Energy Demand and Price Forecasts

New York State Energy Plan 2009

December 2009

1 Overview

This Assessment provides a summary of the energy demand and price reference forecasts that support the New York energy planning and policy development process. Forecasts of total statewide energy demand are disaggregated by sector and fuel type. Price forecasts are shown for oil and natural gas commodity prices, based on world and national markets, as well as for prices of selected retail fuel products that are used in New York by residential, commercial, and industrial customers. Confidence intervals and model validation results are also provided for selected sectors to illustrate the methodology used in developing the forecasts.

The reference forecasts of energy demand, i.e. energy use, and end-use energy prices provide the foundation and analytical underpinnings for New York's energy planning and policy development process. Objective analysis of the impacts of any proposed policies or actions must begin with projections of what is expected in the absence of those policies or actions. The critical metric in analysis of any policy being considered is the expected incremental change, relative to a reference forecast, that is estimated to occur as a result of the policy.

The concept of a reference forecast is to project what is reasonably and plausibly likely to occur given recent history, current trends, and policies and regulations that are known with some level of certainty. Given the 10-year planning horizon of the State Energy Plan, the reference forecasts are intended to project long-term trends that represent general direction and order of magnitude; they are not intended to provide detailed information about short-term (monthly or seasonal) market dynamics or predictions of what may occur over the next one to three years. However, estimated ranges of possible oscillation around the reference forecasts are provided through the use of confidence intervals. While the confidence intervals represent upper and lower bounds for variation around each reference forecast, they do not preclude actual observations occurring outside the confidence intervals due to external shocks, such as extreme weather, structural changes within the economy, geopolitical events, or technological breakthroughs.

2 Energy Demand and Supply in the Electricity Sector

As shown in Figure 1, the forecasts of New York's need for electricity generation, i.e. requirement, presented in this Assessment are developed in three successive steps of layering on the expected impacts of new energy efficiency initiatives in the electricity sector. The forecasts of aggregate electricity demand (GWh) of electricity needed through 2018 were developed by the New York Independent System Operator (NYISO). The projections of electricity production from various generation sources and fuel types (including imports) to meet this need are based on modeling results using the Integrated Planning Model (IPM), developed by ICF Resources International. The Energy Planning Board agencies and authorities worked closely with the NYISO in developing model inputs and reviewing results.

Step 1: Higher Demand (or Econometric) Forecast. The Higher Demand forecast projects electricity use based only on the historical statistical relationship between electricity use and predictor variables such as economic activity and population growth. This forecast represents the expected need for electricity in the absence of the '15 by 15' policy.

Step 2: Starting Point Forecast. The second step, referred to as the Starting Point forecast, is based on the widely-vetted electricity demand forecast used by the NYISO in its Reliability Needs Assessment (RNA), which provides the basis for its system planning and market development activities. The Starting Point forecast assumes that approximately 27 percent of the projected electricity use reductions needed to achieve the '15 by 15' policy goal are achieved.

Step 3: SEP Policy Reference Forecast. The third step is the SEP Policy Reference forecast, which layers on the expected impacts of the fully implemented '15 by 15' policy.

Figure 1. New York Statewide Electricity Requirement

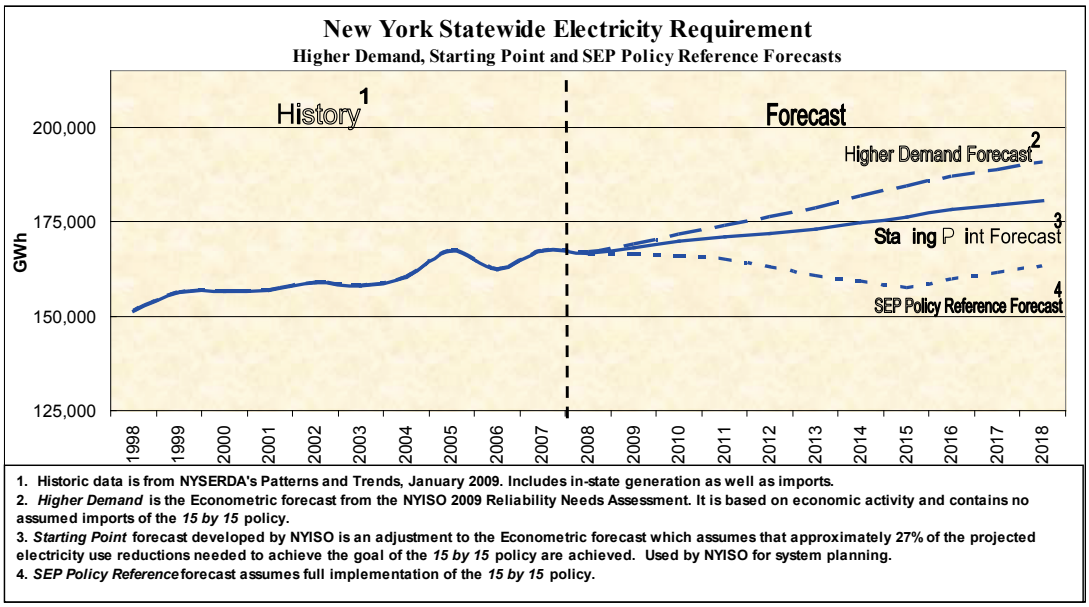


Figure 2 shows projected electricity use in the residential, commercial, and industrial/transportation sectors based on the Higher Demand, Starting Point and SEP Policy Reference forecasts of total system electricity needs. The difference between the total system electricity needs in Figure 1 and the sum of sector-specific needs in Figure 2 is accounted for by system losses at the transmission, substation, and distribution levels. Expected reductions in electricity use due to the '15 by 15' policy are allocated among the various sectors based on historical energy efficiency program results.

