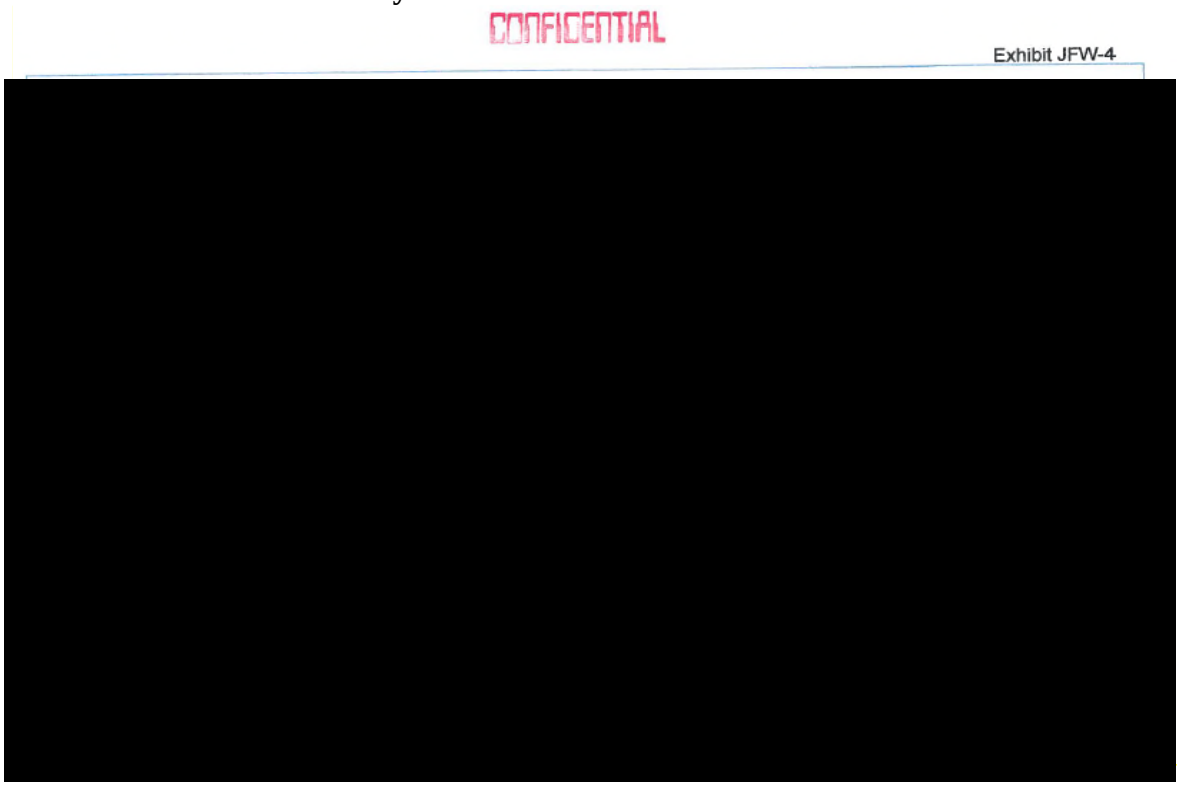
projection; (2) the AEO 2014 "High Oil and Gas Resource" scenario: and (3) Current Forward Prices, with increases thereafter at inflation.

Q. DOES HE PROVIDE A GRAPHICAL REPRESENTATION OF HIS THREE CASES AND THAT OF ICF?

A. Yes. As can be seen below, the case based on forward prices is the lowest in the near term. The graphic also highlights the short window for which NYMEX prices (i.e., forward prices) are available. Moreover, as it turns out and as described below, the figures shown in the graphic greatly overstate the period for which there is reliable NYMEX forward price data, because beyond the first few years the reported prices are primarily offers, not actual transactions; there are few if any transactions.

[**BEGIN CONFIDENTIAL**]

Figure 8
Summary of Mr. Wilson's Natural Gas Price Forecast



[**END CONFIDENTIAL**]

Q. WHAT IS YOUR REACTION TO THE METHODOLOGY USED IN MR. WILSON'S GAS SCENARIOS?

A. Mr. Wilson does not conduct a forecasting effort using an acceptable modeling platform that provides an integrated and methodologically sound assessment for either electric power or gas prices. This is problematic, as I will discuss below. He should have analyzed his cases using an accepted modeling platform to ensure that the relationships among the variables were properly addressed. These relationships are very dynamic and can change over time.

Instead of properly using an accepted modeling approach, Mr. Wilson relies heavily on natural gas futures prices. As discussed below, relying on futures prices over the next two years makes sense, relying on them over years three to five years makes some sense, and relying on them past year five makes little sense, and cannot be the basis of a forecast.

Mr. Wilson also relies in part on EIA AEO projections of natural gas prices. However, he uses them incorrectly. He rejects the EIA reference case and picks one of the more than 20 EIA AEO alternative non-reference gas price cases without adequate justification.

This is significant because the U.S. EIA AEO 2014 reference case projection is on average very close to mine. The EIA AEO 2014 projection in real dollars [**BEGIN CONFIDENTIAL**] [redacted] [**END CONFIDENTIAL CONFIDENTIAL**] than ICF's projection over the same period.[55] The EIA AEO reference case also assumes no national CO_2 emission regulations even though such regulations are now final. If the 2014 EIA AEO included an expected (i.e., expected in

[55] Energy Information Agency, "Annual Energy Outlook 2014".

the mathematical sense which is the probability weighted average of several forecast scenarios) CO_2 regulatory case, and associated emission allowance prices, the gas price could be above my forecast. As noted, the 2015 EIA AEO reference price forecast on average is similar to the 2014 forecast and [**BEGIN CONFIDENTIAL**] [redacted] [**END CONFIDENTIAL**] than the ICF projection. I consider this a small difference, but even this difference cannot be sustained due to the failure to account for CO_2 emission regulations finalized August 3, 2015.

