ISSUE BRIEF

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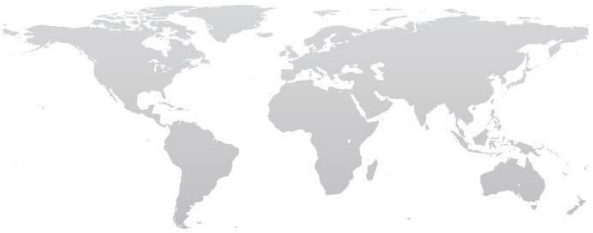
RESOURCES FOR THE FUTURE



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RESOURCES FOR THE FUTURE

The Effect of Natural Gas Supply on Retail Electricity Prices

Karen Palmer, Dallas Burtraw, Matt Woerman, and Blair Beasley[1]

Summary

Simulation modeling indicates that the recently forecasted increase in the supply of domestic natural gas will substantially reduce retail electricity prices over the next 20 years. The modeling also indicates that the predicted lower electricity demand growth will further reduce retail electricity prices. The changes in natural gas supply and electricity demand also directly affect natural gas prices. The model indicates that with increased gas supply and decreased electricity demand, both wellhead and delivered natural gas prices should fall. These changes are substantial and will have a larger effect on projected retail electricity prices than the suite of new electricity regulations recently released by the U.S. Environmental Protection Agency (EPA).

Introduction

Over the past three years, expectations for natural gas prices and electricity demand in the future have evolved substantially, as reflected in adjustments to the energy forecasts produced by the U.S. Energy Information Administration (EIA) in the Annual Energy Outlook (AEO). Between 2009 and 2011, the forecasted natural gas supply expanded multifold and the expected natural gas prices fell substantially (EIA 2009; EIA 2011)[2]. EIA's 2009 forecast projected total natural gas consumption in 2020 of 21.53 trillion cubic feet at an average wellhead price of $6.84/MMBtu, whereas its 2011 forecast projects total natural gas consumption in 2020 of 25.34 trillion cubic feet at an average wellhead price of $4.47/MMBtu. Between these two projections, consumption has increased by almost 18 percent while the price has fallen by about 35 percent.

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[2] In the Annual Energy Outlook for 2012 (EIA 2012), the price of natural gas is forecast to be even lower through the year 2025 than in the Annual Energy Outlook for 2011.

Coincidentally, forecasted electricity demand levels and growth are lower as well because of expanded investments in energy efficiency that cumulate over time and the current downturn in the economy. EIA's 2009 forecast anticipates an additional 99 billion kWh of electricity consumption in 2013 compared with the 2011 forecast. By 2020, however, the difference between the projections increases to 150 billion kWh.

Table 1 compares 2009 and 2011 EIA projections of electricity consumption, as well as natural gas prices and consumption, due to changes in electricity demand and natural gas supply, for 2013, 2016, and 2020.

Table 1. EIA Forecasts

National Natural Gas Prices and Electricity Demand in AEO 2009 and AEO 2011 ($2009)						
	AEO 2009			AEO 2011		
	2013	2016	2020	2013	2016	2020
Electricity demand (billion kWh)	3,869	3,957	4,126	3,770	3,843	3,976
Delivered natural gas price ($/thousand cubic feet)	5.90	6.48	7.48	4.75	4.83	5.13
Wellhead natural gas price ($/million Btu)	5.25	5.84	6.84	4.04	4.20	4.47
Natural gas consumption (trillion cubic feet)	21.0	21.10	21.53	24.44	25.10	25.34

This issue brief examines the effect of increased natural gas supply, lower natural gas wellhead prices, and decreased demand for electricity on retail electricity prices. To determine the effect of these different energy market projections, we use the Haiku electricity market model to simulate electricity market equilibrium outcomes for several combinations of natural gas supply and electricity demand forecasts. These scenarios and the Haiku model are described in more detail below, followed by a discussion of the simulation results and conclusions.

Scenarios Analyzed

We analyze the following three scenarios, which include different combinations of AEO forecasts of natural gas supply and electricity demand. All other characteristics of the Haiku model are the same for the three scenarios.

BASELINE

The baseline scenario reflects EIA's 2011 projections of both electricity demand and natural gas supply.

2011DEMAND_2009NATGAS

This scenario includes EIA's 2011 projection of electricity demand and EIA's 2009 projection of natural gas supply. Relative to the baseline scenario, this scenario shows the effect of lower natural gas supply and higher natural gas wellhead prices.