Figure 2. New York Electricity Demand by Sector

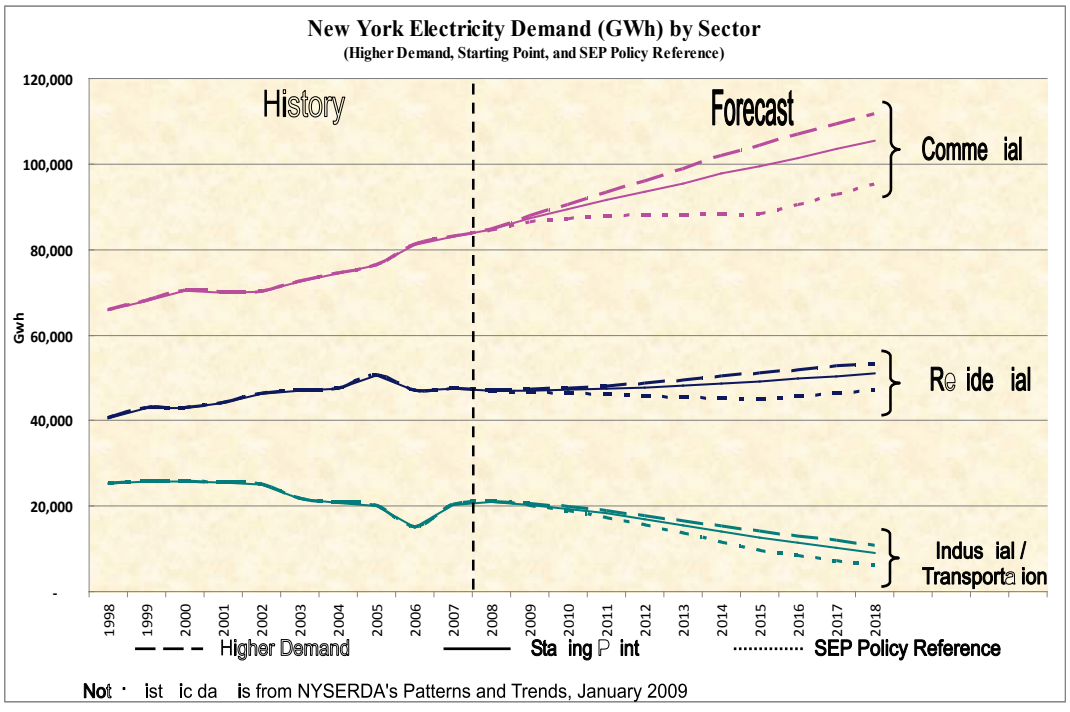


Figure 3 shows demand for each fuel type in the electricity generation sector for the Higher Demand, Starting Point and SEP Policy Reference cases, based on IPM modeling output. The most significant change in energy use in New York's electricity sector, based on each of the three electricity generation cases, is the natural gas demand and the amount of electricity imported into New York. Figure 3 shows the forecasts of total electricity sector energy use as well as fossil fuel demand by fuel type and imports for the Higher Demand, Starting Point, and SEP Policy Reference cases. Annual growth rates and forecast values by fuel type for each of the three cases are also shown in tabular form in Table 1.

Figure 3. Comparison of Fossil Fuel Use and Imports in the Electricity Sector

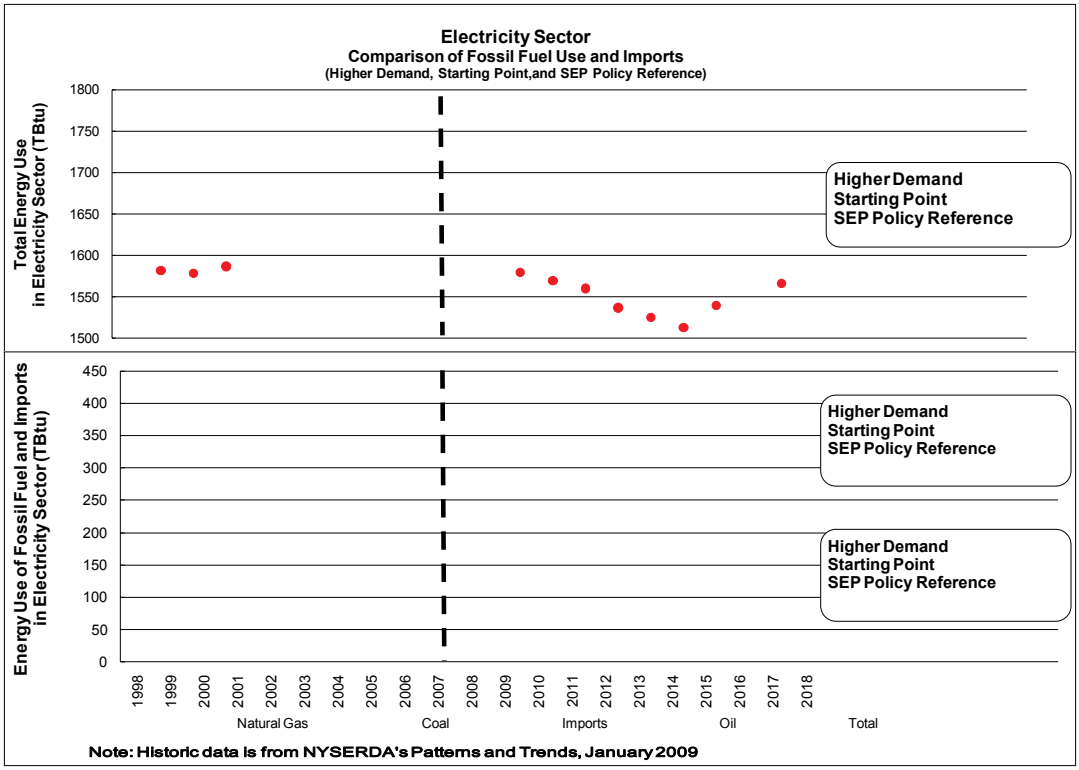


Table 1. New York Electricity Sector Fuel Use for the Higher Demand, Starting Point, and SEP Policy Reference Cases

Electricity Sector Fuel Use in Trillion Btu (Higher Demand Forecast)

Year	Coal	Natural Gas	Petroleum/Other	Imports	Other	Wind	Hydro	Nuclear	Total
2009	204.6	368.0	79.4	145.10	15.0	81.1	275.4	442.4	1610.9
2012	199.0	362.1	51.8	159.60	15.0	131.4	290.0	462.4	1671.1
2015	199.3	376.6	52.5	196.10	15.0	145.3	292.7	462.4	1739.8
2018	198.2	398.9	46.5	195.70	15.0	146.1	292.7	465.7	1758.7
Growth Rate 2009 - 2018	-0.35%	0.90%	-5.76%	3.38%	0.00%	6.75%	0.68%	0.57%	0.98%

Electricity Sector Fuel Use in Trillion Btu (Starting Point Forecast)

Year	Coal	Natural Gas	Petroleum/Other	Imports	Other	Wind	Hydro	Nuclear	Total
2009	205.8	363.4	77.7	142.12	15.0	81.1	286.7	442.4	1614.1
2012	201.0	340.0	46.7	151.43	15.0	127.7	290.0	462.4	1634.1
2015	198.5	337.4	46.0	173.67	15.0	144.9	292.7	462.4	1670.4
2018	198.7	360.8	44.4	183.69	15.0	146.2	292.7	465.7	1707.1
Growth Rate 2009 - 2018	-0.39%	-0.08%	-6.02%	2.89%	0.00%	6.77%	0.23%	0.57%	0.62%

Electricity Sector Fuel Use in Trillion Btu (SEP Policy Reference)

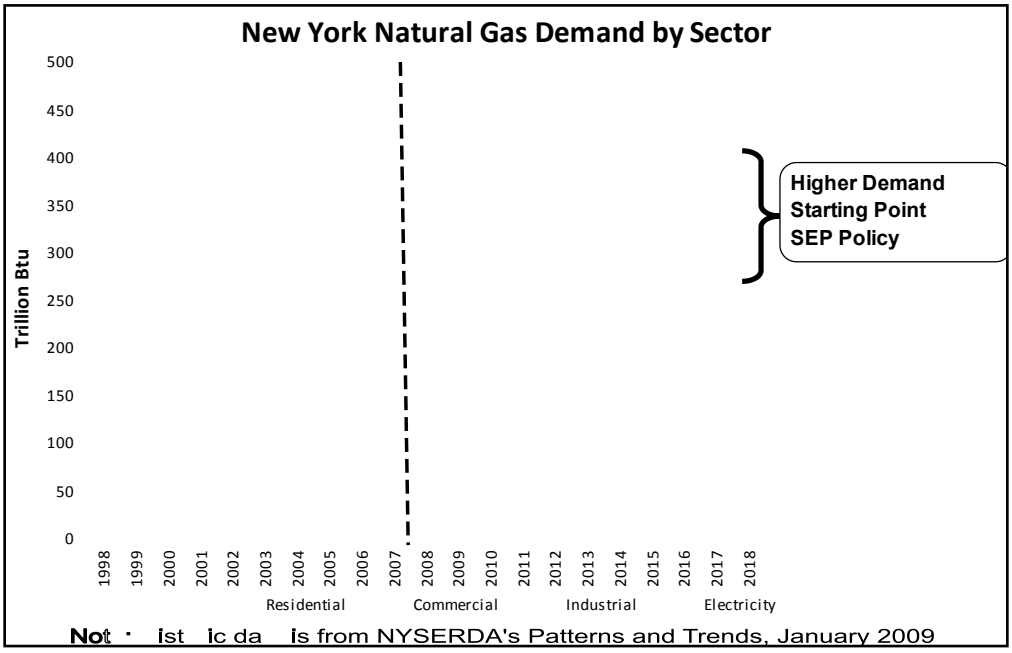
Year	Coal	Natural Gas	Petroleum/Other	Imports	Other	Wind	Hydro	Nuclear	Total
2009	205.8	351.6	74.8	141.70	15.0	81.1	286.7	442.4	1599.1
2012	200.7	298.7	42.5	137.37	15.0	116.5	290.0	460.2	1560.9
2015	198.5	263.9	35.9	103.34	15.0	144.4	292.7	460.2	1513.8
2018	200.2	283.2	36.3	127.94	15.0	145.8	292.7	465.7	1566.8
Growth Rate 2009 - 2018	-0.31%	-2.37%	-7.72%	-1.13%	0.00%	6.73%	0.23%	0.57%	-0.23%