1. The EIA Reference Case

Q. WHAT IS THE VIRTUE OF THE EIA REFERENCE CASE?

A. A key virtue of this case is that it reflects methodologically sound modeling of supply and demand unlike Mr. Wilson's forwards-based case, though its lack of treatment of CO_2 regulations biases the result downward. Another is that it is a reference case and appears to be the closest to a probability weighted expected case. Because the EIA Reference Case is a reference case and based on sound forecasting methodology, it is the most appropriate of the three cases.

Q. HOW DOES THE EIA REFERENCE CASE COMPARE TO YOUR FORECAST?

A. The first natural gas price case discussed by Mr. Wilson but which he ultimately rejects — the EIA reference case — has natural gas prices that are fairly close to, but modestly below, my forecast. Over the 2015 to 2031 period, the average gas price in the EIA reference case is $5.10/MMBtu in real 2013 dollars versus [**BEGIN CONFIDENTIAL**] [redacted] [**END CONFIDENTIAL**]. Nonetheless, Mr. Wilson used the wrong EIA case.

Q. WHAT DO YOU MEAN HE USES THE WRONG EIA CASE?

A. Mr. Wilson picked a reference case that assumes there will not be any regulation of CO_2 emissions.[56] In fact, Mr. Wilson ignores EIA AEO cases with CO_2 regulations included that are available in the same document. When the higher gas prices from EIA's CO_2 regulation cases are used (the GHG10 case),[57] the gap with the ICF case is closed further. Over the 2015 to 2031 period, the average gas price in the GHG10 case is $5.26/MMBtu in real 2013 dollars versus [**BEGIN CONFIDENTIAL**] [redacted] [**END CONFIDENTIAL**]. Thus, the EIA case is closer to ICF's when an EIA estimate CO2 is included in the EIA case.

Q. PLEASE ELABORATE ON MR. WILSON'S TREATMENT OF CO2 AND NATURAL GAS PRICES.

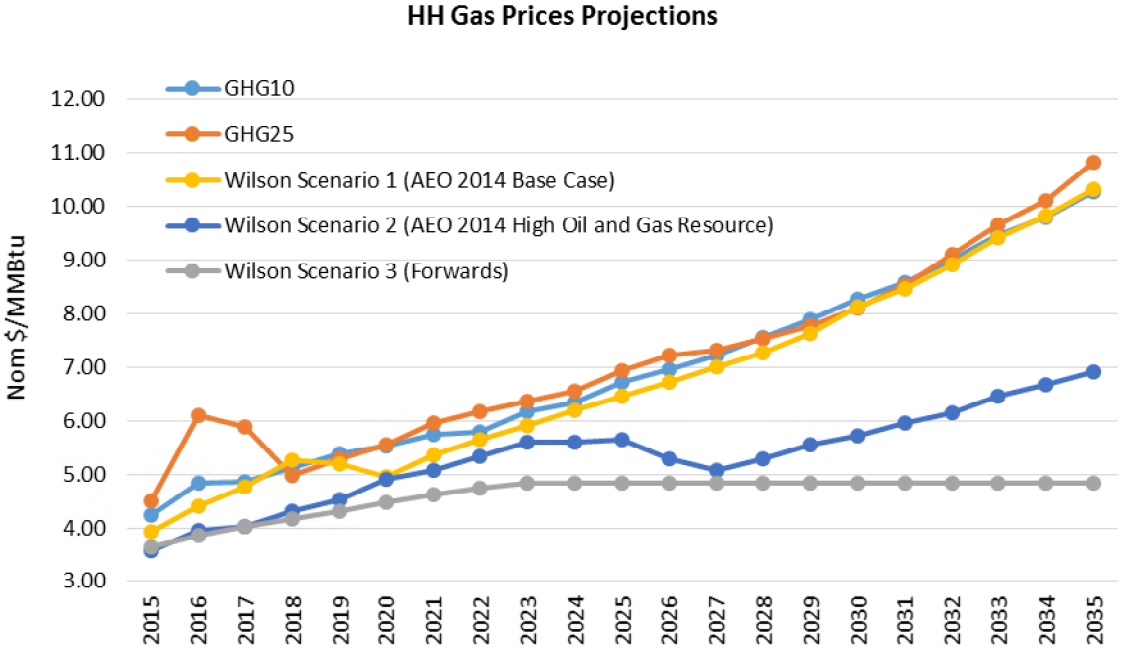
A. There are a number of points that demonstrate his lack of knowledge of the AEO forecasts. First, on page 4549 of his October 2, 2015 testimony, starting on lines 23, Mr. Wilson states that he did not know that AEO 2014 had two cases with forecasts of carbon prices, GHG10 and GHG25. Furthermore, starting on lines 5 of page 4550, he agrees that he does not know the relationship between these two cases and the AEO 2014's reference case. Also, it is not clear that he was aware that the AEO reference case did not model any CO2 emission regulation. This is even though he admits on page 4550 that CO_2 regulations can have upward price pressure on natural gas and power prices. This is also in spite of proposed CO_2 emission regulations being announced in June 2, 2014, approximately six months before he filed his direct testimony, and final CO_2 emission regulations being announced August 3, 2015, two months before he took the stand on October 2, 2015.

[56] http://www.eia.gov/analysis/reports.cfm?t=138 lists the environmental policies analyzed and national CO2 controls is not one of them.

[57] AEO reports two GHG cases: 1) GHG10 and 2) GHG25. We show the lower CO2 price case which is the GHG10 case.

As shown in Figure 9, the two GHG (Greenhouse Gas) cases have higher prices than the AEO reference case (labeled AEO 2014 Base Case). In GHG 25, the 2015 to 2031 gas price is 7% higher than the EIA AEO reference case. The quantitative estimates by EIA of the impact of CO_2 emission regulations on gas price is not the same as mine would be. The key is that CO_2 regulations increase gas prices and this effect needs to be addressed.

Figure 9
EIA Gas Prices – GHG Cases and Wilson Scenarios



Q. WHY IS THE USE OF NON-CO_2 REGULATORY CASES INAPPROPRIATE?

A. It is not appropriate to assume on a probability weighted basis that the federal government will not regulate CO_2 emissions from existing power plants. The U.S. EPA proposed such regulations on June 2, 2014, and finalized them on August 3, 2015. I assume CO_2 emission regulations will occur on a probability weighted basis. These regulations increase demand for natural gas because the combustion of natural gas results

in less CO_2 emissions that coal combustion per MWh generated. Higher demand for gas leads to higher gas prices.