2009DEMAND_2009NATGAS

This scenario includes EIA's 2009 projections of both electricity demand and natural gas supply. Relative to the baseline, this scenario shows the effect of lower natural gas supply and higher natural gas wellhead prices, as well as higher electricity demand. It also shows the incremental effect of higher electricity demand relative to the 2011Demand_2009NatGas model.

Model Characteristics

The Haiku model is a partial equilibrium simulation model that solves for equilibrium outcomes in the electricity market. Haiku can be calibrated to different levels of electricity demand and natural gas supply, such as the AEO forecasts described above. However, Haiku outcomes can vary from these forecasts according to information and policies represented in the model. Other model characteristics, such as data about the existing generation fleet, assumptions about new generating capacity, and current regulatory structures and pollution policies, remain the same for the three scenarios modeled. In these scenarios the Clean Air Interstate Rule (CAIR) is assumed to remain in place. The Cross State Air Pollution Rule (CSAPR) and the Mercury Air Toxics Standards (MATS) are examined in a sensitivity case. For more information on the Haiku electricity market model, see Paul et al. (2009) and Burtraw et al. (2012).

Results

Two expected outcomes of modeling different EIA forecasts of natural gas supply and electricity demand are the effects on natural gas prices and electricity consumption. Delivered and wellhead prices of natural gas appear in Table 2. Under the forecast of lower natural gas supply in 2011Demand_2009NatGas, natural gas prices increase substantially. For example, in 2020 the delivered price is roughly 35 percent higher than in the baseline. With increased demand for electricity in 2009Demand_2009NatGas, natural gas prices further increase; the 2020 delivered price increases another $0.20 per MMBtu, yielding a price approximately 39 percent greater than the baseline price. The differences in wellhead prices are even larger.

Table 2. Natural Gas Prices

Natural Gas Prices									
	Baseline			2011Demand_ 2009NatGas			2009Demand_ 2009NatGas		
	2013	2016	2020	2013	2016	2020	2013	2016	2020
Delivered natural gas ($/MMBtu)	4.6	4.6	4.9	5.4	5.9	6.6	5.5	5.9	6.8
Percentage difference				*17.4%*	*28.3%*	*34.7%*	*19.6%*	*28.3%*	*38.8%*
Wellhead natural gas ($/billion cubic feet)	4.0	4.2	4.4	5.1	5.6	6.4	5.1	5.7	6.6
Percentage difference				*27.5%*	*33.3%*	*45.5%*	*27.5%*	*35.7%*	*50.0%*

Electricity consumption under the three scenarios for the year 2020 is shown in Table 3. This table includes a breakdown of consumption by customer class and electricity market regulatory structure. Total national electricity consumption is greatest under 2009Demand_2009NatGas, which includes the higher EIA forecast of electricity demand. Although the baseline and 2011Demand_2009NatGas both include the lower EIA projection of electricity demand, electricity consumption is lowest under 2011Demand_2009NatGas. This scenario includes the forecast of lower natural gas supply, which leads to higher natural gas prices, as shown above. This yields greater electricity prices, as discussed below, and consumers respond by consuming less electricity.

Table 3. Electricity Consumption

Electricity Consumption in 2020 (TWh)			
	Baseline	**2011Demand_ 2009NatGas**	**2009Demand_ 2009NatGas**
	2020	**2020**	**2020**
National			
Total	3,952	3,869	4,056
Percentage difference		*–2.1%*	*2.6%*
Residential	1,379	1,361	1,466
Percentage difference		*–1.3%*	*6.3%*
Commercial	1,511	1,488	1,598
Percentage difference		*–1.5%*	*5.8%*
Industrial	1,061	1,020	993
Percentage difference		*–3.9%*	*–6.4%*
Cost-of-Service			
Total	2,699	2,657	2,801
Percentage difference		*–1.6%*	*3.8%*
Residential	958.2	948.0	1,027
Percentage difference		*–1.1%*	*7.2%*
Commercial	1,002	988.0	1,069
Percentage difference		*–1.4%*	*6.7%*
Industrial	739.5	721.1	705.9
Percentage difference		*–2.5%*	*–4.5%*
Competitive			
Total	1,252	1,212	1,255
Percentage difference		*–3.2%*	*0.2%*
Residential	421.2	412.7	438.9
Percentage difference		*–2.0%*	*4.2%*
Commercial	509.5	500.0	528.9
Percentage difference		*–1.9%*	*3.8%*
Industrial	321.7	299.2	286.7
Percentage difference		*–7.0%*	*–10.9%*

Another key result of these scenarios is the effect of different forecasts on retail electricity prices, as shown in Figure 1. The left panel of this figure shows the trajectory of national average electricity prices over the simulation time horizon under the three scenarios. The center and right panels of Figure 1 show average electricity prices for the cost-of-service regions and competitive regions, respectively. Nationally and in both regions, EIA's 2009 forecasted natural gas supply leads to higher electricity prices than the 2011 forecast, and EIA's 2009 forecasted electricity

demand further increases electricity prices. These effects are largest in the competitive regions and smallest in the cost-of-service regions.