3 Energy Demand Forecast by Fuel Type and Sector

As shown in Figure 4, the different levels of natural gas demand in the electricity sector associated with the Higher Demand, Starting Point, and SEP Policy Reference cases lead to different levels of total natural gas demand in New York. Natural gas demand reference forecasts for the residential, commercial, and industrial sectors are based on growth rates of Mid-Atlantic (New York, New Jersey, and Pennsylvania) natural gas demand for the respective sectors provided by Energy and Environmental Analysis, Inc. (EEA), a subsidiary of ICF Resources International, dated March 2009. EEA uses a Gas Market Data and Forecasting System to track and analyze monthly behavior in the North American natural gas market. Natural gas market data provided by EEA has been widely vetted by a diverse range of stakeholders in various New York policy and regulatory development processes and is widely used by natural gas producers, pipeline companies, utilities, energy providers, and generation unit owners for planning and analysis.

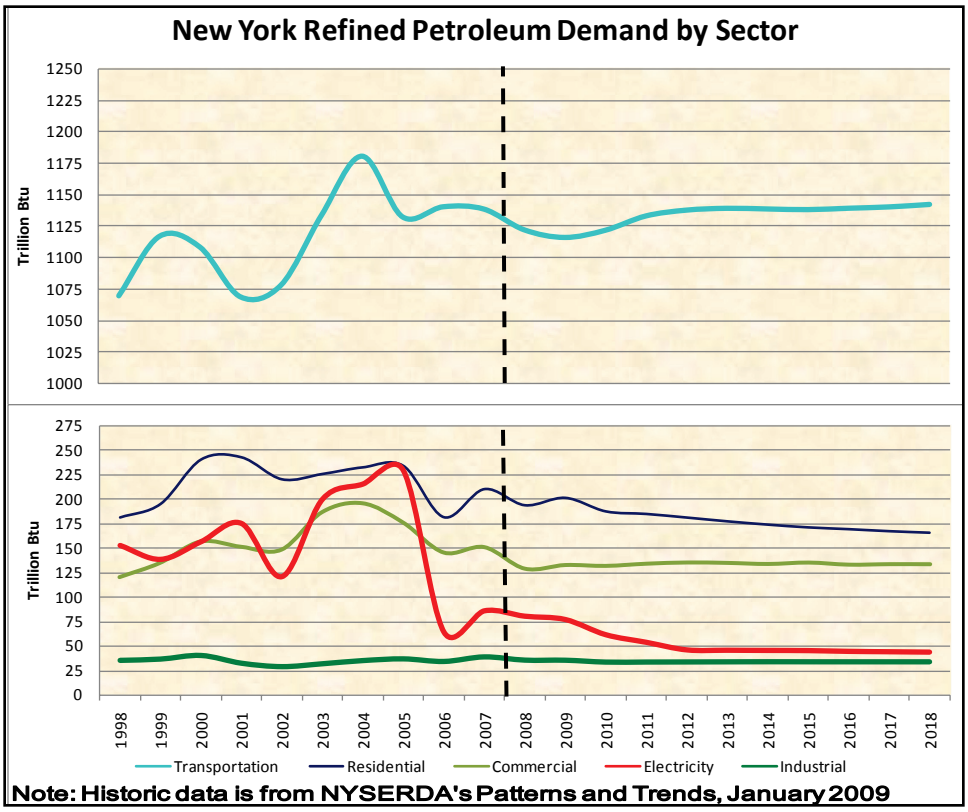
Natural gas use in the residential sector is limited primarily to space heating, water heating, and cooking. Unlike electricity end-use, few new and/or innovative end-uses for natural gas have emerged, and few are envisioned in the future. Thus, changes in natural gas use per household are expected to be primarily a function of the energy efficiency improvements of heating, water heating, and building components as well as changes in population size and housing growth. Because population growth and new housing starts in New York are slowing, natural gas use in the residential sector has an annual growth rate of 0.12 percent between 2009 and 2018. Commercial sector natural gas use is driven by economic growth and construction of new buildings. However, as in the residential sector, much of the growth in gas use due to business expansion is offset by continuing improvements energy efficiency and productivity. Natural gas demand in the commercial sector as shown in Figure 4 grows by 1.25 percent per year over the 10-year planning horizon.

Figure 4. New York Natural Gas Demand by Sector



The petroleum product demand in the electricity sector is only marginally impacted by the choice of the Higher Demand, Starting Point, or SEP Policy Reference case. Thus, the total petroleum demand in New York is virtually the same for each case. Figure 5 shows the total and sector-specific petroleum demand. The petroleum product demand reference forecasts in the residential, commercial, industrial, and transportation sectors are also based on the Mid-Atlantic (New York, New Jersey, and Pennsylvania) growth rates for the respective sectors and were obtained from the U.S. Energy Information Agency (EIA) Annual Energy Outlook (AEO) 2009. EIA uses the National Economic Modeling System (NEMS) to project the energy demand for each of the Mid-Atlantic sectors.