Q. WHY DOES THE EIA'S REFERENCE CASE NOT ASSUME CO_2 REGULATIONS?

A. They explicitly model only finalized regulations, and separately model CO_2 regulation cases. They have not revised their reference case forecasts in light of the recent finalization of CO_2 regulations.

Q. WHAT DOES MR. WILSON DO WITH THE EIA REFERENCE CASE?

A. He rejects it even though it is the most appropriate of the three cases he identifies. Furthermore, he does so without a sound basis. He discusses that a U.S. EIA publication dated December 2013 and entitled, "U.S. Crude Oil and Natural Gas Proved Reserves, 2013", indicates higher proved natural gas reserves. [58] He uses this report as a basis for not relying on the AEO 2014 reference case. He states:

> Again, natural gas price forecasts continue to decline, and I expect that EIA will lower its projection when AEO 2015 is released in January 2015. So this scenario, prepared in 2013, likely overstates natural gas and electric energy prices and revenues, and understates the cost to customers of Rider RRS.[59]

As it turned out, when EIA released its 2015 AEO reference case gas projection, which includes all the information available to EIA, gas prices were practically unchanged and much higher than the High Oil and Gas Resource case. As noted, the EIA AEO 2015 (released April 14, 2015) reference case forecast of average Henry Hub gas price forecast for 2015 to 2031 is lower than the EIA AEO 2014 projection, a point Mr. Comings makes, but only by a very small 1.5% in their reference case. In contrast, EIA's 2014 High Oil and Gas Resource case is 17.4% lower on average for 2015 to 2031 compared

[58] Wilson Direct, page 30 line 15 to page 32 line 15.
[59] Wilson Direct, page 45, lines 17-20.

to the 2014 reference case. This lack of change in gas prices in the reference case compared to the High Oil and Gas Resource (-1.5% versus -17.4%) case is not surprising for two reasons. First, the EIA 2014 High Oil and Gas Resource case is about resources and technology, not proved reserves. The description of this case is:

> Estimated ultimate recovery per shale gas, tight gas, and tight oil well is 50% higher and well spacing is 50% lower (or the number of wells left to be drilled is 100% higher) than in the Reference case. In addition, tight oil resources are added to reflect new plays or the expansion of known tight oil plays and the estimated ultimate recovery for tight and shale wells increases 1%/year to reflect additional technological improvement. Also includes kerogen development, tight oil resources in Alaska, and 50% higher undiscovered resources in the offshore lower 48 states, Alaska, and shale gas in Canada than in the Reference case.[60]

Second, the main geologic basis for forecasting gas prices is gas resources, not proved gas reserves. Resources are much larger than proved reserves; if all there were was proved gas reserves, the country would entirely run out of gas in the early 2020s. Further, it is not surprising that proved reserves increased because 2013 gas prices were higher than 2012 prices; prices are a key factor in shifting gas resources to and from proved reserves. As the report states, proved reserves:

> are estimated volumes of hydrocarbon resources that analysis of geologic and engineering data demonstrates with reasonable certainty are recoverable under existing economic and operating conditions. Reserves estimates change from year to year as new discoveries are made, existing fields are more thoroughly appraised, existing reserves are produced, and prices and technologies change.[61]

Thus, there is insufficient basis for rejecting the reference case and instead using the High Oil and Gas Resources case.

[60] Assumptions to the Annual Energy Outlook 2014", June 2014 (Page 11).
[61] U.S. EIA publication dated December 2013 and entitled, "U.S. Crude Oil and Natural Gas Proved Reserves, 2013", page 5.

2. EIA's High Oil and Gas Resource Case

Q. WHAT IS MR. WILSON'S SECOND CASE?

A. As noted, Mr. Wilson's second case is EIA's AEO case based on "High Oil and Gas" resource assumptions.

Q. HOW MANY EIA AEO NON-REFERENCE CASES ARE THERE?

A. There are numerous cases. In fact, EIA in their 2014 AEO publishes many "scenarios" which they term "cases" and compares them to the "Reference Case" which is not what Mr. Wilson does. Some of the 21 scenarios to which the AEO 2014 Reference Case is compared include:

- Low Economic Growth;
- High Economic Growth;,
- Low Oil Price;
- High Oil Price;
- 2013 Demand Technology;
- High Demand Technology;
- Best Available Demand Technology;
- No Sunset, Extended Policies;
- High Nuclear;
- Accelerated Coal Retirements;
- Accelerated Nuclear Retirements;
- Accelerated Coal and Nuclear Retirements;
- Low Nuclear;
- Low Renewable Technology Cost;

- Low Electricity Demand;
- GHG10;
- GHG25;
- Low Gas Prices;
- Low Oil and Gas Resource; and
- High Oil and Gas Resource. (Mr. Wilson's selected this case.)

There are also many more cases dealing with things like transportation, energy efficiency, coal prices, and competitiveness.

Q. DOES HE PROVIDE SUFFICIENT JUSTIFICATION FOR USING A CASE WITH HIGH OIL AND GAS RESOURCES?

A. No. As discussed, he does not provide a sufficient rationale for choosing this case.

3. NYMEX Futures

Q. WHAT IS MR. WILSON'S THIRD NATURAL GAS PRICE CASE?

A. He relies on the NYMEX forwards prices traded on December 5, 2014. He extrapolates from the limited data for years in which there are not any quotations or transactions - i.e., for the time period from 2024 to 2031. On average, between 2015 and 2031, the price in this case is 24.5% (real $) lower than the EIA reference case, and [**BEGIN CONFIDENTIAL**] [redacted] [**END CONFIDENTIAL**]

Q. HOW DOES MR. WILSON JUSTIFY HIS USE OF NATURAL GAS PRICE PROJECTIONS LOWER THAN ICF'S AND THE EIA REFERENCE CASE?

A. Mr. Wilson justifies his use of lower gas price projections based in part on currently traded forward market natural gas prices.[62]

Q. WHY DO YOU NOT USE FORWARDS FOR LONG-TERM NATURAL GAS FORECASTING?

[62] Wilson Direct, page 10, lines 13-16.