Figure 1. Electricity Prices ($/MWh)

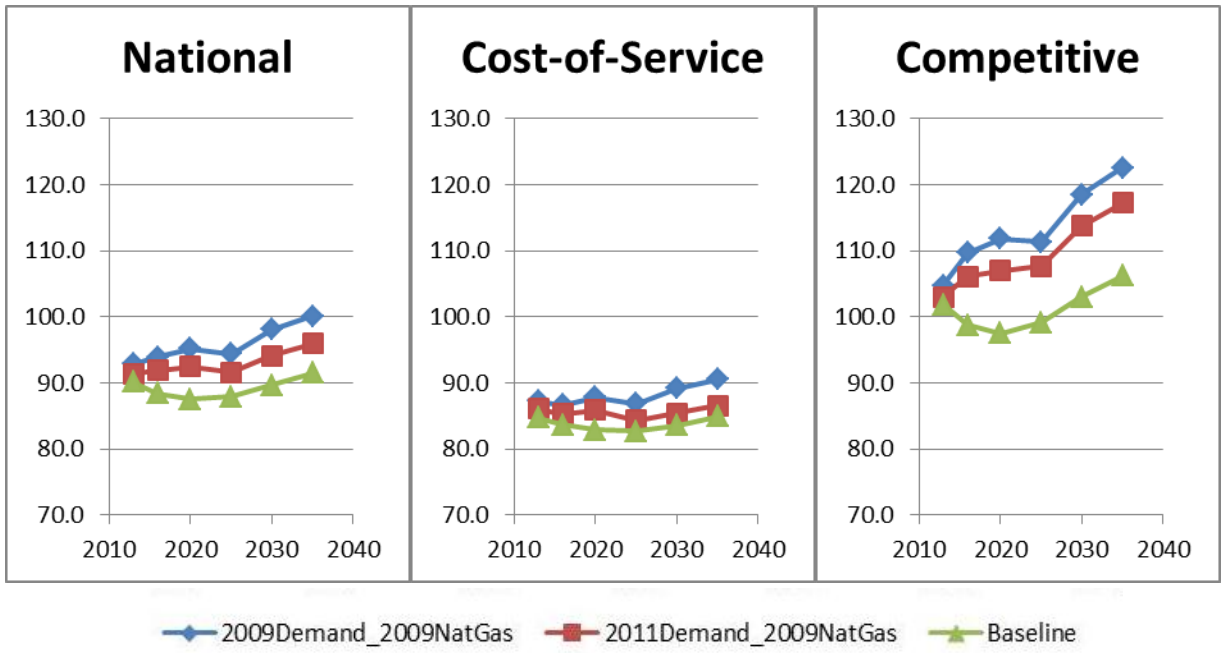


Table 4 also shows national regional electricity prices for 2013, 2016, and 2020. This table includes a breakdown of electricity prices by customer class and the percentage difference from the baseline. For every year and customer class, the same pattern as above holds, with EIA's 2009 forecasted natural gas supply increasing prices and EIA's 2009 forecasted electricity demand further increasing prices. For example, the projected lower natural gas supply in 2011Demand_2009NatGas increases national average electricity prices in 2020 by 5.7 percent. Increasing electricity demand to the level projected in 2009Demand_2009NatGas increases this price by another $2.7 per MWh, yielding a national average electricity price in 2020 that is 8.8 percent above the baseline price.