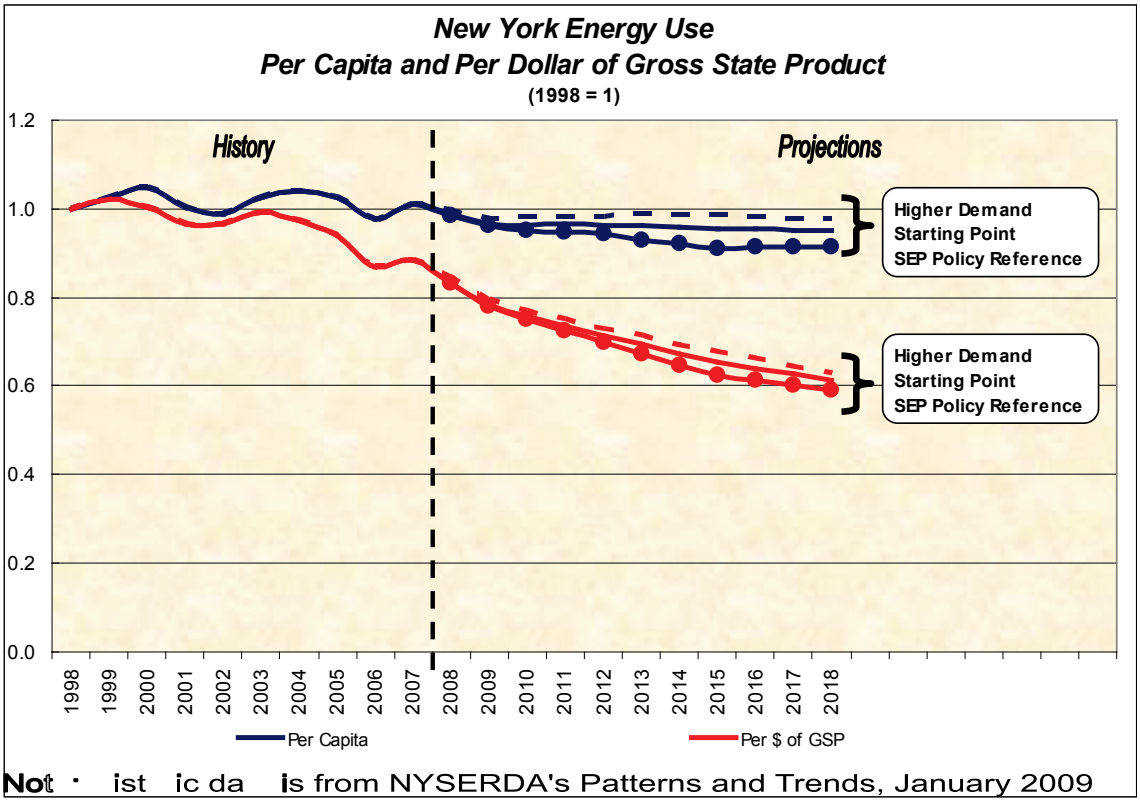
Figure 5. New York Refined Petroleum Demand by Sector



Although the assumptions on which the electricity sector reference cases are based do not significantly impact the total petroleum demand in New York, there are significant assumptions that are implicit in the EIA Mid-Atlantic predictors. The reference forecast developed by EIA contains assumptions about the Energy Independence and Security Act (EISA) of 2007. EISA sets a Corporate Average Fuel Economy (CAFE) target of 35 miles per gallon for the combined fleet of cars and light trucks by model year 2020. Also, a fuel economy program is established for medium- and heavy-duty trucks, and a separate fuel economy standard is created for work trucks. The law also sets a modified renewable fuel standard that starts at 9.0 billion gallons of renewable fuel in 2008 and rises to 36 billion gallons by 2022. Of the latter total, 21 billion gallons is required to be obtained from cellulosic ethanol and other advanced biofuels.

Figure 6 shows aggregate statewide energy use forecasts per capita and per dollar of Gross State Product. The Statewide projections of energy use are shown based on results of the Higher Demand, Starting Point and SEP Policy Reference cases for the electricity sector.

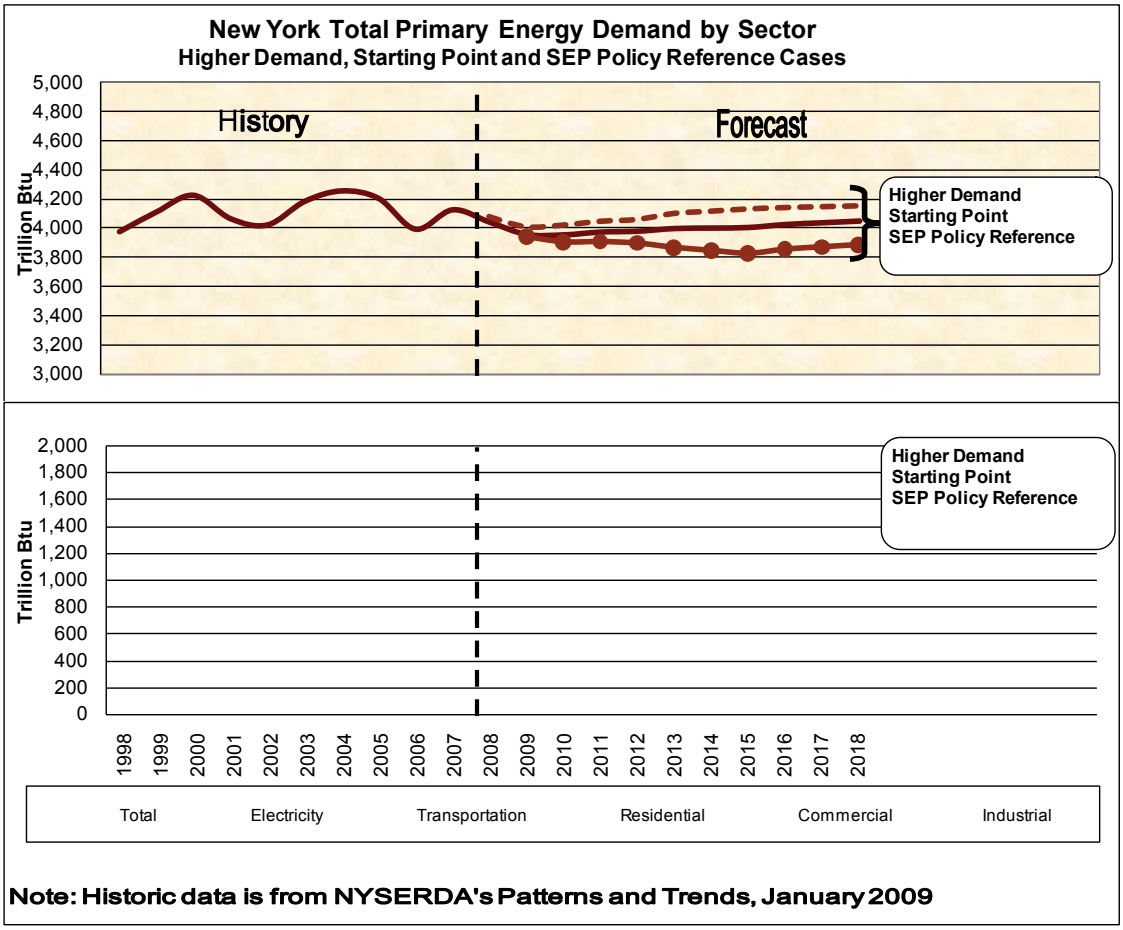
Figure 6. New York Energy Use per Capita and per Dollar of Gross State Product



Aggregate energy use is linked to population growth via increases in housing, commercial floor space, transportation, manufacturing, and services. Since 1998, New York energy use per capita has remained relatively stable. In periods of high energy prices, particularly oil prices, and slow economic growth, energy consumption per capita has been lower compared to periods of low energy prices and high economic growth where energy use tends to be higher. Although there is the expectation that oil prices will remain relatively low over the energy planning horizon (2009 – 2018) compared to its most recent peak, increases in energy efficiency coupled with moderate economic growth are projected to cause lower than normally expected energy use per capita through 2018. The improvements in energy efficiency are a response to the '15 by 15' policy as well as the higher CAFE standards and more stringent lighting standards which contribute to the projected decline in energy use per capita.

Figure 7 shows aggregate statewide forecasts of energy use disaggregated by sector. The statewide projections of energy use across all sectors are shown based on results of the Higher Demand, Starting Point and SEP Policy Reference cases for the electricity sector.

Figure 7. New York Total Primary Energy Demand by Sector



While the projected energy demand data reflect energy policies already implemented and expected with some certainty, anticipated (but highly uncertain) policy proposals, such as a national carbon reduction policy, are not assumed in the reference forecasts. Moreover, broader global issues such political and civil unrest or natural disasters are not assumed in any of the forecasts. It is not possible to measure or quantify such issues within the forecasts using any reasonable modeling technique.