A. I only use forwards for the first two years, and rely on the ICF fundamentals-based forecast of supply and demand for all other periods. I only rely on forwards in the near term because they are only liquid in the near term.

Q. WHAT DO YOU MEAN BY LIQUID ONLY IN THE NEAR TERM?

A. The volume of transactions is extremely low for trading of futures for longer term delivery. Moreover, the price quotations shown for delivery past year five are almost exclusively reflecting offers, not transactions. This small sample size (i.e., the few transactions) is not reflective of the views of market participants. Significant use of these futures offers would result in such a large increase in volume that, prices would change dramatically. Furthermore, if there were attempts to rely on forwards for significant volumes, prices would respond quickly and adversely. For example, an effort to lock in prices by buying now for forward delivery would greatly increase demand for forward contracts, and raise their prices.

Q. HOW ILLIQUID ARE THEY?

A. They are extremely illiquid as shown in Figure 10. In the first two months of 2015, only 24 contracts were transacted for delivery in 2019 or beyond and only 1 was transacted past 2020. In contrast, from the same two months of 2015, approximately 14.7 million contracts traded for delivery in the first two years (i.e., 2015 and 2016). 14.2 million of the 14.7 million traded in the first year (i.e., 2015). The ratio of transactions in the first 2 years to transactions in years 5 and beyond is 14.7 million to 24, or 613,000 to 1, and as noted, there is only one transaction after year 6.[63] Therefore, there is no evidence that the

[63] Mr. Wilson relies on a single day, December 5, 2014. A similar result is obtained for the month of December 2014. In December, 2014, there were no trades for 2020 and beyond, 6 in 2019, 6.6 million for the first two years, and 0.001 million (i.e., approximately 10,000 transactions) for years 2017 -2019.

market conveys significant information about expectations of market participants for the 2017 to 2031 period, which is nearly the entire forecast period.

Figure 10

Number of Futures Contracts Traded per Month for Delivery – January 2014 to February 2015 Trading

Year/Month	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
2014/1	8,589,210	304,250	9,468	2,144	523	5	101	1	1	0	0	0	0
2014/2	7,962,125	357,631	16,016	3,679	504	52	28	0	0	0	0	0	0
2014/3	4,420,592	361,252	15,714	5,367	1,427	15	0	0	0	0	0	0	0
2014/4	4,634,186	450,367	28,105	1,913	70	14	88	3	4	0	0	0	0
2014/5	4,435,529	581,758	15,760	1,144	63	4	5	1	0	0	0	0	0
2014/6	4,717,833	684,471	18,961	3,248	621	5	0	0	0	0	0	0	0
2014/7	4,134,106	867,650	28,287	2,326	952	1,801	0	0	0	0	0	0	0
2014/8	4,240,828	1,115,436	15,489	2,140	831	100	68	5	7	0	0	0	0
2014/9	4,003,345	1,584,166	39,749	3,184	389	1,536	1	0	0	1	0	0	0
2014/10	3,628,475	2,390,915	63,943	3,434	930	123	2	0	0	0	0	0	0
2014/11	2,783,881	5,125,644	84,174	1,393	65	30	8	0	0	1	0	0	0
2014/12	0	6,439,894	119,515	8,116	564	281	6	0	0	0	0	0	0
2015/1	0	7,416,074	226,666	6,095	191	7	6	0	0	0	1	0	0
2015/2	0	6,806,790	242,824	7,890	342	10	0	0	0	0	0	0	0
Total	**53,550,110**	**34,486,298**	**924,671**	**52,073**	**7,472**	**3,983**	**313**	**10**	**12**	**2**	**1**	**0**	**0**

Source: SNL Financial

Q. WHY ELSE SHOULD FUTURES NOT BE USED AS A BASIS FOR LONG-TERM PROJECTIONS IN REGULATORY CASES?

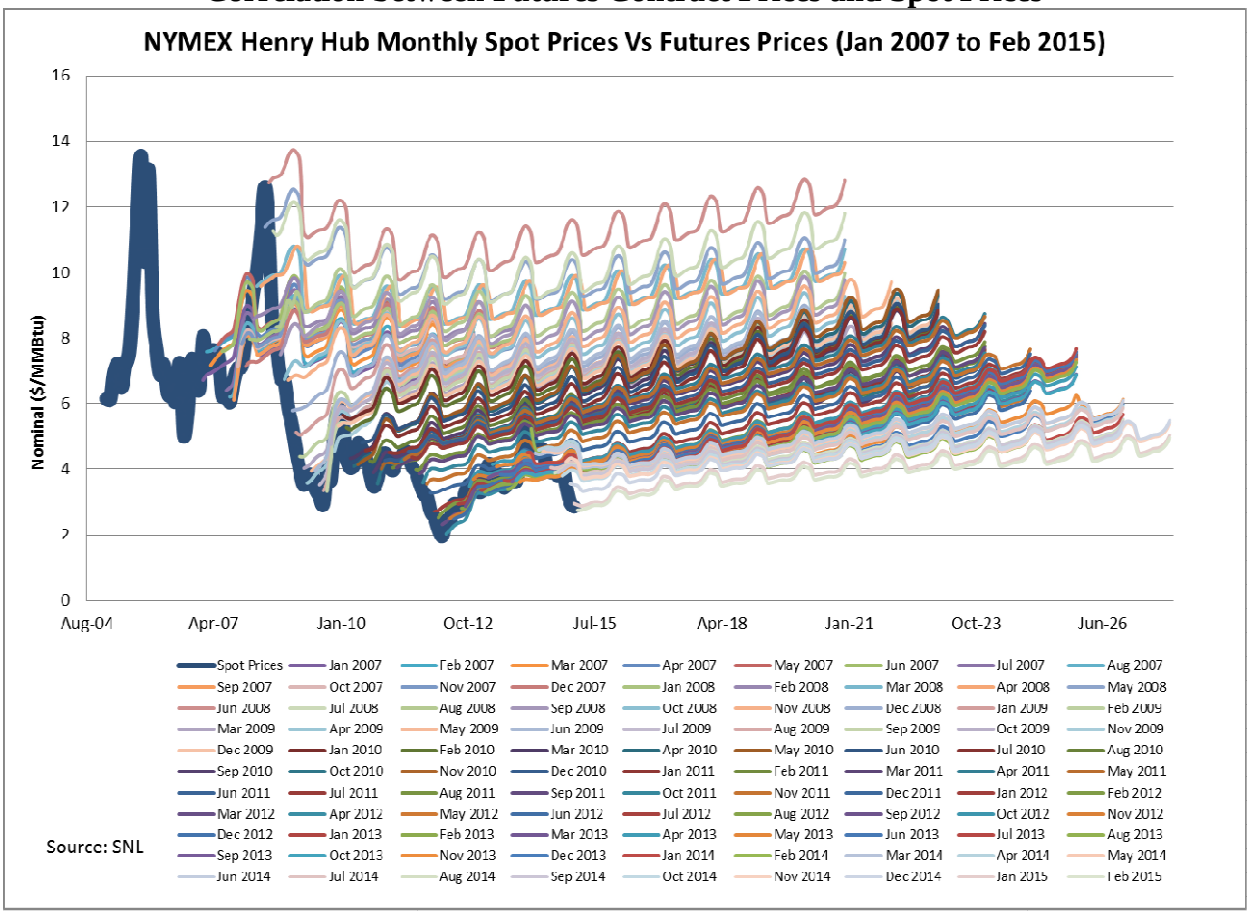
A. They do not reflect an assessment of supply and demand conditions for natural gas, and hence, do not reflect the drivers of long run prices. Therefore, the forwards are not a methodologically sound approach to long-term forecasting – e.g., 10-20 year forecasts.