Table 4. Electricity Prices ($/MWh)

Electricity Prices ($/MWh)									
	Baseline			2011Demand_ 2009NatGas			2009Demand_ 2009NatGas		
	2013	2016	2020	2013	2016	2020	2013	2016	2020
National									
Average	90.1	88.4	87.5	91.4	91.9	92.5	92.8	93.9	95.2
Percentage difference				*1.4%*	*4.0%*	*5.7%*	*3.0 %*	*6.2%*	*8.8%*
Residential	109.9	108.0	106.7	110.9	111.3	111.6	111.5	112.5	113.7
Percentage difference				*0.9%*	*3.1%*	*4.6%*	*1.5%*	*4.2%*	*6.6%*
Commercial	92.6	90.7	89.2	94.4	94.6	94.3	94.8	95.7	96.3
Percentage difference				*1.9%*	*4.3%*	*5.7%*	*2.4%*	*5.5%*	*8.0%*
Industrial	61.2	60.1	60.3	62.2	62.7	64.4	62.9	63.7	66.2
Percentage difference				*1.6%*	*4.3%*	*6.8%*	*2.8%*	*6.0%*	*9.8%*
Cost-of-Service									
Average	84.7	83.6	82.9	86.0	85.3	85.9	87.3	86.7	87.8
Percentage difference				*1.5%*	*2.0%*	*3.6%*	*3.1%*	*3.7%*	*5.9%*
Residential	99.3	98.5	98.1	100.8	100.3	101.1	101.3	100.8	102.3
Percentage difference				*1.5%*	*1.8%*	*3.1%*	*2.0%*	*2.3%*	*4.3%*
Commercial	87.9	86.2	85.0	89.4	88.1	88.0	89.9	88.8	89.5
Percentage difference				*1.7%*	*2.2%*	*3.5%*	*2.3%*	*3.0%*	*5.3%*
Industrial	62.0	61.2	60.4	63.0	62.4	63.0	63.7	63.0	64.1
Percentage difference				*1.6%*	*2.0%*	*4.3%*	*2.7%*	*2.9%*	*6.1%*
Competitive									
Average	101.8	98.7	97.5	103.0	106.1	106.9	104.8	109.7	111.8
Percentage difference				*1.2%*	*7.5%*	*9.6%*	*2.9%*	*11.1%*	*14.7%*
Residential	133.6	129.5	126.3	133.4	136.4	135.6	134.6	139.4	140.3
Percentage difference				*–0.2%*	*5.3%*	*7.4%*	*0.7%*	*7.6%*	*11.1%*
Commercial	101.7	99.3	97.3	104.0	107.0	106.6	104.3	109.3	110.1
Percentage difference				*2.3%*	*7.8%*	*9.6%*	*2.6%*	*10.1%*	*13.2%*
Industrial	59.2	57.7	60.1	60.3	63.5	68.8	61.1	65.2	71.3
Percentage difference				*1.9%*	*10.1%*	*14.5%*	*3.2%*	*13.0%*	*18.6%*

The lower electricity prices in the baseline generate savings for most electricity customers in most years. These savings are largest for commercial customers, followed by residential customers. Table 5 highlights national cumulative savings by customer class under the baseline relative to electricity consumption and prices in scenarios with 2009 natural gas supply forecasts and 2009 demand and natural gas supply forecasts. Results are given in real 2009 dollars as well their present discounted value. The largest cumulative savings arise when the baseline is compared

with 2009Demand_2009NatGas. Here, both overall electricity consumption and electricity prices are higher than the baseline, leading to large expenditure differences.