Table 2 shows forecasts of primary energy demand by sector and fuel type for selected years, with annual growth rates for the 2009 to 2018 period. Figure 8 shows aggregate statewide forecasts of energy use disaggregated by fuel type. The projected impact of the SEP Policy Reference case on statewide fuel use, compared to the Starting Point and the Higher Demand cases, is reduced natural gas use and reduced imports of electricity. More detailed discussion of the electricity modeling cases can be found in the Electricity Assessment.

Table 2. New York Total Primary and On-Site Energy Demand by Sector

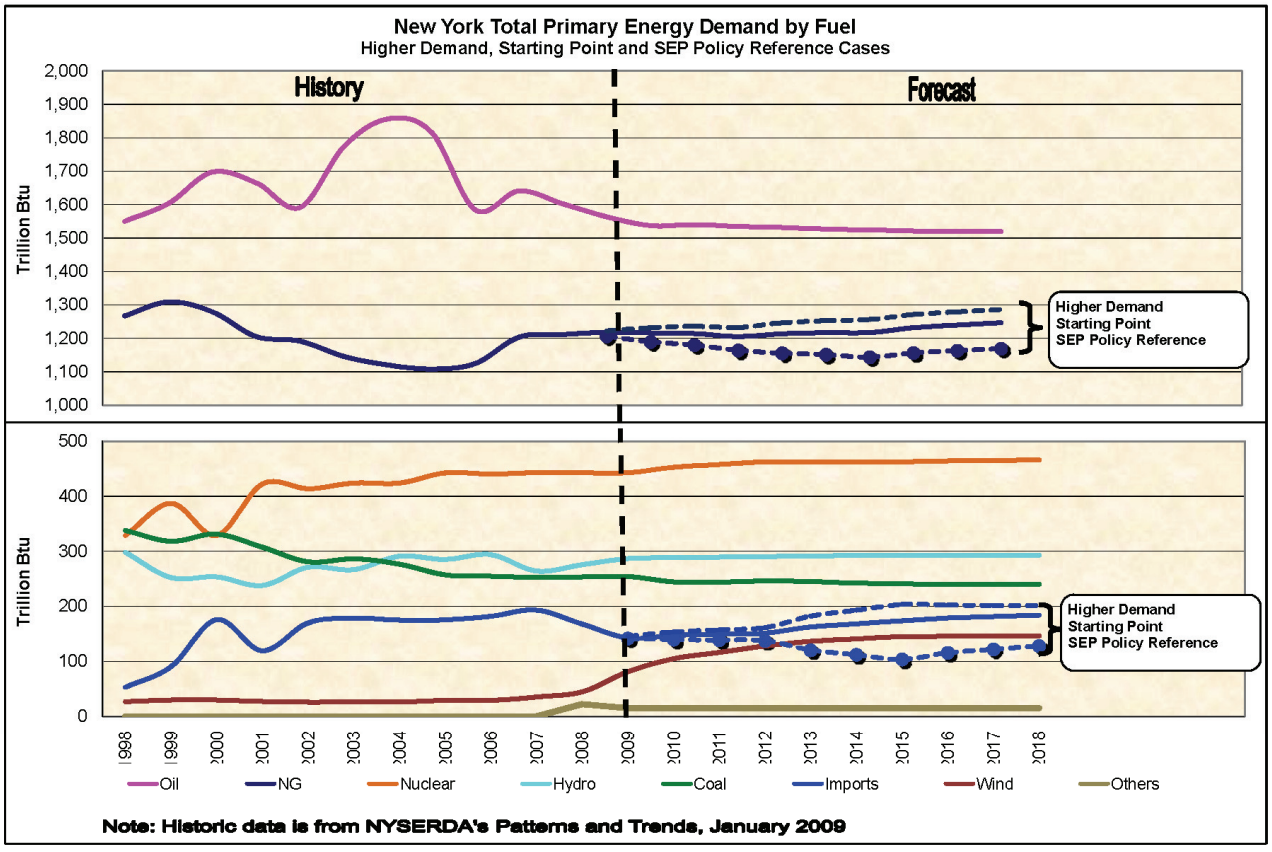
New York Total Primary Energy Demand by Sector in Trillion Btu

Year	Residential	Commercial	Industrial	Transportation	Electricity			Total		
					Higher Demand	Starting Point	Policy-Reference	Higher Demand	w/Starting Point	w/Policy-Reference
2009	625.4	459.7	187.6	1,117.1	1,616.0	1,608.0	1,593.2	4,005.9	3,997.9	3,983.1
2012	609.8	480.4	170.7	1,137.8	1,667.1	1,630.4	1,557.1	4,065.8	4,029.1	3,955.8
2015	600.6	492.8	168.9	1,137.4	1,735.6	1,666.8	1,511.0	4,135.3	4,066.5	3,910.7
2018	594.2	499.3	167.1	1,142.2	1,755.1	1,703.6	1,563.9	4,157.8	4,106.3	3,966.6
Growth Rate 2009 - 2018	-0.57%	0.92%	-1.28%	0.25%	0.92%	0.64%	-0.21%	0.41%	0.30%	-0.05%

On-Site Energy Demand by Sector in Trillion Btu

Year	Residential Sector			Commercial Sector			Industrial Sector			
	Natural Gas	Petroleum/other	Total	Natural Gas	Petroleum/other	Total	Natural Gas	Petroleum/other	Coal	Total
2009	423.9	201.6	625.4	327.0	132.7	459.7	104.0	35.5	48.1	187.6
2012	428.4	181.3	609.8	345.1	135.3	480.4	91.7	33.9	45.1	170.7
2015	429.4	171.2	600.6	357.5	135.2	492.8	92.7	34.1	42.1	168.9
2018	428.4	165.8	594.2	365.7	133.5	499.3	91.7	34.0	41.4	167.1
Growth Rate 2009 - 2018	0.12%	-2.15%	-0.57%	1.25%	0.07%	0.92%	-1.40%	-0.48%	-1.65%	-1.28%

Figure 8. New York Total Primary Energy Demand by Fuel



4 Energy Price Forecasts

4.1 Refined Petroleum, Natural Gas, and Coal Prices

This section discusses the New York refined petroleum product and natural gas price reference forecasts for the residential, commercial, industrial, transportation and electricity sectors. The retail price forecasts are based on their respective commodity prices. The West Texas Intermediate (WTI) light sweet crude oil and Henry Hub (HH) natural gas spot prices are the commodity prices used to forecast all New York refined petroleum product and natural gas prices, respectively. The WTI crude oil spot price based in Cushing Oklahoma is an industry benchmark for commodity oil prices. The HH natural gas spot price is an industry-recognized benchmark price for natural gas east of the Rocky Mountains.[1] The WTI and HH spot prices represent the marginal or last unit of oil and natural gas purchased on the New York Mercantile Exchange where market equilibrium is reached or where supply equals demand.

The commodity prices used to project the retail prices were provided by Energy and Environmental Analysis, Inc. (EEA), dated March 2009. The crude oil commodity price is based on market information about the long-run interaction of global oil supply and demand. The long-run price is largely determined by the cost of bringing new supplies to the market. Potential oil supplies in the model include conventional and unconventional crude oil, bio-fuels, fuels from coal-to-liquids and gas-to-liquids plants, and natural gas liquids. Impacts of global economic activity and population growth rates are also reflected in the forecast model for various regions around the world.