Q. ARE NATURAL GAS PRICES VOLATILE IN THE FUTURES AND SPOT MARKETS?

A. Yes. Futures primarily reflect the spot market prices for natural gas at the time of issuance. This is because of the ability to store natural gas and arbitrage prices in the near term. This is also demonstrated empirically as shown in Figure 11; futures natural gas prices follow spot prices. The heavy dark blue line is the spot price and the colored lines are the futures prices trading at the relevant time period. As discussed, there are practically no transactions for later years, but rather the futures price curve is based primarily on bid and ask quotations. The lower the spot prices, the lower the futures prices. In fact, there is an 81% correlation (put another way, the correlation coefficient is 0.81) between the average futures price and the spot price on a monthly basis for the period covered in the figure below. [64] The maximum possible correlation is 100% which would mean that there is perfect correlation.

[64] Henry Hub historical and futures gas prices from January 2005 to February 2015 were used to calculate the correlation. Both monthly historical prices and Futures were obtained from SNL Financial.

Figure 11
Correlation between Futures Contract Prices and Spot Prices



Q. WHY ELSE IS IT PROBLEMATIC TO USE NYMEX FUTURES PRICES?

A. NYMEX futures prices do not factor in or consider the effect of CO_2 regulations, or any specific CO_2 allowance price forecast (expressed in $/ton). For example, the Clean Power Plan ("CPP"), which would regulate CO_2 emissions from existing plants, starts in 2022. The gas futures price would not reflect the impact of CO_2 regulations because nearly all transactions are for delivery prior to 2020.[65] Mr. Wilson is silent on CO_2 emission allowance price forecasts. If Mr. Wilson believes that there is a chance of CO_2 emission regulations, he cannot use a NYMEX price since it cannot be expected to reflect the impacts of a potential CO_2 program. In light of finalized regulations, he must adjust

[65] *See* Figure 9.

upward the gas price projection. Without a modeling framework of natural gas supply and demand to capture key relationships, he has no basis for this adjustment.

Q. WHAT IS THE RELATIONSHIP BETWEEN CO_2 ALLOWANCE PRICE AND NATURAL GAS PRICE FORECASTS?

A. In the range of CO_2 allowance price forecasts used by ICF, the higher the CO_2 allowance price, the higher the natural gas price and vice versa.

4. Mr. Wilson's Claims About Other Forecasts

Q. DOES MR. WILSON INDICATE THAT OTHER FORECASTS ARE DIFFERENT FROM ICF'S FORECAST?

A. Yes. However, he only presents one base or reference case, the non-CO_2 U.S. EIA Reference Case discussed above. This does not support his position that ICF's forecast is unreliable. Just the opposite, the EIA Reference Case supports the ICF forecast because it is so similar in terms of price, methodology and being a reference case.

Q. DOES MR. WILSON PRESENT ANY OTHER BASE OR REFERENCE CASE THAT SUPPORT HIS ASSERTION THAT OTHER FORECASTS SUPPORT HIS LOW PRICES?

A. No.

Q. WAS THERE ADDITIONAL INFORMATION FOR SUCH COMPARISONS AVAILABLE TO MR. WILSON?

A. Yes. In the 2014 AEO, there is a table comparing 2025 Henry Hub price forecasts in 2012 $ per MMBtu. EVA's forecast is 4% higher than my 2025 forecast in my testimony, and EIA's is 4.4% lower. A third forecast from IHSGI is shown, but it is not an expected value forecast (see earlier discussion on expected values as probability weighed), but simply one of several scenarios.[66] In addition, in the newly released AEO 2015 Report, projections for the year 2025 for Henry Hub natural gas prices in the

[66] US EIA AEO 2014, page CP - 10.

Reference Case increase to $0.15/MMBtu compared to AEO 2014, while the 2035 projection in the Reference Case in AEO 2015 is still close to my forecast. Lastly, US EPA gas price projections are also similar to mine.

5. 2020 forecasts

Q. WHAT DOES MR. WILSON SAY ABOUT YOUR 2020 FORECASTS?

A. Mr. Wilson says they are irrational or a surprise. Mr. Wilson claims that an increase in my forecast gas price in 2020 cannot be accepted even though detailed modeling shows a large increase in gas demand in this period as new capital stock using natural gas comes on line. He argues that it is irrational to have such a large increase because it requires market participants to be surprised.