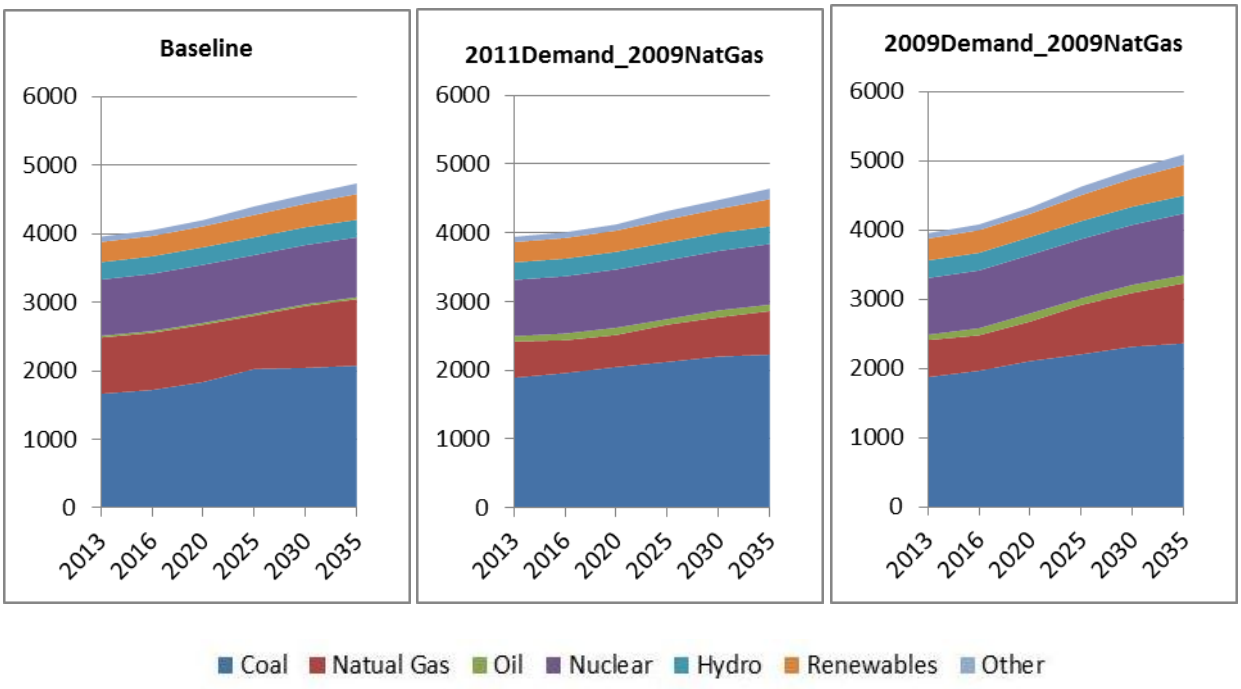
Table 5. Cumulative Savings in the Baseline (Billion $2009)

National Cumulative Savings in the Baseline (Billion $2009)						
	Compared to 2011Demand_2009NatGas					
	Real Dollars			Discounted Value		
	2013	2016	2020	2013	2016	2020
Total	3.5	26.2	70.8	3.5	2.4	57.4
Residential	0.8	8.6	25.8	0.8	7.8	20.7
Commercial	2.2	13.3	33.9	2.2	1.2	27.7
Industrial	0.6	4.1	10.5	0.6	3.7	8.6
	Compared to 2009Demand_2009NatGas					
	Real Dollars			Discounted Value		
	2013	2016	2020	2013	2016	2020
Total	9.9	67.1	203.4	9.9	61.2	163.3
Residential	5.3	34.1	100.6	5.3	31.1	80.9
Commercial	7.9	43.2	111.6	7.9	39.7	91.0
Industrial	–3.4	–10.8	86.9	–3.4	–10.1	61.7

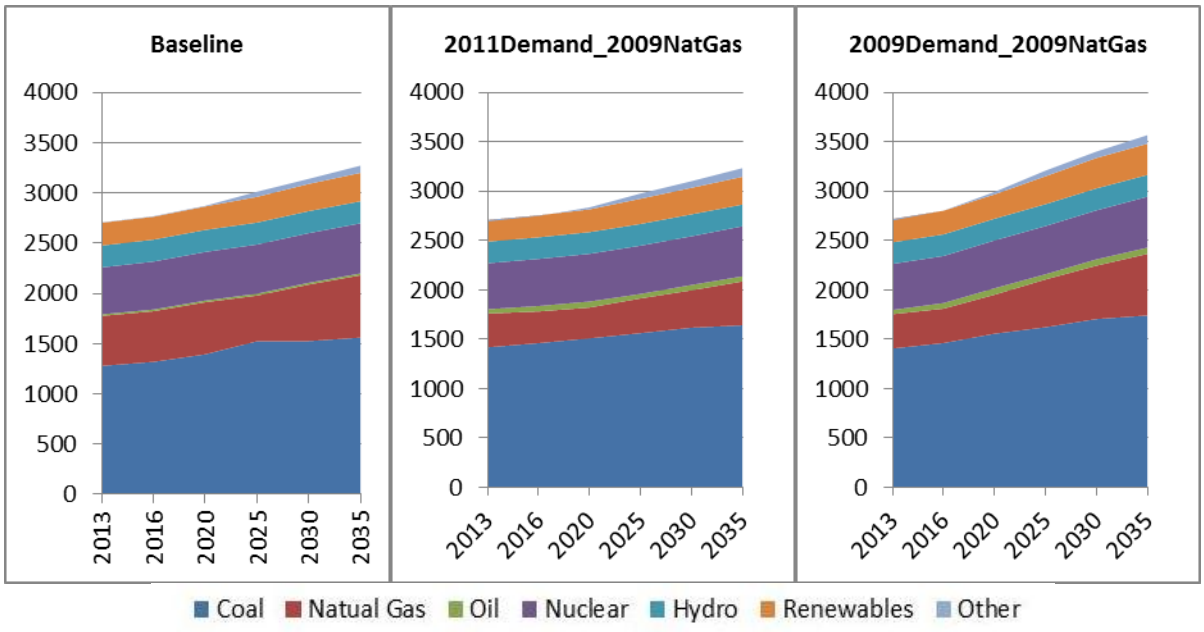
The changes in EIA's forecasted natural gas supply and electricity demand also affect the mix of fuels used to generate electricity. As Figure 2 shows, more electricity is generated from natural gas under the baseline than in the other two scenarios. This trend is most pronounced in the competitive regions. In all of the baseline scenarios, the increased natural gas generation leads to a decrease in consumption of the other fossil fuels, such as coal and oil.