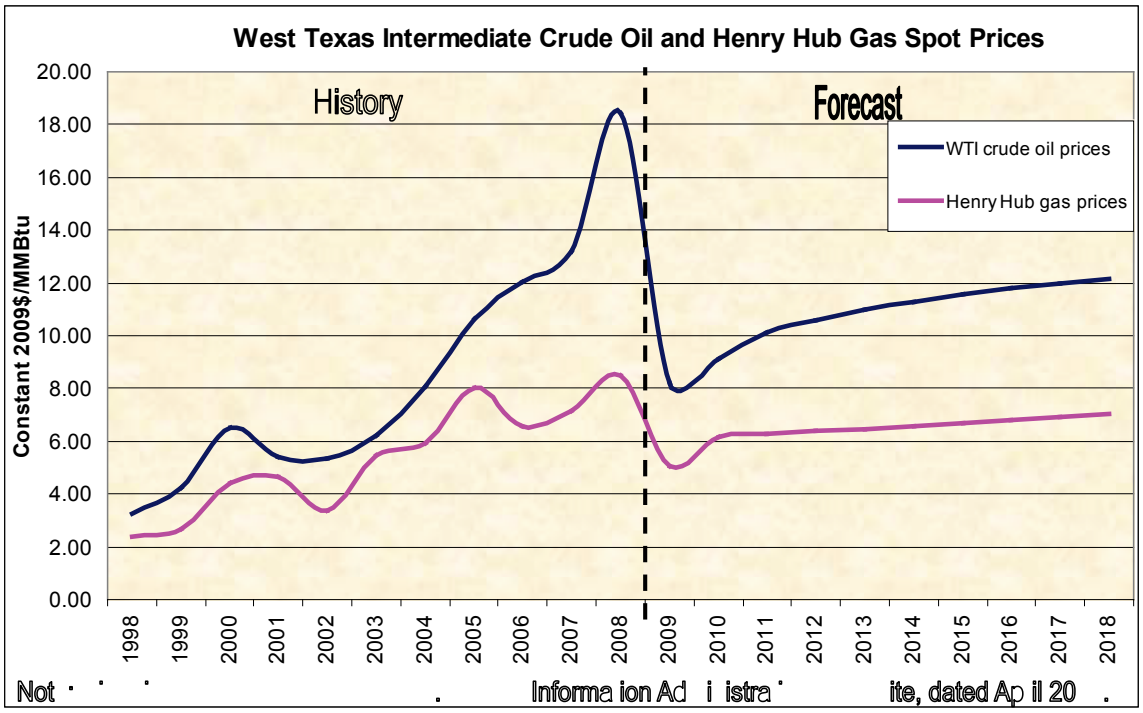
The crude oil commodity price serves as an input into EEA's Gas Market Model (GMM), which provides outputs of various commodity gas prices, such as the Henry Hub gas price. Although the oil price reflects the global market, the natural gas price is primarily based on geographical price points in the national market. The HH gas price in real dollars per MMBtu has historically followed the movement of the WTI oil price in real dollars per barrel with a $7 to $9 WTI oil price to HH gas price ratio. While this ratio is a common rule-of-thumb within the energy industry, the ratio may at times fall outside this range. The forecasts of the WTI oil price and the HH gas price are consistent with this historical relationship.

The spike in the crude oil prices in 2008 reflects the global tightening of supply and demand for crude oil, the rapidly expanding economies of China and India, as well as influences from outside of the market, such as extreme weather patterns, social unrest in certain regions of the world, and perceptions about the economy. While the recent volatility in the markets is captured by a disconnection between the crude oil and natural gas price predictors, it is projected that the commodity prices will remain linked in the long-term as the market moves back into equilibrium. Thus, the drop-off in the oil price over the next year of the forecast is the result of the global recession. Prior to the 2008 drop-off in oil prices, the price of oil was artificially high and the recession corrected that phenomena causing the prices to more accurately reflect the supply and demand interaction in the market. The commodity crude oil spot price forecast provided by EEA was adjusted using real time data from the NYMEX to reflect short-term adjustments to the long-term forecast based on the current economic downturn. Figure 9 shows the natural gas and

[1] Henry Hub is a pipeline hub on the Louisiana Gulf coast.

petroleum commodity price forecasts on which forecasts of retail (end-use) fuel prices in each sector are based.

Figure 9. West Texas Intermediate Crude Oil and Henry Hub Spot Prices



The difference between the WTI oil price and the refined petroleum product prices are the added cost of processing, transportation and distribution. Figure 10 shows the reference forecasts of retail prices of petroleum products relative to the WTI crude oil spot price forecast. Similarly, the difference between a sector end-use price, such as residential natural gas price, and the HH spot price is generally attributed to the cost of transportation and distribution of the natural gas. Figure 11 shows the reference forecasts of retail natural gas prices relative to the HH natural gas spot price forecast.

Figure 10. New York Refined Petroleum Prices and West Texas Intermediate Oil Spot Price

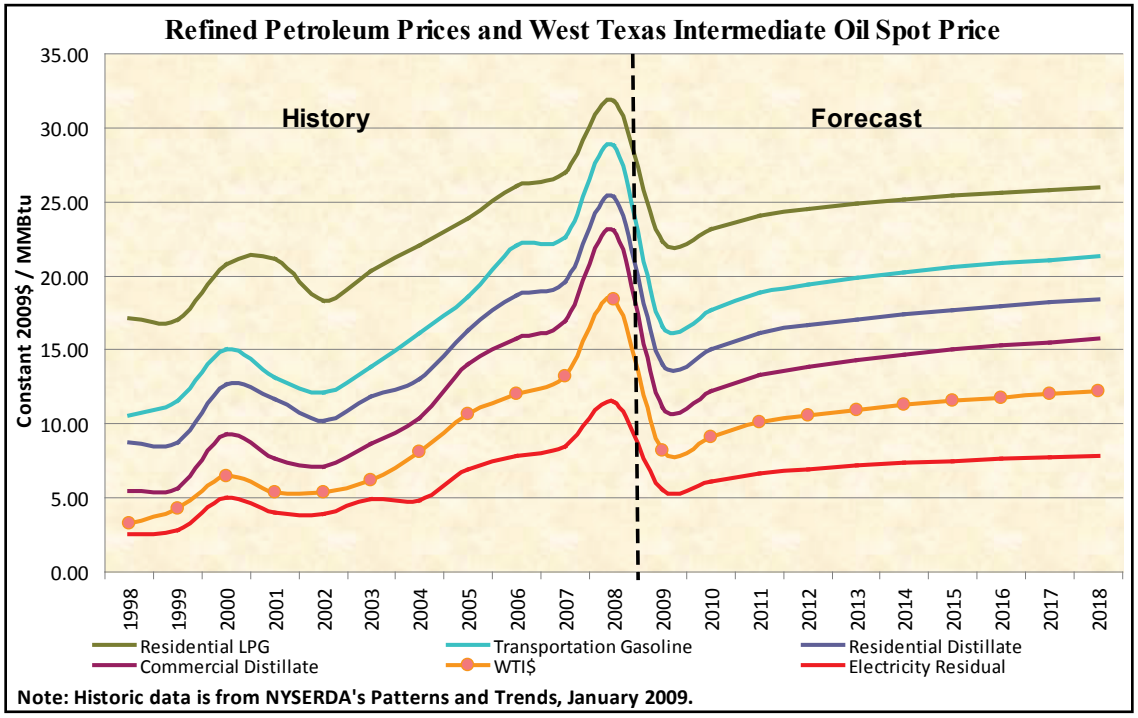
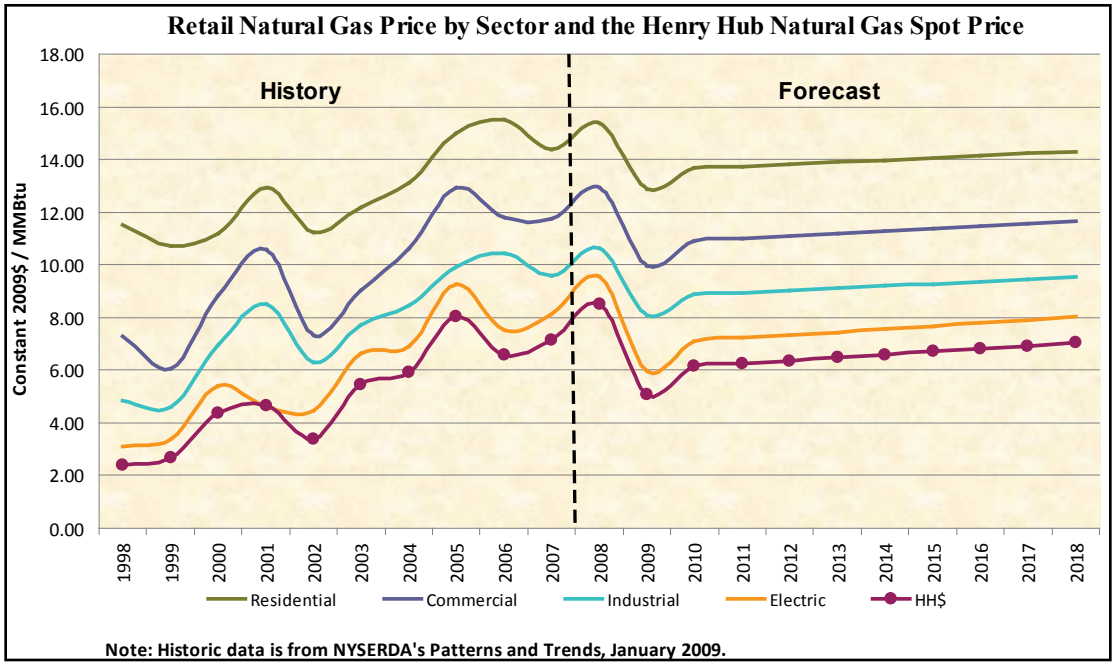