Q. IS THIS CORRECT?

A. No. As discussed, a large increase in demand for natural gas is underway, and there is significant lead time required for this increase due to the need for capital investments. Further, supply is contracting or at the very least is no longer increasing rapidly. The combination of these trends will result in an increase in gas prices. It is not uncommon for market reactions to be non-linear, and not be fully anticipated by industry participants or factored into prices in advance.

V. MR. COMINGS' NATURAL GAS PRICE PROJECTIONS

Q. WHAT DOES MR. COMINGS SAY ABOUT YOUR GAS PRICE FORECASTS?

A. Mr. Comings asserts that my forecasts are too high.

Q. WHAT IS MR. COMINGS' BASIS FOR CLAIMING YOUR FORECAST IS TOO HIGH?

A. Mr. Comings has the following bases for his claims regarding my forecast: (1) NYMEX natural gas futures prices for 2015 and 2016 are lower than I used when preparing my

testimony; (2) the recently released April 2015 U.S. EIA AEO natural gas price forecast is lower than the forecast from 2014; (3) my quarterly natural gas price forecasts are lower than the forecasts I used in preparing the forecasts used in my testimony; (4) my historical gas price forecasts were higher than prices turned out to be; and (5) I have lowered my forecasts over time.[67]

Q. WHAT IS YOUR REACTION TO MR. COMINGS' COMMENTS RELATED TO LOWER NYMEX FUTURES FOR 2015 TO 2016?

A. Near term futures for 2015 and 2016 are lower than when I prepared my forecasts. Natural gas is the most volatile commodity traded and happens now to be low. However, as discussed regarding Mr. Wilson, gas future prices are not an adequate basis for long-term forecasts or even a description of long-term market expectations – they provide useful information for the prompt two years, less useful information for years three to five and little to no material information beyond year five.

Q. WHAT IS YOUR REACTION TO MR. COMINGS' COMMENTS RELATED TO LOWER U.S. EIA GAS PRICE PROJECTIONS BETWEEN 2014 AND 2015?

A. The EIA AEO long-term 2015 to 2031 average projection released in April 2015 is 1.5% lower than the AEO 2014 projection.[68] I consider this a small change and it supports the conclusion that the U.S. EIA AEO long-term gas price projection is relatively stable. Further, as noted, the EIA AEO projections in both 2014 and 2015 incorrectly assume no CO_2 regulations even on a probability weighted basis. Hence, EIA's projection would be higher if it were to take into account CO_2 regulations, and likely even closer to or higher than ICF's forecast.

[67] Comings Supplemental, page 9, lines 6 and 7.
[68] This is a comparison using Henry Hub spot prices between the Reference Cases in AEO 2014 and AEO 2015.

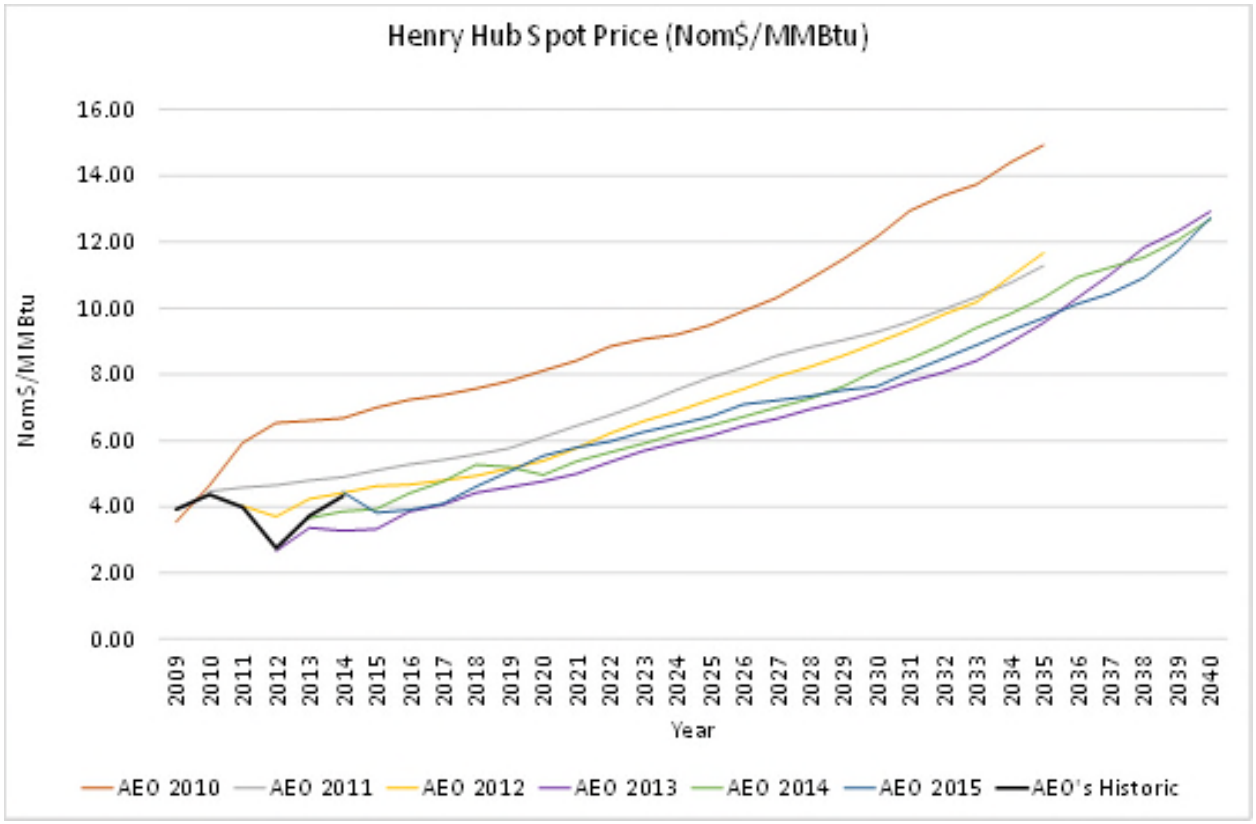
Q. WHAT IS YOUR REACTION TO MR. COMINGS' CLAIM THAT YOUR HISTORICAL GAS PRICE FORECASTS WERE HIGHER THAN GAS PRICES TURNED OUT TO BE?