Figure 2. Generation Mix

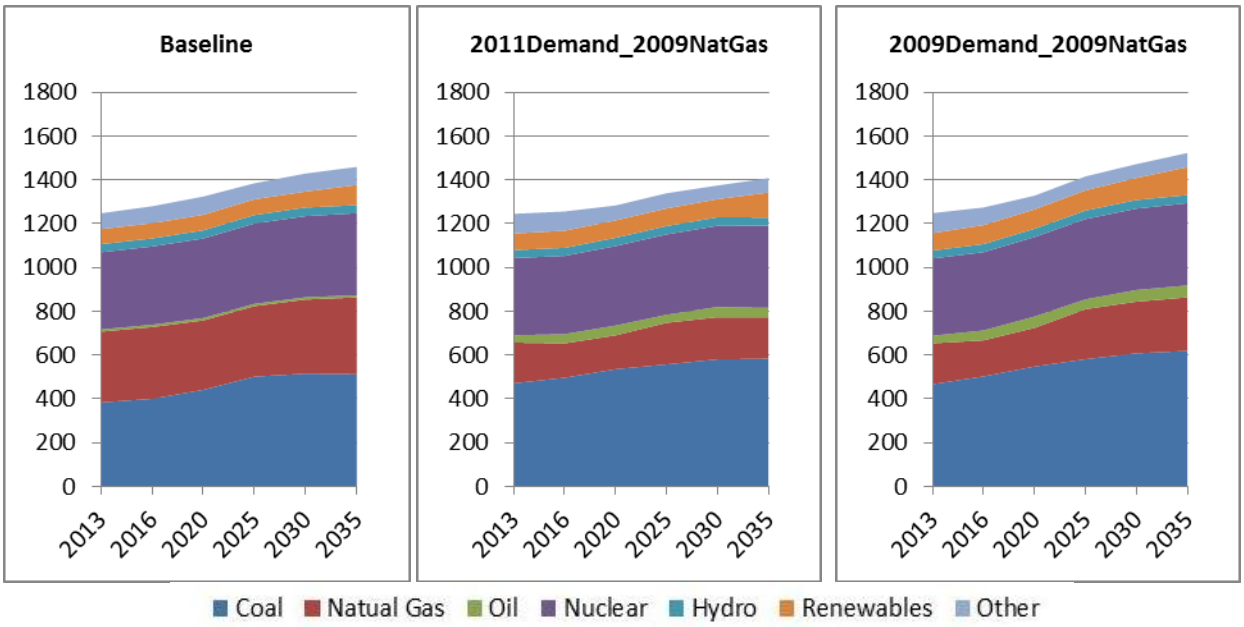
National



Cost-of-Service



Competitive



Effects of CSAPR and MATS

EPA recently issued two regulations that affect electricity prices, independent of these secular natural gas and electricity demand changes. Using Haiku, we model the effects of CSAPR and MATS with EIA's 2011 natural gas supply and electricity demand forecasts. The model indicates that the regulations will increase retail electricity prices by about 1.2 percent by 2035 over the baseline. This is substantially less than the 3.9 percent retail price increase projected for 2035 when EIA's 2009 natural gas supply estimates are used, as well as the 9.4 percent retail price increase projected for 2035 when EIA's 2009 natural gas supply and electricity demand estimates are used.

Conclusion

Haiku modeling indicates that the forecasted increases in domestic natural gas supply will lower retail electricity prices over the next 20 years. This trend increases when EIA's forecasts of decreased electricity demand are also considered. The effect of these supply and demand changes, as captured in EIA's 2009 and 2011 AEO projections, are substantial, with a larger projected effect on retail electricity prices than EPA's CSAPR and MATS regulations.

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