Figure 11. New York Retail Natural Gas Price by Sector and the Henry Hub Gas Spot Price



The weighted average price of coal in the electricity sector is an output of the IPM model used to project fuel use, generation unit utilization, capacity needs, and wholesale electricity prices. The weighted average price of coal is a function of the mix of different types of coal selected on an economic basis to meet generation needs and environmental constraints. Table 3 shows the reference forecasts of coal prices in the electricity sector as well as the HH natural gas and West Texas Intermediate crude oil spot price.

Table 3. Electricity Sector Coal Prices, and WTI and HH Spot Prices (Constant 2009 Dollars)

Year	Electricity Sector Coal Price	Henry Hub Gas Spot Price	WTI Crude Oil Spot Price
2009	2.85	5.08	8.19
2012	2.67	6.37	10.59
2015	2.61	6.70	11.55
2018	2.56	7.03	12.17
Annual Growth Rate	-1.2%	3.7%	4.5%

5 Confidence Intervals and Model Validation

5.1 Confidence Intervals

The confidence intervals represent upper and lower bounds of variation around each reference forecast. Values may occur outside the confidence intervals due to external shocks, such as extreme weather, structural changes to the economic system, geopolitical events, or technology development. The confidence intervals increase in width throughout the forecast period due to the increasing level of uncertainty in each subsequent year. The upper and lower bounds were based on one to two standard deviations of the historic values, indicating at least a 68 percent probability that future values would be expected to fall within the confidence interval. The confidence interval for the first forecast year is based on one standard deviation and grows linearly until it reaches two standard deviations, or a 95 percent probability. Figure 12 shows the upper and lower bounds for the residential fuel oil and natural gas demand. Figure 13 and Figure 14 show the upper and lower bounds for residential natural gas and fuel oil prices.