A. Gas prices have been lowered by the decrease in production costs as applied to shale gas deposits, especially as applied to northeastern U.S. shale gas resources such as the Marcellus. Further, there has been less demand due to the severity of the recession and this has also contributed to lower prices. Neither of these were sufficiently anticipated, and hence, between 2010 and 2011, my gas forecasts were too high. Staring with my 2012 forecast, my forecasts have been relatively stable with expectations of near term natural gas prices at Henry Hub being approximately $3.5/MMBtu to $4/MMBtu. I have forecasted, and continue to forecast, that any deviations on the high or low side from the approximately $4/MMBtu level in the near term will be temporary – i.e., 6 to 18 months. Indeed, this has been the case. Prices in 2012 were $2.75/MMBtu and we emphatically expected reversion to the weather normal level of $4/MMBtu. In 2013 and 2014, nominal Henry Hub gas prices indeed averaged approximately $3.73-$4.37/MMBtu, in line with our forecasts. In addition, in 2014, delivered gas prices in parts of the northeastern US were the highest ever recorded in U.S. gas history, briefly reaching $120/MMBtu — i.e., 30 times higher than $4/MMBtu. As noted, there is compelling evidence that the current low prices cannot and will not be sustained in the longer term. Annual average gas prices will not return to the $10/MMBtu (2013$) seen as recently as 2008, but neither will long-term average prices stay at $4/MMBtu over the next 15 to 20 years. Further, there will be upside and downside volatility around this trend. I am not alone in this view. The U.S. EIA shares a similar view of future gas prices even though they understate long-term gas prices by assuming no CO_2 emission regulations on US powerplants.

Q. WHAT IS YOUR REACTION TO THE CLAIM THAT YOU HAVE HAD TO LOWER YOUR GAS PRICE FORECASTS?

A. As noted, in the 2010 to 2011 period, I did lower gas price forecasts significantly. Since then, adjustments have been much more minor. However, Mr. Comings selectively ignores an even greater lowering of forecasts in the 2010-2011 and in the 2010-2014 periods by the source he relies on: the U.S. EIA AEO.

Figure 12
EIA Gas Price Forecasts over Time



Source: EIA's Annual Energy Outlook forecasts

Q. WHY DID YOUR FORECAST DECREASE OVER TIME DURING THE 2010 TO 2011 PERIOD?

A. My forecast decreased over time primarily related to the treatment of the Marcellus and Utica[69] shale gas, especially over the 2010 to 2011 period. I lowered the cost of

[69] For simplicity I refer to the Marcellus for the Marcellus and Utica shale gas sources. Marcellus is by far the larger of the two. They are both located in similar areas in the northeastern part of the U.S..

producing gas from the Marcellus region, which in turn lowered gas prices. This in turn reflected the growth in knowledge on how and where to drill, and the application of horizontal drilling and fracking technology. These advances converted the known shale gas reserve to being economic at lower price levels.

Q. WHY IS THE MARCELLUS TREATMENT SO IMPORTANT?

A. The increase in output of the Marcellus accounts for half of the increase in U.S. production over the past five years, with the increase in gas production associated with oil production accounting for the other half. The Marcellus is now the largest source of gas in the U.S. with production of Marcellus and Utica accounting for approximately 17 BCFD in a U.S. market of approximately 72 BCFD. The next largest shale gas producing area, the Haynesville, is half the size of the Marcellus and Utica.

Q. WHAT SPECIFICALLY LOWERED THE COST OF PRODUCTION?

A. As Marcellus production has matured, the length of horizontal wells increased, treatment of fracking improved, the number of wells per drilling pad increased, the time to drill the wells decreased, and the Estimated Ultimate Recovery (EUR) of the wells increased approximately from 2.5 to 3 BCF per well to 5-6 BCF per well between 2008 and 2015.

Q. WHY WON'T THIS HISTORY CONTINUE OR BE REPEATED?

A. There are several reasons we do not expect a repeat or continuation:

First, when I say that this remarkable history of increasing production will not continue, it does not mean that the Marcellus is static. Rather, as described below, production will increase but simply not at the same breakneck pace. Indeed, ICF projects that Marcellus will double its output by 2030, and hence, that the largest shale play will be an even greater fraction of U.S. output. This will take approximately 15 years.

However, in order to achieve this growth, the loss in output per well over time must be overcome.

Second, the Marcellus is now a more mature play, and hence learning and cost reductions will slow down. For example, estimated ultimate recovery ("EUR") per well is expected to continue to grow over time, but at a slower rate. Specifically, the Marcellus EUR per well is expected to approximately double as the number of wells drilled doubles, but as production grows, the number of wells takes longer to double. For example, it took approximately four years between 2010 and 2014 for the number of wells to double (from 10,000 wells drilled in 2010 to 20,000 in 2014). As stated above, over this same time period the EUR per well also roughly double. Going forward, drilling is expected to average approximately 2,500 wells per year. Thus, the next doubling of wells drilled, from 20,000 to 40,000 will take 8 years.

Third, there are no other large plays comparable to Marcellus and hence the increase seen in Marcellus is very unlikely to be repeated.

Fourth, in the late 2000s, gas prices reached on an annual average basis of over $10/MMBtu in real dollars. This created a huge incentive for major investments. We do not expect to see an impetus for such a large investment in developing a new technology.

Q. WHAT DOES THIS MEAN FOR MR. COMINGS' ANALYSIS?

A. He asserts that the history of ICF gas price forecasts invalidates our current forecast. Instead, he simply recapitulated what I said at the very beginning of my testimony. Namely, gas prices have been lower because of unexpected developments not to be repeated. His conclusion that this history is a basis for rejecting my current forecast is wrong.

Q. WHAT IS YOUR OVERALL REACTION TO MR. COMINGS' METHODOLOGY FOR GAS FORECASTS?

A. Mr. Comings is similar to Mr. Wilson. He does not base his claims on acceptable modeling methodologies. In fact, he uses no model at all, much less a widely accepted, detailed model. This leads to basic errors.