Figure 12. New York Residential Fuel Oil and Natural Gas Demand

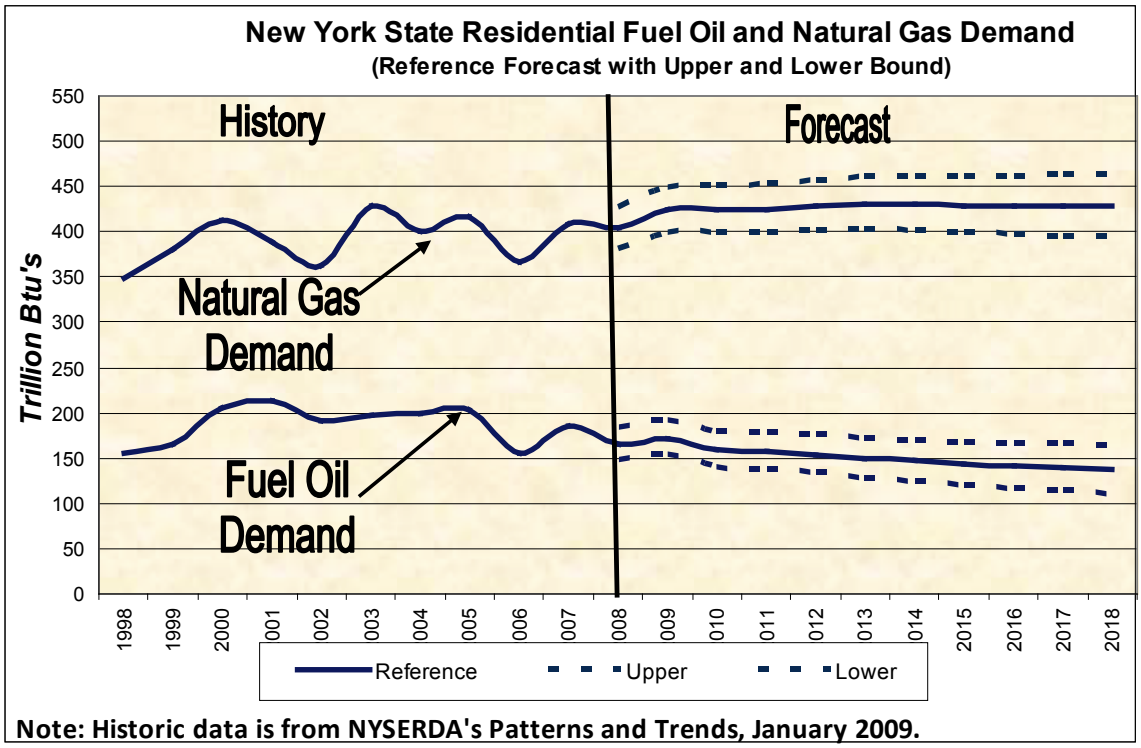


Figure 13. New York Residential Natural Gas Prices

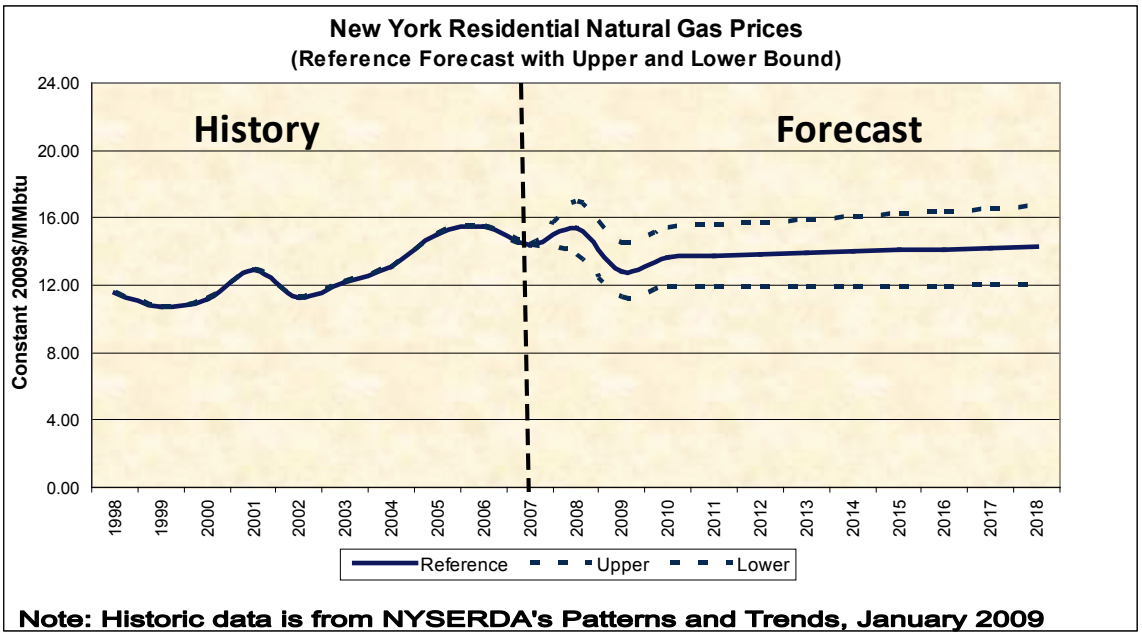
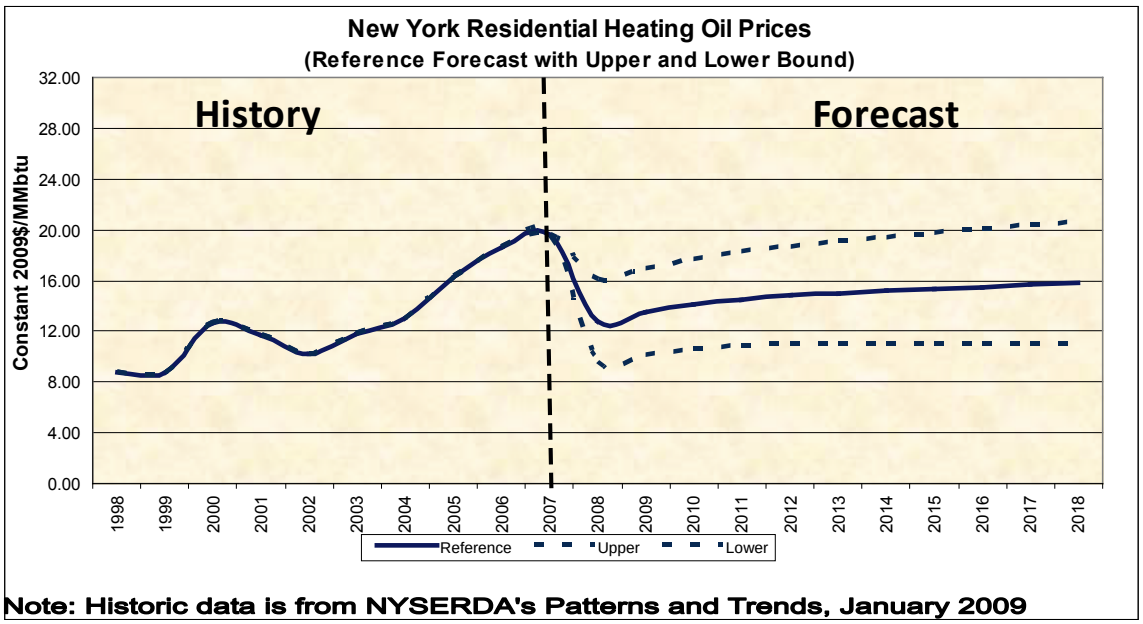


Figure 14. New York Residential Heating Oil Prices



5.2 Model Validation

Model evaluation or *backcast* analysis is accomplished via analysis of the prediction error or the difference between the predicted and actual values. The more tightly the predicted values match the actual, the better the model "fits" the data or the greater the likelihood that the model is sufficiently specified and most variation has been statistically explained. The mean absolute estimated error (MAE) and mean absolute percent estimated error (MAPE) are standard methods of evaluation. An acceptable percentage of estimated error for any given year is approximately five percent; however, three percent or less is preferred. Model fit is also assessed using the adjusted r-squared. To illustrate, Figure 15 and Figure 16 demonstrate the model fit for residential natural gas demand and prices, respectively.

Figure 15. Backcast Analysis of New York Residential Natural Gas Demand

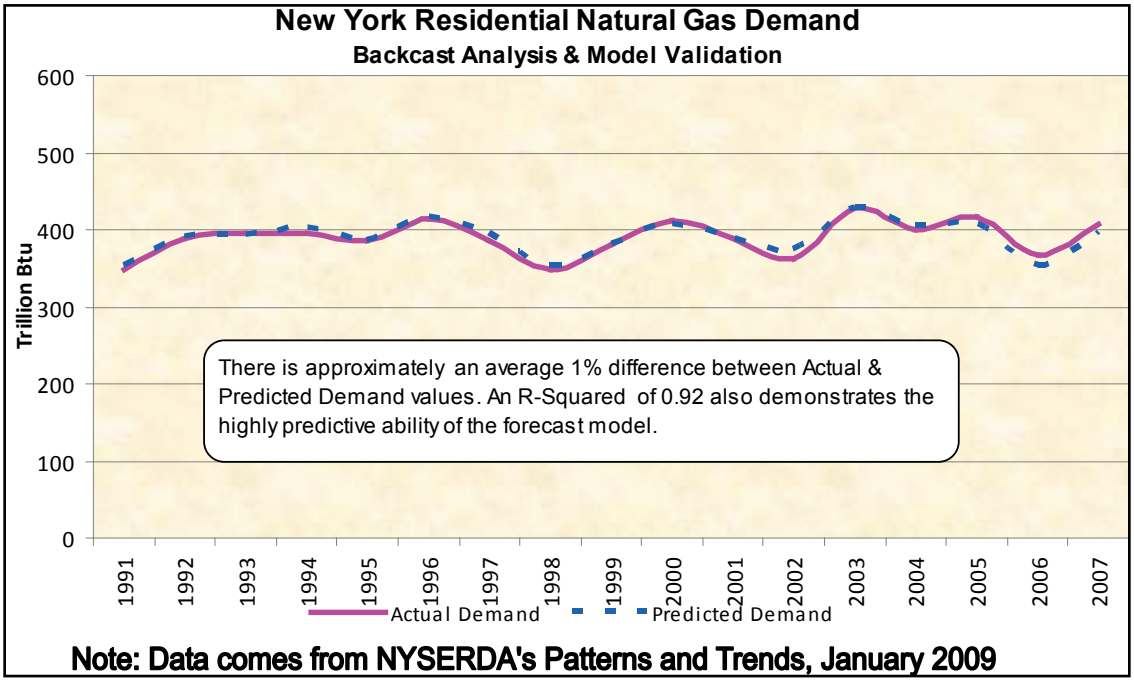


Figure 16. Backcast Analysis of New York Residential Natural Gas Price