For example, Mr. Comings believes that there will be higher CO_2 prices which, all things being equal, would raise gas prices. However, he also relies on EIA reference case for natural gas prices which assumes no CO_2 regulations. This is particularly problematic for Mr. Comings, who asserts that my CO_2 emission allowance price is too low, but relies on the EIA projection without correcting for its absence in the EIA AEO approach. He should significantly increase the EIA projection for higher CO_2 prices and acknowledge my gas price forecast is lower. As noted, my forecast, while [**BEGIN CONFIDENTIAL**] [redacted] [**END CONFIDENTIAL**]

VI. FORECASTING CO_2 EMISSION ALLOWANCE PRICES

Q. PLEASE EXPLAIN THE IMPACT OF MR. COMINGS CO_2 PROJECTION ON HIS NATURAL GAS AND ENERGY PRICE PROJECTIONS?

A. Mr. Comings recommends a higher 2020 CO_2 price (EPA ICF) of $9/ton.[70] In contrast, I forecast [**BEGIN CONFIDENTIAL**] [redacted] [**END CONFIDENTIAL**] for the same period. We now know my forecast is more accurate; the final regulations recently announced start in 2022 and not in 2020 as stated in the proposed regulations announced on June 2, 2014. This overly high CO_2 price of Mr. Comings has large implications for

[70] *See* Comings Direct, page 31, portions of lines 17-18 stating, "the EPA CO2 price modeled for Ohio 111(d) state compliance.". *See* http://www2.epa.gov/airmarkets/analysis-proposed-clean-power-plan. Option 1 State is available at: http://www2.epa.gov/sites/production/files/2015-07/option_1_-_state.zip

electrical energy prices. The very large majority of generation in Ohio is coal.[71] When the marginal price setting generator is coal, Mr. Comings CO_2 assumption adds approximately [**BEGIN CONFIDENTIAL**] [redacted] [**END CONFIDENTIAL**] to the electrical energy price. To illustrate the magnitude of this increase, my 2015 forecast price for the AEP Dayton Hub all hours electrical energy price is approximately $38/MWh. Thus, Mr. Comings should be showing in many hours an approximately 25% increase in prices; on an annual basis, there should be a large increase in electrical energy prices. Therefore, it is impossible that he would recommend a ten percent lower price; he could only do that if he ignores standard practice by not using a standard accepted modeling tool to develop his numbers.

VII. CONCLUSIONS

Q. WHAT ARE YOUR CONCLUSIONS REGARDING MR. WILSON'S AND MR. COMINGS TESTIMONY?

A. My conclusions are:

- **Electrical Energy Forecast** – Mr. Comings and Mr. Wilson ignore my forecast of electrical energy prices, which is reasonably close to actual prices on a year to date basis. They offer no alternative forecast based on accepted modeling tools and provide no other forecasts for electrical energy prices from third parties. This is an especially significant omission because this is the source of the large majority of power plant revenues.
- **Capacity Price Forecast** – Mr. Comings and Mr. Wilson ignore major developments in the PJM capacity market which support my forecasts, and are consistent with my stated expectations. Even when PJM requested and FERC

[71] Coal fueled 67% of Ohio's net electricity generation in 2014, while nuclear and natural gas were 12% and 18% respectively. EIA, State Profile and Energy Estimates - Ohio, http://www.eia.gov/state/?sid=OH

approved the first delay ever in the PJM capacity auction, a delay which indicates something important is happening — because otherwise no one would agree to decrease the time available to add new powerplants to meet load — Mr. Wilson and Mr. Comings ignored these developments. Instead, they describe the grid situation as normal and fully satisfactory. They offer no capacity forecast based on accepted modeling tools and provide no other forecasts for capacity prices from third parties.

- **Natural Gas** – Mr. Comings and Mr. Wilson both mistake short run market fluctuations in price for evidence of long-term market conditions. Forwards are not probative regarding long-term conditions since in the long-term there are practically no transactions, just offers. Recently available evidence on the collapse in drilling and impending very large increases in gas demand support my forecast of rising prices in the coming years, prices which first return to approximately 2013-2014 levels, and then eventually exceed them. Their claims notwithstanding, the only forecasts they provided — those of the U.S. EIA AEO — reinforce and strongly support my conclusions. These forecasts are stable and close to my forecasts, even though they understate prices by ignoring expected CO_2 emission regulations. Correcting for CO_2 could even raise the EIA reference case above ICF's. Other than EIA, neither Mr. Comings nor Mr. Wilson offer any gas price forecast based on accepted modeling tools and provide no other forecasts for natural gas prices from third parties.
- **CO_2** – Mr. Comings thinks that there will be much higher CO_2 emission allowance prices especially in the near term, but he does not allow for any

consequent increase in either gas or power prices. His view regarding higher CO_2 allowance prices ignores the legal, regulatory and other hurdles to CO_2 emission regulations that decrease the expected value. The failure to integrate CO_2 prices into his power and gas projections – i.e., raise both on an expected basis – is a serious methodological failing, and is an exemplar of the methodological deficiencies that characterize the scenarios presented by Mr. Wilson and Mr. Comings.

In conclusion, the alternative price scenarios presented by of Mr. Comings and Mr. Wilson are without basis. The Commission should feel comfortable relying on my forecasts.

Q. PUT ANOTHER WAY, IN LIGHT OF THE ISSUES YOU ADDRESS ABOVE WITH THE TESTIMONIES OF WITNESSES COMINGS AND WILSON, DO YOU FEEL THEIR PROJECTIONS SHOULD BE GIVEN WEIGHT?

A. No. As I discuss in detail above, there are serious methodological problems with the projections offered by each of those witnesses. It would be inappropriate to give projections with serious methodological flaws weight when a sophisticated forecast which properly takes into account all relevant variables is available.

Q. DOES THIS CONCLUDE YOUR REBUTTAL TESTIMONY?

A. Yes.

Summary: Testimony Rebuttal Testimony of Judah Rose electronically filed by Mr. Nathaniel Trevor Alexander on behalf of Ohio Edison Company and The Cleveland Illuminating Company and The Toledo Edison Company